State of MySQL Security: 2022

Alexander Rubin
Senior Database Engineer
Amazon RDS

About me

- Working with MySQL for ~15 years
- Started at MySQL AB 2006
    - Sun Microsystems, Oracle (MySQL Consulting)
    - Percona since 2014
- Joined the Amazon Relational Database Service (RDS) engineering team in 2020
- Currently leading database security team
  - I’m hiring Pentesters/Security Engineers!

Amazon RDS

Set up, operate, and scale a relational database in the cloud with just a few clicks

Amazon Aurora
PostgreSQL-Compatible Edition

Amazon Aurora
MySQL-Compatible Edition

MySQL

PostgreSQL

MariaDB

Microsoft SQL Server

ORACLE

Easy to administer

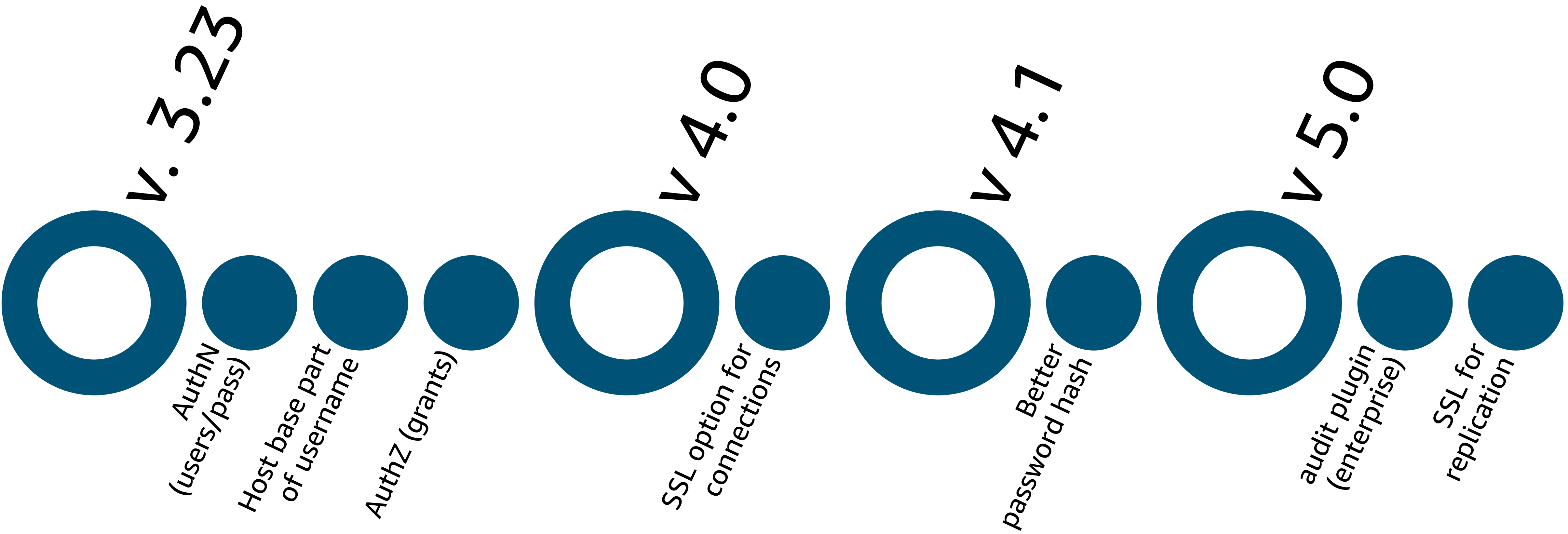
Secure and compliant

Available and durable

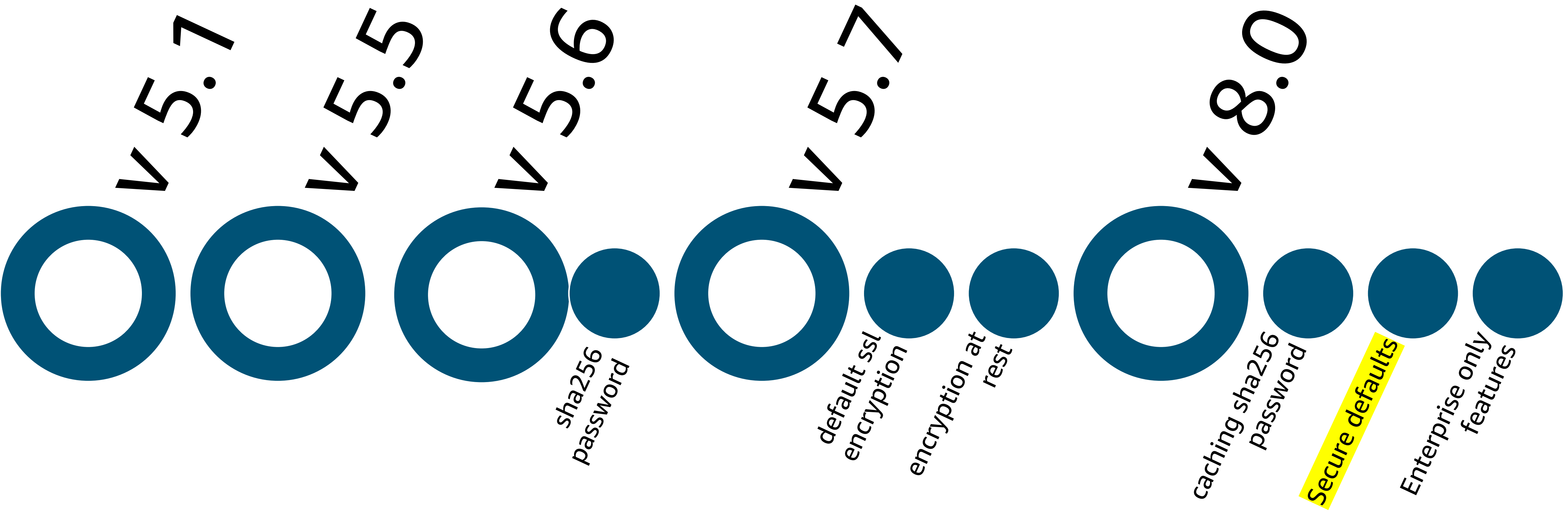
Performant and scalable

How many of you use a specific MySQL version?

MySQL History and Security Features over the years



MySQL History and Security Features over the years



MySQL 8.0 Security feature outline

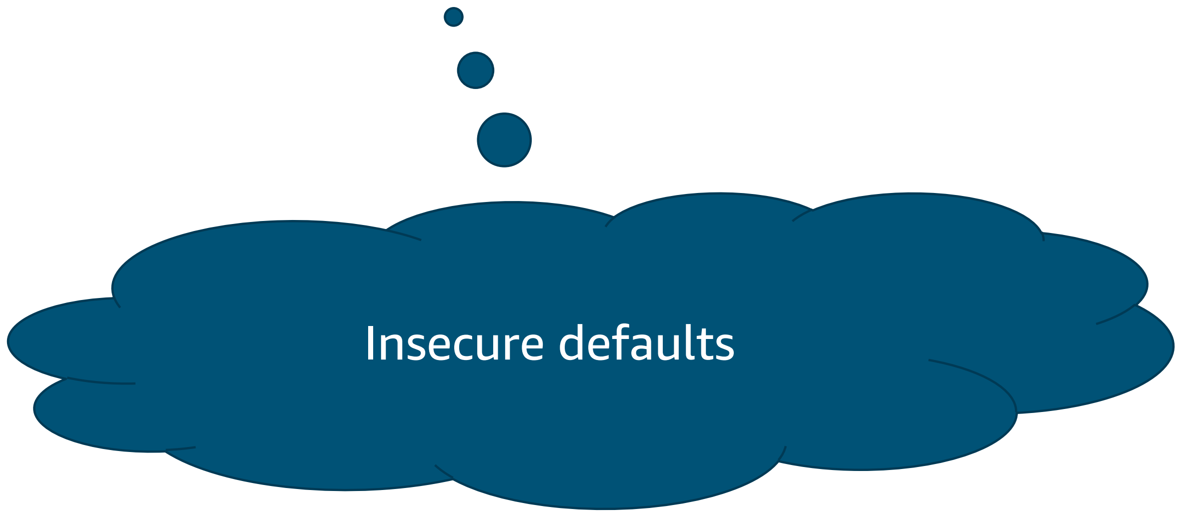
New security features:

- Encryption
  - In flight (SSL/TLS, client->server, replication, etc)
  - At rest (tablespace encryption, key management
  - Various cryptographic functions
- AuthN
  - New auth protocol:
  - New auth methods (Kerberos, etc)
  - Pluggable authentication
- AuthZ
  - Roles

Most important: ”Secure defaults”

Over 3.6 million MySQL servers found exposed on the Internet

Over 3.6 million MySQL servers are publicly exposed on the Internet and responding to queries, making them an attractive target to hackers and extortionists.



https://www.bleepingcomputer.com/news/security/over-36-million-mysql-servers-found-exposed-on-the-internet/

Our agenda

Encryption	• In flight (client->server) • At rest (on disk)
Authentication	• User/password
Authorization	• Grants/roles
Accounting	• Logs: audit log

Our agenda

Encryption	• In flight (client->server) • At rest (on disk)
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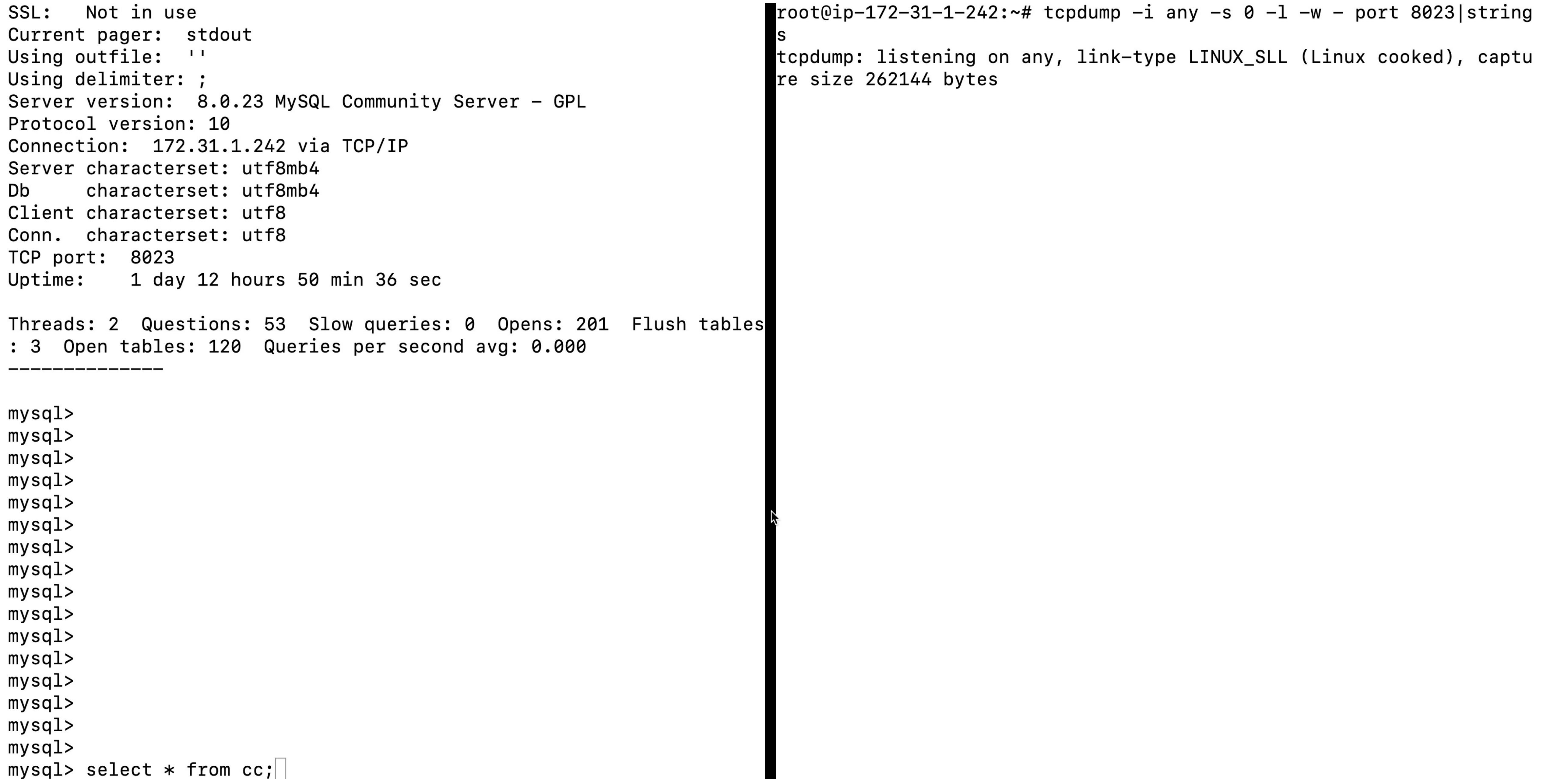
We are here

Data in Flight Encryption – why do we need it?

```
mysql -h 172.31.1.242 -P 5726 -umsandbox -pmsandbox
mysql>
mysql>
mysql> \s
--------------
mysql  Ver 14.14 Distrib 5.7.38, for Linux (x86_64) using  EditLine wrapper


Connection id:   5
Current database: creditcards
Current user:  msandbox@ip-172-31-1-242
SSL:   Not in use
```

Encryption



```
SSL:    Not in use
Current pager:  stdout
Using outfile:  ''
Using delimiter: ;
Server version:  8.0.23 MySQL Community Server - GPL
Protocol version: 10
Connection:  172.31.1.242 via TCP/IP
Server characterset: utf8mb4
Db     characterset: utf8mb4
Client characterset: utf8
Conn.  characterset: utf8
TCP port:  8023
Uptime:    1 day 12 hours 50 min 36 sec

Threads: 2  Questions: 53  Slow queries: 0  Opens: 201  Flush tables
: 3  Open tables: 120  Queries per second avg: 0.000
--------------

mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql> select * from cc;
```

```
root@ip-172-31-1-242:~# tcpdump -i any -s 0 -l -w - port 8023|string
s
tcpdump: listening on any, link-type LINUX_SLL (Linux cooked), captu
re size 262144 bytes
```

Data in Flight Encryption – why do we need it?

```
mysql> SSL:    Not in use
mysql> select * from cc;
+----------------------+
| cc_num               |
+----------------------+
| 1234-4564-0984-9874 |
+----------------------+
1 row in set (0.00 sec)
```

```
# tcpdump -i any -s 0 -l -w - port 8023|strings
tcpdump: listening on any …
select * from cc
creditcards
cc_num
cc_num
1234-4564-0984-9874
```

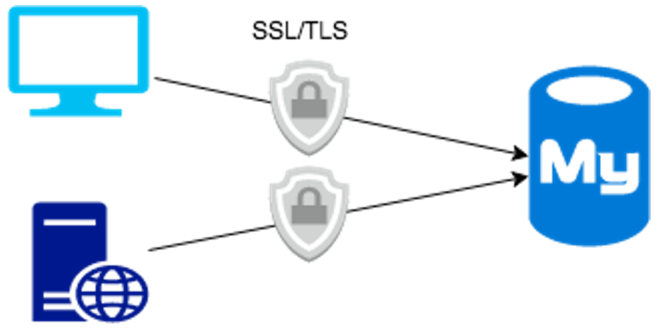
Bad actor intercepted traffic with tcpdump!

Encryption

Data in Flight Encryption - client connection

SSL/TLS: Default in MySQL 5.7+

- If SSL is enabled (default) on the server client will use it
- No need to generate keys and send it to the client
    - Server key - will be generated when MySQL starts
    - Client key will be generated on demand



Encryption

Data in Flight Encryption - client connection

SSL/TLS: Default in MySQL 5.7+

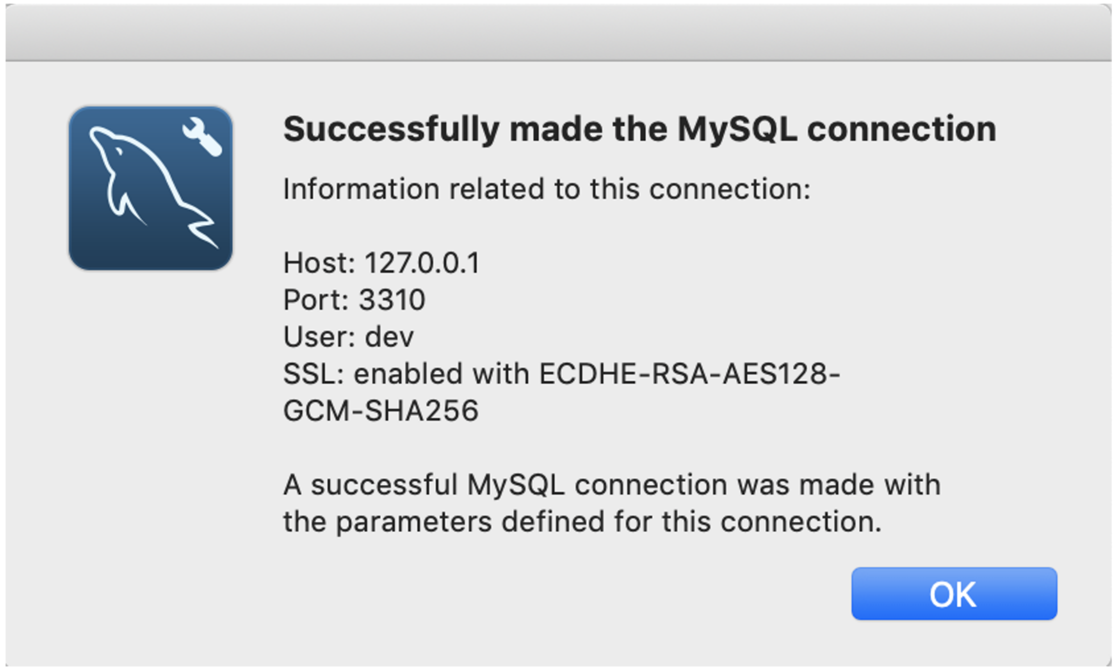
```
$ mysql -h db
Welcome to the MySQL monitor.  Commands end with ; or \g.
...
Server version: 5.7.25-28-57 (GPL)

mysql> \s
--------------
Connection id:          799621
...
SSL:                    Cipher in use is ECDHE-RSA-AES128-GCM-SHA256
```

Encryption

Data in Flight Encryption - client connection

MySQL workbench:



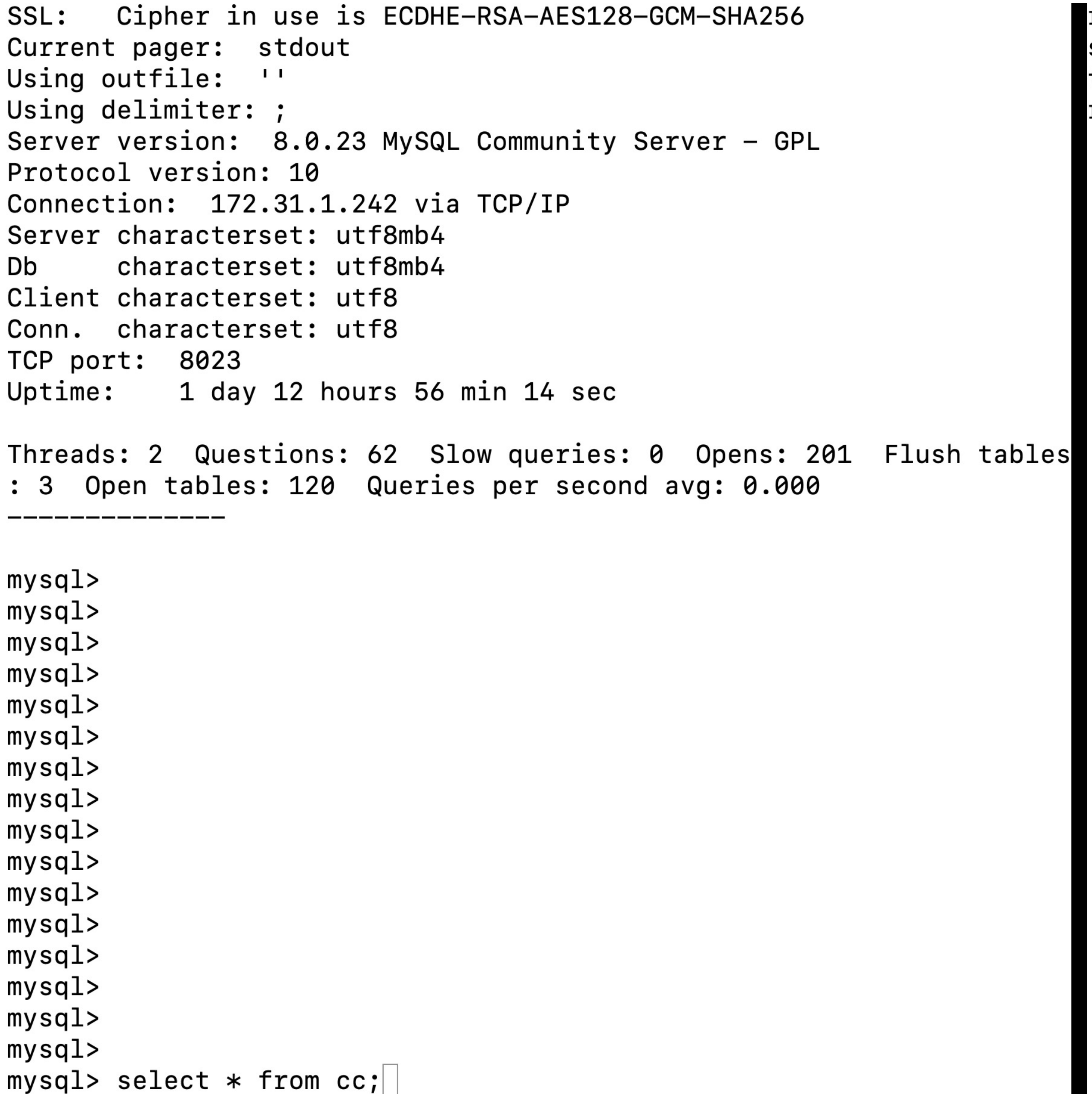
Successfully made the MySQL connection

Information related to this connection:

Host: 127.0.0.1
Port: 3310
User: dev
SSL: enabled with ECDHE-RSA-AES128-GCM-SHA256

A successful MySQL connection was made with the parameters defined for this connection.

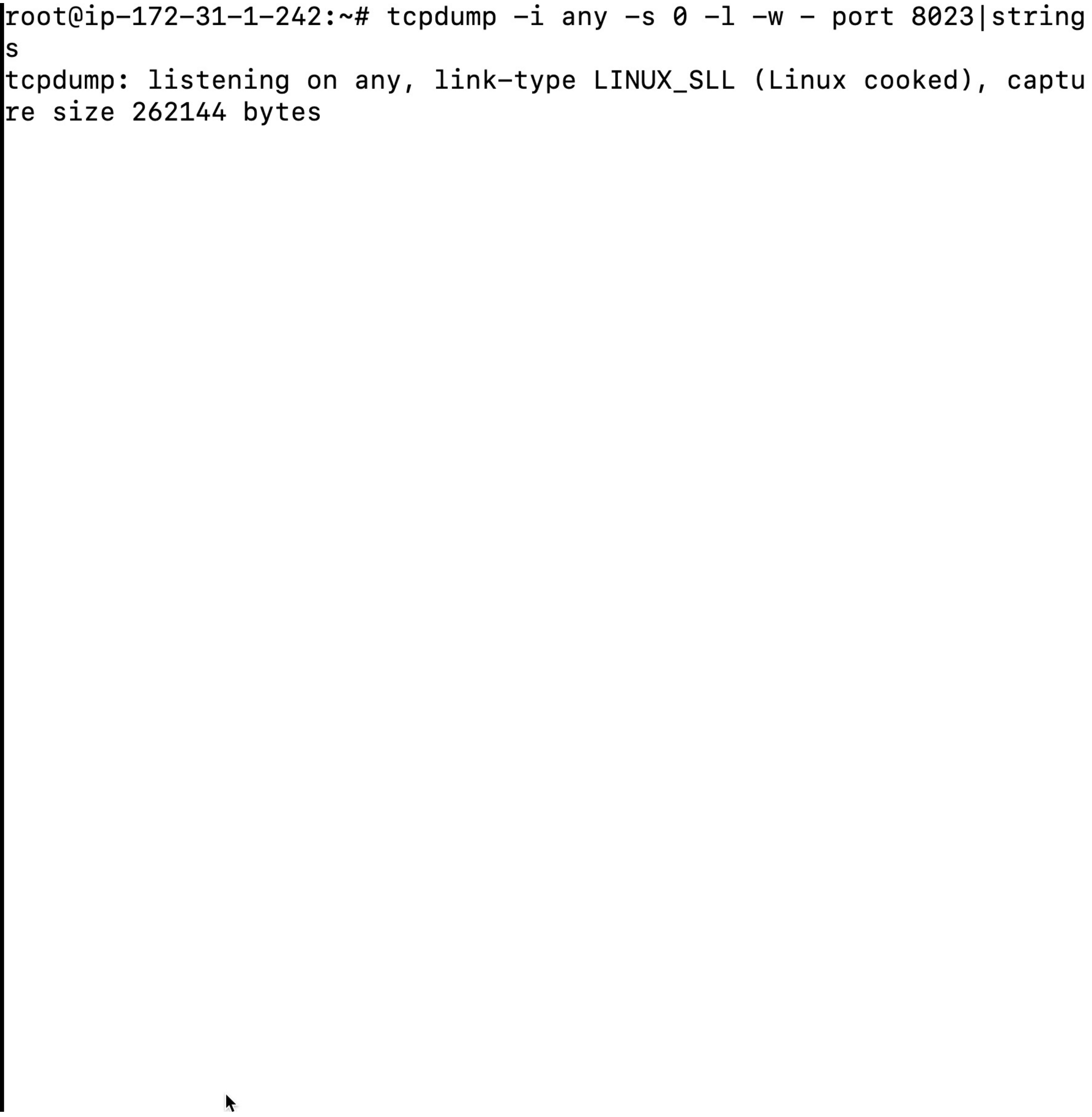
Encryption



```
SSL:    Cipher in use is ECDHE-RSA-AES128-GCM-SHA256
Current pager:  stdout
Using outfile:  ''
Using delimiter: ;
Server version:  8.0.23 MySQL Community Server - GPL
Protocol version: 10
Connection:  172.31.1.242 via TCP/IP
Server characterset: utf8mb4
Db     characterset: utf8mb4
Client characterset: utf8
Conn.  characterset: utf8
TCP port:  8023
Uptime:    1 day 12 hours 56 min 14 sec

Threads: 2  Questions: 62  Slow queries: 0  Opens: 201  Flush tables
: 3  Open tables: 120  Queries per second avg: 0.000
--------------

mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql> select * from cc;
```



```
root@ip-172-31-1-242:~# tcpdump -i any -s 0 -l -w - port 8023|string
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tcpdump: listening on any, link-type LINUX_SLL (Linux cooked), captu
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Data in Flight Encryption – why do we need it?

```
mysql> Cipher in use is
ECDHE-RSA-AES128-GCM-
SHA256
mysql> select * from cc;
+----------------------+
| cc_num               |
+----------------------+
| 1234-4564-0984-9874 |
+----------------------+
1 row in set (0.00 sec)
```

```
# tcpdump -i any -s 0 -l -w - port 8023|strings
tcpdump: listening on any …
```

<garbage>

Protected!

Encryption

Data in Flight Encryption - client connection

Create user and force ssl/tls

```
CREATE USER 'user'@'<host>' IDENTIFIED BY '<pass here>' REQUIRE SSL;

$ mysql> alter user dev@'10.0.0.1' require ssl;
Query OK, 0 rows affected (0.00 sec)

$ mysql -u dev -h 10.0.0.1 -e '\s' | grep SSL
SSL:                    Cipher in use is TLS_AES_256_GCM_SHA384
```

```
$ mysql -u dev -h 10.0.0.1 --skip-ssl
ERROR 1045 (28000): Access denied for user 'dev'@'10.0.0.1' (using
password: YES)
```

Encryption

Data in Flight Encryption - server to server

Protecting communications:

- source -> replica
- between nodes in a cluster
- etc

Encryption

Our agenda

Encryption

- In flight (client->server)
- At rest (on disk)

We are here

Authentication

- User/password

Authorization

- Grants/roles

Accounting

- Logs: audit log

Data at Rest Encryption – Why do we need it?

```
mysql> create table a(s varchar(255)) engine=InnoDB;
Query OK, 0 rows affected (0.01 sec)

mysql> insert into a values ('AlexanderRubin');
Query OK, 1 row affected (0.00 sec)

mysql> insert into a values ('qqqqqq');
Query OK, 1 row affected (0.00 sec)

mysql> update a set s = 'AlexanderRubin';
Query OK, 1 row affected (0.00 sec)
Rows matched: 2  Changed: 1  Warnings: 0
```

Data at Rest Encryption – Why do we need it?

```
/data/mysql# grep -r 'AlexanderRubin' *
Binary file ib_logfile0 matches
Binary file log-bin.000004 matches
Binary file test/a.ibd matches
Binary file xb_doublewrite matches
```

PII data stored on disk
in clear text

Data at Rest Encryption

Transparent Database Encryption (TDE): MySQL implementation

1. Create master key and store it
2. Use master key to encrypt table (tablespace) key
3. Use tablespace key to encrypt table data

More information:
https://dev.mysql.com/doc/refman/8.0/en/innodb-tablespace-encryption.html#innodb-tablespace-encryption-about

Encryption

Data at Rest Encryption

Transparent Database Encryption (TDE): encrypting db files

1. **InnoDB files:** tablespaces, redo logs, undo logs:
   - Available since MySQL 5.7
2. **Binary logs, relay logs:** for MySQL replication:
   - Available in MySQL 8.0 and Percona Server 5.7 & 8.0
3. **Tmp files:** Available in Percona Server 5.7 & 8.0

https://www.percona.com/doc/percona-server/5.7/management/data_at_rest_encryption.html

https://dev.mysql.com/doc/refman/8.0/en/innodb-tablespace-encryption.html

https://mariadb.com/kb/en/library/data-at-rest-encryption-overview/

Data at Rest Encryption: add encryption options

```
[mysqld]
early-plugin-load=keyring_file.so
keyring_file_data=/mount/mysql/mysql-keyring/keyring
innodb_sys_tablespace_encrypt=1
innodb_parallel_dblwr_encrypt=1
innodb_temp_tablespace_encrypt=1
innodb_encrypt_tables=FORCE
innodb_encrypt_online_alter_logs=1
innodb_undo_log_encrypt=1
innodb_redo_log_encrypt=1
innodb_scrub_log=1
master_verify_checksum=1
binlog_checksum=1
encrypt_binlog=1
encrypt_tmp_files=1
```

Encrypt everything!

Data at Rest Encryption

```
mysql> create table a(s varchar(255)) engine=InnoDB /* encrypted='y' */;
Query OK, 0 rows affected (0.01 sec)

mysql> insert into a values ('AlexanderRubin');
Query OK, 1 row affected (0.00 sec)

mysql> insert into a values ('qqqqqq');
Query OK, 1 row affected (0.00 sec)

mysql> update a set s = 'AlexanderRubin';
Query OK, 1 row affected (0.00 sec)
Rows matched: 2  Changed: 1  Warnings: 0
```

Data at Rest Encryption: add encryption options

```
/data/mysql# grep -r 'AlexanderRubin' *
/data/mysql#
```

Nothing found!
(data encrypted)

Our agenda

Encryption	• In flight (client->server) • At rest (on disk)
Authentication	• User/password
Authorization	• Grants/roles
Accounting	• Logs: audit log

We are here

3 A's of Security

- Authentication
- Authorization
- Accounting

security framework that controls access to computer resources, enforces policies, and audits usage.

3 A's in MySQL Security

Authentication

- `mysql -u admin -ppassword1`
- Authentication Plugins
- `SSL encryption`

Authorization

- Access Controls
- Isolation

Accounting

- Logs
  - Audit log
  - General log
  - Binary log

MySQL Security

Authentication

- `mysql -u admin –ppassword1`
- Authentication Plugins
- SSL encryption

Authentication plugins

- MySQL pre-4.1 (old_password): DO NOT USE
- MySQL mysql_native_password: only use in exceptional cases
- MySQL caching_sha256 (since 8.0)

mysql_native_password

Why do we need to use caching_sha256?

```
mysql 5.7> create user b identified by 'password1';
mysql 5.7> create user c identified by 'password1';
```

```
mysql> select user, plugin, authentication_string from mysql.user
       where user in ('a', 'b');
+------+-----------------------+-------------------------------------------+
| user | plugin                | authentication_string                     |
+------+-----------------------+-------------------------------------------+
| a    | mysql_native_password | *668425423DB5193AF921380129F465A6425216D0 |
| b    | mysql_native_password | *668425423DB5193AF921380129F465A6425216D0 |
+------+-----------------------+-------------------------------------------+
2 rows in set (0.00 sec)
```

Unsalted:
SAME hashes

mysql_native_password

Why do we need to use caching_sha256?

```
mysql 5.7> select password('password1');
+-------------------------------------------+
| password('password1')                     |
+-------------------------------------------+
| *668425423DB5193AF921380129F465A6425216D0 |
+-------------------------------------------+
mysql 5.7> SELECT CONCAT('*', UPPER(SHA1(UNHEX(SHA1('password1')))));
+----------------------------------------------------+
| CONCAT('*', UPPER(SHA1(UNHEX(SHA1('password1'))))) |
+----------------------------------------------------+
| *668425423DB5193AF921380129F465A6425216D0          |
+----------------------------------------------------+
```

caching_sha2_password

Why do we need to use caching_sha256?

```
mysql 8.0> create user a identified by 'password1';
mysql 8.0> create user b identified by 'password1';
mysql 8.0> select user, plugin, authentication_string from mysql.user
where user in ('a','b');
+------+-----------------------+-------------------------------------------------------------------------+
| user | plugin                | authentication_string                                                   |
+------+-----------------------+-------------------------------------------------------------------------+
| a    | caching_sha2_password | $A$005$y!NOQ/9<x}hZp5ffcvQ4sbcTpFkdf87jeWZSUdKLEftDe1vCK5BJWlp9         |
| b    | caching_sha2_password | $A$005$r*MAH&4ZtC9sGJVmw.6V/TJmLHgIIYbCLnXAkN2ZFJi82kPD3hiC             |
+------+-----------------------+-------------------------------------------------------------------------+
mysql 8.0> select user, plugin, hex(authentication_string) from mysql.user
where user in ('a','b');
+------+-----------------------+---------------------------+
| user | plugin                | hex(authentication_string)|
+------+-----------------------+---------------------------+
| a    | caching_sha2_password | 244124303035240679214E1…  |
| b    | caching_sha2_password | 24412430303524721A2A1A4…  |
+------+-----------------------+---------------------------+
```

salted – different hashes

But how did a bad actor get the password from hash?

1. Brutforce with hashcat (or other tools)
2. In some cases (able to sniff traffic and no SSL): can auth with hash: https://github.com/cyrus-and/mysql-unsha1

But how did a bad actor get the password from hash?

https://www.percona.com/blog/2020/06/12/brute-force-mysql-password-from-a-hash/

But how did a bad actor get the password from hash?

```
$ hashcat -m 300 -a 0 -D 2 -O -w 3 ./h ./rockyou.txt
```

Word list file

```
Dictionary cache hit:
* Filename..: ./rockyou.txt
* Passwords.: 14344384
* Bytes.....: 139921497
* Keyspace..: 14344384

668425423db5193af921380129f465a6425216d0:password1

Session..........: hashcat
Status...........: Cracked
Hash.Name........: MySQL4.1/MySQL5
Hash.Target......: 668425423db5193af921380129f465a6425216d0
Time.Started.....: Thu Jul 28 23:18:41 2022 (1 sec)
Time.Estimated...: Thu Jul 28 23:18:42 2022 (0 secs)
...

Started: Thu Jul 28 23:18:39 2022
Stopped: Thu Jul 28 23:18:43 2022
```

Cracked in <1 sec

p3.2xlarge ec2 instance

But how did a bad actor get the password from hash?

```
mysql 8.0> select authentication_string from mysql.user
where user = 'app_legacy'
+-------------------------------------------+
| authentication_string                     |
+-------------------------------------------+
| *17C026786E36EE4E76098CC918AB00798DD0AA8C |
+-------------------------------------------+

hashcat# cat legacy
17C026786E36EE4E76098CC918AB00798DD0AA8C
```

mysql_native_password

Can we crack this?

But how did a bad actor get the password from hash?

```
hashcat -m 300 -a 3 ./legacy -1 ?l?u?d?s ?1?1?1?1?1?1
17c026786e36ee4e76098cc918ab00798dd0aa8c:Q1b3-d
Session..........: hashcat
Status...........: Cracked
Time.Started.....: Fri Jul 29 15:57:24 2022 (17 secs)
Hash.Name........: MySQL4.1/MySQL5
Guess.Mask.......: ?1?1?1?1?1?1 [6]
Guess.Charset....: -1 ?l?u?d?s, -2 Undefined,   3 Undefine   -4 Un    ned
Guess.Queue......: 1/1 (100.00%)
Speed.#1.........:  5884.2 MH/s (6.63ms) @ Accel:8
Recovered........: 1/1 (100.00%) Digests
Progress.........: 95011471360/735091890625 (12.
Rejected.........: 0/95011471360 (0.00%)
Restore.Point....: 10485760/81450625 (12.87%)
Restore.Sub.#1...: Salt:0 Amplifier:512-576 Iteratio   -6
Candidate.Engine.: Device Generator
Candidates.#1....: CoS(KK -> ad"^~t
```

Cracked in 17 sec, brutforce mode, 6 random chars

But how did a bad actor get the password from hash?

```
mysql 8.0> SELECT
CONCAT('\$mysql',LEFT(authentication_string,6),'*',INSERT(HEX(SUBSTR(authentication_string
,8)),41,0,'*')) AS hash FROM mysql.user WHERE plugin = 'caching_sha2_password' AND
user='app2';
```

```
$mysql$A$005*360907671C5A3E4A6D53564E47261E2F12562954*643143524E2F696A78534B684454
4F544A346D70743453664A4B71746F5075643339654F65664954544F44
```

`caching_sha2_password`

Can we crack this?

But how did a bad actor get the password from hash?

```
hashcat -m 7401 -a 3 ./new -1 ?l?u?d?s ?1?1?1?1?1?1
Session..........: hashcat
Status...........: Running
Hash.Name........: MySQL $A$ (sha256crypt)
Hash.Target......: $mysql$A$005*360907671C5A3E4A6D53564E47261E2F125629...544F44
Time.Started.....: Fri Jul 29 16:09:17 2022 (1 min, 29 secs)
Time.Estimated...: Mon Aug 29 14:23:15 2022 (30 days, 22 hours)
Kernel.Feature...: Pure Kernel
Guess.Mask.......: ?1?1?1?1?1?1 [6]
Guess.Charset....: -1 ?l?u?d?s, -2 Undefined, -3 Undefined, -4 Undefined
Guess.Queue......: 1/1 (100.00%)
Speed.#1.........:   275.1 kH/s (7.38ms) @ Accel:8 Loops:16 Thr:1024 Vec:1
Recovered........: 0/1 (0.00%) Digests
Progress.........: 24248320/735091890625 (0.00%)
Rejected.........: 0/24248320 (0.00%)
Restore.Point....: 0/7737809375 (0.00%)
Restore.Sub.#1...: Salt:0 Amplifier:37-38 Iteration:1920-1936
Candidate.Engine.: Device Generator
Candidates.#1....: Carier -> CYiQUS
```

But how did a bad actor get the password from hash?

8-chars password with lower and upper case letters and digits for MySQL 5.7 can be recovered only in 2 hours.
The same password for MySQL 8.0 can be recovered in 2.8 years.

https://www.percona.com/blog/2020/06/12/brute-force-mysql-password-from-a-hash/

AuthN conclusion: use `caching_sha2_password`

1. Use caching_sha2_password
2. Use better passwords
3. Make sure the mysql.user is not easily readable

Our agenda

Encryption	• In flight (client->server) • At rest (on disk)
Authentication	• User/password
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Accounting	• Logs: audit log

We are here

MySQL Security

Authorization

- Access Controls
- Isolation

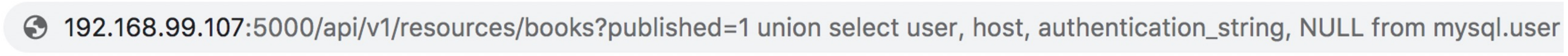
MySQL SQL Injection Example

```
@app.route('/api/v1/resources/books')
def api_filter():
   query_parameters = request.args
   published = query_parameters.get('published')
   author = query_parameters.get('author')

   query = "SELECT * FROM books WHERE"
   if published:
       query += ' published=' + published
 ...
   cursor = mysql.connect().cursor()
   cursor.execute(query)
   results=cursor.fetchall()
   return jsonify(results)
```

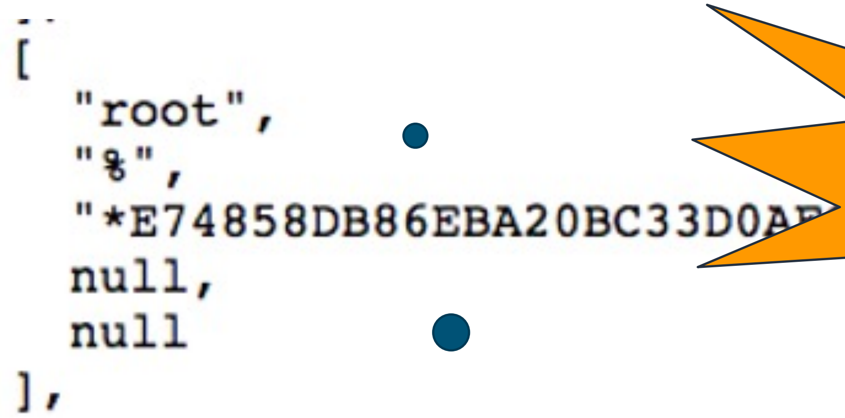
*Adapted code / do not try at home

MySQL SQL Injection Example



192.168.99.107:5000/api/v1/resources/books?published=1 union select user, host, authentication_string, NULL from mysql.user

```
SELECT * FROM books WHERE published = 1
union
select user, host, authentication_string
from mysql.user
```

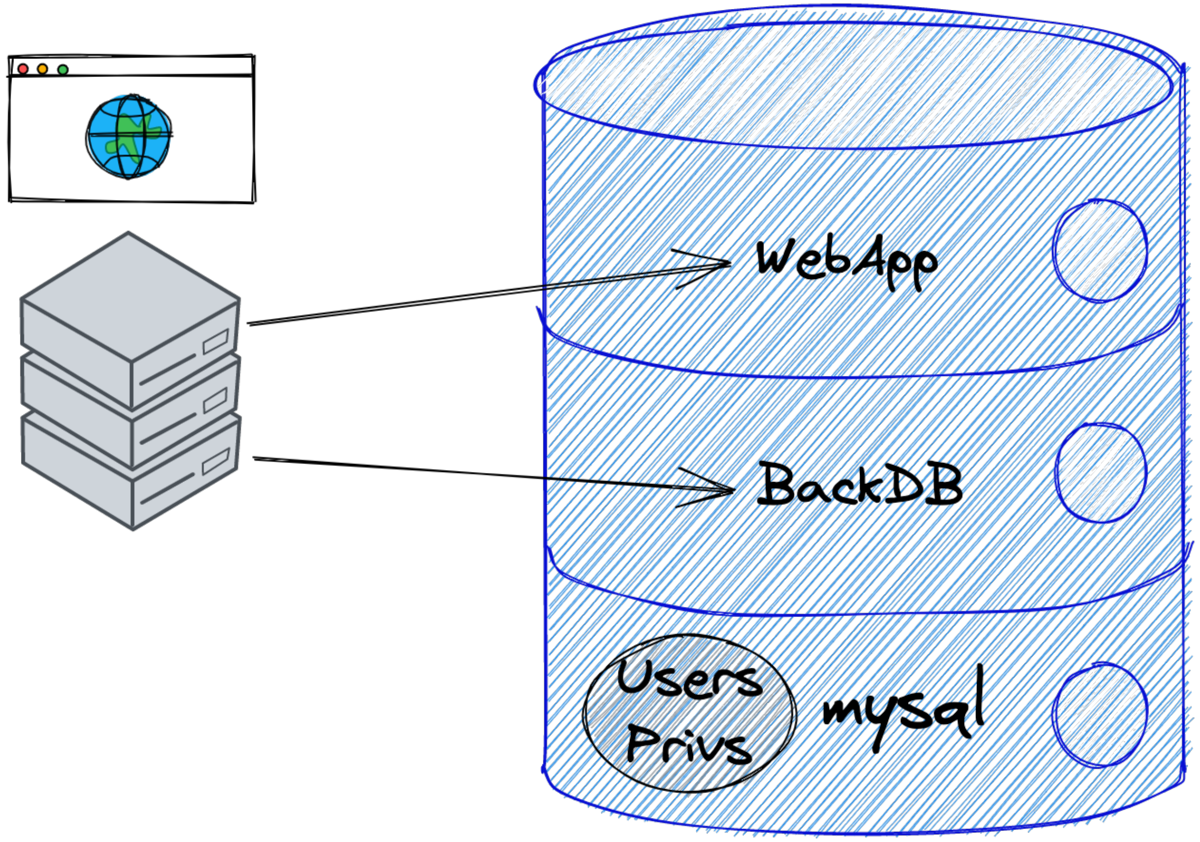


```
[
   "root",
   "%",
   "*E74858DB86EBA20BC33D0AE
   null,
   null
],
```

But why the application user can select from mysql.user?

MySQL privilege model: History

Typical web application with MySQL database (since ~1996)



MySQL privilege model: History

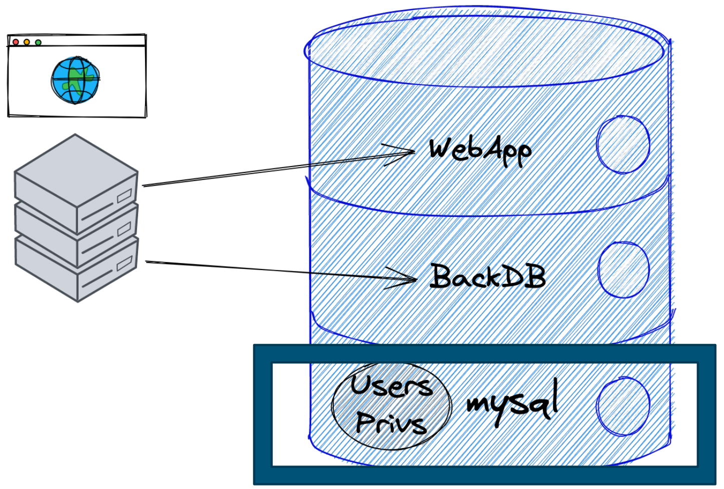
Typical web applications with MySQL database (since ~1996)

```
# create superuser
GRANT ALL PRIVILEGES ON *.* TO 'root'@'%'
WITH GRANT OPTION
```

Super user ("root" user)
= can do everything

```
# create web app db and user
CREATE DATABASE WebApp;
GRANT ALL PRIVILEGES ON `WebApp`.* TO 'app'@'10.%'

# create backend db and user
CREATE DATABASE BackDB;
GRANT ALL PRIVILEGES ON `BackDB`.* TO 'cron'@'10.%'
```



"mysql" db is isolated

MySQL privilege model

Database per customer approach

DB per customer

App creates DB

Good enough for DB isolation?

```
mysql> show databases;
+---------------------------+
| Database                  |
+---------------------------+
| sakila_00KBQa3SpbN9Brvv |
| sakila_014TcXtsuUviCaB7 |
| sakila_01nThhS7ch0l2aD7 |
...
| sakila_zxwrBTtamcQBvbQ8 |
| sakila_zyp3nsGmUmBZPAQn |
| sakila_zzDtuzIyy7fHcLtT |
+---------------------------+
3075 rows in set (0.01 sec)
```

MySQL privilege model

Database per customer approach: Wrong way

WRONG

```
GRANT SELECT,INSERT,UPDATE,DELETE
      ON *.* TO app@'10.%';
```

What is the risk?

```
mysql> select user, host, authentication_string
       from mysql.user;
+-------------------+-----------+----------------------+
| user              | host      | authentication_string |
+-------------------+-----------+----------------------+
| admin             | %         | *C8307................|
…
```

App user can read hash of password for any user!

What is the risk?

```
mysql> show grants;
+----------------------------------------------------------+
| Grants for app@%                                         |
+----------------------------------------------------------+
| GRANT SELECT, INSERT, UPDATE, DELETE ON *.* TO 'app'@'%' |
+----------------------------------------------------------+

mysql> update mysql.user set authentication_string = password('new_password')
    -> where user = 'admin';
Query OK, 1 row affected
...
$ mysql -uadmin -pnew_password

mysql> show grants;
+--------------------------------------------------------------
| Grants for admin@%
+--------------------------------------------------------------+
| GRANT ALL PRIVILEGES ON *.* TO 'admin'@'%' WITH GRANT OPTION |
+--------------------------------------------------------------+
1 row in set (0.00 sec)
```

BOOM!
Changed admin pass!

What is the risk?

```
mysql> show grants;
+----------------------------------------------------------+
| Grants for app@%                                         |
+----------------------------------------------------------+
| GRANT SELECT, INSERT, UPDATE, DELETE ON *.* TO 'app'@'%' |
| GRANT ALL PRIVILEGES ON *.* TO 'app'@'%'                 |
+----------------------------------------------------------+
2 rows in set (0.00 sec)

mysql> update mysql.user set super_priv='y'
    -> where user='app';
Query OK, 1 row affected (0.00 sec)
...
mysql> show grants;
+-----------------------------------------------------------------+
| Grants for app@%                                                |
+-----------------------------------------------------------------+
| GRANT SELECT, INSERT, UPDATE, DELETE, SUPER ON *.* TO 'app'@'%' |
+-----------------------------------------------------------------+
```

Controlling mysql.user table means that you can get any additional privilege

MySQL privilege model

Database per customer approach: Right way

```
# grant multiple database access
GRANT ALL PRIVILEGES
      ON `sakila_%`.* TO 'app'@'10.%'

mysql> create database aaa;
ERROR 1044 (42000): Access denied
      for user 'app'@'10.%' to database 'aaa'

mysql> create database sakila_test;
Query OK, 1 row affected (0.01 sec)
```

```
mysql> show databases;
+-------------------------+
| Database                |
+-------------------------+
| information_schema      |
| sakila_00KBQa3SpbN9Brvv |
| sakila_014TcXtsuUviCaB7 |
| sakila_01nThhS7ch0l2aD7 |
...
| sakila_zxwrBTtamcQBvbQ8 |
| sakila_zyp3nsGmUmBZPAQn |
| sakila_zzDtuzIyy7fHcLtT |
+-------------------------+
3075 rows in set (0.01 sec)
```

MySQL privilege model

Database per customer approach

What if there is no distinct pattern?

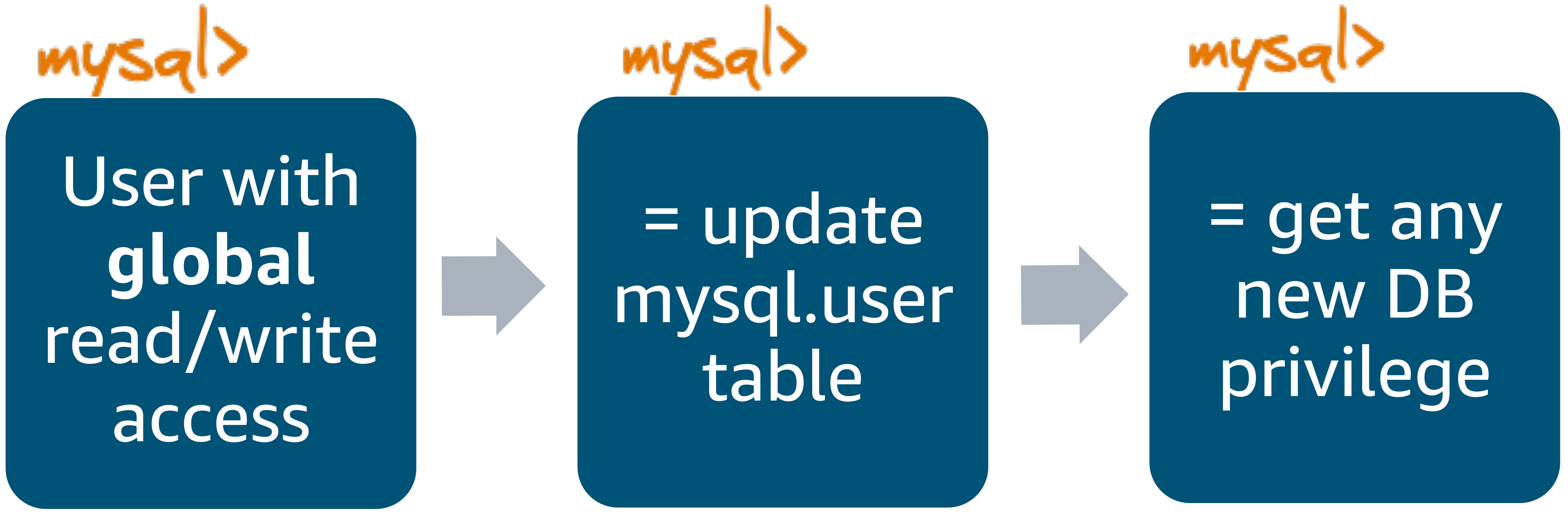
Easy to make mistake and GRANT ALL PRIVIEGES to app user!

```
mysql> show databases;
+------------------+
| Database         |
+------------------+
| 00KBQa3SpbN9Brvv |
| 014TcXtsuUviCaB7 |
| 01nThhS7ch0l2aD7 |
...
| zxwrBTtamcQBvbQ8 |
| zyp3nsGmUmBZPAQn |
| zzDtuzIyy7fHcLtT |
+------------------+
3075 rows in set
```

Easy to make mistake…

Summary

Privilege escalation path



User with **global** read/write access

= update mysql.user table

= get any new DB privilege

Changes in MySQL 8.0

New options

- Partial revokes
- Roles
- Dynamic privileges

MySQL 8.0 privilege model changes

Partial revokes: Game changer

“Prior to MySQL 8.0.16, it is not possible to grant privileges that apply globally except for certain schemas. As of MySQL 8.0.16, that is possible if the [partial_revokes](https://dev.mysql.com/doc/refman/8.0/en/partial-revokes.html) system variable is enabled.”

https://dev.mysql.com/doc/refman/8.0/en/partial-revokes.html

{ Exactly what we need }

MySQL 8.0 privilege model changes

Before: MySQL 5.7

```
mysql 5.7> show grants for app@'10.%';
+----------------------------------------------+
| Grants for app@10.%                          |
+----------------------------------------------+
| GRANT ALL PRIVILEGES ON *.* TO 'app'@'10.%'  |
+----------------------------------------------+
1 row in set (0.00 sec)
```

```
mysql> show databases;
+-------------------+
| Database          |
+-------------------+
| 00KBQa3SpbN9Brvv  |
| 014TcXtsuUviCaB7  |
| 01nThhS7ch0l2aD7  |
...
| mysql             |
3075 rows in set
```

```
mysql 5.7 > revoke all on mysql.* from app@'10.%';
ERROR 1141 (42000): There is no such grant defined for user 'app' on
host '10.%'
```

MySQL 8.0 privilege model changes

Partial revokes in MySQL 8.0

```
mysql 8.0> SET global partial_revokes = ON;
Query OK, 0 rows affected (0.00 sec)

mysql 8.0> grant all on *.* to app@'10.%';
Query OK, 0 rows affected (0.01 sec)

mysql 8.0> revoke all on mysql.* from app@'10.%';
Query OK, 0 rows affected (0.01 sec)
```

```
mysql> show databases;
+-------------------+
| Database          |
+-------------------+
| 00KBQa3SpbN9Brvv |
| 014TcXtsuUviCaB7 |
| 01nThhS7ch0l2aD7 |
...
| mysql            |
...
| zxwrBTtamcQBvbQ8 |
| zyp3nsGmUmBZPAQn |
| zzDtuzIyy7fHcLtT |
+-------------------+
3075 rows in set
```

MySQL 8.0 privilege model changes

Partial revokes in MySQL 8.0

```
# after revoke: access to any db will work
mysql 8.0> create table 00KBQa3SpbN9Brvv.a(i int);
           Query OK, 0 rows affected (0.02 sec)
mysql 8.0> insert into 00KBQa3SpbN9Brvv.a values(1);
           Query OK, 1 row affected (0.01 sec)

# access to mysql db will FAIL
mysql 8.0> update mysql.user
           set authentication_string = 'new’
           where user = 'root';
ERROR 1142 (42000): UPDATE command denied
to user 'app’@’10.%' for table 'user'
```

```
mysql> show databases;
+-------------------+
| Database          |
+-------------------+
| 00KBQa3SpbN9Brvv |
| 014TcXtsuUviCaB7 |
| 01nThhS7ch0l2aD7 |
...
| mysql             |
...
| zxwrBTtamcQBvbQ8 |
| zyp3nsGmUmBZPAQn |
| zzDtuzIyy7fHcLtT |
+-------------------+
3075 rows in set
```

MySQL 8.0 privilege model changes

Roles

“A MySQL role is a named collection of privileges. Like user accounts, roles can have privileges granted to and revoked from them.”

https://dev.mysql.com/doc/refman/8.0/en/roles.html

MySQL 8.0 privilege model changes

Convert app user to roles: Creating role

```
# create role
mysql 8.0> create role app_role;
Query OK, 0 rows affected (0.00 sec)

# grant privileges to ROLE
mysql 8.0> grant all on *.* to app_role;
Query OK, 0 rows affected (0.01 sec)

# revoke mysql db privileges from ROLE
mysql 8.0> revoke all on mysql.* from app_role;
Query OK, 0 rows affected (0.01 sec)
```

Easier to manage user permissions with roles

MySQL 8.0 privilege model changes

Convert app user to roles: Applying role to user

```
# cleanup all privileges first
mysql 8.0> revoke all on *.* from app;
Query OK, 0 rows affected (0.00 sec)

# assign role
mysql 8.0> grant app_role to app;
Query OK, 0 rows affected (0.01 sec)

# make it default
mysql 8.0> set default role app_role to app;
Query OK, 0 rows affected (0.00 sec)
```

MySQL 8.0 privilege model changes

Convert app user to roles: Applying role to user

```
# check grants
mysql 8.0> show grants for `app`@`%`;
+------------------------------------+
| Grants for app@%                   |
+------------------------------------+
| GRANT USAGE ON *.* TO `app`@`%`    |
| GRANT `app_role`@`%` TO `app`@`%`  |
+------------------------------------+
2 rows in set (0.00 sec)
```

USAGE stands for “no privileges.”
SHOW GRANTS displays USAGE to indicate that an account has no privileges at a privilege level.

MySQL 8.0 privilege model changes

Convert app user to roles: Applying role to user

```
# check grants
mysql 8.0> create table 00KBQa3SpbN9Brvv.b(i int);
Query OK, 0 rows affected (0.02 sec)


mysql 8.0> insert into 00KBQa3SpbN9Brvv.b values(1);
Query OK, 1 row affected (0.00 sec)

mysql 8.0> update mysql.user
           set authentication_string = 'new'
            where user = 'root';
ERROR 1142 (42000): UPDATE command denied to user 'app'@10.%' for table
'user'
```

```
mysql> show databases;
+-------------------+
| Database          |
+-------------------+
...
| mysql             |
...
3075 rows in set
```

```
mysql 8.0> revoke all on mysql.* from app_role;
```

AuthZ: Security and Isolation

User with **global** read/write access

→

= update mysql.user table

→

`Access denied`

`… to database 'mysql'`

Our agenda

Encryption	• In flight (client->server) • At rest (on disk)
Authentication	• User/password
Authorization	• Grants/roles
Accounting	• Logs: audit log

We are here

MySQL Security

Accounting

- Logs
  - Audit log
  - General log
  - Binary log

Why do we need audit log?

One of the use case: find attack and research who did it:

```
<AUDIT_RECORD
 "NAME"="Query"
 "TIMESTAMP"="2022-04-29T10:20:10 UTC"
 "COMMAND_CLASS"="select"
 "CONNECTION_ID"="49"
 "STATUS"="0"
 "SQLTEXT"=”
SELECT * FROM books WHERE published = 1
union
select user, host, authentication_string
from mysql.user"
 "USER"="app[app] @ 10.0.0.2 []"
 "HOST"="10.0.0.2"
  />
```

Timestamp

SQL injection

User / host

Thank you!

Alexander Rubin

https://www.linkedin.com/in/alexanderrubin/

I am building an new team in Amazon Web Services **RDS** and looking for Security / **Red Team** / Pentest Engineers.

https://www.amazon.jobs/en/jobs/1963718/sr-database-security-engineer-rds-red-team

Job details: