Delphix

Stop editing code in Production database - a journey from 90's to CI/CD

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OakTable

SYMPOSIUM 42

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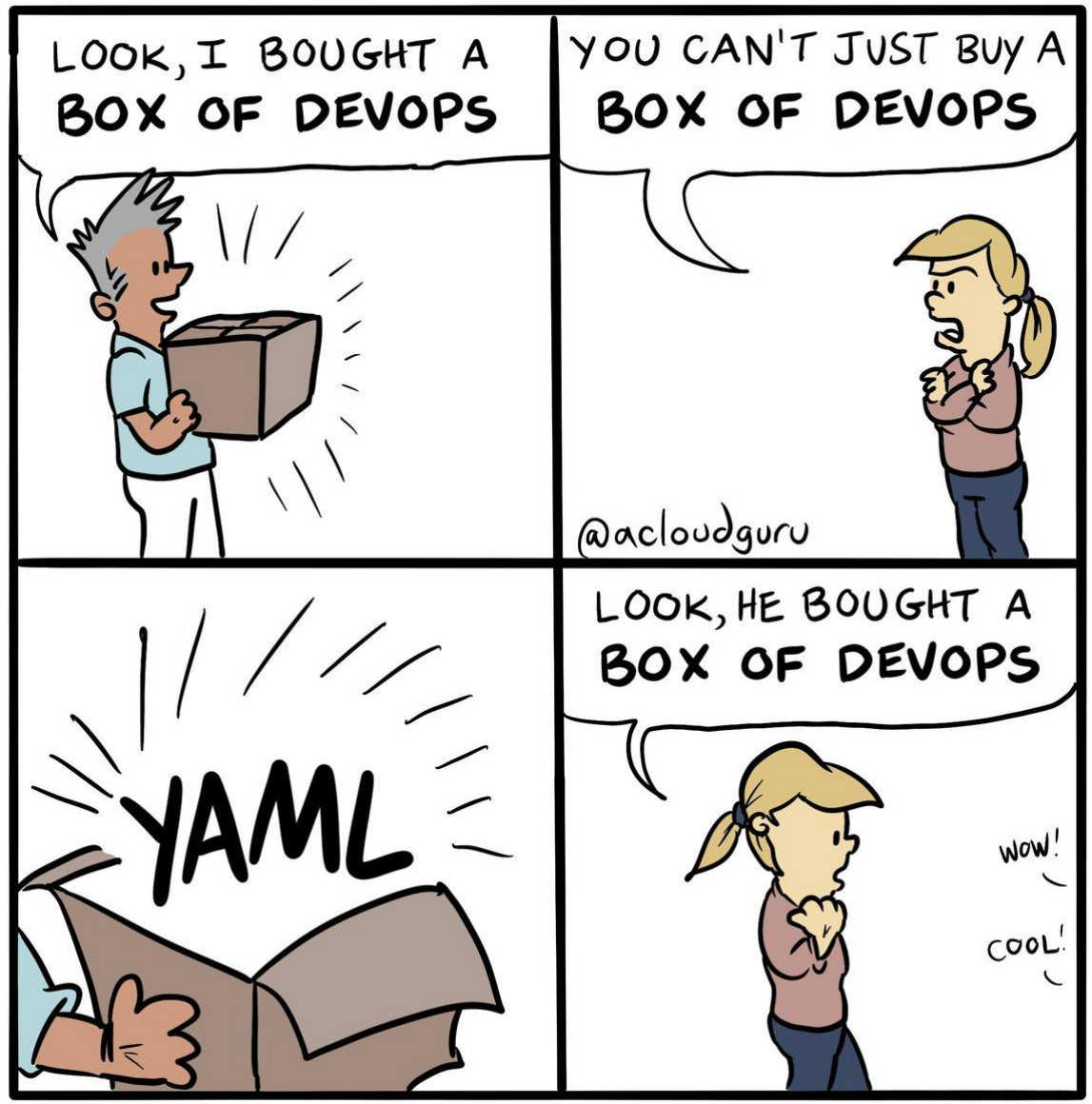
Why this talk ?

A few years of observation how organizations are deploying pipelines / automation with databases

- Characteristic 1
  - The small / midsize group of very mature developers using Oracle since version 8.0 with a lot of PL/SQL and fixing code in production
  - Goal: Growth and have a control and easy to work environment
- Characteristic 2
  - Many different development group using many Oracle database for different applications and having one central “release management” team to process all changes and deploy to production
  - Goal: Going to DevOps model and increasing number of releases


LOOK, I BOUGHT A BOX OF DEVOPS
YOU CAN'T JUST BUY A BOX OF DEVOPS
@acloudguru
YAML
LOOK, HE BOUGHT A BOX OF DEVOPS
WOW!
COOL!

What is important – DBA view

- All problems are cause by …..

CHANGE

- What has been change
- When the change happened
- What to do to fix – best without special tools

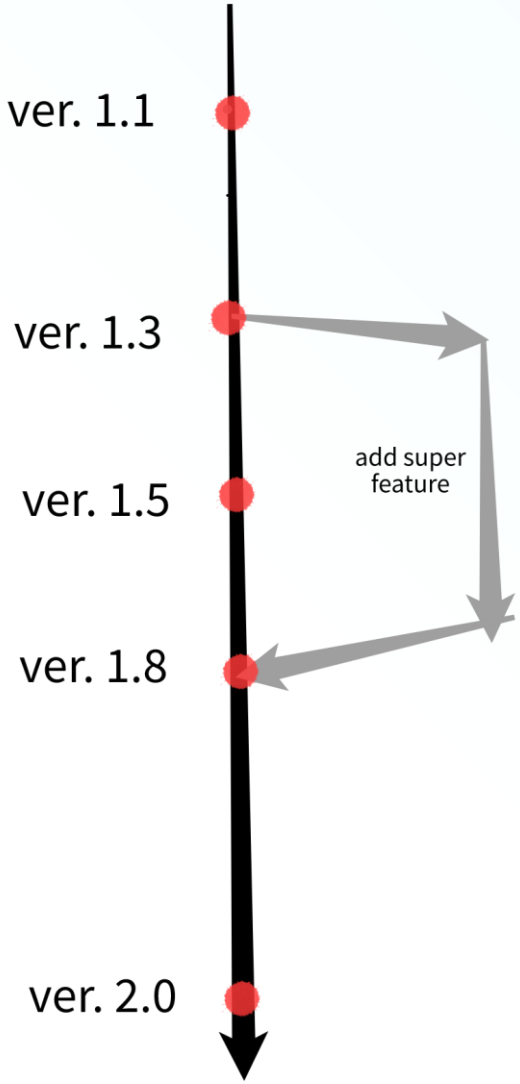
What is important – developer view

- Easy to use
- Works with different tools – even if people will keep working directly with development database(s)
- No adding to much overhead to normal development work

Challenges

- Database has a state – new deployment can’t just replace a database - it has to transform database from current state to a new one
- Replacing code looks easier – although replacing a whole code it’s complicated so it will be rather an incremental approach
- Data are kept in “static” objects – tables – table definition change is possible, but it should guarantee no data loss
- Size of database matter – data transformation to a new schema or even index definition change looks straight forward but execution time depend on data size
- Online vs offline changes
- Different states of databases in different environments

Challenges



DEV
V ??????

INT
v.2.0

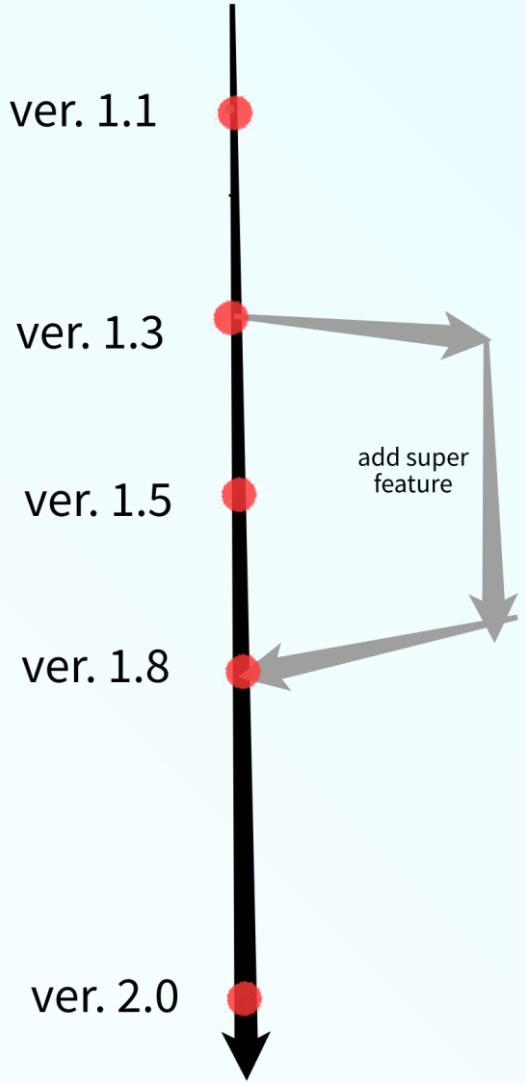
UAT
v.1.8

PREPROD
v.1.5

PRODUCTION
v.1.3

Challenges

- Each object can have a different version – not all changes are redeployed
- Tables doesn’t have a version – maybe in comment ????
- The external tracking of deployed changes and connecting it to source control timeline is mandatory



Tools

- Investigation started with 2 tools:
  - Liquibase
  - Sqlcl (leveraging Liquibase and DBMS_METADATA and DBMS_METADATA_DIFF)

- Result: ”custom” scripts with git and Liquibase

Liquibase

- Changelog

  Liquibase uses a changelog to explicitly list database changes in order. The changelog acts as a ledger of changes and contains a list of changesets (units of change) that Liquibase can execute on a database.

- Change set concept

  Liquibase uses changesets to represent a single change to your database.

Liquibase

- Directory structure
  - One or many repos
  - Owner or owner and type ?

- One or many changes logs
  - One main
  - One object type

- How to manage PL/SQL code

Liquibase

”Static objects”

```
<changeSet author="marcinp" id="create-demotable">
   <createTable tableName="demotable">
      <column name="columnName1" type=”VARCHAR2(355)">
      </column>
   </createTable>
</changeSet>
```

```
--liquibase formatted sql
--changeset marcinp:create-demotable
CREATE TABLE demotable(
  columnName1 VARCHAR (355)
);
--rollback DROP TABLE
--rollback demotable
```

```
<databaseChangeLog … >
<changeSet author="marcin" id=“test_ver" failOnError="true”>
      <sqlFile dbms="oracle” endDelimiter="/"
               path=”TEST_1008_1.sql"
               relativeToChangelogFile="true"
               splitStatements="false"
               stripComments="false"/>
</changeSet>
```

```
cat SCOTT/TABLE/TEST_1008_1.sql
CREATE TABLE "SCOTT"."TEST_1008_1"
   (     "ID" NUMBER(10,0) NOT NULL ENABLE,
         "NEWCOL" VARCHAR2(20)
   ) PCTFREE 10 PCTUSED 40 NOCOMPRESS LOGGING
  TABLESPACE "USERS" ;
```

Liquibase

”Dynamic objects”

proc.xml

```
<databaseChangeLog … >
<changeSet author="marcin" id=“test_ver" failOnError="true">
      <sqlFile dbms="oracle” endDelimiter="/"
               path="PROCEDURE_FOOPROC.sql"
               relativeToChangelogFile="true"
               splitStatements="false"
               stripComments="false"/>
</changeSet>
```

PROCEDURE_FOOPROC.sql

```
CREATE OR REPLACE PROCEDURE
"SCOTT"."FOOPROC"
as begin
         dbms_output.put_line('dev2’);
end;
/
```

```
SQL> select * from DATABASECHANGELOG where filename like 'proc%' order by ORDEREXECUTED;

         ID  AUTHOR      FILENAME                       DATEEXECUTED     EXECTYPE
___________ _______  ____________  _____________________________________  ___________
test_ver     marcin  proc.xml      04-AUG-22 08:13:10.445794000     EXECUTED
```

Liquibase

”Dynamic objects”

proc.xml

```
<databaseChangeLog … >
<changeSet author="marcin" id=“test_ver" failOnError="true">
      <sqlFile dbms="oracle” endDelimiter="/"
               path="PROCEDURE_FOOPROC.sql"
               relativeToChangelogFile="true"
               splitStatements="false"
               stripComments="false"/>
</changeSet>
```

PROCEDURE_FOOPROC.sql

```
CREATE OR REPLACE PROCEDURE
"SCOTT"."FOOPROC"
as begin
         -- lets change a code a bit
        dbms_output.put_line('dev2’);
end;
/
```

```
Unexpected error running Liquibase: Validation Failed:
     1 change sets check sum
          proc1.xml::3e391ce59cbd4491387964970313 9346d0975cbc::marcin@delphix.com was:
8:f0263aa8cb96d8df4168a545e71f2c17 but is now: 8:34e937a19376c6a7d27074744453e251
```

Liquibase

”Dynamic objects”

proc.xml

```
<databaseChangeLog … >
<changeSet author="marcin" id=“test_ver" failOnError="true”
      runOnChange="true">
      <sqlFile dbms="oracle” endDelimiter="/"
               path="PROCEDURE_FOOPROC.sql"
               relativeToChangelogFile="true"
               splitStatements="false"
               stripComments="false"/>
</changeSet>
```

PROCEDURE_FOOPROC.sql

```
CREATE OR REPLACE PROCEDURE
"SCOTT"."FOOPROC"
as begin
         -- lets change a code a bit
         dbms_output.put_line('dev2’);
end;
/
```

```
SQL> select * from DATABASECHANGELOG where filename like 'proc%' order by ORDEREXECUTED;

         ID  AUTHOR     FILENAME                      DATEEXECUTED     EXECTYPE
___________ _______ _____________  ___________________________________  __________
test_ver    marcin  proc.xml      04-AUG-22 08:15:10.445794000     RERAN
```

Sqlcl Liquibase extension

- Directory structure
  - Oracle example is a one directory per schema
  - With v1/v2 subdir but this can be replaced with git
- One or many changes logs
- Oracle example - One main per schema

SQL Developer Command Line

Sqlcl Liquibase extension

```
SQL> lb genschema
lb genschema
[Type - TYPE_SPEC]:                          153 ms
[Type - TYPE_BODY]:                          29 ms
[Type - SEQUENCE]:                           48 ms
[Type - CLUSTER]:                            27 ms
[Type - TABLE]:                              36 ms
[Type - MATERIALIZED_VIEW_LOG]:              19 ms
[Type - MATERIALIZED_VIEW]:                  6 ms
[Type - VIEW]:                               148 ms
[Type - REF_CONSTRAINT]:                     272 ms
[Type - DIMENSION]:                          23 ms
[Type - FUNCTION]:                           27 ms
[Type - PROCEDURE]:                          64 ms
[Type - PACKAGE_SPEC]:                       171 ms
[Type - DB_LINK]:                            14 ms
[Type - SYNONYM]:                            22 ms
[Type - INDEX]:                              202 ms
[Type - TRIGGER]:                            51 ms
[Type - PACKAGE_BODY]:                       252 ms
[Method loadCaptureTable]:                   1864 ms
[Method parseCaptureTableRecords]:           7342 ms
[Method sortCaptureTable]:                   30 ms
[Method createExportChangeLogs]:             3 ms

Export Flags Used:
Export Grants               false
Export Synonyms             false
```

SQL Developer Command Line

Be warned – it may be VERY slow if you have many objects

Sqlcl Liquibase extension

```
SQL> select owner, object_type, count(*) from dba_objects where object_type in (…) and owner in
('UTILITIES','XXXXDATA') group by owner, object_type;

       OWNER     OBJECT_TYPE    COUNT(*)
_____________ _________________ _______
XXXXDATA      INDEX                1033
XXXXDATA      PACKAGE                 1
XXXXDATA      TABLE                1772
XXXXDATA      PROCEDURE               5
UTILITIES     INDEX                1060
UTILITIES     TABLE                2686
UTILITIES     FUNCTION               81
UTILITIES     PROCEDURE             417
UTILITIES     PACKAGE               513
UTILITIES     PACKAGE BODY          513
UTILITIES     VIEW                   66

SQL> select count(*) from dba_constraints where owner in ('UTILITIES','XXXXDATA');
   COUNT(*)
  __________
       7352
```

Liquibase generated by SQLcl

```
SQL> lb genobject -type PROCEDURE -name FOOPROC
Action successfully completed please review created file FOOPROC_procedure.xml

<?xml version="1.0" encoding="UTF-8"?>
<databaseChangeLog
      …
   xsi:schemaLocation="http://www.liquibase.org/xml/ns/dbchangelog
   http://www.liquibase.org/xml/ns/dbchangelog/dbchangelog-3.9.xsd">
   <changeSet id="859147a9947e66e53f87bed03dfefa69db1cb4fe" author="(HR2)-Generated"
   failOnError="false"    >
    <n0:createOracleProcedure objectName="FOOPROC" objectType="PROCEDURE" ownerName="HR2"   >
      <n0:source><![CDATA[CREATE OR REPLACE EDITIONABLE PROCEDURE "HR2"."FOOPROC" as begin null; end;
    ]]></n0:source>
    </n0:createOracleProcedure>
  </changeSet>
</databaseChangeLog>

echo  "CREATE OR REPLACE EDITIONABLE PROCEDURE \"HR2\".\"FOOPROC\" as begin null; end;" | sha1sum
859147a9947e66e53f87bed03dfefa69db1cb4fe  -
```

Liquibase generated by SQLcl

DDL for table – column rename

```
SQL> desc emp
        Name        Null?             Type
_____________ ____________ _________________
EMPNO         NOT NULL     NUMBER(4)
ENAME.                     VARCHAR2(10)
JOB                        VARCHAR2(9)
…

SQL> alter table emp rename column ename to ename_new;

SQL> desc emp
        Name        Null?             Type
_____________ ____________ _________________
EMPNO         NOT NULL     NUMBER(4)
ENAME_NEW                  VARCHAR2(10)
JOB                        VARCHAR2(9)
…
SQL> lb genobject -type TABLE -name EMP

Action successfully completed please review created file emp_table.xml
```

Liquibase generated by SQLcl

DDL for table – column rename - deployment

```
SQL> select * from emp;

   EMPNO      ENAME     JOB     MGR     HIREDATE     SAL     COMM     DEPTNO
________ _________ ______ ______ ___________ ______ _______ _________
      10 marcin


SQL> lb update -changelog emp_table1.xmlScriptRunner Executing:
emp_table1.xml::980a4756ff1533f18092619bdb5f3d8a7dada301::(SCOTT)-Generated -- DONE

######## ERROR SUMMARY ##################
Errors encountered:0

SQL>

SQL> select * from emp;

   EMPNO     JOB     MGR     HIREDATE     SAL     COMM     DEPTNO     ENAME_NEW
________ ______ ______ ___________ ______ _______ _________ ____________
      10
```

Liquibase generated by SQLcl

DDL for table – column rename - deployment

```
SQL> lb rollback -changelog emp_table1.xml -count 1Rolling Back
Changeset:emp_table1.xml::980a4756ff1533f18092619bdb5f3d8a7dada301::(SCOTT)-Generated
ScriptRunner Executing: emp_table1.xml::980a4756ff1533f18092619bdb5f3d8a7dada301::(SCOTT)-Generated -
- DONE

######## ERROR SUMMARY ##################
Errors encountered:0

SQL>

SQL> select * from emp;

   EMPNO     JOB     MGR     HIREDATE     SAL     COMM     DEPTNO     ENAME
________ ______ ______ ___________ ______ _______ _________ ________
      10
```

Liquibase generated by SQLcl

DDL for table – column rename - deployment

```
SQL> lb updatesql -changelog emp_table1.xml
ScriptRunner Logging: emp_table1.xml::980a4756ff1533f18092619bdb5f3d8a7dada301::(SCOTT)-Generated --
DONE

-- ******************************************************************
-- Update Database Script
-- ******************************************************************
-- Change Log: emp_table1.xml
-- Ran at: 16/08/22 08:18
-- Against: HR2@jdbc:oracle:thin:@source:1521/pdbdev
-- Liquibase version: 4.1.1
-- ******************************************************************

-- Changeset emp_table1.xml::980a4756ff1533f18092619bdb5f3d8a7dada301::(SCOTT)-Generated
ALTER TABLE "EMP" ADD ("ENAME_NEW" VARCHAR2(10))
/
  ALTER TABLE "EMP" DROP ("ENAME")
/
```

Solution

- Keep all database objects in source code repository in clear form
- All commits should have a list of objects you want to deploy to the database – to create an artefact
- Use pipeline to:
  - Generate a Liquibase change sets automatically from source code – use commit SHA as ID column
  - Use Liquibase to manage an object state in database
  - Add additional checks, like object dependency, compilation, etc

How to find objects to deploy

- Git can show files changes from last commit
- It’s not enough if some files was not change but it’s still not exist in target system.
  - Deployment into integration fails with rollback
  - New version of body developed, package code is same (it should be always delivered together)
  - New commit has on new version of file, but more files are needed for deployment
  - Object deletion
- Each commit should have a list of files to deploy – developer has a full control what objects will be deployed

How to find objects to deploy

```
cat 5efe7694-d5e2-11ec-b0bb-acde48001122
A,SCOTT/TABLE/TEST_1705_2.sql
A,SCOTT/PRIMARY_KEY/TEST_1705_2_PK.sql
D,SCOTT/INDEX/TEST_1705_2_IND.sql
```

```
cat 385ffe80-d5e8-11ec-9e14-acde48001122
A,SCOTT/VIEW/EMP_VIEW_DEPT.sql
M,SCOTT/PACKAGE_BODY/NEWPACK.sql
```

GIT repository with all code

```
pioro dbcode [main !?]$ ls -l SCOTT/
total 0
drwx------   4 pioro  staff  128 17 May 14:59 FOREIGN_KEY
drwx------   4 pioro  staff  128 17 May 14:59 FUNCTION
drwx------   7 pioro  staff  224 17 May 15:07 INDEX
drwx------   5 pioro  staff  160 17 May 14:59 PACKAGE
drwx------   5 pioro  staff  160 17 May 14:59 PACKAGE_BODY
drwx------  13 pioro  staff  416 17 May 18:17 PRIMARY_KEY
drwx------   4 pioro  staff  128 17 May 14:59 PROCEDURE
drwx------  24 pioro  staff  768 10 Aug 15:05 TABLE
drwx------   6 pioro  staff  192 17 May 15:49 VIEW
```

Solution

Static objects

- Ex. tables
  - Keep a latest definition as CREATE
  - Needs DELTA files with changes

Static objects

```
git checkout 5c41704dac0cdfbb8d949f2d881527167d983724
cat SCOTT/TABLE/TEST_1705_2.sql
CREATE TABLE "SCOTT"."TEST_1705_2"
   (     "ID" NUMBER(10,0) NOT NULL ENABLE,
         "NEWCOL" VARCHAR2(20),
         "COL2" VARCHAR2(20)
   )

git checkout main
cat SCOTT/TABLE/TEST_1705_2.sql
CREATE TABLE "SCOTT"."TEST_1705_2"
   (     "ID" NUMBER(10,0) NOT NULL ENABLE,
         "NEWCOL" VARCHAR2(20),
         "COL2" VARCHAR2(20),
         "COL3" VARCHAR2(100)
   )

cat SCOTT/TABLE/DELTA/TEST_1705_2.sql
alter table TEST_1705_2 add col3 varchar2(100);
```

Solution

“Dynamic” objects

- PL/SQL, views, constraints, indexes
  - Keep a latest definition as CREATE

Dynamic objects

```
git checkout f5a416e6e719f59307765b48e4dba563133d87dc
cat SCOTT/PACKAGE_BODY/NEWPACK.sql

CREATE OR REPLACE EDITIONABLE PACKAGE BODY "SCOTT"."NEWPACK" AS

  procedure newpack_add AS
  BEGIN
    -- TODO: Implementation required for procedure NEWPACK.newpack_add
    NULL;
  END newpack_add;
END NEWPACK;
/
```

Dynamic objects

```
git checkout main
cat SCOTT/PACKAGE_BODY/NEWPACK.sql

CREATE OR REPLACE EDITIONABLE PACKAGE BODY "SCOTT"."NEWPACK" AS

  procedure newpack_add AS
  a varchar2(200);
  BEGIN
    -- TODO: Implementation required for procedure NEWPACK.newpack_add
    -- v3
    select empno into a from EMP_VIEW_DEPT;
  END newpack_add;

END NEWPACK;
/
```

PL/SQL status check with deployment

Compile

Objects are just deployed – Liquibase doesn't know if create package fails

```
  <changeSet author="marcin@delphix.com" id="419335b4bfde476c8c6d855287b248e47f76bdfd"
failOnError="true" runAlways="false" >
      <sqlFile dbms="oracle"
               endDelimiter="/"
               path="PACKAGE_BODY_NEWPACK.sql"
               relativeToChangelogFile="true"
               splitStatements="false"
               stripComments="false"/>
   </changeSet>

   <changeSet author="marcin@delphix.com" id="Validation" runAlways="true" runOnChange="true">
    <preConditions onFail="HALT" onFailMessage="Found invalid object">
      <sqlCheck expectedResult="0"><![CDATA[
        SELECT COUNT(1) FROM user_objects
        WHERE status <> 'VALID' AND object_type = 'PACKAGE BODY' and object_name = 'NEWPACK';
      ]]></sqlCheck>
    </preConditions>
  </changeSet>
```

Compile dependencies

- Compile package / package body
- Your deployed packages can be OK but what about other existing PL/SQL objects depending on deployed code
- Status needs to be checked and some objects needs to be recompiled
- In case of error – a deployment should be rollback

Restricted objects

- Sometimes PL/SQL objects are used by all other objects, for example logging functionality is used by all other objects
- Changing logging may need to stop all online sessions to replace PL/SQL without locking
- Or using Edition-Based Redefinition

- Such objects should be only deployed with extra approval as without EBR it may requires an application downtime

Rollback

- Static objects
  - no rollback – data are king
  - Always move forward
- Dynamic rollback
  - As targets may be on different patch level – rollback scripts needs to be generated per deployment

How to mark release

- Liquibase tag is used to mark a commit scope for Liquibase
- Tag is equal to commit SHA
- Liquibase rollback can use tag
- Release should be defined in git using git tags

Different patch levels or empty database

- Compare database logs with all source control
- Replay missing commits from git
- Risk(s):
  - Depend on source control model there could be wrong commits which never pass tests

- Other approach – take all files from deploy and generate one deployment
- Risk(s):
  - Not all commits are deployed one by one – final stage may require summary of delta changes for static objects

Syncer

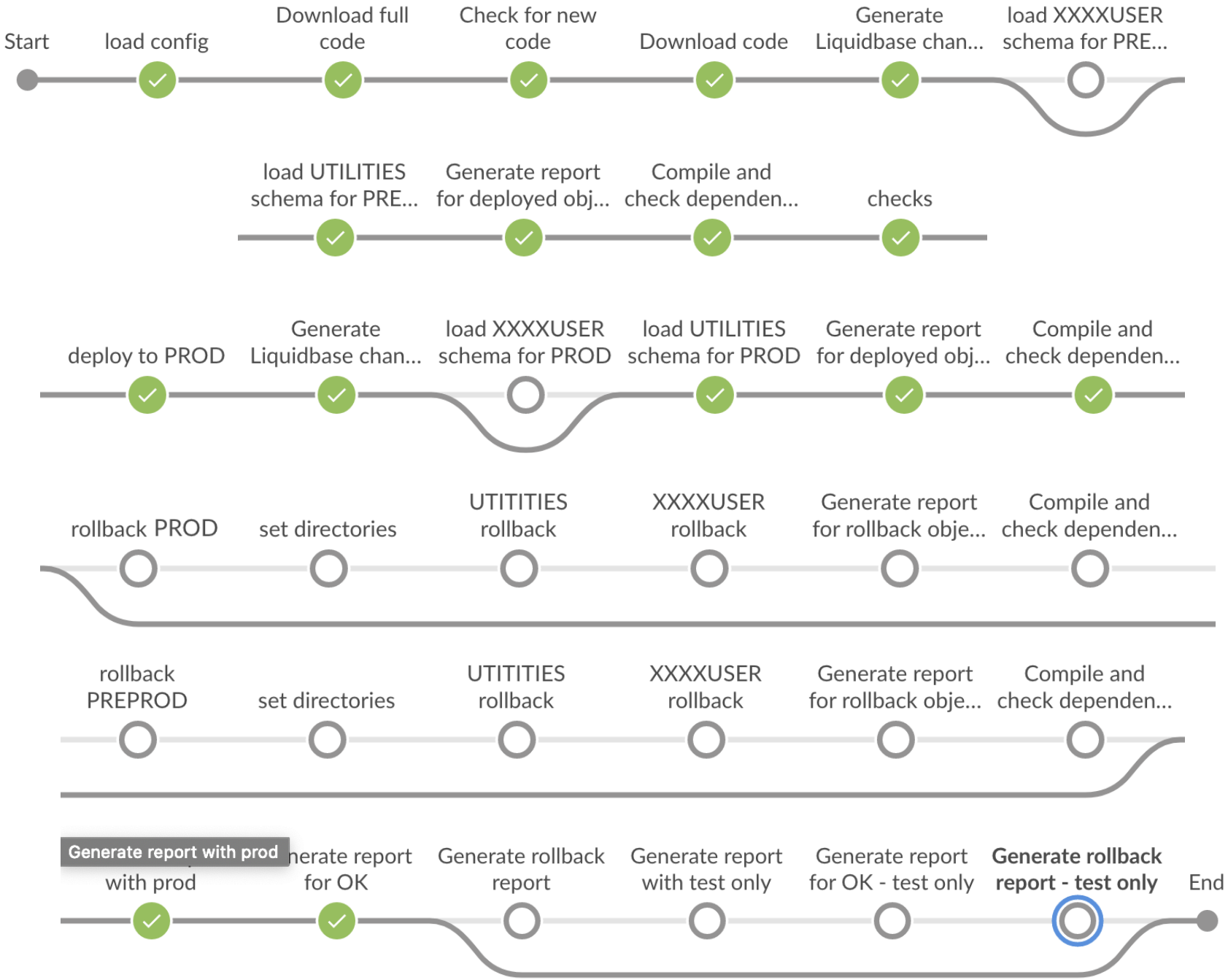
- Help developers to extract source code from database
- Support git operations like commit, push and pull
- Generate a deploy file with list of files to include in deployment
- Potentially add a formatting but this git hooks can be leverage as well

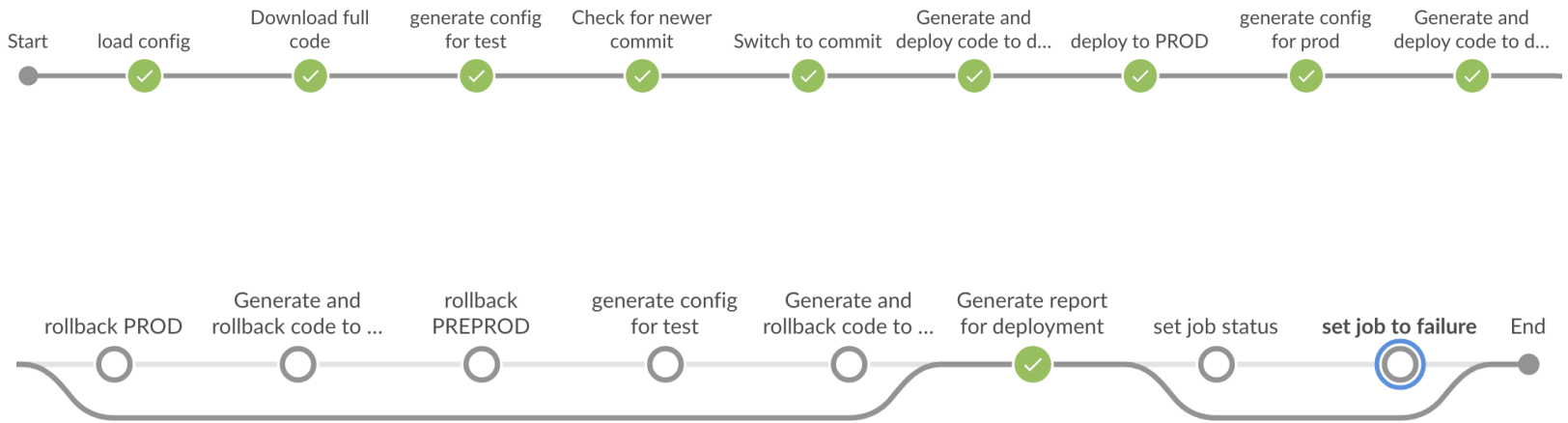
```
python syncer.py extract \
/Users/pioro/mystuff/dbcode/SCOTT/PACKAGE/DEMO_BILL.sql \
/Users/pioro/mystuff/dbcode/SCOTT/PACKAGE/DEPENDON.sql \
/Users/pioro/mystuff/dbcode/SCOTT/PACKAGE_BODY/DEMO_BILL.sql\
/Users/pioro/mystuff/dbcode/SCOTT/PACKAGE_BODY/DEPENDON.sql

python syncer.py commit --message "2 packages"
```

Generator

- Help developers to create a valid LB change logs easily from git repository
- Handle order of deployment
- Handle restrictions
- Handle LB deployments and additional checks
- Generate a report


Start
load config
Download full code
Check for new code
Download code
Generate Liquidbase chan...
load XXXXUSER schema for PRE...
load UTILITIES schema for PRE...
Generate report for deployed obj...
Compile and check dependen...
checks
deploy to PROD
Generate Liquidbase chan...
load XXXXUSER schema for PROD
load UTILITIES schema for PROD
Generate report for deployed obj...
Compile and check dependen...
rollback PROD
set directories
UTITITIES rollback
XXXXUSER rollback
Generate report for rollback obje...
Compile and check dependen...
rollback PREPROD
set directories
UTITITIES rollback
XXXXUSER rollback
Generate report for rollback obje...
Compile and check dependen...
Generate report with prod
with prod
for OK
Generate rollback report
Generate report with test only
Generate report for OK - test only
Generate rollback report - test only
End


Start
load config
Download full code
generate config for test
Check for newer commit
Switch to commit
Generate and deploy code to d...
deploy to PROD
generate config for prod
Generate and deploy code to d...
rollback PROD
Generate and rollback code to ...
rollback PREPROD
generate config for test
Generate and rollback code to ...
Generate report for deployment
set job status
set job to failure
End

Q & A