Universidad del Caribe

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CONOCIMIENTO Y CULTURA PARA EL DESARROLLO HUMANO

INVESTIGACIÓN/ REPORTE/ RESUMEN:

Galera 4 Clúster con MariaDB en Linux

ASIGNATURA:

Cómputo de alto desempeño

ESTUDIANTE:

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PROGRAMA EDUCATIVO:

Ingeniería en Datos e Inteligencia Organizacional

PRESENTADO A:

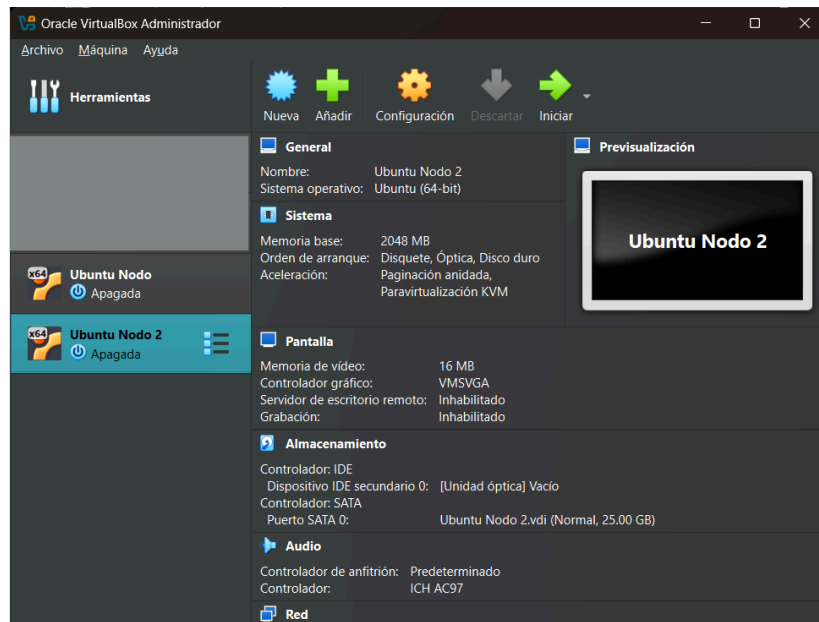## Prof. Ismael Jiménez Sánchez

Cancún, Quintana Roo   **Feb 19, 2025**

En este reporte se documenta el proceso de instalación y configuración de un clúster Galera 4 con MariaDB en Ubuntu Server. Se implementó un clúster inicial de dos nodos, y posteriormente tres nodos, validando la replicación de datos y realizando pruebas de rendimiento mediante benchmark.

Preparación del entorno

- Descargar Ubuntu Server 24.04 ISO.
- Crear una máquina virtual con 1 CPU, 2GB de RAM y 20GB de disco.
- OpenSSH para la administración remota mediante el Shell de Windows.
- Configurar red en "Adaptador puente" para IPs fijas.
- Apagar la MV y clonarla (modo completo) para el segundo nodo.

Instalación de MariaDB y Galera 4

Se actualizó el sistema y se instalaron los paquetes necesarios en ambos nodos:

```
apt update && apt upgrade -y
apt install mariadb-server mariadb-client galera-4 -y
apt install galera-arbitrator-4 -y
apt install mariadb-client libmariadb3 -y
```

```
root@nodo2:/home/iheras# history
    1  clear
    2  apt update && apt upgrade -y
    3  apt install net-tools && apt install software-properties-common && apt install mariadb-server mariadb-client gale
ra-4 && apt install galera-arbitrator-4 && apt -y install mariadb-client libmariadb3 -y
```

Configuración del clúster Galera

Se configuró el archivo `/etc/mysql/mariadb.conf.d/60-galera.cnf` en ambos
nodos con los siguientes parámetros:

```
[mysqld]
binlog_format=ROW
default-storage-engine=innodb
innodb_autoinc_lock_mode=2
bind-address=0.0.0.0

# Galera Provider Configuration
wsrep_on=ON
wsrep_provider=/usr/lib/galera/libgalera_smm.so

# Galera Cluster Configuration
wsrep_cluster_name="test_cluster"
wsrep_cluster_address="gcomm://192.168.0.26,192.168.0.27"

# Galera Synchronization Configuration
wsrep_sst_method=rsync

# Galera Node Configuration
wsrep_node_address="192.168.0.X" # IP del nodo actual
wsrep_node_name="nodoX" # Nodo actual
```

```
root@nodo1:/home/iheras# cat /etc/mysql/mariadb.conf.d/60-galera.cnf
[mysqld]
binlog_format=ROW
default-storage-engine=innodb
innodb_autoinc_lock_mode=2
bind-address=0.0.0.0

# Galera Provider Configuration
wsrep_on=ON
wsrep_provider=/usr/lib/galera/libgalera_smm.so

# Galera Cluster Configuration
wsrep_cluster_name="test_cluster"
wsrep_cluster_address="gcomm://192.168.0.26,192.168.0.27"

# Galera Synchronization Configuration
wsrep_sst_method=rsync

# Galera Node Configuration
wsrep_node_address="192.168.0.26"
wsrep_node_name="nodo1"
```

```
root@nodo2:/home/iheras# cat /etc/mysql/mariadb.conf.d/60-galera.cnf
[mysqld]
binlog_format=ROW
default-storage-engine=innodb
innodb_autoinc_lock_mode=2
bind-address=0.0.0.0

# Galera Provider Configuration
wsrep_on=ON
wsrep_provider=/usr/lib/galera/libgalera_smm.so

# Galera Cluster Configuration
wsrep_cluster_name="test_cluster"
wsrep_cluster_address="gcomm://192.168.0.26,192.168.0.27"

# Galera Synchronization Configuration
wsrep_sst_method=rsync

# Galera Node Configuration
wsrep_node_address="192.168.0.27"
wsrep_node_name="nodo2"
```

Inicio del clúster

Se inició el clúster en el primer nodo:

```
galera_new_cluster
```

En el segundo nodo solo iniciamos MariaDB:

```
systemctl restart mariadb
```

Se verificó el estado del clúster en ambos nodos con:

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

```
root@nodo1:/home/iheras# mysql -u root -p -e "SHOW STATUS LIKE 'wsrep_cluster_size';"
Enter password:
+--------------------+-------+
| Variable_name      | Value |
+--------------------+-------+
| wsrep_cluster_size | 2     |
+--------------------+-------+
root@nodo2:/home/iheras# mysql -u root -p -e "SHOW STATUS LIKE 'wsrep_cluster_size';"
Enter password:
+--------------------+-------+
| Variable_name      | Value |
+--------------------+-------+
| wsrep_cluster_size | 2     |
+--------------------+-------+
```

Crear y validar la replicación de datos

En el Nodo 1 creamos una base de datos de prueba:
```
mysql -u root -p -e "create database sbtest"
```

```
root@nodo1:/home/iheras# mysql -u root -p -e "create database sbtest"
Enter password:
root@nodo1:/home/iheras#
```

Verificamos en el Nodo 2 la replicación:
```
mysql -u root -p -e "SHOW DATABASES;"
```

```
root@nodo2:/home/iheras# mysql -u root -p -e "SHOW DATABASES;"
Enter password:
+--------------------+
| Database           |
+--------------------+
| information_schema |
| mysql              |
| performance_schema |
| sbtest             |
| sys                |
+--------------------+
```

Benchmark de la base de datos

Se instaló sysbench en el Nodo 1:
```
apt install sysbench -y
```

Preparamos los datos sobre los que se realizaron las pruebas:

```
sysbench  --threads=1 --db-driver=mysql --mysql-user=root --events=0
oltp_read_only prepare
```

```
root@nodo1:/home/iheras# sysbench  --threads=1 --db-driver=mysql --mysql-user=root --events=0 oltp_read_only prepare
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Creating table 'sbtest1'...
Inserting 10000 records into 'sbtest1'
Creating a secondary index on 'sbtest1'...
```

Ejecutamos la prueba de rendimiento:

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

```
root@nodo1: /home/iheras    X    root@nodo2: /home/iheras    X    +    v

top - 20:38:17 up  1:32,  3 users,  load average: 1.21, 1.16, 0.60
Tasks: 171 total,   2 running, 168 sleeping,   1 stopped,   0 zombie
%Cpu(s):  9.7 us,  6.8 sy,  0.0 ni,  0.0 id,  0.0 wa,  0.0 hi, 83.5 si,  0.0 st
MiB Mem :   1968.2 total,    170.8 free,    592.6 used,   1385.9 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1375.6 avail Mem

root@nodo1: /home/iheras    X    +    v

root@nodo1:/home/iheras# 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:                            90958
        write:                           0
        other:                           12994
        total:                           103952
    transactions:                        6497    (108.25 per sec.)
    queries:                             103952 (1732.07 per sec.)
    ignored errors:                      0       (0.00 per sec.)
    reconnects:                          0       (0.00 per sec.)

General statistics:
    total time:                          60.0123s
    total number of events:              6497

Latency (ms):
         min:                                      1.07
         avg:                                      9.21
         max:                                     99.99
         95th percentile:                         19.29
         sum:                                  59865.46

Threads fairness:
    events (avg/stddev):           6497.0000/0.00
    execution time (avg/stddev):   59.8655/0.00
```

Notas: Para la prueba `otlp_read_only` se usó el 9.7% del CPU. El total de transacciones fue de 6,497 con 108.25 por segundo y una latencia promedio de 9.21 ms.

Una vez realizada la prueba se eliminaron los datos de prueba:

`sysbench  --threads=1 --db-driver=mysql --mysql-user=root --events=0 oltp_read_only cleanup`

```
root@nodo1:/home/iheras# sysbench  --threads=1 --db-driver=mysql --mysql-user=root --events=0 oltp_read_only cleanup
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Dropping table 'sbtest1'...
```

Se lanzó una prueba de cada set de pruebas en sysbench utilizando un core y los pasos de la prueba anterior. A continuación se muestran los resultados de cada una:

bulk_insert

```
top - 21:00:58 up  1:55,  3 users,  load average: 0.72, 0.22, 0.21
Tasks: 118 total,   2 running, 115 sleeping,   1 stopped,   0 zombie
%Cpu(s): 12.0 us,  9.8 sy,  0.0 ni,  1.6 id,  0.0 wa,  0.0 hi, 76.5 si,  0.0 st
MiB Mem :   1968.2 total,    157.3 free,    605.3 used,   1386.7 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1362.9 avail Mem
```

```
root@nodo1:/home/iheras# sysbench  --threads=1 --db-driver=mysql --mysql-user=root --events=0 bulk_insert prepare
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Creating table 'sbtest1'...
root@nodo1:/home/iheras# sysbench  --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 bulk_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:                           33
        other:                           0
        total:                           33
    transactions:                        1055467 (17465.40 per sec.)
    queries:                             33     (0.55 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.4278s
    total number of events:              1055467

Latency (ms):
        min:                                    0.00
        avg:                                    0.06
        max:                                 3211.73
        95th percentile:                        0.00
        sum:                                58889.91

Threads fairness:
    events (avg/stddev):           1055467.0000/0.00
    execution time (avg/stddev):   58.8899/0.00
```

Notas: Para la prueba `bulk_insert` se usó el 12% del CPU. El total de transacciones fue de 1,055,467 con 17,465.40 por segundo y una latencia promedio de 0.06 ms.

oltp_delete

```
root@nodo1: /home/iheras    ×    root@nodo2: /home/iheras    ×    +    ∨

top - 21:11:23 up  2:05,  3 users,  load average: 1.08, 0.41, 0.26
Tasks: 117 total,   2 running, 114 sleeping,   1 stopped,   0 zombie
%Cpu(s):  3.4 us, 34.5 sy,  0.0 ni,  3.9 id,  1.0 wa,  0.0 hi, 57.3 si,  0.0 st
MiB Mem :   1968.2 total,    151.8 free,    611.4 used,   1386.1 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1356.8 avail Mem
```

```
root@nodo1: /home/iheras    ×    +    ∨

root@nodo1:/home/iheras# 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:                           1832
        other:                           55212
        total:                           57044
    transactions:                        57044  (950.61 per sec.)
    queries:                             57044  (950.61 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0032s
    total number of events:              57044

Latency (ms):
        min:                                    0.01
        avg:                                    1.05
        max:                                  105.13
        95th percentile:                        2.03
        sum:                                59700.92

Threads fairness:
    events (avg/stddev):           57044.0000/0.00
    execution time (avg/stddev):   59.7009/0.00
```

Notas: Para la prueba `oltp_delete` se usó el 3.4% del CPU. El total de transacciones fue de 57,044 con 950.61 por segundo y una latencia promedio de 1.05 ms.

oltp_insert

```
top - 21:15:55 up  2:10,  3 users,  load average: 1.03, 0.52, 0.33
Tasks: 116 total,   1 running, 114 sleeping,   1 stopped,   0 zombie
%Cpu(s):  0.8 us, 33.1 sy,  0.0 ni, 12.7 id,  1.3 wa,  0.0 hi, 52.1 si,  0.0 st
MiB Mem :   1968.2 total,    150.0 free,    612.9 used,   1386.4 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1355.3 avail Mem
```

```
root@nodo1:/home/iheras# 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:                           2584
        other:                           0
        total:                           2584
    transactions:                        2584   (43.05 per sec.)
    queries:                             2584   (43.05 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0136s
    total number of events:              2584

Latency (ms):
        min:                                    4.34
        avg:                                   23.21
        max:                                  146.01
        95th percentile:                       33.72
        sum:                                59967.80

Threads fairness:
    events (avg/stddev):           2584.0000/0.00
    execution time (avg/stddev):   59.9678/0.00
```

Notas: Para la prueba `oltp_insert` se usó el 0.8% del CPU. El total de transacciones fue de 2,584 con 43.05 por segundo y una latencia promedio de 23.21 ms.

oltp_point_select

```
top - 21:40:15 up  2:34,  3 users,  load average: 1.06, 0.41, 0.24
Tasks: 116 total,   1 running, 114 sleeping,   1 stopped,   0 zombie
%Cpu(s): 13.4 us,  7.8 sy,  0.0 ni,  0.0 id,  0.0 wa,  0.0 hi, 78.8 si,  0.0 st
MiB Mem :   1968.2 total,    145.2 free,    617.3 used,   1386.8 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1350.9 avail Mem
```

```
root@nodo1:/home/iheras# 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:                            131121
        write:                           0
        other:                           0
        total:                           131121
    transactions:                        131121 (2185.02 per sec.)
    queries:                             131121 (2185.02 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:              131121

Latency (ms):
        min:                                     0.02
        avg:                                     0.45
        max:                                     58.03
        95th percentile:                         0.59
        sum:                                     59326.18

Threads fairness:
    events (avg/stddev):           131121.0000/0.00
    execution time (avg/stddev):   59.3262/0.00
```

Notas: Para la prueba `oltp_point_select` se usó el 13.4% del CPU. El total de transacciones fue de 131,121 con 2,185.02 por segundo y una latencia promedio de 0.45 ms.

oltp_read_write

```
 root@nodo1: /home/iheras     X      root@nodo2: /home/iheras     X   +   ∨

top - 21:50:16 up  2:44,  3 users,  load average: 0.51, 0.26, 0.21
Tasks: 115 total,   1 running, 113 sleeping,   1 stopped,   0 zombie
%Cpu(s):  4.8 us, 44.3 sy,  0.0 ni,  1.0 id,  1.0 wa,  0.0 hi, 49.0 si,  0.0 st
MiB Mem :   1968.2 total,    144.8 free,    617.5 used,   1387.0 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1350.7 avail Mem

 root@nodo1: /home/iheras     X    +   ∨

root@nodo1:/home/iheras# 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:                            26866
        write:                           6895
        other:                           4619
        total:                           38380
    transactions:                        1919    (31.97 per sec.)
    queries:                             38380   (639.32 per sec.)
    ignored errors:                      0       (0.00 per sec.)
    reconnects:                          0       (0.00 per sec.)

General statistics:
    total time:                          60.0171s
    total number of events:              1919

Latency (ms):
        min:                                    3.30
        avg:                                   31.26
        max:                                  139.81
        95th percentile:                       48.34
        sum:                                59990.65

Threads fairness:
    events (avg/stddev):           1919.0000/0.00
    execution time (avg/stddev):   59.9907/0.00
```

Notas: Para la prueba `oltp_read_write` se usó el 4.8% del CPU. El total de transacciones fue de 1,919 con 31.97 por segundo y una latencia promedio de 31.26 ms.

oltp_update_index

```
top - 21:55:57 up  2:50,  3 users,  load average: 0.63, 0.35, 0.26
Tasks: 115 total,   1 running, 113 sleeping,   1 stopped,   0 zombie
%Cpu(s):  0.9 us, 32.6 sy,  0.0 ni, 11.6 id,  1.3 wa,  0.0 hi, 53.6 si,  0.0 st
MiB Mem :   1968.2 total,    140.6 free,    621.4 used,   1387.3 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1346.8 avail Mem
```

```
root@nodo1:/home/iheras# 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:                           2451
        other:                           2431
        total:                           4882
    transactions:                        4882   (81.34 per sec.)
    queries:                             4882   (81.34 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0142s
    total number of events:              4882

Latency (ms):
        min:                                    0.06
        avg:                                   12.28
        max:                                  153.87
        95th percentile:                       31.37
        sum:                                59973.98

Threads fairness:
    events (avg/stddev):           4882.0000/0.00
    execution time (avg/stddev):   59.9740/0.00
```

Notas: Para la prueba `oltp_update_index` se usó el 0.9% del CPU. El total de transacciones fue de 4,882 con 81.34 por segundo y una latencia promedio de 12.28 ms.

oltp_update_non_index

```
top - 21:59:14 up  2:53,  3 users,  load average: 0.91, 0.46, 0.31
Tasks: 116 total,   2 running, 113 sleeping,   1 stopped,   0 zombie
%Cpu(s):  0.8 us, 33.5 sy,  0.0 ni, 10.6 id,  2.1 wa,  0.0 hi, 53.0 si,  0.0 st
MiB Mem :   1968.2 total,    140.1 free,    621.6 used,   1387.6 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1346.6 avail Mem
```

```
root@nodo1:/home/iheras# 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:                           2571
        other:                           2608
        total:                           5179
    transactions:                        5179    (86.28 per sec.)
    queries:                             5179    (86.28 per sec.)
    ignored errors:                      0       (0.00 per sec.)
    reconnects:                          0       (0.00 per sec.)

General statistics:
    total time:                          60.0250s
    total number of events:              5179

Latency (ms):
        min:                                    0.06
        avg:                                   11.58
        max:                                   82.79
        95th percentile:                       29.72
        sum:                                59991.83

Threads fairness:
    events (avg/stddev):           5179.0000/0.00
    execution time (avg/stddev):   59.9918/0.00
```

Notas: Para la prueba `oltp_update_non_index` se usó el 0.8% del CPU. El total de transacciones fue de 5,179 con 86.28 por segundo y una latencia promedio de 11.58 ms.

oltp_write_only

```
 root@nodo1: /home/iheras    ×     root@nodo2: /home/iheras    ×    +    ∨
top - 22:18:02 up  3:12,  3 users,  load average: 0.49, 0.17, 0.16
Tasks: 117 total,   2 running, 114 sleeping,   1 stopped,   0 zombie
%Cpu(s):  0.9 us, 33.5 sy,  0.0 ni,  9.9 id,  1.3 wa,  0.0 hi, 54.5 si,  0.0 st
MiB Mem :   1968.2 total,    135.1 free,    626.3 used,   1387.9 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1341.9 avail Mem
```

```
 root@nodo1: /home/iheras    ×    +    ∨
root@nodo1:/home/iheras# 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:                           8822
        other:                           5800
        total:                           14622
    transactions:                        2437     (40.60 per sec.)
    queries:                             14622    (243.61 per sec.)
    ignored errors:                      0        (0.00 per sec.)
    reconnects:                          0        (0.00 per sec.)


General statistics:
    total time:                          60.0197s
    total number of events:              2437

Latency (ms):
        min:                                     4.81
        avg:                                    24.62
        max:                                    88.33
        95th percentile:                        36.89
        sum:                                 59991.67

Threads fairness:
    events (avg/stddev):         2437.0000/0.00
    execution time (avg/stddev):   59.9917/0.00
```

Notas: Para la prueba `oltp_write_only` se usó el 0.9% del CPU. El total de transacciones fue de 2,437 con 40.60 por segundo y una latencia promedio de 24.62 ms.

select_random_points

```
root@nodo1: /home/iheras      ×    root@nodo2: /home/iheras      ×    +  ∨

top - 22:24:38 up  3:18,  3 users,  load average: 0.60, 0.36, 0.24
Tasks: 115 total,   2 running, 112 sleeping,   1 stopped,   0 zombie
%Cpu(s): 12.8 us,  4.1 sy,  0.0 ni,  0.0 id,  0.0 wa,  0.0 hi, 83.1 si,  0.0 st
MiB Mem :   1968.2 total,    134.6 free,    626.6 used,   1388.1 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1341.7 avail Mem
```

```
root@nodo1: /home/iheras      ×    +  ∨

root@nodo1:/home/iheras# 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:                            5919
        write:                           0
        other:                           0
        total:                           5919
    transactions:                        5919   (98.60 per sec.)
    queries:                             5919   (98.60 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0118s
    total number of events:              5919

Latency (ms):
        min:                                    0.80
        avg:                                   10.12
        max:                                  126.00
        95th percentile:                       20.74
        sum:                                59876.62

Threads fairness:
    events (avg/stddev):           5919.0000/0.00
    execution time (avg/stddev):   59.8766/0.00
```
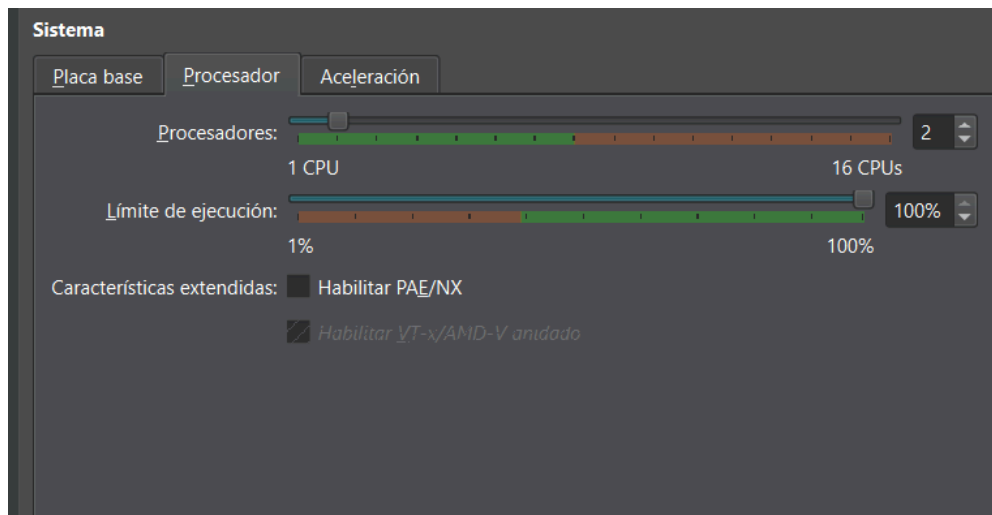
Notas: Para la prueba `select_random_points` se usó el 12.8% del CPU. El total de transacciones fue de 5,919 con 98.60 por segundo y una latencia promedio de 10.12 ms.

select_random_ranges

```
top - 22:28:52 up  3:22,  3 users,  load average: 0.42, 0.34, 0.27
Tasks: 115 total,   2 running, 112 sleeping,   1 stopped,   0 zombie
%Cpu(s): 13.7 us,  3.4 sy,  0.0 ni,  0.0 id,  0.0 wa,  0.0 hi, 82.9 si,  0.0 st
MiB Mem :   1968.2 total,    134.2 free,    626.8 used,   1388.2 buff/cache
MiB Swap:   2048.0 total,   2047.7 free,      0.3 used.   1341.4 avail Mem
```

```
root@nodo1:/home/iheras# 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:                            6642
        write:                           0
        other:                           0
        total:                           6642
    transactions:                        6642   (110.66 per sec.)
    queries:                             6642   (110.66 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0034s
    total number of events:              6642

Latency (ms):
        min:                                    0.56
        avg:                                    9.01
        max:                                    138.84
        95th percentile:                        19.29
        sum:                                    59872.53

Threads fairness:
    events (avg/stddev):          6642.0000/0.00
    execution time (avg/stddev):  59.8725/0.00
```

Notas: Para la prueba `select_random_ranges` se usó el 13.7% del CPU. El total de transacciones fue de 6,642 con 110.66 por segundo y una latencia promedio de 9.01 ms.

Pruebas con 2 cores

Se realizaron las mismas pruebas de sysbench pero ahora con dos cores en ambos nodos.

bulk_insert

```
SQL statistics:
    queries performed:
        read:                            0
        write:                           49
        other:                           0
        total:                           49
    transactions:                        1521467 (25185.83 per sec.)
    queries:                             49      (0.81 per sec.)
    ignored errors:                      0       (0.00 per sec.)
    reconnects:                          0       (0.00 per sec.)

General statistics:
    total time:                          60.4059s
    total number of events:              1521467

Latency (ms):
        min:                                     0.00
        avg:                                     0.04
        max:                                     4086.52
        95th percentile:                         0.00
        sum:                                     58813.96

Threads fairness:
    events (avg/stddev):         1521467.0000/0.00
    execution time (avg/stddev):  58.8140/0.00
```

Notas: Para la prueba `bulk_insert` se usó el 39.3% del primer CPU y 7.1% del segundo. El total de transacciones fue de 1,521,467 con 25,185.83 por segundo y una latencia promedio de 0.04 ms.

oltp_delete

```
top - 23:30:12 up 20 min,  2 users,  load average: 0.61, 0.37, 0.37
Tasks: 128 total,   1 running, 127 sleeping,   0 stopped,   0 zombie
%Cpu0  : 13.3 us, 25.7 sy,  0.0 ni, 47.7 id,  4.6 wa,  0.0 hi,  8.7 si,  0.0 st
%Cpu1  :  7.6 us, 25.7 sy,  0.0 ni, 28.6 id,  1.0 wa,  0.0 hi, 37.1 si,  0.0 st
MiB Mem :   1967.9 total,   1162.8 free,    536.8 used,    417.1 buff/cache

root@nodo1:/home/iheras# 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:                          1361
        other:                          22491
        total:                          23852
    transactions:                       23852  (397.47 per sec.)
    queries:                            23852  (397.47 per sec.)
    ignored errors:                     0      (0.00 per sec.)
    reconnects:                         0      (0.00 per sec.)

General statistics:
    total time:                         60.0071s
    total number of events:             23852

Latency (ms):
        min:                                    0.00
        avg:                                    2.51
        max:                                    145.89
        95th percentile:                        12.98
        sum:                                    59866.82

Threads fairness:
    events (avg/stddev):           23852.0000/0.00
    execution time (avg/stddev):   59.8668/0.00
```

Notas: Para la prueba `otlp_delete` se usó el 13.3% del primer CPU y 7.6% del segundo. El total de transacciones fue de 23,852 con 397.47 por segundo y una latencia promedio de 397.47 ms.

oltp_insert

```
SQL statistics:
    queries performed:
        read:                          0
        write:                         3399
        other:                         0
        total:                         3399
    transactions:                      3399    (56.63 per sec.)
    queries:                           3399    (56.63 per sec.)
    ignored errors:                    0       (0.00 per sec.)
    reconnects:                        0       (0.00 per sec.)

General statistics:
    total time:                        60.0170s
    total number of events:            3399

Latency (ms):
        min:                                   1.55
        avg:                                  17.64
        max:                                  70.67
        95th percentile:                      25.74
        sum:                               59958.20

Threads fairness:
    events (avg/stddev):           3399.0000/0.00
    execution time (avg/stddev):   59.9582/0.00
```

Notas: Para la prueba `otlp_insert` se usó el 8.2% del primer CPU y 0.5% del segundo. El total de transacciones fue de 3,399 con 56.63 por segundo y una latencia promedio de 17.64 ms.

oltp_point_select

```
SQL statistics:
    queries performed:
        read:                           269398
        write:                          0
        other:                          0
        total:                          269398
    transactions:                       269398 (4489.27 per sec.)
    queries:                            269398 (4489.27 per sec.)
    ignored errors:                     0      (0.00 per sec.)
    reconnects:                         0      (0.00 per sec.)

General statistics:
    total time:                         60.0009s
    total number of events:             269398

Latency (ms):
        min:                                      0.02
        avg:                                      0.22
        max:                                    187.30
        95th percentile:                          0.39
        sum:                                  59406.39

Threads fairness:
    events (avg/stddev):            269398.0000/0.00
    execution time (avg/stddev):    59.4064/0.00
```

Notas: Para la prueba `otlp_point_select` se usó el 9.4% del primer CPU y 7.4% del segundo. El total de transacciones fue de 269,393 con 4,489.27 por segundo y una latencia promedio de 0.22 ms.

oltp_read_only

```
SQL statistics:
    queries performed:
        read:                      171528
        write:                     0
        other:                     24504
        total:                     196032
    transactions:                  12252  (204.18 per sec.)
    queries:                       196032 (3266.82 per sec.)
    ignored errors:                0      (0.00 per sec.)
    reconnects:                    0      (0.00 per sec.)

General statistics:
    total time:                    60.0035s
    total number of events:        12252

Latency (ms):
        min:                                1.12
        avg:                                4.89
        max:                              140.92
        95th percentile:                    6.21
        sum:                            59883.00

Threads fairness:
    events (avg/stddev):           12252.0000/0.00
    execution time (avg/stddev):   59.8830/0.00
```

Notas: Para la prueba `otlp_read_only` se usó el 1.6% del primer CPU y 11.3% del segundo. El total de transacciones fue de 12,252 con 204.18 por segundo y una latencia promedio de 4.89 ms.

oltp_read_write

```
top - 23:39:48 up 30 min,  2 users,  load average: 0.68, 1.45, 1.01
Tasks: 129 total,   1 running, 128 sleeping,   0 stopped,   0 zombie
%Cpu0  : 15.1 us, 21.7 sy,  0.0 ni, 52.4 id,  5.2 wa,  0.0 hi,  5.7 si,  0.0 st
%Cpu1  :  3.6 us, 23.8 sy,  0.0 ni, 34.7 id,  1.0 wa,  0.0 hi, 36.8 si,  0.0 st

root@nodo1:/home/iheras# 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:                           16226
        write:                          4157
        other:                          2797
        total:                          23180
    transactions:                       1159    (19.30 per sec.)
    queries:                            23180   (386.07 per sec.)
    ignored errors:                     0       (0.00 per sec.)
    reconnects:                         0       (0.00 per sec.)

General statistics:
    total time:                         60.0297s
    total number of events:             1159

Latency (ms):
        min:                                    7.50
        avg:                                   51.77
        max:                                  177.15
        95th percentile:                       87.56
        sum:                                59996.59

Threads fairness:
    events (avg/stddev):           1159.0000/0.00
    execution time (avg/stddev):   59.9966/0.00
```

Notas: Para la prueba `otlp_read_write` se usó el 15.1% del primer CPU y 3.6% del segundo. El total de transacciones fue de 1,159 con 19.30 por segundo y una latencia promedio de 51.77 ms.

oltp_update_index

```
top - 23:42:20 up 32 min,  2 users,  load average: 0.95, 1.21, 0.98
Tasks: 126 total,   1 running, 125 sleeping,   0 stopped,   0 zombie
%Cpu0  : 11.8 us, 19.8 sy,  0.0 ni, 42.5 id, 17.5 wa,  0.0 hi,  8.5 si,  0.0 st
%Cpu1  :  1.4 us, 18.8 sy,  0.0 ni, 43.0 id,  0.5 wa,  0.0 hi, 36.2 si,  0.0 st

root@nodo1:/home/iheras# 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:                           3215
        other:                           3402
        total:                           6617
    transactions:                        6617    (110.23 per sec.)
    queries:                             6617    (110.23 per sec.)
    ignored errors:                      0       (0.00 per sec.)
    reconnects:                          0       (0.00 per sec.)

General statistics:
    total time:                          60.0277s
    total number of events:              6617

Latency (ms):
        min:                                      0.03
        avg:                                      9.06
        max:                                     69.86
        95th percentile:                         23.10
        sum:                                  59930.79

Threads fairness:
    events (avg/stddev):            6617.0000/0.00
    execution time (avg/stddev):    59.9308/0.00
```

Notas: Para la prueba `otlp_update_index` se usó el 11.8% del primer CPU y 1.4% del segundo. El total de transacciones fue de 6,617 con 110.23 por segundo y una latencia promedio de 9.06 ms.

oltp_update_non_index

```
top - 23:44:33 up 35 min,  2 users,  load average: 0.37, 0.90, 0.90
Tasks: 125 total,   3 running, 122 sleeping,   0 stopped,   0 zombie
%Cpu0  :  9.3 us, 17.7 sy,  0.0 ni, 48.8 id, 14.4 wa,  0.0 hi,  9.8 si,  0.0 st
%Cpu1  :  1.0 us, 23.7 sy,  0.0 ni, 37.7 id,  1.0 wa,  0.0 hi, 36.7 si,  0.0 st
```
```
root@nodo1:/home/iheras# 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:                              3072
        other:                              3250
        total:                              6322
    transactions:                           6322    (105.33 per sec.)
    queries:                                6322    (105.33 per sec.)
    ignored errors:                         0       (0.00 per sec.)
    reconnects:                             0       (0.00 per sec.)

General statistics:
    total time:                             60.0122s
    total number of events:                 6322

Latency (ms):
        min:                                        0.04
        avg:                                        9.48
        max:                                        86.68
        95th percentile:                           23.95
        sum:                                     59907.69

Threads fairness:
    events (avg/stddev):            6322.0000/0.00
    execution time (avg/stddev):    59.9077/0.00
```

Notas: Para la prueba `otlp_update_non_index` se usó el 9.3% del primer CPU y 1.0% del segundo. El total de transacciones fue de 6,322 con 105.33 por segundo y una latencia promedio de 9.48 ms.

oltp_write_only

```
 root@nodo1: /home/iheras    ×     root@nodo2: /home/iheras    ×    +  ∨
top - 23:51:02 up 41 min,  2 users,  load average: 0.35, 0.38, 0.64
Tasks: 127 total,   2 running, 125 sleeping,   0 stopped,   0 zombie
%Cpu0  : 12.1 us, 22.3 sy,  0.0 ni, 47.9 id,  9.8 wa,  0.0 hi,  7.9 si,  0.0 st
%Cpu1  :  1.5 us, 23.2 sy,  0.0 ni, 37.9 id,  1.0 wa,  0.0 hi, 36.5 si,  0.0 st

 root@nodo1: /home/iheras    ×    +  ∨

root@nodo1:/home/iheras# 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:                              9513
        other:                              6189
        total:                              15702
    transactions:                           2617    (43.59 per sec.)
    queries:                                15702   (261.57 per sec.)
    ignored errors:                         0       (0.00 per sec.)
    reconnects:                             0       (0.00 per sec.)

General statistics:
    total time:                             60.0262s
    total number of events:                 2617

Latency (ms):
        min:                                        4.74
        avg:                                       22.92
        max:                                      136.58
        95th percentile:                           38.25
        sum:                                    59970.66

Threads fairness:
    events (avg/stddev):           2617.0000/0.00
    execution time (avg/stddev):   59.9707/0.00
```

Notas: Para la prueba `otlp_write_only` se usó el 12.1% del primer CPU y 1.5% del segundo. El total de transacciones fue de 2,617 con 43.59 por segundo y una latencia promedio de 22.92 ms.

select_random_points


```
top - 23:54:50 up 45 min,  2 users,  load average: 0.63, 0.43, 0.61
Tasks: 128 total,   2 running, 126 sleeping,   0 stopped,   0 zombie
%Cpu0  :  2.3 us,  5.9 sy,  0.0 ni, 90.6 id,  0.0 wa,  0.0 hi,  1.2 si,  0.0 st
%Cpu1  : 23.2 us, 38.4 sy,  0.0 ni,  2.4 id,  0.0 wa,  0.0 hi, 36.0 si,  0.0 st

root@nodo1:/home/iheras# 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:                     9953
        write:                    0
        other:                    0
        total:                    9953
    transactions:                 9953    (165.85 per sec.)
    queries:                      9953    (165.85 per sec.)
    ignored errors:               0       (0.00 per sec.)
    reconnects:                   0       (0.00 per sec.)

General statistics:
    total time:                   60.0088s
    total number of events:       9953

Latency (ms):
        min:                              0.96
        avg:                              6.02
        max:                            292.25
        95th percentile:                 17.32
        sum:                          59903.97

Threads fairness:
    events (avg/stddev):          9953.0000/0.00
    execution time (avg/stddev):  59.9040/0.00
```

Notas: Para la prueba `select_random_points` se usó el 2.3% del primer CPU y 23.2% del segundo. El total de transacciones fue de 9,953 con 165.85 por segundo y una latencia promedio de 6.02 ms.

select_random_ranges

```
top - 23:57:02 up 47 min,  2 users,  load average: 0.54, 0.60, 0.66
Tasks: 129 total,   1 running, 128 sleeping,   0 stopped,   0 zombie
%Cpu0 : 24.2 us, 11.4 sy,  0.0 ni, 62.5 id,  0.4 wa,  0.0 hi,  1.5 si,  0.0 st
%Cpu1 : 12.7 us, 12.7 sy,  0.0 ni, 27.4 id,  0.0 wa,  0.0 hi, 47.1 si,  0.0 st

root@nodo1:/home/iheras# 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:                           12702
        write:                          0
        other:                          0
        total:                          12702
    transactions:                       12702  (211.53 per sec.)
    queries:                            12702  (211.53 per sec.)
    ignored errors:                     0      (0.00 per sec.)
    reconnects:                         0      (0.00 per sec.)

General statistics:
    total time:                         60.0156s
    total number of events:             12702

Latency (ms):
        min:                                     0.48
        avg:                                     4.71
        max:                                    69.58
        95th percentile:                         9.22
        sum:                                 59873.19

Threads fairness:
    events (avg/stddev):        12702.0000/0.00
    execution time (avg/stddev):  59.8732/0.00
```
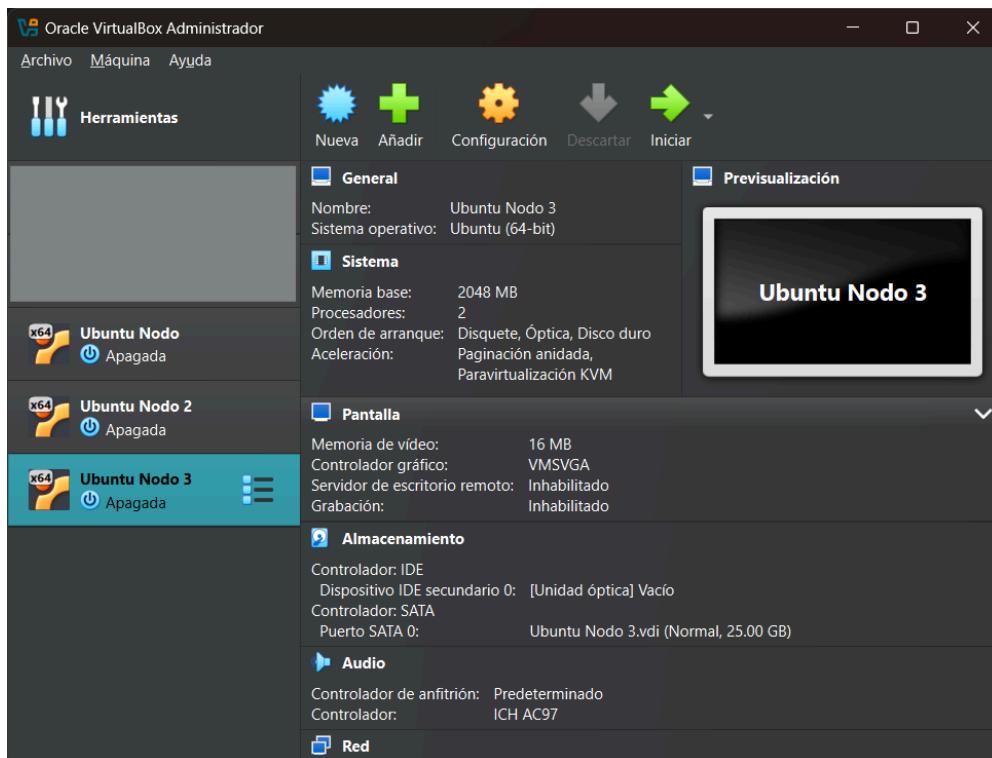
Notas: Para la prueba `select_random_ranges` se usó el 24.3% del primer CPU y 12.7% del segundo. El total de transacciones fue de 12,702 con 211.53 por segundo y una latencia promedio de 4.71 ms.

Agregar un tercer nodo

Se clonó una VM desde uno de los nodos.

Se cambió la IP y `wsrep_node_name` en `60-galera.cnf`

```
[mysqld]
binlog_format=ROW
default-storage-engine=innodb
innodb_autoinc_lock_mode=2
bind-address=0.0.0.0

# Galera Provider Configuration
wsrep_on=ON
wsrep_provider=/usr/lib/galera/libgalera_smm.so

# Galera Cluster Configuration
wsrep_cluster_name="test_cluster"
wsrep_cluster_address="gcomm://192.168.0.26,192.168.0.27,192.168.0.29"

# Galera Synchronization Configuration
wsrep_sst_method=rsync

# Galera Node Configuration
wsrep_node_address="192.168.0.29"
wsrep_node_name="nodo3"
```

Agregamos su IP en `wsrep_cluster_address` en todos los nodos.

En el nuevo nodo iniciamos MariaDB y luego verificamos que el clúster tiene 3 nodos.

```
root@nodo3:/home/iheras# systemctl restart mariadb
root@nodo3:/home/iheras# mysql -u root -p -e "SHOW STATUS LIKE 'wsrep_cluster_size';"
Enter password:
+--------------------+-------+
| Variable_name      | Value |
+--------------------+-------+
| wsrep_cluster_size | 3     |
+--------------------+-------+
```

Benchmark con 3 nodos

bulk_insert

```
root@nodo1: /home/iheras    ×    root@nodo2: /home/iheras    ×    root@nodo3: /home/iheras    ×    +  ∨

top - 18:35:13 up 20 min,  2 users,  load average: 0.63, 0.24, 0.13
Tasks: 127 total,   1 running, 126 sleeping,   0 stopped,   0 zombie
%Cpu0  : 20.8 us,  6.9 sy,  0.0 ni, 52.0 id,  1.5 wa,  0.0 hi, 18.8 si,  0.0 st
%Cpu1  :  7.6 us, 25.5 sy,  0.0 ni, 21.7 id,  0.5 wa,  0.0 hi, 44.6 si,  0.0 st
```

```
root@nodo1: /home/iheras    ×    +  ∨

root@nodo1:/home/iheras# sysbench  --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 bulk_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:                         35
        other:                         0
        total:                         35
    transactions:                      1113717 (18275.40 per sec.)
    queries:                           35     (0.57 per sec.)
    ignored errors:                    0      (0.00 per sec.)
    reconnects:                        0      (0.00 per sec.)

General statistics:
    total time:                        60.9314s
    total number of events:            1113717

Latency (ms):
        min:                                   0.00
        avg:                                   0.05
        max:                                6193.53
        95th percentile:                       0.00
        sum:                               59372.67

Threads fairness:
    events (avg/stddev):           1113717.0000/0.00
    execution time (avg/stddev):   59.3727/0.00
```

Notas: Para la prueba `bulk_insert` se usó el 20.8% del primer CPU y 7.6% del segundo. El total de transacciones fue de 1,113,717 con 18,275.40 por segundo y una latencia promedio de 0.05 ms.

oltp_delete

```
top - 18:43:49 up 28 min,  2 users,  load average: 0.35, 0.19, 0.16
Tasks: 126 total,   3 running, 123 sleeping,   0 stopped,   0 zombie
%Cpu0  : 11.8 us, 24.0 sy,  0.0 ni, 40.7 id,  8.3 wa,  0.0 hi, 15.2 si,  0.0 st
%Cpu1  :  0.5 us, 16.7 sy,  0.0 ni, 47.4 id,  0.5 wa,  0.0 hi, 34.9 si,  0.0 st

root@nodo1:/home/iheras# 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:                           953
        other:                           26778
        total:                           27731
    transactions:                        27731  (462.09 per sec.)
    queries:                             27731  (462.09 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0043s
    total number of events:              27731

Latency (ms):
        min:                                    0.05
        avg:                                    2.16
        max:                                  204.03
        95th percentile:                        5.47
        sum:                                59827.90

Threads fairness:
    events (avg/stddev):           27731.0000/0.00
    execution time (avg/stddev):   59.8279/0.00
```

Notas: Para la prueba `oltp_delete` se usó el 11.8% del primer CPU y 0.5% del segundo. El total de transacciones fue de 27,731 con 462.09 por segundo y una latencia promedio de 2.16 ms.

oltp_insert

```
 root@nodo1: /home/iheras    ×    root@nodo2: /home/iheras    ×    root@nodo3: /home/iheras    ×    +   ∨

top - 18:45:57 up 31 min,  2 users,  load average: 1.04, 0.45, 0.26
Tasks: 126 total,   1 running, 125 sleeping,   0 stopped,   0 zombie
%Cpu0  :  5.9 us, 17.3 sy,  0.0 ni, 47.6 id, 11.4 wa,  0.0 hi, 17.8 si,  0.0 st
%Cpu1  :  1.0 us, 20.1 sy,  0.0 ni, 41.6 id,  0.5 wa,  0.0 hi, 36.8 si,  0.0 st
```

```
 root@nodo1: /home/iheras    ×    +   ∨

root@nodo1:/home/iheras# 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:                           1937
        other:                           0
        total:                           1937
    transactions:                        1937   (32.27 per sec.)
    queries:                             1937   (32.27 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:              1937

Latency (ms):
        min:                                    6.39
        avg:                                   30.95
        max:                                  144.67
        95th percentile:                       48.34
        sum:                                59954.01

Threads fairness:
    events (avg/stddev):           1937.0000/0.00
    execution time (avg/stddev):   59.9540/0.00
```

Notas: Para la prueba `oltp_delete` se usó el 5.9% del primer CPU y 1.0% del segundo. El total de transacciones fue de 1,937 con 32.27 por segundo y una latencia promedio de 30.95 ms.

oltp_point_select

```
top - 18:50:26 up 35 min,  2 users,  load average: 0.15, 0.31, 0.25
Tasks: 128 total,   2 running, 126 sleeping,   0 stopped,   0 zombie
%Cpu0  : 11.1 us, 20.3 sy,  0.0 ni, 64.5 id,  0.9 wa,  0.0 hi,  3.2 si,  0.0 st
%Cpu1  :  6.5 us, 31.8 sy,  0.0 ni, 24.7 id,  0.0 wa,  0.0 hi, 37.1 si,  0.0 st
```

```
root@nodo1:/home/iheras# 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:                            217867
        write:                           0
        other:                           0
        total:                           217867
    transactions:                        217867 (3630.82 per sec.)
    queries:                             217867 (3630.82 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0012s
    total number of events:              217867

Latency (ms):
        min:                                    0.02
        avg:                                    0.27
        max:                                   86.09
        95th percentile:                        0.51
        sum:                                59451.25

Threads fairness:
    events (avg/stddev):           217867.0000/0.00
    execution time (avg/stddev):   59.4512/0.00
```

Notas: Para la prueba `oltp_point_select` se usó el 11.1% del primer CPU y 6.5% del segundo. El total de transacciones fue de 217,867 con 3,630.82 por segundo y una latencia promedio de 0.27 ms.

oltp_read_only

```
top - 18:53:57 up 39 min,  2 users,  load average: 0.27, 0.34, 0.28
Tasks: 127 total,   1 running, 126 sleeping,   0 stopped,   0 zombie
%Cpu0  : 16.5 us, 22.5 sy,  0.0 ni, 51.8 id,  0.0 wa,  0.0 hi,  9.2 si,  0.0 st
%Cpu1  :  4.0 us, 25.3 sy,  0.0 ni, 37.9 id,  0.6 wa,  0.0 hi, 32.2 si,  0.0 st
```

```
root@nodo1:/home/iheras# 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:                            172284
        write:                           0
        other:                           24612
        total:                           196896
    transactions:                        12306  (205.07 per sec.)
    queries:                             196896 (3281.17 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0040s
    total number of events:              12306

Latency (ms):
        min:                                    0.88
        avg:                                    4.86
        max:                                  329.60
        95th percentile:                        8.74
        sum:                                59849.08

Threads fairness:
    events (avg/stddev):           12306.0000/0.00
    execution time (avg/stddev):   59.8491/0.00
```

Notas: Para la prueba `oltp_read_only` se usó el 16.5% del primer CPU y 4.0% del segundo. El total de transacciones fue de 12,306 con 205.07 por segundo y una latencia promedio de 4.86 ms.

oltp_read_write

Notas: Para la prueba `oltp_read_write` se usó el 14.1% del primer CPU y 3.0% del segundo. El total de transacciones fue de 1,157 con 205.07 por segundo y una latencia promedio de 4.86 ms.

oltp_update_index

```
root@nodo1: /home/iheras    ×    root@nodo2: /home/iheras    ×    root@nodo3: /home/iheras    ×    +    ∨

top - 19:12:33 up 57 min,  2 users,  load average: 0.32, 0.21, 0.24
Tasks: 131 total,   2 running, 129 sleeping,   0 stopped,   0 zombie
%Cpu0  :  9.5 us, 19.1 sy,  0.0 ni, 43.2 id, 12.1 wa,  0.0 hi, 16.1 si,  0.0 st
%Cpu1  :  0.5 us, 16.3 sy,  0.0 ni, 46.9 id,  0.5 wa,  0.0 hi, 35.9 si,  0.0 st
```

```
root@nodo1: /home/iheras    ×    +    ∨

root@nodo1:/home/iheras# 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:                   1951
        other:                   3919
        total:                   5870
    transactions:                5870   (97.80 per sec.)
    queries:                     5870   (97.80 per sec.)
    ignored errors:              0      (0.00 per sec.)
    reconnects:                  0      (0.00 per sec.)

General statistics:
    total time:                  60.0124s
    total number of events:      5870

Latency (ms):
        min:                              0.06
        avg:                             10.21
        max:                            237.25
        95th percentile:                 36.24
        sum:                          59915.41

Threads fairness:
    events (avg/stddev):         5870.0000/0.00
    execution time (avg/stddev): 59.9154/0.00
```

Notas: Para la prueba `oltp_update_index` se usó el 9.5% del primer CPU y 0.5% del segundo. El total de transacciones fue de 5,870 con 97.80 por segundo y una latencia promedio de 10.21 ms.

oltp_update_non_index

```
top - 19:18:36 up  1:03,  2 users,  load average: 0.55, 0.33, 0.29
Tasks: 130 total,   1 running, 129 sleeping,   0 stopped,   0 zombie
%Cpu0  :  6.2 us, 19.6 sy,  0.0 ni, 43.8 id,  8.8 wa,  0.0 hi, 21.6 si,  0.0 st
%Cpu1  :  1.5 us, 24.1 sy,  0.0 ni, 36.9 id,  1.0 wa,  0.0 hi, 36.5 si,  0.0 st
```

root@nodo1:/home/iheras   ✕   + ˅

```
root@nodo1:/home/iheras# 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:                           2095
        other:                           4236
        total:                           6331
    transactions:                        6331   (105.47 per sec.)
    queries:                             6331   (105.47 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0186s
    total number of events:              6331

Latency (ms):
         min:                                    0.07
         avg:                                    9.47
         max:                                  211.96
         95th percentile:                       34.33
         sum:                                59936.66

Threads fairness:
    events (avg/stddev):           6331.0000/0.00
    execution time (avg/stddev):   59.9367/0.00
```

Notas: Para la prueba `oltp_update_non_index` se usó el 6.2% del primer CPU y 1.5% del segundo. El total de transacciones fue de 6,331 con 105.47 por segundo y una latencia promedio de 9.47 ms.

oltp_write_only

```
top - 19:31:08 up  1:16,  2 users,  load average: 0.44, 0.29, 0.28
Tasks: 129 total,   2 running, 127 sleeping,   0 stopped,   0 zombie
%Cpu0  : 10.9 us, 17.1 sy,  0.0 ni, 45.1 id, 10.9 wa,  0.0 hi, 16.1 si,  0.0 st
%Cpu1  :  1.4 us, 19.0 sy,  0.0 ni, 44.3 id,  0.5 wa,  0.0 hi, 34.8 si,  0.0 st
```

root@nodo1: /home/iheras   ×   +   ∨

```
root@nodo1:/home/iheras# 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:                           6010
        other:                           4364
        total:                           10374
    transactions:                        1729    (28.81 per sec.)
    queries:                             10374   (172.85 per sec.)
    ignored errors:                      0       (0.00 per sec.)
    reconnects:                          0       (0.00 per sec.)

General statistics:
    total time:                          60.0089s
    total number of events:              1729

Latency (ms):
        min:                                    9.02
        avg:                                   34.69
        max:                                  189.92
        95th percentile:                       57.87
        sum:                                59973.08

Threads fairness:
    events (avg/stddev):           1729.0000/0.00
    execution time (avg/stddev):   59.9731/0.00
```

Notas: Para la prueba `oltp_write_only` se usó el 10.9% del primer CPU y 1.4% del segundo. El total de transacciones fue de 1,729 con 28.81 por segundo y una latencia promedio de 34.69 ms.

select_random_points

```
top - 19:35:35 up  1:20,  2 users,  load average: 0.32, 0.28, 0.28
Tasks: 130 total,   1 running, 129 sleeping,   0 stopped,   0 zombie
%Cpu0  : 30.6 us, 28.2 sy,  0.0 ni, 35.9 id,  0.0 wa,  0.0 hi,  5.2 si,  0.0 st
%Cpu1  : 13.8 us, 26.0 sy,  0.0 ni, 35.7 id,  0.0 wa,  0.0 hi, 24.5 si,  0.0 st
```

```
root@nodo1:/home/iheras# 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:                            7064
        write:                           0
        other:                           0
        total:                           7064
    transactions:                        7064    (117.72 per sec.)
    queries:                             7064    (117.72 per sec.)
    ignored errors:                      0       (0.00 per sec.)
    reconnects:                          0       (0.00 per sec.)

General statistics:
    total time:                          60.0045s
    total number of events:              7064

Latency (ms):
        min:                                      1.08
        avg:                                      8.48
        max:                                    231.32
        95th percentile:                         21.50
        sum:                                  59906.98

Threads fairness:
    events (avg/stddev):           7064.0000/0.00
    execution time (avg/stddev):   59.9070/0.00
```

Notas: Para la prueba `select_random_points` se usó el 30.6% del primer CPU y 13.8% del segundo. El total de transacciones fue de 7,064 con 117.72 por segundo y una latencia promedio de 8.48 ms.

select_random_ranges

```
top - 19:38:17 up  1:23,  2 users,  load average: 0.55, 0.44, 0.34
Tasks: 128 total,   1 running, 127 sleeping,   0 stopped,   0 zombie
%Cpu0  : 24.5 us,  7.8 sy,  0.0 ni, 58.4 id,  0.4 wa,  0.0 hi,  9.0 si,  0.0 st
%Cpu1  :  1.8 us, 12.0 sy,  0.0 ni, 54.8 id,  0.0 wa,  0.0 hi, 31.3 si,  0.0 st

root@nodo1:/home/iheras# 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:                            13690
        write:                           0
        other:                           0
        total:                           13690
    transactions:                        13690  (228.12 per sec.)
    queries:                             13690  (228.12 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.0095s
    total number of events:              13690

Latency (ms):
             min:                                0.61
             avg:                                4.37
             max:                              123.72
             95th percentile:                    7.43
             sum:                            59890.86

Threads fairness:
    events (avg/stddev):           13690.0000/0.00
    execution time (avg/stddev):   59.8909/0.00
```

Notas: Para la prueba `select_random_ranges` se usó el 24.5% del primer CPU y 1.8% del segundo. El total de transacciones fue de 13,690 con 228.12 por segundo y una latencia promedio de 4.37 ms.

Conclusión

Las pruebas de rendimiento con sysbench mostraron que el rendimiento varía según la operación evaluada. En general, las pruebas de lectura (oltp_read_only, oltp_point_select) presentaron baja latencia y un alto número de transacciones por segundo, mientras que las operaciones de escritura (oltp_insert, oltp_write_only) fueron más demandantes en términos de latencia y consumo de CPU.

El aumento en la cantidad de nodos permitió distribuir la carga, mejorando el rendimiento en algunas pruebas, aunque en otras se observó una ligera degradación debido a la sobrecarga de sincronización entre nodos. Esto sugiere que el escalado horizontal en Galera debe planificarse con base en la carga de trabajo esperada.