Daylight Saving Time (DST) demystified

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Make IT 2022
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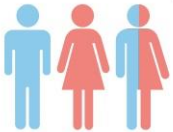
118 MILLION CHF
TURNOVER

300 SLA's
(SERVICE LEVEL AGREEMENTS)

4000
TRAINING PARTICIPANTS PER YEAR

800
CUSTOMERS



700
EMPLOYEES

5 MILLION CHF
BUDGET FOR SCIENCE AND DEVELOPMENT PER YEAR

EXPERIENCE FROM
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Agenda

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1. Fundamentals
2. Data Types
3. Upgrade
4. Pitfalls

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Fundamentals

Daylight Saving Time

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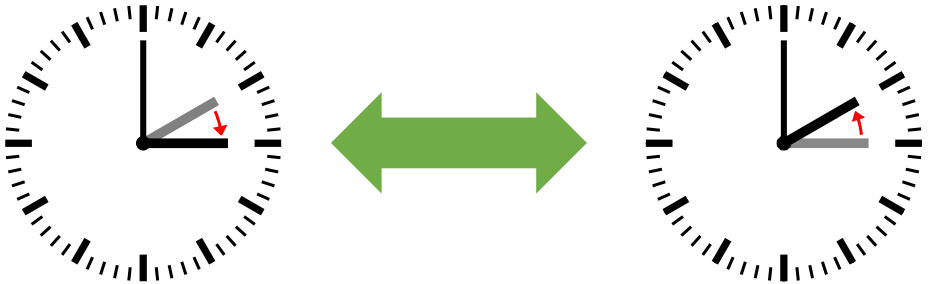
*„Daylight saving time (DST), also daylight savings time or daylight time (United States) and summer time (United Kingdom, European Union, and others), is the **practice of advancing clocks during summer months so that darkness falls later each day** according to the clock.“*



DST Begin **DST End**

Source: https://en.wikipedia.org/wiki/Daylight_saving_time

Time Zone Updates 1/2

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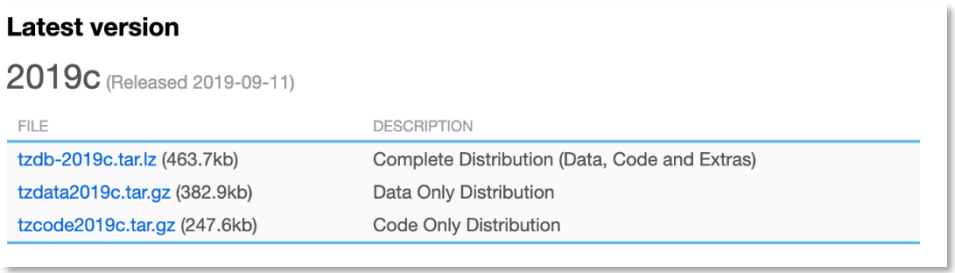
- Oracle monitors the commonly used IANA Time Zone (Olsen) Mailing List
  - See: http://www.iana.org/time-zones



Latest version

2019c (Released 2019-09-11)

FILE	DESCRIPTION
tzdb-2019c.tar.lz (463.7kb)	Complete Distribution (Data, Code and Extras)
tzdata2019c.tar.gz (382.9kb)	Data Only Distribution
tzcode2019c.tar.gz (247.6kb)	Code Only Distribution

- If a defined amount of non-historical changes exist, a DST patch is released
  - 15th June / 15th December include all changes until 15th May resp. 15. November
- Check My Oracle Support Note 412160.1 for new DST patches

There is no official source for DST updates.

Time Zone Updates 2/2

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- Example: Changes of the DSTv34 update (MOS Note 2602555.1)

Brazil no longer observes DST.
Palestine "springs forward" on 2019-03-30 instead of 2019-03-23.
Metlakatla "fell back" to rejoin Alaska Time on 2019-01-20 at 02:00.
São Tomé and Príncipe switches from +01 to +00 on 2019-01-01.
Qyzylorda, Kazakhstan moved from +06 to +05 on 2018-12-21.
New zone Asia/Qostanay because Qostanay, Kazakhstan didn't move.
Metlakatla, Alaska observes PST this winter only.

Fiji ends DST 2019-01-13
Morocco will continue to adjust clocks around Ramadan

Time Zone Files 1/2

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- The **definition of the time zones** are stored in a so called **Time Zone File**
  - Files are located at $ORACLE_HOME/oracore/zoneinfo

Filename	Description
timezlrg_<Version>.dat	Large time zone file containing all time zones in the database
timezone_<Version>.dat	Small time zone containing the most commonly used time zones

- Every Oracle Database release includes a **current and historical Time Zone Files**
- Historical Time Zone Files allow the upgrade of the Time Zone Version of an existing database to be postponed after the database upgrade itself

DST updates are always cumulative and include DST transition dates up to the year 2040.

Time Zone Files 2/2

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- Use **V$TIMEZONE_FILE** to get the currently used time zone version
  - If the database is in NOMOUNT or MOUNT state, the maximum available time zone version is returned

```
SQL> SELECT * FROM V$TIMEZONE_FILE;

FILENAME              VERSION    CON_ID
-------------------- ---------- ----------
timezlrg_32.dat               32          0
```

- Use DBMS_DST to get the maximum available Time Zone File version

```
SQL> SELECT DBMS_DST.GET_LATEST_TIMEZONE_VERSION FROM DUAL;

GET_LATEST_TIMEZONE_VERSION
---------------------------
                         32
```

Default Time Zones

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- Overview of the default time zones of the latest Oracle releases

Release	Time Zone Version	IANA Version
12c Release 1	18	tzdata2012c
12c Release 2	26	tzdata2016d
18c	31	tzdata2017c
19c	32	tzdata2018e

- Query DATABASE_PROPERTIES or CDB_PROPERTIES to get the current time zone

```
SQL> SELECT * FROM DATABASE_PROPERTIES WHERE property_name LIKE 'DST%';

PROPERTY_NAME                  PROPERTY_V DESCRIPTION
------------------------------ ---------- ----------------------------------------
DST_SECONDARY_TT_VERSION       0          Version of secondary timezone data file
DST_PRIMARY_TT_VERSION         32         Version of primary timezone data file
DST_UPGRADE_STATE              NONE       State of Day Light Saving Time Upgrade
```

Dump Time Zone

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- On Linux/Unix you can dump the OS time zone to get details about DST transitions

```
$> zdump -v Europe/Berlin | grep 2019

Europe/Berlin  Sun Mar 31 00:59:59 2019 UTC = Sun Mar 31 01:59:59 2019 CET isdst=0 gmtoff=3600
Europe/Berlin  Sun Mar 31 01:00:00 2019 UTC = Sun Mar 31 03:00:00 2019 CEST isdst=1 gmtoff=7200
Europe/Berlin  Sun Oct 27 00:59:59 2019 UTC = Sun Oct 27 02:59:59 2019 CEST isdst=1 gmtoff=7200
Europe/Berlin  Sun Oct 27 01:00:00 2019 UTC = Sun Oct 27 02:00:00 2019 CET isdst=0 gmtoff=3600
```

Time Zone Definition

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Offset

- Not affected by DST updates

```
SQL> ALTER SESSION SET TIME_ZONE = '+01:00';
```

Named Time Zone

- Recommended way to interact with time zones
- Check V$TIMEZONE_NAMES to get an overview of known time zones
  - Usage of "Macro-region/region" syntax is recommended, avoid abbreviations
- **Affected by DST updates**

```
SQL> ALTER SESSION SET TIME_ZONE = 'Europe/Berlin';
```

Database Time Zone 1/2

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- Only used to **normalize values** of TIMESTAMP WITH LOCAL TIME ZONE (TSLTZ) columns
- Does not have to match the time zone of the database server
- Can be defined during database creation
  - The default time zone is **derived from the OS time zone** (as offset)

```
SQL> CREATE DATABASE "TVDCDB1" ... SET TIME_ZONE = '+01:00';
```

- Can be changed afterwards using ALTER DATABASE command
  - Only possible if **no TSLTZ columns exist** in the database, otherwise ORA-30079
  - A **database restart** is required

```
SQL> ALTER DATABASE SET TIME_ZONE = '+00:00';
```

Should be set to an offset (e.g. 00:00) or to a named time zone without DST (e.g. UTC or GMT)

Database Time Zone 2/2

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- Different ways to get the database time zone

```
SQL> SELECT property_value FROM database_properties
      WHERE property_name = 'DBTIMEZONE';

PROPERTY_VALUE
----------------------------------------------------
+02:00

SQL> SELECT DBTIMEZONE FROM dual;

DBTIMEZONE
----------
+02:00
```

It is possible to have different time zones in a CDB and its PDBs – use CDB_PROPERTIES to get a complete overview.

Session Time Zone 1/2

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- Is set to the offset of the client OS time zone, e.g. Europe/Berlin → +01:00 or +02:00 (DST)
- Can be influenced by two environment parameters before a connection is established
  - **TZ:** Named time zones are converted to an offset, not available on Windows

```
$> export TZ='+02:00'
$> export TZ='Europe/Berlin'
```

  - **ORA_SDTZ:** Support for named time zones, available on all platforms

```
$> export ORA_SDTZ='OS_TZ'          # Use local OS timezone
$> export ORA_SDTZ='DB_TZ'          # Use database timezone
$> export ORA_SDTZ='+02:00'
$> export ORA_SDTZ='Europe/Berlin'
```

On Windows you can set ORA_SDTZ also in the registry, but don‘t use quotes.

Session Time Zone 2/2

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- After a connection is established, time zone can be changed using ALTER SESSION commands

```
SQL> ALTER SESSION SET TIME_ZONE = local;
SQL> ALTER SESSION SET TIME_ZONE = dbtimezone;
SQL> ALTER SESSION SET TIME_ZONE = '+02:00';
SQL> ALTER SESSION SET TIME_ZONE = 'Europe/Berlin';
```

- Get session time zone

```
SQL> SELECT SESSIONTIMEZONE FROM dual;

SESSIONTIMEZONE
------------------------------------------------
+01:00
```

Use a session time zone that fits to the environment of the client.

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Data Types

SYSDATE / SYSTIMESTAMP

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- Does not rely on the defined database time zone
- Instead the **time/time zone of the database server** itself is returned
  - For Listener connections, the settings of the database that were set, when the database was started, are used
  - For local connections, the current settings are considered
  - Internally OS commands GetTimeOfDay (Linux/Unix) and GetSystemTime (Windows) are used
- Usage of the database time zone can be forced by setting underscore parameter
  - Does not apply to SYSTIMESTAMP

```
SQL> ALTER SYSTEM SET "_sysdate_at_dbtimezone" = TRUE SCOPE = SPFILE;
```

Use CURRENT_TIMESTAMP to always get the time zone of the client.

TIMESTAMP WITH TIME ZONE (TSTZ)

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- Data type **depends on the time zone version**
  - Includes TIMEZONE_HOUR, TIMEZONE_MINUTE, TIMEZONE_REGION, TIMEZONE_ABBR
- Timestamps with time zone information are **converted to UTC** internally
  - **Transition rules** of the Time Zone File are applied
  - ID of the **original time zone is stored** in the column
- Timestamps which are affected by time zone changes have to be converted
  - Use utltz_* scripts to estimate the amount of data

```
SQL> @?/rdbms/admin/utltz_countstats.sql    -- Uses Optimizer statistics
SQL> @?/rdbms/admin/utltz_countstar.sql     -- Executes COUNT(*) queries
```

Run utltz_countstats.sql only, when Optimizer statistics are up-to-date.

TIMESTAMP WITH LOCAL TIME ZONE (TSLTZ)

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- Data type **depends on the session time zone**
- Will be converted from the session time zone to the database time zone during insert and vice-versa during retrieval
  - ID of the time zone is not stored
- DST updates have no direct influence on the data
  - But if the used time zone has changed, different values can be returned

The data dictionary does not use this data type.

Example 1/2

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- Usage of the different data types

```
SQL> CREATE TABLE t (
   text_col  VARCHAR2(50 CHAR),
   date_col  DATE,
   ts_col    TIMESTAMP,
   tstz_col  TIMESTAMP WITH TIME ZONE,
   tsltz_col TIMESTAMP WITH LOCAL TIME ZONE
);

SQL> ALTER SESSION SET TIME_ZONE = '+02:00';
SQL> INSERT INTO t VALUES(
        'with_offset', SYSDATE, SYSTIMESTAMP, SYSTIMESTAMP AT TIME ZONE '-05:00',
        CAST(SYSDATE AS TIMESTAMP WITH LOCAL TIME ZONE));

SQL> ALTER SESSION SET TIME_ZONE = 'Europe/Berlin';
SQL> INSERT INTO t VALUES(
        'with_named_tz', SYSDATE, SYSTIMESTAMP, SYSTIMESTAMP AT TIME ZONE 'America/New_York',
        CAST(SYSDATE AS TIMESTAMP WITH LOCAL TIME ZONE));
```

To get the offset of a named time zone use TZ_OFFSET function.

Example 2/2

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- Select data with different session time zones

```
SQL> ALTER SESSION SET TIME_ZONE = '+01:00';
SQL> SELECT * FROM t;

TEXT_COL        DATE_COL TS_COL                    TSTZ_COL                                    TSLTZ_COL
--------------- -------- ------------------------- ------------------------------------------- -------------------------
with_offset     17.11.19 17.11.19 20:46:25,474070  17.11.19 14:46:25,474070 -05:00             17.11.19 19:46:25,000000
with_named_tz   17.11.19 17.11.19 20:46:46,841567  17.11.19 14:46:46,841567 AMERICA/NEW_YORK   17.11.19 20:46:46,000000

SQL> ALTER SESSION SET TIME_ZONE = 'America/New_York';
SQL> SELECT * FROM t;

TEXT_COL        DATE_COL TS_COL                    TSTZ_COL                                    TSLTZ_COL
--------------- -------- ------------------------- ------------------------------------------- -------------------------
with_offset     17.11.19 17.11.19 20:46:25,474070  17.11.19 14:46:25,474070 -05:00             17.11.19 13:46:25,000000
with_named_tz   17.11.19 17.11.19 20:46:46,841567  17.11.19 14:46:46,841567 AMERICA/NEW_YORK   17.11.19 14:46:46,000000
```

Column Formatting

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- Different parameters can change the output format of date and timestamp columns
- **NLS_DATE_FORMAT:** Affects DATE columns

```
SQL> ALTER SESSION SET NLS_DATE_FORMAT = 'dd.mm.yyyy HH24:MI';
```

- **NLS_TIMESTAMP_FORMAT:** Affects TIMESTAMP and TSLTZ columns

```
SQL> ALTER SESSION SET NLS_TIMESTAMP_FORMAT = 'dd.mm.yyyy HH24:MI';
```

- **NLS_TIMESTAMP_TZ_FORMAT:** Affects TSTZ columns
  - Use **TZR** placeholder to display time zone
  - Use **TZH** and **TZM** placeholders to show always the offset (hour / minute)

```
SQL> ALTER SESSION SET NLS_TIMESTAMP_TZ_FORMAT = 'dd.mm.yyyy HH24:MI TZR';
SQL> ALTER SESSION SET NLS_TIMESTAMP_TZ_FORMAT = 'dd.mm.yyyy HH24:MI TZH:TZM';
```

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Upgrade

What Products should be updated?

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- **Oracle Database** and **Oracle Client** can use different time zone versions (11gR2 and higher)
  - Errors may be seen with this setup (e.g. ORA-01805)
  - Performance overhead
  - As recommendation, use the same time zone version
- **Oracle Grid Infrastructure** does not need to be updated
- **Enterprise Manager Agent** should be updated, when the underlying OS time zone changed
  - For known issues see MOS Note 2598380.1
- …

Install DST Patch 1/2

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- Download DST patch from My Oracle Support Portal for your target Oracle release
  - Use Note 406410.1 to identify patch number

Patch Name	Description	Release	Platform (Language)	Size	Updated
29997937	RDBMS - DSTV34 UPDATE - TZDATA2019B (Patch)	19.0.0.0.0	Linux x86-64 (American English)	391.3 KB	3+ months ago

- Unzip the patch

```
$> unzip p29997937_190000_Linux-x86-64.zip

...
  inflating: 29997937/files/oracore/zoneinfo/timezlrg_34.dat
  inflating: 29997937/files/oracore/zoneinfo/big/timezone_34.dat
  inflating: 29997937/files/oracore/zoneinfo/big/timezlrg_34.dat
  inflating: 29997937/files/oracore/zoneinfo/readme_34.txt
  inflating: 29997937/files/oracore/zoneinfo/timezone_34.dat
  inflating: 29997937/files/oracore/zoneinfo/little/timezlrg_34.dat
  inflating: 29997937/files/oracore/zoneinfo/little/timezone_34.dat
...
```

Check file <Patch ID>/files/oracore/zoneinfo/readme._xx.txt to see what has changed.

Install DST Patch 2/2

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- Install patch 2997937 (DST v34) using OPatch

```
$> cd 2997937
$> $ORACLE_HOME/OPatch/opatch apply

...

Verifying environment and performing prerequisite checks...
OPatch continues with these patches:   29997937

Do you want to proceed? [y|n]
y
User Responded with: Y
All checks passed.
Backing up files...
Applying interim patch '29997937' to OH '/u00/app/oracle/product/19'

Patching component oracle.oracore.rsf, 19.0.0.0.0...
Patch 29997937 successfully applied.
Log file location: /u00/app/oracle/product/19/cfgtoollogs/opatch/opatch2019-11-16_17-33-06PM_1.log

OPatch succeeded.
```

Use the latest version of Opatch – search for Patch ID 6880880 in My Oracle Support Portal.

Automatic DST Upgrade

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- Upgrade of the time zone version can be performed during the database upgrade
  - Despite the graphical way, DBUA supports a command line parameter

```
$> dbua -silent ... -upgradeTimezone true
```

- If you use dbupgrade utility (recommended), then you have to perform a time zone upgrade after the database upgrade manually
- AutoUpgrade support upgrade of the time zone version
  - Default value is yes

```
xxx.timezone_upg=yes
```

Manual DST Upgrade Scripts

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- Starting with 18c Oracle provides easy-to-use scripts to upgrade the time zone version
  - Located in the $ORACLE_HOME/rdbms/admin directory

```
$> ls -l $ORACLE_HOME/rdbms/admin/utltz_upg*
-rw-r--r-- 1 oracle oinstall 21526 Sep  9  2017 utltz_upg_apply.sql
-rw-r--r-- 1 oracle oinstall 16974 Jul 14 11:54 utltz_upg_apply_sys.sql
-rw-r--r-- 1 oracle oinstall  9531 Jul 14 11:54 utltz_upg_apply_user.sql
-rw-r--r-- 1 oracle oinstall 33684 Sep  9  2017 utltz_upg_check.sql
```

Script	Description
utltz_upg_check.sql	Check prerequisites and prepares the database for the time zone upgrade
utltz_upg_apply.sql	Upgrades the time zone version to highest version, identified by utltz_upg_check.sql
utltz_upg_apply_sql.sql	Performs changes to the data dictionary and upgrades system tables with TSTZ columns
utltz_upg_apply_user.sql	Upgrades non-SYS TSTZ data

Internally DBMS_DST package is used to upgrade the time zone version.

Manual DST Upgrade – non-CDB

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- Check affected tables

```
SQL> @?/rdbms/admin/utltz_countstar.sql
SQL> @?/rdbms/admin/utltz_countstats.sql  -- Usage of Optimizer statistics
```

- Check prerequisites and prepare database for upgrade

```
SQL> @?/rdbms/admin/utltz_upg_check.sql
```

- Start of the time zone upgrade

```
SQL> @?/rdbms/admin/utltz_upg_apply.sql
```

Check MOS Note 1509653.1 for manual upgrades using DBMS_DST directly.

Manual DST Upgrade – CDB

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- In a CDB environment use catcon.pl to perform against the CDB and every PDB
- Check affected tables

```
$> export PATH=$ORACLE_HOME/perl/bin:$PATH
$> cd $ORACLE_HOME/rdbms/admin
$> perl catcon.pl -l /tmp -b utltz_count -d $PWD utltz_countstar.sql
```

- Check prerequisites and prepare database for upgrade

```
$> perl catcon.pl -l /tmp -b utltz_check -d $PWD -c 'CDB$ROOT' utltz_upg_check.sql
$> perl catcon.pl -l /tmp -b utltz_check -d $PWD utltz_upg_check.sql
```

- Start of the time zone upgrade

```
$> perl catcon.pl -l /tmp -b utltz_apply -d $PWD -c 'CDB$ROOT' utltz_upg_apply.sql
$> perl catcon.pl -l /tmp -b utltz_apply -d $PWD -c 'PDB$SEED' utltz_upg_apply.sql
$> perl catcon.pl -l /tmp -b utltz_apply -d $PWD -C 'CDB$ROOT' utltz_upg_apply.sql
```

It is not necessary to upgrade all PDBs to the same time zone version.

OJVM DST Upgrade

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- OJVM and RDBMS DST upgrades are not depending on each other
- See **MOS Note 416860.1** on how to get the current OJVM DST version
- OJVM DST upgrades are not included in the RDBMS DST patch

```
$> cd 29997959
$> $ORACLE_HOME/OPatch/opatch apply
```

- After installation of the patch, **run post SQL scripts**

```
SQL> @?/javavm/admin/fixTZa.sql
SQL> @?/javavm/admin/fixTZb.sql
```

- It is also possible to **upgrade** the time zone version of the **Oracle Home JDK using TZUpdater**
  - Only necessary, if 3rd party applications are using this JDK

In a CDB environment run above fixup scripts in the CDB and all PDBs, where the OJVM component is installed.

DST Downgrade

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- Downgrade of the database time zone version is not possible
- DST Patch can be roll backed using OPatch, but it has influence on the DST capabilities

```
$> opatch rollback –id 2997937
```

- **DST feature will be disabled**, if the Time Zone Version is not found
  - Query against V$TIMEZONE_FILE returns no rows

```
2019-11-17T22:07:13.994758+01:00
TVDCDB2_TVDPDB1(3):Failed to find timezone data file. qesdpiStartup(DST_0
2019-11-17T22:07:13.994842+01:00
TVDCDB2_TVDPDB1(3):Daylight Saving Time feature is disabled
```

- Execution of DBMS_DST leads to an ORA-56921: invalid time zone version error

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Pitfalls

PDB Creation / Cloning

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- When you create a new local PDB, the **time zone version of PDB$SEED will be used**
- If the time zone version of the source PDB is not available during remote cloning, DST feature will be disabled

```
2019-11-17T22:07:13.994842+01:00
TVDCDB2_TVDPDB1(3):Daylight Saving Time feature is disabled
```

- Officially upgrade of the PDB$SEED is not supported, but possible
  - Excerpt from the Oracle Database Globalization Support Guide 19c

> PDB$SEED is always assigned the time zone version at the time of CDB creation. The time zone version of PDB$SEED cannot be changed.

Data Pump

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- Time Zone version is **recorded in the dumpfile**
- If the target Time Zone version is higher, then the **data will be converted during the import**
- **ORA-39405** is raised, when the target Time Zone version is lower

```
ORA-39405: Oracle Data Pump does not support importing from a source
database with TSTZ version 34 into a target database with TSTZ version 32.
```

  - Even when no TSTZ columns are part of the import
  - Data Pump does not scan the whole dumpfile to check the existence of TSTZ columns

Transportable Tablespaces

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- If time zone version is different, then TSTZ are not created
  - A warning is displayed during metadata import
- If the database time zone is different, then TSLTZ tables are not transported
  - Set, if possible the database time zone to the source time zone
- Affected tables have to be transported the conventional way using Data Pump Export/Import

Further Information

Oracle Globalization Support Guide
https://docs.oracle.com/en/database/oracle/oracle-database/19/nlspg/datetime-data-types-and-time-zone-support.html#GUID-7A1BA319-767A-43CC-A579-4DAC7063B243

Timezone Data Versions in the JRE Software
https://www.oracle.com/technetwork/java/javase/tzdata-versions-138805.html

My Oracle Support Notes

- Updated DST Transitions and New Time Zones in Oracle RDBMS and OJVM Time Zone File Patches (Doc ID 412160.1)
- How to Determine Whether Time Zone Changes Will Affect Your Database (Doc ID 406410.1)
- Timestamps & time zones - Frequently Asked Questions (Doc ID 340512.1)
- How to test daylight savings time (DST) (Doc ID 1007266.1)

Questions and answers..

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