



**PERCONA**  

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**LIVEONLINE**  
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# Inspecting MySQL Servers

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## The Percona Support way

- Fernando Laudares Camargos  
*Percona Support Team*



# **The Percona Support way**



# Where do I start?

1. Getting to “know” the server
2. Understanding how the server behaves under load

# Knowing the server

What kind of box is hosting the service?

*pt-summary*

<https://www.percona.com/doc/percona-toolkit/LATEST/pt-summary.html>



**PERCONA**  
Toolkit

<https://www.percona.com/software/database-tools/percona-toolkit>

## Percona repositories

<https://www.percona.com/doc/percona-repo-config/index.html>

```
$ sudo apt-get/yum install percona-toolkit
```

# *What MySQL?*

Key information  
summarized

*pt-mysql-summary*

<https://www.percona.com/doc/percona-toolkit/LATEST/pt-mysql-summary.html>

# First impressions

*pt-summaries* help  
provide a “static”  
view of the server

How does it perform in *motion* ?



<https://upload.wikimedia.org/wikipedia/commons/7/72/Motor.gif>

# Tuning

Performance is dependent on:

- physical resources
- workload

We tune a server for the workload it runs

# An engine in motion

Observation can be divided into:

- OS level
- Database level

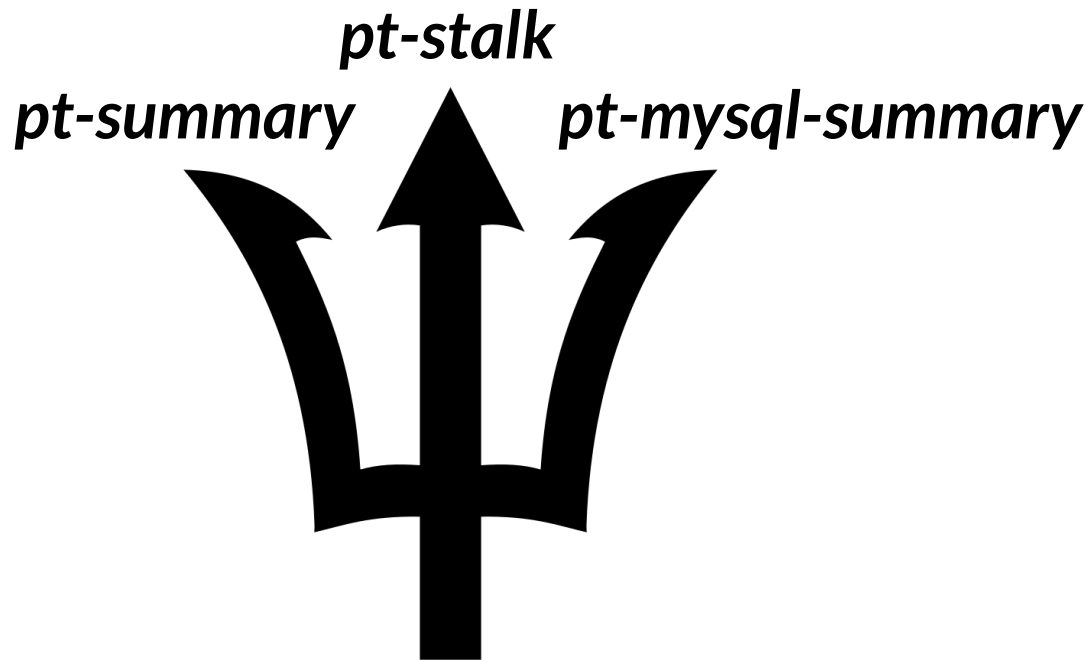
***pt-stalk***

<https://www.percona.com/doc/percona-toolkit/LATEST/pt-stalk.html>



[https://www.youtube.com/embed/l\\_mZkMf4YGs](https://www.youtube.com/embed/l_mZkMf4YGs)

# Percona Support favorite triad



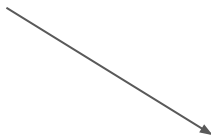
Source: [https://upload.wikimedia.org/wikipedia/commons/a/a7/Barbados\\_trident.svg](https://upload.wikimedia.org/wikipedia/commons/a/a7/Barbados_trident.svg)

# Simple procedure

```
sudo pt-summary > pt-summary.out
```

```
sudo pt-mysql-summary -- --user=root --password=<password> >  
pt-mysql-summary.out
```

```
sudo pt-stalk --no-stalk --iterations=2 --sleep=30 --  
--user=root --password=<password>
```



`--dest=/var/lib/pt-stalk`



The excerpts of data used in this presentation is a mix-and-match taken from various different server reports to better illustrate each situation, adjusted as necessary to remove any sensitive data.



# Knowing the server

# The heart and soul of the server

# Percona Toolkit System Summary Report #####

```
    Date | 2021-02-19 16:11:19 UTC (local TZ: CET +0100)
  Hostname | my.server.net
    Uptime | 199 days,  2:35,  1 user,  load average: 5.37, 3.94, 2.74
    System | Dell Inc.; PowerEdge R730; vNot Specified (Rack Mount Chassis)
Service Tag | 4XYSG62
  Platform | Linux
    Release | CentOS Linux release 7.8.2003 (Core)
    Kernel  | 3.10.0-1127.18.2.el7.x86_64
Architecture | CPU = 64-bit, OS = 64-bit
  Threading | NPTL 2.17
    SELinux | Disabled
Virtualized | No virtualization detected
```

# Processing power

```
# Processor #####  
Processors | physical = 2, cores = 16, virtual = 32, hyperthreading = yes  
Speeds | 1x2900.585, 1x3103.320, 1x3305.859, 4x3399.804, 13x3400.000,  
2x3400.390, 1x3400.781, 1x3402.148, 1x3405.859, 1x3442.968, 1x3443.554,  
1x3453.320, 1x3461.132, 1x3478.906, 1x3573.242, 1x3577.929  
Models | 32xIntel(R) Xeon(R) CPU E5-2667 v3 @ 3.20GHz  
Caches | 32x20480 KB
```

```
$ for i in /sys/devices/system/cpu/cpu*/cpufreq/scaling_governor ;  
do { echo "performance" > $i; } done
```

# Memory

```
# Memory #####  
      Total | 94.3G  
      Free | 6.7G  
      Used | physical = 87.6G, swap allocated = 16.0G, swap used = 604.2M,  
virtual = 88.2G  
      Buffers | 354.8M  
      Caches | 81.0G  
      Dirty | 332 kB  
      UsedRSS | 4.5G  
      Swappiness | 60  
      DirtyPolicy | 20, 10  
      DirtyStatus | 0, 0
```

```
$ echo "vm.swappiness = 1" >> /etc/sysctl.conf  
$ sysctl -p
```

# THP

```
# Memory management #####  
Transparent huge pages are enabled.
```

*(...) database workloads often perform poorly with THP enabled, because **they tend to have sparse rather than contiguous memory access patterns**.  
When running MongoDB on Linux, THP should be disabled for best performance.*

- <https://docs.mongodb.com/manual/tutorial/transparent-huge-pages/>

```
$ echo "never" > /sys/kernel/mm/transparent_hugepage/enabled  
$ echo "never" > /sys/kernel/mm/transparent_hugepage/defrag
```

# Storage

# Mounted Filesystems #####

| Filesystem         | Size | Used | Type  | Opts                       | Mountpoint |
|--------------------|------|------|-------|----------------------------|------------|
| 10.1.1.240:/backup | 3.0T | 37%  | nfs   | rw,bg,soft,addr=10.1.1.240 | /backup    |
| /dev/mapper/data   | 4.3T | 42%  | ext4  | rw,noatime,nodiratime      | /data      |
| /dev/mapper/system | 20G  | 23%  | ext4  | rw                         | /          |
| /dev/sda2          | 504M | 6%   | ext2  | rw                         | /boot      |
| tmpfs              | 48G  | 0%   | tmpfs | rw                         | /dev/shm   |

# Storage

# RAID Controller #####

Controller | LSI Logic MegaRAID SAS

Model | ServeRAID M5210, PCIE interface, 8 ports

Cache | 1024MB Memory, BBU

BBU | % Charged, Temperature 24C, isSOHGood=

| VirtualDev | Size     | RAID Level | Disks | SpnDpth | Stripe | Status         | Cache |
|------------|----------|------------|-------|---------|--------|----------------|-------|
| 0(no name) | 1.089 TB | 0 (: -1-0) | 2     | Depth-1 | 256 KB | Optimal WB, RA |       |
| 1(no name) | 4.361 TB | 0 (: -5-3) | 5     | Depth-1 | 256 KB | Optimal WB, RA |       |

| PhysicalDev | Type | State   | Errors | Vendor | Model         | Size                            |
|-------------|------|---------|--------|--------|---------------|---------------------------------|
| Hard Disk   | SAS  | Online, | 0/0/0  | LENOVO | XST1200MM0018 | XL592S4009N7HL592L592L592 1.090 |
| Hard Disk   | SAS  | Online, | 0/0/0  | LENOVO | XST1200MM0018 | XL592S400AD3GL592L592L592 1.090 |
| Hard Disk   | SAS  | Online, | 0/0/0  | LENOVO | XST1200MM0018 | XL592S400AD0BL592L592L592 1.090 |
| Hard Disk   | SAS  | Online, | 0/0/0  | LENOVO | XST1200MM0018 | XL592S4009NSML592L592L592 1.090 |
| Hard Disk   | SAS  | Online, | 0/2/0  | LENOVO | XST1200MM0018 | XL592S400AD49L592L592L592 1.090 |
| Hard Disk   | SAS  | Online, | 0/0/0  | LENOVO | XST1200MM0018 | XL592S400AD5JL592L592L592 1.090 |
| Hard Disk   | SAS  | Online, | 0/0/0  | LENOVO | XST1200MM0018 | XL592S4009NB7L592L592L592 1.090 |

# Storage

```
# Disk Schedulers And Queue Size #####  
dm-0 | 128  
dm-1 | 128  
dm-2 | 128  
dm-3 | 128  
dm-4 | 128  
dm-5 | 128  
sda | [deadline] 128  
sdb | [deadline] 128
```

```
$ echo "noop" > /sys/block/sdb/queue/scheduler
```

# A quick look into what is running

```
# Top Processes #####
  PID USER      PR  NI   VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
12313 mysqladm  20   0  65.8g  63.2g  11724 S   721.1  80.5   5698:16 mysqld
   10 root       20   0      0      0      0 S    10.5   0.0   213:58.07 rcu_sched
   25 root       20   0      0      0      0 S     5.3   0.0   488:46.43 ksoftirqd/3
   66 root       20   0      0      0      0 S     5.3   0.0   477:53.52 ksoftirqd/+
   76 root       20   0      0      0      0 S     5.3   0.0   510:34.38 ksoftirqd/+
   81 root       20   0      0      0      0 S     5.3   0.0   514:53.12 ksoftirqd/+
 6010 root       20   0 670928 79788   3368 S     5.3   0.1   5578:29 guard_stap
 6573 mysqladm  20   0 168900   2648   1704 R     5.3   0.0    0:00.04 top
    1 root       20   0 212568   7796   3116 S     0.0   0.0   53:18.47 systemd
```



# What MySQL?

# Header information

```
# Percona Toolkit MySQL Summary Report #####
      System time | 2020-10-08 15:30:53 UTC (local TZ: CDT -0500)
# Instances #####
Port  Data Directory          Nice OOM Socket
=====
3306 /home/mysqladm/mysql/data 0    0    /mysqladm/tmp/mysql.sock
# MySQL Executable #####
      Path to executable | /mysqladm/Percona-Server-5.7.25-28-Linux.x86_64.ssl101/bin/mysqld
      Has symbols | Yes
```

# Header information

# Report On Port 3306 #####

|             |  |                                                                  |
|-------------|--|------------------------------------------------------------------|
| User        |  | mysqladm@%                                                       |
| Time        |  | 2021-04-08 10:30:53 (CDT)                                        |
| Hostname    |  | myservename                                                      |
| Version     |  | 5.7.25-28-log Percona Server (GPL), Release 28, Revision c335905 |
| Built On    |  | Linux x86_64                                                     |
| Started     |  | 2021-04-07 08:53 (up 1+01:37:04)                                 |
| Databases   |  | 6                                                                |
| Datadir     |  | /home/mysqladm/mysql/data/                                       |
| Processes   |  | 2000 connected, 1500 running                                     |
| Replication |  | Is not a slave, has 2 slaves connected                           |
| Pidfile     |  | /mysqladm/tmp/mysqld.pid (exists)                                |

# Processes

A single sample of `SHOW FULL PROCESSLIST`

# Status Variables

2 sample of `SHOW GLOBAL STATUS`

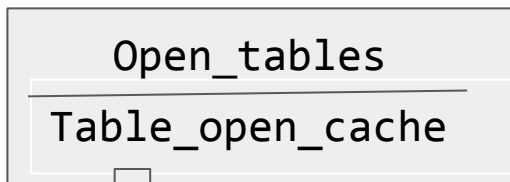
# MySQL settings

## Table cache

# Table cache #####

Size | 512  
Usage | 225%

- 16 instances
- Each with:  
(512/16) = 32 entries



- 5.5 → 400
- 5.6 → 2000
- 8.0 → 4000

## Table\_open\_cache

- 5.6 → 1
- 5.7 → 16

# MySQL settings

## Query cache

```
# Query cache #####  
      query_cache_type | ON  
           Size | 100.0M  
          Usage | 6%  
HitToInsertRatio | 200%
```

### Disabling:

```
query_cache_type=0  
query_cache_size=0
```

# The main storage engine

There are about 170 innodb\_ prefixed variables in MySQL 8.0

# InnoDB #####

|                               |                                             |                                                                                           |
|-------------------------------|---------------------------------------------|-------------------------------------------------------------------------------------------|
| Version                       | 5.7.29                                      |                                                                                           |
| Buffer Pool Size              | 50.0G                                       |                                                                                           |
| Buffer Pool Fill              | 100%                                        | → $\text{Innodb\_buffer\_pool\_pages\_total} - \text{Innodb\_buffer\_pool\_pages\_free}$  |
| Buffer Pool Dirty             | 1%                                          |                                                                                           |
| File Per Table                | ON                                          | → $\text{Innodb\_buffer\_pool\_pages\_total} - \text{Innodb\_buffer\_pool\_pages\_dirty}$ |
| Page Size                     | 16k                                         |                                                                                           |
| <i>Redo log</i> Log File Size | 2 * 2.0G = 4.0G                             |                                                                                           |
| Log Buffer Size               | 16M                                         | → $\text{innodb\_log\_files\_in\_group} * \text{innodb\_log\_file\_size}$                 |
| Flush Method                  | O_DIRECT                                    |                                                                                           |
| Flush Log At Commit           | 1                                           | → $\text{innodb\_flush\_log\_at\_trx\_commit}$                                            |
| XA Support                    | ON                                          |                                                                                           |
| Checksums                     | ON                                          |                                                                                           |
| Doublewrite                   | ON                                          |                                                                                           |
| R/W I/O Threads               | 4 4                                         |                                                                                           |
| I/O Capacity                  | 200                                         |                                                                                           |
| Thread Concurrency            | 0                                           |                                                                                           |
| Concurrency Tickets           | 5000                                        |                                                                                           |
| Commit Concurrency            | 0                                           |                                                                                           |
| Txn Isolation Level           | READ-COMMITTED                              |                                                                                           |
| Adaptive Flushing             | ON                                          |                                                                                           |
| Adaptive Checkpoint           |                                             |                                                                                           |
| Checkpoint Age                | 1G                                          |                                                                                           |
| InnoDB Queue                  | 0 queries inside InnoDB, 0 queries in queue |                                                                                           |
| Oldest Transaction            | 0 Seconds                                   |                                                                                           |
| History List Len              | 95                                          |                                                                                           |

512G :

- 80% → BP
- 100G left (?)

# Binary logging

```
# Binary Logging #####
```

```
Binlogs | 108  
Zero-Sized | 0  
Total Size | 104.4G  
binlog_format | ROW  
expire_logs_days | 5  
sync_binlog | 1  
server_id | 1  
binlog_do_db |  
binlog_ignore_db |
```



8.0:  
binlog\_expire\_logs\_seconds

# Best of the rest

## Temporary tables

```
max_heap_table_size | 64M  
tmp_table_size      | 64M
```

tmpdir → /dev/shm

*fast*

|              |
|--------------|
| in-memory    |
| 1 2 3 ... 64 |



*slow*

|              |
|--------------|
| on-disk      |
| 65 66 67 ... |

$$256M * 500 = 122G$$

- Optimize your queries to rely less on temp tables -

# Best of the rest

## MySQL error log

```
log | ON  
log_error | /var/lib/mysql/mysql.err  
log_warnings | 2  
      ↘ log_error_verbosity
```

## Slow query log

~~log\_slow\_queries~~

- `slow_query_log = 1`
- `long_query_time = 0`
- `log_slow_rate_limit`

\$ **pt-query-digest** <slow\_query\_log\_file>

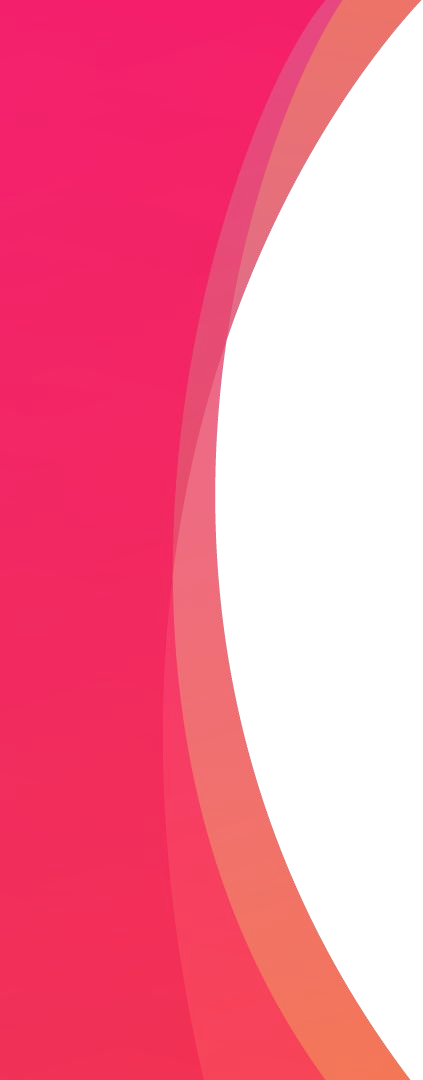
<https://www.percona.com/doc/percona-toolkit/LATEST/pt-query-digest.html>

# Configuration file

Only if *mysqld* has been started with  
`--defaults-file ...`

# Memory allocator

*Jemalloc*?



# **An engine in motion**

# A mix of

```
$ ls /var/lib/pt-stalk/
2021_05_01_12_55_30-df
2021_05_01_12_55_30-disk-space
2021_05_01_12_55_30-diskstats
2021_05_01_12_55_30-hostname
2021_05_01_12_55_30-innodbstatus1
2021_05_01_12_55_30-innodbstatus2
2021_05_01_12_55_30-interrupts
2021_05_01_12_55_30-iostat
2021_05_01_12_55_30-iostat-overall
2021_05_01_12_55_30-log_error
2021_05_01_12_55_30-lsof
2021_05_01_12_55_30-meminfo
2021_05_01_12_55_30-mpstat
2021_05_01_12_55_30-mpstat-overall
2021_05_01_12_55_30-mutex-status1
2021_05_01_12_55_30-mutex-status2
2021_05_01_12_55_30-mysqldadmin
2021_05_01_12_55_30-netstat
2021_05_01_12_55_30-netstat_s
2021_05_01_12_55_30-opentables1
2021_05_01_12_55_30-opentables2
2021_05_01_12_55_30-output
2021_05_01_12_55_30-pmap
2021_05_01_12_55_30-processlist
2021_05_01_12_55_30-procstat
2021_05_01_12_55_30-procvmstat
2021_05_01_12_55_30-ps
2021_05_01_12_55_30-slabinfo
2021_05_01_12_55_30-slave-status
2021_05_01_12_55_30-sysctl
2021_05_01_12_55_30-top
2021_05_01_12_55_30-trigger
2021_05_01_12_55_30-variables
2021_05_01_12_55_30-vmstat
2021_05_01_12_55_30-vmstat-overall
2021_05_01_12_56_00-df
2021_05_01_12_56_00-disk-space
2021_05_01_12_56_00-diskstats
2021_05_01_12_56_00-hostname
2021_05_01_12_56_00-innodbstatus1
2021_05_01_12_56_00-innodbstatus2
2021_05_01_12_56_00-interrupts
2021_05_01_12_56_00-iostat
2021_05_01_12_56_00-iostat-overall
2021_05_01_12_56_00-log_error
2021_05_01_12_56_00-lsof
2021_05_01_12_56_00-meminfo
2021_05_01_12_56_00-mpstat
2021_05_01_12_56_00-mpstat-overall
2021_05_01_12_56_00-mutex-status1
2021_05_01_12_56_00-mutex-status2
2021_05_01_12_56_00-mysqldadmin
2021_05_01_12_56_00-netstat
2021_05_01_12_56_00-netstat_s
2021_05_01_12_56_00-opentables1
2021_05_01_12_56_00-opentables2
2021_05_01_12_56_00-output
2021_05_01_12_56_00-pmap
2021_05_01_12_56_00-processlist
2021_05_01_12_56_00-procstat
2021_05_01_12_56_00-procvmstat
2021_05_01_12_56_00-ps
2021_05_01_12_56_00-slabinfo
2021_05_01_12_56_00-slave-status
2021_05_01_12_56_00-sysctl
2021_05_01_12_56_00-top
2021_05_01_12_56_00-trigger
2021_05_01_12_56_00-variables
2021_05_01_12_56_00-vmstat
2021_05_01_12_56_00-vmstat-overall
```

# ics data

# A mix of OS and MySQL diagnostics data



```
2021_05_01_12_55_30-df
2021_05_01_12_55_30-disk-space
2021_05_01_12_55_30-diskstats
2021_05_01_12_55_30-hostname
2021_05_01_12_55_30-interrupts
2021_05_01_12_55_30-iostat
2021_05_01_12_55_30-iostat-overall
2021_05_01_12_55_30-lsof
2021_05_01_12_55_30-meminfo
2021_05_01_12_55_30-mpstat
2021_05_01_12_55_30-mpstat-overall
2021_05_01_12_55_30-netstat
2021_05_01_12_55_30-netstat_s
2021_05_01_12_55_30-pmap
2021_05_01_12_55_30-procstat
2021_05_01_12_55_30-procvmstat
2021_05_01_12_55_30-ps
2021_05_01_12_55_30-sysctl
2021_05_01_12_55_30-top
2021_05_01_12_55_30-vmstat
2021_05_01_12_55_30-vmstat-overall
```



```
2021_05_01_12_55_30-innodbstatus1
2021_05_01_12_55_30-innodbstatus2
2021_05_01_12_55_30-log_error
2021_05_01_12_55_30-mutex-status1
2021_05_01_12_55_30-mutex-status2
2021_05_01_12_55_30-mysqldadmin
2021_05_01_12_55_30-opentables1
2021_05_01_12_55_30-opentables2
2021_05_01_12_55_30-processlist
2021_05_01_12_55_30-slave-status
2021_05_01_12_55_30-variables
```

*pt-stalk*

```
2021_05_01_12_55_30-output
2021_05_01_12_55_30-trigger
```

# Was the server under moderate or high load when the data was captured?

## top

```
top - 11:23:16 up 14 days, 23:54,  4 users,  load average: 20.17, 17.82, 14.98
Tasks: 262 total,   1 running, 261 sleeping,   0 stopped,   0 zombie
%Cpu(s): 78.2 us,   6.9 sy,   0.0 ni, 14.2 id,   0.4 wa,   0.0 hi,   0.4 si,   0.0 st
KiB Mem : 13186303+total,   658972 free, 11101868+used, 20185376 buff/cache
KiB Swap: 8388604 total,   8215548 free,   173056 used. 20041612 avail Mem
```

| PID   | USER  | PR | NI | VIRT   | RES    | SHR    | S | %CPU | %MEM | TIME+   | COMMAND |
|-------|-------|----|----|--------|--------|--------|---|------|------|---------|---------|
| 3408  | mysql | 20 | 0  | 112.4g | 104.9g | 141832 | S | 1169 | 83.4 | 3761:10 | mysqld  |
| 16379 | root  | 20 | 0  | 113652 | 1340   | 608    | S | 6.2  | 0.0  | 0:00.01 | bash    |
| 16530 | root  | 20 | 0  | 162020 | 2180   | 1528   | R | 6.2  | 0.0  | 0:00.01 | top     |
| 1     | root  | 20 | 0  | 52148  | 3448   | 1940   | S | 0.0  | 0.0  | 4:37.76 | systemd |

# Was the server under moderate or high load when the data was captured?

top

(76.9/192=) **40%**

```
top - 15:30:26 up 258 days, 21 min, 16 users,  load average: 76.90, 78.63, 80.69
Tasks: 1711 total,  1 running, 1710 sleeping,   0 stopped,   0 zombie
%Cpu(s): 23.2 us,  6.5 sy,  0.0 ni, 59.7 id, 10.0 wa,  0.0 hi,  0.7 si,  0.0 st
KiB Mem : 15847333+total, 8529432 free, 78651558+used, 78968825+buff/cache
KiB Swap: 23488102+total, 23441689+free,  464128 used. 79652627+avail Mem
```

| PID   | USER   | PR | NI | VIRT   | RES    | SHR    | S | %CPU  | %MEM | TIME+     | COMMAND |
|-------|--------|----|----|--------|--------|--------|---|-------|------|-----------|---------|
| 45930 | mysql  | 20 | 0  | 652.5g | 645.5g | 10128  | S | 2163  | 42.7 | 160718:24 | mysqld  |
| 91413 | apuser | 20 | 0  | 34.8g  | 9.1g   | 164012 | S | 368.4 | 0.6  | 1037:45   | java    |
| 11450 | root   | 20 | 0  | 173092 | 4332   | 1920   | R | 21.1  | 0.0  | 0:00.05   | top     |

Was the  
server under  
moderate or  
high load  
when the  
data was  
captured?

## meminfo

TS 1616111316.005848775 2021-03-18 23:48:36

```
MemTotal:      197910740 kB
MemFree:       3300968 kB
MemAvailable:  15070884 kB
Buffers:       137580 kB
Cached:        11954976 kB
SwapCached:    0 kB
Active:        178836988 kB
Inactive:      7812608 kB
Active(anon):  174796296 kB
Inactive(anon): 162712 kB
Active(file):  4040692 kB
Inactive(file): 7649896 kB
Unevictable:   0 kB
Mlocked:      0 kB
SwapTotal:     0 kB
SwapFree:      0 kB
(...)
AnonHugePages: 108390400 kB
```

# Depicting CPU usage and I/O

## mpstat

| 11:23:16 AM | CPU | %usr   | %nice | %sys | %iowait |
|-------------|-----|--------|-------|------|---------|
| 11:23:17 AM | all | 77.51  | 0.00  | 1.50 | 0.94    |
| 11:23:17 AM | 0   | 91.92  | 0.00  | 1.01 | 0.00    |
| 11:23:17 AM | 1   | 61.86  | 0.00  | 2.06 | 3.09    |
| 11:23:17 AM | 2   | 67.68  | 0.00  | 3.03 | 1.01    |
| 11:23:17 AM | 3   | 81.00  | 0.00  | 2.00 | 0.00    |
| 11:23:17 AM | 4   | 100.00 | 0.00  | 0.00 | 0.00    |
| 11:23:17 AM | 5   | 55.56  | 0.00  | 2.02 | 3.03    |
| 11:23:17 AM | 6   | 73.74  | 0.00  | 3.03 | 0.00    |
| 11:23:17 AM | 7   | 62.63  | 0.00  | 1.01 | 0.00    |
| 11:23:17 AM | 8   | 56.00  | 0.00  | 3.00 | 3.00    |
| 11:23:17 AM | 9   | 82.00  | 0.00  | 1.00 | 2.00    |
| 11:23:17 AM | 10  | 98.02  | 0.00  | 0.00 | 0.00    |
| 11:23:17 AM | 11  | 67.68  | 0.00  | 1.01 | 1.01    |
| 11:23:17 AM | 12  | 79.80  | 0.00  | 2.02 | 0.00    |
| 11:23:17 AM | 13  | 100.00 | 0.00  | 0.00 | 0.00    |
| 11:23:17 AM | 14  | 87.88  | 0.00  | 2.02 | 0.00    |
| 11:23:17 AM | 15  | 76.24  | 0.00  | 0.99 | 0.99    |

## variables

| %irq | %soft | %steal | %guest | %gnice | %idle |
|------|-------|--------|--------|--------|-------|
|------|-------|--------|--------|--------|-------|

```
$ grep "slave_parallel_" *-variables
slave_parallel_type      LOGICAL_CLOCK
slave_parallel_workers    8
```

|      |      |      |      |      |       |
|------|------|------|------|------|-------|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00  |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 39.39 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 23.23 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 36.36 |
| 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 37.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 15.00 |
| 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 0.99  |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 30.30 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.18 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00  |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.10 |
| 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 20.79 |

# Depicting CPU usage and I/O

## iostat

| Device: | rrqm/s | wrqm/s | r/s  | w/s            | rkB/s | wkB/s    | avgrq-sz | avgqu-sz    | await | r_await | w_await | svctm | %util |
|---------|--------|--------|------|----------------|-------|----------|----------|-------------|-------|---------|---------|-------|-------|
| sdb     | 0.00   | 4.00   | 0.00 | <b>1187.00</b> | 0.00  | 58873.33 | 99.20    | <b>4.71</b> | 3.97  | 0.00    | 3.97    | 0.04  | 5.20  |
| sda     | 0.00   | 0.00   | 0.00 | 0.33           | 0.00  | 1.33     | 8.00     | 0.00        | 0.00  | 0.00    | 0.00    | 0.00  | 0.00  |
| dm-0    | 0.00   | 0.00   | 0.00 | 0.00           | 0.00  | 0.00     | 0.00     | 0.00        | 0.00  | 0.00    | 0.00    | 0.00  | 0.00  |
| dm-1    | 0.00   | 0.00   | 0.00 | 1187.33        | 0.00  | 58841.33 | 99.12    | 4.76        | 4.01  | 0.00    | 4.01    | 0.04  | 5.20  |

## variables

```
$ grep "innodb_io_capacity" *-variables
innodb_io_capacity 1000
innodb_io_capacity_max 10000
```

# Depicting CPU usage and I/O

## vmstat

```
procs -----memory----- ---swap-- -----io----- -system-- -----cpu-----
r  b   swpd   free   buff   cache   si   so    bi    bo    in    cs  us  sy  id  wa  st
28  2  172544 676900 160176 20025276    0    0   158   243    1    1 16   1 83   0   0
29  0  172544 672692 160312 20027832  260    0  1064  3588 22249 3959 95   2   3   0   0
17  0  172544 669032 160316 20028860   52    0   348  3436 20754 5070 78   2  20   1   0
(...)
13  0  172544 697792 160536 19998792    0    0   576  3600 19421 5221 73   2  24   1   0
21  0  173056 705116 160532 19991780    0  300  1744  3936 183103 4090 86   3  10   1   0
11  0  173056 696420 160540 19999820    0   88  7360  3548 48524 4451 82   2  16   0   0
21  0  173056 692664 160540 20003536    0    0  3280  3716 20936 4711 88   2   9   1   0
```

# MySQL in motion

SHOW GLOBAL STATUS —→ mysqladmin

***pt-mext***

<https://www.percona.com/doc/percona-toolkit/LATEST/pt-mext.html>

```
$ pt-mext -r -- cat 2021_05_01_12_55_30-mysqladmin > ptmext.out
```

# Does my hot data fit in memory?

```
$ grep "Innodb_buffer_pool_read_requests\|Innodb_buffer_pool_reads" ptmext.out
```

```
Innodb_buffer_pool_read_requests      69496091591      4040274      3636485
3475398      3509297      3324067      2790171      3811242
3820111      4472993      4240323      3603441      4636822
4713943      4880787      4032916      4328607      3959668
4187900      3883735      3850137      4166323      3933372
3628560      4101771      2766796      3220822      4093628
3581942

Innodb_buffer_pool_reads      9420027      12      17
7      11      28      21      16
53      5      4      17      10
9      14      9
30      4      6
10      1      115
56
```

| Raw value | <i>pt-mext</i> |
|-----------|----------------|
| 9420027   | 9420027        |
| 9420039   | +12            |
| 9420056   | +17            |
| 9420063   | +7             |

# Looking at temporary tables

```
$ grep "tmp_table_size\\|max_heap_table_size" *-variables  
max_heap_table_size 209715200  
tmp_table_size 209715200
```

|                                |     |     |           |     |     |     |
|--------------------------------|-----|-----|-----------|-----|-----|-----|
| <b>Created_tmp_tables</b>      |     |     | 134023235 | 115 | 546 | 525 |
| 474                            | 542 | 452 | 550       | 557 | 493 | 641 |
| 763                            | 548 | 356 | 250       | 558 | 419 | 129 |
| 23                             | 19  | 406 | 234       | 595 | 542 | 420 |
| 419                            | 511 | 637 | 271       |     |     |     |
| <b>Created_tmp_disk_tables</b> |     |     | 61327112  | 73  | 523 | 501 |
| 448                            | 518 | 421 | 533       | 540 | 464 | 618 |
| 741                            | 528 | 332 | 216       | 522 | 400 | 113 |
| 8                              | 7   | 363 | 208       | 575 | 519 | 396 |
| 400                            | 483 | 610 | 236       |     |     |     |

# Looking at temporary tables

```
top - 15:54:29 up 126 days,  1:18,  3 users,  load average: 4.17, 4.34, 4.70
Tasks: 445 total,   4 running, 441 sleeping,   0 stopped,   0 zombie
%Cpu(s):  8.0 us,  6.3 sy,   0.0 ni, 71.8 id, 13.5 wa,   0.0 hi,   0.4 si,   0.0 st
KiB Mem : 13176490+total, 1973120 free, 10337484+used, 26416932 buff/cache
KiB Swap: 10485756 total,   562384 free,  9923372 used. 26613916 avail Mem
```

| PID   | USER  | PR | NI | VIRT   | RES   | SHR  | S | %CPU  | %MEM | TIME+    | COMMAND |
|-------|-------|----|----|--------|-------|------|---|-------|------|----------|---------|
| 11830 | mysql | 20 | 0  | 111.4g | 93.8g | 8760 | S | 175.0 | 74.6 | 10332:00 | mysqld  |

| procs |   | -----memory----- |         |      |          | ---swap-- |    | -----io---- |       | -system-- |       | -----cpu----- |    |    |    |    |
|-------|---|------------------|---------|------|----------|-----------|----|-------------|-------|-----------|-------|---------------|----|----|----|----|
| r     | b | swpd             | free    | buff | cache    | si        | so | bi          | bo    | in        | cs    | us            | sy | id | wa | st |
| 18    | 4 | 9923884          | 1988808 | 40   | 26417080 | 1         | 1  | 33          | 584   | 0         | 0     | 2             | 1  | 97 | 0  | 0  |
| 5     | 3 | 9919788          | 1980508 | 40   | 26424644 | 5556      | 0  | 17444       | 30576 | 42479     | 53317 | 4             | 2  | 82 | 11 | 0  |
| 2     | 3 | 9912876          | 1970328 | 40   | 26427844 | 7872      | 0  | 21856       | 35881 | 50203     | 67962 | 6             | 2  | 82 | 11 | 0  |
| 2     | 3 | 9903404          | 1955664 | 40   | 26433916 | 10992     | 0  | 24208       | 41452 | 58789     | 76326 | 6             | 2  | 82 | 10 | 0  |
| 3     | 4 | 9893932          | 1938188 | 40   | 26437384 | 11008     | 0  | 25712       | 39040 | 54518     | 65092 | 6             | 2  | 82 | 11 | 0  |
| 5     | 3 | 9888044          | 1926884 | 40   | 26442912 | 7776      | 0  | 27152       | 37513 | 75462     | 82150 | 17            | 3  | 71 | 9  | 0  |
| 2     | 4 | 9881644          | 1917948 | 40   | 26445612 | 7336      | 0  | 23288       | 32787 | 44001     | 53016 | 7             | 2  | 79 | 12 | 0  |
| 5     | 4 | 9869612          | 1896296 | 40   | 26450052 | 15308     | 0  | 30748       | 34702 | 50177     | 58230 | 9             | 2  | 77 | 12 | 0  |

# Contention at the table cache level

|                                   |      |           |      |      |      |
|-----------------------------------|------|-----------|------|------|------|
| <b>Opened_tables</b>              |      | 17369503  | 123  | 179  | 187  |
| 228                               | 307  | 296       | 350  | 209  | 208  |
| 192                               | 219  | 308       | 183  | 316  | 260  |
| 312                               | 291  | 123       | 237  | 152  | 146  |
| 208                               | 273  | 284       | 335  | 110  | 238  |
| <b>Table_open_cache_hits</b>      |      | 697915937 | 5362 | 7645 | 6461 |
| 4789                              | 4815 | 5912      | 6569 | 5989 | 7260 |
| 4128                              | 5892 | 7822      | 4265 | 7562 | 5032 |
| 6892                              | 6451 | 2865      | 5740 | 5475 | 3744 |
| 5568                              | 6137 | 4688      | 5687 | 1940 | 3743 |
| <b>Table_open_cache_misses</b>    |      | 17355555  | 123  | 179  | 187  |
| 228                               | 307  | 296       | 350  | 209  | 208  |
| 192                               | 219  | 308       | 183  | 316  | 260  |
| 312                               | 290  | 123       | 237  | 152  | 146  |
| 208                               | 273  | 284       | 335  | 110  | 238  |
| <b>Table_open_cache_overflows</b> |      | 17344722  | 123  | 179  | 187  |
| 228                               | 307  | 296       | 350  | 209  | 208  |
| 192                               | 219  | 308       | 183  | 316  | 260  |
| 312                               | 290  | 123       |      |      | 146  |
| 208                               | 273  | 284       |      |      | 238  |

```
$ grep table_open_cache *-variables
table_open_cache 10708
table_open_cache_instances 16
```

# Looking inside the (real) engine

SHOW ENGINE INNODB STATUS —————→ *innodbstatus*

## Transactions running

```
$ grep "\---TRANSACTION" innodbstatus |wc -l  
2503
```

```
$ grep "\---TRANSACTION" innodbstatus | grep ACTIVE | wc -l  
273
```

*Tuning the engine  
for the race track*

innodb\_thread\_concurrency

—————→ The workload dictates how  
MySQL should be tuned!

# Long-running transactions

```
trx_id: 48793810 transactions
trx_state: RUNNING
trx_started: 2020-08-21 10:00:23
trx_requested_lock_id: NULL
trx_wait_started: NULL
trx_weight: 3805639
---TRANSACTION 48793810, ACTIVE 293183 sec
106688 lock struct(s), heap size 10887376, 1642661 row lock(s), undo log entries 3698942
MySQL thread id 349, OS thread handle 140316247336704, query id 64765183 myserver.hostname.com
172.x.x.x myuser
Trx read view will not see trx with id >= 48793810, sees < 48793810
trx_tables_in_use: 0
trx_tables_locked: 11
```

## processlist

```
trx_lock_structs: 106688
trx_lock_memory_bytes: 10887376
Id: 349
trx_rows_locked: 1642663
User: myuser
trx_rows_modified: 3698951
Host:
trx_concurrency_tickets: 0
myserver.hostname.com:60260
trx_isolation_level: REPEATABLE_READ
db: mydatabase
trx_unique_checks: 1
Command: Sleep
trx_foreign_key_checks: 1
Time: 1
trx_last_foreign_key_error: NULL
State:
trx_adaptive_hash_latched: 0
Info: NULL
trx_adaptive_hash_timeout: 0
Rows_sent: 0
Rows_examined: 0
trx_is_read_only: 0
trx_autocommit_non_locking: 0
```

## lock-waits

```
who blocks: thread 349 from
myserver.hostname.com:60260
idle_in_trx: 1
max_wait_time: 49
num_waiters: 10
```

# Checkpointing and redo log space

```
$ grep "Log sequence number" 2020_08_24_15_*-innodbstatus1  
2020_08_24_15_30_25-innodbstatus1:Log sequence number 66452632416280  
2020_08_24_15_30_55-innodbstatus1:Log sequence number 66453484080767
```

$$(66453484080767 - 66452632416280) * 2 * 60 \approx 95\text{G/h}$$
$$20\text{min} \approx (\text{innodb\_log\_file\_size} \rightarrow 16\text{G}) \times (\text{innodb\_log\_files\_in\_group} \rightarrow 2)$$

# Adaptive Hash Index

```
$ grep "hash searches" innodbstatus  
19000.00 hash searches/s, 1955000.00 non-hash searches/s
```

`Innodb_adaptive_hash_index = 0`

*Experiment with and without it*

# A quick note on processlist

## processlist

```
$ cat processlist|grep  
Command:|sort|uniq -c|sort -rn  
2750 Command: Sleep  
1226 Command: Query  
36 Command: Connect  
29 Command: Binlog Dump  
2 Command: Execute
```

```
$ cat processlist|grep State:|sort|uniq -c|sort -rn  
2750 State:  
548 State: Opening tables  
369 State: statistics  
103 State: Sending data  
68 State: starting  
31 State: query end  
31 State: Creating sort index  
29 State: Waiting for the slave SQL thread to free enough relay log space  
27 State: update  
18 State: executing  
17 State: Master has sent all binlog to slave; waiting for more updates  
14 State: Sending to client  
7 State: updating  
6 State: Receiving from client  
6 State: preparing for alter table  
5 State: checking permissions  
4 State: Waiting for table metadata lock  
4 State: closing tables  
3 State: System lock  
1 State: Sending binlog event to slave  
1 State: preparing  
1 State: creating table
```

# What to check next ...

- *pt-stalk* running in the background as a *daemon*
- The best complement to our beloved trifecta is **PMM**!

Check it out at:

<https://pmmdemo.percona.com/>

# THANK YOU!



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**MAY 12 - 13th**  
**2021**