

Oracle Converged Database

Overview

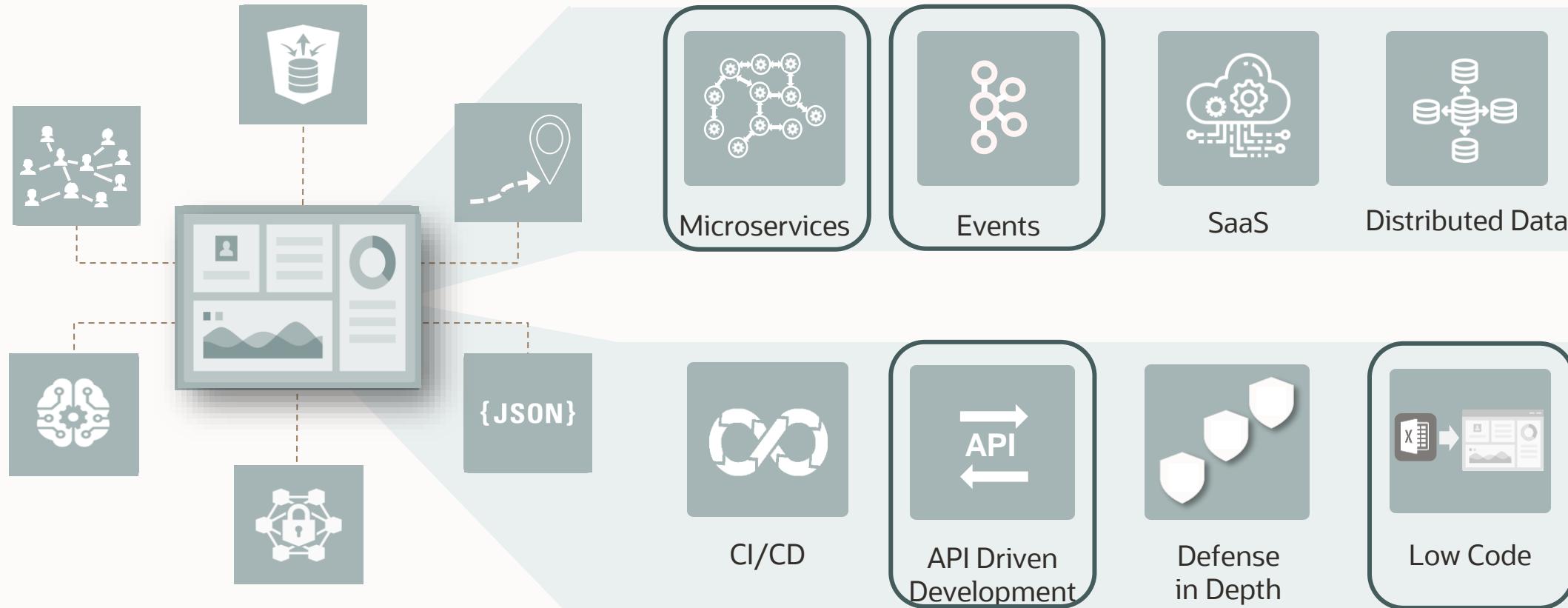
Witold Świerzy

EMEA Data Management Expert

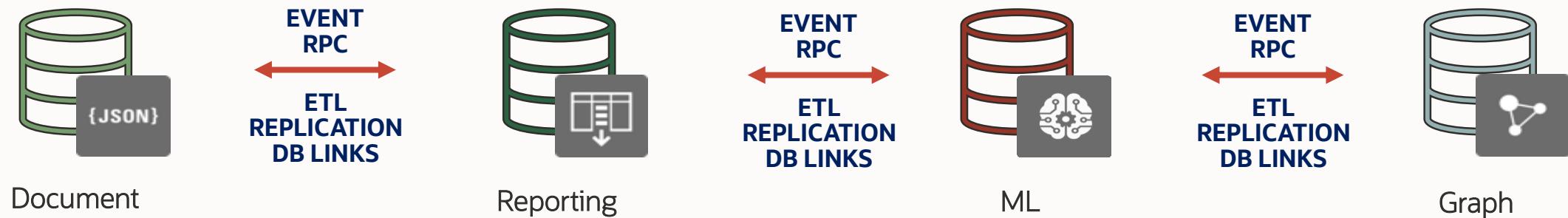
April 2023



Modern Apps Need To Generate Value From Data in New Ways They Are Built Using New Development Methodologies and Technologies



Traditional paradigm: using multiple single-purpose databases



Traditional paradigm assumes using many single-purpose databases drives to

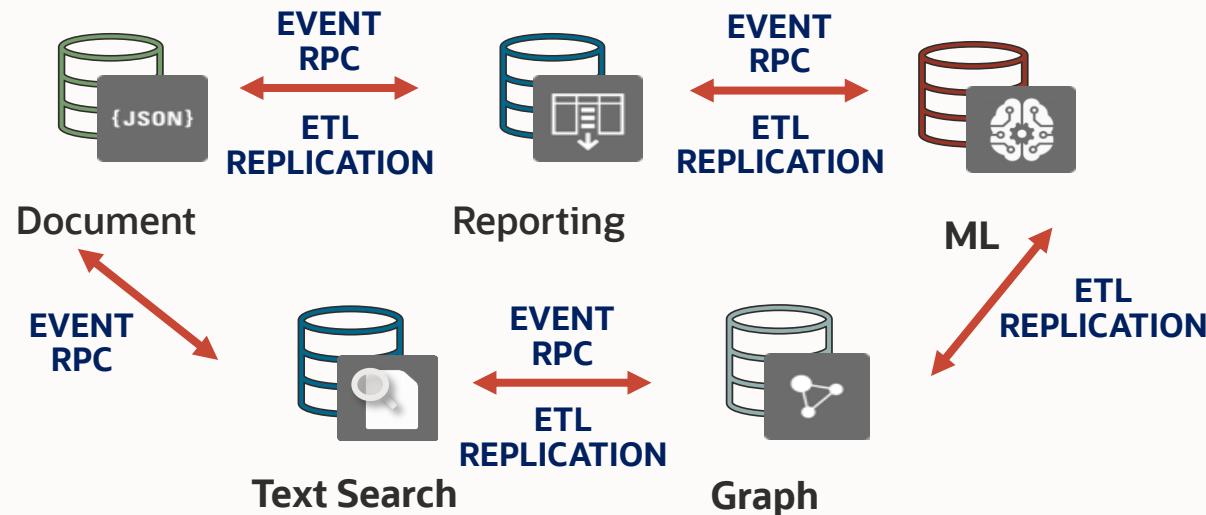
- High level of complexity of maintenance and development process
- High TCO Costs

Contrasting Developer Architectures

Heterogeneous Strategy

Developers Focused on Integration

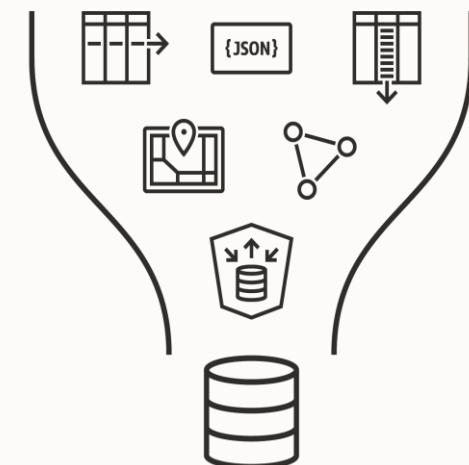
Every app requires **distributed execution** and **data movement** across multiple fragmented databases



Oracle Strategy

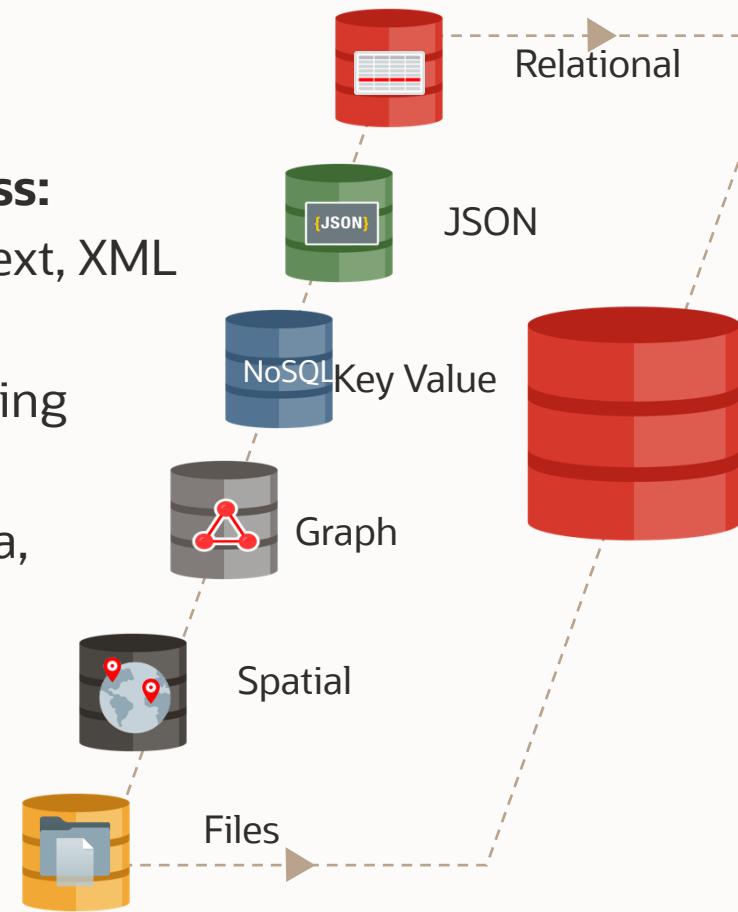
Developers Focused on Innovation

Simply invoke a SQL or REST API to run report, ML, graph, spatial, blockchain, IoT, etc. in a **converged** database



Oracle Converged Cross-Model Database

- Any data, all workloads
- Full data synergy
- Best in class in **Every Class**:
 - Documents - JSON, Text, XML
 - Key-Value
 - AI and Machine Learning
 - Spatial and Graph
 - IoT, Times Series, Data, FS, Binary Data, etc.



Developers get what they want

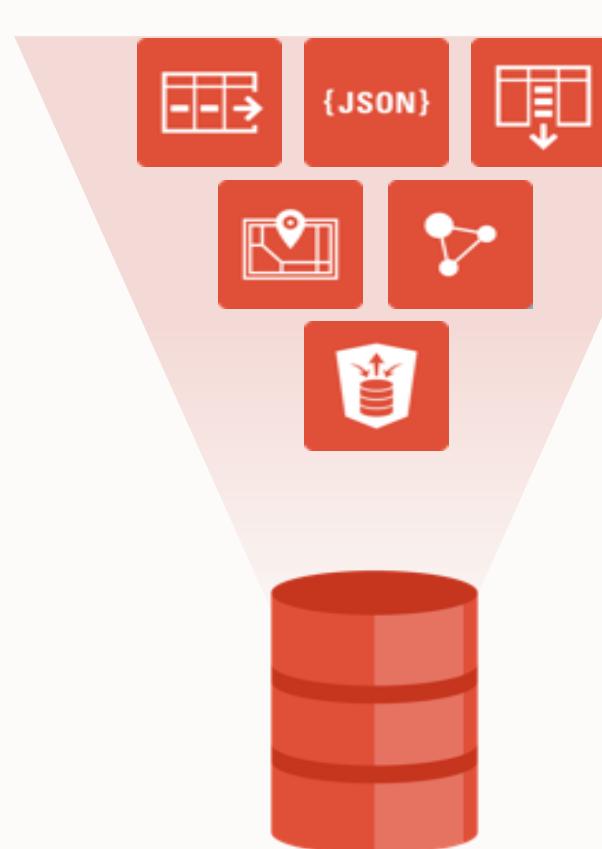
- Open Standards
- Simple APIs
- Polyglot
- Query across all data types
- **ACID Transactions across all data types without any limitations**

Analysts & Ops get what they need

- Consistent, queryable view of data
- Powerful query and analytics
- Reliability
- Scalability
- Security

Oracle Converged Database

support for all modern Languages/Drivers/Tools/APIs



C
C++
Java
.Net
JavaScript
Python
PHP
R
Go
Rust
Ruby
Perl

- SQL and PL/SQL
 - SQL Developer, Data Modeler
 - VS Code plugin
 - SQLcl (modern sqlplus)
 - With *Advanced Liquibase*
- Collections API
- SODA drivers
 - JSON results
- Data As a Microservice with REST API
- JSON Data through HTTPS

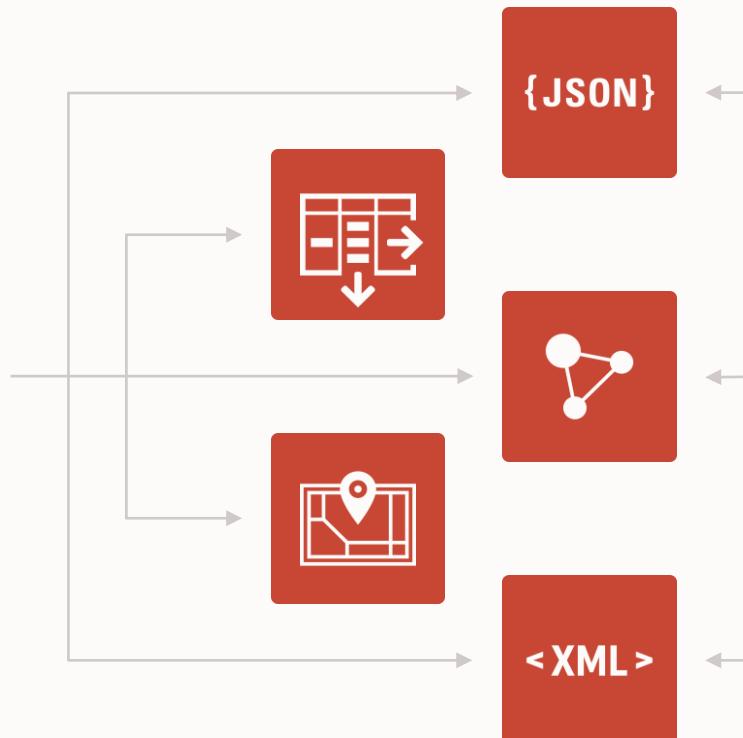
Oracle Converged Database

Access data via SQL & REST or model-specific APIs: your choice

Cross-Model Data Access

SQL & REST

Relational, Graph,
Document, Spatial,
Temporal, multidimensional



Model-Specific Data Access

SODA

Pre-built REST APIs for JSON

PGQL

Property
Graph

SPARQL

RDF Graph

XQUERY

Developers can easily access multiple data models simultaneously via SQL, REST and APIs

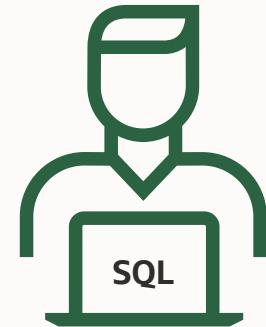
Oracle Converged Database

Accessing the data with the **universal language of SQL**

Oracle makes it simple to access data from all data models via a single query

For example, a recommendation query can span 3 different models:

1. Find a customers' friends within 3-hop friendship (Graph)
2. Identify those who have watched similar movies (JSON)
3. And those who provided feedback with a 5-star rating (Key-Value)



Oracle Database allows developers to query external data via external tables

- Data can reside locally, in Hadoop, NoSQL and/or any cloud storage
- Data can be in a variety of formats, including delimited, Parquet, ORC, Avro, JSON, and more
- Can be used in any query or transaction alongside data persisted in the database

Oracle Cross-Model Converged Database

holistic view of all the data



```
select p.id, p.name,  
       sl.json_doc.quantity Anzahl  
  from  
product p, customer c, store s, sales sl  
 where  
sl.json_value(json_doc,'$.product_id')=p.id  
and  
contains(p.notes,fuzzy('Lifferkosten'), 1) > 0  
and  
sl.json_value(json_doc,'$.CUSTNumber'  
returning number) = c.cust_ids  
and  
s.store_id = 1234  
and  
sdo_within_distance(c.location,  
s.location,'distance=20')='TRUE'
```

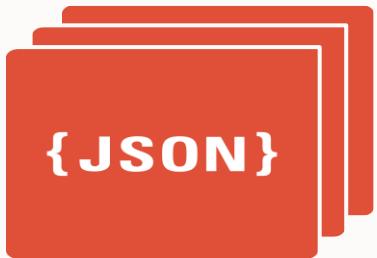
Oracle JSON

Oracle Text

Oracle Spatial

Oracle Converged Database

Support for JSON and XML documents



Oracle makes it simple to use **JSON** and **XML** documents

Freely mix JSON and non-JSON data types

Native Data Guide allows you to quickly determine what data you have

Transparent scale-out with Full ACID transactions

Index any JSON element for fast OLTP

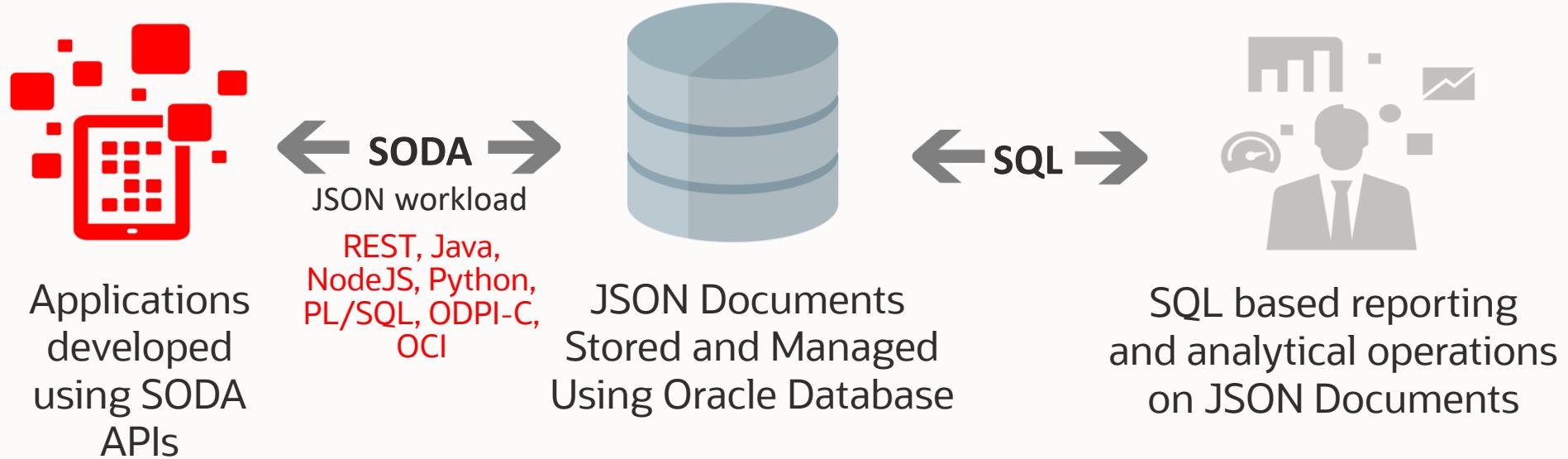
Declarative Parallel SQL processing on all formats

Run complex joins across multiple JSON documents and collections

No need for custom application code to accomplish basic data management tasks

Oracle Converged Database

support for JSON data and SODA API



Access JSON Data via Oracle SODA (Simple Oracle Document Access)



No need to know SQL!

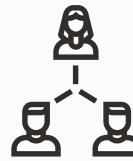
- Any Oracle Database supports SODA
 - On Premises (12.2 and beyond)
 - All Cloud Services
- Enable schema-less development on top of an Oracle Database
- Provide a simple NoSQL-style API for working with documents
 - Use to manage JSON data in Oracle Database for CRUD (Create, Read, Update, Delete) operations
- Make it easy to use Oracle as a NoSQL-style document store
 - Allow developers to work with Oracle without learning SQL
 - Allow a developer to work with Oracle without DBA support

SODA in Command Line

Examples: CRUD operations

- Create a collection or insert new documents to a collection

```
soda create musiccollection;
soda insert musiccollection {"name": "Rolling
Stones", "img_url": "..."};
```



- Retrieve documents from a collection

```
soda get musiccollection -f {"name": "Queen"};
```

- Update existing documents in a collection

```
soda replace musiccollection
5B34ED2FDCE643A1AAA2519B47B18ED0 {"name": "Pink
Floyd", "img_url": "..."};
```

- Delete operation

```
soda remove musiccollection -k {"name": "The Eagles"}
```

SQL> desc musiccollection

Name	Null?	Type
ID	NOT NULL	VARCHAR2(255)
CREATED_ON	NOT NULL	TIMESTAMP(6)
LAST_MODIFIED	NOT NULL	TIMESTAMP(6)
VERSION	NOT NULL	VARCHAR2(255)
JSON_DOCUMENT		BLOB

SQL> info musiccollection

TABLE: MUSICCOLLECTION
LAST ANALYZED:2022-04-06 16:48:01.0
ROWS :4
SAMPLE SIZE :4
INMEMORY :DISABLED
COMMENTS :

Columns

NAME	DATA TYPE	NULL
*ID	VARCHAR2(255 BYTE)	No

...

Indexes

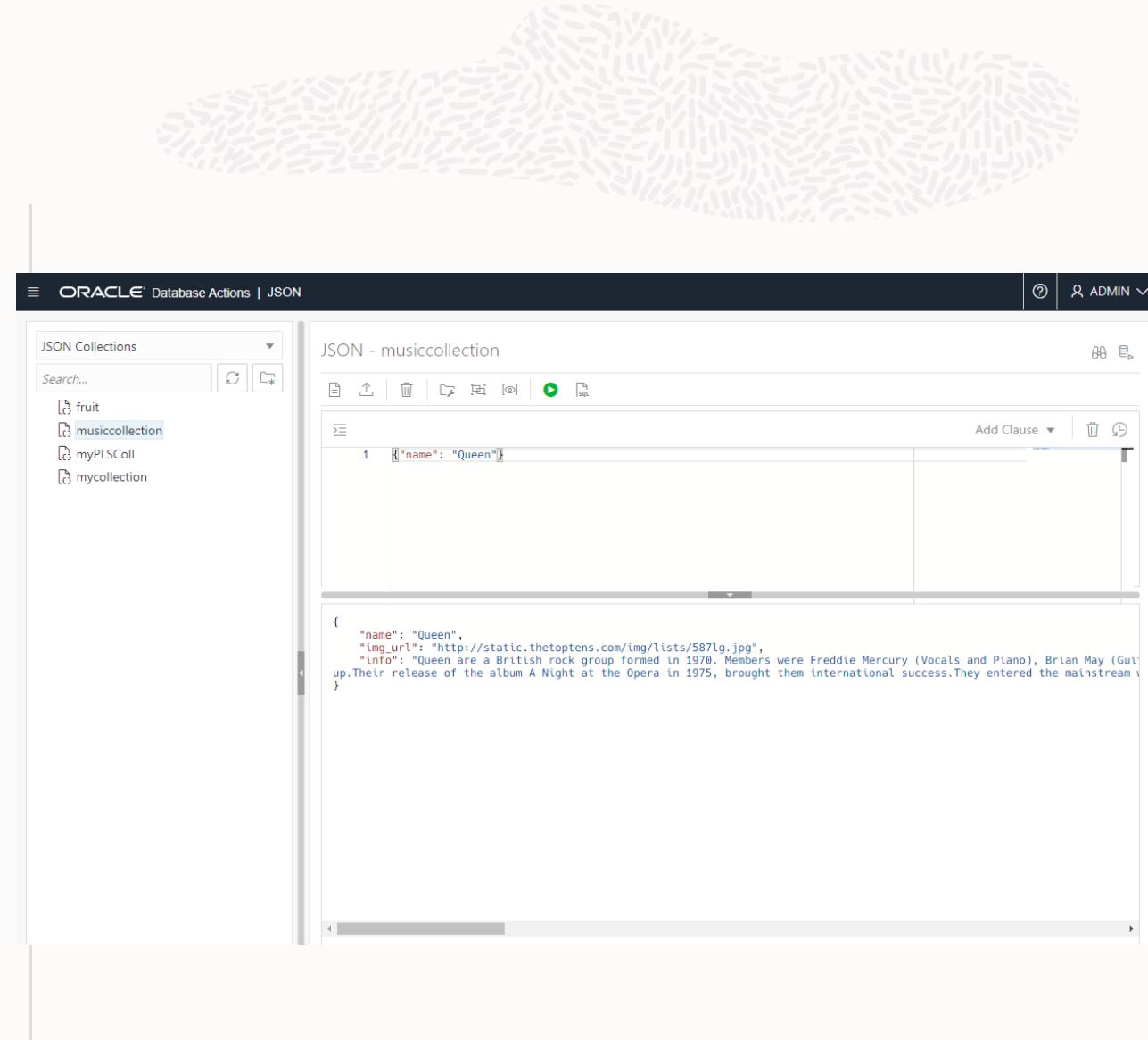
ADMIN.SYS_C0030132	UNIQUE	VALID	ID
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What's behind?



Database Actions: {} JSON

- Create, edit and manage collections and documents
- Search using Query By Example (QBE)
- Create search, functional or spatial indexes
- View the JSON Data Guide diagram for a collection



Oracle Database - support for MongoDB

Develop and run MongoDB workloads in the Oracle Database



Modern document-centric development

- JSON Collections-based data model
- Rich clients – MongoDB API, REST and SODA based development API
- Native JSON storage with advanced indexes and optimized performance

... and proven enterprise functionality

- **Full ACID Transactions without any limitations**
- **SQL-based Reporting and Analytics (including scalable parallel execution, ML/AI built in the database)**

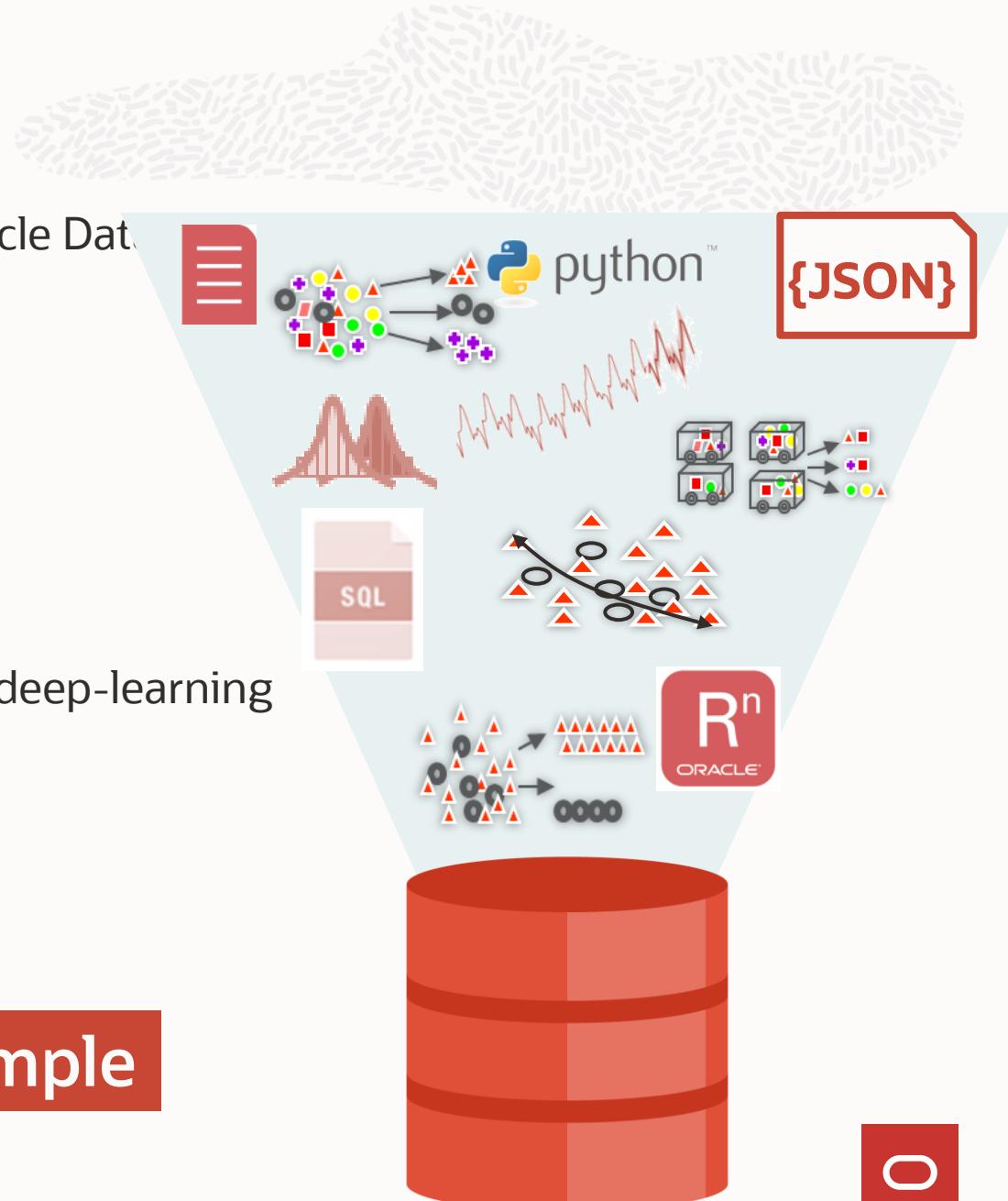
... running on any Oracle Database edition

- Availability
- Security
- Elasticity

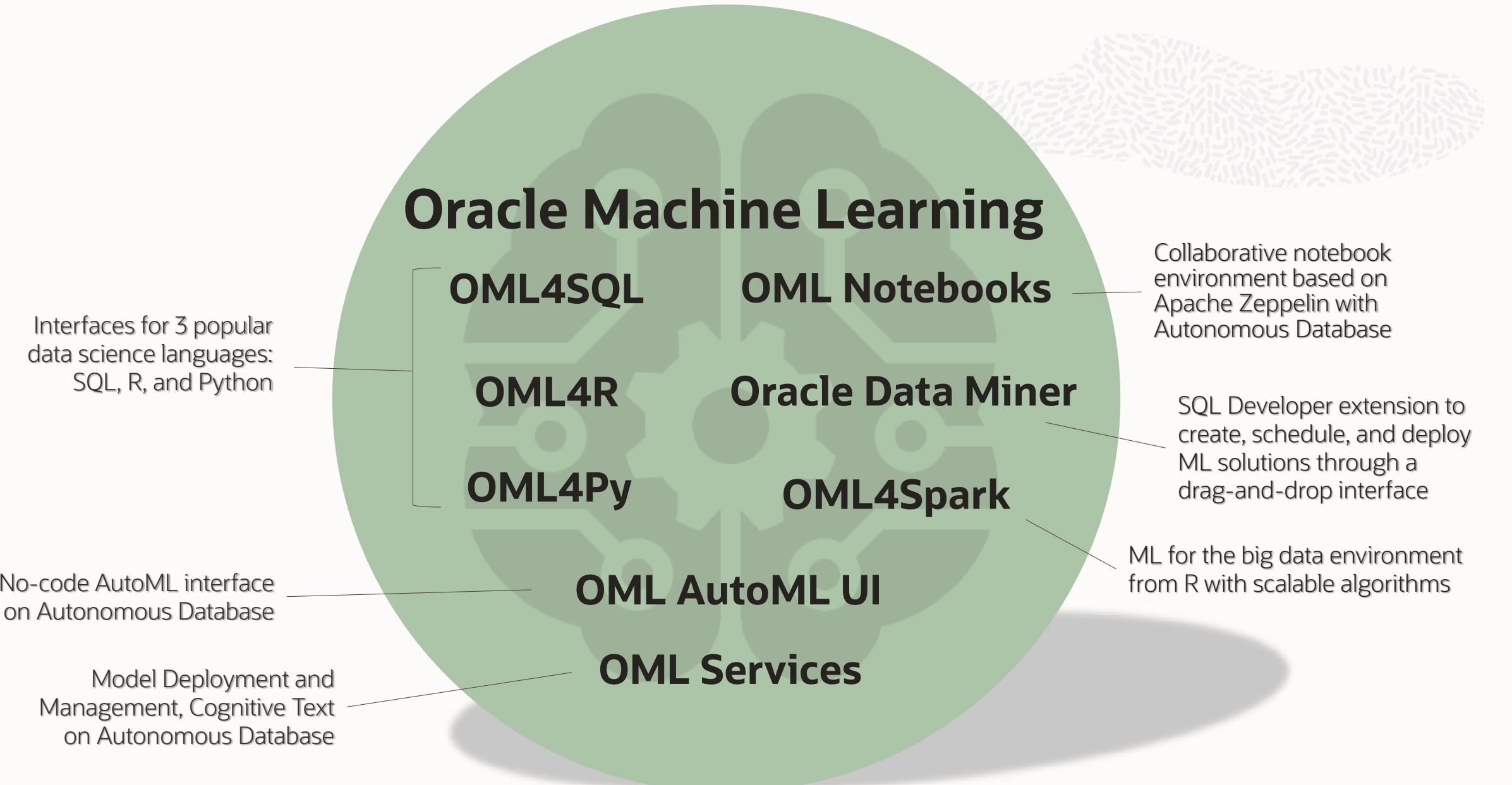
Oracle Converged Database

Machine Learning integrated in Oracle Database

- Machine learning models and algorithms run inside Oracle Database
 - Data stays in-place
 - Massively parallel execution
- Flexible model building
 - SQL, R or Python
 - Oracle Data Miner
 - Oracle AutoML
 - Over 30 in-database **parallel** ML algorithms including deep-learning



Oracle Makes Machine Learning Simple



Supervised Learning vs Unsupervised Learning

Two categories of Machine Learning algorithms

Supervised Learning

Has a known answer (target) to learn from and compare against

- **Classification** predicts a discrete target
- **Regression** predicts a continuous numeric target
- **Time Series Forecasting** predicts time-dependent future values based on previously observed values

Terms related to this category

Target is what you're trying to predict

Predictors/variables/features are data used to predict the target

Case ID is the unique identifier per row/example/case

ML Model is the representation of the patterns found in the data, that can be used to serve a particular purpose in the context of an algorithm

[OML Algorithm Cheat Sheet](#)



Unsupervised Learning

Finds patterns, but no known answer to learn from or compare against

- **Clustering** groups objects such that objects in the same group are more similar to each other, than to those in other groups (clusters)
- **Market Basket Analyzis** (Association Rules) discovers the rules, that determine how or why certain items are connected: happen, used or purchased together
- **Anomaly Detection** finds unusual cases in data, that may warrant further exploration or investigation
- **Feature Extraction** creates derived values (feature) used in subsequent ML steps , may concentrate the " signal" in the data



Oracle Machine Learning Algorithms and Analytics in Oracle Database

CLASSIFICATION

- Naïve Bayes
- Logistic Regression (GLM)
- Decision Tree
- Random Forest
- Neural Network
- Support Vector Machine (SVM)
- Explicit Semantic Analysis
- *XGBoost**

ANOMALY DETECTION

- One-Class SVM
- *MSET-SPRT**

CLUSTERING

- Hierarchical K-Means
- Hierarchical O-Cluster
- Expectation Maximization (EM)

TIME SERIES

- Forecasting - Exponential Smoothing
- Includes popular models
e.g. Holt-Winters with trends, seasonality, irregular time series

[OML Algorithm Cheat Sheet](#)

REGRESSION

- Generalized Linear Model (GLM)
- Support Vector Machine (SVM)
- Stepwise Linear regression
- Neural Network
- *XGBoost**

ATTRIBUTE IMPORTANCE

- Minimum Description Length
- Random Forest
- Unsupervised Pairwise KL Divergence
- CUR decomposition for row & AI

ASSOCIATION RULES

- A priori

PREDICTIVE QUERIES

- Predict, cluster, detect, features

SQL ANALYTICS

- SQL Windows
- SQL Patterns
- SQL Aggregates

FEATURE EXTRACTION

- Principal Comp Analysis (PCA)
- Non-negative Matrix Factorization
- Singular Value Decomposition (SVD)
- Explicit Semantic Analysis (ESA)

ROW IMPORTANCE

- CUR Decomposition

RANKING

- *XGBoost**

TEXT MINING SUPPORT

- Algorithms support text columns
- Tokenization and theme extraction
- Explicit Semantic Analysis (ESA)

STATISTICAL FUNCTIONS

- min, max, median, stdev, t-test, F-test, Pearson's, Chi-Sq, ANOVA, etc.

Includes support for Partitioned Models, Transactional data and aggregations

* *New in 21c*

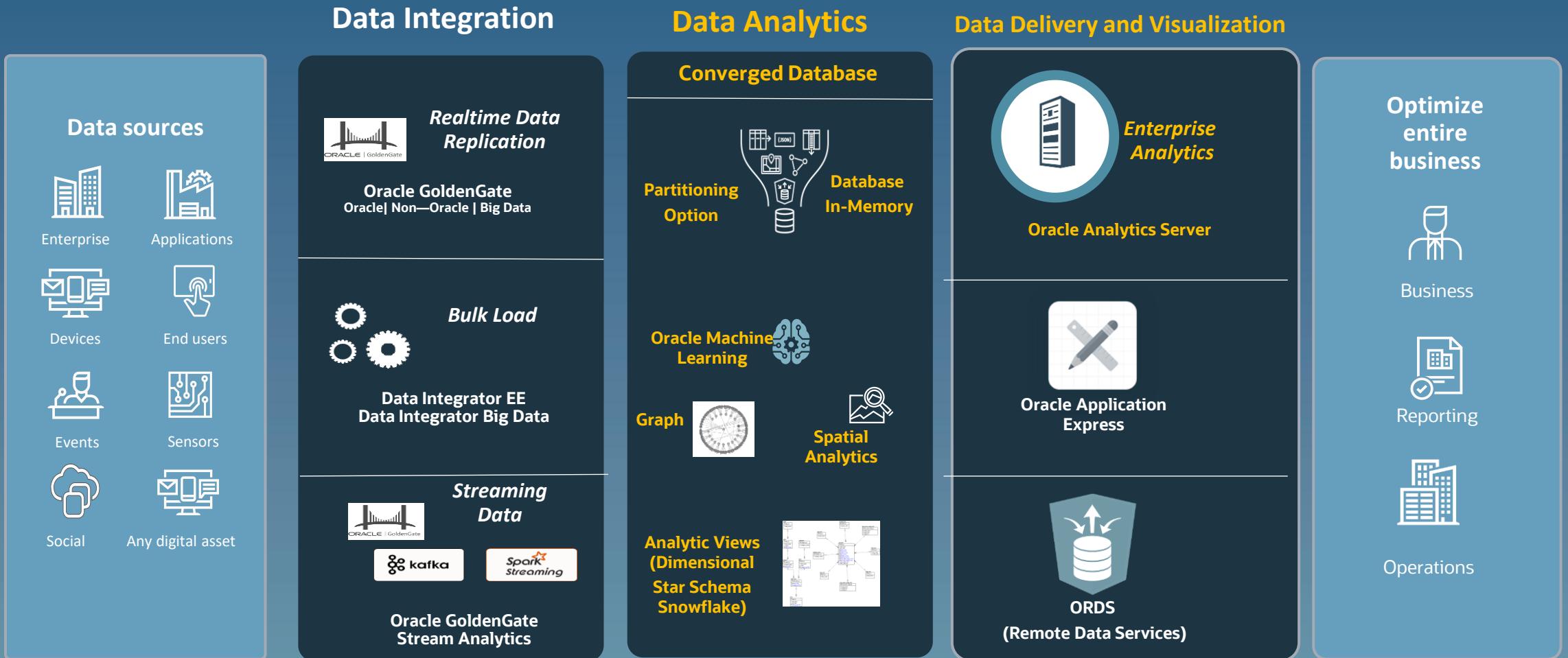


Oracle Machine Learning interfaces and platform availability

IDE	OML Component	Oracle Autonomous Database (19c, 21c)	Oracle Database (19c, 21c, 23c)	Oracle DBCS	Oracle Exadata CI/C@C
SQL Developer SQL*Plus	OML4SQL	✓ ADB-S, ADB-D, ADB C@C	✓	✓	✓
Python client PyCharm, Zeppelin, Jupyter	OML4Py	✓ ADB-S	✓	✓	✓
R client RStudio (Server)	OML4R	✓ ADB-S	✓	✓	✓
Zeppelin Notebook	OML Notebooks (SQL, PL/SQL, Python, markdown)	✓ ADB-S			
No-code UI	OML AutoML UI	✓ ADB-S			
REST API clients Postman	OML Services	✓ ADB-S			
No-code UI in SQL Developer	Oracle Data Miner	✓ ADB-S, ADB-D, ADB C@C	✓	✓	✓



Oracle Solutions for a *Converged Data Platform* for Analytics



Oracle Converged Database

support for Graph Analytics



Oracle makes it simple to use Graph Analytics to discover:

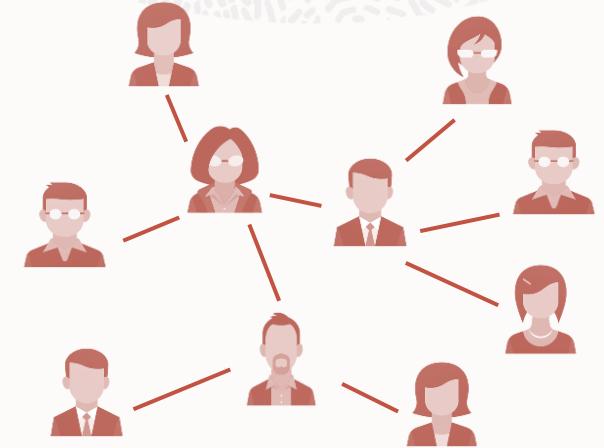
- Influencers, dependencies, communities, ranking, customer 360, etc.

Over 50 in-memory parallel analytic graph functions

- Easy implementation with declarative SQL-like queries

Oracle also provides an Open-Source Graph Query Language (PGQL)

PGQL allows users to specify graph patterns which are matched against vertices and edges in a graph



Previously a priced option, now **FREE** in all Oracle Database Editions

Graph Analytics

PGQL

SQL-like graph pattern query language

- Fixed-length patterns
- Variable-length patterns
- Taking into account labels on vertices and edges

Using SQL constructs

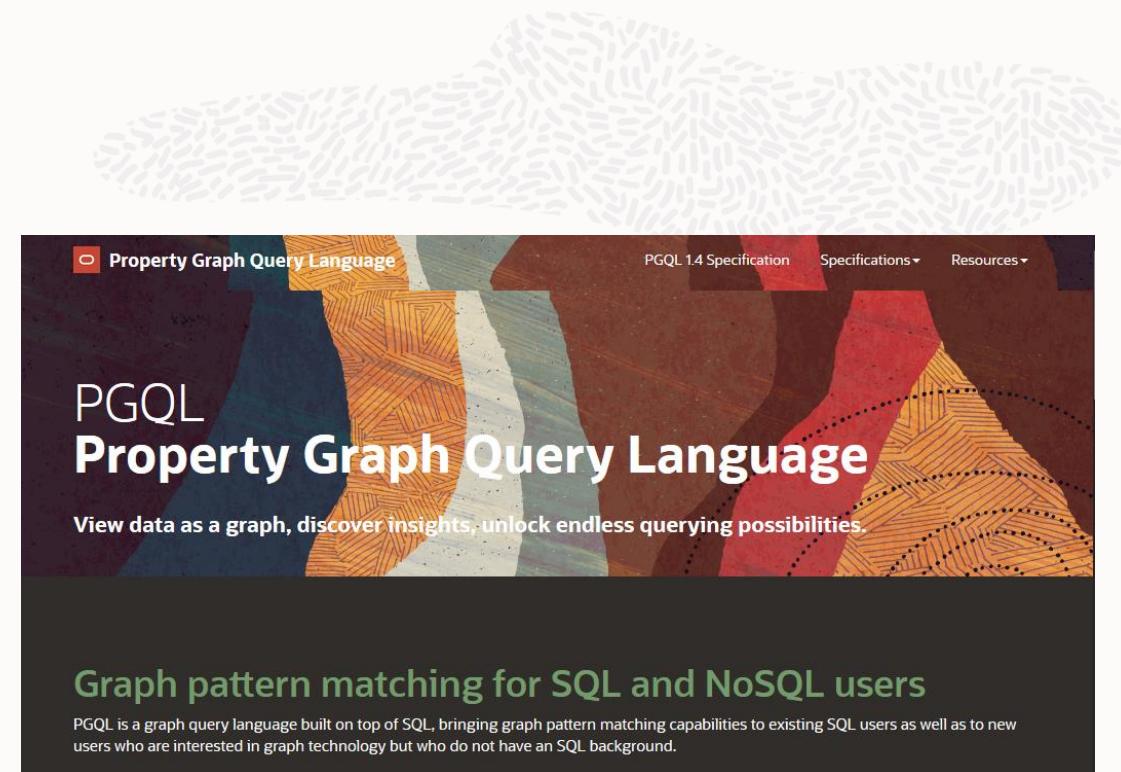
- SELECT, FROM, WHERE, GROUP BY, ...
- Subqueries like WHERE EXISTS
- Complement with graph pattern in MATCH clause

Graph modification

- INSERT, UPDATE, DELETE

DDL

- CREATE PROPERTY GRAPH



The screenshot shows the PGQL website homepage. The header features the PGQL logo and navigation links for "PGQL 1.4 Specification", "Specifications", and "Resources". The main title "Property Graph Query Language" is prominently displayed with a subtitle "View data as a graph, discover insights, unlock endless querying possibilities." Below this, a section titled "Graph pattern matching for SQL and NoSQL users" describes PGQL as a graph query language built on top of SQL. A URL link <https://www.pgql-lang.org> is provided at the bottom.

Making it easy for SQL developers
to write graph queries

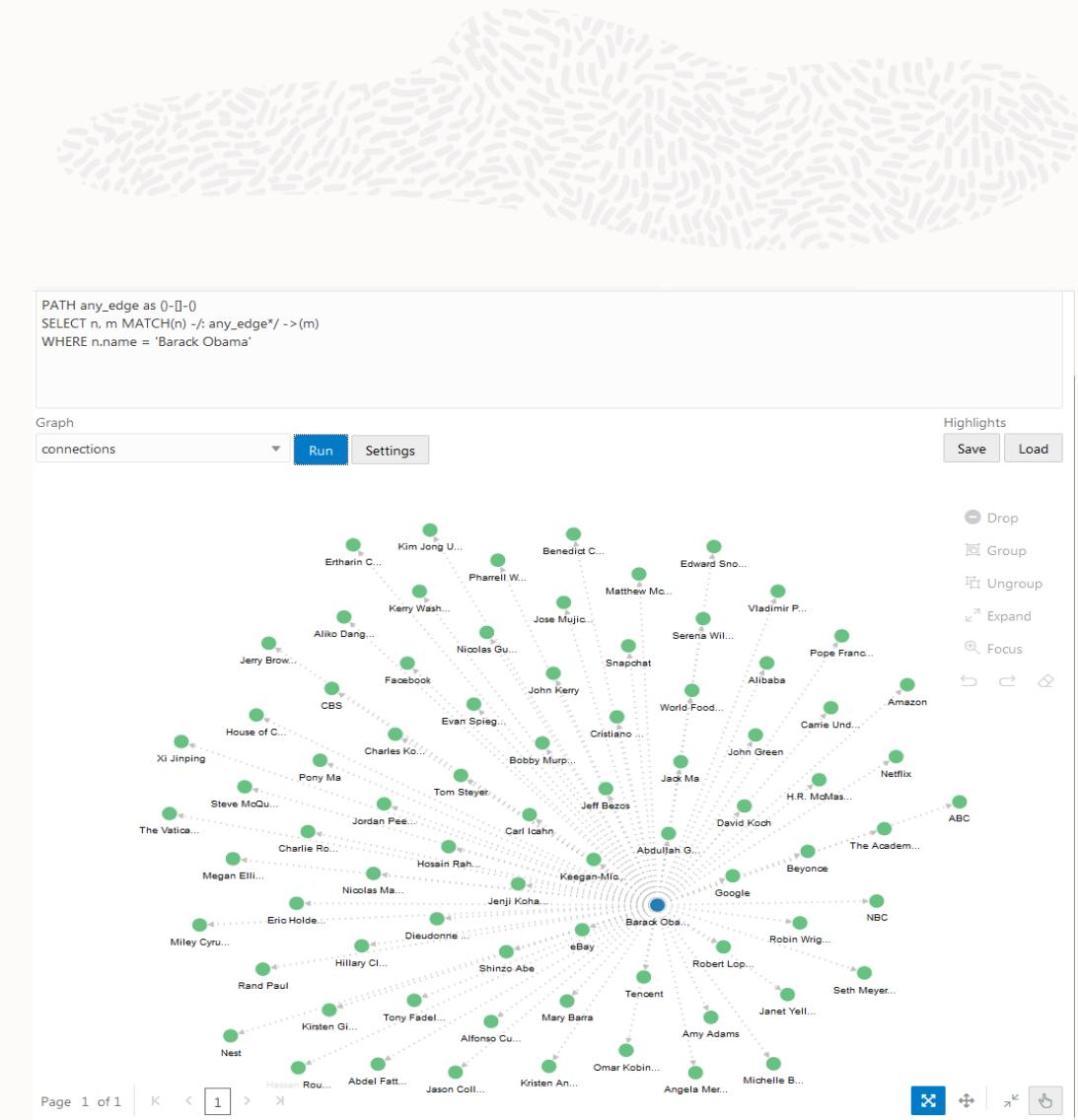
Oracle Converged Database

Support for Graph Analytics

Open-Source Graph Query Language, PGQL allows you to specify graph patterns which are matched against vertices and edges in a graph

-- Find the out-going edges from Barack Obama

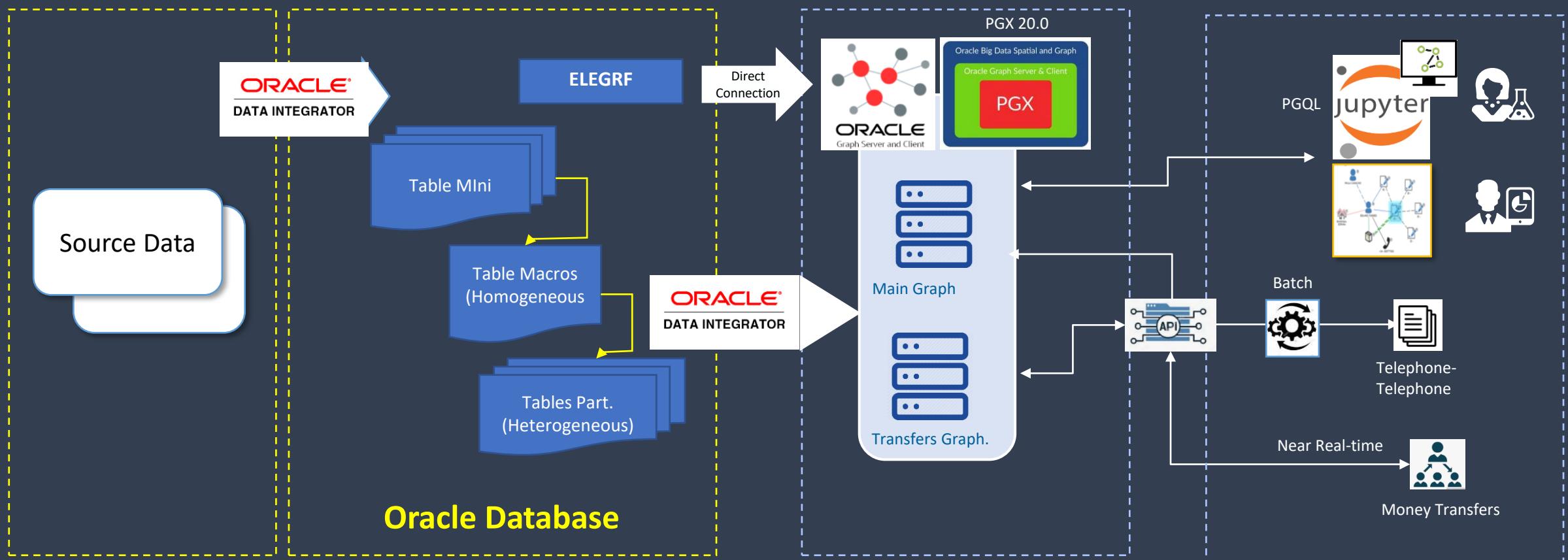
```
PATH  any_edge as ()-[]-()
SELECT n, m MATCH(n) -/: any_edge*/->(m)
WHERE n.name = 'Barack Obama'
```



Oracle Graph Analytics – complete enterprise solution

Our graph infrastructure consists of three different parts:

- (1) Preparing edge/node data for PGX in EXADATA.
- (2) Loading the data into the **Graph Server** and generating the graph in memory.
- (3) **Visualization** of the graph and Batch/Online integration.



Oracle Converged Database

Performance-related features and options



Parallel Query

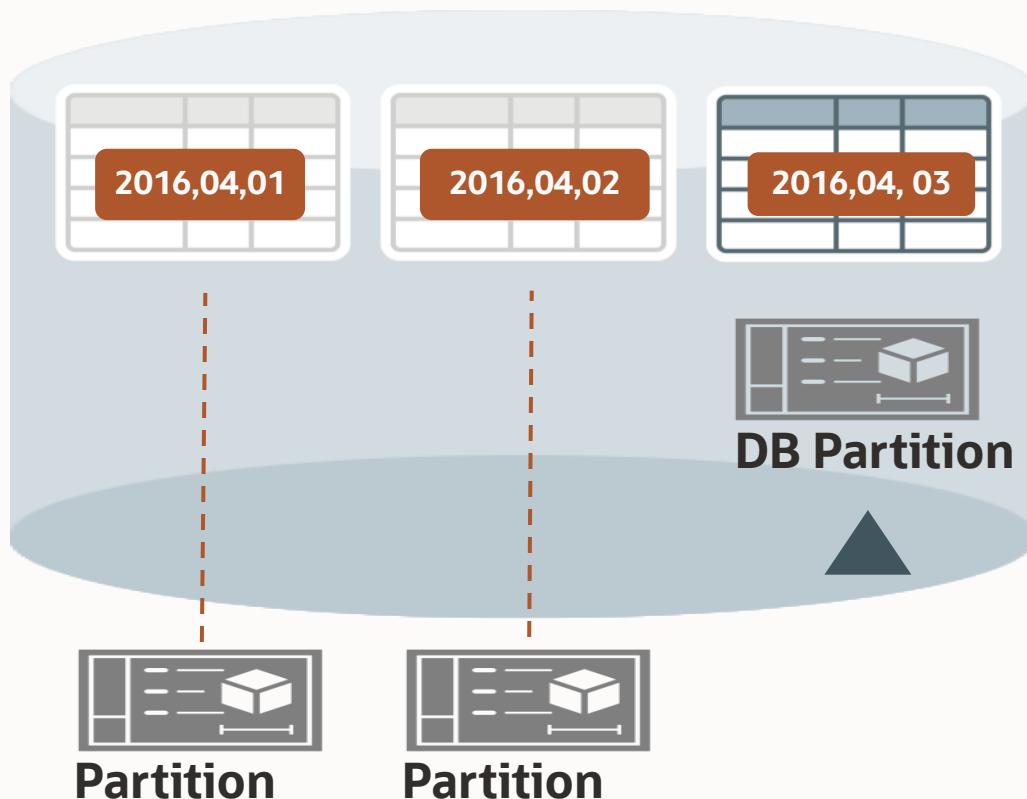
- Automatically parallelize queries, DML and DDL statements
- Adaptive optimization protects against overloading
- Supported by Resource Manager

Partitioning

- Enables large tables and indexes to be split into smaller pieces called partitions
- Increases **performance** and manageability
 - Data loads, joins and pruning,
 - Index creation and rebuilding,
 - Optimizer statistics management,
 - Backup and recovery

Oracle Converged Database - Hybrid Data Management: “Outside-In”

Hybrid Partitioned Tables



- Combination of internal (database) and external partitions
- External resources are files on Linux, in Hadoop Distributed File System (HDFS), in Oracle Objectstore, AWS S3 or Azure
- Use Cases:
 - Move non-active partitions to external files
 - Use inexpensive storage options
 - No relocation of data required
 - Big Data Queries

More details related to licensing can be found [here](#)

Performance & Scalability



Real Application Clusters (RAC)

What

- Multiple instances running on different servers access the same physical database, and take full advantage of the **combined** memory capacity and processing power
- Provides the highest database availability by **removing** individual database servers as a **single point of failure**



Why

- Improve **scalability**
- Reduce **costs**, scaling out on commodity hardware
- Improve **availability**

When

- Organizations with growing data volumes that require linear scalability
- Downtime unacceptable / very costly
- Considering Autonomous Database Cloud (requirement for 16 or more OCPUs)



Performance & Scalability

Oracle Advanced Compression

What

- Comprehensive set of **compression** capabilities
- Designed to improve **performance** and reduce **storage costs**
- No applications changes required

Why

- **Improve performance:** 2.5x better query performance typical
- **Reduce storage costs:** Compression ratios of **2x to 4x** typical

When

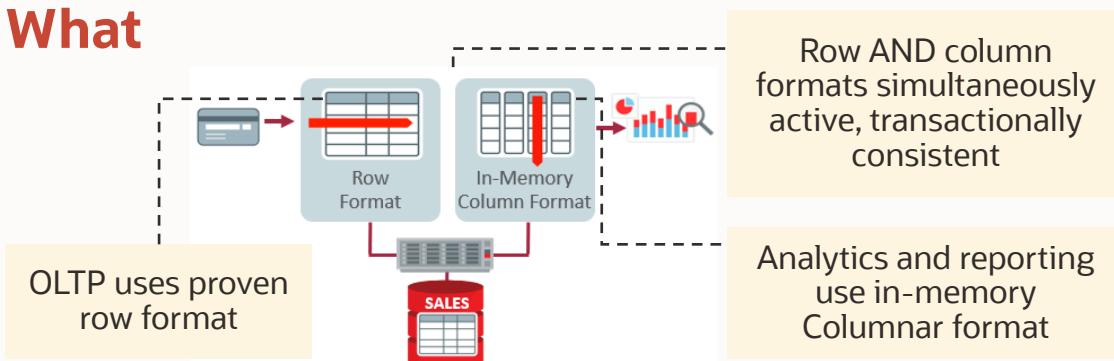
- Cost savings initiative
- Need to improve database performance
- Considering Hybrid Cloud (reduced storage costs in cloud and faster data transfer)

Performance & Scalability



Oracle Database In-Memory

What



Why

- Speed up **analytics** by 100x, mixed workloads 2x
- **No application changes**
- **Simple** to implement

When

- Want to accelerate analytics and mixed workloads
- Need for real-time reporting on OLTP data
- Has implemented or consider implementing separate operational data stores / data marts for reporting purposes (removes need for those)





Performance & Scalability

Oracle Real Application Testing

What

- Capture and replay real production workloads to assess the **effect of system changes** in test environments **before deploying in production**
- Database Replay: to determine the **overall impact of the change**
- SQL Performance Analyzer: to assess the impact **on SQL performance**

Why

- Assess impact of system changes in **days vs months**
- **Highest quality testing** for Oracle Database
(possible to test actual production workloads)

When

- Customers considering upgrades, patches or configuration, infrastructure and other changes
- Planning a move to Autonomous Database: assess the impact





Performance & Scalability

Oracle Diagnostic Pack

What

- Comprehensive set of real time and automatic performance diagnostics & monitoring functionality, avoiding manual DBA work

Why

- **Significantly simplifies** database performance management
- Ensure **performance SLAs**
- Better **capacity / utilization** planning

When

- Need to improve database performance
- Managing large set of databases
- Business critical applications
- Need to improve DBA productivity and reduce costs



Performance & Scalability

Oracle Tuning Pack

What

- Automates database tuning by optimizing SQL statements, schema design and in-memory column usage
- Provides recommendations, or automatically implements

Why

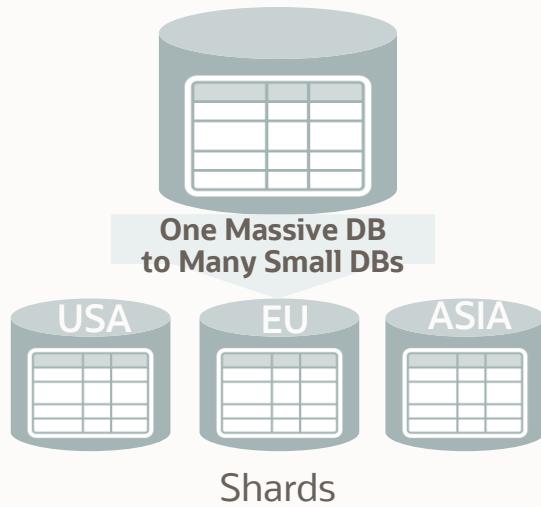
- **Highly performing** applications
- **Considerable time saved** tuning databases
- **Optimization** of infrastructure resources

When

- Need to improve database performance
- Managing large set of databases
- Business critical applications
- Need to improve DBA productivity and reduce costs
- Using Database In-Memory (In-Memory Advisor)

Oracle Converged Database

Native Sharding Simplifies Distributed Data Architecture



Oracle makes it simple for Apps to deliver **Data Sovereignty** or **Massive-Scale** using native Sharding

Shard monolith databases into a farm of smaller databases

- Shards can be placed in-country to satisfy data sovereignty
- Shards are fully isolated - linear scalability of data and users
- Routes SQL based on shard key, or runs cross shard SQL
- Online addition and reorganization of shards

All the benefits of sharding with all the benefits of a mature SQL Database

Oracle Converged Database

Performance-related features and options

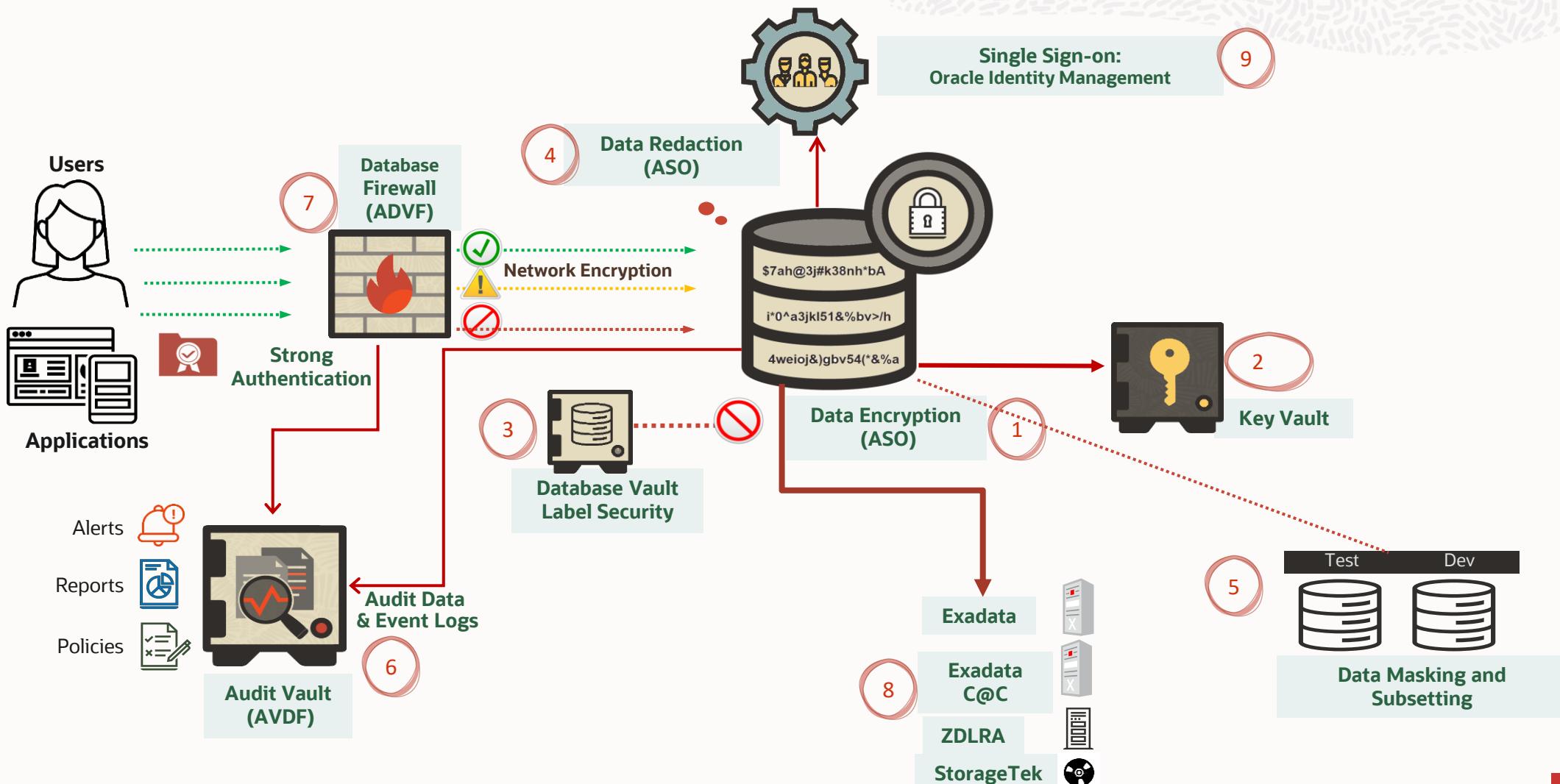


Resource Manager

Allows the database to have more control over how hardware resources are allocated

- Guarantee certain sessions a minimum amount of CPU regardless of the load on the system and the number of users.
- Distribute available CPU by allocating percentages of CPU time to different users and applications. In a data warehouse, a higher percentage can be given to ROLAP (relational online analytical processing) applications than to batch jobs.
- Limit the degree of parallelism of any operation performed by members of a group of users.
- Manage the order of parallel statements in the parallel statement queue. Parallel statements from a critical application can be enqueued ahead of parallel statements from a low priority group of users.
- Limit the number of parallel execution servers that a group of users can use. This ensures that all the available parallel execution servers are not allocated to only one group of users.
- Supports all the options of Oracle Database, including Real Application Clusters

Oracle's unique approach: Maximum Security Architecture



Comprehensive Security Controls for Oracle Databases

Assess

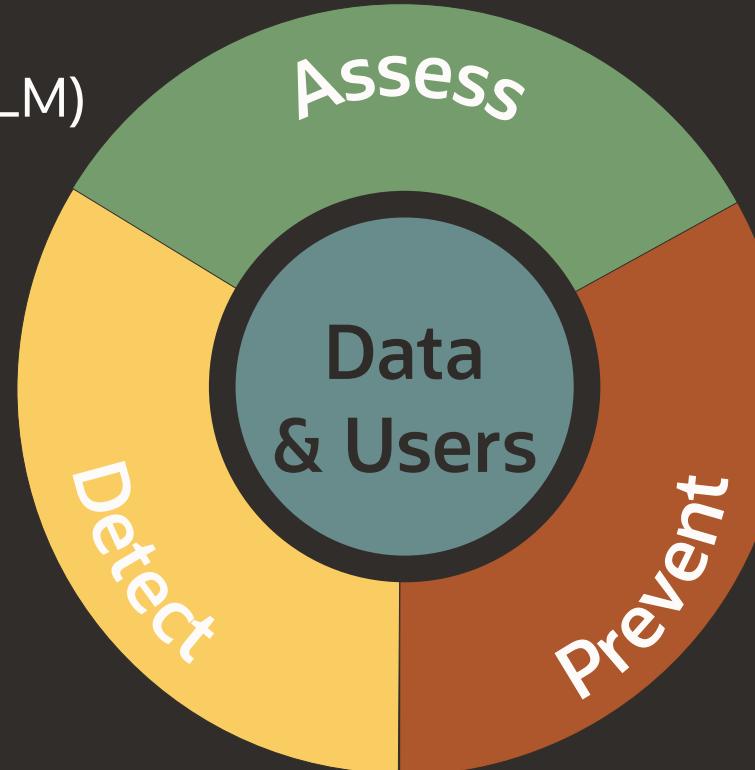
Config-Assessment(DBSAT, DBLM)
Data Discovery
Privilege Analysis*

Detect

Activity Auditing
Audit Vault
Database Firewall*

Prevent

Transparent Data Encryption & Key Vault
Data Masking, Data Redaction
Database Vault*



Data

Label Security
Virtual Private Database (VPD)
Real Application Security (RAS)*
DB Cryptographic Toolkit

Users

Password, PKI, Kerberos, Radius
Proxy Users, Password Profiles
Roles and Privileges
Oracle & Active Directory

Advanced Security Option



Authorized
Display

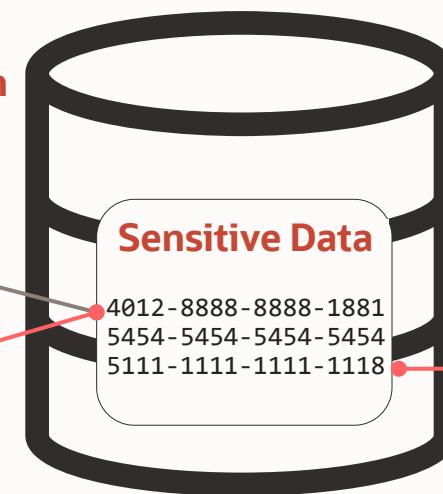


Redacted
Display

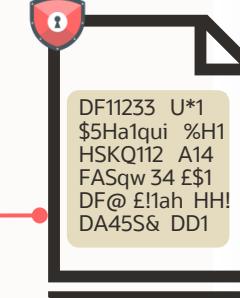


Applications

**Data
Redaction**



**Transparent
Data
Encryption**



Encrypted
Data



Disks



Backups

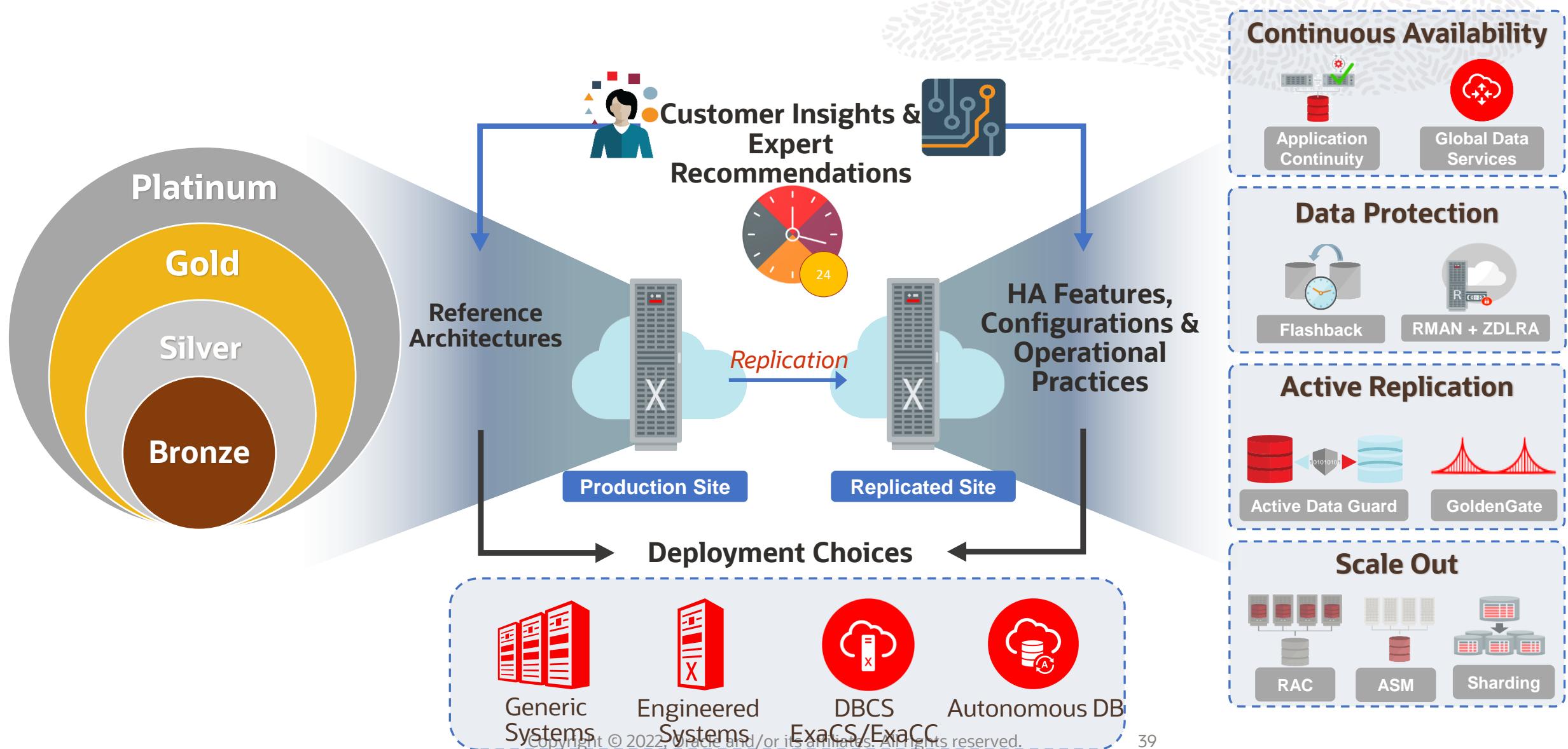


Exports



Off-Site Facilities

Oracle's validated Maximum Availability Architecture (MAA)



Oracle MAA Reference Architectures

Aligns Oracle Capabilities with Customer Service Level Requirements



The best platform for Oracle Database

60 Exadata-only features for Oracle Database

Availability

1. Fast Node and Cell Death Detection
2. Fast Network Failure Detection
3. Redundancy Protection on cellsrv shutdown
4. Redundancy Protection on Cell shutdown
5. Reduced Brownout for Instance Recovery
6. ILOM Hang Detection and Repair
7. Automatic ASM Mirror Read on IO error corruption
8. IO error prevention with Exadata disk scrubbing/ASM Corruption repair
9. Corruption Prevention with HARD support
10. Elimination of false-positive drive failures
11. Redundancy Check During Power Down
12. Blue OK-to-remove LED Light notification
13. Health Factor on predictively failed disks
14. Disk Confinement
15. I/O hang detection and repair
16. Drop Hard Disk for Replacement
17. Drop BBU for Replacement

Security

1. Full Stack Patching
2. Minimal Attack Surface
3. Pre-Scanned & fixed system stack using STIG, Nessus, and Qualys
4. Advanced Intrusion Detection Environment (AIDE) –similar to virus scanners
5. SGX Integration in Exadata Storage Cells

Performance

1. Active/Active IB Network
2. Exadata Smart Write Back, Smart Flash Logging, Smart Scan, and Reverse Offload
3. Fastest Redo Apply and Instance Recovery
4. Efficient re-silver rebalance after Flash failure
5. I/O latency capping for reads and writes
6. Cell IO timeout threshold
7. Smart Write Back Flash Cache Persistence
8. I/O and network resource management
9. Cell to cell offload for disk repair
10. Cell-to-Cell Rebalance Preserves FlashCache
11. Appliance Mode Support

Scalability

1. Infiniband Cluster Interconnect
2. Remote Direct Memory Access on Storage I/O
3. Exadata High Redundancy Storage
4. High Performance I/O – 6.57 million IOPS from SQL
5. Low Latency I/O – 200 microseconds
6. In-Memory Data Mirroring
7. Hybrid Columnar Compression
8. Bloom Filter Joins
9. In-Memory Columnar Tables
10. In-Memory External Tables
11. Memory Optimized Key/Value Data
12. Higher Consolidation Density

Efficiency

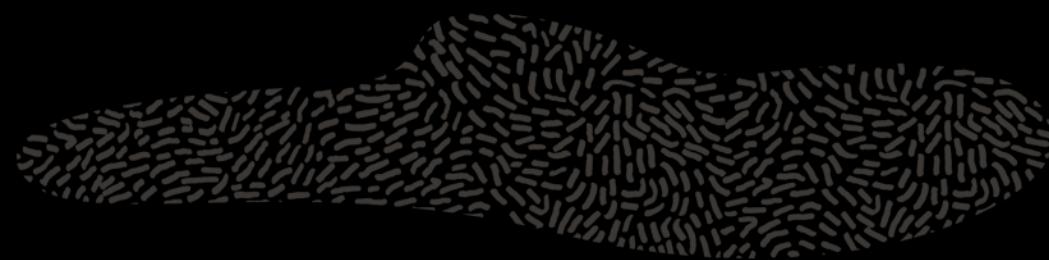
1. Exadata Elastic Configuration
2. Cell Alert Summary
3. Flash and Disk Lifecycle Management Alerts
4. Auto Online
5. Auto Disk Management
6. Priority Rebalance Support
7. EM Failure Reporting
8. Failure Monitoring on Database Servers
9. Updating Database nodes with Patchmgr
10. Optimized and Faster Exadata Patching
11. Custom Diagnostic Package for Cell alerts
12. VLAN support and automation
13. Exachk – full stack health check with critical issue alerts
14. Automatic Statistics
15. Automatic Indexing



Oracle Database

The most advanced database platform in the market

- Convergence is supported by all the database options



Consolidated and Mixed-Workloads



Multitenant Database, Exadata,
OLTP and analytics in one

Fault-Tolerant Availability



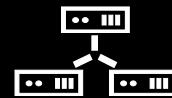
RAC, Data Guard, Flashback, Online
Data Reorg, Online Patching, MAA

Highest Security



Data Safe, Advanced Security,
Encryption, Roles, Privileges ...

Transparent Scaling



- RAC, Exadata, Parallel SQL,
Native Sharding

Comprehensive Data Model Support



JSON, text, graph, spatial, blockchain

Powerful Analytics



In-memory analytics, machine
learning, data partitioning

These technologies fully support converged database and are transparent to cross- and multi-model applications

Summary

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Modern applications need to generate value from data in new ways

- They are built using new development methodologies and technologies
- But it complicates Database Architecture by using multiple single-purpose databases
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Oracle's strategy – Rethink Database Architecture to

- Simplify App Development
- Simplify App Architecture

Oracle Converged Database is the only DBMS, which

- delivers the unified and holistic view of all the data
- Supports all paradigms of modern app development

Simplifies App Development



In-Database
Containers



Microservices



Analytics and
ML



Database Native
Low Code

Simplifies App Architecture



Transactional
Event



Data Event



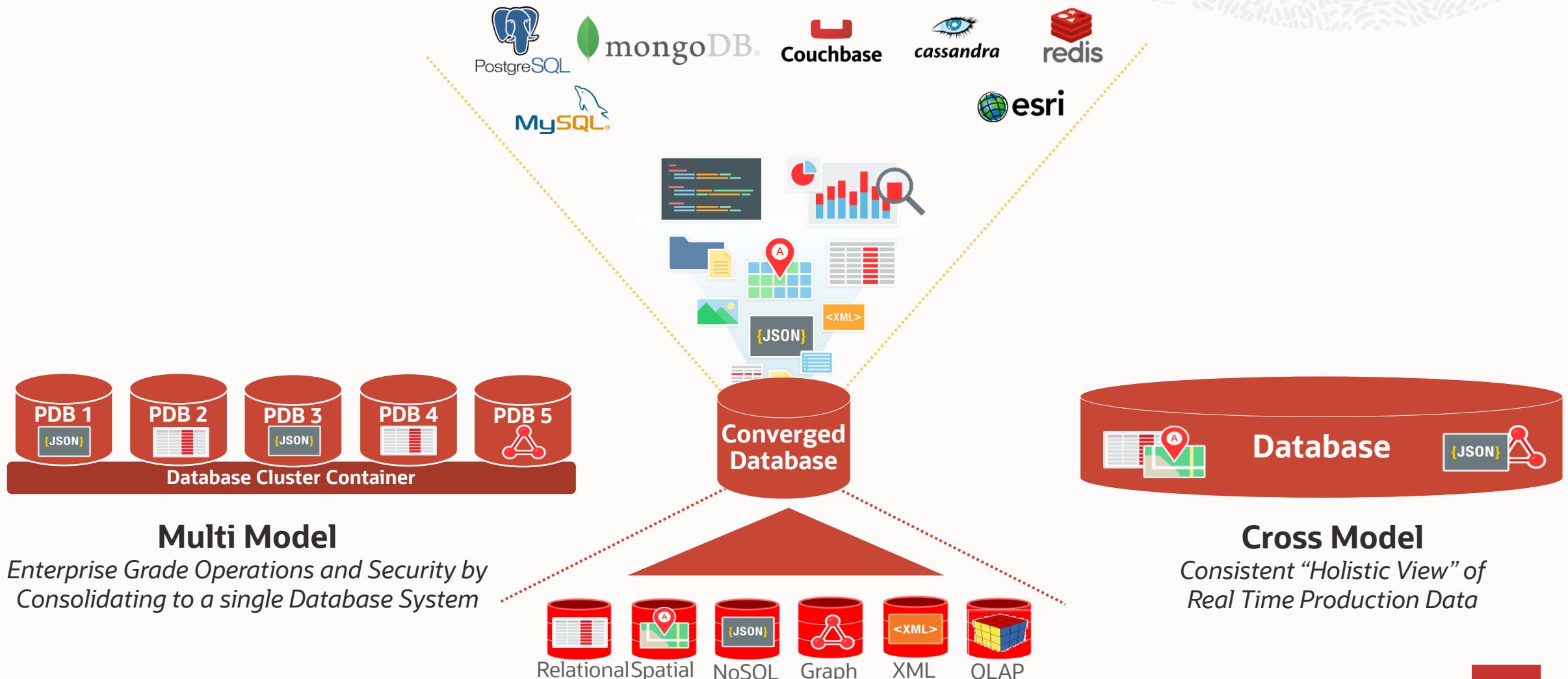
Native REST



Sharding

Oracle Converged Database

Multi- and Cross-Model Database



Application Express (APEX)

Low-code environment for Oracle Converged Database



- **Low code** app dev platform
- Browser IDE automatically creates an App starting from a spreadsheet or a table
- SQL and REST friendly
- Deep integration with Oracle database
- Eliminates the complexity of Middle-tiers, connection management, state management, mapping database types to app types, scaling and HA
- Development of responsive and mobile apps
- 500K+ developer community

The screenshot shows the Oracle App Builder interface. At the top, there's a toolbar with various icons and dropdown menus like 'App Builder', 'SQL Workshop', 'Team Development', 'App Gallery', and search functions. Below the toolbar, a navigation pane shows 'Application 143' and 'Page Designer'. The main area has two code editors: 'Code Editor - SQL Query' containing the SQL statement 'select * from projects', and 'Code Editor - JavaScript' containing a snippet of JavaScript code. A large, dark, rounded rectangular callout bubble highlights the word 'APEX' in the SQL code editor. Another similar callout bubble highlights the word 'JavaScript' in the JavaScript code editor.

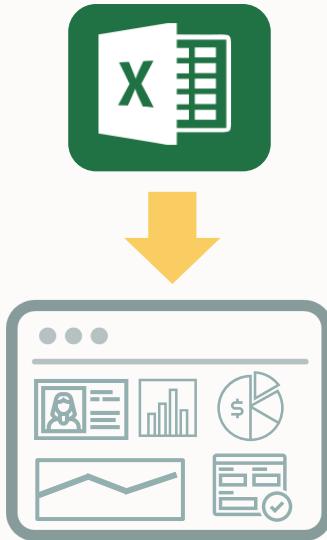
```
1 select * from projects
```

```
table.appendTo(that.container);
}
} else {
    console.error('No rows found in the response');
}
};

window.onload = function() {
    jQuery(document).ready(function() {
        var table = new RestTable({
            dataSourceUrl: 'https://apex.oracle.com/pls/apex/mike_ow18/projects/tasks',
            useFetchApi: true,
            container: 'body',
            includeRowNumbers: true
        });
        table.render();
    });
}
```

Application Express (APEX)

Low-code environment for Oracle Converged Database



Oracle makes it simple to create Low-Code Apps

Oracle APEX Low-Code IDE automatically creates an App starting from a spreadsheet or a table – **data driven dev**

Deep integration with the database eliminates the complexity of

- Middle-tiers, connection management, state management, mapping database types to app types, scaling, and HA

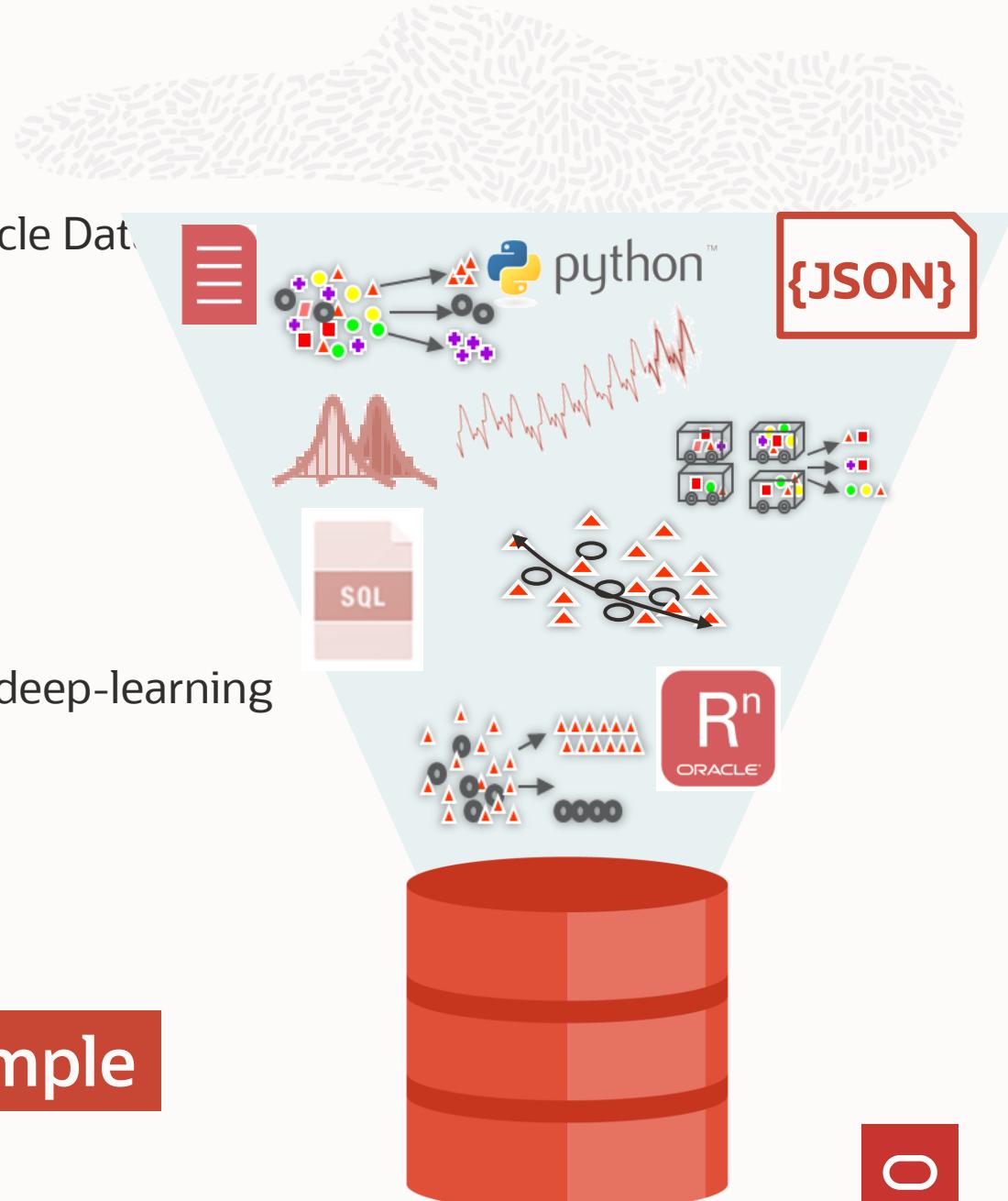
Create an enterprise App in hours – fastest time-to-value

Easily iterate the App to match evolving needs of business

Oracle Converged Database

Machine Learning integrated in Oracle Database

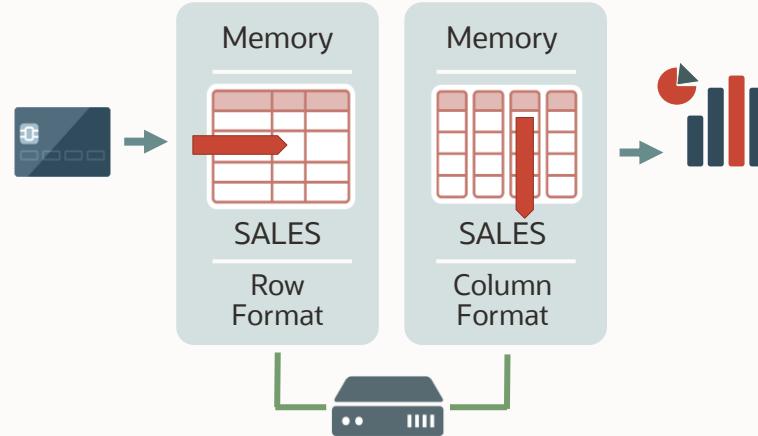
- Machine learning models and algorithms run inside Oracle Database
 - Data stays in-place
 - Massively parallel execution
- Flexible model building
 - SQL, R or Python
 - Oracle Data Miner
 - Oracle AutoML
 - Over 30 in-database **parallel** ML algorithms including deep-learning



Oracle Makes Machine Learning Simple

Oracle Converged Database

Database In-Memory support for real-time analytics



Oracle makes it simple for Apps to provide instant data insights

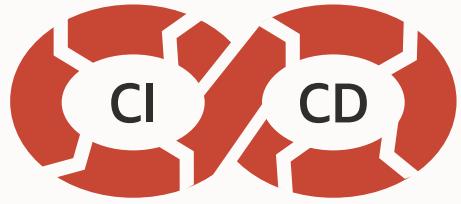
In-memory columnar formats and automatic parallel processing enable **Analytics to transparently run 100x faster**

No app changes needed - easy to deploy in Data Warehouse or OLTP database

More details related to licensing can be found [here](#)

Oracle Converged Database

Online Data Evolution Simplifies Continuous Delivery



Oracle makes it simple to perform Continuous Delivery (CI/CD) of application enhancements

No need to batch app changes into infrequent downtime windows

Support for fully online schema and data evolution

- Edition Based Redefinition, Online Table Redefinition, native JSON and XML
- Extensively used by Salesforce, E-biz, and Fusion Applications

Oracle Converged Database

Liquibase and SQLcl Simplifies Continuous Delivery



What's Liquibase?

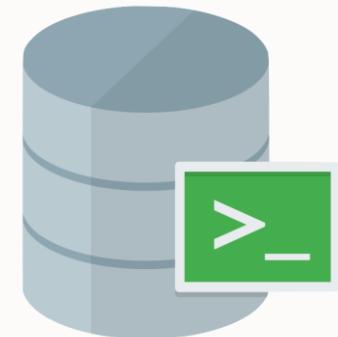
Liquibase is an open-source database-independent library for tracking, managing and applying database schema changes

What's SQLcl?

Oracle SQLcl (SQL Developer Command Line) is a Java-based command-line interface for Oracle Database
Using SQLcl, you can execute SQL and PL/SQL statements interactively or as a batch file
SQLcl provides inline editing, statement completion, command recall, and supports existing SQL*Plus scripts

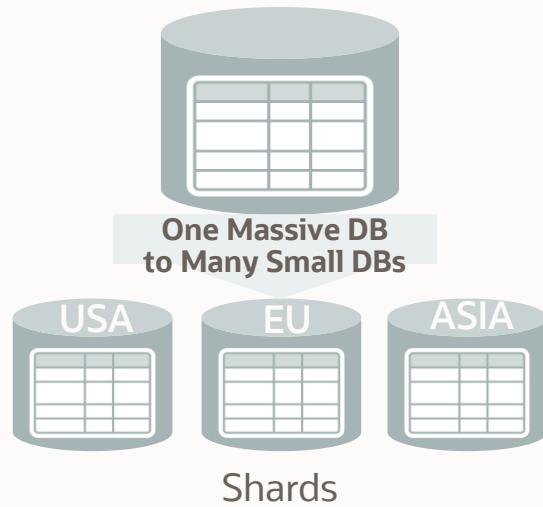
How do they work together?

The Liquibase feature in SQLcl enables you to execute commands to generate a changelog for a single object or for a full schema (changeset and changelogs)
You can also manually create changelogs and apply them to multiple databases



Oracle Converged Database

Native Sharding Simplifies Distributed Data Architecture



Oracle makes it simple for Apps to deliver **Data Sovereignty** or **Massive-Scale** using native Sharding

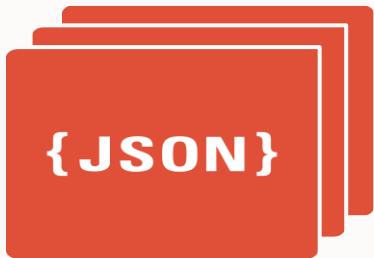
Shard monolith databases into a farm of smaller databases

- Shards can be placed in-country to satisfy data sovereignty
- Shards are fully isolated - linear scalability of data and users
- Routes SQL based on shard key, or runs cross shard SQL
- Online addition and reorganization of shards

All the benefits of sharding with all the benefits of a mature SQL Database

Oracle Converged Database

Support for JSON and XML documents



Oracle makes it simple to use **JSON** and XML documents

Freely mix JSON and non-JSON data types

Native Data Guide allows you to quickly determine what data you have

Transparent scale-out with Full ACID transactions

Index any JSON element for fast OLTP

Declarative Parallel SQL analytics on all formats

Run complex joins across multiple JSON documents and collections

No need for custom application code to accomplish basic data management tasks

Oracle Converged Database

support for JSON data and SODA API



Applications
developed
using SODA
APIs

← SODA →
JSON workload

REST, Java,
NodeJS, Python,
PL/SQL, ODPI-C,
OCI



JSON Documents
Stored and Managed
Using Oracle Database

← SQL →



SQL based reporting
and analytical operations
on JSON Documents

Oracle Converged Database

support for Data Driven Apps with Blockchain Data

```
CREATE Blockchain Table  
  Trade_Ledger;
```

TRADE LEDGER

ID	User	Value	Hash
1	Tom	500	ADSJS
2	Carol	176	%SHS
3	Steve	300	SH@1
4	Jean	1	DHD3
5	Mike	732	*EGG
6	Sarah	632	AH11
7	Eve	25	LIO\$
8	Prisha	850	SHS4

BLOCKCHAIN TABLE

Special blockchain tables

- Insert Only tables
- Inserted rows are **cryptographically chained**
- Chain can be verified and signed by participants

Simple to integrate into apps

- Look like standard tables with declarative SQL
- Full analytics and transactions on blockchain data

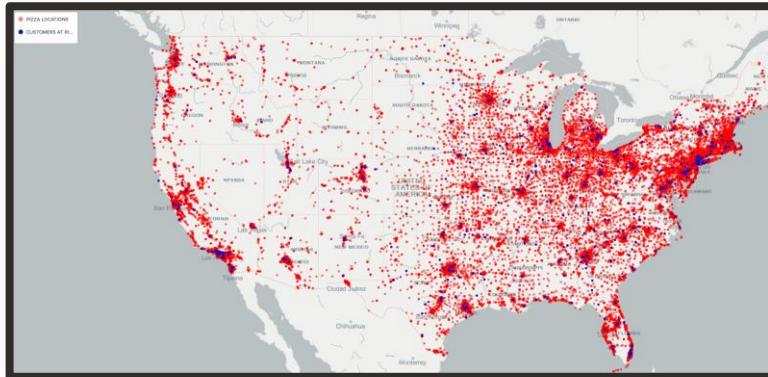
Use Cases

- Central unchangeable data such as measured values from IoT devices
- Compliance data for auditing reasons

More details related to licensing can be found [here](#)

Oracle Converged Database

support for Data Driven Apps Create Value using Spatial Data



Oracle makes it **simple** to use location intelligence analytics and mapping services

- Compute distance between places, assets, people
- Analyze transportation, telecom, or utilities networks, sales territories, etc.

100s of in-database spatial operators and functions

- Over 60 spatial topology functions and procedures
- Over 125 Spatial Network functions and procedures

Previously a priced option, now **FREE** in all Oracle Database Editions

Oracle Converged Database

support for Graph Analytics



Oracle makes it simple to use Graph Analytics to discover:

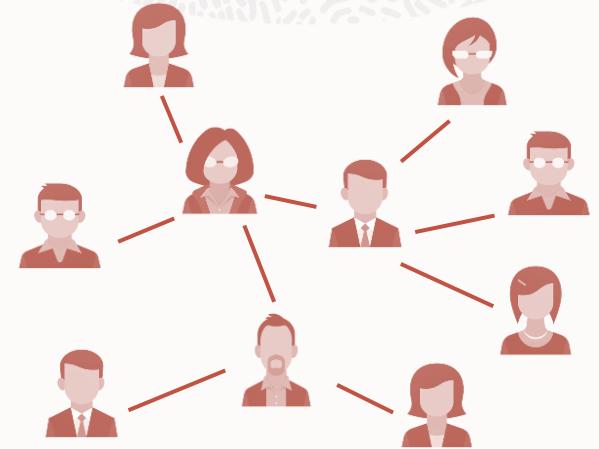
- Influencers, dependencies, communities, ranking, customer 360, etc.

Over 50 in-memory parallel analytic graph functions

- Easy implementation with declarative SQL-like queries

Oracle also provides an Open-Source Graph Query Language (PGQL)

PGQL allows users to specify graph patterns which are matched against vertices and edges in a graph



Previously a priced option, now **FREE** in all Oracle Database Editions

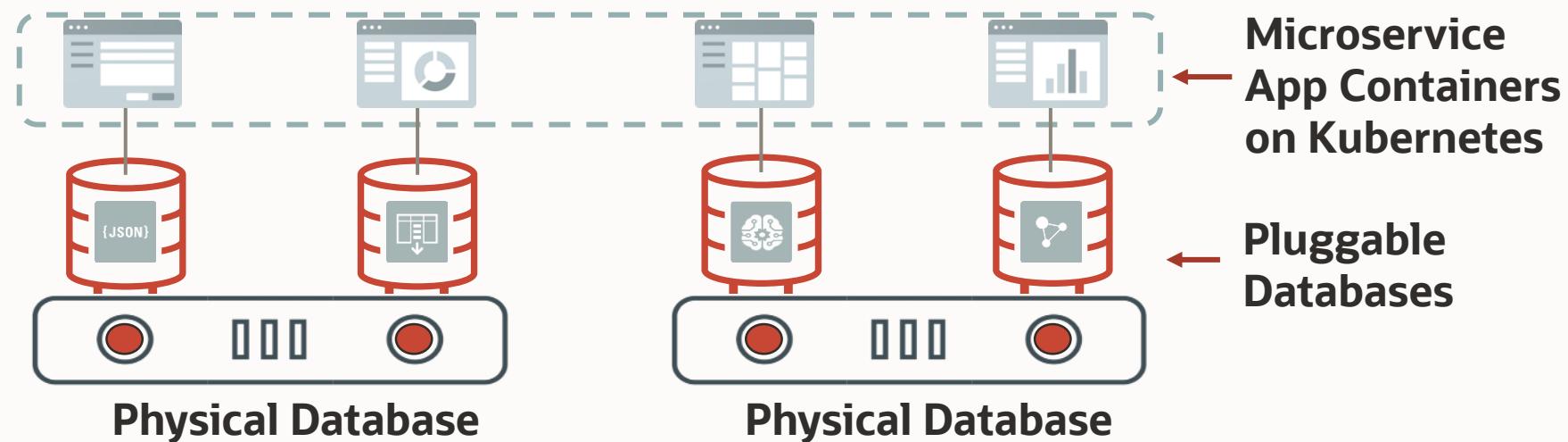
Oracle Converged Database

support for Microservice Architectures



Oracle makes it simple for each Microservice to store its data in a logically separate Data Container called a Pluggable Database

Pluggable Databases can easily be physically combined to simplify deployment, or separated to improve isolation and scalability

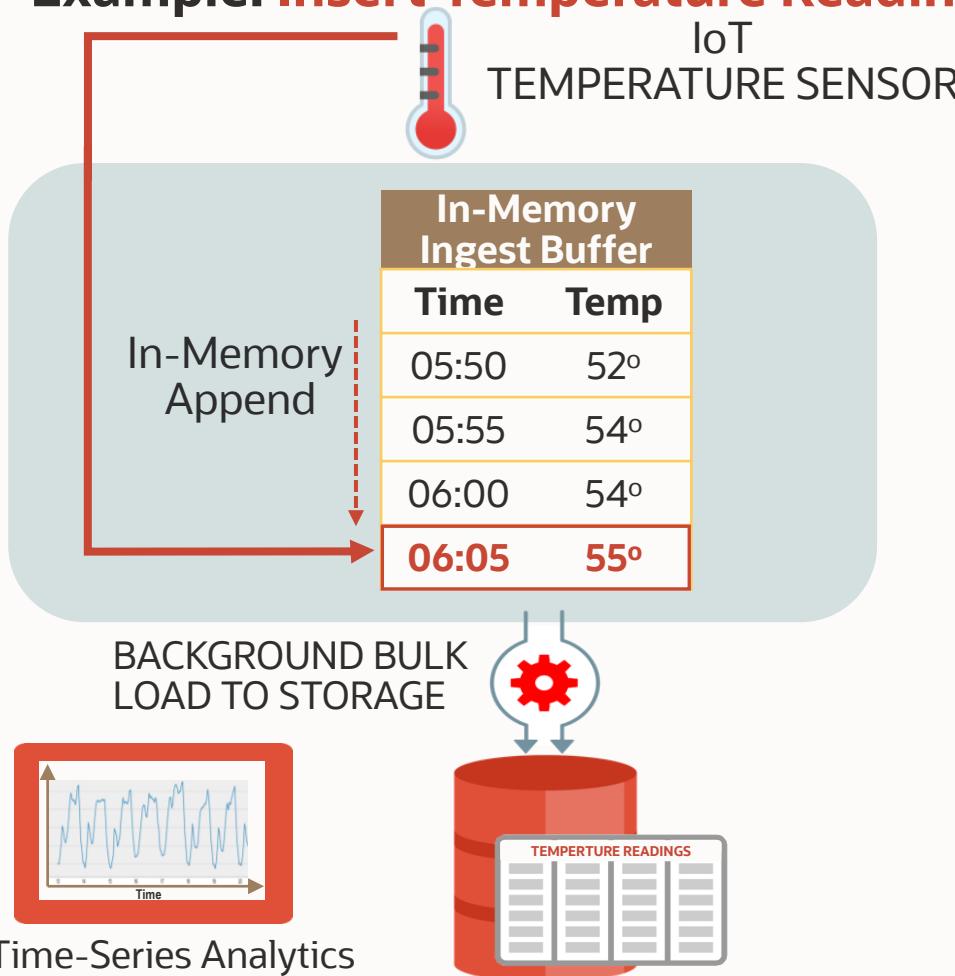


More details related to licensing can be found [here](#)

Oracle Converged Database

Support for IoT

Example: Insert Temperature Readings



Oracle makes it simple to stream and analyze IoT Data

Standard SQL INSERT quickly deposits IoT Data into memory buffers

Bulk loaded into DB in background

Ultra-fast - 25 million inserts per second on two socket server

Integrated time-series analytics enables you to instantly analyze IoT data

More details related to licensing can be found [here](#)

Oracle Converged Database

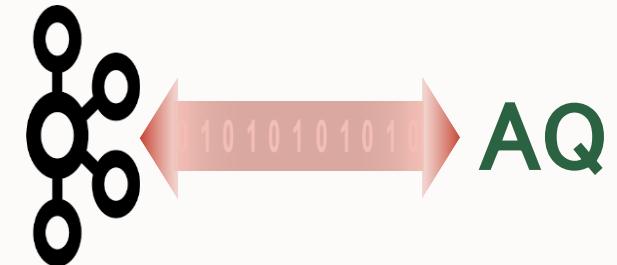
support for Event Driven Architectures



Oracle makes it simple to implement event-driven apps

Oracle implements event streaming to and from Kafka

- Golden Gate replication can stream database changes **into** Kafka
- **New:** Oracle Database can query events **from** Kafka



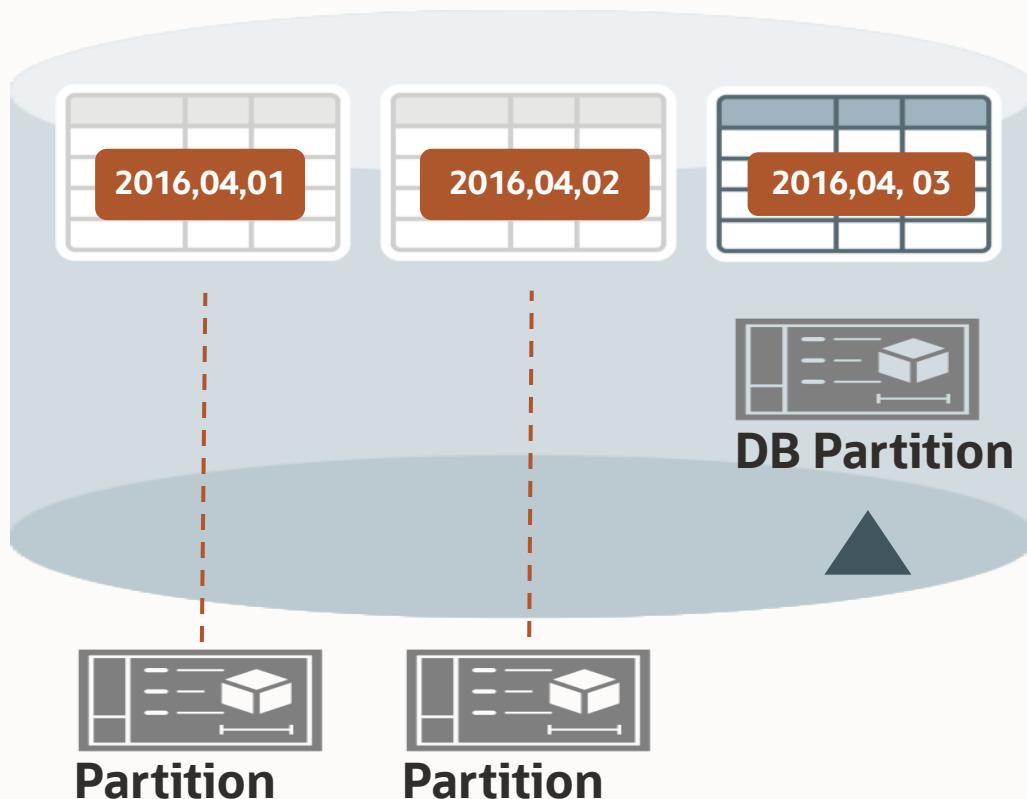
Oracle Database Queues have supported events inside the DB for decades

- DB Queues provide ACID transactions and powerful SQL queries over events
- Confluent connector streams events between Kafka and DB Queues

More details related to licensing can be found [here](#)

Oracle Converged Database - Hybrid Data Management: “Outside-In”

Hybrid Partitioned Tables



- Combination of internal (database) and external partitions
- External resources are files on Linux, in Hadoop Distributed File System (HDFS), in Oracle Objectstore, AWS S3 or Azure
- Use Cases:
 - Move non-active partitions to external files
 - Use inexpensive storage options
 - No relocation of data required
 - Big Data Queries

More details related to licensing can be found [here](#)

Oracle Autonomous Database - support for MongoDB

Develop and run MongoDB workloads in the Oracle Autonomous Database



Modern document-centric development

- JSON Collections-based data model
- Rich clients – MongoDB API, REST and SODA based development API
- Native JSON storage with advanced indexes and optimized performance

... and proven enterprise functionality

- ACID Transactions
- SQL-based Reporting and Analytics (including scalable parallel execution)

... running on the Autonomous Database platform

- Availability
- Security
- Elasticity

Oracle Database

The most advanced database platform in the market



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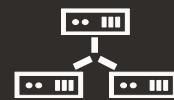
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In-Database
Containers



Microservices



Analytics and
ML



Database Native
Low Code

Simplifies App Architecture



Transactional
Event



Data Event



Native REST



Sharding

Thank you

ORACLE



AgrarMarkt Austria accelerates grant processing with Oracle Database

- AgrarMarkt Austria (AMA) manages the payment of EU subsidies to farmers. Farmers apply for funding at AMA by providing information on what they grow and on which land parcel, making the process is highly dependent on accurate mapping of farm parcels.
- As a long-time Oracle Database user, AMA appreciates Oracle's unique combination of converged database solutions, from spatial to JSON, and the ability to quickly spin up applications with APEX
- Combination of Oracle spatial/graph features and APEX allow farm assessments to be completed **4-5X faster** than before, with **100X fewer** invalid/incorrect geometries in data processing



“Having everything we need in the one converged database—from spatial data to the ability to quickly generate reports and spin up APEX applications—helps us process grant requests in the shortest time possible.”

Markus Flatscher

Lead DevOps

AgrarMarkt Austria



SATLOG uses Converged Database Processing to simplify and automate common logistics workflows

- Germany-based SATLOG helps increase the productivity of fleets across a variety of industries with various delivery requirements—inner city, regional, and long distance trucking. The company's telematics ecosystem includes specialized tablets inside trucks, software as a service, and KPIs for logistics.
- Integrating data from multiple systems—the rear and side cameras, turn assistant, and tire pressure system—into a single stream of data was a challenge for the company. It needed near real-time location and telematics data in dashboards. And data security across this entire process is critical.
- With business and data volumes growing at rapid rates, the company's aging on-premises Oracle database infrastructure had increasing maintenance and downtime issues, which impacted development to keep pace with market opportunities



" SATLOG achieves better integration and performance making fleets more productive with Oracle Autonomous Transaction Processing and its included Spatial, APEX, and JSON services on Oracle Cloud Infrastructure"

Juergen Stausberg
CEO, SATLOG



DPDHL uses Oracle JSON for parcel tracking system to increase performance and stability of the system

- DPDHL had a relational store for parcel tracking system. They began suffering from performance problems caused by contention and many join between tables. They considered to use JSON as a non-normalized store as JSON would remove the need for many joins. They considered MongoDB for this but eventually found Oracle JSON to be much better than MongoDB.
- They found Oracle JSON so much better that they started a second project to migrate existing MongoDB and Informix application (customer data) to use solely Oracle instead.
- Tests were conducted to determine how long query times would take - a query to retrieve information in the Oracle database took 250 milliseconds. With MongoDB (Enterprise), using JSON data this took a mere 40 milliseconds but enterprise capabilities for handling large amounts of data was missing.
- they needed the SQL capabilities in the same database for reporting – so the “converged database” proposition was and is extremely compelling.



As the COVID pandemic kicked in, DPDHL expected parcel tracking to go through the roof – which it did. Performance and scalability were impacting growth of the business. They needed a system that could scale very well and offer reporting capabilities.

Oracle Converged Database proposal has won with MongoDB thanks to its SQL capabilities

Unicredit uses Converged Database to provide a scalable, secure solution.

- Unicredit's goals were to reduce costs but at the same time improve productivity, security and scalability. They were looking to consolidate to reduce costs, and as the number of transactions were increasing they needed to ensure these could be managed and processed and not compromise on performance. They needed to decide which database technology could manage this: Oracle or Postgres.
- As they compared against Postgres, there were many features which Oracle had to address the business need that Postgres did not offer. Oracle Converged Database (Enterprise Edition) for productivity. Database Vault, Audit Vault and Encryption for security and Real Application Clusters for scalability. Other technologies they used were in-memory database and parallel processing to improve performance and technologies to further reduce cost – advanced compression, automatic storage mgt, online re-organization and transportable tablespaces. Flashback query and XML in the database were also key technologies.



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Zagrebačka bank increases cash loans by 15% within 18 months

- ZABA accounts for 25% of the Croatian banking sector's total assets
- Sought to use modern predictive analytics to better and more quickly target customers for new banking products and services
- Results back in hours instead of days, increasing cash loan business 15% within 18 months
- Oracle Advanced Analytics on Oracle Database

Read More



“With Oracle Advanced Analytics we execute computations on thousands of attributes in parallel—impossible with open-source R. Analyzing in Oracle Database without moving data increases our agility. Oracle Advanced Analytics enables us to make quality decisions on time, increasing our cash loans business 15%.”

Jadranka Novoselovic, Head of Business Intelligence Development, Zagrebačka Bank

CaixaBank accelerates innovation with Oracle as data platform

- Spain's largest domestic bank with 14 million customers
- Needed to integrate customer experience across branch, internet, phone and mobile
- Consolidated 17 data marts into one
- Built a data pool based Oracle database and its tools integrated with other big data sources
- Minimized data movement with analytics in place
- Secured, monitored and audited all access
- Integrated real time analytics with transaction processing for fraud detection, personalize offers, improved risk management



“Given our focus on customer-oriented innovation, our Oracle solutions enable us to focus on providing our customers with added value knowing our cutting-edge technology gives us a competitive edge.”

Luis Esteban,
Chief Data Officer, CaixaBank



UK National Health Service identifies \$156m in savings in first three months

- The UK Department of Health asked the NHBSA to identify opportunities to reduce costs and eliminate waste in primary care dental and pharmacy contractors and the European Health Insurance Card
- NHBSA chose an end-to-end Oracle solution including Oracle Advanced Analytics and Oracle Database that identified up to US\$156 million in potential savings from benefit fraud and error reduction

Read More



“Oracle Advanced Analytics data mining capabilities and... performance really impressed us. The overall solution is very fast, and our investment very quickly provided value. We can now do so much more with our data, resulting in significant savings for the NHS as a whole.”

Nina Monckton, Head of Information Services,
NHS Business Services Authority

Union Investment accelerates application transformation

- Union Investment – based in Germany
 - A leading European asset manager
 - \$250 Billion in assets and 4.5 M customers
 - Manage over 1000 funds sold by over 1100 banks
- Needed to develop new FondsProfiler tool
 - Enable 800 staff to access fund data
 - Enable fund managers to design and launch new funds without IT support
- Used Oracle Application Express (APEX) to accelerate development
- Eliminated manual spreadsheet process and reduced costs
- Improved customer service and visibility

Read More



“We have a long history with Oracle Database, which we rely on to be efficient in our asset management business. ... and by using Oracle Application Express we have developed a game-changing web application at the very heart of our business, which has enabled process improvements throughout our core operations.”

Rolf Fillinger, Team Leader, Union Investment
(Union IT-Services GmbH)

Siemens Mobility reduces App Dev costs by 90%

- Siemens Mobility GmbH is a specialized part of the Siemens Group in Germany targeted to the segment of the railway electrification.
- Enhanced data and application availability and minimized the operation overhead by moving custom applications and new app dev from on premises to APEX on Oracle cloud in just 2 weeks
- Maximized the convenience of developing new applications, improved integration of all necessary components and saw 90 % cost savings compared to On-premise solution with APEX and Autonomous Transaction Processing



Approved customer reference



POMPEII

Archaeological Park of Pompeii reopens safely during COVID-19

- Ancient ruins site is preserved and promoted for normally 3 million annual visitors
- Cloud native app MyPompeii built with Blockchain, Mobile, Kubernetes, and Spatial on ATP in 6 weeks
- Enables tourists to enter with electronic ticket and view real-time park heat map for social distancing
- Allows park officials to track visitors and redirect them to minimize congestion or high-risk situations
- Supplements other safety initiatives and point of interest information to enhance guest experience



"We decided to use Oracle Cloud Infrastructure Data Science Service because it allows us to leapfrog the management of GPU servers, including the installation of the CUDA drivers, and to scale our compute resources, when an urgent conference deadline comes up."

Dr. Matthias Qian

Departmental Lecturer, Department of Economics, University of Oxford

[Read the story](#)

University of Oxford researchers predict career pay using Oracle Cloud

- Dr. Matthias Qian and his team developed deep learning models for salary prediction and analyzing AI adoption across professions
- Chose Oracle Cloud for its unique features around data profiling, model development, and model explanation
- Tested and trained predictive models while keeping data private

1 million

Job ads
analyzed

10 minutes

To obtain
200GB of
memory

On-demand

Access to
scalable,
high-speed
compute

Vodafone Group

- British communications company, providing mobile, fixed, broadband and TV
- Uses APEX to manage entire infrastructure lifecycle from provisioning to retirement
- APEX was selected as it is flexible, easy to customize, and allows for developing applications incredibly quickly with minimal coding

Approved customer reference



Veterans Institute Drives Volunteers Productivity

- Netherlands Veterans Institute (VI) aims at promoting social recognition for the efforts made by armed forces veterans on behalf of the Dutch state and Dutch society
- Developed Tracking application using Oracle APEX in the cloud replacing inefficient spreadsheets for handling recognition of Dutch veterans
- New APEX application reduced administration time and costs, resulted in more impact to schools, and more time for volunteers



Approved customer reference



Evry Builds Highly Customized and Scalable Apps

- Evry is the Nordic region's second-largest IT services company
- Built a platform to quickly develop and launch customized, scalable applications for their customers on mobile devices and desktops
- Implemented Oracle Database Cloud Service including the web development tool Oracle APEX and reduced the time and cost for development of applications by 50%
- Used Oracle APEX to increase sales by 30% by entering new markets targeting small and medium sized enterprises



Approved customer reference

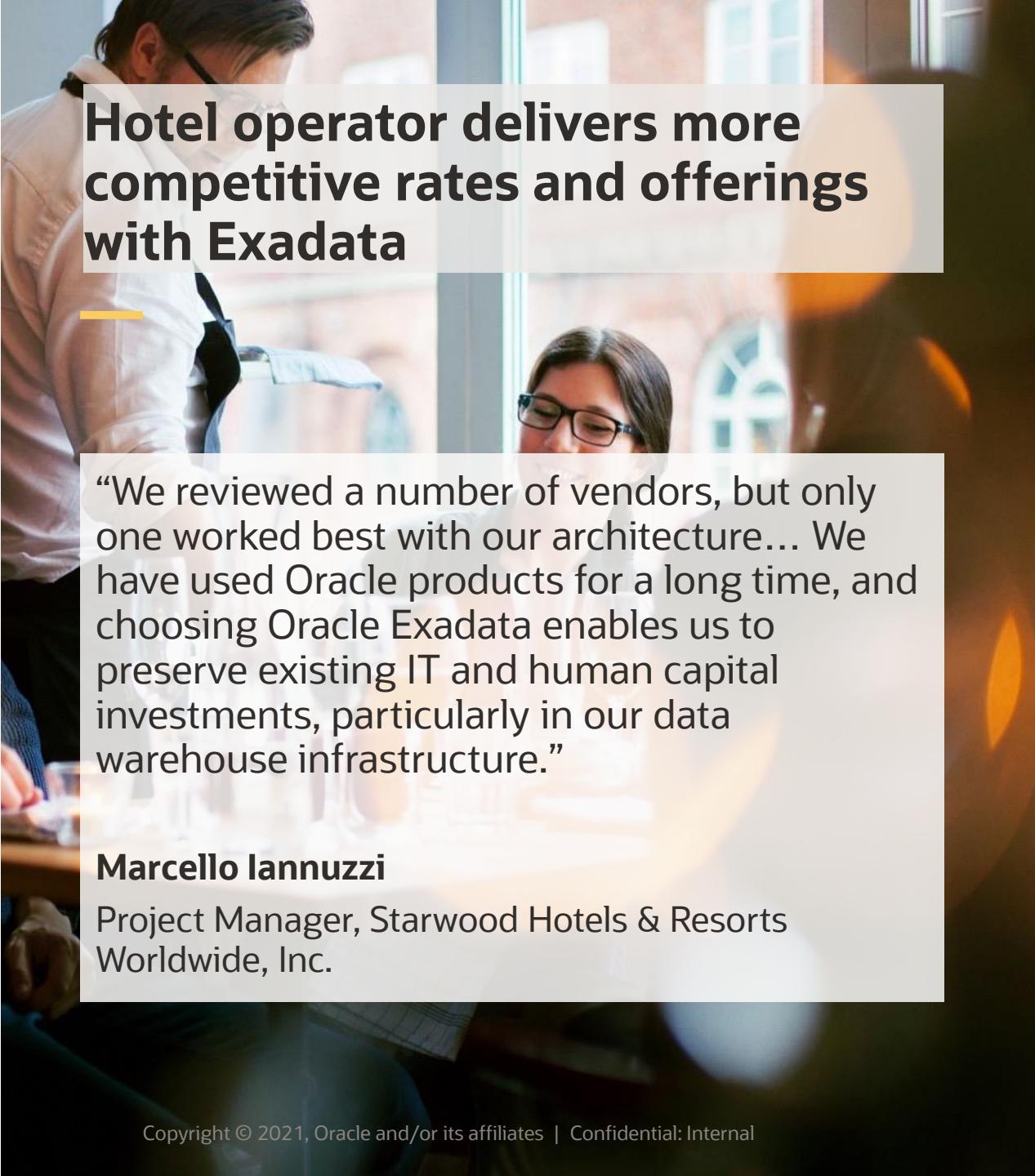
Essilor

- Essilor is a French-based international optic company that designs, manufactures and markets lenses, and owns almost 50% of corrective lens market share
- Uses APEX to build mobile applications, which costs less than traditional mobile development



Approved customer reference

Hotel operator delivers more competitive rates and offerings with Exadata



“We reviewed a number of vendors, but only one worked best with our architecture... We have used Oracle products for a long time, and choosing Oracle Exadata enables us to preserve existing IT and human capital investments, particularly in our data warehouse infrastructure.”

Marcello Iannuzzi

Project Manager, Starwood Hotels & Resorts
Worldwide, Inc.

233X

Speedup in accessing reservation data updates

Real-time

Posting of transactions to data warehouse

6X faster

Extract, transform, and load (ETL) operations for business reports



Autonomous Database and APEX enable **intelligent mining**

- **Helps minimize waste** generated during mining operations
- **6X faster app development** with APEX
- DBA workloads **reduced by 65%**



“I can **build and deploy applications almost right away** so that I can get people access to data. I don’t know of any other platform where I can do that out of the box.”

Frank Hoogendoorn
Chief Data Officer
Minesense

Paysafe – Leading Global Online Payments Provider

- Providing online payment solutions – real-time payments, e-Wallets
- \$1B annual revenue; 500,000 payments / day
- With rapid, real time, automated payment cycle, need to detect fraud fast – upon money movement, and in investigation, visualizing payment flows
- Using Oracle Database graph to store payments and model and analyze payment flows



CUSTOMER PERSPECTIVE

- Only graph analysis can find patterns of fraud in payment flows fast, in real time
- Protect customers from fraud while providing positive customer experience
- Scalable graph analytics with Oracle Database

Accenture

- Migrated from DBCS OCI-C to Gen 2 OCI
- Moved several APEX applications to Autonomous, including
 - Training Scheduling Application
 - Specialized Community apps
 - Employee management tool
 - Accenture Fit
 - Analytics
- They saw a 14X performance increase over other cloud environments, and developer was immediately productive with APEX on Autonomous
- Eliminated or reduced operational activities such as monitoring and backup



Oracle BlueKai scales to 1 million transactions per second with Oracle Database Sharding on OCI

- BlueKai Data Management Platform (DMP) operated billions of end-user profiles. Existing NoSQL solution did not provide features like backup/recovery, regular security patches, cross region replication
- Deployed Oracle Sharding, with no changes to existing application code. About 105 nodes distributed across Oracle Cloud Infrastructure availability domains and regions to handle 3-way replication using Oracle Data Guard
- Achieved low-latency read/write of < 5ms, median latency < 1ms and seamless failover with Oracle Data Guard
- Optimized the application to use Oracle DB JSON support to improve performance



“When thinking of alternatives to an Oracle Sharded Database, you aren’t thinking about a single database. Instead, you are thinking about a group of databases that each perform in one specific area. The promise of a sharded Oracle Database is that it can perform in all of the areas we need it to.”

Matt Abrams

Group Vice President of Engineering, Oracle BlueKai Data Management Platform

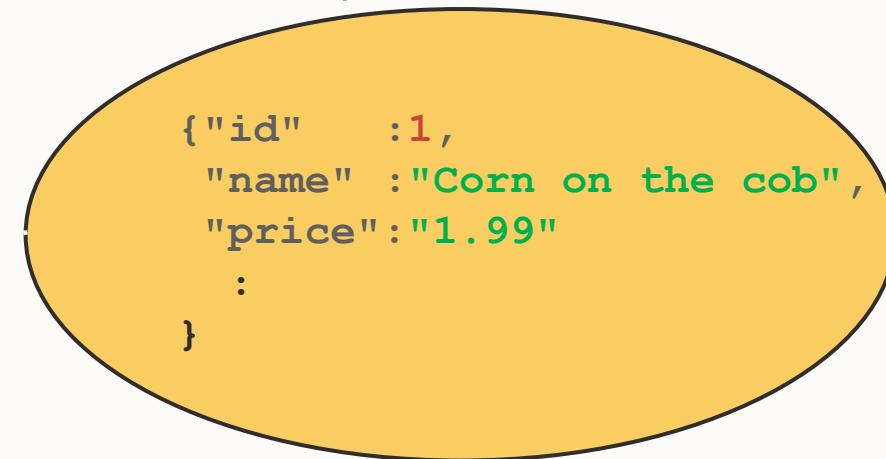


Oracle Converged Database

Native SQL Support for JSON

```
-- 1. Create a menu-items table  
-- where menus items are stored as JSON
```

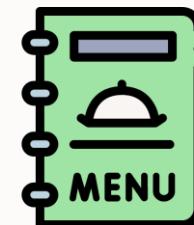
```
CREATE TABLE menu-items(  
    rest_name    VARCHAR2(255),  
    menu-item    JSON);
```



```
-- 2. Use simple dot notation to access  
-- elements within the JSON docs
```

```
SELECT m.menu-item.name item,  
       m.menu-item.price price  
FROM   menu-items m;
```

ITEM	PRICE
-----	-----
Corn on the cob	1.99



Oracle Converged Database

Support for IoT

--1. Create temperature reading table
-- with the MEMOPTIMIZE WRITE

```
CREATE TABLE temp_readings
  (meterid      NUMBER,
   readtime     TIMESTAMP,
   temp_reading NUMBER)
MEMOPTIMIZE FOR WRITE;
```

-- 2. Begin streaming data into the table

```
INSERT /*+ memoptimize_write */
INTO temp_readings VALUES(...,...);
```

-- 3. Use built-in analytic functions to calculate the difference between temp readings

```
SELECT meterid, readtime, temp_reading,
       LAG(temp_reading, 1, 0) OVER (ORDER BY meterid, readtime) AS prev_tmp,
       temp_reading - LAG(temp_reading, 1, 0) OVER (ORDER BY meterid, readtime) AS dif
FROM   temp_reading;
```

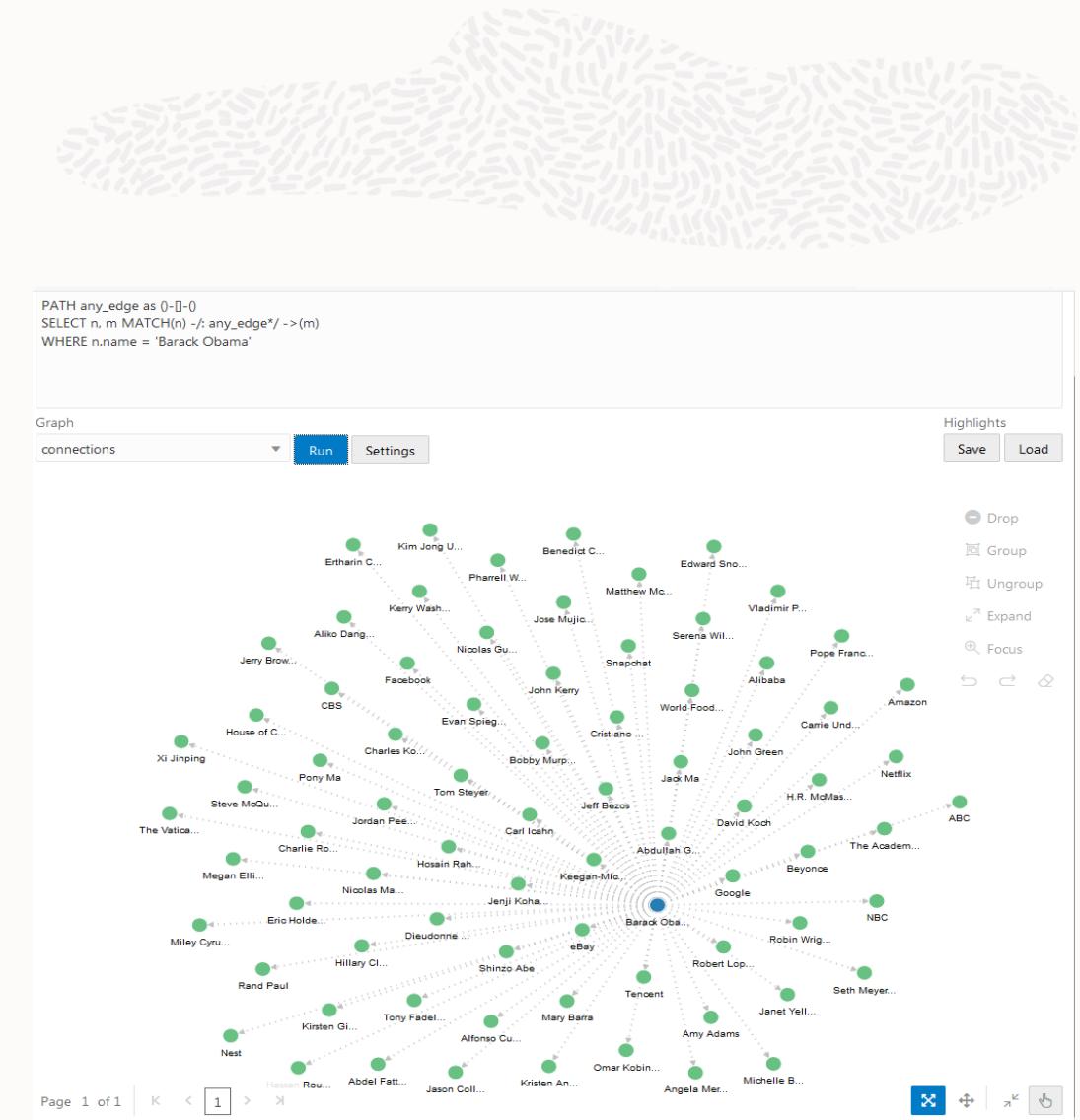
Oracle Converged Database

Support for Graph Analytics

Open-Source Graph Query Language, PGQL allows you to specify graph patterns which are matched against vertices and edges in a graph

-- Find the out-going edges from Barack Obama

```
PATH  any_edge as ()-[]-()
SELECT n, m MATCH(n) -/: any_edge*/->(m)
WHERE n.name = 'Barack Obama'
```



Oracle Converged Database

Crypto-Secure Data with Blockchain Tables



-- 1. Create a blockchain table to record trades

```
CREATE BLOCKCHAIN TABLE trade_ledger (Order_Id number, Customer_Name varchar2(100),  
Order_Date date, order_value number(8,2)).....;
```

-- 2. Data can easily be inserted using standard SQL commands

```
INSERT INTO trade_ledger VALUES(1,'Dominic','08-AUG-2020', 1000);
```

-- 3. However, Update and Delete commands are are not possible

```
DELETE trade_ledger WHERE order_id=1;  
Error: ORA-05715: operation not allowed on the blockchain table
```

-- 4. Can Verify that no one has attempted to tamper with any of the data using new PL/SQL pkg

```
DBMS_BLOCKCHAIN_TABLE.VERIFY_ROWS('BCHAIN','TRADE_LEDGER', number_of_rows_verified=>v_row);
```

Oracle Converged Database

Full support for Spatial Data in SQL



built-in functions and operators allowing for querying and processing the spatial



```
-- Find all restaurants within 5KM of our home  
SELECT r.name  
FROM Restaurants r,  
      geod_locations l  
WHERE l.location_name = 'Home'  
AND   SDO_WITHIN_DISTANCE(r.location,  
                           l.geom ,  
                           'distance=5 unit=km')='TRUE';
```

Oracle Converged Database

Oracle Machine Learning & Adv. Analytics Portfolio

CLASSIFICATION

- Naïve Bayes
- Logistic Regression (GLM)
- Decision Tree
- Random Forest
- Neural Network
- Support Vector Machine
- Explicit Semantic Analysis



CLUSTERING

- Hierarchical K-Means
- Hierarchical O-Cluster
- Expectation Maximization (EM)



ANOMALY DETECTION

- One-Class SVM



TIME SERIES

- State of the art forecasting using Exponential Smoothing
- Includes all popular models e.g. Holt-Winters with trends, seasons, irregularity, missing data

REGRESSION

- Linear Model
- Generalized Linear Model
- Support Vector Machine (SVM)
- Stepwise Linear regression
- Neural Network
- LASSO *



ATTRIBUTE IMPORTANCE

- Minimum Description Length
- Principal Comp Analysis (PCA)
- Unsupervised Pair-wise KL Div
- CUR decomposition for row & AI



ASSOCIATION RULES

- A priori/ market basket



PREDICTIVE QUERIES

- Predict, cluster, detect, features

SQL ANALYTICS

- SQL Windows, SQL Patterns, SQL Aggregates



FEATURE EXTRACTION

- Principal Comp Analysis (PCA)
- Non-negative Matrix Factorization
- Singular Value Decomposition (SVD)
- Explicit Semantic Analysis (ESA)



TEXT MINING SUPPORT

- Algorithms support text
- Tokenization and theme extraction
- Explicit Semantic Analysis (ESA) for document similarity



STATISTICAL FUNCTIONS

- Basic statistics: min, max, median, stdev, t-test, F-test, Pearson's, Chi-Sq, ANOVA, etc.



R PACKAGES

- CRAN R Algorithm Packages through Embedded R Execution
- Spark MLlib algorithm integration

EXPORTABLE ML MODELS

- REST APIs for deployment

