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STUMBLING STONES WHEN MIGRATING FROM ORACLE

BY LAURENZ ALBE

ABOUT ME AND MY COMPANY

- Who is Laurenz Albe?
- Who is CYBERTEC?

LAURENZ ALBE

SENIOR DATABASE CONSULTANT

- contributions to PostgreSQL and related projects since 2006
- maintainer of the Oracle Foreign Data Wrapper
- PostgreSQL support, training, consulting and development
- working for CYBERTEC since 2017

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About CYBERTEC

- Inhouse development
- International team of developers
- Specialized in data services
- Owner-managed since 2000

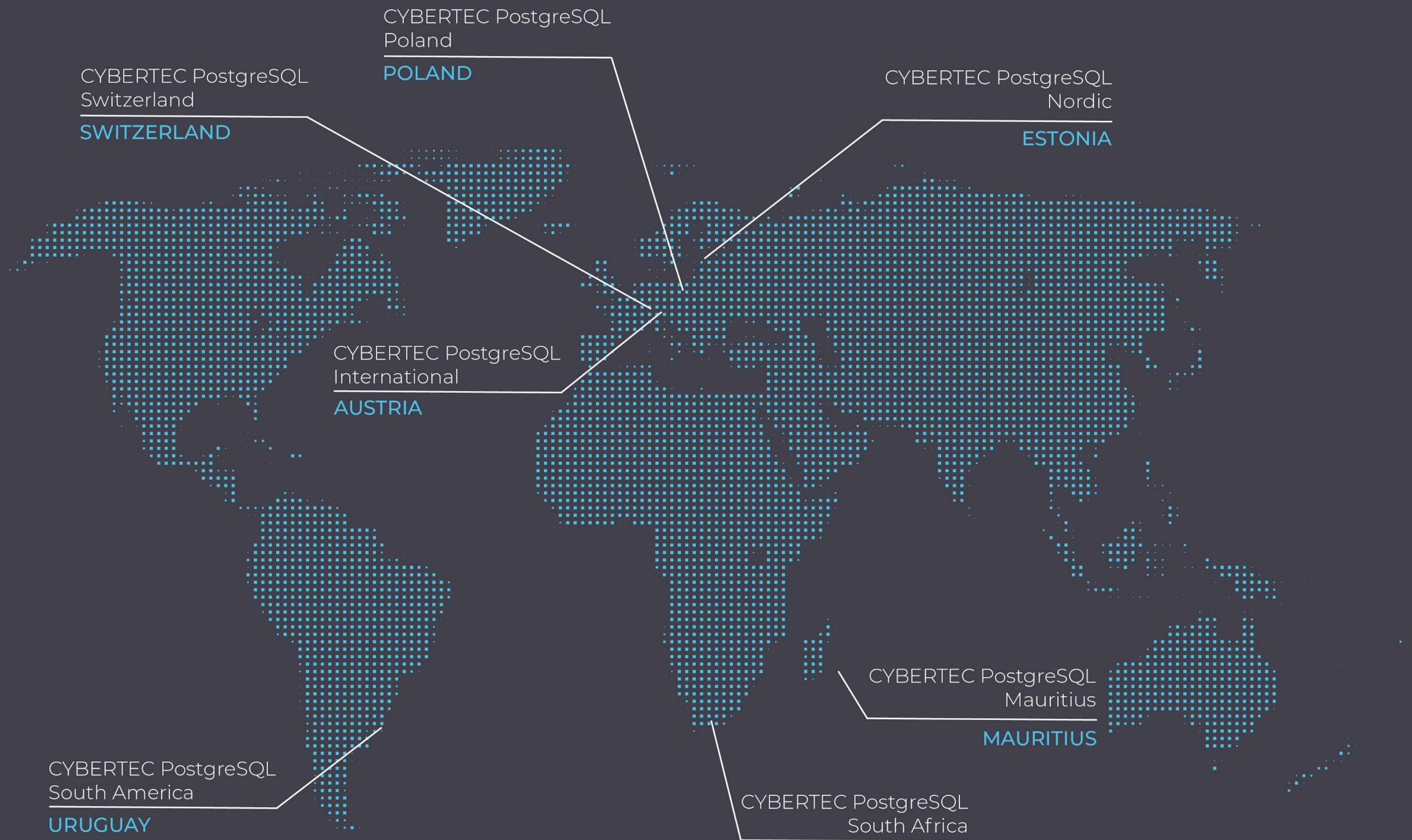
DATABASE SERVICES

DATA Science

- Artificial Intelligence
- Machine Learning
- Big Data
- Business Intelligence
- Data Mining
- etc.

POSTGRESQL Services

- 24/7 Support
- Training
- Consulting
- Performance Tuning
- Clustering
- etc.



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CLIENT SECTORS

- ICT
- University
- Government
- Automotive
- Industry
- Trade
- Finance
- etc.

AGENDA

- Overview
- Understanding open source and PostgreSQL
- Migrate the schema (DDL)
- Data migration
- Migrating stored code
- Migrating SQL
- Migrating the application
- Migration tools

OVERVIEW

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MIGRATION STEPS

- understand open source software and PostgreSQL
- migrate the schema (DDL)
- migrate the data
- migrate stored code (PL/SQL, Java)
- migrate SQL
- migrate the application

MIGRATION STEPS
(ACTUAL SIZE)

- understand open source software and PostgreSQL
- migrate the schema (DDL)
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UNDERSTANDING OPEN SOURCE AND POSTGRESQL

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THE SHIFT TO OPEN SOURCE

- This is written by some enthusiasts in their spare time, right?
- Is this "enterprise ready"?
- Where can I get support?
- Why do I have to install and integrate so many different pieces of software (PostgreSQL, PostGIS, backup software, extensions, GUI clients, monitoring,…)?
- What if open source software is no longer maintained?
- It's for free, so I don't have to invest anything, right?

TRANSACTIONS, UNDO, MULTIVERSIONING

- both Oracle and PostgreSQL use multiversioning, so concurrency and locking are similar (but not equal!)
- big transactions are no problem in PostgreSQL (but long transactions are), so less need to “batch” large transactions
- no UNDO tablespace in PostgreSQL, no “snapshot too old”, immediate rollback

But:

- `UPDATE`-heavy workloads are problematic in PostgreSQL (may need “HOT update” and autovacuum tuning)
- table size will grow (all that visibility information)
- I no statement-level rollback

SCHEMAS, USERS AND SYNONYMS

Oracle has a reduced metadata model:

- a schema is always tied to a user with the same name
- ownership is determined by the schema
- only objects in your own schema can be referenced without schema

Synonyms are there largely to overcome these limitations

- can often be replaced by an appropriate `search_path` setting
- for other uses, a view is usually just as good

VIEWS AND DEPENDENCIES

- Oracle tables be dropped/modified even if views depend on them
  - views become “invalid” and cause an error when used
- PostgreSQL is stricter about data integrity
- Schema upgrade procedures more difficult in PostgreSQL
  - but to make up for it, we have transactional DDL
- Materialized View support much more sophisticated in Oracle
  - replace `ON COMMIT REFRESH` with triggers in PostgreSQL

TABLESPACES

- tablespaces are important in Oracle
  - Oracle essentially implements its own file system
- PostgreSQL uses the host file system
  - tablespaces are rarely necessary
- Resist the urge to create tablespaces during migration!

MIGRATE THE SCHEMA (DDL)

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DATA TYPE TRANSLATION

- PostgreSQL has way more data types, so the problem is often which one to choose
- `DATE` to `date` or `timestamp(0)`?
- `NUMBER` to integer, bigint, double precision or numeric?
  - Oracle allows foreign keys from `NUMBER(5)` to `NUMBER`
  - must take care to migrate them to the same data type
- `BLOB` to `bytea` or Large Objects?
  - easy, use `bytea`

DATA MIGRATION

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GENERAL CONSIDERATIONS

- Oracle makes it hard to export data in clear text
  - probably on purpose to make migration harder
- this is often the least complicated step, but the one that causes the most down time
- reducing down time is difficult
  - run migration of table data in parallel
  - use “change data capture” for replication and switch-over with little down time (only available with commercial tools)

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DATA MIGRATION PROBLEMS

- corrupted strings in Oracle (more common than you think!)

  `invalid byte sequence for encoding "UTF8": 0x80`

- zero bytes in Oracle

  `invalid byte sequence for encoding "UTF8": 0x00`

  - can be filtered out during migration

- infinite numbers (~ and -~)
  - can be mapped to `Infinity` in double precision, problematic otherwise

Most of these problems have to be solved in Oracle before migration.

MIGRATING STORED CODE

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MIGRATING PL/SQL

- PL/pgSQL is a clone of PL/SQL, but sufficiently different (e.g., `RETURNS` vs. `RETURN`)
- some tools provide automated translation, but a lot of manual work may remain
- no `COMMIT/ROLLBACK` in PostgreSQL functions, limited support in procedures
  - often in “batched deletes”, → can be omitted
- no `PRAGMA AUTONOMOUS_TRANSACTION` in PostgreSQL
  - can sometimes be worked around with `dblink`
- no `BULK COLLECT` with arrays
  - process row by row

Shift transaction management to the application.

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MIGRATING PL/SQL PACKAGES

- option to use closed source fork from EDB
- workaround: creating a schema with functions
  - no “package global variables” and types
- no large PL/SQL library in PostgreSQL
  - move code to the application
  - re-implement code in PL/Python or PL/PerlU
  - extension “orafce” provides some compatibility

MIGRATING PL/SQL TRIGGERS

- has to be split in two parts: trigger function and trigger
  - benefit: easier code reuse
- auto-increment triggers fetching from a sequence can be simplified to column `DEFAULT`
- no “logon triggers” in PostgreSQL
  - avoid or shift code to the application

MIGRATING SQL

WHERE DOES SQL OCCUR?

- application code
  - ORMs and other abstraction layers reduce this
- views
- PL/SQL code
- column `DEFAULT` clauses
- index definitions

Usually requires manual intervention; migration tools may help.

SQL: JOIN SYNTAX

```
SELECT b.col1, a.col2
FROM base_table b, attributes a
WHERE b.id=a.b_id(+);
```

has to be translated to

```
SELECT b.col1, a.col2
FROM base_table b
    LEFT JOIN attributes a ON b.id = a.b_id;
```

Always simple, but annoying!

SQL: EMPTY STRINGS

- Oracle treats empty strings as `NULL`
- as a consequence,
  `'hello' || NULL`
  is not NULL in Oracle
- translate into
  `concat('hello', NULL)`
  or use "`coalesce(strcol, '')`"

This is a very frequent problem.

SQL: CURRENT DATE/TIME

- most Oracle code uses proprietary functions:
  - `SYSDATE`
  - `SYSTIMESTAMP`
- has to be translated:
  - the literal translation would be `clock_timestamp()`
  - sometimes `current_date` or `current_timestamp` is better
- easy with search and replace

SQL: SEQUENCES

- Oracle code to fetch the next sequence value:
  `asequence.NEXTVAL`
- PostgreSQL code to fetch the next sequence value:
  `nextval('asequence')`
- both don't support the SQL standard way:
  `NEXT VALUE FOR asequence`

MIGRATING THE APPLICATION

MIGRATING THE APPLICATION

- can be hard
  - hard coded dynamically composed SQL everywhere
- can be almost trivial
  - use an ORM that supports both Oracle and PostgreSQL
- requires **thorough testing**
- some differences (transaction handling, concurrency) may cause problems only during testing

MIGRATION TOOLS

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POSTGRESQL FORKS

- some PostgreSQL forks (for example EDB) provide good compatibility
  - but believe no claim of “drop-in replacement”
  - carefully consider if you want to end up with closed source
- consider using “orafce” for more compatibility
  - open source, but still another dependency
- it may be worth the effort to invest a little more and end up with free standard PostgreSQL

ORA2PG

- the most widely used open source migration tool
  - time-tested and proven, but not 100% bug free
- generates a DDL script, exports and imports data
  - universally usable, but takes its time
- attempts to translate PL/SQL
  - simple search/replace, quality limited

ORA_MIGRATOR

- open source, uses the Oracle Foreign Data Wrapper
- directly migrates data into the target database
  - no export/import, therefore faster
- requires `oracle_fdw` in the target database
  - usually not an option with hosted databases
- no attempt to migrate PL/SQL
- provides a simple replication solution using triggers to reduce down time

CYBERTEC MIGRATOR

THE EASIEST WAY FROM ORACLE TO POSTGRESQL

- SAVE HIGH LICENCE COSTS
- VISUAL MONITORING
- SIMPLE & FAST MIGRATION

COMPLETE SCHEMA CONVERSION	AUTOMATIC CODE REWRITE	CLOSE-TO ZERO DOWNTIME

CYBERTEC MIGRATOR

- commercial
- comfortable GUI driven migration
- fast, highly parallelized data migration
- high-quality PL/SQL conversion
- close-to zero downtime with change data capture under development

More information:
https://www.cybertec-postgresql.com/en/products/cybertec-migrator/

QUESTIONS?

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