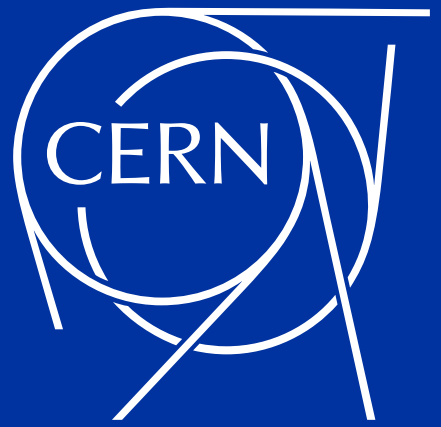

A dive into Database Resident Connection Pooling

Andrzej Nowicki

POUG 2023

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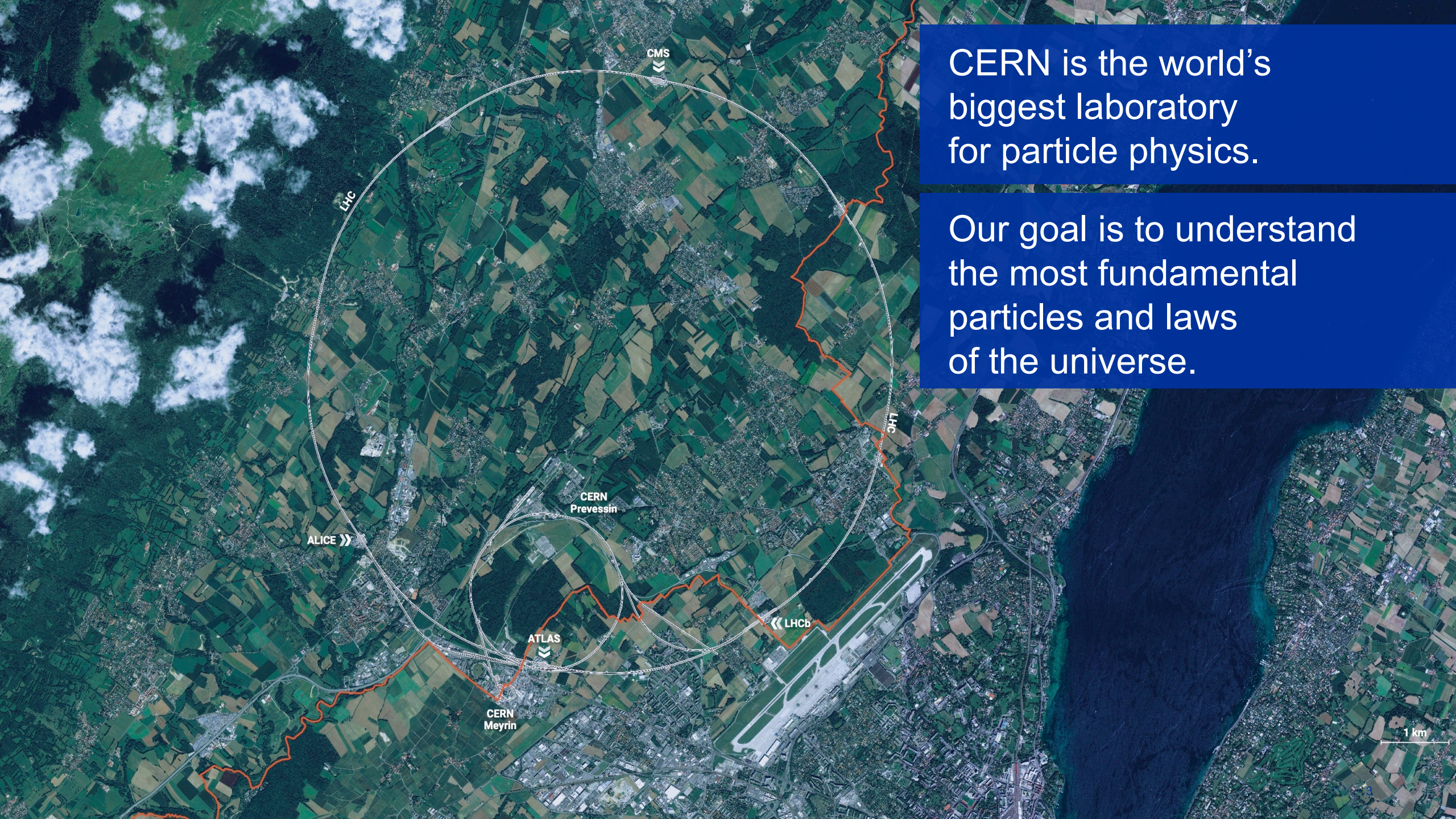
12 years of Oracle DB experience
Database Engineer @ CERN since 2020

andrzejnowicki

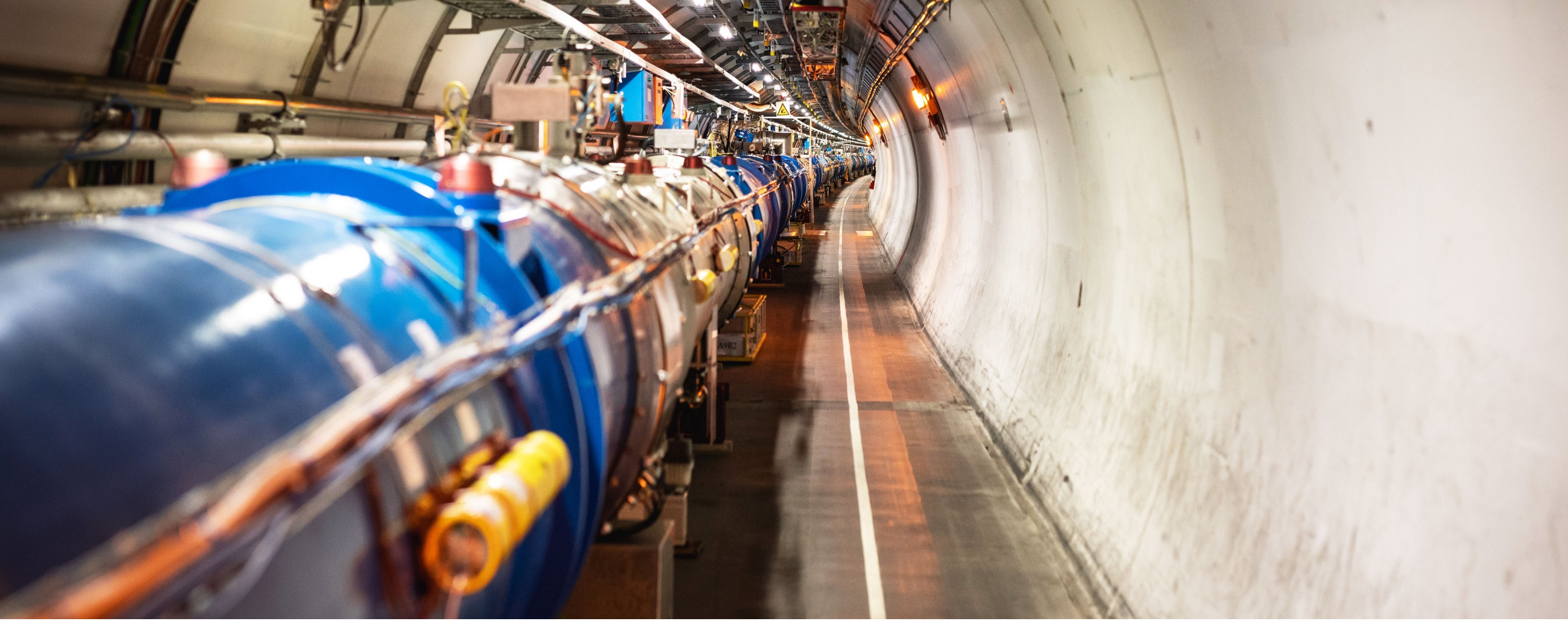
andrzej.nowicki@cern.ch

www.andrzejnowicki.pl

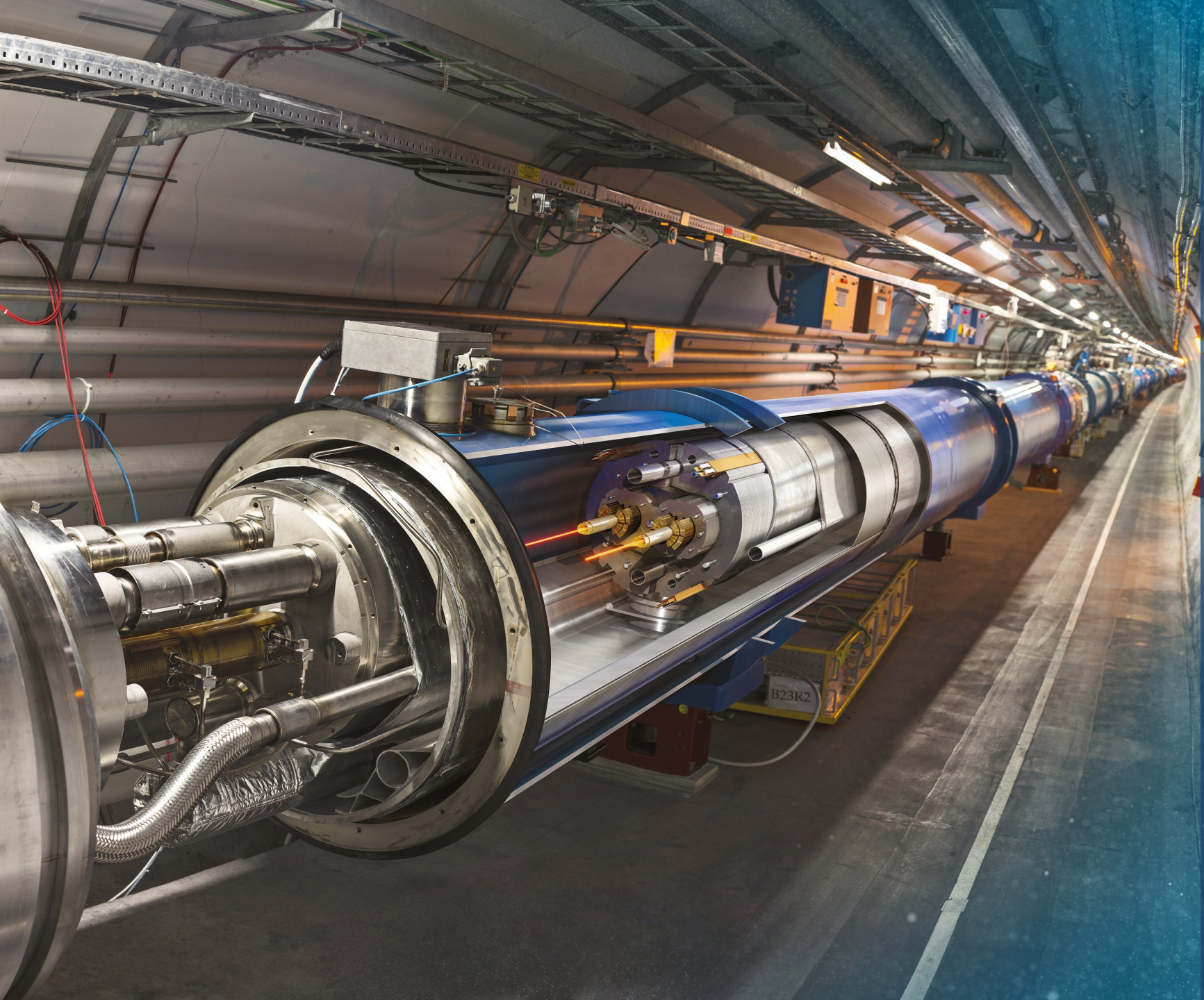


CERN is the world's biggest laboratory for particle physics.

Our goal is to understand the most fundamental particles and laws of the universe.

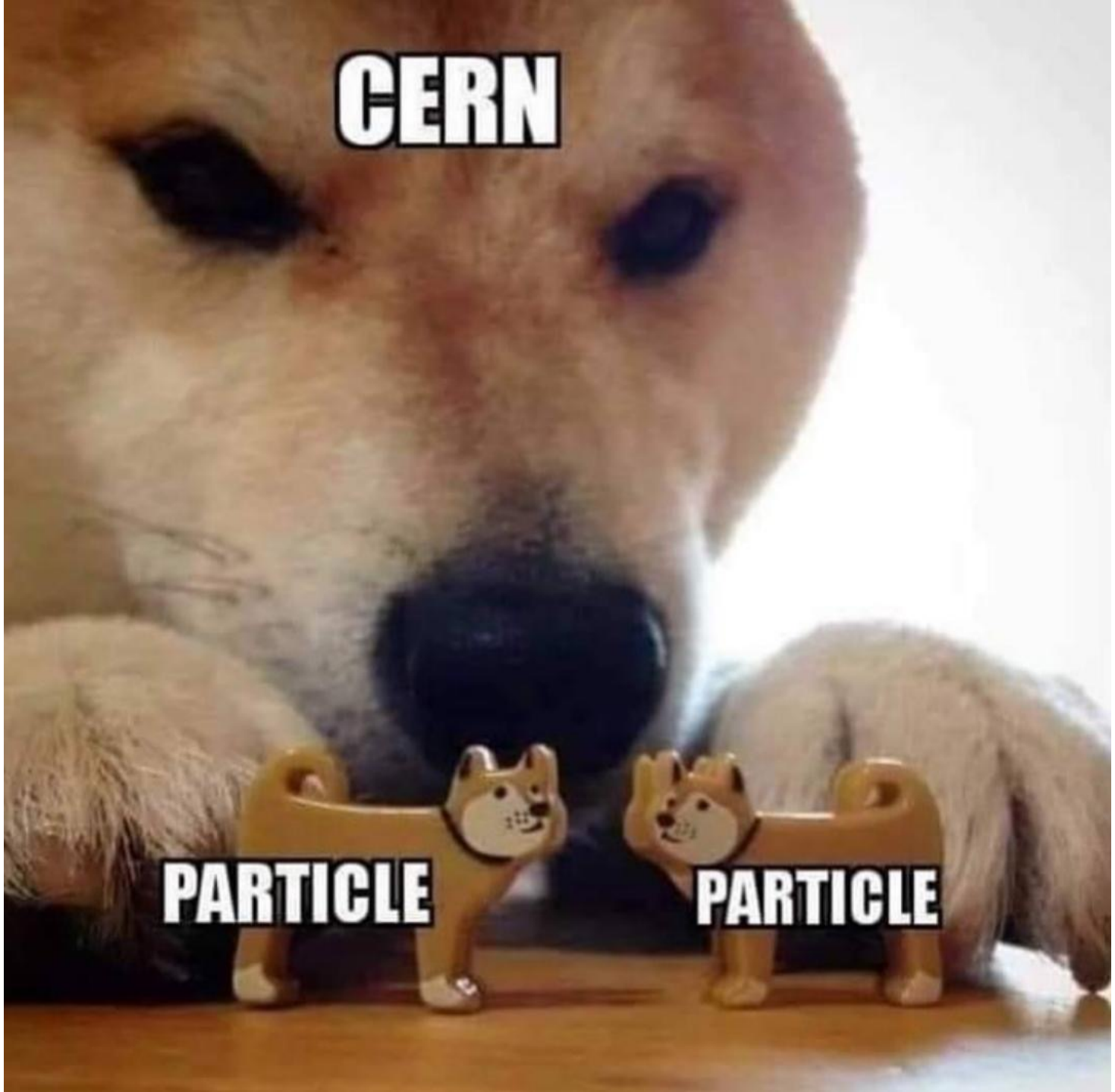


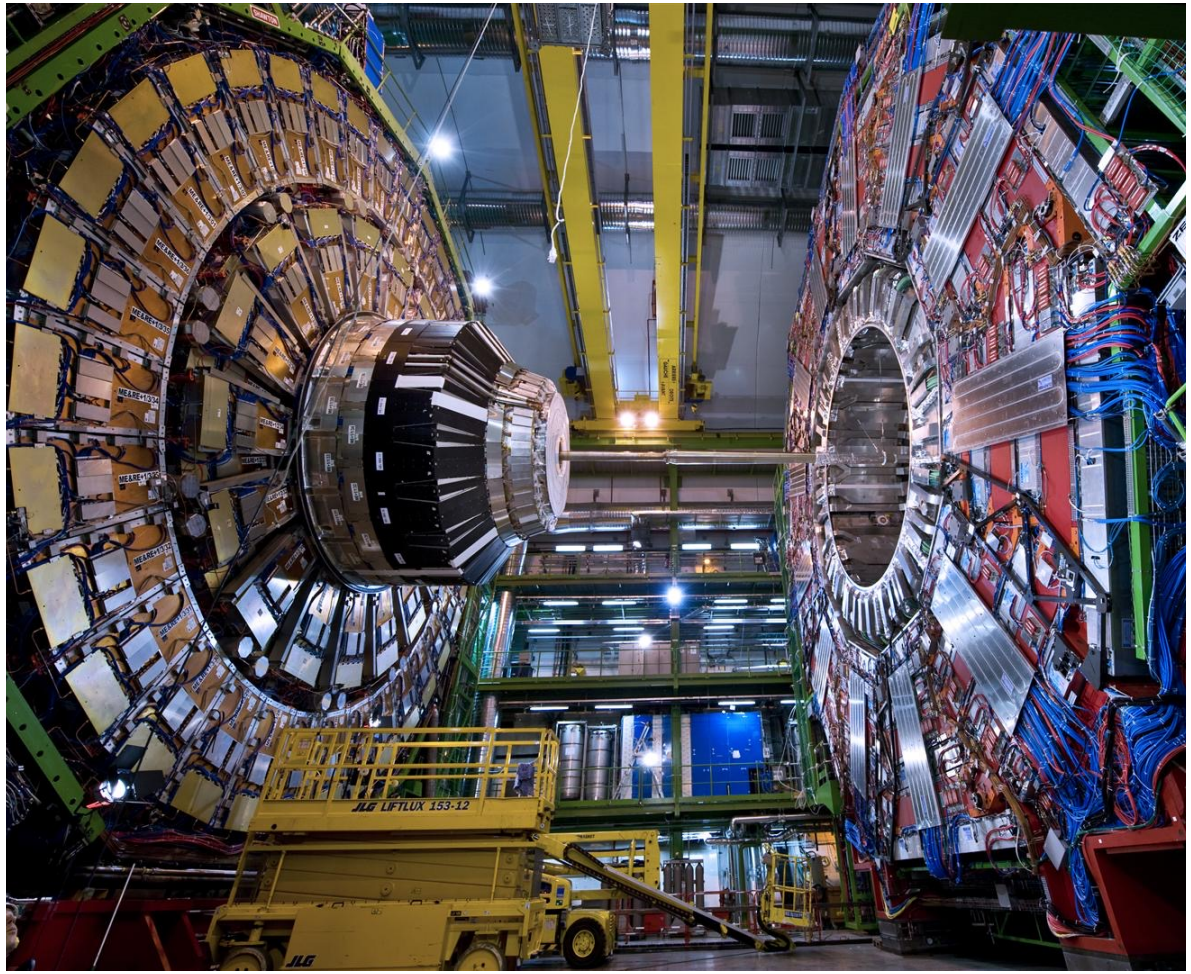
Large Hadron Collider (LHC)

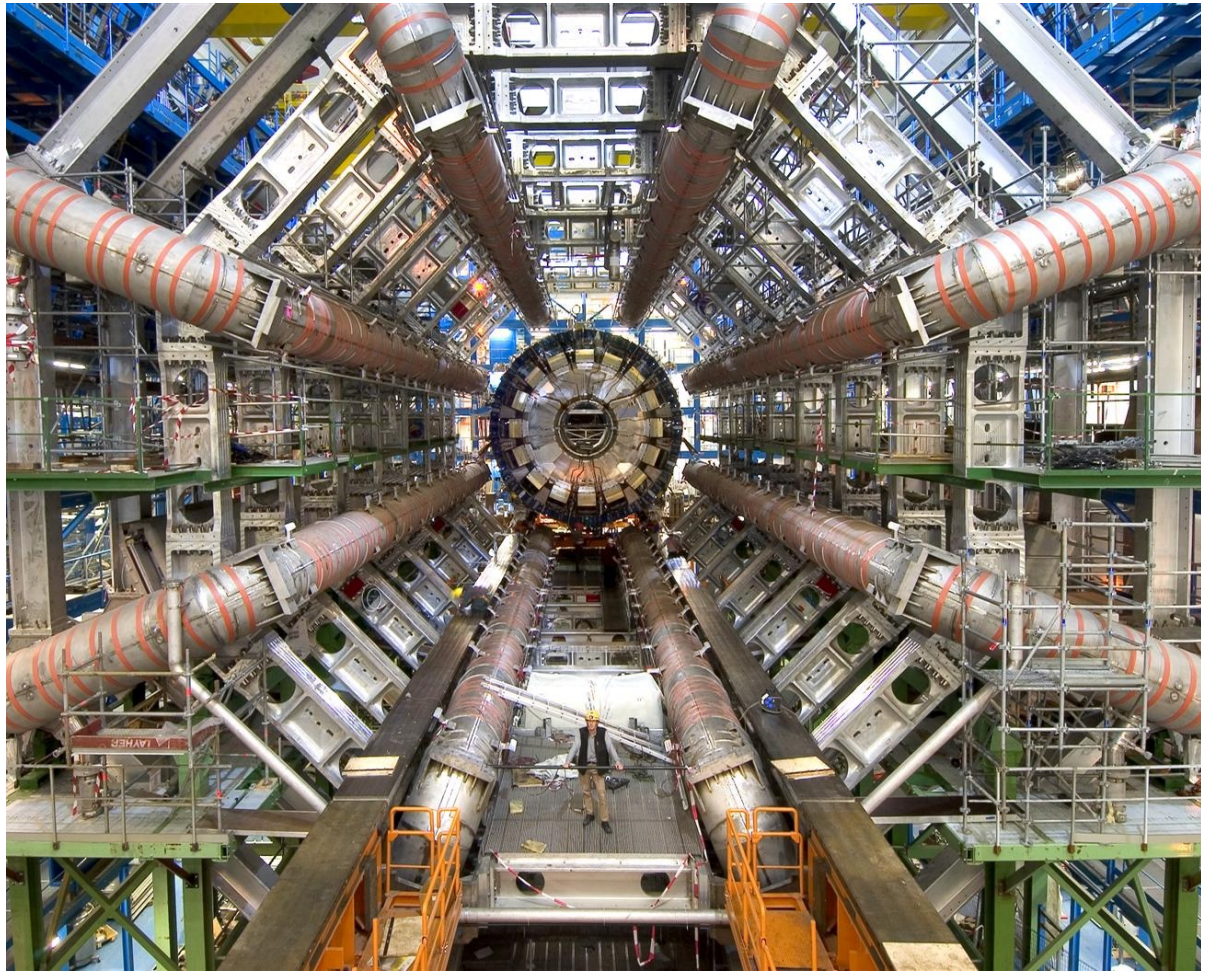


Large Hadron Collider (LHC)

- 27 km (17 mi) in circumference
- About 100 m (300 ft) underground
- Superconducting magnets steer the particles around the ring
- Particles are accelerated to close to the speed of light


CERN
PARTICLE
PARTICLE


JLG LIFTLUX 153-12
JLG



IT @ CERN

Databases at CERN

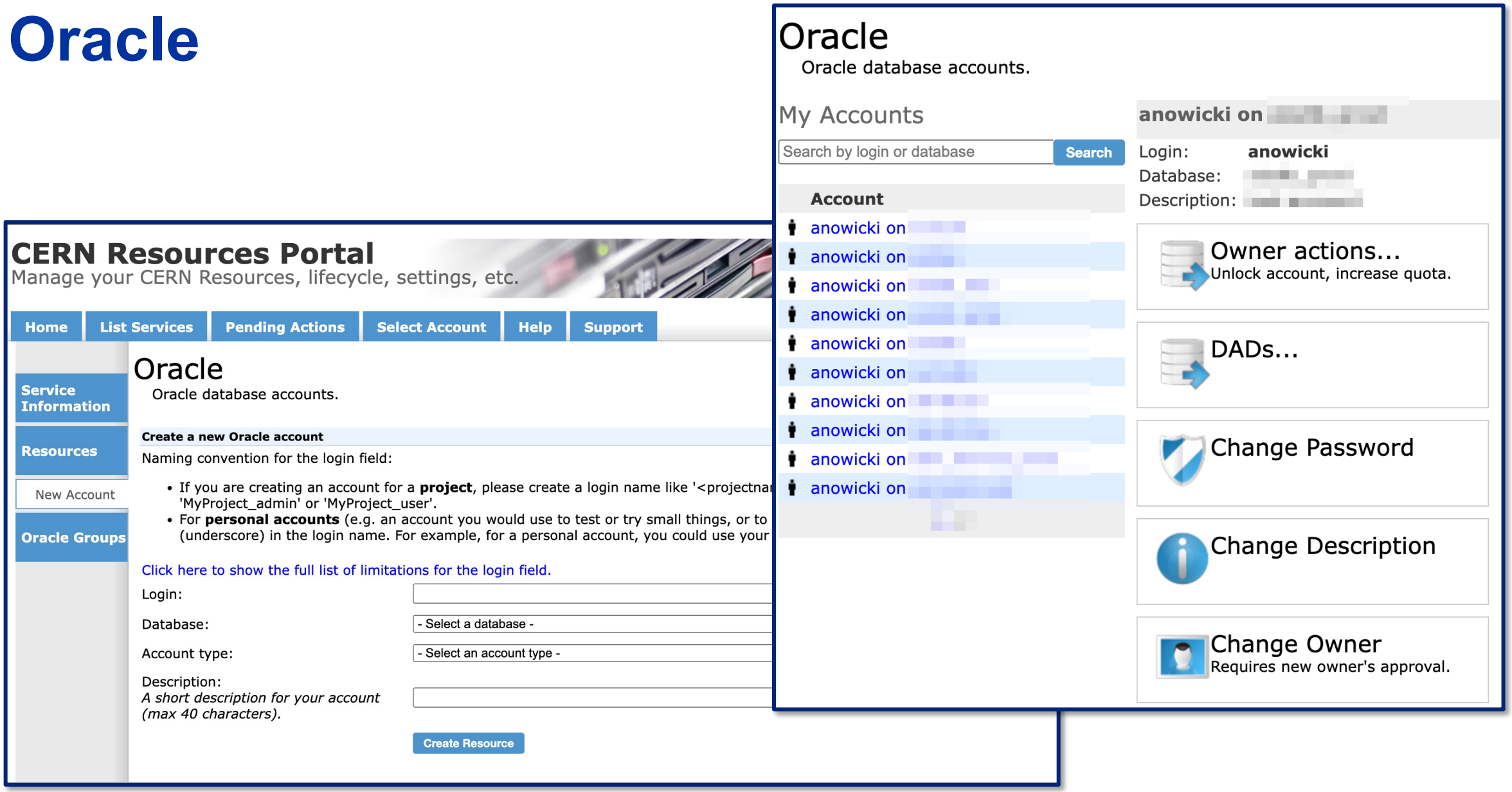
Oracle since 1982

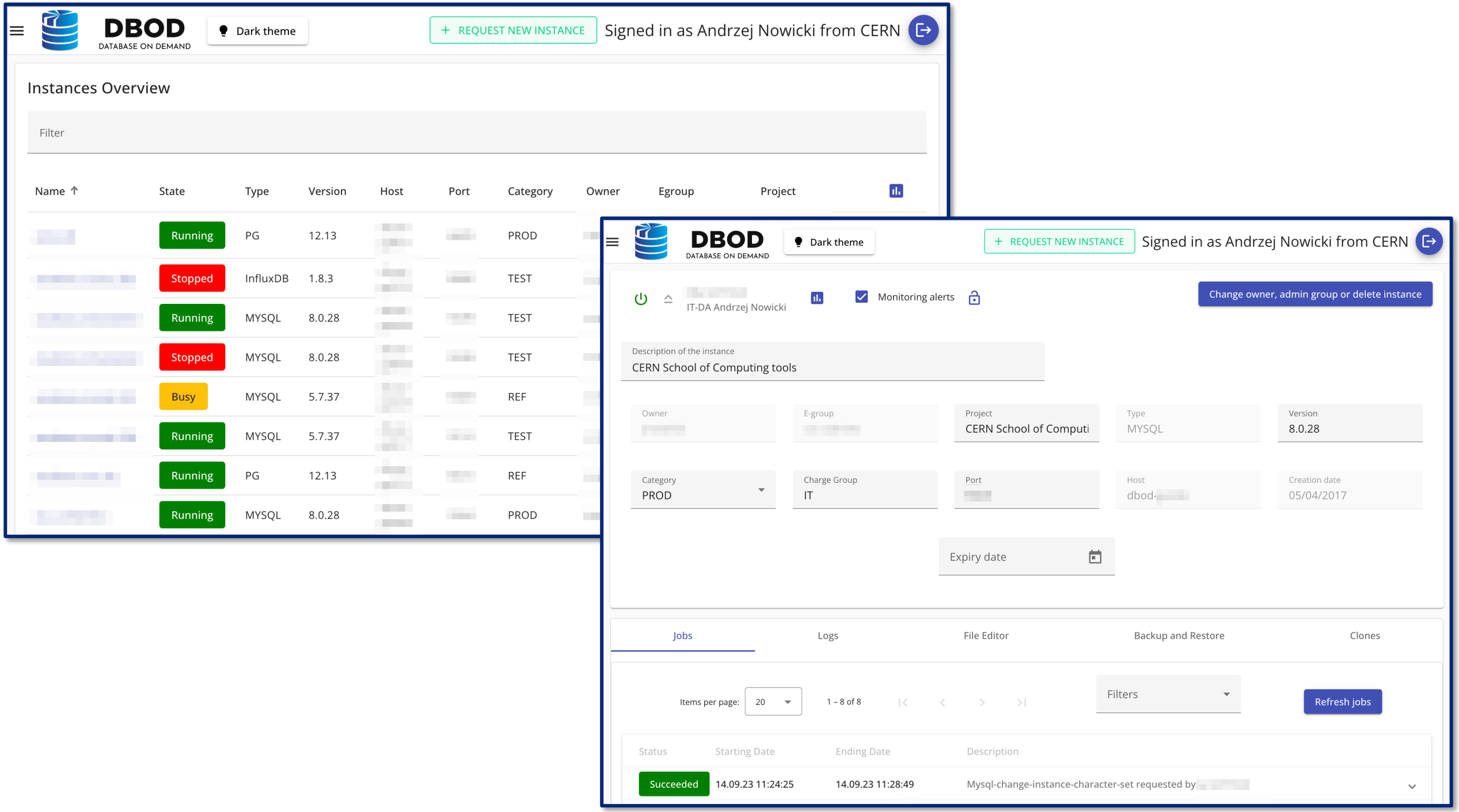
- 105 Oracle databases, more than 11.800 Oracle accounts
- RAC, Active Data Guard, GoldenGate, OEM, RMAN, APEX, Cloud, …
- Complex environment

Database on Demand (DBoD) since 2011

- ≈600 MySQL, ≈400 PostgreSQL, ≈200 InfluxDB
- Automated backup and recovery services, monitoring, clones, replicas
- HA MySQL clusters (Proxy + primary replica)

Oracle


CERN Resources Portal
Manage your CERN Resources, lifecycle, settings, etc.
Home
List Services
Pending Actions
Select Account
Help
Support
Service Information
Resources
New Account
Oracle Groups
Oracle
Oracle database accounts.
Create a new Oracle account
Naming convention for the login field:
If you are creating an account for a project, please create a login name like '<projectnar
'MyProject_admin' or 'MyProject_user'.
For personal accounts (e.g. an account you would use to test or try small things, or to
(underscore) in the login name. For example, for a personal account, you could use your
Click here to show the full list of limitations for the login field.
Login:
Database:
- Select a database -
Account type:
- Select an account type -
Description:
A short description for your account
(max 40 characters).
Create Resource
Oracle
Oracle database accounts.
My Accounts
Search by login or database
Search
Account
anowicki on
anowicki on
anowicki on
anowicki on
anowicki on
anowicki on
anowicki on
anowicki on
anowicki on
anowicki on
anowicki on
anowicki on
Login:
anowicki
Database:
Description:
Owner actions...
Unlock account, increase quota.
DADs...
Change Password
Change Description
Change Owner
Requires new owner's approval.

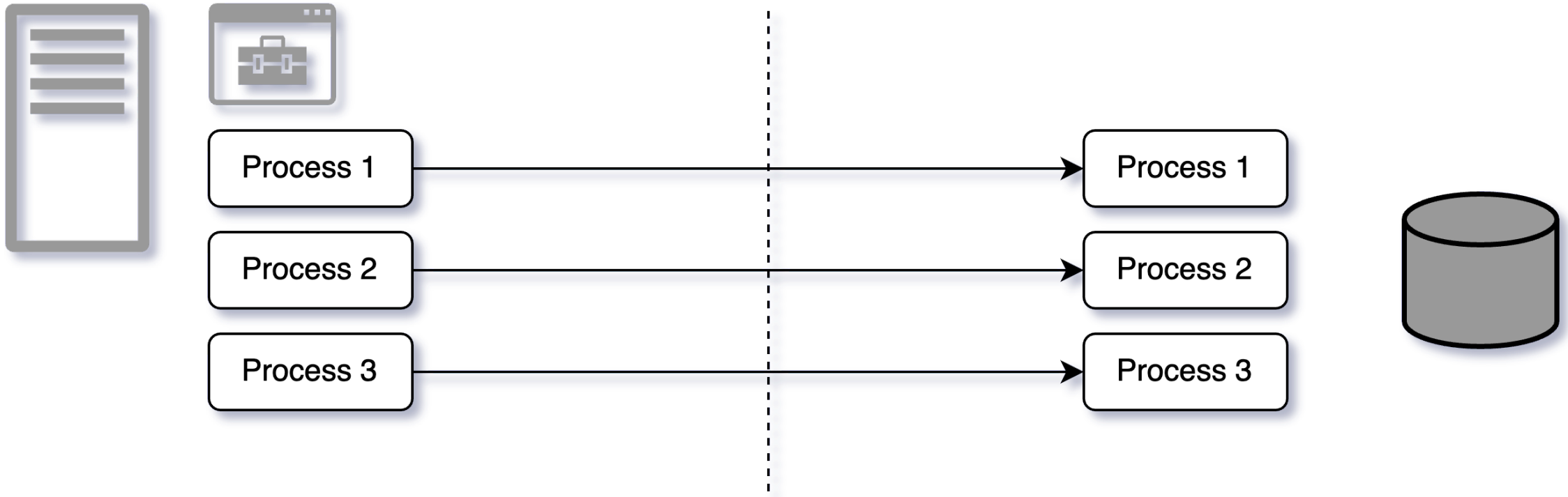

DBOD
DATABASE ON DEMAND
Dark theme
+ REQUEST NEW INSTANCE
Signed in as Andrzej Nowicki from CERN
Instances Overview
Filter
Name
State
Type
Version
Host
Port
Category
Owner
Egroup
Project
Running PG 12.13 PROD
Stopped InfluxDB 1.8.3 TEST
Running MYSQL 8.0.28 TEST
Stopped MYSQL 8.0.28 TEST
Busy MYSQL 5.7.37 REF
Running MYSQL 5.7.37 TEST
Running PG 12.13 REF
Running MYSQL 8.0.28 PROD
DBOD
DATABASE ON DEMAND
Dark theme
+ REQUEST NEW INSTANCE
Signed in as Andrzej Nowicki from CERN
IT-DA Andrzej Nowicki
Monitoring alerts
Change owner, admin group or delete instance
Description of the instance
CERN School of Computing tools
Owner
E-group
Project
CERN School of Computi
Type
MYSQL
Version
8.0.28
Category
PROD
Charge Group
IT
Port
Host
dbod-
Creation date
05/04/2017
Expiry date
Jobs
Logs
File Editor
Backup and Restore
Clones
Items per page:
20
1 – 8 of 8
Filters
Refresh jobs
Status
Starting Date
Ending Date
Description
Succeeded
14.09.23 11:24:25
14.09.23 11:28:49
Mysql-change-instance-character-set requested by

Size of the database environment

	Total size
Oracle	≈5 PB
DBoD (MySQL, PostrgeSQL, InfluxDB)	≈150 TB
Backups	≈3 PB

Show of hands:
Who’s using DRCP?

Dedicated servers

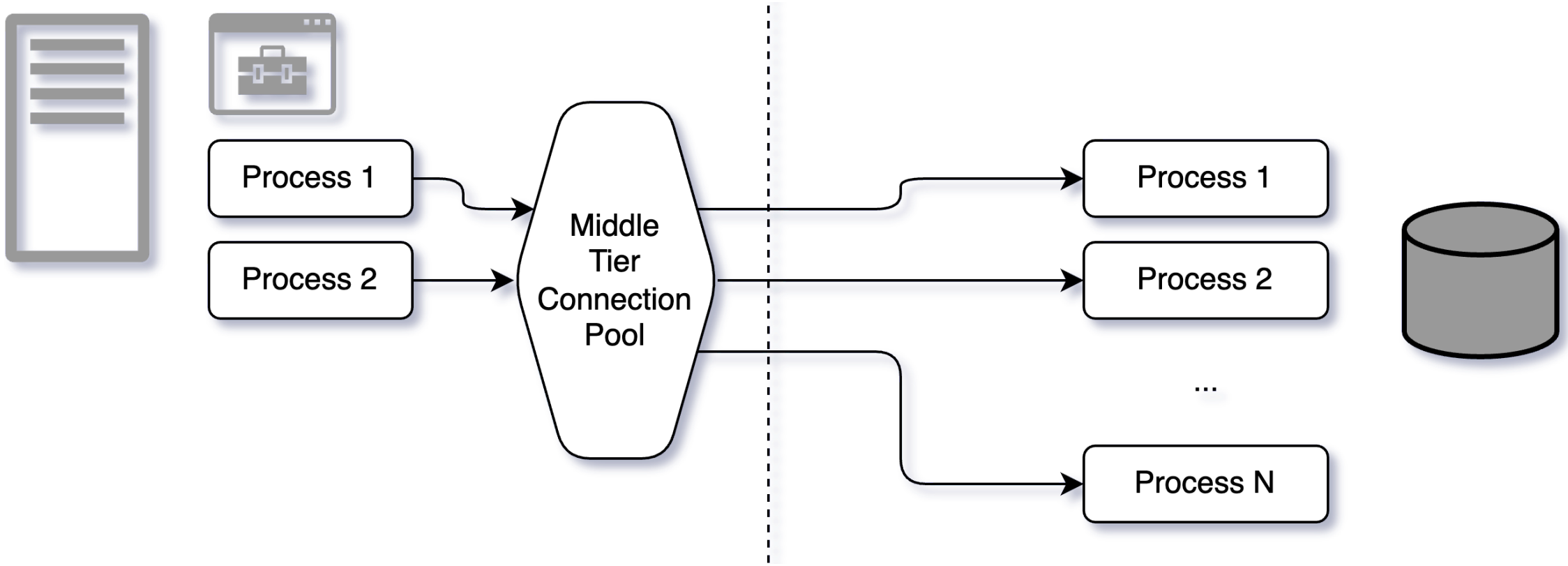


Dedicated servers – downsides?

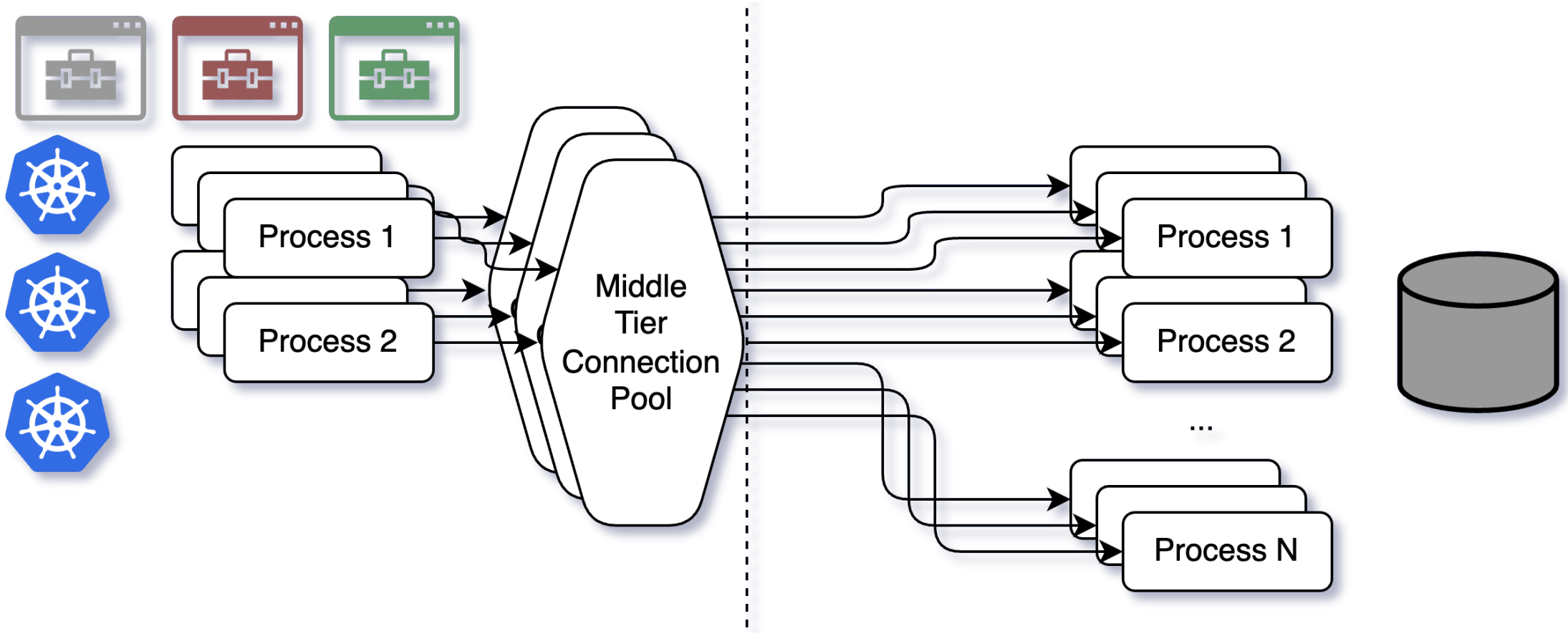
Establishing a new connection is slow.

- New connections require CPU & memory allocation
- A new server process is forked, memory is allocated, background SQLs are executed, latches are held briefly.
- Authorization and authentication takes some time too (entry in audit log, logon triggers).

Middle tier connection pooling



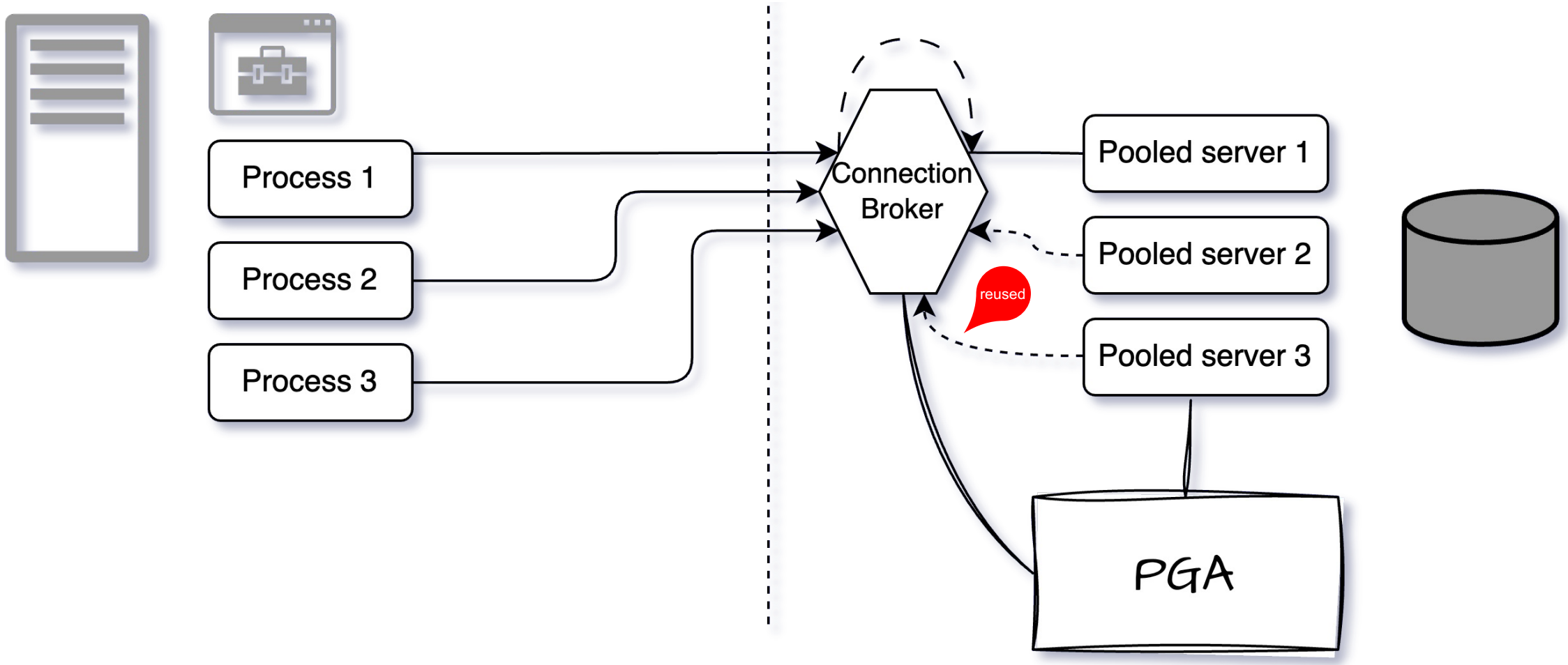
Middle tier connection pooling



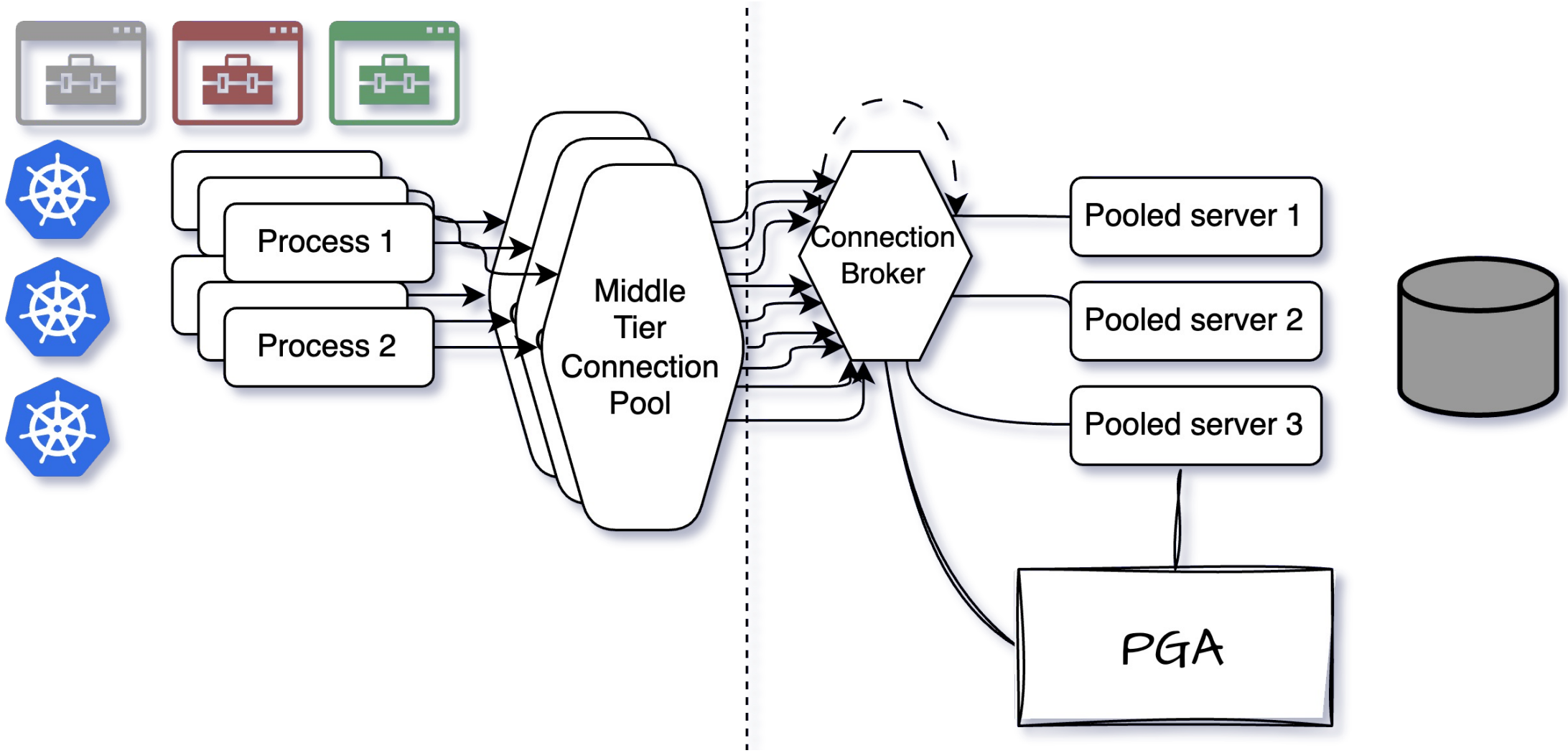
Middle tier connection pooling – downsides?

- **Poorly scaled pools might cause problems related to connection storms**
- **Multiple pools in k8s**

DRCP


Process 1
Process 2
Process 3
Connection Broker
Pooled server 1
Pooled server 2
Pooled server 3
reused
PGA

DRCP


Process 1
Process 2
Middle Tier Connection Pool
Connection Broker
Pooled server 1
Pooled server 2
Pooled server 3
PGA

DRCP benefits

- **Should resist connection storms**
- **Reducing resource usage on the database server**

Comparison

Dedicated Server	Shared Server	Database Resident Connection Pooling
Releasing database resources involves **terminating the session and server process**.	Releasing database resources involves **terminating the session**.	Releasing database resources involves **releasing the pooled server to the pool**.
Session memory is allocated from the **PGA**.	Session memory is allocated from the **SGA**.	Session memory is allocated from the **PGA**.

Let’s give it a test!

HOWTO – Database side

```
EXEC DBMS_CONNECTION_POOL.START_POOL;
```

HOWTO – Client

Pass a value to the connection property:

`oracle.jdbc.DRCPConnectionClass` *or* `cclass` **(cx_Oracle, oracledb)**

AND

```
CONNECTION_POOLED =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = localhost)(PORT = 1521))
    (CONNECT_DATA =
      (SERVICE_NAME = SVC)
      (SERVER = POOLED)
      (POOL_NAME = POUG23)
    )
  )
```

23c

```
conn user/pass@//localhost:1521/svc:pooled
```

Let’s give it a test!

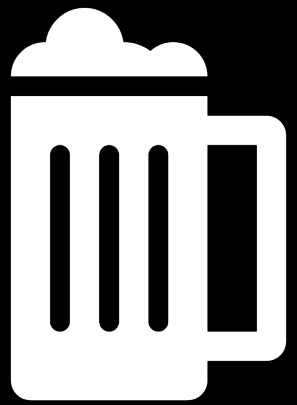
```
import oracledb
import time


def tester(service,number):
        print ("Running test. {} connections to {}".format(number,service))
        before=time.time()
        for i in range(number):
                connection=oracledb.connect(user=un,pass=pw,dsn=service)
        after=time.time()
        print ("Test finished.\n{:.1f} s".format(after-before))
        return after-before


tester("xxx.cern.ch/xxx",1000)
tester("xxx.cern.ch/xxx:POOLED",1000)
```

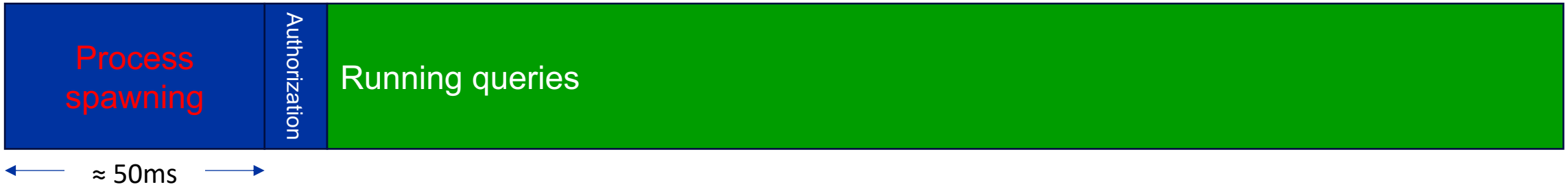
Let’s give it a test!

```
$ python3 test.py
Running test. 1000 connections to xxx.cern.ch/xxx
Test finished.
59.6 s
Running test. 1000 connections to xxx.cern.ch/xxx:POOLED
Test finished.
10.1 s
```



Let’s give it a test!

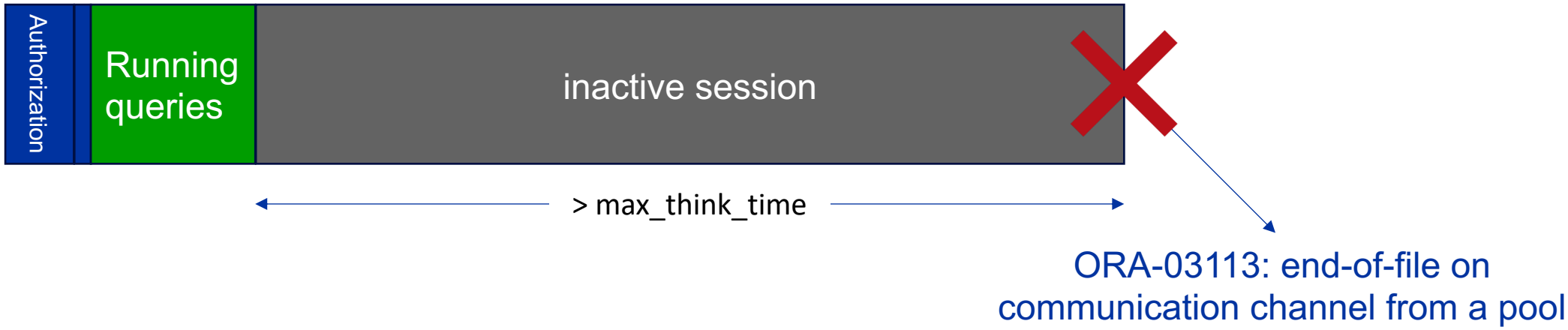
Dedicated:



DRCP:

Inactive sessions?

DRCP:



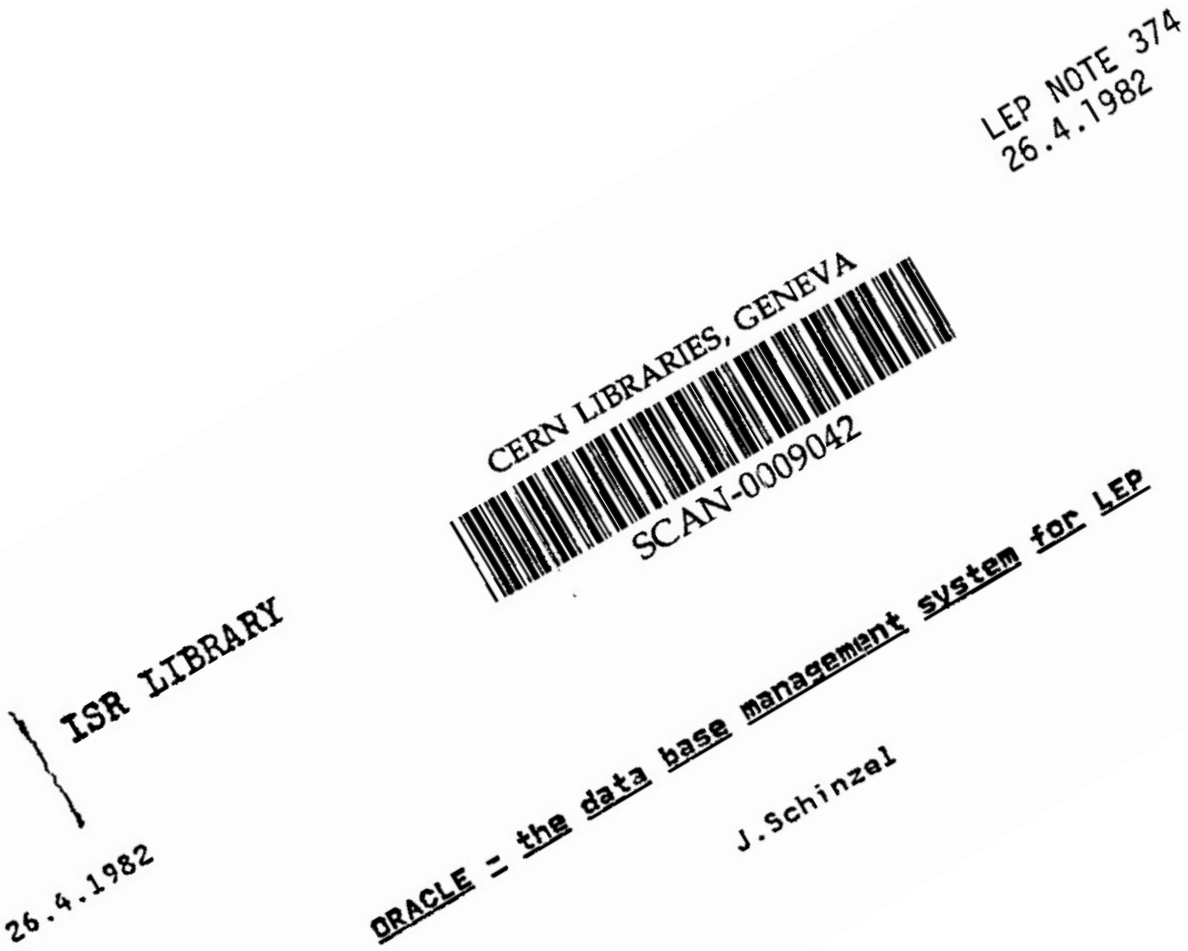
Other tests!

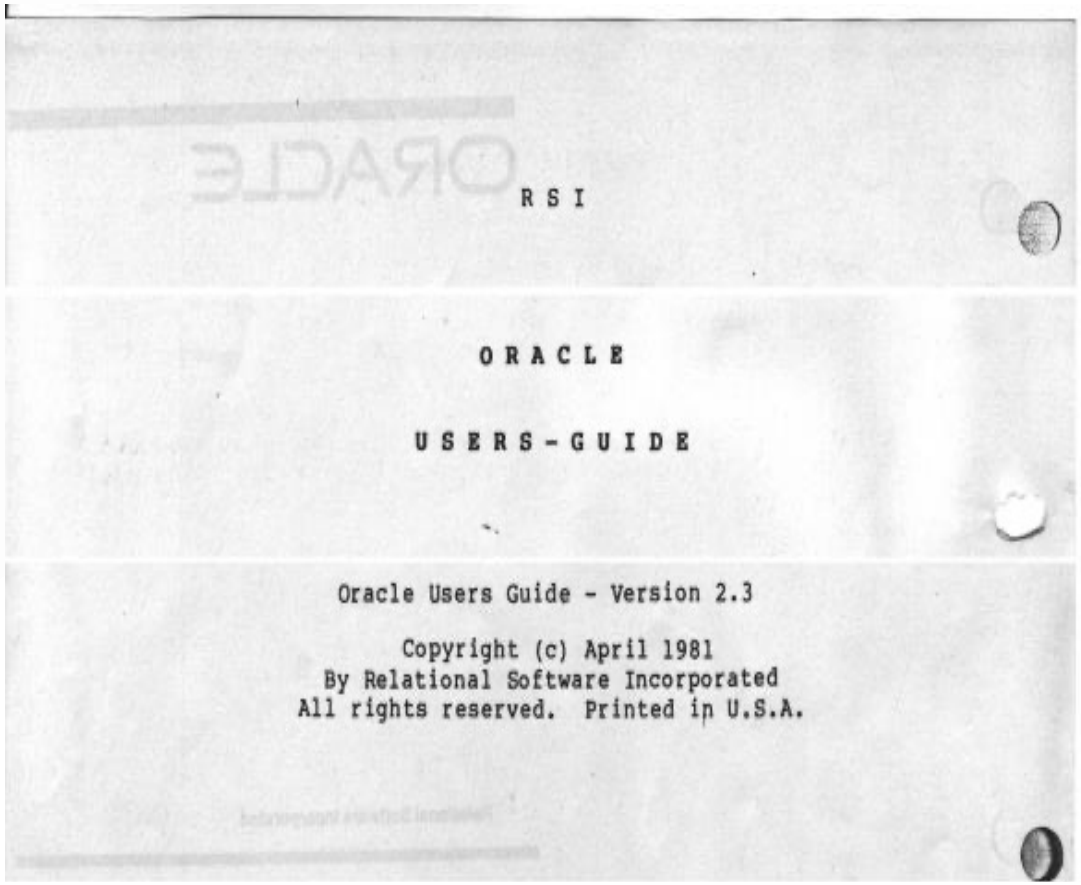
Simple PHP application running on Apache:

10x improvement in average response time and max request throughput

https://workwiththebest.intraway.com/blog-post/performance-oracle-pool-with-php/

Let’s check the documentation



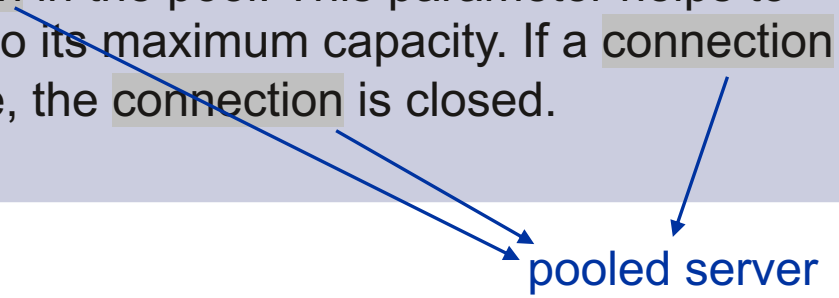


DBMS_CONNECTION_POOL

Parameter	Description
ADD_POOL (23c)	Adds a new pool to the multiple pool DRCP.
ALTER_PARAM	Alters a specific configuration parameter as a standalone unit, without affecting the other parameters.
CONFIGURE_POOL	Configures the pool with advanced options.
REMOVE_POOL	Removes a pool from the multiple pool DRCP.
RESTORE_DEFAULTS	Restores the pool to the default settings
START_POOL	Starts the pool for operations. Only after this procedure is called, the pool can be used by the connection clients for creating sessions.
STOP_POOL	Stops the pool and makes it unavailable for the registered connection clients.

Parameters – scaling the pool of servers

Parameter	Description
`pool_name`	The name of the pool to be added to the DRCP.
`minsize`	The minimum number of pooled servers in the pool. The default value is 0.
`maxsize`	The maximum number of pooled servers allowed in the pool. The default value is 40.
`incrsize`	Pool would increment by this number of pooled server when pooled servers are unavailable at application request time. The default value is 2.
`inactivity_timeout`	TTL (Time to live) for an idle session in the pool. This parameter helps to shrink the pool when it is not used to its maximum capacity. If a connection remains in the pool idle for this time, the connection is closed. The default value is 300.



Parameters – clients

Parameter	Description
session_cached_cursors	The number of session cursors to cache in each pooled server session. The default value is 20. Turn on SESSION_CACHED_CURSORS for all connections in the pool. This is an existing init.ora parameter.
max_think_time	The maximum time of inactivity, in seconds, for a client after it obtains a pooled server from the pool with **no open transactions in it**. After obtaining a pooled server from the pool, if the client application does not issue a database call for the time specified by MAX_THINK_TIME, the pooled server is freed and the client connection is terminated. The default value is 120.
max_txn_think_time	The maximum time of inactivity, in seconds, for a client after it obtains a pooled server from the pool with **an open transaction**. After obtaining the pooled server from the pool, if the client application does not issue a database call for the time specified by MAX_TXN_THINK_TIME, then the pooled server is freed, and the client connection is terminated. The default value of this parameter is the value of the MAX_THINK_TIME parameter.

Parameters – max lifetime of pooled server

Parameter	Description
`max_use_session`	Maximum number of times a connection can be taken and released to the pool. The default value is 500000.
`max_lifetime_session`	TTL (Time to live) in seconds for a pooled session. The default value is 86400.

max_use_session and max_lifetime_session
allow for software rejuvenation or defensive approaches to
***potential bugs, leaks, accumulations, and like problems**,*
by getting brand new sessions once in a while.

https://docs.oracle.com/en/database/oracle/oracle-database/23/arpls/DBMS_CONNECTION_POOL.html

DB parameters related to DRCP

Parameter	Description
21c ENABLE_PER_PDB_DRCP	This parameter specifies if DRCP is configured at the CDB level or per PDB. The default value is **FALSE**.
19.11 DRCP_DEDICATED_OPT	The default is **YES** in 19c and **NO** from 21c onwards. Dedicated optimization makes DRCP operate like a dedicated server when the number of connections to the DRCP broker is **less than the maximum size of the DRCP pool**. Dedicated optimization allows the number of open pooled servers to grow to the maximum size, even when the connections are inactive.
21c DRCP_CONNECTION_LIMIT	This parameter provides limits on the number of DRCP connections for a PDB. If a PDB has a session limit, the default is 10 * sessions. Otherwise, it is unlimited.
CONNECTION_BROKERS	This parameter specifies the connection broker types, the number of connection brokers of each type, and the maximum number of connections per broker. When per-PDB DRCP is enabled, a PDB admin user cannot set this parameter in the PDB.

Connection class

Connection classes group connections that can be shared together.

Useful for applications relying on explicit roles:

> *If sessions with explicit roles enabled are released to the pool, they can later be assigned to connections (of the same user) that need the default logon role.*

You can control sharing of the sessions by setting:
connection class and purity parameters

Limitations

Cannot be performed via DRCP connections:

- Shutting down the database
- Stopping DRCP
- **Changing the password for the connected user**
- Using shared **database links to connect to a DRCP** that is on a different instance

…

Users can mix data encryption/data integrity combinations.
However, users must segregate each such combination by using connection classes.|
For example, if the user application must specify AES256 as the encryption mechanism for one set of connections and AES128 for another set of connections, then the application must specify different connection classes for each set.

RAC

[…] configuration is applied to each database instance.

Starting or stopping the pool on one instance
starts or stops the pool on all instances.

https://docs.oracle.com/en/database/oracle/oracle-database/23/adfns/performance-and-scalability.html

Data Guard

On a physical standby database:

*You can **start** the pool only if the pool is **running** on the **primary** database.*
*You can **stop** the pool only if the pool is **stopped** on the **primary** database.*
You cannot configure, restore to defaults, or alter pool parameters.

On a logical standby database:

All pool operations are allowed.

https://docs.oracle.com/en/database/oracle/oracle-database/23/adfns/performance-and-scalability.html

Oracle Recommendations

*“DRCP is typically recommended for applications with a **large number** of connections.*

*Shared servers are recommended for applications with a **medium number** of connections.*

*Dedicated sessions are recommended for applications with a **small number** of connections.*

The threshold sizes depend on the amount of memory available on the database host.”

https://docs.oracle.com/en/database/oracle/oracle-database/23/adfns/performance-and-scalability.html


We should give recommendations in our docs!
Let's be ambiguous!
"it depends"
Let's provide something useful
imgflip.com

Oracle Recommendations

“DRCP is generally recommended for

…
Large-scale web deployments with several web servers, micro-services, or middle-tiers that require database access and client-side pools

Web architectures that need to support high client connection traffic with minimum memory usage on the database host”

https://www.oracle.com/docs/tech/drcp-technical-brief.pdf

Monitoring views

```
> select connection_pool, status, maxsize from dba_cpool_info;

CONNECTION_POOL                STATUS MAXSIZE
------------------------------ ------- -------
SYS_DEFAULT_CONNECTION_POOL     ACTIVE      40

> SELECT num_requests, num_hits, num_misses, num_waits FROM v$cpool_stats;

  NUM_REQUESTS       NUM_HITS     NUM_MISSES NUM_WAITS
-------------- -------------- -------------- ----------
          5158            225           4933        111
```

Misconfigured client without class

The “correct” way of connecting:

```
connection=oracledb.connect(user=un,pass=pw,dsn=service)
```

```
connection=oracledb.connect(user=un,pass=pw,dsn=service,
                            cclass="poug23",
                            purity=oracledb.PURITY_SELF)
```

reuse session memory

```
connection=oracledb.connect(user=un,pass=pw,dsn=service,
                            cclass="poug23",
                            purity=oracledb.PURITY_NEW)
```

don’t reuse

Monitoring views

DBA_CPOOL_INFO	– parameters and status
V$CPOOL_STATS	– stats about the usage per connection pool
V$CPOOL_CC_INFO	– info about connection classes
V$CPOOL_CC_STATS	– stats per connection class
V$CPOOL_CONN_INFO	– connection information (connection class, machine name, etc.)
V$AUTHPOOL_STATS 21c	– stats on the authentication pool

Internals – processes

Nnnn – Connection Broker Processes

```
alter system set connection_brokers='((TYPE=POOLED)(BROKERS=1))';
```

Lnnn – Pooled Server Process

Internals – listener registration

```
> lsnrctl services
 Instance "XXX", status READY, has 2 handler(s) for this service...
    Handler(s):
      "DEDICATED" established:959654 refused:0 state:ready
         LOCAL SERVER
      "N000" established:6404 refused:0 current:100 max:40000 state:ready
         CMON <machine: XXXXXXXX.cern.ch, pid: 16858>
         (ADDRESS=(PROTOCOL=tcp)(HOST=127.0.0.1)(PORT=27834))
```

Debugging?

```
SQL> select sid,serial#,server,paddr from v$session where username='ANOWICKI';

    SID SERIAL# SERVER    PADDR
------- ------- --------- ----------------
   3517   26694 DEDICATED 00000002C03C1628
   3137   37140 POOLED    00000002C03DC2E8

SQL> select addr, program, tracefile from v$process
     where addr in (select paddr from v$session where username='ANOWICKI');

ADDR             PROGRAM                                TRACEFILE
---------------- -------------------------------------- ----------------------------
00000002C03C1628 oracle@xxxxxxxxx.cern.ch               [...]/SID_ora_6391.trc
00000002C03DC2E8 oracle@xxxxxxxxx.cern.ch (L063)        [...]/SID_l063_48875.trc
```

Debugging?

```
SQL> select value from v$diag_info where name='Default Trace File';

VALUE
--------------------------------------------------------------------------------
.../diag/rdbms/DB_UNIQ_NAME/SID/trace/SID_l063_48875.trc
```

Is it for everyone?

Make your own tests!

Let’s check the licencing

CONFIDENTIAL

CERN/FC/2876
Original: English
10 September 1985

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

FINANCE COMMITTE

Two-hundred-and-sixth Meeting

Geneva - 19 September 1985

PROPOSAL FOR THE ACQUISITION BY CERN OF LICENCES
FOR THE ORACLE DATABASE MANAGEMENT SYSTEM

This document concerns the acquisition of licences to permit extension of the database management system used at CERN.

For the reasons set out in this document, the Finance Committee is invited to agree that licences be acquired from ORACLE CORPORATION EUROPE for the central IBM and DEC VAX/VMS services and the LEP Project database service at a total price not exceeding 142 200 US dollars, not subject to revision, with annual maintenance payments amounting to an average of 25 000 US dollars during a three-year period. The Finance Committee is also invited to agree to the expansion of existing ORACLE licences, now in use

Let’s check the licencing

Table 1-7 Manageability

Feature / Option / Pack	Free	BaseDB EE	BaseDB EE-HP	BaseDB EE-EP	Notes
Database Resident Connection Pooling Per PDB for Tenancy Management	Y	Y	Y	Y	

https://docs.oracle.com/en/database/oracle/oracle-database/23/dblic/Licensing-Information.html

Problems?

ORA-03135 Error With DRCP Connections (Doc ID 2618488.1)

ORA-03135: connection lost contact

min_auth_servers / max_auth_servers

ORA-12152 Errors when DRCP in Use (Doc ID 2735203.1)

ORA-12152: TNS:unable to send break message

Fixed in 23c, patch available for earlier

Waiting for 23c

Before 23c: only one DRCP is allowed.

In 23c, it will be possible to have multiple DRCP configured.

Reading material

https://www.oracle.com/docs/tech/drcp-technical-brief.pdf


Come visit CERN!
https://visit.cern

Thank you !

andrzejnowicki

andrzej.nowicki@cern.ch

www.andrzejnowicki.pl