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Easy MySQL server performance tuning for everyone

why 8MB is not enough and 256KB definitely is

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Customer Support, MySQL





Who am I?

Trent Lloyd

- Based in Perth, Australia
- 2002: Linux, Free Software and Open Source enthusiast with PLUG
- 2003: Systems Administration & Support for Linux in Web Hosting
- 2003, 2004: Linux.conf.au IPv6 Mini-Conference
- 2005: Project Team for Avahi – Bonjour compatible mDNS/DNS-SD service discovery stack for Linux
- 2007: Support Engineer for MySQL



MySQL Overview

- World's most popular open source database
- Leading database for web applications
- Estimated to have over 15 million active installations
- GPL 2.0 with FLOSS exception
- Lead development by Oracle who continues to invest heavily
- MySQL 5.5 GA and 5.6GA released under Oracle



MySQL 5.5

- Scalability improvements
- InnoDB Default
- Semi-sync replication
- IPv6 Support
- Metadata locking
- Performance Schema



MySQL 5.6

- More scalability work
- Persistent Optimizer Stats
- memcached API
- Partitions
 - Exchange partitions
- Multi-threaded replication slaves
- Binary log checksum
- GTID replication



THIS IS A VERY
SIMPLISTIC OVERVIEW



WHY TUNE THE SERVER?



Why tune the server

**MYSQL DOES NOT AUTOMATICALLY
SCALE TO SERVER SPECIFICATIONS**



Why tune the server

Configuration Defaults

- RAM usage (<128MB)
- Server Connections (<100)
- Tables (<500)
- Memory data caching (5.1: 8MB, 5.5+: 128MB)



Configuration File

- my.cnf file
- ini format

- On-disk location
 - /etc/mysql/my.cnf
 - /etc/my.cnf
 - /usr/local/mysql/my.cnf



Configuration File

Example

```
[mysqld_safe]
socket          = /var/run/mysqld/mysqld.sock
```

```
[mysqld]
user            = mysql
datadir        = /var/lib/mysql
innodb_buffer_pool_size = 128M
max_allowed_packet = 16M
sort_buffer_size = 256K
```



Configuration Settings

Runtime View

```
mysql> SHOW GLOBAL VARIABLES;
+-----+
| Variable_name          | Value |
+-----+
| auto_increment_increment | 1     |
| auto_increment_offset   | 1     |
| autocommit              | ON    |
| automatic_sp_privileges | ON    |
| ...                     |      |
+-----+
```

426 rows in set (0.00 sec)



Configuration Settings

Runtime View

```
mysql> SHOW GLOBAL VARIABLES LIKE 'innodb_buffer_pool_size';
```

Variable_name	Value
innodb_buffer_pool_size	134217728

```
1 row in set (0.00 sec)
```



Configuration File

Dynamic Changes

- Values copied from global scope to session scope on connection
- Dynamic variables can be updated at runtime

```
SET GLOBAL sort_buffer_size=128*1024;  
SET SESSION sort_buffer_size=128*1024;
```

- Restart required to re-read my.cnf

Server System Variables

Table 5.3. System Variable Summary

Name	Cmd-Line	Option file	System Var	Var Scope	Dynamic
audit_log_buffer_size			Yes	Global	No
audit_log_file			Yes	Global	No
audit_log_flush			Yes	Global	Yes
audit_log_format			Yes	Global	No
audit_log_policy			Yes	Global	Yes
audit_log_rotate_on_size			Yes	Global	Yes
audit_log_strategy			Yes	Global	No
auto_increment_increment			Yes	Both	Yes
auto_increment_offset			Yes	Both	Yes
autocommit	Yes	Yes	Yes	Both	Yes
automatic_sp_privileges			Yes	Global	Yes
back_log			Yes	Global	No
basedir	Yes	Yes	Yes	Global	No

<http://dev.mysql.com/doc/refman/5.6/en/server-system-variables.html>

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Server System Variables

- [socket](#)

Command-Line Format	<code>--socket=name</code>
Option-File Format	<code>socket</code>
System Variable Name	<code>socket</code>
Variable Scope	Global
Dynamic Variable	No
	Permitted Values
	Type <code>file name</code>
	Default <code>/tmp/mysql.sock</code>

On Unix platforms, this variable is the name of the socket file that is used for local client connections. The default is `/tmp/mysql.sock`. (For some distribution formats, the directory might be different, such as `/var/lib/mysql` for RPMs.)

On Windows, this variable is the name of the named pipe that is used for local client connections. The default value is `MySQL` (not case sensitive).

- <http://dev.mysql.com/doc/refman/5.6/en/server-system-variables.html>



Server System Status

```
mysql> show global status;
```

Variable_name	Value
Bytes_received	56490295673
Bytes_sent	4289020206565
Com_commit	54551771
Com_select	189018735
Com_update	7443524
Created_tmp_tables	5415701
Select_full_join	248874
Select_range	17551031



Performance Schema

- Incredibly powerful
- Outside of the scope of this talk

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Example case



Max Connections

ERROR 1040 (HY000): Too many connections



Max Connections

```
mysql> show global status like '%connections';
```

Variable_name	Value
Connections	3889463
Max_used_connections	151

```
Mysql> show global variables like 'max_connections';
```

Variable_name	Value
max_connections	151



Max Connections

```
[mysqld]  
max_connections=1000
```



Max Connections

```
kernel: [1182395.730878] lowmem_reserve[]: 0 0 0 0
kernel: [1182395.730881] DMA: 3*4kB 3*8kB 3*16kB 4*32kB 3*64kB 1*128kB 1*256kB 1*512kB 2*1024kB 0*2048kB 2*40
kernel: [1182395.730900] DMA32: 62*4kB 4*8kB 3*16kB 4*32kB 2*64kB 0*128kB 1*256kB 0*512kB 1*1024kB 1*2048kB 1
kernel: [1182395.730908] Swap cache: add 0, delete 0, find 0/0, race 0+0
kernel: [1182395.730910] Free swap = 0kB
kernel: [1182395.730911] Total swap = 0kB
kernel: [1182395.730912] Free swap:                0kB
kernel: [1182395.740886] 1048576 pages of RAM
kernel: [1182395.740893] 21255 reserved pages
kernel: [1182395.740894] 39897 pages shared
kernel: [1182395.740895] 0 pages swap cached
kernel: [1182395.740898] Out of memory: kill process 25246 (mysqld) score 73450 or a child
kernel: [1182395.740913] Killed process 25246 (mysqld)
```


BIGGER NUMBERS ARE NOT BETTER NUMBERS





You're doing it wrong

```
sort_buffer_size = 32M
read_buffer_size = 32M
read_rnd_buffer_size = 128M
myisam_sort_buffer_size = 128M
thread_concurrency = 100
query_cache_size = 1G
max_connections = 2000
```



You're doing it wrong

- Per-connection buffers
- Global buffers

Parameter	MySQL Default	Your Value
key_buffer_size	64 MB	64 MB
+ query_cache_size	64 MB	1024 MB
+ tmp_table_size	32 MB	32 MB
+ innodb_buffer_pool_size	8 MB	2048 MB
+ innodb_additional_mem_pool_size	1 MB	8 MB
+ innodb_log_buffer_size	1 MB	1 MB
+ max_connections	150	2000
x		
sort_buffer_size	2 MB	32 MB
+ read_buffer_size	0.128 MB	32 MB
+ read_rnd_buffer_size	0.256 MB	128 MB
+ join_buffer_size	0.128 MB	8 MB
+ thread_stack	0.196 MB	0.196 MB
+ binlog_cache_size	0 MB	0 MB
Totals:	576.2 MB	403569 MB

Calculator image credit: www.mysqlcalculator.com

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It's our fault

my-small.cnf
<= 64MB

my-large.cnf
512MB

my-huge.cnf
1-2 GB



It's our fault

	MySQL 3.23.58 (April 2003)
my-small.cnf ≤ 64MB	
my-large.cnf 512MB	
my-huge.cnf 1-2 GB	

It's our fault

	MySQL 3.23.58 (April 2003)
my-small.cnf ≤ 64MB	table_cache = 4 sort_buffer_size = 64K key_buffer_size = 16K
my-large.cnf 512MB	table_cache=256 sort_buffer_size = 1M key_buffer_size = 256M
my-huge.cnf 1-2 GB	table_cache = 512 sort_buffer_size = 2M key_buffer_size = 384M

It's our fault

	MySQL 3.23.58 (April 2003)	MySQL 5.5.34 (December 2013)
my-small.cnf ≤ 64MB	table_cache = 4 sort_buffer_size = 64K key_buffer_size = 16K	
my-large.cnf 512MB	table_cache=256 sort_buffer_size = 1M key_buffer_size = 256M	
my-huge.cnf 1-2 GB	table_cache = 512 sort_buffer_size = 2M key_buffer_size = 384M	

It's our fault

	MySQL 3.23.58 (April 2003)	MySQL 5.5.34 (December 2013)
my-small.cnf ≤ 64MB	table_cache = 4 sort_buffer_size = 64K key_buffer_size = 16K	table_cache = 4 sort_buffer_size = 64K key_buffer_size = 16K
my-large.cnf 512MB	table_cache=256 sort_buffer_size = 1M key_buffer_size = 256M	table_cache=256 sort_buffer_size = 1M key_buffer_size = 256M
my-huge.cnf 1-2 GB	table_cache = 512 sort_buffer_size = 2M key_buffer_size = 384M	table_cache = 512 Sort_buffer_size = 2M key_buffer_size = 384M

It's our fault

	MySQL 3.23.58 (April 2003)	MySQL 5.5.34 (December 2013)
my-small.cnf ≤ 64MB	table_cache = 4 sort_buffer_size = 64K key_buffer_size = 16K	table_cache = 4 sort_buffer_size = 64K key_buffer_size = 16K
my-large.cnf 512MB	table_cache=256 sort_buffer_size = 1M key_buffer_size = 256M	table_cache=256 sort_buffer_size = 1M key_buffer_size = 256M
my-huge.cnf 1-2 GB	table_cache = 512 sort_buffer_size = 2M key_buffer_size = 384M	table_cache = 512 Sort_buffer_size = 2M key_buffer_size = 384M
my-innodb-heavy-4G.cnf 4 GB		sort_buffer_size = 8M read_rnd_buffer_size = 16M join_buffer_size = 8M



Optimal MySQL Configuration #1

```
[mysqld]  
user=mysql
```



AVOID EXCESSIVE TUNING

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System Specifications



MySQL Process List

- Multi-core is good for multi-queries
- As much RAM as you can afford

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System Information



MySQL Process List

- SHOW PROCESSLIST

```
+----+-----+-----+-----+-----+-----+-----+
| Id | User | Host                | db   | Command | Time | State           |
+----+-----+-----+-----+-----+-----+-----+
|  1 | root | localhost:32893     | NULL | Sleep   |    0 |                 |
| 31 | root | localhost:41831     | db34 | Query   |    4 | Opening tables |
| 88 | root | localhost:41831     | db00 | Query   |    2 | Opening tables |
| 89 | root | localhost:41831     | db34 | Query   |    7 | Opening tables |
| 43 | root | localhost:41831     | db33 | Query   |    3 | Closing tables |
```



System Utilisation

```
trentl@membrane:~$ vmstat 5 5
procs  -----memory-----  ---swap--  -----io-----  -system--  -----cpu-----
 r  b   swpd   free   buff  cache   si   so    bi    bo    in   cs  us  sy  id  wa
 1  0  629284 110472 45292 423132    9    4   85   532    3    0  20  7  72  1
 0  0  629284 110216 45300 423132    0    0    0    98   113  245  2  1  97  0
 0  0  629284 110216 45304 423132    0    0    0   147   110  241  2  1  97  0
 0  0  629284 110216 45312 423132    0    0    0    25   111  250  2  1  98  0
 0  0  629284 109844 45316 423536    0    0    0   228   123  235  2  0  98  0
```




System Utilisation

```
top - 09:50:33 up 221 days, 10:32,  2 users,  load average: 1.62, 1.51, 1.59
Tasks: 144 total,  1 running, 143 sleeping,  0 stopped,  0 zombie
Cpu(s): 12.5%us,  0.7%sy,  0.0%ni, 86.1%id,  0.3%wa,  0.0%hi,  0.3%si,  0.0%st
Mem:   8103040k total,  7859836k used,  243204k free,  158228k buffers
Swap:  3903484k total,  1923204k used,  1980280k free,  669072k cached
```

```
  PID USER      PR  NI  VIRT  RES  SHR  S  %CPU  %MEM    TIME+  COMMAND
 3685 mysql-cu  20   0 6664m 4.6g 5368  S   105  58.9 206987:27 mysqld
 6922 mysql-in  20   0 2073m 773m 4896  S    1   9.8   3084:08 mysqld
```

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Caches and limits

Tables, Connections, Threads...



Max Connections

```
mysql> show global status like '%connect%';
+-----+
| Variable_name      | Value    |
+-----+
| Connections        | 3889463  |
| Max_used_connections | 151      |
| Threads_connected  | 47       |
+-----+

mysql> show global variables like 'max_connections';
+-----+
| Variable_name | Value |
+-----+
| max_connections | 151  |
+-----+
```



Table Cache

How to check it's performance

- Every query using a table opens a copy (even of the same table)
- Un-used copies are cached for later re-use

```
mysql [localhost] {msandbox} ((none)) > SHOW GLOBAL STATUS LIKE 'open%tab%';
```

```
+-----+-----+
| Variable_name          | Value |
+-----+-----+
| Open_table_definitions | 128   |
| Open_tables            | 64    |
| Opened_table_definitions | 5144  |
| Opened_tables          | 503039|
+-----+-----+
```



Table Cache

Signs of trouble

- SHOW PROCESSLIST

```
+-----+-----+-----+-----+-----+-----+-----+
| Id | User | Host                | db   | Command | Time | State           |
+-----+-----+-----+-----+-----+-----+-----+
|  1 | root | localhost:32893    | NULL | Sleep   |    0 |                 |
| 31 | root | localhost:41831    | db34 | Query   |    4 | Opening tables |
| 88 | root | localhost:41831    | db00 | Query   |    2 | Opening tables |
| 89 | root | localhost:41831    | db34 | Query   |    7 | Opening tables |
| 43 | root | localhost:41831    | db33 | Query   |    3 | Closing tables |
```



Table Cache

Determine the optimum value

- $\text{max_connections} * (\text{tables used per connection})$
- Example:

```
table_open_cache = 4000  
table_definition_cache = 10000
```



Thread Cache

How to check it's performance

- Every connection to the MySQL server uses it's own thread
- Creating threads is expensive, they are saved for re-use

```
mysql> SHOW GLOBAL STATUS LIKE 'Threads_%';
```

Variable_name	Value
Threads_cached	0
Threads_connected	40
Threads_created	144254
Threads_running	1
Connections	144258



Thread Cache

Determine the optimum value

- 0 ... max_connections

- Example:

```
thread_cache = 100
```


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Big Buffers

data & index memory caching, query
caching



MyISAM: Key Buffer (key_buffer_size)

- MyISAM **Index** Data
- Includes mysql.* tables (user permissions, etc)
- Note: MyISAM relies upon OS file system cache for **data**



MyISAM: Key Buffer (key_buffer_size)

How to check it's performance

```
mysql> SHOW GLOBAL STATUS LIKE 'Key_%';
```

Variable_name	Value
Key_blocks_not_flushed	0
Key_blocks_unused	6694
Key_blocks_used	7
Key_read_requests	26330574
Key_reads	0
Key_write_requests	14194766
Key_writes	0

```
7 rows in set (0.00 sec)
```



InnoDB: Buffer Pool (`innodb_buffer_pool_size`)

Stores InnoDB pages (data and indexes) in memory

InnoDB: Buffer Pool (innodb_buffer_pool_size)

Checking it's performance

```
mysql> SHOW GLOBAL STATUS LIKE 'Innodb_buffer_pool_%';
```

Variable_name	Value
Innodb_buffer_pool_pages_data	506
Innodb_buffer_pool_pages_dirty	269
Innodb_buffer_pool_pages_free	0
Innodb_buffer_pool_pages_total	512
Innodb_buffer_pool_read_requests	179226033200
Innodb_buffer_pool_reads	630885779

$(630885779/179226033200) * 100 = 0.35\%$

InnoDB: Buffer Pool (innodb_buffer_pool_size)

Checking it's performance

```
mysql> SHOW GLOBAL STATUS LIKE 'Innodb_buffer_pool_%';
```

Variable_name	Value
Innodb_buffer_pool_pages_data	506
Innodb_buffer_pool_pages_dirty	269
Innodb_buffer_pool_pages_free	0
Innodb_buffer_pool_pages_total	512
Innodb_buffer_pool_read_requests	179226033200
Innodb_buffer_pool_reads	630885779

```
(630885779/179226033200) * 100 = 0.35%
```



Query Cache (query_cache_size)

- It's a trap!
- Query Text -> Query Result Set



Query Cache (query_cache_size)

Checking it's performance

```
mysql> SHOW GLOBAL STATUS LIKE 'Qcache%';
```

Variable_name	Value
Qcache_free_blocks	217
Qcache_free_memory	27842216
Qcache_hits	2000610
Qcache_inserts	3046887
Qcache_lowmem_prunes	117517
Qcache_not_cached	3930499
Qcache_queries_in_cache	2920
Qcache_total_blocks	6172



YOU CAN PROBABLY STOP HERE

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Little Buffers

per-query sort buffer, join buffer, read
buffer...



256KB

- malloc() 100,000 times

Time for	128k:	0.035259
Time for	256k:	0.009718
Time for	1M:	0.478129
Time for	5M:	0.968945
Time for	10M:	0.965172
Time for	50M:	0.674316
Time for	500M:	1.018901

- 256k: libc malloc() switches from dynamic sized heap to mmap



sort_buffer_size

```
mysql> show global status like 'Sort_merge_passes';
+-----+-----+
| Variable_name      | Value |
+-----+-----+
| Sort_merge_passes | 4174  |
+-----+-----+
```

- 5.5: sort_buffer_size allocated in full
- 5.6: Optimiser guesses a size with a limit of sort_buffer_size
- 5.6: Does not buffer rows not matching limit



read_buffer_size

Default: 128K Range: 8200 .. 2GB

- MyISAM specific
- Only used for full table scans
- Probably won't be doing this on most online systems
- Possibly used for data warehousing, reporting, processing



read_buffer_size

```
mysql> set read_buffer_size=8*1024;
mysql> select * from t1 where a like 'la%';
Empty set (2.34 sec)
mysql> set read_buffer_size=128*1024;
mysql> select * from t1 where a like 'la%';
Empty set (1.64 sec)
mysql> set read_buffer_size=256*1024;
mysql> select * from t1 where a like 'la%';
Empty set (1.78 sec)
mysql> set read_buffer_size=1024*1024;
mysql> select * from t1 where a like 'la%';
Empty set (1.53 sec)
mysql> set read_buffer_size=10024*1024;
mysql> select * from t1 where a like 'la%';
Empty set (2.03 sec)
```



read_rnd_buffer_size

- Used for all storage engines
- When scanning tables with an index
- Optimally read rows after sort

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SUMMARY



DO

- `innodb_buffer_pool_size`
- `max_connections`
- `key_buffer_size`



DO NOT

- Set every variable
- Copy configs from Google

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QUESTION TIME

Why Penguin's have short lives



Hardware and Software

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Engineered to Work Together

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