

OUG Scotland, DBA SIG, April 30th 2008

Oracle Forensics

By

Pete Finnigan

Written Friday, 19th October 2007

Introduction - Commercial Slide. ☹️

- PeteFinnigan.com Limited
- Founded February 2003
- CEO Pete Finnigan
- Clients UK, States, Europe
- Specialists in researching and securing Oracle databases providing consultancy and training
- <http://www.petefinnigan.com>
- Author of Oracle security step-by-step
- Published many papers, regular speaker (UK, USA, Slovenia, Norway, more)
- Member of the Oak Table Network



Agenda

- What is forensics and Oracle forensics?
- In real terms what does it mean?
- What information is out there
- Are there any tools?
- The issues – audit on, audit off and more
- Where to find forensic data
- Finding evidence – correlating data
- Plan for forensic analysis – make it easy

What is Forensics?

fo·ren·sics

n. (used with a sing. verb)

1. The art or study of formal debate; argumentation.
2. The use of science and technology to investigate and establish facts in criminal or civil courts of law.

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What is Oracle Forensics?

- Oracle forensics is the process by which someone (an auditor?) tries to determine when / how / why (and by who) something happened by gathering correlated and incriminating evidence.
- Oracle forensics often occurs when as an auditor I am called in to help a client discover how a breach occurred and hopefully some clue as to who did it.
- These techniques are often championed through the need to do this with no audit trail, no archive logs or worse – the success rates are dependant on how fast we can look and what is available.
- If this leads to criminal proceedings the evidence must be gathered without distortion or change to the system.

What Information Is Out There?

- Pete Finnigan (2003) - Detecting SQL Injection in Oracle - <http://www.securityfocus.com/infocus/1714> some forensics ideas - mining redo, sql extraction, trace, audit
- Pete Finnigan (2004) – Oracle Forensics module – SANS training
- Arup nanda (2005) – Mining for clues - <http://www.oracle.com/technology/oramag/oracle/05-jul/o45dba.html>
- Alex Gorbachev (2006) – Log Miner for forensics - <http://www.pythian.com/blogs/269/oracle-logminer-helps-investigate-security-issues>
- Paul Wright (2006/7) – Number of papers – <http://www.oracleforensics.com> + his SANS GSOC paper http://www.sans.org/reading_room/whitepapers/application/

What Information Is Out There? (2)

- David Litchfield (2007) – 6 part paper - <http://www.databasesecurity.com/>
- Alejandro Vargas (2007) – Log Miner 10g Implementation Example - <http://static7.userland.com/oracle/gems/alejandroVargas/logminerexample.pdf>
- David Litchfield (2007) – Blackhat paper - <http://www.databasesecurity.com/dbsec/forensics.ppt>
- 2 books – (note: one of the books is not available as I write this):
 - (2007) - Oracle Forensics: Paul Wright – ISBN-10-0977671526
 - (2008) - Oracle Forensics Analysis Using the Forensic Examiners Database Scalpel (FEDS) Tool - ISBN-10: 047019118X – *Title has changed recently*

Are There Any Tools?

- Yes and no
- There are no specific Oracle forensics tools – Yet.
 - David is developing FEDS (or whatever it will eventually be called)
- Most of the evidence can be extracted with existing tools
 - Existing OS forensics tools can be used
 - Simple SQL Queries
 - Database dumps
 - More exotic options, BBED, ORA-Dude, AUL/MyDUL
 - Connect to the SGA to read the SQL in the SGA

The Issues

- The problem when you want to investigate why is that inevitably there is no audit trail
- If audit is on, then use it. Beware of testing for altered audit trails (*This is one of the key tenets of forensics – validity and chain of custody*)
- If no audit and archive log is on use the changes captured
- If no audit, no archive logs then there is still hope
- Mining blocks and redo is time consuming and error prone
- Detecting “Select” statements is harder

Where To Find Forensic Data

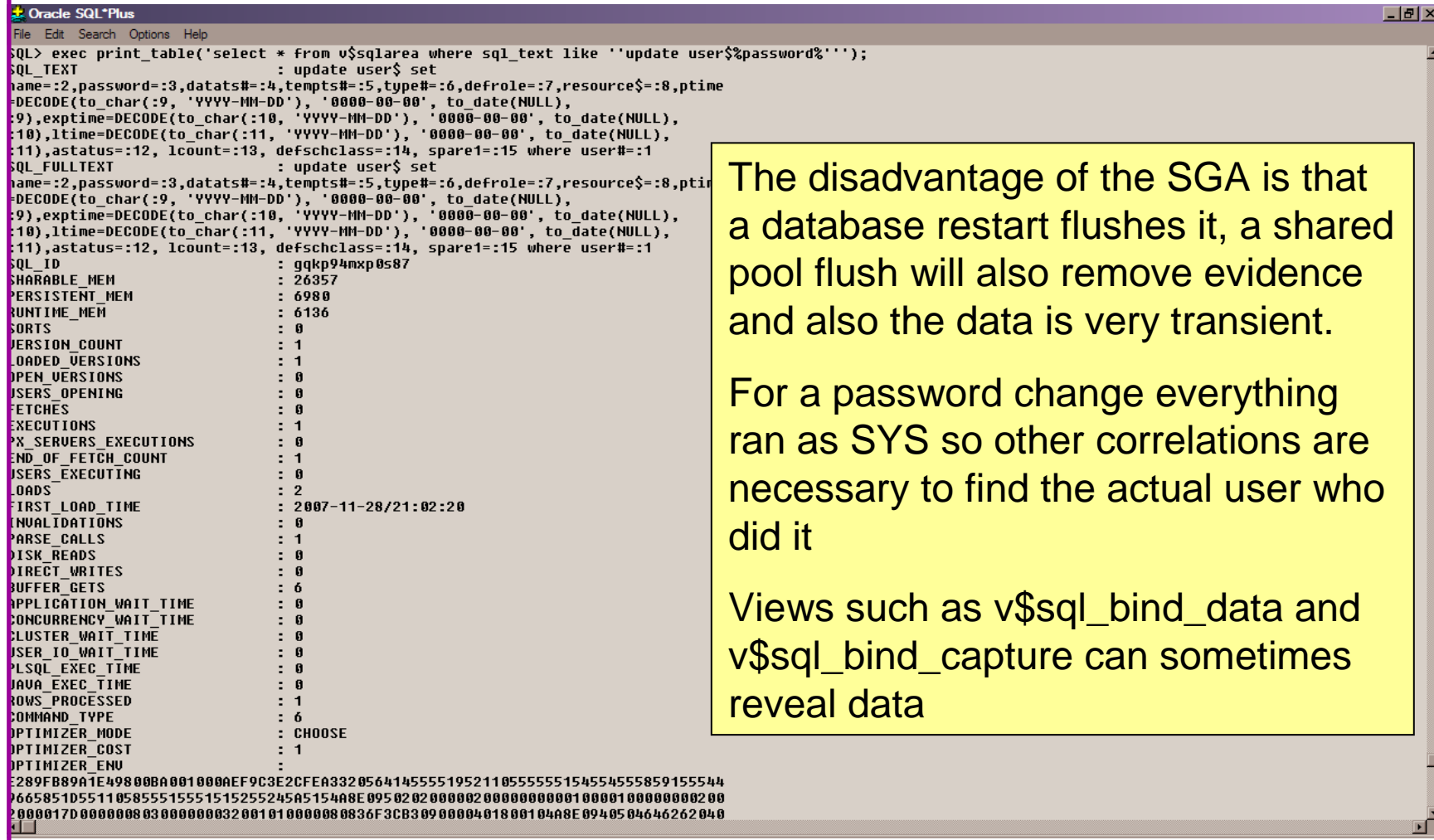
- TNS listener log
- Many types of trace files
- Sqlnet logs (server and clients)
- Sysdba audit logs
- Datafiles for deleted data
- Redo (and archive) logs
- SGA (v\$sql etc)
- Apache access logs

Oracle is great at leaving a whole swathe of evidence!!

Where To Find Forensic Data (2)

- v\$db_object_cache
- Wrh\$%% views
- Wri\$ views
- Statspack views
- col_usage\$
- Audit trails –
 - AUD\$, FGA_LOG\$
 - Application audit (who/when, triggers, other)
- Flashback, recycle bin
- More?

Looking For A Password Change



The screenshot shows the Oracle SQL*Plus interface with a query executed: `SQL> exec print_table('select * from v$sqlarea where sql_text like ''update user$password%'');`. The output displays the details of a SQL statement, including its full text, parameters, and various performance statistics. The full text of the statement is `update user$ set`. The statistics show that the statement was executed once, with a first load time of 2007-11-28/21:02:20.

```
SQL> exec print_table('select * from v$sqlarea where sql_text like ''update user$password%'');
SQL_TEXT
      : update user$ set
name=:2,password=:3,datats#=:4,tempsts#=:5,type#=:6,defrole=:7,resource$=:8,ptime
=DECODE(to_char(:9, 'YYYY-MM-DD'), '0000-00-00', to_date(NULL),
:9),exptime=DECODE(to_char(:10, 'YYYY-MM-DD'), '0000-00-00', to_date(NULL),
:10),ltime=DECODE(to_char(:11, 'YYYY-MM-DD'), '0000-00-00', to_date(NULL),
:11),astatus=:12, lcount=:13, defschclass=:14, spare1=:15 where user#=:1
SQL_FULLTEXT
      : update user$ set
name=:2,password=:3,datats#=:4,tempsts#=:5,type#=:6,defrole=:7,resource$=:8,pti
=DECODE(to_char(:9, 'YYYY-MM-DD'), '0000-00-00', to_date(NULL),
:9),exptime=DECODE(to_char(:10, 'YYYY-MM-DD'), '0000-00-00', to_date(NULL),
:10),ltime=DECODE(to_char(:11, 'YYYY-MM-DD'), '0000-00-00', to_date(NULL),
:11),astatus=:12, lcount=:13, defschclass=:14, spare1=:15 where user#=:1
SQL_ID
      : gqkp94mxp0s87
SHARABLE_MEM
      : 26357
PERSISTENT_MEM
      : 6980
RUNTIME_MEM
      : 6136
SORTS
      : 0
VERSION_COUNT
      : 1
LOADED_VERSIONS
      : 1
OPEN_VERSIONS
      : 0
USERS_OPENING
      : 0
FETCHES
      : 0
EXECUTIONS
      : 1
PX_SERVERS_EXECUTIONS
      : 0
END_OF_FETCH_COUNT
      : 1
USERS_EXECUTING
      : 0
LOADS
      : 2
FIRST_LOAD_TIME
      : 2007-11-28/21:02:20
INVALIDATIONS
      : 0
PARSE_CALLS
      : 1
DISK_READS
      : 0
DIRECT_WRITES
      : 0
BUFFER_GETS
      : 6
APPLICATION_WAIT_TIME
      : 0
CONCURRENCY_WAIT_TIME
      : 0
CLUSTER_WAIT_TIME
      : 0
USER_IO_WAIT_TIME
      : 0
PLSQL_EXEC_TIME
      : 0
JAVA_EXEC_TIME
      : 0
ROWS_PROCESSED
      : 1
COMMAND_TYPE
      : 6
OPTIMIZER_MODE
      : CHOOSE
OPTIMIZER_COST
      : 1
OPTIMIZER_ENU
      :
E289FB89A1E49800BA001000AEF9C3E2CFEA33205641455551952110555555154554555859155544
06658510551105855515551515255245A5154A8E09502020000020000000001000010000000200
2000017D000000803000000032001010000080836F3CB3090000401800104A8E0940504646262040
```

The disadvantage of the SGA is that a database restart flushes it, a shared pool flush will also remove evidence and also the data is very transient.

For a password change everything ran as SYS so other correlations are necessary to find the actual user who did it

Views such as `v$sql_bind_data` and `v$sql_bind_capture` can sometimes reveal data

Data Gathering From AUD\$

```
Oracle SQL*Plus
File Edit Search Options Help
SQL> exec print_table('select * from dba_audit_trail where action_name=''ALTER USER''');
OS_USERNAME           : ORACLE_HACK_BOX\Admin
USERNAME              : SCOTT
USERHOST              : WORKGROUP\ORACLE_HACK_BOX
TERMINAL              : ORACLE_HACK_BOX
TIMESTAMP             : 24-nov-2007 22:01:08
OWNER                 :
OBJ_NAME              : SYSTEM
ACTION                : 43
ACTION_NAME           : ALTER USER
NEW_OWNER             :
NEW_NAME              :
OBJ_PRIVILEGE         :
SYS_PRIVILEGE         :
ADMIN_OPTION          :
GRANTEE               :
AUDIT_OPTION          :
SES_ACTIONS           :
LOGOFF_TIME           :
LOGOFF_LREAD          :
LOGOFF_PREAD          :
LOGOFF_LWRITE         :
LOGOFF_DLOCK          :
COMMENT_TEXT          :
SESSIONID             : 651
ENTRYID               : 2
STATEMENTID           : 7
RETURNCODE            : 0
PRIV_USED             : ALTER USER
CLIENT_ID             :
ECONTEXT_ID           :
SESSION_CPU           :
EXTENDED_TIMESTAMP    : 24-NOV-07 22.01.07.609000 +00:00
PROXY_SESSIONID       :
GLOBAL_UID            :
INSTANCE_NUMBER       : 0
OS_PROCESS            : 2768:8024
TRANSACTIONID         :
SCN                   : 0
SQL_BIND              :
SQL_TEXT              :
```

The advantage of the audit trail is that historic data is present

Audit trail Example

- If an audit trail exists then this can provide the best evidence
 - Check for SYS.AUD\$ or core audit to OS
 - Check for SYS.FGA_LOG\$
 - Check for Triggers and shadow tables
 - Test for who/when (E-Business Suite supports this)
- Don't depend on audit though as it may have been altered! (you need to prove it is valid)
- Detect possible data changes first
 - Look for gaps
 - Correlate the audit trail (time, rowid, session, access and change to the audit trail itself – audit on audit)

Audit Example 2

```
Oracle SQL*Plus
File Edit Search Options Help
SQL> 1
  1 select rowid,userid,action#,obj$name
  2* from sys.aud$
SQL> /
```

ROWID	USERID	ACTION#	OBJ\$NAME
AAAAIUABAAABFKAAB	SCOTT	101	
AAAAIUABAAABFKAAC	X	101	
AAAAIUABAAABFKAAD	SYSTEM	100	
AAAAIUABAAABFKAAD	SYSTEM	100	
AAAAIUABAAABFKAAD	SYSTEM	101	
AAAAIUABAAABFKAAD	SYSTEM	43	SYSTEM
AAAAIUABAAABFKAAD	X	101	
AAAAIUABAAABFKAAD	SYSTEM	101	
AAAAIUABAAABFKAAD	X	101	
AAAAIUABAAABFKAAD	SYSTEM	101	
AAAAIUABAAABFKAAD	X	101	
AAAAIUABAAABFKAAM	SYSTEM	101	
AAAAIUABAAABFKAAN	SYSTEM	100	
AAAAIUABAAABFKAAD	SYSTEM	43	SYSTEM
AAAAIUABAAABFKAAP	SYSTEM	7	AUD\$

```
15 rows selected.
SQL>
```

Beware of deleted rows
Can you spot the issue?

Timestamps

```
Oracle SQL*Plus
File Edit Search Options Help

SQL> exec print_table('select * from sys.user$ where name=''SYSTEM''');
USER#           : 5
NAME            : SYSTEM
TYPE#          : 1
PASSWORD       : D4DF7931AB130E37
DATATS#        : 0
TEMPTS#        : 3
CTIME          : 30-aug-2005 13:50:29
PTIME         : 28-nov-2007 21:02:20
EXPTIME       :
LTIME         :
RESOURCE$     : 0
AUDIT$        :
DEFROLE       : 1
DEFGRP#       :
DEFGRP_SEQ#   :
ASTATUS       : 0
LCOUNT        : 0
DEFSCHCLASS   : DEFAULT_CONSUMER_GROUP
EXT_USERNAME  :
SPARE1        : 0
SPARE2        :
SPARE3        :
SPARE4        :
SPARE5        :
SPARE6        :
-----
PL/SQL procedure successfully completed.

SQL>
```

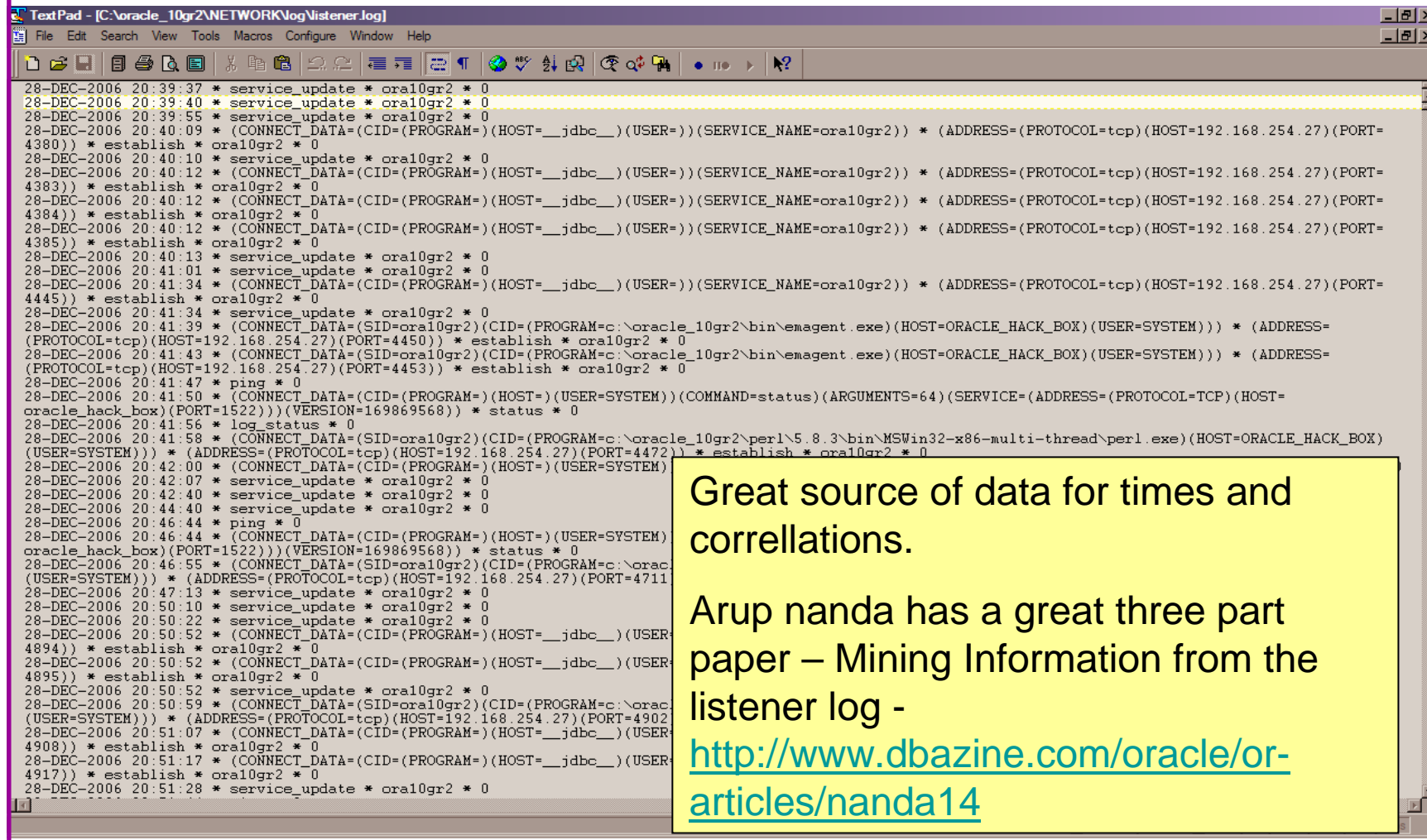
Using timestamps on the object you are investigating or in general across the database can be useful to detect change and also for correlation

This is one of the tenets of forensics – create a timeline

Correlation

- Use correlation in two ways
 - If you have one piece of evidence look for others with matching values (could be time, address, sql_hash, scn, xid ...)
 - If you don't know what to search for, i.e. you have been hacked but not sure how but know the time period; use the timestamp to locate all correlated evidence.
- Use timestamps on objects, redo (Log Mining) and more within the database
- Correlate time based evidence with external sources (oracle) such as listener.log, sql*net logs, sysdba trace, OS evidence and more
- Correlate user information with OS logs, client PC logs, firewalls, personal firewalls, web server logs

Tertiary Data – Listener.log



```
TextPad - [C:\oracle_10gr2\NETWORK\log\listener.log]
File Edit Search View Tools Macros Configure Window Help
28-DEC-2006 20:39:37 * service_update * ora10gr2 * 0
28-DEC-2006 20:39:40 * service_update * ora10gr2 * 0
28-DEC-2006 20:39:55 * service_update * ora10gr2 * 0
28-DEC-2006 20:40:09 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=__jdbcc__(USER=))(SERVICE_NAME=ora10gr2)) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4380)) * establish * ora10gr2 * 0
28-DEC-2006 20:40:10 * service_update * ora10gr2 * 0
28-DEC-2006 20:40:12 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=__jdbcc__(USER=))(SERVICE_NAME=ora10gr2)) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4383)) * establish * ora10gr2 * 0
28-DEC-2006 20:40:12 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=__jdbcc__(USER=))(SERVICE_NAME=ora10gr2)) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4384)) * establish * ora10gr2 * 0
28-DEC-2006 20:40:12 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=__jdbcc__(USER=))(SERVICE_NAME=ora10gr2)) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4385)) * establish * ora10gr2 * 0
28-DEC-2006 20:40:13 * service_update * ora10gr2 * 0
28-DEC-2006 20:41:01 * service_update * ora10gr2 * 0
28-DEC-2006 20:41:34 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=__jdbcc__(USER=))(SERVICE_NAME=ora10gr2)) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4445)) * establish * ora10gr2 * 0
28-DEC-2006 20:41:34 * service_update * ora10gr2 * 0
28-DEC-2006 20:41:39 * (CONNECT_DATA=(SID=ora10gr2)(CID=(PROGRAM=c:\oracle_10gr2\bin\emagent.exe)(HOST=ORACLE_HACK_BOX)(USER=SYSTEM))) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4450)) * establish * ora10gr2 * 0
28-DEC-2006 20:41:43 * (CONNECT_DATA=(SID=ora10gr2)(CID=(PROGRAM=c:\oracle_10gr2\bin\emagent.exe)(HOST=ORACLE_HACK_BOX)(USER=SYSTEM))) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4453)) * establish * ora10gr2 * 0
28-DEC-2006 20:41:47 * ping * 0
28-DEC-2006 20:41:50 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=)(USER=SYSTEM))(COMMAND=status)(ARGUMENTS=64)(SERVICE=(ADDRESS=(PROTOCOL=TCP)(HOST=oracle_hack_box)(PORT=1522)))(VERSION=169869568)) * status * 0
28-DEC-2006 20:41:56 * log_status * 0
28-DEC-2006 20:41:58 * (CONNECT_DATA=(SID=ora10gr2)(CID=(PROGRAM=c:\oracle_10gr2\perl\5.8.3\bin\MSWin32-x86-multi-thread\perl.exe)(HOST=ORACLE_HACK_BOX)(USER=SYSTEM))) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4472)) * establish * ora10gr2 * 0
28-DEC-2006 20:42:00 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=)(USER=SYSTEM))) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4472)) * establish * ora10gr2 * 0
28-DEC-2006 20:42:07 * service_update * ora10gr2 * 0
28-DEC-2006 20:42:40 * service_update * ora10gr2 * 0
28-DEC-2006 20:44:40 * service_update * ora10gr2 * 0
28-DEC-2006 20:46:44 * ping * 0
28-DEC-2006 20:46:44 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=)(USER=SYSTEM))(VERSION=169869568)) * status * 0
28-DEC-2006 20:46:55 * (CONNECT_DATA=(SID=ora10gr2)(CID=(PROGRAM=c:\oracle_10gr2\bin\emagent.exe)(HOST=ORACLE_HACK_BOX)(USER=SYSTEM))) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4711)) * establish * ora10gr2 * 0
28-DEC-2006 20:47:13 * service_update * ora10gr2 * 0
28-DEC-2006 20:50:10 * service_update * ora10gr2 * 0
28-DEC-2006 20:50:22 * service_update * ora10gr2 * 0
28-DEC-2006 20:50:52 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=__jdbcc__(USER=))(SERVICE_NAME=ora10gr2)) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4902)) * establish * ora10gr2 * 0
28-DEC-2006 20:50:52 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=__jdbcc__(USER=))(SERVICE_NAME=ora10gr2)) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4902)) * establish * ora10gr2 * 0
28-DEC-2006 20:50:59 * (CONNECT_DATA=(SID=ora10gr2)(CID=(PROGRAM=c:\oracle_10gr2\bin\emagent.exe)(HOST=ORACLE_HACK_BOX)(USER=SYSTEM))) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4902)) * establish * ora10gr2 * 0
28-DEC-2006 20:51:07 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=__jdbcc__(USER=))(SERVICE_NAME=ora10gr2)) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4908)) * establish * ora10gr2 * 0
28-DEC-2006 20:51:17 * (CONNECT_DATA=(CID=(PROGRAM=)(HOST=__jdbcc__(USER=))(SERVICE_NAME=ora10gr2)) * (ADDRESS=(PROTOCOL=tcp)(HOST=192.168.254.27)(PORT=4917)) * establish * ora10gr2 * 0
28-DEC-2006 20:51:28 * service_update * ora10gr2 * 0
```

Great source of data for times and correlations.

Arup nanda has a great three part paper – Mining Information from the listener log - <http://www.dbazine.com/oracle/articles/nanda14>

Tertiary Data – SYSDBA Audit

Event Properties

Event

Date: 26/11/2007 Source: Oracle.ora10gr2
Time: 11:16:26 Category: None
Type: Information Event ID: 34
User: N/A
Computer: ORACLE_HACK_BOX

Description:

Audit trail: ACTION : 'CONNECT' DATABASE USER: '/' PRIVILEGE :
SYSDBA CLIENT USER: NT AUTHORITY\SYSTEM CLIENT
TERMINAL: ORACLE_HACK_BOX STATUS: 0 .

Data: Bytes Words

On *Nix boxes look in audit_file_dest for trace files. PID based trace files – hard to correlate

Shows SYS (actually SYSDBA) audit if audit_sys_operations=TRUE

Connects are audited by default as sysdba

OK Cancel Apply

Deleted Data

- David introduced the idea of looking for deleted data in data blocks in his 6 part Oracle forensics series.
- This is not new as others more concerned with recovery, block internals, DUL like tools have found this years ago.
- The idea is being built into FEDS ([we believe](#))
- Beware:
 - This is unsupported – in terms of undefined results
 - The deleted data is transient
- Recycle bin and Flashback also good options (If available)
- As are Redo and archive logs (not transient) – again if available
- Tools like BBED could be used or hex editors

Database Dumps

```
TextPad - [C:\oracle\admin\ora10gr2\udump\ora10gr2_ora_1236.trc]
File Edit Search View Tools Macros Configure Window Help
[Icons]
BUCKET 67381 total object count=1
BUCKET 67383:
LIBRARY OBJECT HANDLE: handle=254dca20 mutex=254DCAD4(1)
name=alter user system identified by *****
hash=984a88cebf148a570e53fcd989d30737 timestamp=11-28-2007 21:02:19
namespace=CRSR flags=RON/KGHP/TIM/PNO/SML/KST/DBN/MTX/[120100d0]
kkkk-dddd-llll=0000-0001-0001 lock=0 pin=0 latch#=3 hpc=0000 hlc=0000
lwt=254DCA7C[254DCA7C,254DCA7C] ltm=254DCA84[254DCA84,254DCA84]
pwt=254DCA60[254DCA60,254DCA60] ptm=254DCA68[254DCA68,254DCA68]
ref=254DCA9C[254DCA9C,254DCA9C] lnd=254DCAA8[254DC430,254EF33C]
LIBRARY OBJECT: object=2fb0add8
type=CRSR flags=EXS[0001] pflags=[0000] status=VALD load=0
CHILDREN: size=16
child#  table reference
-----
      0 2fb0ad64 2fb0aa18 2
DATA BLOCKS:
data#  heap  pointer
-----
      0 2560dc28 2fb0ae70 I/
BUCKET 67383 total object count=1
BUCKET 67505:
LIBRARY OBJECT HANDLE: handle=11
```

```
SQL> alter session set events 'immediate
trace name library_cache level 10';

Session altered.

SQL>
```

```
38215 19 Read Ovr Block Sync Rec Caps
```

Investigation Without Disturbance

- If a suspected breach has occurred
- Plan ahead – i.e. don't blunder in
- Consider:
 - Can the results of the investigation be trusted
 - Altering the database or shutting down could remove evidence – e.g. shared pool is cleared
 - The investigation should not alter the data or create a large foot print in the database thereby changing the value of the investigation

Investigation Without Disturbance (2)

- Establish the server state – users, ports, files, dll's, memory, system time etc
- Collect Oracle files – sysdba trace, archive logs, alert log, listener log, sqlnet logs, trace, copy data files (if possible)
- Grab the SQL from v\$sql (direct SGA access is an option - <http://www.petefinnigan.com/other.htm>)
- Grab SYS.AUD\$ and SYS.FGA_LOG\$
- Grab AWR and statspack if available
- Analyse changes to users and roles and privileges
- Checksum the PL/SQL, Java, triggers, views
- Investigate

Log Miner

```
Oracle SQL*Plus
File Edit Search Options Help
SQL> connect sys/change_on_install as sysdba
Connected.
SQL> select distinct member logfilename from v$logfile;

LOGFILENAME
-----
C:\ORACLE\ORADATA\ORA10GR2\REDO03.LOG
C:\ORACLE\ORADATA\ORA10GR2\REDO02.LOG
C:\ORACLE\ORADATA\ORA10GR2\REDO01.LOG

SQL> begin
  2 dbms_logmnr.add_logfile('C:\ORACLE\ORADATA\ORA10GR2\REDO03.LOG');
  3 dbms_logmnr.add_logfile('C:\ORACLE\ORADATA\ORA10GR2\REDO02.LOG');
  4 dbms_logmnr.add_logfile('C:\ORACLE\ORADATA\ORA10GR2\REDO01.LOG');
  5 end;
  6 /

SQL> begin
P   2 dbms_logmnr.start_logmnr(options => dbms_logmnr.dict_from_online_catalog);
S   3 end;
   4 /
```


Log Miner 2

```
Oracle SQL*Plus
File Edit Search Options Help

SQL>
SQL> edit aud

SQL> get aud
 1 select username,to_char(timestamp,'DD-MON-YYYY HH24:MI:SS') timestamp,
 2 seg_owner,operation,sql_undo
 3 from v$logmnr_contents
 4 where table_name='AUD$'
 5* and sql_redo like '%AAAAIuAABAAABFKAAB%'
 6 /

-----
USERNAME                                TIMESTAMP
-----
SEG_OWNER                                OPERATION
-----
SQL_UNDO
-----
                29-NOV-2007 21:29:38
SYS
UPDATE
update "SYS"."AUD$" set "ACTION#" = '100', "RETURNCODE" = '0', "LOGOFF$LREAD" =
NULL, "LOGOFF$PREAD" = NULL, "LOGOFF$LWRITE" = NULL, "LOGOFF$DEAD" = NULL, "LOGO
FF$TIME" = NULL, "SESSIONCPU" = NULL where "ACTION#" = '101' and "RETURNCODE" =
'0' and "LOGOFF$LREAD" = '282' and "LOGOFF$PREAD" = '0' and "LOGOFF$LWRITE" = '6
' and "LOGOFF$DEAD" = '0' and "LOGOFF$TIME" = TO_DATE('29-NOV-07', 'DD-MON-RR')

-----
USERNAME                                TIMESTAMP
-----
SEG_OWNER                                OPERATION
-----
SQL_UNDO
-----
and "SESSIONCPU" = '6' and ROWID = 'AAAAIuAABAAABFKAAB';

SQL>
```

Log Miner 3

```
Oracle SQL*Plus
File Edit Search Options Help
SQL> col username for a8
SQL> col timestamp for a20
SQL> col seg_type_name for a8
SQL> col seg_name for a10
SQL> col sql_redo for a30 wrap
SQL> edit
Wrote file afiedt.buf

 1 select username,to_char(timestamp,'DD-MON-YYYY HH24:MI:SS') timestamp,
 2   seg_type_name,seg_name,sql_redo
 3 from v$logmnr_contents
 4 where operation='DDL'
 5* and sql_redo like 'alter user%'
SQL> /

USERNAME  TIMESTAMP                SEG_TYPE  SEG_NAME  SQL_REDO
-----
SYSTEM    28-NOV-2007 21:02:20  USER      alter user system identified b
y  VALUES 'D4DF7931AB130E37' ;

SQL> |
```

Build A Toolkit

- What can we build as toolkit?
- Mining blocks not ideal – time biased and not consistent – FEDS look promising BUT
- A Tool kit should / Could be methodology include:
 - A plan of actions
 - OS commands to gather files
 - SQL commands to gather details from the database
 - Dump commands

Conclusions

- Looked at what are forensics and what are Oracle forensics?
- Looked at what information is out there
- Looked at the issues – audit on, audit off and more
- Looked at where to find forensic data
- Looked at finding evidence – correlating data
- Oracle Forensics is a new and exciting area and very current due to recent data losses

```
create or replace function log_start(fv_path
return utl_file.file_type is
  lv_fptr utl_file.file_type:=null;
  lv_module varchar2(100):='log_start';
begin
  Oracle Security Expertise
dbms_output.disable;
```

Any Questions?

Contact - Pete Finnigan

PeteFinnigan.com Limited

9 Beech Grove, Acomb

York, YO26 5LD

Phone: +44 (0) 1904 791188

Mobile: +44 (0) 7742 114223

Email: pete@petefinnigan.com