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Using Oracle SQL Stored Outlines & Optimizer Plan Stability

Mike Ault

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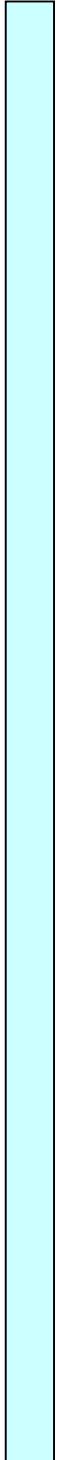
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Using Oracle SQL Stored Outlines & Optimizer Plan Stability

By Mike Ault

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Introduction

In versions of Oracle prior to Oracle8i the only way to stabilize an execution plan was to ensure that tables were analyzed frequently and that the relative ratios of rows in the tables involved stayed relatively stable. Neither of these options in pre-Oracle8i for stabilizing execution plans worked 100 percent of the time. In Oracle8i a new feature known as OUTLINEs has been added.

An outline allows the DBA to tune a SQL statement and then store the optimizer plan for the statement in what is known as an OUTLINE. From that point forward whenever an identical SQL statement to the one in the OUTLINE is used, it will use the optimizer instructions contained in the OUTLINE.

Setting Up for Use of Outlines

If you install using the DBCA (Database Creation Assistant) or through a manual script and run the catproc.sql script, then the OUTLINE option (in ENTEPRISE edition) is automatically installed.

The OUTLN schema is created automatically during installation of Oracle8i and Oracle9i. This schema is granted connect, resource, and execute any procedure privileges. The OUTLN schema acts as a place to centrally manage metadata associated with stored outlines.

Installing OUTLN Schema “After the Fact”

It is possible to install the OUTLN schema after the database has been created. As was said above, this is not usually suggested. Make sure that the OUTLN schema has been dropped using the cascade option before running this script. You may want to review the C0800050.sql script for your release in case there have been updates since the script below was generated. This process should work for RDBMS release 8.1.5 or greater.

This script MUST be run as the user INTERNAL or SYS. This script was extracted from C0800050.sql. After running this script, the user will need to run

catalog.sql and catproc.sql. These scripts must be run as the user SYS or INTERNAL.

Script to Install OUTLN Schema

Here is the extracted script which can be used to rebuild or initially install the OUTLN schema if for some reason the OUTLN schema becomes unusable or was never installed.

```
set serveroutput on

DECLARE
    user_exists EXCEPTION;
    outln_user number;
    outln_tables number;
    extra_outln_tables number;
    DDL_CURSOR integer;
BEGIN
    select count(*) into outln_user from user$ where name='OUTLN';

    select count(*) into outln_tables from obj$ where name in
        ('OL$', 'OL$HINTS') and owner#=
        (select user# from user$ where name='OUTLN');

    select count(*) into extra_outln_tables from obj$ where name not in
        ('OL$', 'OL$HINTS') and type#=2 and owner#=
        (select user# from user$ where name='OUTLN');

    DDL_CURSOR := dbms_sql.open_cursor;
    IF outln_user = 0 THEN
        dbms_sql.parse(DDL_CURSOR, 'create user outln identified by outln',
                       dbms_sql.native);
        dbms_sql.parse(DDL_CURSOR,
                      'grant connect, resource, execute any procedure to
outln',
                      dbms_sql.native);
        dbms_sql.parse(DDL_CURSOR, 'create table outln.ol$ ( ' ||
        'ol_name          varchar2(30), ' ||
        'sql_text         long, ' ||
        'textlen          number, ' ||
        'signature        raw(16), ' ||
        'hash_value       number, ' ||
        'category         varchar2(30), ' ||
        'version          varchar2(64), ' ||
        'creator          varchar2(30), ' ||
        'timestamp        date, ' ||
        'flags            number, ' ||
        'hintcount        number)', dbms_sql.native);
        dbms_sql.parse(DDL_CURSOR, 'create table outln.ol$hints ( ' ||
        'ol_name          varchar2(30), ' ||
        'hint#            number, ' ||
        'category         varchar2(30), ' ||
        'hint_type        number, ' ||
        'hint_text        varchar2(512), ' ||
        'stage#           number, ' ||
```

```

'node#           number, '|| 
'table_name      varchar2(30),  '|| 
'table_tin       number,  '|| 
'table_pos       number)', dbms_sql.native);
dbms_sql.parse(DDL_CURSOR, 'create unique index outln.ol$name '|| 
  'on outln.ol$(ol_name)', dbms_sql.native);
dbms_sql.parse(DDL_CURSOR, 'create unique index outln.ol$signature '|| 
  'on outln.ol$(signature,category)', dbms_sql.native);
dbms_sql.parse(DDL_CURSOR, 'create unique index outln.ol$hnt_num '|| 
  'on outln.ol$hints(ol_name, hint#)', dbms_sql.native);
dbms_output.put_line('OUTLN CREATION SUCCESSFUL');

ELSE
  IF outln_tables!=2 or extra_outln_tables!=0 THEN
    dbms_output.put_line('ERROR - OUTLN USER ALREADY EXISTS');
    RAISE user_exists;
  ELSE
    dbms_output.put_line('OUTLN CREATION SUCCESSFUL');
  END IF;
END IF;

EXCEPTION
  WHEN user_exists THEN
    RAISE;
END;
/

```

General Facts about OUTLN Schema

The schema OUTLN owns the package OUTLN_PKG that is used to manage stored outlines and their outline categories. The database administrator should change the password for the OUTLN schema just as for the SYS and SYSTEM schemas. OUTLINES are not available in the STANDARD release of Oracle only in the ENTERPRISE release.

The "c0800050.sql" upgrade script from 8.0.5 to 8.1.x also creates the schema OUTLN.

The package outln_pkg is created by script "dbmsol.sql" in the \$ORACLE_HOME/rdbms/admin directory. The "dbmsol.sql" script is called from "catproc.sql". The file "prvtol.plb" creates the body of "outln_pkg"; it is also called from catproc.

There are other tables (base tables), indexes, grants, and synonyms related to this package created during the install process by the SQL.BSQ script.

After carefully tuning an application, you might want to ensure that the optimizer generates the same execution plan whenever the same SQL statements are

executed. This is accomplished via OUTLINEs. OUTLINEs can be generated in either the rule or cost based optimizer. Plan stability allows you to maintain the same execution plans for the same SQL statements, regardless of changes to the database such as re-analyzing tables, adding or deleting data, modifying a table's columns, constraints, or indexes, changing the system configuration, or even upgrading to a new version of the optimizer.

The CREATE OUTLINE statement creates a stored outline, which contains a set of attributes that the optimizer uses to create an execution plan. Stored outlines can also be created automatically by setting the system parameter CREATE_STORED_OUTLINES to TRUE.

The system parameter USE_STORED_OUTLINES can be set to TRUE, FALSE, or a category name to indicate whether to make use of existing stored outlines for queries that are being executed. The OUTLN_PKG package provides procedures used for managing stored outlines.

Requirements for OUTLINE Use

The only privilege needed to create outlines is the CREATE ANY OUTLINE privilege. However it is also useful to be able to select from DBA_OUTLINES To force a session to either use or not create outlines you would issue the command:

```
ALTER SESSION SET CREATE_STORED_OUTLINES = TRUE | FALSE | <category>
```

This command causes Oracle to automatically create outlines for all SQL statements issued during the session. If set to TRUE then the category name for the outlines is set to DEFAULT.

Note: Category should not be quoted contrary to documentation

To turn on or off the creation of stored outlines at the system level issue the command:

```
ALTER SYSTEM SET CREATE_STORED_OUTLINES = TRUE | FALSE | <category>
[NOOVERRIDE]
```

This determines whether Oracle should automatically create and store an outline for each query submitted on the system. These outlines are stored in the DEFAULT category. If a particular query already has an outline defined for it in

the DEFAULT category, that outline will remain and a new outline will not be created.

The NOOVERRIDE option specifies that this system setting will not override the setting for any session in which this parameter was explicitly set.

It should be noted that outlines overide all other optimizer settings. They are only used if a session explicitly requests that they be used using the following command.

```
ALTER SESSION SET USE_STORED_OUTLINES = TRUE | FALSE | <category>
```

Note: As with the previous commands, category should not be quoted contrary to documentation

If USE_STORED_OUTLINES is set to TRUE then the DEFAULT category is used. If set to a category then TRUE is assumed and that category is used.

When set Oracle checks for a known stored plan based on an address calculated from the SQL TEXT of the statement. If a plan exists in the selected category then that plan will be used (provided it is valid).

Some General Usage Notes:

- Plan outlines are global: They apply to all identical statements
- Outlines, if present, will be used, regardless of which user issues the statement.
- Use of an outline is based on the SQL TEXT being IDENTICAL
- Use is NOT based on resolved names of underlying objects so changing a synonym etc.. still uses the outline (if it is valid)
- When creating outlines outside the application ensure:
 - SQL TEXT is identical character for character
 - Binds should be of the expected type when creating the outline to ensure the correct plan is obtained.

Views Used With OUTLINES

These views are defined by the script catol.sql:

View	Description
USER_OUTLINES	Shows all OUTLINEs owned by user
ALL_OUTLINES	Shows all OUTLINEs accessible by user
DBA_OUTLINES	Shows all OUTLINEs defined in system
USER_OUTLINE_HINTS	Shows hints for all users OUTLINEs
ALL_OUTLINE_HINTS	Shows hints for all OUTLINEs accessible by user
DBA_OUTLINE_HINTS	Shows hints for all OUTLINEs in system

All of these views are based on the tables OUTLN.OL\$ and OUTLN.OL\$HINTS

Packages Used with OUTLINEs

Packages are defined in the script dbmsol.sql.

Package	Description
DBMS_OUTLN (actually OUTLN_PKG)	Used To mange outlines
DBMS_OUTLN_EDIT (actually OUTLN_EDIT_PKG)	Used to edit outlines

Plan Stability

This storing of plan outlines for SQL statements is known as plan stability and insures that changes in the Oracle environment don't affect the way a SQL statement is optimized by the cost based optimizer. If you wish, Oracle will define plans for all issued SQL statements at the time they are executed and this stored plan will be reused until altered or dropped. Generally I do not suggest using the automatic outline feature as it can lead to poor plans being reused by the optimizer. It makes more sense to monitor for high cost statements and tune them as required, storing an outline for them only once they have been properly tuned.

As with the storage of SQL in the shared pool, storage of outlines depends on the statement being reissued in an identical fashion each time it is used. If even one space is out of place the stored outline is not reused. (Note: In Oracle9i excess white space is cleaned from SQL before use, so this limit is only for pre-9i databases.) Therefore your queries should be stored as PL/SQL procedures, functions or packages (or perhaps Java routines) and bind variables should

always be used. This allows reuse of the stored image of the SQL as well as reuse of stored outlines.

Remember that to be useful over the life of an application the outlines will have to be periodically verified by checking SQL statement performance. If performance of SQL statements degrades the stored outline may have to be dropped and regenerated after the SQL is re-tuned.

Creation of a OUTLINE object

Outlines are created using the CREATE OUTLINE command, the syntax for this command is:

```
CREATE [OR REPLACE] OUTLINE outline_name  
[FOR CATEGORY category_name]  
ON statement;
```

Where:

- Outline_name -- is a unique name for the outline
- [FOR CATEGORY category_name] – This optional clause allows more than one outline to be associated with a single query by specifying multiple categories each named uniquely.
- ON statement – This specifies the statement for which the outline is prepared.

An example would be:

```

CREATE OR REPLACE OUTLINE get_tables
ON
SELECT
a.owner,
a.table_name,
a.tablespace_name,
SUM(b.bytes),
COUNT(b.table_name) extents
FROM
    dba_tables a,
    dba_extents b
WHERE
    a.owner=b.owner
    AND a.table_name=b.table_name
GROUP BY
    a.owner, a.table_name, a.tablespace_name;

```

Assuming the above select is a part of a stored PL/SQL procedure or perhaps part of a view, the stored outline will now be used each time an exactly matching SQL statement is issued.

Altering a OUTLINE

Outlines are altered using the ALTER OUTLINE or CREATE OR REPLACE form of the CREATE command. The format of the command is identical whether it is used for initial creation or replacement of an existing outline. For example, what if we want to add SUM(b.blocks) to the previous example?

```

CREATE OR REPLACE OUTLINE get_tables
ON
SELECT
a.owner,
a.table_name,
a.tablespace_name,
SUM(b.bytes),
COUNT(b.table_name) extents,
SUM(b.blocks)
FROM
    dba_tables a,
    dba_extents b
WHERE
    a.owner=b.owner
    AND a.table_name=b.table_name
GROUP BY
    a.owner, a.table_name, a.tablespace_name;

```

The above example has the effect of altering the stored outline *get_tables* to include any changes brought about by inclusion of the SUM(b.blocks) in the

SELECT list. But what if we want to rename the outline or change a category name? The ALTER OUTLINE command has the format:

```
ALTER OUTLINE outline_name  
[REBUILD]  
[RENAME TO new_outline_name]  
[CHANGE CATEGORY TO new_category_name]
```

The ALTER OUTLINE command allows us to rebuild the outline for an existing outline_name as well as rename the outline or change its category. The benefit of using the ALTER OUTLINE command is that we do not have to respecify the complete SQL statement as we would have to using the CREATE OR REPLACE command.

Dropping an OUTLINE

Outlines are dropped using the DROP OUTLINE command the syntax for this command is:

```
DROP OUTLINE outline_name;
```

Use of the OUTLN_PKG To Manage SQL Stored Outlines

The OUTLN_PKG package provides for the management of stored outlines. A stored outline is an execution plan for a specific SQL statement. A stored outline permits the optimizer to stabilize a SQL statement's execution plan giving repeatable execution plans even when data and statistics change.

The DBA should take care to whom they grant execute on the OUTLN_PKG, by default it is not granted to the public user group nor is a public synonym created. The following sections show the packages in the OUTLN_PKG.

DROP_UNUSED

The drop_unused procedure is used to drop outlines that have not been used in the compilation of SQL statements. The drop_unused procedure has no arguments.

```
SQL> EXECUTE OUTLN_PKG.DROP_UNUSED;  
PL/SQL procedure successfully executed.
```

To determine if a SQL statement OUTLINE is unused, perform a select against the DBA_OUTLINES view:

```
SQL> desc dba_outlines;  
Name          Null?    Type  
-----  
NAME          VARCHAR2(30)  
OWNER         VARCHAR2(30)  
CATEGORY      VARCHAR2(30)  
USED          VARCHAR2(9)  
TIMESTAMP     DATE  
VERSION       VARCHAR2(64)  
SQL_TEXT      LONG  
  
SQL> set long 1000  
SQL> select * from dba_outlines where used='UNUSED';
```

NAME	OWNER	CATEGORY	USED	TIMESTAMP	VERSION	SQL_TEXT
TEST_OUTLINE	SYSTEM	TEST	UNUSED	08-MAY-99	8.1.3.0.0	<pre>select a.table_name, b.tablespace_name, c.file_name from dba_tables a, dba_tablespaces b, dba_data_files c where a.tablespace_name = b.tablespace_name and b.tablespace_name = c.tablespace_name and c.file_id = (select min(d.file_id) from dba_data_files d where c.tablespace_name = d.tablespace_name)</pre>

1 row selected.

SQL> execute sys.outln_pkg.drop_unused;

PL/SQL procedure successfully completed.

SQL> select * from dba_outlines where used='UNUSED' ;

no rows selected

Remember, the procedure drops all unused outlines so use it carefully.

DROP_BY_CAT

The drop_by_cat procedure drops all outlines that belong to a specific category. The procedure drop_by_cat has one input variable, cat, a VARCHAR 2 that corresponds to the name of the category you want to drop.

```
SQL> create outline test_outline for category test on
  2  select a.table_name, b.tablespace_name, c.file_name from
  3  dba_tables a, dba_tablespaces b, dba_data_files c
  4  where
  5  a.tablespace_name=b.tablespace_name
  6  and b.tablespace_name=c.tablespace_name
  7  and c.file_id = (select min(d.file_id) from dba_data_files d
  8  where c.tablespace_name=d.tablespace_name)
  9 ;
Operation 180 succeeded.
```

SQL> select * from dba_outlines where category='TEST' ;

NAME	OWNER	CATEGORY	USED	TIMESTAMP	VERSION	SQL_TEXT
TEST_OUTLINE	SYSTEM	TEST	UNUSED	08-MAY-99	8.1.3.0.0	select a.table_name, b.tablespace_name, c.file_name from dba_tables a, dba tablespaces b, dba_data_files c where a.tablespace_name=b.tablespace_name and b.tablespace_name=c.tablespace_name and c.file_id = (select min(d.file_id) from dba_data_files d where c.tablespace_name=d.tablespace_name)

1 row selected.

```
SQL> execute sys.outln_pkg.drop_by_cat('TEST');

PL/SQL procedure successfully completed.

SQL> select * from dba_outlines where category='TEST';

no rows selected
```

UPDATE_BY_CAT

The update_by_cat procedure changes all of the outlines in one category to a new category. If the SQL text in an outline already has an outline in the target category, then it is not merged into the new category. The procedure has two input variables, oldcat VARCHAR2 and newcat VARCHAR2 where oldcat corresponds to the category to be merged and newcat is the new category that oldcat is to be merged with.

```
SQL> create outline test_outline for category test on
  2  select a.table_name, b.tablespace_name, c.file_name from
  3  dba_tables a, dba tablespaces b, dba_data_files c
  4  where
  5  a.tablespace_name=b.tablespace_name
  6  and b.tablespace_name=c.tablespace_name
  7  and c.file_id = (select min(d.file_id) from dba_data_files d
  8  where c.tablespace_name=d.tablespace_name)
  9  ;
```

Operation 180 succeeded.

```
SQL> create outline test_outline2 for category test on
  2  select * from dba_data_files;
```

Operation 180 succeeded.

```
SQL> create outline prod_outline1 for category prod on
  2  select owner,table_name from dba_tables;
```

Operation 180 succeeded.

```
SQL> create outline prod_outline2 for category prod on
  2  select * from dba_data_files;
```

Operation 180 succeeded.

```
SQL>  select name,category from dba_outlines order by category
```

NAME	CATEGORY
PROD_OUTLINE1	PROD
PROD_OUTLINE2	PROD
TEST_OUTLINE2	TEST
TEST_OUTLINE	TEST

4 rows selected.

```
SQL> execute sys.outln_pkg.update_by_cat('TEST','PROD');
```

PL/SQL procedure successfully completed.

```
SQL> select name,category from dba_outlines order by category;
```

NAME	CATEGORY
TEST_OUTLINE	PROD
PROD_OUTLINE1	PROD
PROD_OUTLINE2	PROD
TEST_OUTLINE2	TEST

4 rows selected.

As a result of the update_by_cat procedure call we moved the TEST_OUTLINE outline into the PROD category, but the TEST_OUTLINE2, since it is a duplicate of PROD_OUTLINE2, was not merged.

New Procedures for Oracle9i

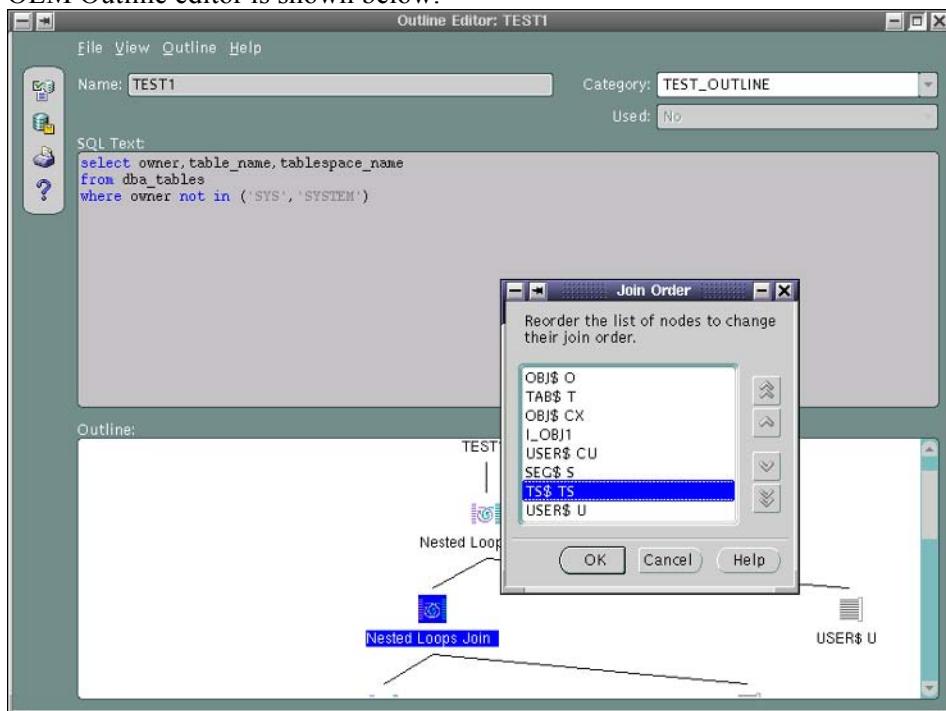
In Oracle9i the OUTLN_PKG has been expanded to include several new procedures:

Procedure	Use
CLEAR_USED Procedure	Marks all outlines UNUSED
EXACT_TEXT_SIGNATURES Procedure	Used when reverting a 9i database back to 8i, alters the signatures back to 8i format.
DROP_COLLISION Procedure	Drops an outline with an ol\$.hintcount value that does not match the number of hints for that outline in ol\$hints.

Procedure	Use
DROP_EXTRAS Procedure	Cleans up after an import by dropping extra hint records not accounted for by hintcount.
DROP_UNREFD_HINTS Procedure	Drops hint records that have no corresponding outline in the OL\$ table.
UPDATE_SIGNATURES Procedure	Used when importing an 8i outline into a 9i database to update signatures.

Manually Editing Plans

In Oracle9i, you can edit stored outlines either with the Outline Editor in Enterprise Manager (OEM) or manually by querying the local OL\$HINTS tables and performing DML against the appropriate hint records. A screen shot of the OEM Outline editor is shown below.



Using DML and Packages to Edit Outlines

This is an example of editing the outlines manually. The steps are as follows:

1. Create a new public stored outline
2. Create a private outline
3. Edit the private outline, test the result
4. Publicize the edits by creating a public stored outline from your private outline.

A Detailed Example

Let's look at a more detailed example.

1. Create a new public stored outline

- a. First, ensure that the required privileges have been granted.

```
SQL> connect system as sysdba
Enter password:
Connected.

SQL> grant create any outline to scott;

Grant succeeded.

SQL> grant execute on dbms_outln to scott;

Grant succeeded.

SQL> grant execute on dbms_outln_edit to scott;

Grant succeeded.
```

- b. Connect and set your environment. In this example, you will set hash_join_enabled=false and you will still be able to enforce a hash join by editing your stored outline.

```
SQL> connect scott
Enter password:
Connected.

SQL> set pages 1000

SQL> alter session set optimizer_goal=all_rows;

Session altered.
```

```
SQL> alter session set hash_join_enabled=false;
Session altered.
```

- c. Create standard demo tables in Scott's schema.

```
SQL> @$ORACLE_HOME/sqlplus/demo/demobld.sql
Building demonstration tables. Please wait.
Demonstration table build is complete.
```

- d. Analyze the tables for Oracle cost-based optimizer.

```
SQL> analyze table emp compute statistics;
Table analyzed.

SQL> analyze table dept compute statistics;
Table analyzed.
```

- e. Check the current execution plan for the query involved.

```
SQL> set autotrace on explain

SQL> select e.ename from emp e, dept d where e.deptno=d.deptno;

ENAME
-----
SMITH
ALLEN
WARD
JONES
MARTIN
BLAKE
CLARK
SCOTT
KING
TURNER
ADAMS
JAMES
FORD
MILLER

14 rows selected.

Execution Plan
-----
0      SELECT STATEMENT Optimizer=ALL_ROWS (Cost=126 Card=41
Bytes=
1353)
1  0   NESTED LOOPS (Cost=126 Card=41 Bytes=1353)
2  1   TABLE ACCESS (FULL) OF 'EMP' (Cost=4 Card=41 Bytes=820)
3  1   TABLE ACCESS (FULL) OF 'DEPT' (Cost=3 Card=41 Bytes=533)

SQL> set autotrace off
```

f. Create a public outline

```
SQL> create or replace outline outln1
2  on select e.ename from emp e, dept d where e.deptno=d.deptno;
outline created.
```

2. Create a private outline

- a. Create the Edit Tables in your schema, to store information about your private outlines. The tables created in this step must be there for the next step, otherwise you will get error:

```
ORA-18009 "one or more outline system tables do not exist".
SQL> execute dbms_outln_edit.create_edit_tables;
PL/SQL procedure successfully completed.
```

- b. Create your private outline by cloning it from the Public outline.

```
SQL> create private outline priv_outln1 from outln1;
outline created.
```

3. Edit the private outline, test the result

- a. After you create the private outline, new entries appear in the table ol\$hints. This table is created in your schema by running the procedure create_edit_tables. Let's examine the contents relevant to the newly created private outline.

```
SQL> column hint# format 999999
SQL> column hint_text format a28
SQL> column user_table_name format a16

SQL> select hint#, hint_text, user_table_name from ol$hints
2  where ol_name = 'PRIV_OUTLN1';

 HINT# HINT_TEXT                                USER_TABLE_NAME
----- -----
 1 NOREWRITE
 2 NOREWRITE
 3 NO_EXPAND
 4 PQ_DISTRIBUTE(D NONE NONE)      SCOTT.DEPT
 5 USE_NL(D)                           SCOTT.DEPT
 6 ORDERED
 7 NO_FACT(D)                          SCOTT.DEPT
 8 NO_FACT(E)                          SCOTT.EMP
 9 FULL(E)                            SCOTT.EMP
```

```
10 FULL(D)                               SCOTT.DEPT
10 rows selected.
```

- b. Edit the outline by performing DML against the appropriate hint records in the ol\$hints table. In this example, you will change the hint USE_NL to USE_HASH.

```
SQL> update ol$hints set hint_text='USE_HASH(D)'
2  where hint# = 5;

1 row updated.

SQL> commit;

Commit complete.
```

Query the table ol\$hints to see the changes.

```
SQL> select hint#, hint_text, user_table_name from ol$hints
2  where ol_name = 'PRIV_OUTLN1';

      HINT#  HINT_TEXT          USER_TABLE_NAME
-----  -----
      1  NOREWRITE
      2  NOREWRITE
      3  NO_EXPAND
      4  PQ_DISTRIBUTE(D NONE NONE)    SCOTT.DEPT
      5  USE_HASH(D)                  SCOTT.DEPT
      6  ORDERED
      7  NO_FACT(D)                 SCOTT.DEPT
      8  NO_FACT(E)                 SCOTT.EMP
      9  FULL(E)                     SCOTT.EMP
     10  FULL(D)                   SCOTT.DEPT

10 rows selected.
```

- c. After manually editing the outline, re-synchronize the stored outline definition using the following procedure:

```
SQL> execute
dbms_outln_edit.refresh_private_outline('PRIV_OUTLN1');

PL/SQL procedure successfully completed.
```

Note that the private outline name must match in case to ol\$hints.ol_name

Alternatively, you can use:

```
SQL> alter system flush shared_pool or
```

```
or  
SQL> create private outline priv_outln1 from private  
priv_outln1;
```

- d. Set the parameter use_private_outlines, otherwise the query will still use nested loops instead of not hash join.

```
SQL> alter session set use_private_outlines=true;  
Session altered.
```

- e. Test the current execution plan for the query, to confirm that Oracle optimizer is now using hash join method for this query.

```
SQL> set autotrace on explain  
SQL> select e.ename from emp e, dept d where e.deptno=d.deptno;  
  
ENAME  
-----  
MILLER  
KING  
CLARK  
FORD  
ADAMS  
SCOTT  
JONES  
SMITH  
JAMES  
TURNER  
BLAKE  
MARTIN  
WARD  
ALLEN  
  
14 rows selected.  
  
Execution Plan  
-----  
0  SELECT STATEMENT Optimizer=ALL_ROWS (Cost=10 Card=41  
Bytes=1353)  
1  0 HASH JOIN (Cost=10 Card=41 Bytes=1353)  
2  1 TABLE ACCESS (FULL) OF 'EMP' (Cost=4 Card=41 Bytes=820)  
3  1 TABLE ACCESS (FULL) OF 'DEPT' (Cost=3 Card=41 Bytes=533)
```

4. Publicize the edits by creating a public stored outline from your private outline.

If you want to preserve your edits for public use, then publicize the edits with the following statement:

```
SQL> create or replace outline outln2 from private priv_outln1;  
Outline created.
```

Using DBMS_OUTLN_EDIT. GENERATE_SIGNATURE

The GENERATE_SIGNATURE procedure is mistakenly attributed to the OUTLN_PKG in the Oracle documentation set, in actuality it is located in the OUTLN_EDIT_PKG which is synonmed to be DBMS_OUTLN_EDIT. Passing the GENERATE_SIGNATURE procedure a SQL statement will return a RAW signature of the SQL which can then be used to probe the outline tables to see if that SQL has an existing OUTLINE.

When using GENERATE_SIGNATURE, it is probably easiest to create an anonymous PL/SQL script to return the signature or the SQL and OUTLINE name to you. The signature is a RAW, so in the example, shown below, we return the outline name.

```
SQL> set serveroutput on

SQL> declare
2   sql_text varchar2(200);
3   ret_sql_text varchar2(200);
4   ret_outline_name varchar2(32);
5   gen_sig raw(16);
6   begin
7     sql_text := 'select owner, table_name, tablespace_name
8       from
9      dba_tables
10      where owner not in '
11    ('||chr(39)||'SYS'||chr(39)||','||chr(39)||'SYSTEM'||chr(39)||'||');
12    dbms_outln_edit.generate_signature(sql_text,gen_sig);
13    select a.sql_text, a.name into ret_sql_text, ret_outline_name
14    from dba_outlines a where signature=gen_sig;
15    dbms_output.put_line('Sql text for'||name||':'||ret_sql_text);
16  end;
17* /
```

```
Sql text for TEST1: select owner,table_name,tablespace_name
from dba_tables
where
owner not in ('SYS','SYSTEM')

PL/SQL procedure successfully completed.
```

Once you have identified the SQL statement for which you want to edit the hint structure, you use the DBMS_OUTLN_EDIT procedure to perform the edits as shown above.

Replacing a Non-Hinted Outline

In many applications you are not allowed to change source code. This means that you cannot, or are unable to, add hints to force behavior. As we have seen OUTLINES place hints into statements at the parse level, by using an OUTLINE you can force hints into statements. Let's look at a technique to perform this operation.

Technique

Let's call the SQL statement to optimize 'ORIGINALSQL'

1. Find the hints to optimize the original SQL statement. Let's call the same SQL statement with hints 'HINTSQL'
2. Create the OUTLINE for ORIGINALSQL
3. Create the OUTLINE for HINTSQL
4. Exchange the OUTLINE plan between the two OUTLINES
5. Drop the OUTLINE for HINTSQL
6. Now the OUTLINE plan for ORIGINALSQL is the same as the execution plan of HINTSQL which uses HINTs.

Only the point 5 (Exchange the OUTLINE plan between the two OUTLINES) is detailed below. The rest of the steps are covered in the bulk of the paper.

Under the sys or outln user, simply exchange outline names used in step 2 and 3:

```
UPDATE OUTLN.OL$HINTS
SET
OL_NAME=DECODE(OL_NAME,'HINTSQL','ORIGINALSQL','ORIGINALSQL','HINTSQL')
WHERE OL_NAME IN ('HINTSQL','ORIGINALSQL');
Commit;
```

Example

Let's look at an example using the SCOTT schema using the example schema objects. Under the Schema scott with EMP and DEPT tables, create this index on DEPT.LOC:

```
create index I_DEPT$LOC ON DEPT (LOC);
```

Next, analyze the tables emp and dept.

```
Analyze table emp compute statistics;
Analyze table dept compute statistics;
```

The Original SQL statement we want to optimize is:

```
select sum(SAL) total, DEPT.DNAME from EMP,DEPT
where EMP.DEPTNO(+) = DEPT.DEPTNO
and DEPT.LOC= 'DALLAS'
```

```
group by DEPT.DNAME;
```

The original explain plan for this SQL statement should be

```
0      SELECT STATEMENT Optimizer=CHOOSE
1      0      SORT (GROUP BY)
2      1      NESTED LOOPS (OUTER)
3      2          TABLE ACCESS (FULL) OF 'DEPT'
4      2          TABLE ACCESS (FULL) OF 'EMP'
```

The same SQL statement with the INDEX_ASC hint is:

```
select /*+ INDEX_ASC (DEPT I_DEPT$LOC) */ sum(SAL) total, DEPT.DNAME
from EMP,DEPT
where EMP.DEPTNO(+) = DEPT.DEPTNO
and DEPT.LOC= 'DALLAS'
group by DEPT.DNAME;
```

The revised explain plan for this SQL statement should be:

```
0      SELECT STATEMENT Optimizer=CHOOSE
1      0      SORT (GROUP BY)
2      1      NESTED LOOPS (OUTER)
3      2          TABLE ACCESS (BY INDEX ROWID) OF 'DEPT'
4      3              INDEX (RANGE SCAN) OF 'I_DEPT$LOC' (NON-UNIQUE)
5      2          TABLE ACCESS (FULL) OF 'EMP'
```

Using the original statement, create an OUTLINE called ORIGINALSQL:

```
CREATE OR REPLACE OUTLINE ORIGINALSQL ON
select sum(SAL) total, DEPT.DNAME from EMP,DEPT
where EMP.DEPTNO(+) = DEPT.DEPTNO
and DEPT.LOC= 'DALLAS'
group by DEPT.DNAME;
```

Now create the OUTLINE for the hinted SQL and call it HINTSQL:

```
CREATE OR REPLACE OUTLINE HINTSQL ON
select /*+ INDEX_ASC (DEPT I_DEPT$LOC) */ sum(SAL) total, DEPT.DNAME
from EMP,DEPT
where EMP.DEPTNO(+) = DEPT.DEPTNO
and DEPT.LOC= 'DALLAS'
group by DEPT.DNAME;
```

Under SYS or OUTLN user exchange outline plans by exchanging the names in the table:

```
UPDATE OUTLN.OL$HINTS
SET
OL_NAME=DECODE(OL_NAME,'HINTSQL','ORIGINALSQL','ORIGINALSQL','HINTSQL')
WHERE OL_NAME IN ('ORIGINALSQL','HINTSQL');
```

```
commmit;
```

Please note that the outline names used (ORIGINALSQL and HINTSQL) must be unique.

Now under the SCOTT user, drop the temporary OUTLINE HINTSQL.

```
DROP OUTLINE HINTSQL;
```

Now check that the new access plan for the original SQL uses the new hint:

```
alter session set query_rewrite_enabled = true;
alter session set use_stored_outlines = true;
select sum(SAL) total, DEPT.DNAME from EMP,DEPT
where EMP.DEPTNO(+) = DEPT.DEPTNO
and DEPT.LOC= 'DALLAS'
group by DEPT.DNAME;
```

The plan for this SQL is now the same access plan as the SQL with HINTS.

```
0      SELECT STATEMENT Optimizer=CHOOSE
1      0      SORT (GROUP BY)
2      1      NESTED LOOPS (OUTER)
3      2          TABLE ACCESS (BY INDEX ROWID) OF 'DEPT'
4      3              INDEX (RANGE SCAN) OF 'I_DEPT$LOC' (NON-UNIQUE)
5      2          TABLE ACCESS (FULL) OF 'EMP'
```

Moving OUTLINES from One DB to Another

A user may want to copy OUTLINES from one database to another, for example, to copy the outlines of an application from a test database to a production database. This can easily be done utilizing Oracle's export and import routines.

Scenario

Once the optimization for an application is achieved in a test database, you can move the outlines created and stored for the application in a production database. Instead of recreating these outlines in the production database using the CREATE OUTLINE ... FOR CATEGORY command for each optimized query of the application, export the outlines for the specified category from the test database, and then import these in the production database.

Technique

1. The outlines for all categories are inserted in the OL\$ and OL\$HINTS tables owned by OUTLN schema.
2. The OUTLN schema, OL\$ and OL\$HINTS tables are created during the database creation while sql.bsq is executed:

```

create user outln identified by outln
/
grant connect to outln
/
grant resource to outln
/
grant execute any procedure to outln
/
create table outln.ol$
(
  ol_name          varchar2(30),           /* named is potentially
generated */
  sql_text         long,                  /* the SQL stmt being outlined */
  textlen          number,                /* length of SQL stmt */
  signature        raw(16),               /* signature of sql_text */
  hash_value       number,                /* KGL's calculated hash value */
  category         varchar2(30),          /* category name */
  version          varchar2(64),          /* db version @ outline creation
*/
  creator          varchar2(30),          /* user from whom outline created
*/
  timestamp        date,                 /* time of creation */
  flags            number,               /* e.g. everUsed, bindVars, dynSql
*/
  hintcount        number,               /* number of hints on the outline */
)
/
create table outln.ol$hints
(
  ol_name          varchar2(30),           /* outline name */
  hint#,           number,                /* which hint for a given outline */
  category         varchar2(30),          /* collection/grouping name */
  hint_type        number,                /* type of hint */
  hint_text        varchar2(512),          /* hint specific information */
  stage#           number,                /* stage of hint generation/applic'n
*/
  node#number,      /* QBC node id */
  table_name       varchar2(30),          /* for ORDERED hint */
  table_tin        number,                /* table instance number */
  table_pos        number,                /* for ORDERED hint */
)
/
create unique index outln.ol$name on outln.ol$(ol_name)
/
create unique index outln.ol$signature on outln.ol$(signature,category)
/
create unique index outln.ol$hnt_num on outln.ol$hints(ol_name, hint#)

```

/

3. Export the data from the OUTLN.OL\$ and OUTLN.OL\$HINTS from the test database, selecting the appropriate category for the required application with the new 8i QUERY export parameter.
4. In the production database, it is recommended to store all stored outlines in a separate tablespace. If this is not set yet, create a new tablespace, and set this tablespace as the default one for the OUTLN schema user. Drop the OL\$ and OL\$HINTS tables so that the import recreates them in the appropriate tablespace.
5. Import the OUTLN.OL\$ and OUTLN.OL\$HINTS tables and/or rows only depending on the status of the previous step in the production database.

Example

Using the QUERY option in export you can select distinct categories of outlines from the test database. To get the appropriate category for the application to be exported you will need to issue a SELECT similar to:

```
SQL> select distinct(category), ol_name from outln.ol$hints;
```

CATEGORY	OL_NAME
COURSE	SYS_OUTLINE_0003140951400000
COURSE	SYS_OUTLINE_0003140952040001
COURSE	SYS_OUTLINE_0003140953500002
COURSE	SYS_OUTLINE_0003140955480003
TRAIN	CO_CL_JOIN
TRAIN	DEPT_LOC

For this example, the category of outlines for the application is TRAIN. So now we export the outlines for the TRAIN category:

```
% more exp_parfile (show the contents of the exp_parfile file)
tables=ol$,ol$hints query="WHERE CATEGORY=\`TRAIN\`"
% exp outln/outln parfile=exp_parfile

Export: Release 8.1.6.0.0 - Production on Tue Mar 14 11:05:07 2000
(c) Copyright 1999 Oracle Corporation. All rights reserved.

Connected to: Oracle8i Enterprise Edition Release 8.1.6.0.0 - Production
With the Partitioning option
JServer Release 8.1.6.0.0 - Production
Export done in US7ASCII character set and US7ASCII NCHAR character set
server uses WE8ISO8859P9 character set (possible charset conversion)
```

```
About to export specified tables via Conventional Path ...
. . exporting table                                OL$                  2 rows
exported
. . exporting table                                OL$HINTS            17 rows
exported
Export terminated successfully without warnings.
%
```

If you had wanted to export all outlines of all categories, you would have exported using no QUERY clause:

```
% exp system/manager owner=outln
...
. about to export OUTLN's tables via Conventional Path ...
. . exporting table                                OL$                  9 rows
exported
. . exporting table                                OL$HINTS            68 rows
exported
```

Now we create a new tablespace for outlines of all categories in the production database (if not already done.)

```
SQL> create tablespace TBS_OUTLINES
  2  datafile '/oracle2/OFA_base/u01/oradata/V816/ts_outln01.dbf' size 2M;
Tablespace created.
```

Next we set the tablespace dedicated for stored outlines as the default tablespace for the OUTLN schema, owner of all outlines (if not already done.)

```
SQL> alter user OUTLN default tablespace TBS_OUTLINES;
User altered.
```

Now we drop the OUTLN.OL\$ and OUTLN.OL\$HINTS tables to let import recreate them in the appropriate tablespace (if not already done.)

```
SQL> drop table outln.ol$;
Table dropped.
```

```
SQL> drop table outln.ol$hints;
Table dropped.
```

Now we Import the outlines of the TRAIN category into the production database:

```
% imp outln/outln full=Y
```

```
Import: Release 8.1.6.0.0 - Production on Tue Mar 14 11:24:15 2000
(c) Copyright 1999 Oracle Corporation. All rights reserved.
```

```
Connected to: Oracle8i Enterprise Edition Release 8.1.6.0.0 - Production
With the Partitioning option
JServer Release 8.1.6.0.0 - Production
```

```
Export file created by EXPORT:V08.01.06 via conventional path
import done in US7ASCII character set and US7ASCII NCHAR character set
import server uses WE8ISO8859P9 character set (possible charset
conversion)
. . importing OUTLN's objects into OUTLN
. . . importing table                                "OL$"          2 rows
imported
. . . importing table                                "OL$HINTS"      17 rows
imported
Import terminated successfully without warnings.
```

Of course you could have also imported the tables into a different user and then used an INSERT using a SELECT to add the outlines if you wanted to retain the outlines already in production.

Summary

The OUTLN_PKG and DBMS_OUTLN_EDIT packages are powerful new features in Oracle. By their capability to add “stealth” hints to Oracle SQL statements without altering code they allow the DBA greater flexibility in tuning “hands off” systems than was ever available before. By using import and export and specialized editing techniques statement execution plans can be easily modified “under the hood” without touching production code.