

# DTGen ASOF Demonstration

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## Introduction:

The exercises in this demonstration are focused on the history and audit functionality of DTGen functionality. All functionality in these exercises is available through both command line and graphical user interface (GUI) mode. For simplicity in understanding the under-lying workings of DTGen, these exercises are conducted entirely in command-line mode.

The "basic" demonstration should be reviewed before running these exercises. Several concepts introduced in those exercises not explained here. Exercise #1 in this demonstration is similar to Exercise #1 in the basic demonstration.

The exercises in this directory are numbered and must be executed in sequential order. The demonstration users must be created with the "create\_demo\_users.sql" script in the parent directory before the first exercise is run. The demonstration users must be dropped with the "drop\_demo\_users.sql" script before the "create\_demo\_users.sql" script can be re-run. These exercises also assume that the default username/password (dtgen/dtgen) is still in use for the generator. Names and passwords are set in the "vars.sql" script and can be modified, if necessary. Also, the DTGen database objects must be installed in the database and the DTGen must be ready to generate code.

## Exercise #1: Entity Based History and Audit

### Command Line:

```
sqlplus /nolog @e1
```

*Exercise #1 modifies the database. The "drop\_demo\_users.sql" and "create\_demo\_users.sql" scripts must be used to reset the database before re-running this exercise.*

Based on the demobld.sql script, this exercise implements the EMP and DEPT tables using DTGen. The script for this exercise performs the following functions:

1. Removes any old DEMO2 Items from DTGEN
2. Creates new DEMO2 Items in DTGEN
3. Generates the DEMO2 Application in DTGEN
4. Creates the "install\_db.sql" script
5. Runs the "install\_db.sql" script
6. Loads and Reports Data

Steps 1-3 are captured in the "e1.LST" file. Following is a example of e1.LST.

```
Login to dtgen
Connected.
Remove old DEMO2 Schema from DTGEN
create a DEMO2 Schema in DTGEN
Generate Demo2 Application
Capture install_db.sql Script
```

Step 4 is captured in the "install\_db.sql" file. This file is about 79 kbytes and has over 3,000 lines. Due to its size, it is not listed here. It contains all the code generated by DTGen for this application.

Steps 5 and 6 are captured in the "install.LST" file. Step 5 is the execution of the install\_db.sql script.

```
Login to dtgen_db_demo
Connected.
```

```
FILE_NAME
-----
-) create_glob
```

```
FILE_NAME
-----
-) create_ods
```

```
TABLE_NAME
-----
*** dept ***
```

```
TABLE_NAME
-----
*** emp ***
```

```
FILE_NAME
-----
-) create_integ
```

```
TABLE_NAME
-----
*** dept ***
```

```
TABLE_NAME
-----
*** emp ***
```

```
FILE_NAME
-----
-) create_oltp
```

```
TABLE_NAME
-----
*** dept ***
```

```

TABLE_NAME
-----
***   emp   ***

FILE_NAME
-----
-) create_mods

```

The above listing represents a successful installation of the application generated by DTGen. This application is small in that it only has 2 tables, 1 tier (the database tier), and no user schema.

The DEPT table is silently loaded with data. A query of column comments on the DEPT table from the data dictionary help identify what each column's data represents. Following the column comments is a report of all the data in the DEPT table (active view) for the selected columns.

COLUMN_NAME	COMMENTS
ID	Surrogate Primary Key for this table
DEPTNO	Department Number
DNAME	Name of the Department
LOC	Location for the Department
AUD_BEG_USR	User that created this record
AUD_BEG_DTM	Date/Time this record was created (must be in nanoseconds)

  

ID	DEPTNO	DNAME	LOC	AUD_BEG_USR	AUD_BEG_DTM
1	10	ACCOUNTING	NEW YORK	Dataload	01-NOV-80 12
2	20	RESEARCH	DALLAS	Dataload	01-NOV-80 12
3	30	SALES	CHICAGO	THOMPSON	17-AUG-82 12
4	40	OPERATIONS	BOSTON	JAMES	12-FEB-82 12

The EMP table is also silently loaded with data. The same queries of column comments and data on the EMP table (active view) are shown.

COLUMN_NAME	COMMENTS
ID	Surrogate Primary Key for this table
EMPNO	Employee Number
ENAME	Employee Name
JOB	Job Title
MGR_EMP_NK1	EMP Natural Key Value 1: Employee Number
HIREDATE	Date the Employee was hired
SAL	Employee's Salary
DEPT_NK1	DEPT Natural Key Value 1: Department Number
AUD_BEG_USR	User that created this record
AUD_BEG_DTM	Date/Time this record was created (must be in nanoseconds)

  

ID	EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	DEPT	AUD_BEG_USR	AUD_BEG_DTM
3	7369	SMITH	CLERK	7902	17-DEC-80	800	20	SMITH	26-FEB-83 12
4	7499	ALLEN	SALESMAN	7698	20-FEB-81	1600	30	THOMPSON	12-MAY-81 12
5	7521	WARD	SALESMAN	7698	22-FEB-81	1250	30	THOMPSON	14-MAY-81 12
6	7566	JONES	MANAGER	7839	02-APR-81	2975	20	SMITH	29-NOV-81 12
14	7654	MARTIN	SALESMAN	7698	28-SEP-81	1250	30	SMITH	26-SEP-81 12
8	7698	BLAKE	MANAGER	7839	01-MAY-81	2850	30	SMITH	30-NOV-81 12
9	7782	CLARK	MANAGER	7839	09-JUN-81	2450	10	SMITH	26-NOV-81 12
20	7788	SCOTT	ANALYST	7566	09-DEC-82	3000	20	JAMES	11-DEC-82 12
15	7839	KING	PRESIDENT		17-NOV-81	5000	10	SMITH	18-NOV-81 12
13	7844	TURNER	SALESMAN	7698	08-SEP-81	1500	30	SMITH	06-SEP-81 12
21	7876	ADAMS	CLERK	7788	12-JAN-83	1100	20	SMITH	12-JAN-83 12
17	7900	JAMES	CLERK	7698	03-DEC-81	950	30	SMITH	05-DEC-81 12
18	7902	FORD	ANALYST	7566	03-DEC-81	3000	20	SMITH	01-DEC-81 12
19	7934	MILLER	CLERK	7782	23-JAN-82	1300	10	JAMES	21-JAN-82 12

In addition to the DEPT and EMP tables, this exercise also loaded a DEPT audit table called DEPT\_AUD and an EMP history table called EMP\_HIST.

COLUMN_NAME	COMMENTS
DEPT_ID	Surrogate Primary Key from the ACTIVE table
AUD_BEG_USR	User that created this record
AUD_END_USR	User that modified/deleted this record
AUD_BEG_DTM	Date/Time this record was created (must be in nanoseconds)
AUD_END_DTM	Date/Time this record was modified/deleted (must be in nanoseconds)
DEPTNO	Department Number
DNAME	Name of the Department
LOC	Location for the Department

DEPT_ID	DEPTNO	DNAME	LOC	AUD_BEG_	AUD_BEG_D	AUD_END_	AUD_END_D
3	20	SALES	ST LOUIS	Datload	01-NOV-80	THOMPSON	17-AUG-82
4	40	OPERATIONS	BUFFALO	Datload	01-NOV-80	JAMES	12-FEB-82

In the DEPT\_AUD listing above, the column comments for the columns starting with "AUD\_" indicate the user and date/time of modifications are being tracked, even after a record has been updated or deleted. The data records show that the SALES department was originally in St. Louis and the OPERATIONS department was originally in Buffalo.

COLUMN_NAME	COMMENTS
EMP_ID	Surrogate Primary Key from the ACTIVE table
AUD_BEG_USR	User that created this record
AUD_END_USR	User that modified/deleted this record
AUD_BEG_DTM	Date/Time this record was created (must be in nanoseconds)
AUD_END_DTM	Date/Time this record was modified/deleted (must be in nanoseconds)
EMPNO	Employee Number
ENAME	Employee Name
JOB	Job Title
MGR_EMP_ID	Surrogate Key of Employee's Manager

EMPNO	EMP_ID	ENAME	JOB	MGR_	AUD_BEG_	AUD_BEG_D	AUD_END_	AUD_END_D
7301	1	ELLISON	PRESIDENT		DAVIS	04-NOV-80	THOMPSON	28-JUN-81
7344	2	DAVIS	CLERK	1	DAVIS	14-NOV-80	THOMPSON	25-JUN-81
7344	2	DAVIS	CLERK	11	THOMPSON	25-JUN-81	THOMPSON	20-AUG-81
7344	2	DAVIS	CLERK	12	THOMPSON	20-AUG-81	SMITH	29-NOV-81
7344	2	DAVIS	CLERK	15	SMITH	29-NOV-81	SMITH	06-DEC-81
7369	3	THOMPSON	CLERK	1	DAVIS	15-DEC-80	THOMPSON	25-JUN-81
7369	3	THOMPSON	CLERK	11	THOMPSON	25-JUN-81	SMITH	21-AUG-81
7369	3	SMITH	CLERK	12	SMITH	21-AUG-81	SMITH	01-DEC-81
7369	3	SMITH	CLERK	15	SMITH	01-DEC-81	SMITH	26-FEB-83
7499	4	ALLEN	SALESMAN	1	THOMPSON	17-FEB-81	THOMPSON	12-MAY-81
7521	5	WARD	SALESMAN	1	THOMPSON	24-FEB-81	THOMPSON	14-MAY-81
7566	6	JONES	MANAGER	1	THOMPSON	03-APR-81	THOMPSON	24-JUN-81
7566	6	JONES	MANAGER	11	THOMPSON	24-JUN-81	SMITH	22-AUG-81
7566	6	JONES	MANAGER	12	SMITH	22-AUG-81	SMITH	29-NOV-81
7654	7	MARTIN	SALESMAN	1	THOMPSON	16-APR-81	THOMPSON	13-MAY-81
7698	8	BLAKE	MANAGER	1	THOMPSON	02-MAY-81	THOMPSON	24-JUN-81
7698	8	BLAKE	MANAGER	11	THOMPSON	24-JUN-81	THOMPSON	19-AUG-81
7698	8	BLAKE	MANAGER	12	THOMPSON	19-AUG-81	SMITH	30-NOV-81
7782	9	CLARK	MANAGER	1	THOMPSON	07-JUN-81	THOMPSON	23-JUN-81
7782	9	CLARK	MANAGER	11	THOMPSON	23-JUN-81	SMITH	23-AUG-81
7782	9	CLARK	MANAGER	12	SMITH	23-AUG-81	SMITH	26-NOV-81
7788	10	SCOTT	ANALYST	6	THOMPSON	10-JUN-81	JAMES	09-MAR-82
7839	11	KING	PRESIDENT		THOMPSON	18-JUN-81	SMITH	30-AUG-81
7840	12	LANE	PRESIDENT		THOMPSON	12-AUG-81	SMITH	29-NOV-81
7876	16	ADAMS	CLERK	6	SMITH	20-NOV-81	JAMES	13-JUN-82

In the EMP\_HIST listing above, the column comments and data for selected columns are queried. The column comments for the columns show that both "\_AUD" and "\_HIST" tables include the audit columns that start with "AUD\_". Each record from EMP\_HIST represents a record that was in EMP\_ACT from AUD\_BEG\_DTM to AUD\_END\_DTM. Notice that EMPNO 7369 changes

names from THOMPSON to SMITH. This name change was entered into EMP\_ACT on August 2<sup>1st</sup>, 1981. (i.e. Both AUD\_BEG\_DTM of the record with the new ENAME and the AUD\_END\_DTM of the previous record have the same date.)

## Exercise #2: EFF vs. LOG Table Types

### Command Line:

```
sqlplus /nolog @e2
```

*Exercise #2 does not modify the database. (The DEPT\_SEQ and EMP\_SEQ sequences are incremented by one). This exercise can be repeated without problem.*

Exercise #1 included a brief introduction to the DEPT\_AUD and EMP\_HIST tables. Below are the DTGen settings that generated those tables.

```
Login to dtgen
Connected.
```

```
VALUE DESCRIPTION
```

```
-----
EFF  A historical table type with effective/audit begin/end timestamps and
      begin/end user recording
LOG  An audit table type with audit only begin/end timestamps and begin/end
      user recording
NON  A none or nothing table type without begin/end timestamps or begin/end
      user recording
```

```

      SEQ NAME          TYP
-----
      10 dept          LOG
      20 emp           EFF
```

For any table configured in DTGen, one of these 3 table types must be selected. In the "basics" demonstration, "NON" was set as the table type for both tables. This demonstration shows the use of LOG and EFF table types. An example of when to use LOG versus EFF is also represented with these tables. The DEPT table holds department information, which is slow moving (doesn't change often or rapidly) and is generally known well in advance of any changes to the applicaiton data (i.e. Adding a new department). Constrast the employee information, which can be fast moving and needs to be recorded as occuring at a specific time (effectivity) in addition to simple audit recording.

```
SQL>
SQL> select id, deptno dept, loc,
2      aud_beg_usr, aud_beg_dtm
3      from dept_act where deptno = 50;

no rows selected

SQL> select dept_id id, deptno dept, loc,
2      aud_beg_usr, aud_beg_dtm, aud_end_usr, aud_end_dtm
3      from dept_aud where deptno = 50;

no rows selected
```

There are no records for a department with a DEPTNO of "50".

```
SQL>
SQL> execute util.set_usr('USER1');
```

```

PL/SQL procedure successfully completed.

SQL> select systimestamp from dual;

SYSTIMESTAMP
-----
17-APR-12 04.35.54

1 row selected.

SQL> insert into dept_act (deptno, dname, loc)
  2   values (50, 'NEW_DEPT', 'LZ');

1 row created.

SQL>
SQL> select id, deptno dept, loc,
  2   aud_beg_usr, aud_beg_dtm
  3   from dept_act where deptno = 50;

ID DEPT LOC AUD_BEG_USR AUD_BEG_DTM
--- --- ---
5   50 LZ   USER1       17-APR-12 04.35.54

1 row selected.

SQL> select dept_id id, deptno dept, loc,
  2   aud_beg_usr, aud_beg_dtm, aud_end_usr, aud_end_dtm
  3   from dept_aud where deptno = 50;

no rows selected

```

After setting the util.set\_usr, the time is reported and a DEPT record is created. The last 2 queries above show that a DEPT\_ACT record was created by the util.set\_usr value at the current time, and here are no DEPT\_AUD records.

```

SQL>
SQL> execute dbms_lock.sleep(1);

PL/SQL procedure successfully completed.

SQL> execute util.set_usr('USER2');

PL/SQL procedure successfully completed.

SQL> select systimestamp from dual;

SYSTIMESTAMP
-----
17-APR-12 04.35.55

1 row selected.

SQL> update dept_act
  2   set loc = 'LA'
  3   where deptno = 50;

1 row updated.

SQL>
SQL> select id, deptno dept, loc,
  2   aud_beg_usr, aud_beg_dtm
  3   from dept_act where deptno = 50;

ID DEPT LOC AUD_BEG_USR AUD_BEG_DTM
--- --- ---
5   50 LA   USER2       17-APR-12 04.35.55

1 row selected.

SQL> select dept_id id, deptno dept, loc,
  2   aud_beg_usr, aud_beg_dtm, aud_end_usr, aud_end_dtm
  3   from dept_aud where deptno = 50;

```

ID	DEPT	LOC	AUD_BEG_USR	AUD_BEG_DTM	AUD_END_USR	AUD_END_DTM
5	50	LZ	USER1	17-APR-12 04.35.54	USER2	17-APR-12 04.35.55

1 row selected.

In the sequence above, the DBMS\_LOCK.SLEEP function is used to elapse one second before running the update with a different util.set\_usr. The last 2 queries above show one record in each DEPT\_ACT and DEPT\_AUD. The DEPT\_AUD record is the previous DEPT\_ACT record. Also, the DEPT\_AUD record has a matching AUD\_END\_DTM to the AUD\_BEG\_DTM of the new DEPT\_ACT record. Notice that USER2 is recorded as the AUD\_END\_USR in DEPT\_AUD and the AUD\_BEG\_USR in DEPT\_ACT.

```
SQL>
SQL> execute dbms_lock.sleep(1);

PL/SQL procedure successfully completed.

SQL> execute util.set_usr('USER3');

PL/SQL procedure successfully completed.

SQL> select systimestamp from dual;

SYSTIMESTAMP
-----
17-APR-12 04.35.56

1 row selected.

SQL> delete from dept_act where deptno = 50;

1 row deleted.

SQL>
SQL> select id, deptno dept, loc,
2     aud_beg_usr, aud_beg_dtm
3     from dept_act where deptno = 50;

no rows selected

SQL> select dept_id id, deptno dept, loc,
2     aud_beg_usr, aud_beg_dtm, aud_end_usr, aud_end_dtm
3     from dept_aud where deptno = 50;
```

ID	DEPT	LOC	AUD_BEG_USR	AUD_BEG_DTM	AUD_END_USR	AUD_END_DTM
5	50	LZ	USER1	17-APR-12 04.35.54	USER2	17-APR-12 04.35.55
5	50	LA	USER2	17-APR-12 04.35.55	USER3	17-APR-12 04.35.56

2 rows selected.

In the sequence above, a delete is run on DEPT\_ACT, resulting in no DEPT\_ACT records and 2 DEPT\_AUD records. This functionality works the same for the DEPT\_DML API calls.

Below, the same set of processes will be repeated for an employee record.

```
SQL>
SQL> select id, empno, ename, to_char(eff_beg_dtm,'DD HH24:MI:SS') eff_beg_dtm,
2     aud_beg_usr, to_char(aud_beg_dtm,'DD HH24:MI:SS') aud_beg_dtm
3     from emp_act where empno = 9999;

no rows selected

SQL> select emp_id id, empno, ename,
2     to_char(eff_beg_dtm,'DD HH24:MI:SS') eff_beg_dtm,
3     aud_beg_usr, to_char(aud_beg_dtm,'DD HH24:MI:SS') aud_beg_dtm,
4     to_char(eff_end_dtm,'DD HH24:MI:SS') eff_end_dtm,
```

```

5     aud_end_usr, to_char(aud_end_dtm,'DD HH24:MI:SS') aud_end_dtm
6     from emp_hist where empno = 9999;

no rows selected

SQL>
SQL> execute util.set_usr('USER1');

PL/SQL procedure successfully completed.

SQL> select systimestamp from dual;

SYSTIMESTAMP
-----
17-APR-12 08.25.17

1 row selected.

SQL> insert into emp_act (empno, ename, job, hiredate, sal, dept_nkl,
2     eff_beg_dtm)
3     values (9999, 'NEW_EMP', 'CLERK', sysdate, 100, 40,
4     to_timestamp('1983-6-1 11', 'YYYY-MM-DD HH24'));

1 row created.

SQL>
SQL> select id, empno, ename, to_char(eff_beg_dtm,'DD HH24:MI:SS') eff_beg_dtm,
2     aud_beg_usr, to_char(aud_beg_dtm,'DD HH24:MI:SS') aud_beg_dtm
3     from emp_act where empno = 9999;

ID EMPNO ENAME      EFF_BEG_DTM AUD_B AUD_BEG_DTM
---
22  9999 NEW_EMP    01 11:00:00 USER1 17 20:25:17

1 row selected.

SQL> select emp_id id, empno, ename,
2     to_char(eff_beg_dtm,'DD HH24:MI:SS') eff_beg_dtm,
3     aud_beg_usr, to_char(aud_beg_dtm,'DD HH24:MI:SS') aud_beg_dtm,
4     to_char(eff_end_dtm,'DD HH24:MI:SS') eff_end_dtm,
5     aud_end_usr, to_char(aud_end_dtm,'DD HH24:MI:SS') aud_end_dtm
6     from emp_hist where empno = 9999;

no rows selected

```

Notice that the EMP\_ACT active view has the EFF\_BEG\_DTM column that DEPT\_ACT does not. This is a key difference between EFF and LOG. This additional effectivity column allows a date/time in the past to be entered and referenced as the effective time an event occurred. Otherwise, the LOG table only records when an event was entered, as the AUD\_BEG\_DTM is acquired from the system clock and cannot be entered.

The first 2 queries show there are no EMP\_ACT records with an EMPNO of 9999. After the user is set and the time is queried, a record is inserted into the EMP\_ACT active view with an effectivity date/time of June 1<sup>st</sup>, 1983 at 11am. The record is returned from the EMP\_ACT query and no records are returned from EMP\_HIST.

```

SQL>
SQL> execute dbms_lock.sleep(1);

PL/SQL procedure successfully completed.

SQL> execute util.set_usr('USER2');

PL/SQL procedure successfully completed.

SQL> select systimestamp from dual;

SYSTIMESTAMP
-----
17-APR-12 08.25.18

```



```

1 row selected.

SQL> update emp_act
2   set  ename = 'UPD_EMP',
3       eff_beg_dtm = to_timestamp('1983-6-2 12', 'YYYY-MM-DD HH24')
4   where empno = 9999;

1 row updated.

SQL>
SQL> select id, empno, ename, to_char(eff_beg_dtm,'DD HH24:MI:SS') eff_beg_dtm,
2   aud_beg_usr, to_char(aud_beg_dtm,'DD HH24:MI:SS') aud_beg_dtm
3   from emp_act where empno = 9999;

ID EMPNO ENAME      EFF_BEG_DTM AUD_B AUD_BEG_DTM
---
22  9999 UPD_EMP    02 12:00:00 USER2 17 20:25:18

1 row selected.

SQL> select emp_id id, empno, ename,
2   to_char(eff_beg_dtm,'DD HH24:MI:SS') eff_beg_dtm,
3   aud_beg_usr, to_char(aud_beg_dtm,'DD HH24:MI:SS') aud_beg_dtm,
4   to_char(eff_end_dtm,'DD HH24:MI:SS') eff_end_dtm,
5   aud_end_usr, to_char(aud_end_dtm,'DD HH24:MI:SS') aud_end_dtm
6   from emp_hist where empno = 9999;

ID EMPNO ENAME      EFF_BEG_DTM AUD_B AUD_BEG_DTM EFF_END_DTM AUD_E AUD_END_DTM
---
22  9999 NEW_EMP    01 11:00:00 USER1 17 20:25:17 02 12:00:00 USER2 17 20:25:18

1 row selected.

```

Again, the user is set and the time is queried. An update is issued against the active view with an effectivity date/time of June 2<sup>nd</sup>, 1983 at 12pm. Each of the last 2 queries return 1 record showing the effectivity that was entered. AUD\_BEG\_DTM and AUD\_END\_DTM will always have the current date/time as these values are not allowed to be entered.

```

SQL>
SQL> execute dbms_lock.sleep(1);

PL/SQL procedure successfully completed.

SQL> select systimestamp from dual;

SYSTIMESTAMP
-----
17-APR-12 08.25.19

1 row selected.

SQL> declare
2   eff_end_dtm timestamp with local time zone;
3   emp_id      number;
4   begin
5       util.set_usr('USER3');
6       select id into emp_id
7       from emp_act where empno = 9999;
8       eff_end_dtm := to_timestamp('1983-6-3 13', 'YYYY-MM-DD HH24');
9       emp_dml.del(emp_id, eff_end_dtm);
10  end;
11  /

PL/SQL procedure successfully completed.

SQL>
SQL> select id, empno, ename, to_char(eff_beg_dtm,'DD HH24:MI:SS') eff_beg_dtm,
2   aud_beg_usr, to_char(aud_beg_dtm,'DD HH24:MI:SS') aud_beg_dtm
3   from emp_act where empno = 9999;

no rows selected

SQL> select emp_id id, empno, ename,
2   to_char(eff_beg_dtm,'DD HH24:MI:SS') eff_beg_dtm,

```

```

3     aud_beg_usr, to_char(aud_beg_dtm,'DD HH24:MI:SS') aud_beg_dtm,
4     to_char(eff_end_dtm,'DD HH24:MI:SS') eff_end_dtm,
5     aud_end_usr, to_char(aud_end_dtm,'DD HH24:MI:SS') aud_end_dtm
6     from emp_hist where empno = 9999;

ID EMPNO ENAME      EFF_BEG_DTM AUD_B AUD_BEG_DTM EFF_END_DTM AUD_E AUD_END_DTM
---
22  9999 NEW_EMP    01 11:00:00 USER1 17 20:25:17 02 12:00:00 USER2 17 20:25:18
22  9999 UPD_EMP    02 12:00:00 USER2 17 20:25:18 03 13:00:00 USER3 17 20:25:19

2 rows selected.

SQL>
SQL> rollback;

Rollback complete.

```

Notice the EMP\_DML.DEL procedure was used to delete the record using an effectivity date/time of June 3<sup>rd</sup>, 1983 at 1pm. The DML package API is the only way to enter an EFF\_END\_DTM during a delete. There is no corresponding functionality available using the EMP\_ACT active view. Otherwise, the EMP\_DML.INS and EMP\_DML\_UPD procedures work the same as insert and delete SQL on the EMP\_ACT active view.

## Exercise #3: Point-in-Time ASOF Views

### Command Line:

```
sqlplus /nolog @e3
```

*Exercise #3 does not modify the database. This exercise can be repeated without problem.*

In this exercise, we take a trip back in time using the DTGen version of flashback query. The ASOF view on each table returns data that was current during the "util.set\_asof\_dtm" date/time specified. Referential integrity is not specifically enforced in the AUD and HIST data. However, since referential integrity was enforced at any given time, the data for any point in time should have integrity. (NOTE: Referential integrity is not guaranteed until Issue #2 is resolved. See "<http://code.google.com/p/dtgen/issues/detail?id=2>")

The following query joins the EMP\_ASOF and DEPT\_ASOF views at a point in time of January 1<sup>st</sup>, 1983 (midnight).

```

SQL>
SQL> execute util.set_asof_dtm(to_timestamp('1983-01-01', 'YYYY-MM-DD'))

PL/SQL procedure successfully completed.

SQL>
SQL> select empno, ename, job, mgr_emp_nk1, hiredate, sal, deptno, dname, loc
2     from emp_asof e, dept_asof d where e.dept_id = d.id
3     order by empno;

EMPNO ENAME      JOB      MGR_EMP_NK1 HIREDATE      SAL DEPTNO DNAME      LOC
-----
7369 SMITH      CLERK      7839 17-DEC-80      800      10 ACCOUNTING NEW YORK
7499 ALLEN      SALESMAN   7698 20-FEB-81     1600      30 SALES      CHICAGO
7521 WARD        SALESMAN   7698 22-FEB-81     1250      30 SALES      CHICAGO
7566 JONES      MANAGER    7839 02-APR-81     2975      20 RESEARCH  DALLAS
7654 MARTIN    SALESMAN   7698 28-SEP-81     1250      30 SALES      CHICAGO
7698 BLAKE      MANAGER    7839 01-MAY-81     2850      30 SALES      CHICAGO
7782 CLARK      MANAGER    7839 09-JUN-81     2450      10 ACCOUNTING NEW YORK
7788 SCOTT      ANALYST    7566 09-DEC-82     3000      20 RESEARCH  DALLAS
7839 KING        PRESIDENT  17-NOV-81     5000      10 ACCOUNTING NEW YORK
7844 TURNER    SALESMAN   7698 08-SEP-81     1500      30 SALES      CHICAGO

```

7900 JAMES	CLERK	7698 03-DEC-81	950	30 SALES	CHICAGO
7902 FORD	ANALYST	7566 03-DEC-81	3000	20 RESEARCH	DALLAS
7934 MILLER	CLERK	7782 23-JAN-82	1300	10 ACCOUNTING	NEW YORK

13 rows selected.

Data from the original dmobld.sql script showed that ADAMS the CLERK was hired on January 12<sup>th</sup>, 1983. Since the query above is for data some 11 days earlier, ADAMS is missing from the list. The following is the same query with "asof\_dtm" set one year earlier.

```
SQL>
SQL> execute util.set_asof_dtm(to_timestamp('1982-01-01', 'YYYY-MM-DD'))

PL/SQL procedure successfully completed.

SQL>
SQL> select empno, ename, job, mgr_emp_nk1, hiredate, sal, deptno, dname, loc
       2   from emp_asof e, dept_asof d where e.dept_id = d.id
       3   order by empno;
```

EMPNO	ENAME	JOB	MGR_EMP_NK1	HIREDATE	SAL	DEPTNO	DNAME	LOC
7369	SMITH	CLERK	7839	17-DEC-80	800	10	ACCOUNTING	NEW YORK
7499	ALLEN	SALESMAN	7698	20-FEB-81	1600	20	SALES	ST LOUIS
7521	WARD	SALESMAN	7698	22-FEB-81	1250	20	SALES	ST LOUIS
7566	JONES	MANAGER	7839	02-APR-81	2975	20	RESEARCH	DALLAS
7654	MARTIN	SALESMAN	7698	28-SEP-81	1250	20	SALES	ST LOUIS
7698	BLAKE	MANAGER	7839	01-MAY-81	2850	20	SALES	ST LOUIS
7782	CLARK	MANAGER	7839	09-JUN-81	2450	10	ACCOUNTING	NEW YORK
7788	SCOTT	ANALYST	7566	12-JUN-81	3000	20	RESEARCH	DALLAS
7839	KING	PRESIDENT		17-NOV-81	5000	10	ACCOUNTING	NEW YORK
7844	TURNER	SALESMAN	7698	08-SEP-81	1500	20	SALES	ST LOUIS
7876	ADAMS	CLERK	7566	22-NOV-81	1100	20	RESEARCH	DALLAS
7900	JAMES	CLERK	7698	03-DEC-81	950	20	SALES	ST LOUIS
7902	FORD	ANALYST	7566	03-DEC-81	3000	20	RESEARCH	DALLAS

13 rows selected.

Notice is that the SALES department is in St. Louis. Sometime during 1982, the SALES department must have been moved to Chicago. With a HIREDATE of January 23<sup>rd</sup>, 1982, MILLER is not on the list. However, ADAMS the CLERK is back on the list. Given the sequential assignment of EMPNO 7876, ADAMS was hired, left, and re-hired with the same EMPNO (but a new EMP record). More interesting data can be seen on September 1<sup>st</sup>, 1981 and June 1<sup>st</sup>, 1981.

## Exercise #4: Audited POP Functions

### Command Line:

```
sqlplus /nolog @e4
```

*Exercise #4 modifies the database. The "drop\_demo\_users.sql", "create\_demo\_users.sql", and "e1.sql" scripts must be used to reset the database before re-running this exercise.*

Each table defined in DTGen as a "LOG" or "EFF" table type has a "POP" or undo package generated for it. The POP function can undo all DML on a record. Below, department 40 will be staffed with new hires and transfers.

```
SQL>
SQL> select id did, deptno, dname, loc from dept_act;
```

DID	DEPTNO	DNAME	LOC
1	10	ACCOUNTING	NEW YORK

```

2          20 RESEARCH      DALLAS
3          30 SALES        CHICAGO
4          40 OPERATIONS    BOSTON

4 rows selected.

SQL>
SQL> select empno, ename, job, dept_id did, dept_nkl dept, aud_beg_usr, aud_beg_dtm
2   from emp_act where dept_nkl = 40;

no rows selected

SQL>
SQL> execute util.set_usr('SMITH');

PL/SQL procedure successfully completed.

SQL>
SQL> -- Add a new manager MCMURRY to the Operations Department
SQL> insert into emp_act (empno, ename, job, mgr_emp_nkl, hiredate, sal, dept_id)
2   values (8156, 'MCMURRY', 'MANAGER', 7839, sysdate, 2975, 4);

1 row created.

SQL>
SQL> -- Add a new analyst WALKER to the Operations Department
SQL> insert into emp_act (empno, ename, job, mgr_emp_nkl, hiredate, sal, dept_nkl)
2   values (8157, 'WALKER', 'ANALYST', 8156, sysdate, 3000, 40);

1 row created.

SQL>
SQL> -- Transfer an analyst SCOTT to the Operations Department
SQL> update emp_act
2   set dept_id = 4
3   ,mgr_emp_nkl = 8156
4   where empno = 7788;

1 row updated.

SQL>
SQL> -- Transfer a clerk JAMES to the Operations Department
SQL> update emp_act
2   set dept_nkl = 40
3   ,mgr_emp_nkl = 8156
4   where empno = 7902;

1 row updated.

SQL>
SQL> commit;

Commit complete.

```

In the sequence of steps above, department 40 is confirmed to have no employees. SMITH adds two new employees to the department and transfers 2 existing employees. The transaction is committed. However, something went wrong.

```

SQL>
SQL> select id eid, empno, ename, job, dept_id did, dept_nkl dept,
2   aud_beg_usr, aud_beg_dtm
3   from emp_act where dept_nkl = 40;

```

EID	EMPNO	ENAME	JOB	DID	DEPT	AUD_BEG	AUD_BEG_D
18	7902	FORD	ANALYST	4	40	SMITH	18-APR-12
20	7788	SCOTT	ANALYST	4	40	SMITH	18-APR-12
23	8156	MCMURRY	MANAGER	4	40	SMITH	18-APR-12
24	8157	WALKER	ANALYST	4	40	SMITH	18-APR-12

4 rows selected.

In the department listng above, FORD has been mistakenly transfered to department 40. MILLER

will use the POP procedure to undo the "committed" error and re-transfer the correct employee.

```
SQL>
SQL> execute util.set_usr('MILLER');

PL/SQL procedure successfully completed.

SQL>
SQL> select emp_id eid, empno, ename, dept_id did,
2         aud_beg_usr, aud_beg_dtm, aud_end_usr, aud_end_dtm
3   from emp_hist where empno = 7902;

EID EMPNO ENAME      DID AUD_BEG AUD_BEG_D AUD_END AUD_END_D
--- --
18  7902 FORD        2  SMITH   02-DEC-81 SMITH   18-APR-12

1 row selected.

SQL>
SQL> -- Undo the transfer of FORD to the Operations Department
SQL> declare
2   emp_id number;
3   begin
4     select id into emp_id from emp_act where empno = 7902;
5     emp_pop.at_server(emp_id);
6   end;
7   /

PL/SQL procedure successfully completed.

SQL>
SQL> -- Transfer a clerk JAMES to the Operations Department
SQL> update emp_act
2   set dept_nk1 = 40
3     ,mgr_emp_nk1 = 8156
4   where empno = 7900;

1 row updated.

SQL>
SQL> select id eid, empno, ename, job, dept_id did, dept_nk1 dept,
2         aud_beg_usr, aud_beg_dtm
3   from emp_act where dept_nk1 = 40 or empno = 7902;

EID EMPNO ENAME      JOB      DID DEPT AUD_BEG AUD_BEG_D
--- --
17  7900 JAMES      CLERK      4  40 MILLER  18-APR-12
18  7902 FORD      ANALYST    2  20 SMITH   01-DEC-81
20  7788 SCOTT     ANALYST    4  40 SMITH   18-APR-12
23  8156 MCMURRY    MANAGER    4  40 SMITH   18-APR-12
24  8157 WALKER    ANALYST    4  40 SMITH   18-APR-12

5 rows selected.

SQL>
SQL> select emp_id eid, empno, ename, dept_id did,
2         aud_beg_usr, aud_beg_dtm, aud_end_usr, aud_end_dtm
3   from emp_hist where empno = 7902;

no rows selected

SQL>
SQL> commit;

Commit complete.
```

In the first query above, FORD's history record is displayed, showing that he was in DEPT\_ID 2. MILLER uses the EMP\_POP.AT\_SERVER procedures to "undo" the last DML on FORD's employment record. Then, MILLER correctly transfers JAMES to department 40 (DEPT\_ID 4). Notice that the EMP\_ACT record for FORD in the last query shows the original AUD\_BEG\_DTM of December 1<sup>st</sup>, 1981. Even though the EMP\_ACT and EMP\_HIST tables don't show any record of the POP occurring, the POP was recorded in the EMP\_PDAT table.

```
SQL>
SQL> select emp_id eid, pop_dml, pop_usr, pop_dtm, empno, ename,
2         aud_beg_usr, aud_beg_dtm, aud_prev_beg_usr, aud_prev_beg_dtm
3         from emp_pdat;

EID POP_DM POP_USR POP_DTM EMPNO ENAME AUD_BEG AUD_BEG_D AUD_PRE AUD_PREV_
--- --
18 UPDATE MILLER 18-APR-12 7902 FORD SMITH 18-APR-12 SMITH 01-DEC-81

1 row selected.
```

The query above shows that MILLER "popped" an UPDATE statement on FORD's employment record (ID 18) that was performed by SMITH on April 12<sup>th</sup>, 2012. Note that the AUD\_PREV\_BEG\_USR of SMITH is the value restored to the AUD\_BEG\_USR in the EMP\_ACT record. Also note that the AUD\_PREV\_BEG\_DTM of December 1<sup>st</sup>, 1981 is the value restored to the AUD\_BEG\_DTM in the EMP\_ACT record. These values, along with the ID from the original EMP\_ACT record, can be used to trace the audit trail back to the original EMP\_ACT or EMP\_HIST records, regardless of how many times a record is "popped".

## Exercise #5: All Instances View

### Command Line:

```
sqlplus /nolog @e5
```

*Exercise #5 does not modify the database. This exercise can be repeated without problem.*

Each record that was originally created in the EMP table is tracked through all the DML performed on it (including the use of the POP procedure). The original record is tracked via the ID it was originally assigned in the EMP table. In the EMP table, each record represents an instance of employment.

```
SQL>
SQL> select empno, ename, id eid, stat, dept_id did,
2         aud_beg_usr, aud_beg_dtm, aud_end_usr, aud_end_dtm
3         from emp_all order by empno, id;

EMPNO ENAME EID STAT DID AUD_BEG AUD_BEG_D AUD_END AUD_END_D
-----
7301 ELLISON 1 HIST 1 DAVIS 30-OCT-80 THOMPSON 30-JUN-81
7344 DAVIS 2 HIST 1 SMITH 28-NOV-81 SMITH 10-DEC-81
7369 SMITH 3 ACT 2 SMITH 28-FEB-83
7499 ALLEN 4 ACT 3 THOMPSON 14-MAY-81
7521 WARD 5 ACT 3 THOMPSON 14-MAY-81
7566 JONES 6 ACT 2 SMITH 30-NOV-81
7654 MARTIN 7 HIST 3 THOMPSON 18-APR-81 THOMPSON 14-MAY-81
7654 MARTIN 14 ACT 3 SMITH 26-SEP-81
7698 BLAKE 8 ACT 3 SMITH 28-NOV-81
7782 CLARK 9 ACT 1 SMITH 01-DEC-81
7788 SCOTT 10 HIST 2 THOMPSON 10-JUN-81 JAMES 07-MAR-82
7788 SCOTT 20 ACT 4 SMITH 18-APR-12
7839 KING 11 HIST 1 THOMPSON 14-JUN-81 SMITH 29-AUG-81
7839 KING 15 ACT 1 SMITH 15-NOV-81
7840 LANE 12 HIST 1 THOMPSON 15-AUG-81 SMITH 28-NOV-81
7844 TURNER 13 ACT 3 SMITH 09-SEP-81
7876 ADAMS 16 HIST 2 SMITH 24-NOV-81 JAMES 15-JUN-82
7876 ADAMS 21 ACT 2 SMITH 09-JAN-83
7900 JAMES 17 ACT 4 MILLER 18-APR-12
7902 FORD 18 ACT 2 SMITH 02-DEC-81
7934 MILLER 19 ACT 1 JAMES 22-JAN-82
8156 MCMURRY 23 ACT 4 SMITH 18-APR-12
8157 WALKER 24 ACT 4 SMITH 18-APR-12
```

23 rows selected.

In the EMP\_ALL query above, EMPNO 7654 MARTIN has 2 instances of employment. The first instance was last modified/entered on April 18<sup>th</sup>, 1981 and deleted on May 14<sup>th</sup>, 1981 as captured by EMP ID 7. Later, MARTIN returned to the company, maintained the same EMPNO, but received a new instance of employment as captured by EMP ID 14. The STAT data shows that EMP ID is "ACT" or active, so MARTIN is still employed on this, the second instance of employment. In the example below, SMITH will be retired from the company by deleting the current employment instance from EMP\_ACT.

```
SQL>
SQL> execute util.set_usr('MILLER');

PL/SQL procedure successfully completed.
```

```
SQL>
SQL> -- SMITH retires today
SQL> delete from emp_act
2   where empno = 7369;
```

1 row deleted.

```
SQL>
SQL> select empno, ename, id eid, stat, dept_id did,
2          aud_beg_usr, aud_beg_dtm, aud_end_usr, aud_end_dtm
3   from emp_all order by empno, id;
```

EMPNO	ENAME	EID	STAT	DID	AUD_BEG_	AUD_BEG_D	AUD_END_	AUD_END_D
7301	ELLISON	1	HIST	1	DAVIS	30-OCT-80	THOMPSON	30-JUN-81
7344	DAVIS	2	HIST	1	SMITH	28-NOV-81	SMITH	10-DEC-81
7369	SMITH	3	HIST	2	SMITH	28-FEB-83	MILLER	18-APR-12
7499	ALLEN	4	ACT	3	THOMPSON	14-MAY-81		
7521	WARD	5	ACT	3	THOMPSON	14-MAY-81		
7566	JONES	6	ACT	2	SMITH	30-NOV-81		
7654	MARTIN	7	HIST	3	THOMPSON	18-APR-81	THOMPSON	14-MAY-81
7654	MARTIN	14	ACT	3	SMITH	26-SEP-81		
7698	BLAKE	8	ACT	3	SMITH	28-NOV-81		
7782	CLARK	9	ACT	1	SMITH	01-DEC-81		
7788	SCOTT	10	HIST	2	THOMPSON	10-JUN-81	JAMES	07-MAR-82
7788	SCOTT	20	ACT	4	SMITH	18-APR-12		
7839	KING	11	HIST	1	THOMPSON	14-JUN-81	SMITH	29-AUG-81
7839	KING	15	ACT	1	SMITH	15-NOV-81		
7840	LANE	12	HIST	1	THOMPSON	15-AUG-81	SMITH	28-NOV-81
7844	TURNER	13	ACT	3	SMITH	09-SEP-81		
7876	ADAMS	16	HIST	2	SMITH	24-NOV-81	JAMES	15-JUN-82
7876	ADAMS	21	ACT	2	SMITH	09-JAN-83		
7900	JAMES	17	ACT	4	MILLER	18-APR-12		
7902	FORD	18	ACT	2	SMITH	02-DEC-81		
7934	MILLER	19	ACT	1	JAMES	22-JAN-82		
8156	MCMURRY	23	ACT	4	SMITH	18-APR-12		
8157	WALKER	24	ACT	4	SMITH	18-APR-12		

23 rows selected.

```
SQL>
SQL> select empno, ename, id eid, dept_id did, aud_beg_usr, aud_beg_dtm
2   from emp_act where empno = 7369;
```

no rows selected

```
SQL>
SQL> rollback;
```

Rollback complete.

Notice that the STAT of SMITH (EMP ID 3) has changed from ACT to HIST. This shows that EMP ID 3 is no longer an active instance of employment (no longer in EMP\_ACT), which is confirmed by the last query. The EMP\_ALL view will display all instances.

## Exercise #6: Transportable ASOF Data

### Command Line:

N/A

*Exercise #6 does not modify the database. There is no exercise.*

Oracle introduced a mechanism to hold rollback entries for use by "flashback" queries to provide data as it was at some previous point in time. Since the source of this data is the rollback segments, transporting this data has limitations. DTGen provides a schema based approach flashback query. This schema based data is more easily transported to different databases and servers than rollback segment data. The loading of data for this demonstration is a transport of ASOF data to this schema. These exercises would have required rebuilding Oracle's rollback segment data. Additionally, the data in this exercise was not created perfectly, i.e. It was edited during the production process. It is impossible to edit any historical mistakes in the rollback segments.