



Operational DBA In A Nutshell

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PERCONA
LIVE

Introduction

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- Welcome!
- Who are we?
 - Fans of devopsreactions.tumblr.com
- What will we talk about?



Basic Housekeeping

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- Full Day Tutorial
- HandsOn!, Laptop Required
- Breaks
- Wireless SSID = ??
- How to ask for help
- Using the documentation

Beware!

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- I know what `replicate_same_server_id` is!
- I know all GRANTS by heart!
- `pt-query-digest` is my favorite tool!
- I've been dealing with replication inconsistencies for a while already!
- My backup environment is the most awesome there is!

Beware!

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- I know what `replicate_same_server_id` is!
- I know all GRANTs by heart!
- `pt-query-digest` is my favorite tool!
- I've been dealing with replication inconsistencies for a while already!
- My backup environment is the most awesome there is!

**TAKE THE DAY OFF
AND GET SOME BEER**

Operational DBA In A Nutshell

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- Setting Up Today's Environment
- Installation
- Logging In
- MySQL Privileges
- Diagnostics
- Troubleshooting
- Monitoring
- Backups
- Replication
- Schema Changes
- Configuration Optimization

How doing operations feels



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How doing operations feels



Today's Application - Basic IMDB Interface

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[Login](#) [Signup](#)

MyMovies

There are 50005 users, 1543720 movies and 2812743 actors in the system.

Random Movie
[Entre Calais et Douvres](#) (1897)

Latest comments

Featured User
[Larry.B.Fargo@dodgit.com](#)

Online right now

Being viewed right now
[Paul Calderon](#)
[Pulp Fiction](#) (1994)
[Tight Security](#) (2001)
[Assrar fi rammel](#) (1954)
[John Travolta](#)

Setting Up Our VM

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- Copy Files From USB Stick
- Install VirtualBox, Import Virtual Machine
- Change ~/Library/VirtualBox/VirtualBox.xml
 - ~/.virtualbox/VirtualBox.xml

```
<MachineRegistry>
  <MachineEntry uuid="{d4a72cfa-d3f1-4d8e-8e32-f72315c48faf}" src="/Users/gryp/
VirtualBox VMs/PLMCE Slave (32bit)/PLMCE Slave (32bit).vbox"/>
  <MachineEntry uuid="{50109a84-d2f1-4992-b359-b1c1b40fbbda}" src="/Users/gryp/
VirtualBox VMs/PLMCE master (32bit)/PLMCE master (32bit).vbox"/>
</MachineRegistry>
```

{50109a84-d2f1-4992-b359-b1c1b40fbbda}

- Test Connectivity
 - ssh -p 2221 root@localhost (password: vagrant)
 - <http://localhost:8080/> (should see an apache test page)

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How doing operations feels



Installation Of MySQL - HandsOn!

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- Install Percona Server

```
# yum install Percona-Server-server-55  
Percona-Server-client-55
```

- Verify if you can connect

```
# mysql
```

- Verify the application:

— <http://localhost:8080/my-movies/>

```
[root@node1 ~]# mysql  
Welcome to the MySQL monitor.  O  
Your MySQL connection id is 270  
Server version: 5.5.30-30.2-log  
500
```

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```
node1 mysql>
```



Operational DBA In A Nutshell

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How doing operations feels



Logging In - HandsOn!

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```
$ mysql
mysql> SHOW DATABASES;
mysql> USE imdb;
mysql> SHOW TABLES;
mysql> SELECT * FROM users LIMIT 1;
mysql> SHOW PROCESSLIST;
```

Operational DBA In A Nutshell

- Setting Up Today's Environment
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- **MySQL Privileges**
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How doing operations feels



MySQL Privileges

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- Users
- Grants
- mysql database
- pt-show-grants
- Default Permissions
- Creating Application user

Asking the security team for a firewall exception



- Identify users based on: user@host
 - user: username
 - host: hostname/ip of the client that connects
 - different host, different user, different 'grants'
- Examples:
`'fred'@'localhost', 'root'@'localhost'`
`'lefred'@'app0001', 'dijkske'@'192.168.%'`
`'ledijkske'@'192.168.1__', 'fredjen'@'app.fq.dn'`
- Creating A User:
`>CREATE USER 'lefred'@'app0001';`
- Drop user: change CREATE into DROP

- Grant the user some kind of privilege
- Grant ... to:
 - server,
database,
table,
 - column,
trigger,
stored procedure,
 - view,
index
- Example: INSERT, SELECT, UPDATE, DELETE
- SQL Command:
 - >GRANT SELECT ON db.* TO 'lefred'@'app0001';
 - >GRANT INSERT ON *.* TO 'lefred'@'app0001';
- Revoking privileges: change GRANT into REVOKE

Table/Column Level Grants

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- Possible:
 - > GRANT SELECT ON db.table TO 'lefred'@'app';
 - > GRANT SELECT (col) ON db.table to 'fr'@'app';
- Too much columns might make authentication slower
- Not commonly used

Password

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```
> SET PASSWORD FOR 'lfred'@'app0001' =  
PASSWORD('pass');
```

```
> SELECT PASSWORD('pass')\G  
PASSWORD('pass'):  
*196BDEDE2AE4F84CA44C47D54D78478C7E2BD7B7
```

```
> SET PASSWORD FOR 'lfred'@'app0001' =  
'*196BDEDE2...';
```

```
> CREATE USER 'lfred'@'app0001' IDENTIFIED  
BY 'pass';
```

```
> CREATE USER 'fred'@'app' IDENTIFIED BY  
PASSWORD '*196BDEDE2...';
```

```
> GRANT SELECT ON db.* TO 'fred'@'app'  
IDENTIFIED BY 'pass';
```

- Complete list of grants:

CREATE
DROP
GRANT OPTION
LOCK TABLES
EVENT
ALTER
DELETE
INDEX
INSERT
SELECT
UPDATE
CREATE TEMPORARY TABLES
TRIGGER
CREATE VIEW
SHOW VIEW

ALTER ROUTINE
CREATE ROUTINE
EXECUTE
FILE
CREATE USER
PROCESS
PROXY
RELOAD
REPLICATION CLIENT
REPLICATION SLAVE
SHOW DATABASES
SHUTDOWN
SUPER
ALL [PRIVILEGES]
USAGE

SHOW GRANTS

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```
> SHOW GRANTS;
```

```
+-----+
| Grants for root@localhost |
+-----+
| GRANT ALL PRIVILEGES ON *.* TO 'root'@'localhost' IDENTIFIED BY |
| PASSWORD '*81F5E21E35407D884A6CD4A731AEBFB6AF209E1B' WITH GRANT |
| OPTION |
+-----+
```

```
> SHOW GRANTS FOR 'lefred'@'app0001';
```

```
+-----+
| Grants for lefred@app0001 |
+-----+
| GRANT INSERT ON *.* TO 'lefred'@'app0001' |
| GRANT SELECT ON `db`.* TO 'lefred'@'app0001' |
+-----+
```

mysql Database

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```
node1 mysql> show tables;
```

Tables_in_mysql	plugin
	proc
	procs_priv
columns_priv	proxies_priv
db	servers
event	slow_log
func	tables_priv
general_log	time_zone
help_category	time_zone_leap_second
help_keyword	time_zone_name
help_relation	time_zone_transition
help_topic	time_zone_transition_type
host	user
ndb_binlog_index	

24 rows in set (0.00 sec)



mysql Database

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- Do not give rights for app or general users to the MySQL database
- DML statements are possible on mysql database
 - use `FLUSH PRIVILEGES` to apply

MySQL Privileges - HandsOn!

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- Install Percona Toolkit

```
# yum install percona-toolkit  
# pt-show-grants
```

- show all grants on a system (in order)
 - good for version control

```
[root@node1 lib]# pt-show-grants  
-- Grants dumped by pt-show-grants  
-- Dumped from server Localhost via UNIX socket, MySQL  
5.5.30-30.2-log at 2013-04-19 00:18:28  
-- Grants for ''@'localhost'  
GRANT USAGE ON *.* TO ''@'localhost';  
-- Grants for ''@'node1'  
GRANT USAGE ON *.* TO ''@'node1';  
-- Grants for 'cactiuser'@'localhost'  
GRANT USAGE ON *.* TO 'cactiuser'@'localhost' IDENTIFIED BY  
PASSWORD '*43DD7940383044FBDE5B177730FAD3405BC6DAD7';
```

MySQL Privileges - HandsOn!

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```
[root@node1 lib]# pt-show-grants
-- Grants dumped by pt-show-grants
-- Dumped from server Localhost via UNIX socket, MySQL
5.5.30-30.2-log at 2013-04-19 00:18:28
-- Grants for '@'localhost'
GRANT USAGE ON *.* TO '@'localhost';
-- Grants for '@'node1'
GRANT USAGE ON *.* TO '@'node1';
-- Grants for 'cactiuser'@'localhost'
GRANT USAGE ON *.* TO 'cactiuser'@'localhost' IDENTIFIED BY
PASSWORD '*43DD7940383044FBDE5B177730FAD3405BC6DAD7';
GRANT ALL PRIVILEGES ON `cacti`.* TO 'cactiuser'@'localhost';
-- Grants for 'root'@'127.0.0.1'
GRANT ALL PRIVILEGES ON *.* TO 'root'@'127.0.0.1' WITH GRANT
OPTION;
-- Grants for 'root'@':::1'
GRANT ALL PRIVILEGES ON *.* TO 'root'@':::1' WITH GRANT
OPTION;
-- Grants for 'root'@'localhost'
```

Default Permissions Are Bad - HandsOn!

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```
# mysql_secure_installation
```

```
Enter current password for root (enter for none):
```

```
OK, successfully used password, moving on...
```

```
Set root password? [Y/n] y
```

```
New password: root
```

```
Re-enter new password: root
```

```
Remove anonymous users? [Y/n] y
```

```
Disallow root login remotely? [Y/n] y
```

```
Remove test database and access to it? [Y/n] y
```

```
Reload privilege tables now? [Y/n] y
```

All done! If you've completed all of the above steps, your MySQL installation should now be secure.

Thanks for using MySQL!

MySQL Privileges - HandsOn!

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- Now we have 'secure' privileges

```
$ mysql -u root -p  
create a ~/.my.cnf
```

- Create a user for 'my-movies' application

```
mysql> GRANT ALL PRIVILEGES ON imdb.* TO  
'mymovies'@'localhost' IDENTIFIED BY 'password';  
Change user&password:  
/var/www/html/my-movies/lib/config.inc.php
```

- Verify Application:

```
http://localhost:8080/my-movies
```

- Doublecheck with pt-show-grants

```
# pt-show-grants -u root -proot
```

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How doing operations feels



Troubleshooting

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- Diagnostics
 - Operating System
 - MySQL
- Queries
- Percona Toolkit
- Trending
- Alerting

Troubleshooting a problem that I don't understand



Add Some Load First - HandsOn!

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- Open up New Terminal window
`$ /home/percona/add_load.py`

Diagnostics - HandsOn!

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- MySQL:

- Errorlog: `/var/lib/mysql/node1.err`
- `SHOW GLOBAL STATUS`
- `mysqladmin extended-status`
- `SHOW ENGINE INNODB STATUS`
- `SHOW PROCESSLIST`

- OS metrics (memory, cpu...)

- `vmstat`, `iostat`, `mpstat`, `meminfo`, `top`, `ps`
- Trending (Cacti and newer (-:))
- Upper Layer Instrumentation (Application, Front-end, Caching)



Percona Toolkit

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- `pt-mext`
- `pt-diskstats`
- `pt-query-digest`

pt-mext - HandsOn!

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```
$ pt-mext -r -- mysqladmin ext -i 10 -c 3
```

Binlog_cache_disk_use	0	0	0
Binlog_cache_use	0	0	0
Bytes_received	2875788973602	1738235	346057
Bytes_sent	863929033790	588078	536398
Com_begin	6298644573	3516	5102
Com_delete	23721852	26	51
Com_insert	4454794705	1518	3287
Com_replace	527848577	197	121
Com_select	6993291133	8114	7594
Com_set_option	5112076	250	262
Connections	7331059	250	262
Created_tmp_disk_tables	113568	0	0
Created_tmp_files	7803	0	0
Created_tmp_tables	729281259	1816	479

pt-mext

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Handler_commit	4002481284	5295	4911
Handler_delete	7256841	10	25
Handler_discover	0	0	0
Handler_prepare	0	0	0
Handler_read_first	47274	0	0
Handler_read_key	42993091324	34920	27522
Handler_read_next	19633194815	16911	10142
Handler_read_prev	2440127	0	0
Handler_read_rnd	488760449	40	12
Handler_read_rnd_next	2731205271	268	231
Handler_rollback	5781	0	0
Handler_savepoint	0	0	0
Handler_savepoint_rollback	0	0	0
Handler_update	7022320034	10047	3329
Handler_write	7334430104	1945	3638

pt-mext

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Qcache_free_blocks	2899	100	-15
Qcache_free_memory	519642808	164104	-8080
Qcache_hits	325634530	0	0
Qcache_inserts	978847229	194	104
Qcache_lowmem_prunes	19158357	0	0
Qcache_not_cached	211301010	806	798
Qcache_queries_in_cache	3677	-112	9
Qcache_total_blocks	10277	-131	6
Threads_cached	9	1	0
Threads_connected	11	-1	0
Threads_created	294	0	0
Threads_running	5	-3	0
Uptime	21912350	10	10

- Look at current global behavior of database
- Query Optimization necessary? (sorting_%, handler_%, range_%, tmp_table_%)
- Innodb misbehaving?
- ...

Disk Subsystem Statistics

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- *iostat* commonly used:

```
$ iostat -x -m 1
```

Device:	rrqm/s	wrqm/s	r/s	w/s	rsec/s	wsec/s	avgrq-sz	avgqu-sz	await	svctm	%util
sda	0.00	73.27	0.00	54.46	0.00	1061.39	19.49	4.84	88.80	18.36	100.00
sda1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda2	0.00	73.27	0.00	54.46	0.00	1061.39	19.49	4.84	88.80	18.36	100.00
sdb	0.00	451.49	0.99	338.61	7.92	6368.32	18.78	144.23	420.93	2.94	100.00
sdb1	0.00	451.49	0.99	338.61	7.92	6368.32	18.78	144.23	420.93	2.94	100.00

- %util: how many % of time at least one request was busy
- await+svctm:
 - response time
 - writes and reads combined

pt-diskstats - HandsOn!

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- reads */proc/diskstats*, shows wr/rd response time

```
$ pt-diskstats --devices-regex sdb1
```

<i>device</i>	<i>rd_s</i>	<i>rd_avkb</i>	<i>rd_mb_s</i>	<i>rd_mrg</i>	<i>rd_cnc</i>	<i>rd_rt</i>
<i>sda</i>	<i>0.1</i>	<i>4.0</i>	<i>0.0</i>	<i>0%</i>	<i>0.0</i>	<i>5.0</i>
<i>sda2</i>	<i>0.1</i>	<i>4.0</i>	<i>0.0</i>	<i>0%</i>	<i>0.0</i>	<i>5.0</i>
<i>sdb</i>	<i>119.8</i>	<i>5.3</i>	<i>0.6</i>	<i>0%</i>	<i>0.5</i>	<i>4.1</i>
<i>sdb1</i>	<i>119.8</i>	<i>5.3</i>	<i>0.6</i>	<i>0%</i>	<i>0.5</i>	<i>4.1</i>

pt-diskstats - HandsOn!

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<i>device</i>	<i>wr_s</i>	<i>wr_avkb</i>	<i>wr_mb_s</i>	<i>wr_mrg</i>	<i>wr_cnc</i>	<i>wr_rt</i>
<i>sda</i>	<i>23.5</i>	<i>35.6</i>	<i>0.8</i>	<i>89%</i>	<i>1.2</i>	<i>5.9</i>
<i>sda2</i>	<i>23.5</i>	<i>35.6</i>	<i>0.8</i>	<i>89%</i>	<i>1.2</i>	<i>5.9</i>
<i>sdb</i>	<i>160.3</i>	<i>7.5</i>	<i>1.2</i>	<i>47%</i>	<i>18.3</i>	<i>61.0</i>
<i>sdb1</i>	<i>160.3</i>	<i>7.5</i>	<i>1.2</i>	<i>47%</i>	<i>18.3</i>	<i>61.0</i>

pt-diskstats - HandsOn!

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<i>device</i>	<i>busy</i>	<i>in_prg</i>	<i>io_s</i>	<i>qtime</i>	<i>stim</i>
<i>sda</i>	7%	0	23.6	5.6	0.3
<i>sda2</i>	7%	0	23.6	5.6	0.3
<i>sdb</i>	47%	0	280.0	43.6	1.1
<i>sdb1</i>	47%	0	280.0	43.6	1.1

Enhanced Slow Log Statistics - HandsOn!

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```
> SET GLOBAL slow_query_log=on;  
> SET GLOBAL slow_query_log_file='/var/  
lib/mysql/slow.log';  
> SET GLOBAL long_query_time=0;;  
> SET GLOBAL log_slow_verbosity=full;
```

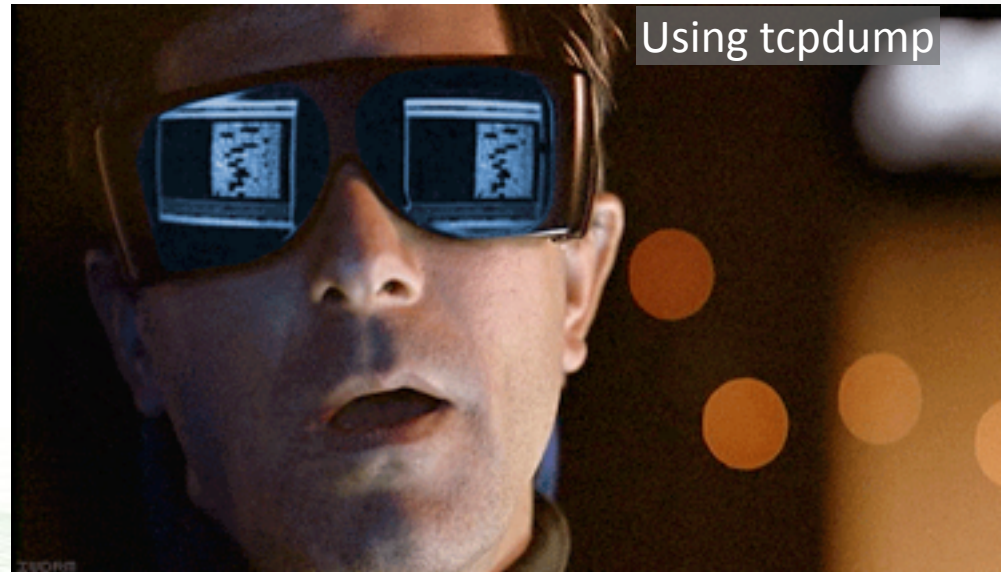
```
tail -n 200 /var/lib/mysql/slow.log
```

```
# Time: 100924 13:58:47  
# User@Host: root[root] @ localhost []  
# Thread_id: 10  Schema: imdb  Last_errno: 0  Killed: 0  
# Query_time: 399.563977  Lock_time: 0.000110  Rows_sent: 1  Rows_examined: 46313608  
Rows_affected: 0  Rows_read: 1  
# Bytes_sent: 131  Tmp_tables: 1  Tmp_disk_tables: 1  Tmp_table_sizes: 25194923  
# InnoDB_trx_id: 1403  
# QC_Hit: No  Full_scan: Yes  Full_join: No  Tmp_table: Yes  Tmp_table_on_disk: Yes  
# Filesort: Yes  Filesort_on_disk: Yes  Merge_passes: 5  
#   InnoDB_IO_r_ops: 1064749  InnoDB_IO_r_bytes: 17444847616  
#   InnoDB_IO_r_wait: 26.935662  
#   InnoDB_rec_lock_wait: 0.000000  InnoDB_queue_wait: 0.000000  
#   InnoDB_pages_distinct: 65329  
SET timestamp=1285336727;  
select STRAIGHT_JOIN count(*) as c, person_id  FROM cast_info FORCE INDEX(person_id) INNER JOIN
```

pt-query-digest - HandsOn!

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- generate reports from
 - slow query log
`pt-query-digest /var/lib/mysql/slow.log | less`
 - general log (not so useful)
 - tcpdump
- group-by& order-by: db/ip/host/query_time:sum/
max/min/count



Using tcpdump

pt-query-digest - HandsOn!

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```
# Profile
# Rank QID      Response time Calls  R/Call  Apdx  V/M Item
# ==  ==  =====
#   1 ... 1349.6240 62.4% 11976 0.1127 1.00 0.03 SELECT table1 table9 table2
table3 table4
#   2 ... 114.9014 5.3% 437 0.2629 1.00 0.50 SELECT table5 table6 table8
table7 table6 table8 table10
#   3 ... 92.9441 4.3% 791 0.1175 1.00 0.06 SELECT table13
#   4 ... 77.5712 3.6% 43 1.8040 0.65 0.73 SELECT table11 table12
table9 table2 table14 table15 table16 table14 table17
#   5 ... 67.1673 3.1% 296 0.2269 1.00 0.17 SELECT table8 table4 table14
table8 table18
#   6 ... 49.0330 2.3% 15630 0.0031 1.00 0.00 ADMIN CONNECT
#   7 ... 43.4990 2.0% 274 0.1588 1.00 0.12 SELECT table19
#   8 ... 30.0898 1.4% 416 0.0723 1.00 0.07 SELECT table13
#   9 ... 19.6506 0.9% 13424 0.0015 1.00 0.01 UPDATE table20
```

pt-query-digest - HandsOn!

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```
# Query 1: 17.06 QPS, 1.92x concurrency, ID 0x3928FBFF36663F33 at byte 1417466467
# Attribute      pct      total      min      max      avg      95%      stddev      median
# =====
# Count          1      11976
# Exec time      62      1350s      25ms     395ms     113ms     219ms      54ms        91ms
# Rows affected  0         0         0         0         0.00      0         0.00        0
# Query size     23      28.75M     2.46k     2.46k     2.46k     2.38k        0         2.38k
# warning coun   11      51.51K     0      12.80K     4.40      0      233.99      0
```

pt-query-digest - HandsOn!

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```
# Query_time distribution
# 1us
# 10us #####
# 100us #####
# 1ms ##
# 10ms #
# 100ms #####
# 1s
# 10s+
# Tables

# SHOW TABLE STATUS LIKE 'table19'\G
# SHOW CREATE TABLE `table19`\G
# EXPLAIN /*!50100 PARTITIONS*/
SELECT user_agent_id, search_engine FROM table19 WHERE user_agent='Mozilla/4.0
(compatible; MSIE 7.0; Windows NT 5.1; .NET CLR 1.0.3705)'\G
```

pt-query-digest - HandsOn!

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```
# Item 1: 3.41 QPS, 0.97x concurrency, ID 0xABCE5AD2A2DD1BA1 at byte 288124661
# Attribute      pct      total      min      max      avg      95%      stddev      median
# =====
# Count          0        519
# Exec time      2        148s      11us     33s     285ms    53ms      2s          26us
# Lock time      0         5ms        0      334us    9us     66us     32us         0
# Rows sent      0         41         0         1      0.08    0.99     0.27         0
# Rows examine   1      4.97M      0 445.49k  9.80k    5.73k   49.33k         0
# Rows affected  0          2         0         1      0.00      0      0.06         0
# Rows read      1      2.01M      0 250.47k  3.96k    1.96   27.94k      0.99
# Bytes sent     0 241.20k    11    8.01k   475.89  918.49  689.98  258.32
# Merge passes   0          0         0         0         0         0         0         0
# Tmp tables     0         15         0         1      0.03      0      0.17         0
# Tmp disk tbl   0          3         0         1      0.01      0      0.08         0
```

pt-query-digest - HandsOn!

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# Tmp tbl size	0	4.78k	0	4.78k	9.43	0	211.60	0
# Query size	0	100.95k	19	2.71k	199.17	363.48	206.60	151.03
# InnoDB:								
# IO r bytes	0	0	0	0	0	0	0	0
# IO r ops	0	0	0	0	0	0	0	0
# IO r wait	0	0	0	0	0	0	0	0
# pages distin	1	67.99k	0	10.64k	1.26k	3.88k	2.47k	31.70
# queue wait	0	0	0	0	0	0	0	0
# rec lock wai	0	0	0	0	0	0	0	0
# Boolean:								
# Filesort	0% yes,	99% no						
# Full scan	7% yes,	92% no						
# QC Hit	78% yes,	21% no						
# Tmp table	2% yes,	97% no						
# Tmp table on	0% yes,	99% no						

pt-query-digest - HandsOn!

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- store reports in db: `--review,--review-table8`
- enhanced filtering capabilities
 - '`$event->{fingerprint} =~ m/`
`^select/`'
 - '`$event->{Warning_count} > 1`'
 - '`$event->{InnoDB_IO_r_ops} > 50`'
 - '`$event->{QC_hit} = "Yes"`'
 - '`$event->{Bytes} >= m/^1_048_576/`'

Trending

48

- Go to the cacti installation:
<http://localhost:8080/cacti/>
user: admin
pass: plmce
- Graphs ->
 - Preset: Last Half Hour
 - Graphs Per Page: 100
 - GO!

Optimizing This Application

49

- The problem is that the database is not optimized, indexing is not done properly
- We have Some Suggestions:

```
$ less /home/percona/.data/billkarwin-opt.sql
```

- Apply the changes:

```
$ cat ~percona/.data/billkarwin-opt.sql | mysql
```

- Have another look with pt-query-digest

```
$ cd /var/lib/mysql/; mv slow.log slow.log_old  
$ killall -HUP mysqld  
$ /home/percona/add_load.py  
$ pt-query-digest /var/lib/mysql/slow.log | less
```

Alerting

50

- Nagios, Zabbix, Icinga, ZenOss....
- Things To Alert on:
 - Can Connect to MySQL.
 - Replication IO Thread is OK
 - Replication SQL Thread is OK
 - Replication Seconds Behind Master.
 - Connections
 - InnoDB is enabled.
 - No tables are marked as corrupt.
- Not the best: tmp tables, ratios, qps
- Focus on what matters: usually in upper layers

Operational DBA In A Nutshell

- Setting Up Today's Environment
- Installation
- Logging In
- MySQL Privileges
- Diagnostics
- Troubleshooting
- Monitoring
- **Backups**

- Replication
- Schema Changes
- Configuration Optimization



How doing operations feels



Backing up your Data - Challenges

52

- MySQL is multi-engine
 - Different storage engines call for different strategies
- MySQL can be quite busy
 - Do we need to shut it down?
 - How much load will we generate?
 - How quickly can we restore?

Backing up your Data - Concepts

53

- Impact of Backup
 - **Hot backup** - does not prevent readers or writers from performing operations.
 - **Warm backup** - readers may continue, but write activity must be queued until the backup is completed.
 - **Cold backup** - system is unavailable during backup window.

Backing up your Data - Concepts

54

- Type of Backup
 - **Physical** - stores data in the “native” format.
 - **Logical** - stores data in a generic representation, such as a SQL dump.

A few available backup solutions

55

	Impact	Warmth	Backup Time	Restore Time
Cold Backup	very high	cold	very fast	fast
mysqldump	high	warm	medium	slow
Snapshotting	high/medium	hot/warm	fast	fast
MySQL Enterprise Backup	low/medium	warm	fast	fast
XtraBackup	low/medium	warm	fast	fast

- Included by default with MySQL
- Logical backup solution - creates SQL file to reproduce data
- Pro's
 - Easy to use, reliable
- Cons
 - High performance impact, long restore time

mysqldump - HandsOn!

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- Take backup:

```
# mysqldump --all-databases --single-transaction  
> /var/backup/dump.sql
```

- --all-databases for every database (including mysql).
- --single-transaction is only safe when all InnoDB.
- This ensures a hot backup.
- --master-data=1 (optional) records the binary log coordinates.

- Restore as follows:

```
# mysql < dump.sql
```

mysqldump - HandsOn!

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```
[root@node1 ~]# vmstat 5
```

```
procs -----memory----- ---swap-- -----io----- --system-- -----cpu-----
r  b   swpd   free   buff  cache   si   so    bi    bo    in   cs  us  sy  id  wa  st
0  0    4316   3844    936  74820    2    9   8438   7121   501 1810 17 12 64  7  0
0  3    4316   4020   1092  74504    0    0    39    54    37  65  0  0 94  5  0
0  0    4316   3596   1112  75016    0    0   107   10    38  71  0  0 95  5  0
0  0    4316   3692   1112  75032    0    0     0     0    25  47  0  0 100  0  0
0  0    4316   3992   1156  74512    0    0    50    50    42  78  0  0 99  0  0
1  5    4316  10464   1768  67396    0    0   4816     0   273 1371  9  6 83  3  0
2  3    4316   4176    492  74600    0    0  20922  19623  1186 4066 57 35  0  8  0
2  3    4316   3080    508  75664    0    0  19482  15578  1089 5046 54 38  0  8  0
1  3    4540   3076    716  74828    0   45  17785  17338  1293 4411 54 36  0 10  0
2  4    6068   3856    736  71172    0  306  15406  10082  1256 4365 62 35  0  2  0
3  3    8280   3048    184  66460    0    0  26261  19267  1135 4789 51 35  0 14  0
1  2   10036   4144    452  66584    0  351  35832  31802  1472 1981 53 34  0 12  0
0  2   10180   4088    200  67304    0   29  38532  30722  1376 2997 56 35  0  9  0
2  2   12468   4140    148  69028    6   77  29004  26610  1387 2785 60 34  0  6  0
1  0   14628   4328   2552  59096    0  432  21390  15741  1397 4629 51 35  0 14  0
0  0   14628  20048   2868  61040    0    0    396    71   635 2187 26 19 54  1  0
0  0   14628  19932   2884  61220    0    0     34    16    36  58  0  0 99  1  0
0  0   14628  19628   2916  61588    0    0     72    54    39  74  0  0 90 10  0
0  0   14624  19564   2940  61636    6    0     16    11    34  62  0  0 100  0  0
0  0   14624  19620   2964  61636    0    0     0     41    34  62  0  0 90 10  0
0  0   14624  18900   2988  62308    0    0    137    34    43  80  0  0 99  1  0
```

mysqldump - HandsOn!

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```
[root@node1 ~]# vmstat 5
```

```
procs  -----memory-----  ---swap--  -----io-----  --system--  -----cpu-----
r  b    swpd    free    buff    cache    si    so    bi    bo    in    cs    us    sy    id    wa    st
0  0     4316    3844    936     74820    2     9    8438  7121  501  1810  17    12    64    7    0
0  3     4316    4020    1092    74504    0     0     39    54    37    65    0     0    94    5    0
0  0     4316    3596    1112    75016    0     0    107    10    38    71    0     0    95    5    0
0  0     4316    3692    1112    75032    0     0      0     0    25    47    0     0   100    0    0
0  0     4316    3992    1156    74512    0     0     50    50    42    78    0     0    99    0    0
1  5     4316   10464   1768    67396    0     0   4816     0   273  1371    9     6    83    3    0
2  3     4316    4176    492    74600    0     0
2  3     4316    3080    508    75664    0     0
1  3     4540    3076    716    74828    0    45
2  4     6068    3856    736    71172    0   306
3  3     8280    3048    184    66460    0     0
1  2    10036    4144    452    66584    0   351
0  2    10180    4088    200    67304    0    29
2  2    12468    4140    148    69028    6    77
1  0    14628    4328   2552   59096    0   432
0  0    14628   20048   2868   61040    0     0
0  0    14628   19932   2884   61220    0     0
0  0    14628   19628   2916   61588    0     0
0  0    14624   19564   2940   61636    6     0
0  0    14624   19620   2964   61636    0     0
0  0    14624   18900   2988   62308    0     0
```

Waiting on MySQLdump to Finish



- Completely free and open source
- Physical backup solution - Stores data in similar format as the original.
- Pro's
 - Powerful, scriptable, feature-packed
- Cons
 - Multiple steps required to restore, complexity

XtraBackup - Features

60

- Non-blocking
- Support for MyISAM
- Compression
- Partial Backups
- Throttling
- Incremental Backups
- Exporting/Importing individual tables
- Streaming
- Parallel copying
- ...

XtraBackup - Operation

61

- 3 separate "manual" steps are required:
 - (1) - Backing up
 - (2) - Preparing InnoDB files for recovery
 - (3) - Restoring the files

XtraBackup - Operation (2)

62

- Performing and restoring a mixed full backup:
 - Backing up **(1)**:
 - Copy datafiles while recording transaction log changes
 - FLUSH TABLES WITH READ LOCK;
 - Get binlog position
 - Copy all .MYD, .MYI, .TRG, .TRN, ... files
 - Stop recording transaction log changes
 - UNLOCK TABLES;
- Preparing/Restoring:
 - Prepare backup by applying recorded tlog changes **(2)**
- Restoring files to original location **(3)**

XtraBackup - HandsOn!

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- Simple full backup and restore:

(1)

```
# innobackupex /var/backup
```

(2)

```
# innobackupex --apply-log /var/backup/  
[backupfolder]/
```

(3)

```
# innobackupex --copy-back /var/backup/  
[backupfolder]/
```

```
# chown -R mysql:mysql /var/lib/mysql
```

XtraBackup - HandsOn!

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(1) - Full Backup

```
[root@node1 ~]# innobackupex /var/backup/
```

```
InnoDB Backup Utility v1.5.1-xtrabackup; Copyright 2003, 2009 Innobase Oy  
and Percona Ireland Ltd 2009-2012. All Rights Reserved.
```

```
This software is published under  
the GNU GENERAL PUBLIC LICENSE Version 2, June 1991.
```

```
130421 18:26:20 innobackupex: Starting mysql with options: --unbuffered --  
130421 18:26:20 innobackupex: Connected to database with mysql child process (pid=633)  
130421 18:26:26 innobackupex: Connection to database server closed  
IMPORTANT: Please check that the backup run completes successfully.  
At the end of a successful backup run innobackupex  
prints "completed OK!".
```

```
innobackupex: Using mysql Ver 14.14 Distrib 5.5.30, for Linux (i686) using readline 5.1  
innobackupex: Using mysql server version Copyright (c) 2000, 2013, Oracle and/or its affiliates  
All rights reserved.
```

```
innobackupex: Created backup directory /var/backup/2013-04-21_18-26-26  
130421 18:26:26 innobackupex: Starting mysql with options: --unbuffered --  
130421 18:26:26 innobackupex: Connected to database with mysql child process (pid=633)
```

XtraBackup - HandsOn!

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Backup Folder Structure

```
[root@node1 2013-04-21_18-26-26]# ls
backup  backup-my.cnf  cacti  ibdata1  imdb  mysql  performance_schema
xtrabackup_binary  xtrabackup_binlog_info  xtrabackup_checkpoints  xtrabackup_logfile
```

(2) - Applying the transaction logs

```
[root@node1 2013-04-21_18-26-26]# innobackupex --apply-log /var/backup/2013-04-21_18-26-26/
```

```
InnoDB Backup Utility v1.5.1-xtrabackup; Copyright 2003, 2009 Innobase Oy
and Percona Ireland Ltd 2009-2012. All Rights Reserved.
```

```
This software is published under
the GNU GENERAL PUBLIC LICENSE Version 2, June 1991.
```

```
IMPORTANT: Please check that the apply-log run completes successfully.
           At the end of a successful apply-log run innobackupex
           prints "completed OK!".
```

```
130421 18:34:38 innobackupex: Starting ibbackup with command: xtrabackup_55 --defaults-file="/var/
2013-04-21_18-26-26/backup-my.cnf" --defaults-group="mysqld" --prepare --target-dir=/var/lib/mysql
tmpdir=/tmp
```

```
xtrabackup_55 version 2.0.6 for Percona Server 5.5.16 Linux (i686) (revision id: 521)
xtrabackup: cd to /var/lib/mysql/backup/2013-04-21_18-26-26
xtrabackup: This target seems to be not prepared yet.
xtrabackup: xtrabackup_logfile detected: size=2097152, start_lsn=(8915647136)
xtrabackup: Temporary instance for recovery is set as followings.
```

Understanding Backup Requirements

66

- Recovery Time Objective - How quickly must I restore?
- Recovery Point Objective - How much data can I lose?
- Risks - What failures should this data be protected against?

Advanced Backup Topics

67

- Incremental Backups
 - HandsOn!
- Delayed Slaves
 - Using pt-slave-delay to keep a slave behind on its master by a certain amount of time.
 - Good help against potential disastrous user mistakes
 - Example:

```
# pt-slave-delay --delay 1m --interval 15s
```

Advanced Backup Topics - HandsOn!

68

- Incremental Backup:

1. Create a full backup

```
2. # innobackupex --incremental /var/backup/inc/ --incremental-  
    basedir=/var/backup/[backupfolder]
```

- Incremental Restore:

```
3. # innobackupex --apply-log --redo-only /var/backup/[backupfolder]
```

- Preparing the base backup FIRST

```
4. # innobackupex --apply-log --redo-only /var/backup/[backupfolder] --  
    incremental-basedir=/var/backup/inc/[incbackupfolder]
```

- Applying each incremental backup to the base

```
5. # innobackupex --apply-log /var/backup/[backupfolder]
```

- Finish preparing the now completed base backup

6. Restore as usual

Advanced Backup Topics

69

- Point-In-Time recovery
 - Making use of the binary log
 - mysqlbinlog can be used to pipe commands into mysql
 - Use in combination with incremental backups to restore right up to the point where the disaster occurred.

Advanced Backup Topics

70

- Checking backup binlog position

```
[root@node1 2013-04-21_18-58-22]# cat xtrabackup_binlog_info
node1-bin.000006          243118
```

- Checking binlog contents

```
[root@node1 mysql]# mysqlbinlog --start-position=243118 --stop-position=243300 node1-bin.000006
/*!50530 SET @@SESSION.PSEUDO_SLAVE_MODE=1*/;
/*!40019 SET @@session.max_insert_delayed_threads=0*/;
/*!50003 SET @OLD_COMPLETION_TYPE=@@COMPLETION_TYPE,COMPLETION_TYPE=0*/;
[...]
```

- Applying contents to mysql

```
[root@node1 mysql]# mysqlbinlog --start-position=243118 --stop-position=243300
node1-bin.000006 | mysql
```

Advanced Backup Topics

71

- Managing & Retaining your backups
 - Storing offsite in case of disaster
 - Recovery testing
 - Retention policies
 - Monitoring Backup & Restore success rate

XtraBackup - HandsOn!

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- Please run the following commands to prep your environment for the next parts:

```
# cd /var/lib/mysql/backup  
# ln -s `ls -t1 | grep 2013* | head -n1` latest_full
```

Operational DBA In A Nutshell

- Setting Up Today's Environment
- Installation
- Logging In
- MySQL Privileges
- Diagnostics
- Troubleshooting
- Monitoring
- Backups

- **Replication**
- Schema Changes
- Configuration Optimization



How doing operations feels



MySQL Replication

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- Replication?
- Binary Logs
- Setting Up Replication
- Commands
- Breaking & Fixing Replication
- Inconsistencies

What is Replication?

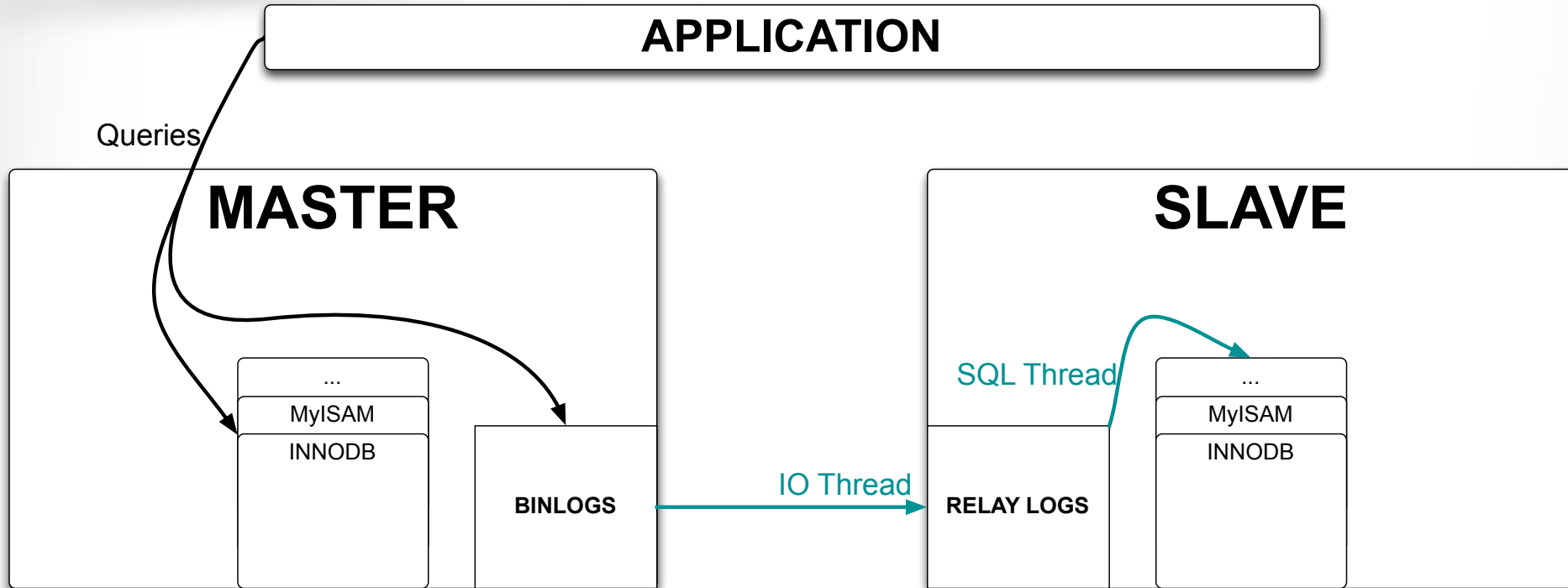
75

Replication enables data from one MySQL database server (the master) to be replicated to one or more MySQL database servers (the slaves)

(Source: <http://dev.mysql.com/doc/refman/5.5/en/replication.html>)

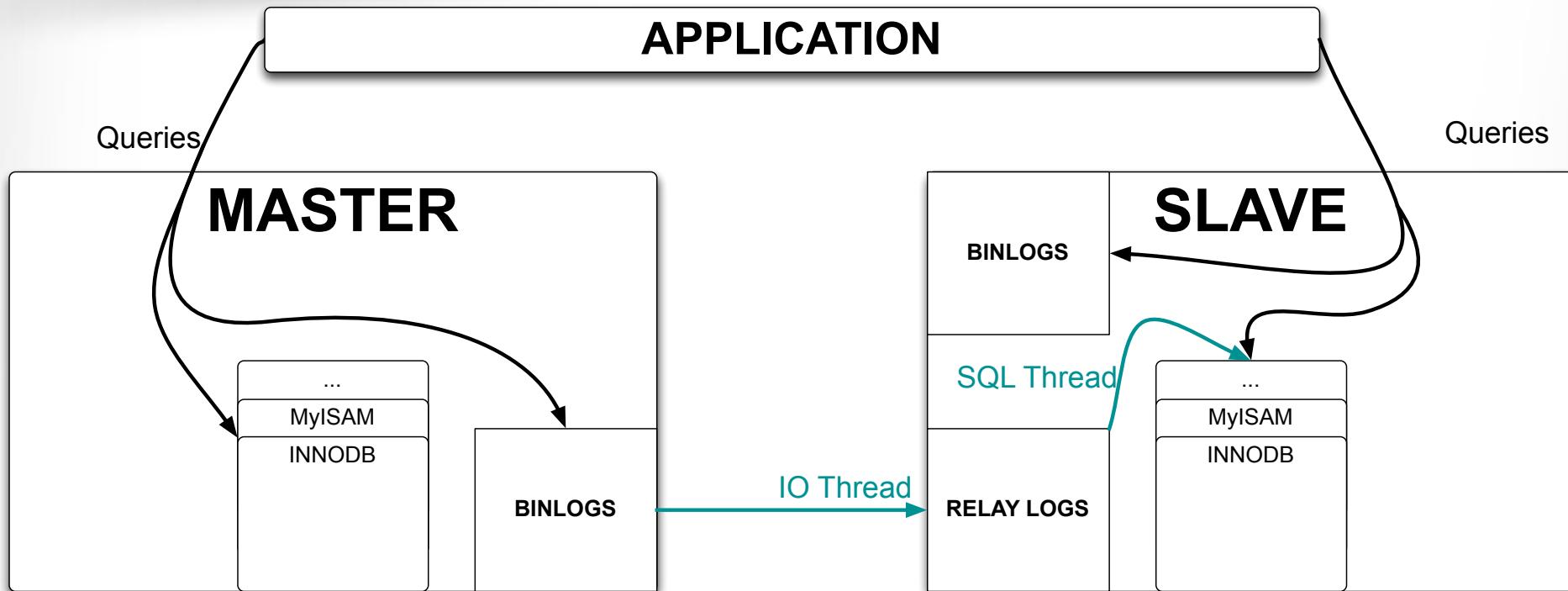
Replication Diagram

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Replication Diagram

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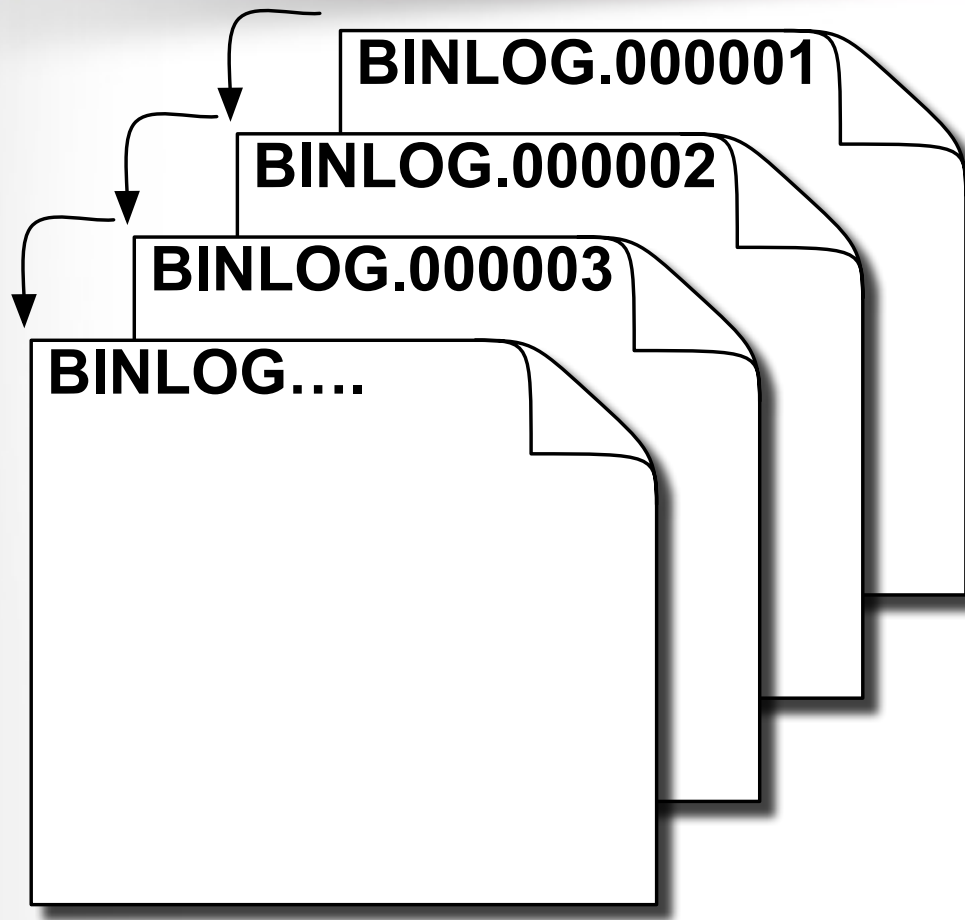
Replication

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- Happens at MySQL level, not Storage Engine Level
- Asynchronous! (Semi-sync available in 5.5)
- A server can have only 1 master
- IO Thread: Fetches from master
- SQL Thread: Executes on slave
- Single Threaded Execution (Until 5.6)
- Different schema's are possible between master and slave (Watch out!!):
 - different indexes
 - storage engines
 - data types, columns

Binary Logs

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BINLOG.index

BINLOG.000001
BINLOG.000002
BINLOG.000003

Binary Logs

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- Set of files
- Contains all writes and schema changes
- != REDO/Transaction log
- Rotated when full (Set `max_binlog_size`)
- Incrementing numbers
(000001,000002,000003,...)
- Relay Logs are also binary logs
- 2 Formats:
 - Statement Based (SBR)
 - Row Based (RBR, since MySQL 5.1)
- Binary file

Binary Logs - Info Files

81

- `master.info`
 - Contains IO Thread information & connection information
- `relay.info`
 - Contains SQL Thread information

Binary Log - Formats (`binlog_format`)

82

- Statement Based Replication (SBR):
 - Writes statements to binary logs, slave executes the stmts
(An update stmt that changes 1 row but reads many will also do the same on the slave)
 - Some functions are non-deterministic and cause inconsistencies:
 - `UUID( )`, `SYSDATE( )`, `FOUND_ROWS( )`, `UPDATE ... LIMIT` without `ORDER BY...`
 - Works for `NOW( )`: timestamp included in binary log
 - More complete list of issues:
<http://dev.mysql.com/doc/refman/5.5/en/replication-features.html>

Binary Log - Formats (`binlog_format`)

83

- Row Based Replication (RBR, since 5.1):
 - Write row changes (larger binlogs)
 - Check `Binlog_cache_disk_use`, possibly increase `binlog_cache_size`
 - Does not need to parse/execute queries, just make the changes necessary
 - Much less/different issues compared to SBR:
<http://dev.mysql.com/doc/refman/5.5/en/replication-rbr-usage.html>
- Mixed: Combination of both: defaults to SBR, use RBR when necessary

Looking at Binary Log Contents

84

- `mysqlbinlog`
- `SHOW BINLOG EVENTS`

Example SBR

85

```
> SHOW GLOBAL VARIABLES LIKE 'binlog_format';
```

Variable_name	Value
binlog_format	STATEMENT

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

```
> CREATE DATABASE replication;
```

```
Query OK, 1 row affected (0.14 sec)
```

```
> use replication
```

```
Database changed
```

```
> CREATE TABLE repl (a int) ENGINE=innodb;
```

```
Query OK, 0 rows affected (0.25 sec)
```

```
> INSERT INTO repl VALUES (1);
```

```
Query OK, 1 row affected (0.14 sec)
```

Example SBR - mysqlbinlog

86

```
# mysqlbinlog mysql-bin.000193
...
# at 106
#120106 15:19:13 server id 9999  end_log_pos 203      Query
      thread_id=11
CREATE DATABASE replication
/*!*/;
# at 203
#120106 15:19:32 server id 9999  end_log_pos 312      Query
      thread_id=11  exec_time=1  error_code=0
use replication/*!*/;
SET TIMESTAMP=1325859572/*!*/;
CREATE TABLE repl (a INT) ENGINE=innodb
/*!*/;
# at 312
#120106 15:19:55 server id 9999  end_log_pos 387      Query
      thread_id=11  exec_time=0  error_code=0
SET TIMESTAMP=1325859595/*!*/;
BEGIN
/*!*/.
```

```
> SHOW BINLOG EVENTS FROM 106\G
```

```
***** 1. row *****
```

```
Log_name: mysql-bin.000193
```

```
Pos: 106
```

```
Event_type: Query
```

```
Server_id: 1
```

```
End_log_pos: 203
```

```
Info: CREATE DATABASE replication
```

```
***** 2. row *****
```

```
Log_name: mysql-bin.000193
```

```
Pos: 203
```

```
Event_type: Query
```

```
Server_id: 1
```

```
End_log_pos: 312
```

```
Info: use `replication`; CREATE TABLE repl (a INT)
```

```
ENGINE=innodb
```

```
***** 3. row *****
```

```
Log_name: mysql-bin.000193
```

```
Pos: 312
```

```
Event_type: Query
```

```
Server_id: 1
```

```
End_log_pos: 387
```

```
Info: BEGIN
```

```
***** 4. row *****
```

Example RBR

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```
> SHOW GLOBAL VARIABLES LIKE 'binlog_format';
```

Variable_name	Value
binlog_format	ROW

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

```
> CREATE DATABASE replication;
```

```
Query OK, 1 row affected (0.14 sec)
```

```
> use replication
```

```
Database changed
```

```
> CREATE TABLE repl (a int) ENGINE=innodb;
```

```
Query OK, 0 rows affected (0.25 sec)
```

```
> INSERT INTO repl VALUES (1);
```

```
Query OK, 1 row affected (0.14 sec)
```

Example RBR - mysqlbinlog

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```
# mysqlbinlog mysql-bin.000193 --start-position=606
...
# at 606
#120106 15:54:54 server id 1  end_log_pos 703  Query
      thread_id=11 exec_time=0  error_code=0
CREATE DATABASE replication
/*!*/;
# at 703
#120106 15:55:02 server id 1  end_log_pos 812  Query
      thread_id=11 exec_time=0  error_code=0
use replication/*!*/;
SET TIMESTAMP=1325861702/*!*/;
CREATE TABLE repl (a int) ENGINE=innodb
/*!*/;
# at 812
...
# at 937
#120106 15:55:06 server id 1  end_log_pos 937  Table_map:
`replication`.`repl` mapped to number 17
#120106 15:55:06 server id 1  end_log_pos 971  Write rows: table
```

Example RBR - mysqlbinlog --verbose

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```
# mysqlbinlog mysql-bin.000193 --verbose --verbose
...
# at 937
#120106 15:55:06 server id 1  end_log_pos 937  Table_map:
`replication`.`repl` mapped to number 17
#120106 15:55:06 server id 1  end_log_pos 971  Write_rows: table
id 17 flags: STMT_END_F

BINLOG '
SgsHTxMBAAAAMgAAAKkDAAAAABEAAAAAAAAAEAC3JlcGxpY2F0aW9uAARyZXBsAAEDAA
E=
SgsHTxcBAAAAlgAAAMsDAAAAABEAAAAAAAAAEAAf/+AQAAAA==
' /*!*/;
### INSERT INTO replication.repl
### SET
### @1=1 /* INT meta=0 nullable=1 is_null=0 */
# at 971
```

```
> SHOW BINLOG EVENTS FROM 606\G
```

```
***** 1. row *****
```

```
Log_name: mysql-bin.000193
```

```
Pos: 606
```

```
Event_type: Query
```

```
Server_id: 1
```

```
End_log_pos: 703
```

```
Info: CREATE DATABASE replication
```

```
***** 2. row *****
```

```
Log_name: mysql-bin.000193
```

```
Pos: 703
```

```
Event_type: Query
```

```
Server_id: 1
```

```
End_log_pos: 812
```

```
Info: use `replication`; CREATE TABLE repl (a int)
```

```
ENGINE=innodb
```

```
...
```

```
***** 4. row *****
```

```
Log_name: mysql-bin.000193
```

```
Pos: 887
```

```
Event_type: Table_map
```

```
Server_id: 1
```

```
End_log_pos: 937
```

```
Info: table_id: 17 (replication.repl)
```

Setting up Replication

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- Prerequisites
- Change master/slave MySQL configuration
- Configure Replication
- Start Replication/Check Status

Prerequisites - HandsOn!

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- No way to easily create slave with 1 command
- It's required to Create/Restore **consistent** backup
 - with mysqldump, use `--master-data` or `xtrabackup`
- Binlog file and position from backup should be recorded
 - Example
 - File: `mysql-bin.000008`, Pos: 106
- ```
slave# rm -rf /var/lib/mysql/*
slave# scp -r root@192.168.70.1:/var/backup/latest_full /var/lib/mysql/
slave# chown -R mysql:mysql /var/lib/mysql/
```

# Change master/slave Configuration - HandsOn!

94

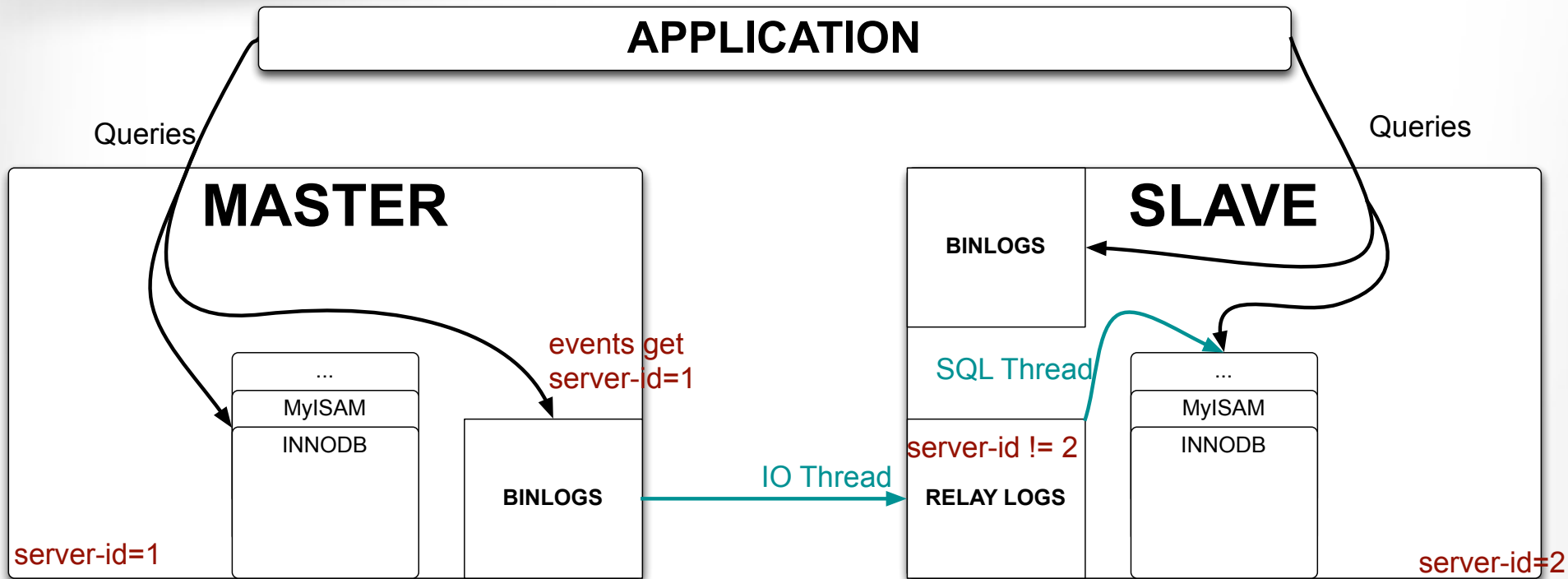
- On the master:
  - Enable Binary Logging: `log-bin=log-bin`
  - Set Server ID: `server-id=1` (already done)
- On the slave:
  - Set Server ID:

```
$ vi /etc/my.cnf
```

```
server-id=2
```

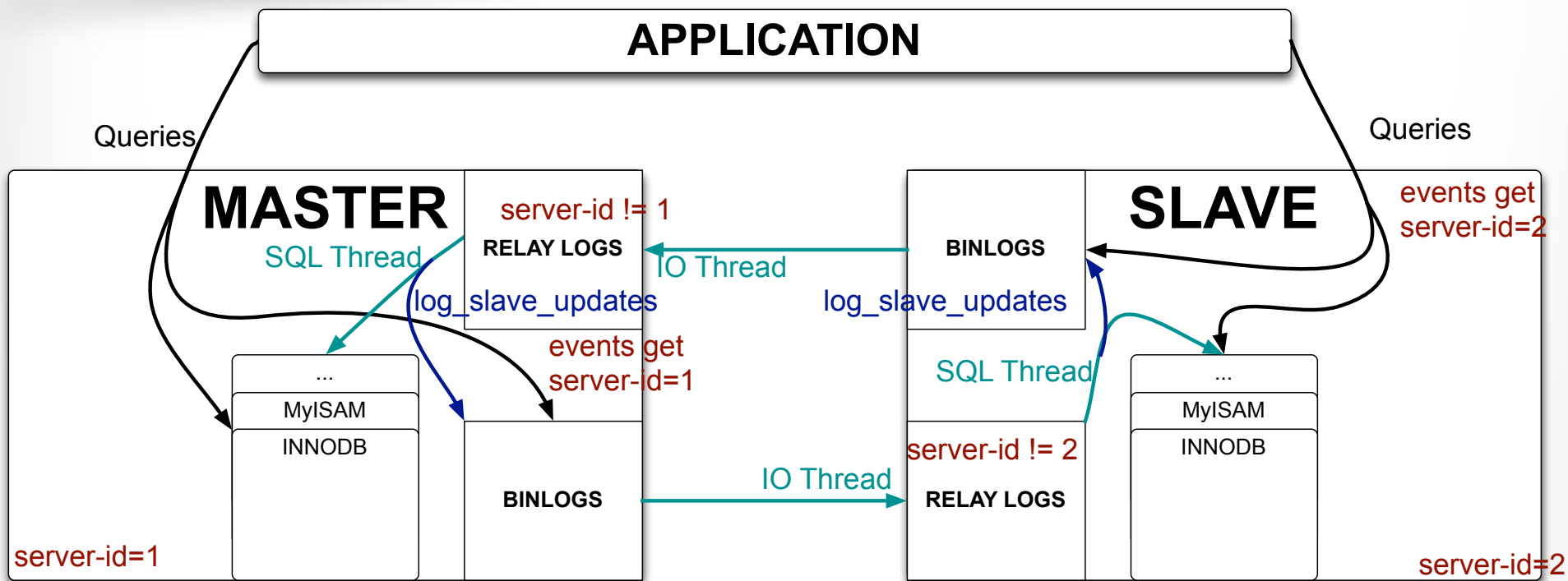
# Why server-id ?

95



# Why server-id ?

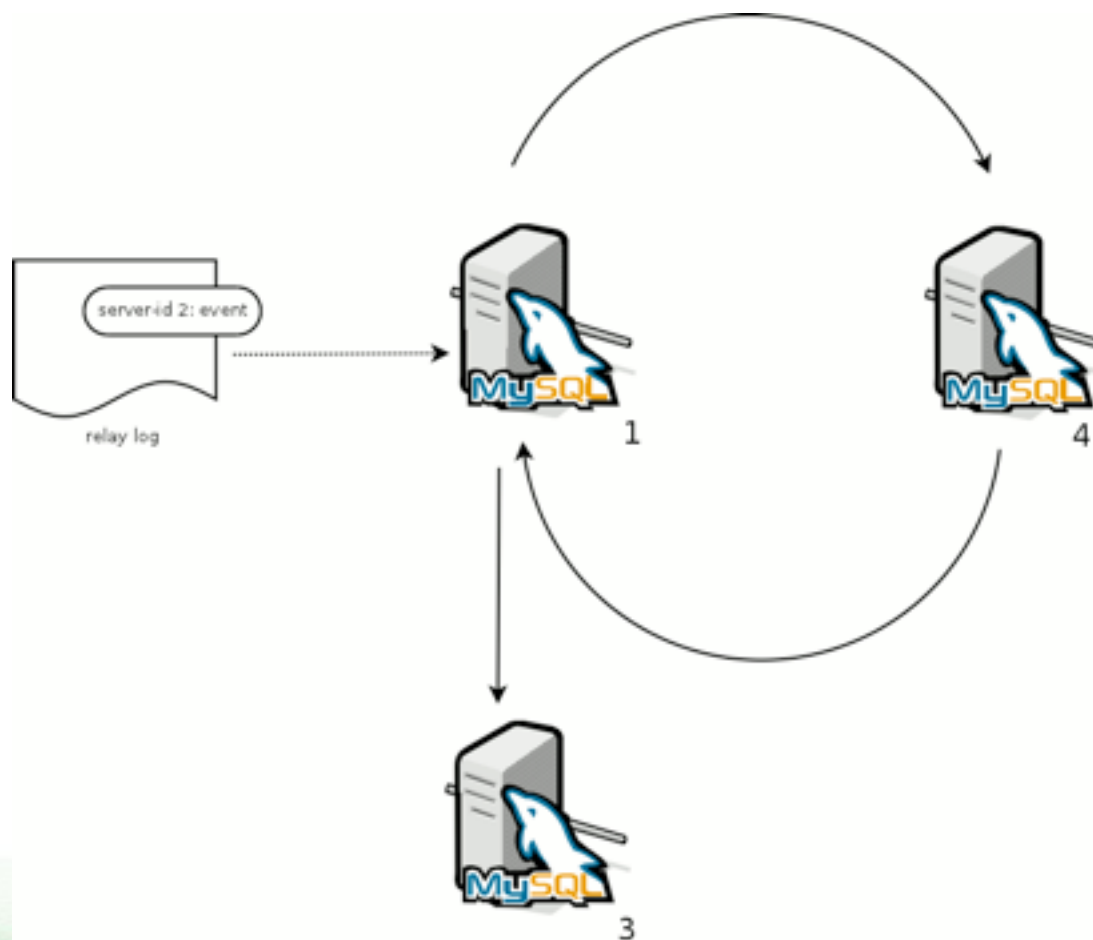
96



# Why server-id ?

97

- lefred didn't like my diagram, here is his version





# Round 1

98

# Round 1

98



# Round 1

98



**VS**

# Round 1

98



**VS**



# Round 1

98



**VS**



## Who Wins?

# Why server-id ?

99

- Avoid events to be written more than once
- `replicate_same_server_id` does what it says

# Configure Replication - HandsOn!

100

- On Master, add permissions:

```
node1> GRANT REPLICATION SLAVE ON *.* TO
'repl'@'%' IDENTIFIED BY 'slaveme';
```

- Get Binlog file/Position from backup:

```
cat /var/lib/mysql/
xtrabackup_binlog_info
```

- On Slave, configure replication:

```
node2> CHANGE MASTER TO
MASTER_HOST='192.168.70.1',
MASTER_USER='repl',
MASTER_PASSWORD='slaveme',
MASTER_LOG_FILE='__yourfile__',
MASTER_LOG_POS='__yourpos__';
```

slave> **START SLAVE;**

slave> **SHOW SLAVE STATUS\G**

Slave\_IO\_State: Waiting for master to send event

Master\_Host: master

Master\_User: repl

Master\_Port: 3306

Connect\_Retry: 60

Master\_Log\_File: mysql-bin.000008

Read\_Master\_Log\_Pos: 254

Relay\_Log\_File: relay-bin.000002

Relay\_Log\_Pos: 399

Relay\_Master\_Log\_File: mysql-bin.000008

Slave\_IO\_Running: Yes

Slave\_SQL\_Running: Yes

Replicate\_Do\_DB:

Replicate\_Ignore\_DB:

Replicate\_Do\_Table:

Replicate\_Ignore\_Table:

Replicate\_Wild\_Do\_Table:

Replicate\_Wild\_Ignore\_Table:

Last\_Errno: 0

Last\_Error:

Skip\_Counter: 0

Exec\_Master\_Log\_Pos: 254

Relay\_Log\_Space: 566

Until\_Condition: None

Until\_Log\_File:

Until\_Log\_Pos: 0

Master\_SSL\_Allowed: No

Master\_SSL\_CA\_File:

Master\_SSL\_CA\_Path:

Master\_SSL\_Cert:

Master\_SSL\_Cipher:

Master\_SSL\_Key:

**Seconds\_Behind\_Master: 0**

Master\_SSL\_Verify\_Server\_Cert: No

Last\_IO\_Errno: 0

Last\_IO\_Error:

Last\_SQL\_Errno: 0

Last SQL Error:

IO Thread State

IO Thread Read Up To

101

SQL Thread Read Up To

Threads Running?

How Far Is Slave Behind?

# Commands

102

- SQL Commands
  - Administrative Commands
  - Diagnostics Commands
- Shell Commands
  - `mysqlbinlog`

# Administrative Commands - HandsOn!

103

- Rotate binary log: `FLUSH BINARY LOGS`
- Rotate relay log: `FLUSH RELAY LOGS`
- `START/STOP SLAVE IO_THREAD/SQL_THREAD`
- Remove binary logs:  
`PURGE MASTER LOGS TO 'mysql-bin.000005';`  
`PURGE MASTER LOGS`  
`BEFORE '2012-01-01 00:00:00';`
- Remove all binary logs: `RESET MASTER`
- Remove slave configuration and files: `RESET SLAVE`

# Diagnostics Commands

104

- On Master
  - SHOW MASTER STATUS
  - SHOW PROCESSLIST
  - SHOW SLAVE HOSTS
  - SHOW BINLOG EVENTS
- On Slave
  - SHOW SLAVE STATUS
  - SHOW PROCESSLIST

# On Master:SHOW MASTER STATUS - HandsOn!

105

- Current binary log file and position:

```
master> SHOW MASTER STATUS\G
***** 1. row *****
 File: mysql-bin.000008
 Position: 254
 Binlog_Do_DB:
 Binlog_Ignore_DB: 1 row in set (0.00 sec)
```

# On Master: SHOW PROCESSLIST - HandsOn!

106

- Find Connected Slaves using SHOW PROCESSLIST:

```
master> SHOW PROCESSLIST\G
```

```
...
```

```
***** 2. row *****
```

```
Id: 4
```

```
User: repl
```

```
Host: localhost:43537
```

```
db: NULL
```

```
Command: Binlog Dump
```

```
Time: 1264
```

```
State: Has sent all binlog to slave; waiting for binlog to be
updated
```

```
Info: NULL
```

```
...
```

# On Slave: SHOW PROCESSLIST - HandsOn!

107

- Slave Thread Status:

```
SLAVE> SHOW PROCESSLIST\G
***** 1. row *****
 Id: 5
 User: system user
 Host:
 db: NULL
Command: Connect
 Time: 88611
 State: Waiting for master to send event
 Info: NULL
***** 2. row *****
 Id: 8
 User: system user
 Host:
 db: NULL
Command: Connect
 Time: 83
 State: Has read all relay log; waiting for the slave I/O thread to update
it
 Info: NULL
```

# Other Common Configuration Options

108

- Filtering: `binlog-%, replicate-%`
- Don't start replication at start:  
`skip_slave_start`
- Put relay log events in it's own binary log:  
`log_slave_updates`
- Disallow writing on slaves: `read_only`
- Automatically remove binlogs:  
`expire_logs_days`
- Change binlog format: `binlog_format`

# Filtering on Master

109

- `binlog-do-db=...`, `binlog-ignore-db=...`
- Warning! Different behavior between SBR and RBR:
  - SBR: Log all statements executed if the 'default database' (use database) should be binlogged
  - RBR: Log all row changes of the databases that should be binlogged

# Filtering on Slave

110

- `replicate-do-db=` & `replicate-ignore-db=`
- Warning! Different behavior between SBR and RBR  
Similar to `binlog-do/ignore-db`
- `replicate-do/ignore-table`: Filter on table level
- `replicate-wild-do/ignore-table`: Use wildcards (`%`, `_`) to filter on table level
- `replicate-rewrite-db=db1->db2`

# Breaking & Fixing Replication - HandsOn!

111

- Create table on Slave First, then Master:

```
CREATE TABLE imdb.plmce
(
 id int auto_increment primary key,
 name varchar(20)
);
```

- Check Slave Status:

```
slave> SHOW SLAVE STATUS\G
```

- Replication broke :(

# Breaking & Fixing Replication - HandsOn!

112

- Replication is Broken.
- Here we understand what went wrong. Let's just skip this record:

```
slave> SET GLOBAL
SQL_SLAVE_SKIP_COUNTER=1;
slave> START SLAVE
SQL_THREAD;
```



Listening to someone  
saying that he skipped a  
record and now  
replication works fine

# Inconsistencies - HandsOn!

113

- Let's delete some data from the slave:

```
node2> DELETE FROM imdb.users LIMIT 10;
```

- On the Master:

```
pt-table-checksum --tables imdb.users
--no-check-binlog-forma
```

- After Checksumming,  
let's verify:

```
pt-table-checksum \
--replicate-check-only
```



Almost ran an UPDATE without  
WHERE clause

# Fixing the Inconsistencies - HandsOn!

114

- Verify what data is wrong:

```
pt-table-sync --print --replicate percona.checksums \
localhost
```

- Approve and Execute:

```
pt-table-sync --execute --replicate percona.checksums \
localhost
```

- Warning! Split Brain situations may need different fixes

# Operational DBA In A Nutshell

- Setting Up Today's Environment
- Installation
- Logging In
- MySQL Privileges
- Diagnostics
- Troubleshooting
- Monitoring
- Backups

- Replication
- **Schema Changes**
- Configuration Optimization



How doing operations feels



# Schema Changes - Techniques

116

- Downtime
  - Con: Downtime
- Disable functionality in Application
  - Con: Partly Downtime
- Through replication
  - Con: A lot of Master/Slave roles being switches, time consuming, troublesome
- Online Schema Changes
  - Pro: Online!

# Online Schema Changes - HandsOn!

117

- Open second terminal

```
node1> insert into title
(title, series_years) values
('plmce !', '2013');
```

- pt-online-schema-change

```
time pt-online-schema-change \
--execute --alter \
"ADD INDEX new_idx (series_years)" \
D=imdb,t=title
```

- Users triggers/views

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How doing operations feels



# Optimization - Things Not To Optimize

119

- `innodb_io_capacity`: don't oversize
- `sort_buffer_size`, `join_buffer_size`, `read_buffer_size`, `read_rnd_buffer_size`: leave default globally
- `innodb_thread_concurrency`: Default is fine for most environments
- `query_cache_type`, `query_cache_size`: disable or do not oversize (+64MB)
- `innodb_flush_method=O_DIRECT` and `ext3`

# Optimization - Things To Optimize

120

- `innodb_log_file_size`: Increase InnoDB Transaction Logs

```
mysql> pager grep sequence
mysql> show engine innodb status\G
select sleep(60); show engine innodb
status\G
```

- `innodb_stats_on_metadata=0`
- `innodb_buffer_pool_size`
- `innodb_io_capacity`
- change the shared memory allocator (jemalloc)

```
[mysqld_safe]
malloc-lib=/usr/lib64/libjemalloc.so.1
```

# Configuration Wizard - HandsOn!

121

- <http://tools.percona.com>

## Optimize your MySQL Server

Leverage our expertise to create a good starting configuration for a MySQL server.

This tool will walk you through all of the steps necessary to create a ready to use MySQL configuration file in about 5 minutes.

**Generate A Configuration Now**

# Want to learn more?

122

- Some good resources to help you along:
  - Books
    - High Performance MySQL, 3rd Edition (Baron Schwartz, Peter Zaitsev, Vadim Tkachenko)
    - Effective MySQL series (Ronald Bradford)
    - Instant InnoDB (Matt Reid)



# Want to learn more?

123

- Some good resources to help you along:
  - Blogs
    - Planet MySQL: [planet.mysql.com](http://planet.mysql.com)
    - MySQL Performance Blog: [www.mysqlperformanceblog.com](http://www.mysqlperformanceblog.com)
  - Recorded Webinars
    - [www.percona.tv](http://www.percona.tv)

# Want to learn more?

124

- Some good entry-level talks at this conference
  - How to Design Indexes, Really - Bill Karwin
  - Backups in the Real World: Challenges and Solution - Ryan Huddleston
  - Choosing Hardware for MySQL - Kenny Gryp
  - Getting started with Tungsten Replicator - Neil Armitage
  - Load Balancing MySQL with HAProxy - Peter Boros
  - myq\_gadgets - Simple scripts to expose the inner workings of your MySQL server - Jay Janssen
  - You know SSD's make MySQL fast, but do you know why? - Jared Hulbert

# Operational DBA In A Nutshell - Q&A

125

- Setting Up Today's Environment
- Installation
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How doing operations now feels

# Operational DBA In A Nutshell - Q&A

125

- Setting Up Today's Environment
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How doing operations now feels



**I must go**