Oracle and Docker

Oracle Databases in Docker Container

Stefan Oehrli

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Platform Architect, Trainer and Partner at Trivadis
- Since 1997 active in various IT areas
- Since 2008 with Trivadis AG
- More than 20 years of experience in Oracle databases

Focus: Protecting data and operating databases securely
- Security assessments and reviews
- Database security concepts and their implementation
- Oracle Backup & Recovery concepts and troubleshooting
- Oracle Enterprise User Security, Advanced Security, Database Vault, …
- Oracle Directory Services

Co-author of the book The Oracle DBA (Hanser, 2016/07)

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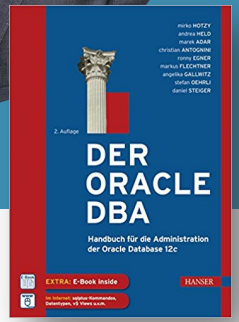

ORACLE ACE

BASEL | BERN | BRUGG | BUKAREST | DÜSSELDORF | FRANKFURT A.M. | FREIBURG I.BR. | GENF
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Agenda

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- Introduction
- Docker images, container and volumes
- Database image
- Database container
- Use cases
- Licensing
- Summary

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Introduction

What is Docker?

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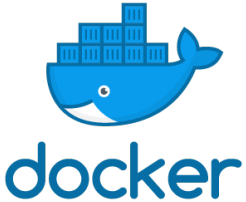

- One software container platform
  - Developed from Linux / Linux containers
- Available...
  - ... for Linux, Mac OS and Windows
  - ... as Community Edition (CE) and Enterprise Edition (EE)
- Part of the Linux Open Container Initiative (OCI)
- Docker is not the only implementation of Linux containers
  - Core OS / Rkt, LXC Linux Containers, OpenVZ, Mesos Containerizer,...
  - Docker has the largest market share
- Increase the **interchangeability** and **reproducibility** of objectives

Oracle support for Docker

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- Various Oracle products are supported and certified for Docker
  - MOS Note 2216342.1 *Oracle Support for Database Running on Docker*
  - MOS Note 2017945.1 *Support Information for Oracle WebLogic Server and Oracle Fusion Middleware Running in Docker Containers*
- Container Oracle Linux 7 / UEK4 Kernel or Red Hat Enterprise Linux 7 as base image
- Oracle sources for images or official build sources
  - Oracle Docker Build Sources on GitHub https://github.com/oracle/docker-images
  - Oracle Container Registry https://container-registry.oracle.com
  - Oracle Container Engine and Registry https://developer.oracle.com/containers
  - Oracle auf Docker Hub https://hub.docker.com/publishers/oracle

What else about containers?

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- There is no such thing as THE container.
- Single Process / Service
  - No replacement for VMs
- Small space requirement
- Dealing with identities and sensitive data
- Dealing with data persistent
- Understanding how to build containers, but
  - ...not every container has to be adapted individually
  - ...use available and trusted container repositories

Source: Volkswagen Advertising (June 2016)

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Docker images, container and volumes

Virtualization

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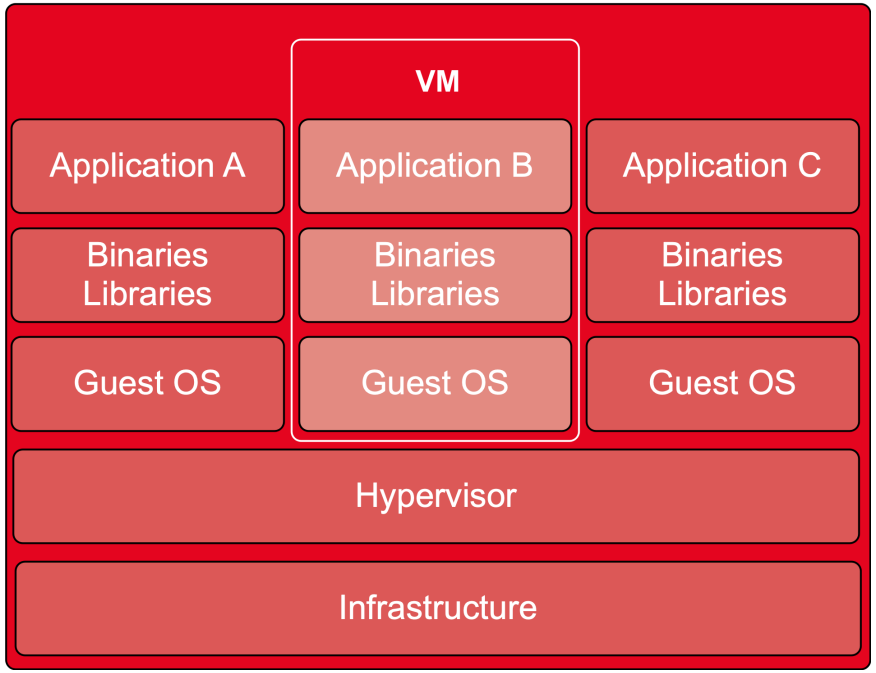
- Use of common infrastructure
- each VM is a "server
  - guest operating system
  - Software and libraries
  - uses
- Redundancy
- Effort for setting up the VMs



Docker container

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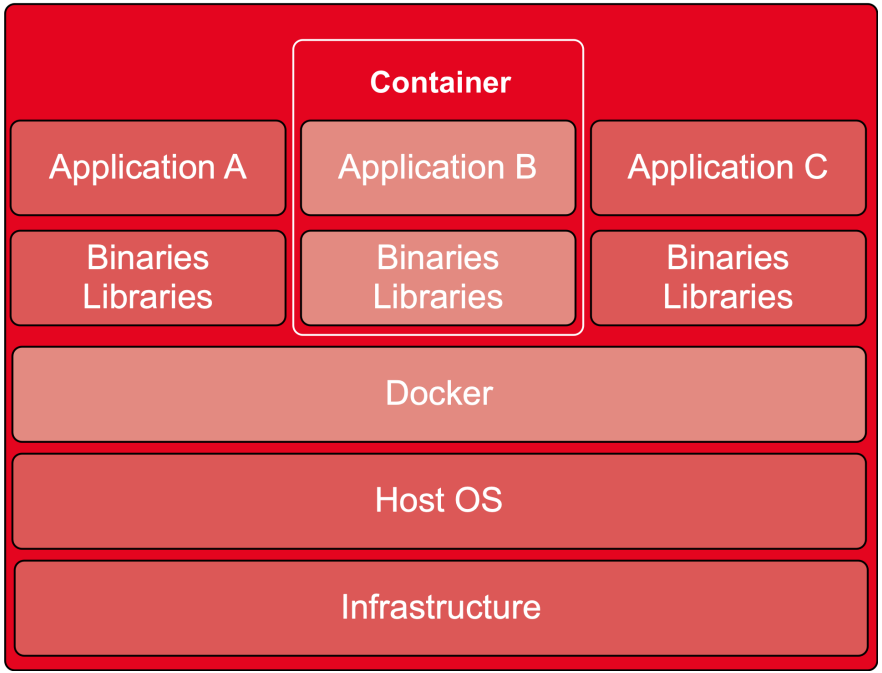

- Use of common infrastructure
- a host operating system
- Applications are "packaged
  - Only necessary libraries and software components
- Use of existing images
- Slim
- Reproducible
  - Because automatically created
- Docker Image are **immutable**

Docker components

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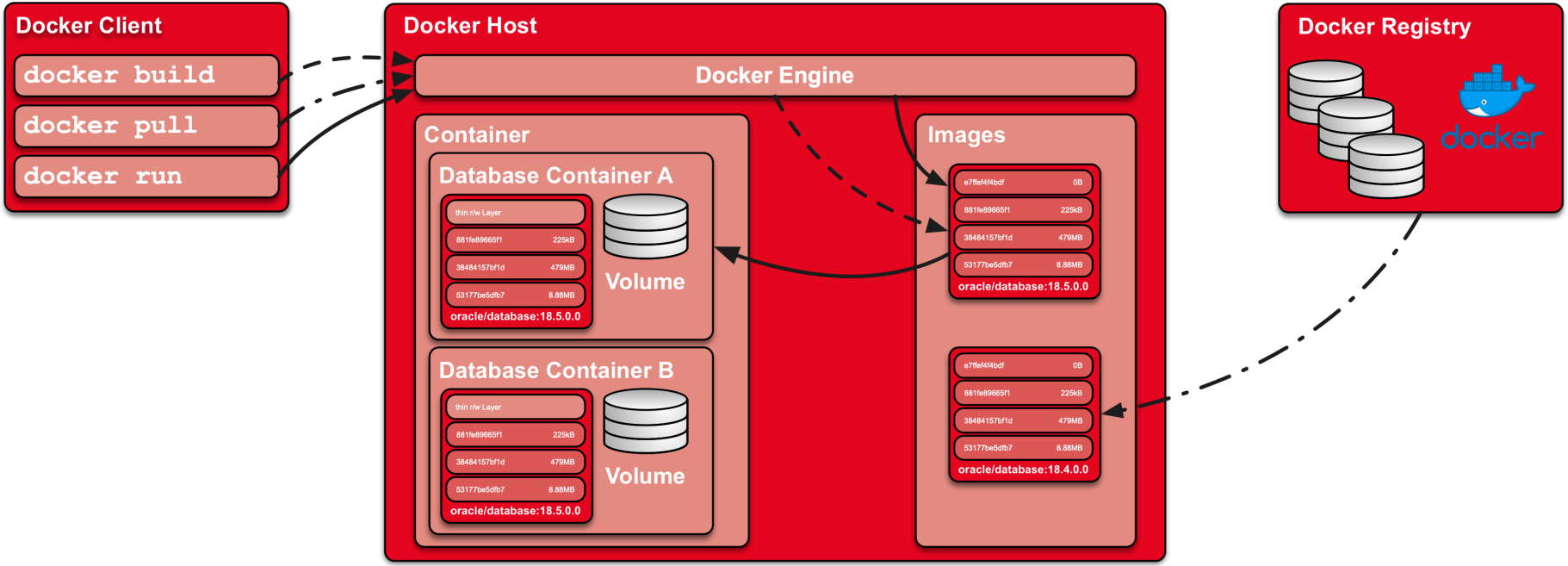

Volumes

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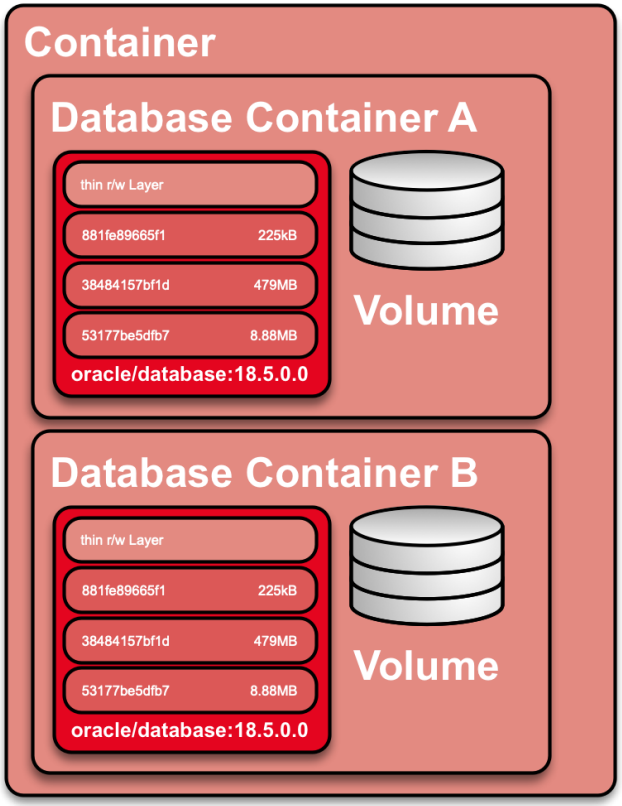
- Docker Image are immutable
  - Changes only in a new image
- A container is based on an image
  - Top Layer read/write
  - No persistence over the lifetime of the container
- Securing data persistence through volumes
  - Data is outside the container
- Lifecycle…
  - New image
  - New container
  - current volume



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Database image

Prerequisites

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- Docker environment e.g. Docker Desktop for Mac OS
- Deploying Oracle Software
  - Oracle Database Enterprise Edition 18c (18.3.0.0)
  - Oracle Database Release Update 18.6.0.0.0 (Patch 29301631)
  - Oracle OJVM Release Update 18.6.0.0.190416 (Patch 29249584)
  - OPatch 12.2.0.1.17 for DB 18.x releases (APR 2019) (Patch 6880880)
- Deploying the Docker Base Image

```
docker pull oraclelinux:7-slim
```

- Deploy the Docker Build scripts e.g. https://github.com/oehrlis/docker

```
git clone https://github.com/oehrlis/docker
```

Build image

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- Start Docker Build with the command **`docker build`**

```
cd docker/OracleDatabase/18.6.0.0
docker build -t oracle/database:18.6.0.0 .
```

- Dockerfile uses Multi-Stage Build
  - Available from Docker 17.05
  - Use of multiple FROM statements
  - Splitting the build process into several sections
  - Reduction of image size
- software is part of the build context and is copied
  - Optional download of the software from a local web server

Dockerfile

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- Base image
  - Setting the environment
  - OS configuration of the basic image
- Build image
  - Copying Oracle binaries and patch files
  - Installing the Oracle software
  - Installation of the Oracle Patch, Trivadis Basenv™
- Target image
  - Copying the software from the build image
  - Completion of the installation (root.sh scripts)
  - Definition of ports, volume and start script

Dockerfile

```
FROM oraclelinux:7-slim AS base
...
```

```
FROM base AS builder
...
```

```
FROM base
...
```

Image build scripts

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Dockerfile uses different scripts for configuring the image

- **00_setup_oradba_init.sh** Installation of the latest OraDBA Init scripts
- 01_setup_os_db.sh OS Setup Configuration
  - Users, create groups
  - Install YUM Software Packages
- **10_setup_db_18.6.sh** Installation of the Oracle Binaries
  - Oracle Basis Release
  - Release Updates and Oracle JVM Update
- **20_setup_basenv.sh** Installation of Trivadis BasEnvTM
- **5n_xxxxx_database.sh** Various scripts for configuring the container

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Database container

Oracle database container

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- Starting or instantiating an Oracle database container with `docker run`
  - specify host (`--hostname`) and container name (`--name`)
  - Volume for the database files
  - Oracle instance name as environment variable `ORACLE_SID`
  - Executing the container command `CMD`

```
docker run --detach --hostname tdb186s --name tdb186s \
  --volume /data/docker/volumes/tdb186s:/u01 \
  -p 1521:1521 -p 5500:5500 -e ORACLE_SID=TDB186S \
  oracle/database:18.6.0.0
```

- Control of the container log and status of the DB with **`docker logs -f tdb186s`**

Procedure for container start

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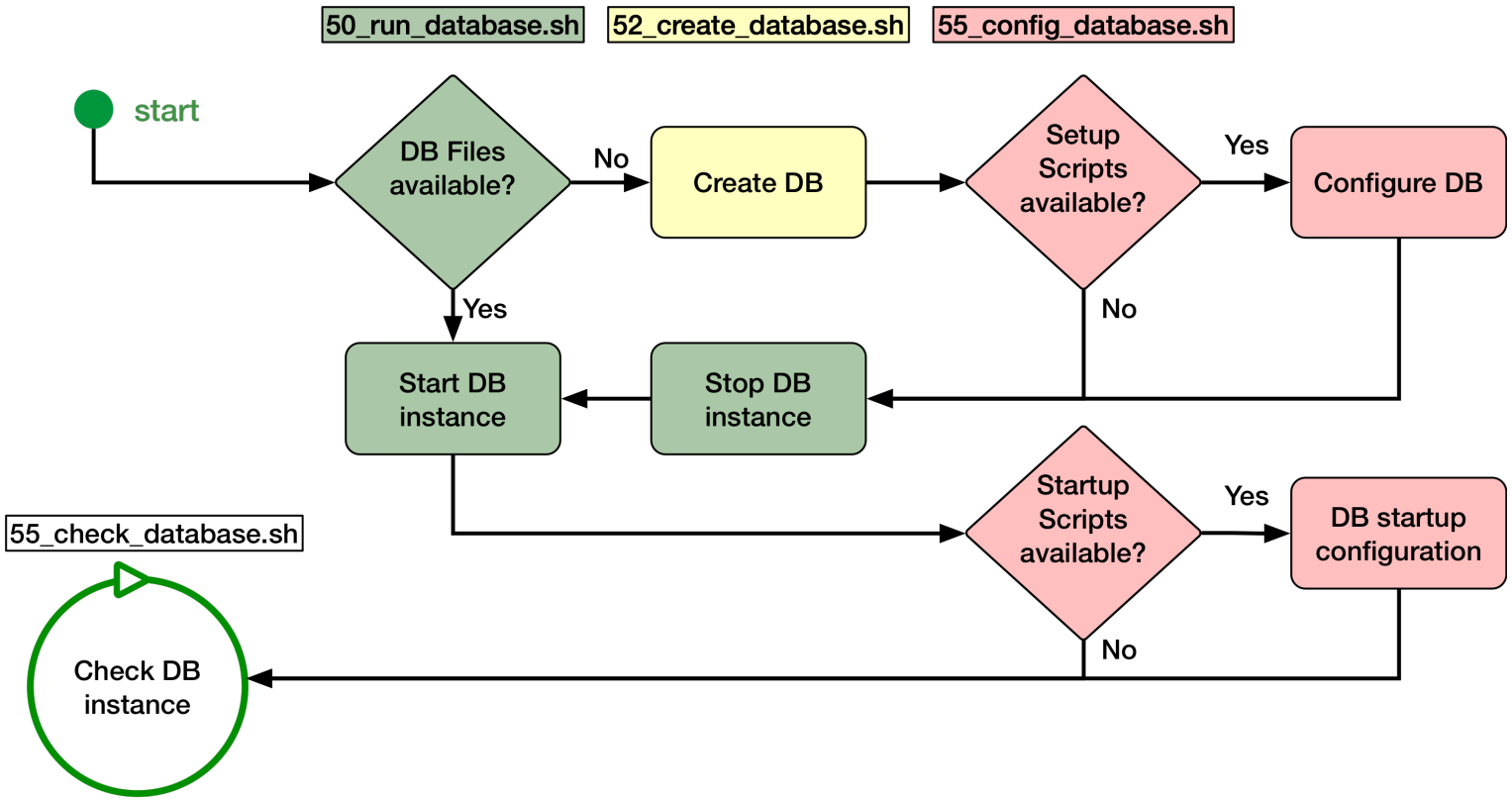

Container Scripts

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- **50_run_database.**sh checks the volume and starts the database with…
  - **50_start_database.sh** If no database exists, the script
  - **52_create_database.sh** is called
- **50_start_database.sh** starts the listener and the database instance
- **52_create_database.sh** creates a database with the dbca. Base parameters can be adjusted with environment variables
- **55_config_database.sh** checks whether configuration files (*.sh or *.sql) are present in the directory `${INSTANCE_INIT}/setup` or `${INSTANCE_INIT}/startup` respectively.
- **55_check_database.sh** is used for the health check of the Docker container and checks the status of the database instance

Container variables

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Variable	Purpose
ORACLE_SID	Oracle SID or database name. Default value is TDB186S
CONTAINER	Flag for creating an Oracle container database Default value is FALSE
ORACLE_PDB	Oracle PDB Name. Default value PDB1
ORACLE CHARACTERSET	Oracle character set. Default value AL32UTF8
ORACLE_PWD	Password for the SYS user. The default password is generated and stored in the admin directory
INSTANCE_INIT	Directory for the instance configuration files
ORADBA_RSP	Various variables for the adaptation of the dbca template

Completion of initial container start

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- At the first start, **50_run_database.sh** creates a database.
- Checking the output of 50_run_database.sh with `docker logs tdb186s`

```
SQL> Disconnected from Oracle Database 18c Enterprise Edition Release 18.0.0.0.0 - Production
Version 18.6.0.0.0
/u00/app/oracle
/u00/app/oracle
The Oracle base remains unchanged with value /u00/app/oracle
-----------------------------------------------------------------
 - DATABASE TDB186S IS READY TO USE!
-----------------------------------------------------------------
-----------------------------------------------------------------
   Tail output of alert log from TDB186S:
-----------------------------------------------------------------
The following output is now a tail of the alert.log:
Starting background process AQPC
2019-05-21T08:39:24.818101+00:00
AQPC started with pid=45, OS id=3873
2019-05-21T08:39:26.200725+00:00
Starting background process CJQ0
Completed: ALTER DATABASE OPEN
```

Access to the database container

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- Access for applications via exported ports e.g. 1521
  - Different whether on Windows, MacOS and Linux
  - Docker runs on Linux "native" only
- Access via command line with **`docker exec`** and sqlplus, bash etc.

```
soe@gaia:~/docker/OracleDatabase/18.6.0.0/ [ic12201] docker exec -it tdb186s sqlplus / as sysdba

SQL*Plus: Release 18.0.0.0.0 - Production on Tue May 21 08:23:56 2019
Version 18.6.0.0.0

Copyright (c) 1982, 2018, Oracle.  All rights reserved.


Connected to:
Oracle Database 18c Enterprise Edition Release 18.0.0.0.0 - Production
Version 18.6.0.0.0

SQL>
```

Access to the database container

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  - Docker runs on Linux "native" only
- Access via command line with **`docker exec`** and sqlplus, bash etc.

```
soe@gaia:~/docker/OracleDatabase/18.6.0.0/ [ic12201] docker exec -it tdb186s bash --login

TYPE (Cluster|DG) : SID/PROCESS  STATUS      HOME      [2019-05-21 08:37:25]
-------------------------------------------------------------------------------
Dummy rdbms_ee     : rdbms18600   n/a         /u00/app/oracle/product/18.0.0.0

DB-instance (N|N)  : TDB186S      open        /u00/app/oracle/product/18.0.0.0

Listener           : LISTENER     up          /u00/app/oracle/product/18.0.0.0

oracle@tdb186s:/u00/app/oracle/ [rdbms18600]
```

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Use cases

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- Oracle databases in containers can also be used in a microservice environment
- Corresponding build and configuration scripts must be developed individually
- Real Application Cluster (RAC) for test and development officially supported
  - Oracle example on GitHub https://github.com/oracle/docker-images
- Use of Oracle Container
  - Docker container contains single-PDB
  - PDB can be plugged/unplugged relatively easily
- Using Docker Compose
  - No manual docker commands
  - Link container
  - Establishment of a private network

Docker compose

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- Define all parameter, volumes, network etc. in a YAML file
  - Default name is **docker-compose.yml**
  - Can contain multiple containers
- Started and managed via **docker-compose** command or regular **docker** command
- Start the container in background / detach

```
docker-compose up -d
```

- Shutting down either by stop or down
  - **down** will remove the container
  - **stop** just stops the service / container

```
docker-compose down
```

Docker compose file

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- Example **docker-compose.yml file** for tdb186s
  - YAML, watches out for the correct whitespace characters

```
tdb186s:
  image: ${DOCKER_USER}/${DOCKER_REPO}:18.6.0.0
  container_name: tdb186s
  hostname: tdb186s
  restart: unless-stopped
  network_mode: bridge
  volumes:
    - ${DOCKER_VOLUME_BASE}/tdb186s:/u01
    - ./config:/u01/config
  ports:
    - "1521"
  environment:
    CONTAINER: 'FALSE’
    INSTANCE_INIT: /u01/config
    ORACLE_SID: TDB186S
```

Oracle Enterprise User Security

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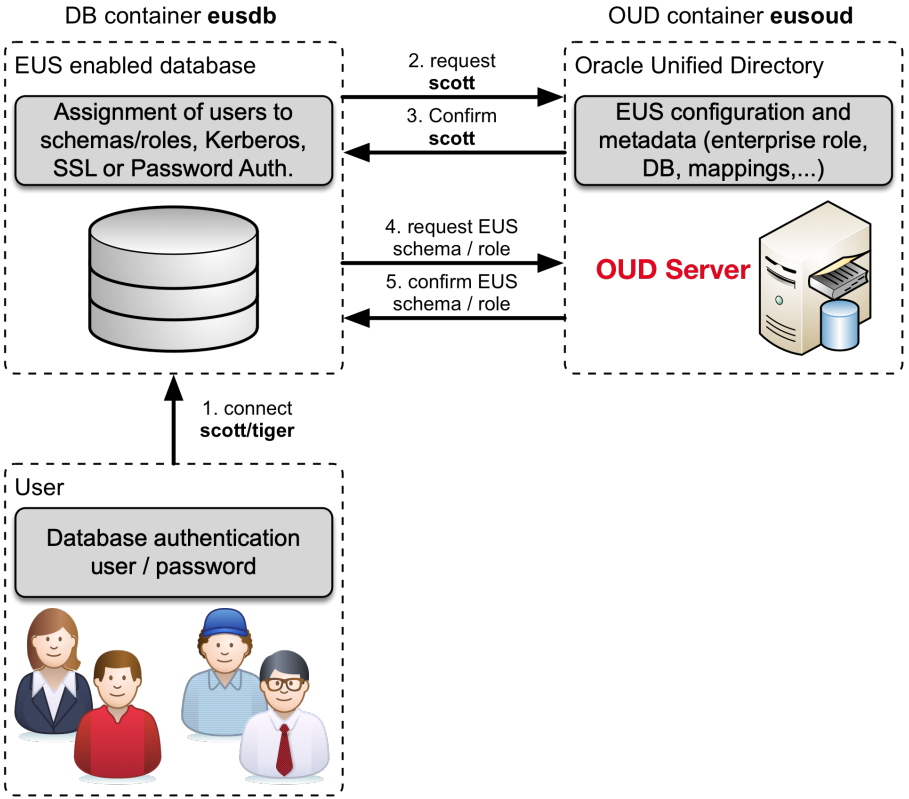
- Oracle Database Container
  - Demo Schema with VPD
- Oracle Unified Directory Container
  - Directory with EUS suffix
- Initial start of containers
  - Creating the DB / Directory
  - Registration of the DB
  - Configuration of EUS
- Available on GitHub
  - https://github.com/oehrlis/docker/tree/master/samples/eus



Oracle DB and Docker best practice

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- Always use the latest Docker version at least Docker CE 17.03
  - **`btrfs`** is the recommended storage driver alternative **`overlay2`**
- Use latest images and build files
- Use data containers or volumes to ensure persistence
- Container are not VM's
  - Patching, HA, B&R and Security work differently
  - Basically there is no reason to login to the container

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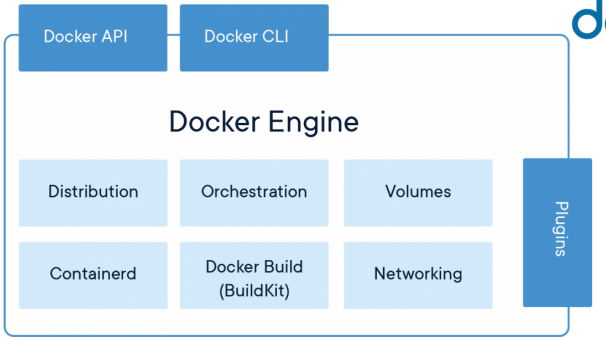
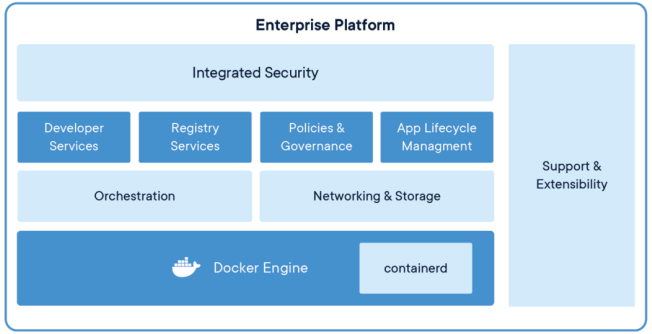
Licensing

Licensing - Docker

- Docker Desktop
  - Docker application for Mac or Windows
  - Available as community and new enterprise version
- Docker Engine
  - Available for different Linux distributions
  - Community and enterprise version available
- Docker Enterprise
  - Complete container platform based on Docker Engine
  - Additional components like support, trusted registry, orchestration, security etc.





Source: https://www.docker.com/products

Licensing - Oracle

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Oracle Software

- Docker allows to limit resources like CPU, Memory, etc.
- Limitation not applicable in the context of Oracle licensing!
- CPU cores of the Docker hosts determine the required licenses
- Analogous challenge to virtualization

Possible solutions

- Using Oracle Express Edition 18c in the Docker Environment
- Oracle ULA (Unlimited License Agreement)
- Development of a dedicated docker infrastructure for Oracle software

18c ORACLE Database

Source: Oracle Inc.

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Summary

Summary

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- Oracle databases can be set up easily and quickly in containers.
- Docker based databases are not suited for high io performance.
- Use of Docker volumes is mandatory to ensures data persistence.
- The development of clear use cases and suitable architecture is a prerequisite.
- As with virtualization, licensing remains one of the major challenges.

Question and answers...

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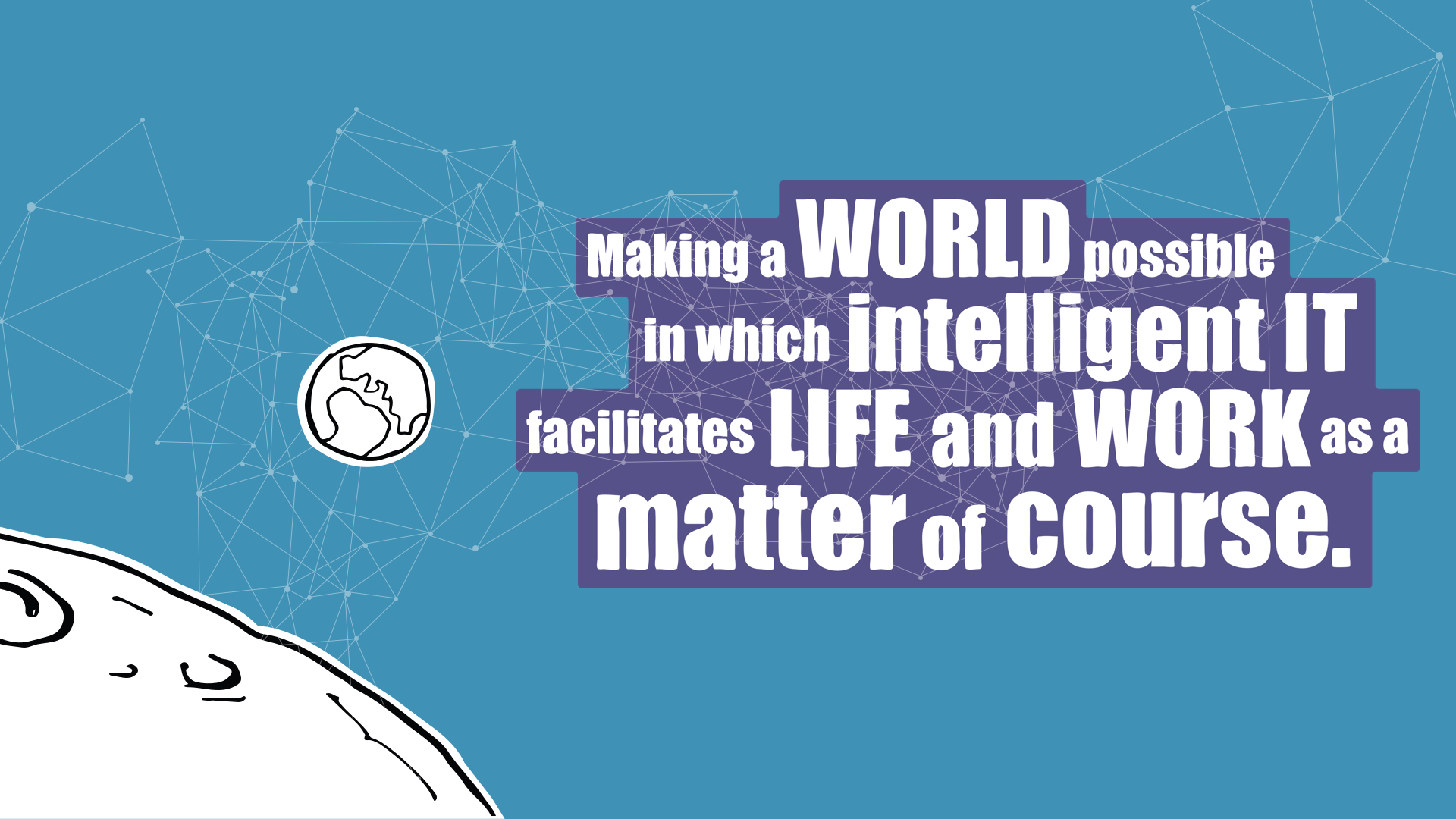
Making a WORLD possible
in which intelligent IT
facilitates LIFE and WORK as a
matter of course.