ORACLE

Oracle Autonomous Database: A Look Under the Hood

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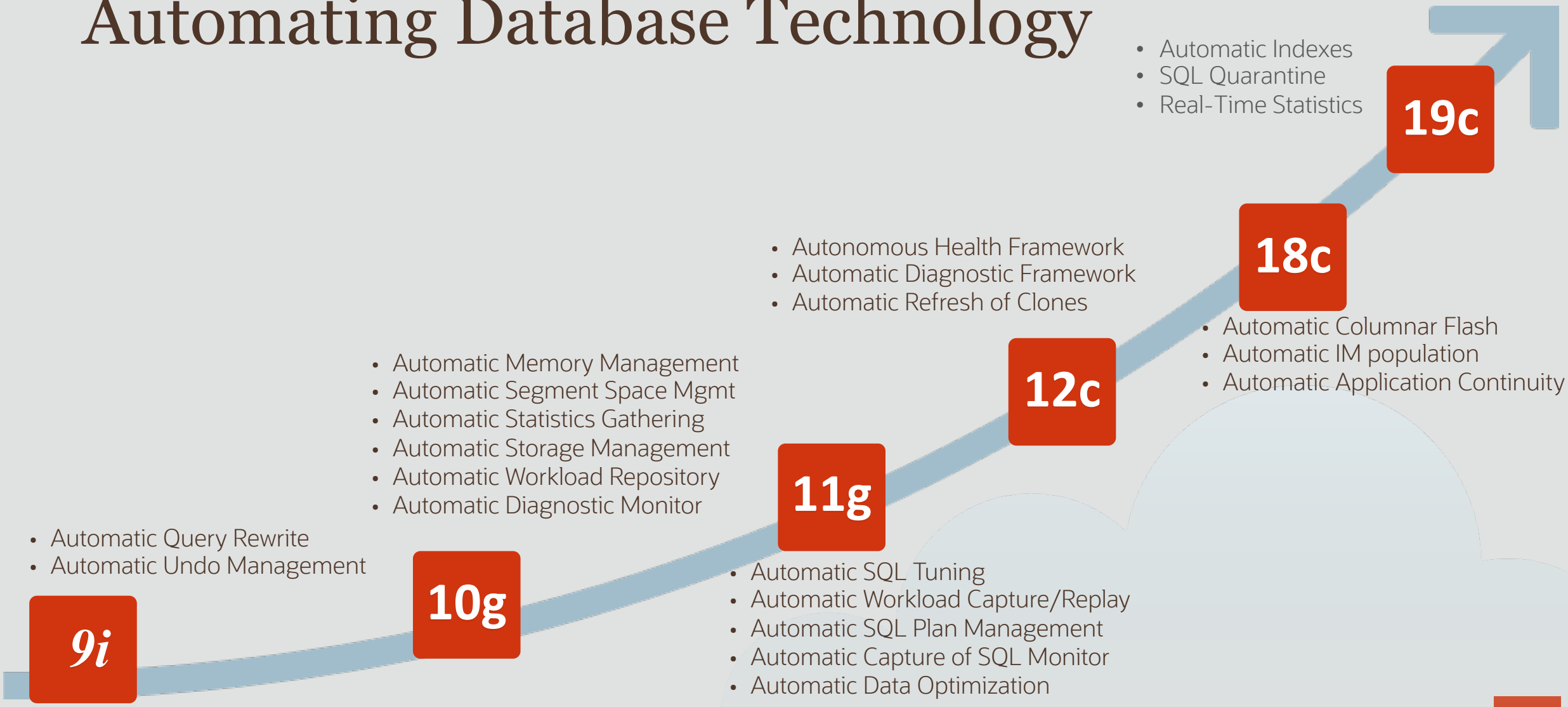
Autonomous Database Introduction

Oracle Spent Last 20 Years Automating Database Technology



Oracle Spent Last 10 Years Automating Database Infrastructure

2008

- Smart Scan
- Infiniband Scale-Out

- Database Aware Flash Cache
- Storage Indexes
- Hybrid Columnar Data

- IO Priorities
- Data Mining Offload
- Offload Decryption

- Network Resource Mgmt
- Prioritized File Recovery

- Direct-to-wire Protocol
- JSON and XML offload
- Instant failure detection

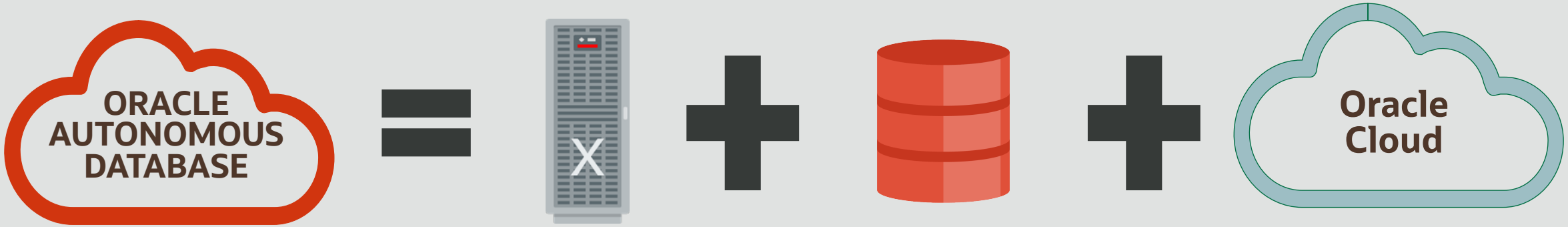
- In-Memory Columnar in Flash
- Smart Fusion Block Transfer

- Exadata Cloud Service

2019

Autonomous Database Completes the Job

Eliminates All the Complexity of Mission Critical Databases



Complete Infrastructure Automation

Complete Database Automation

Automated Data Center Operations and Machine Learning

Autonomous Database: Continuous Enhancements

Serverless | Dedicated | Free

OCTOBER
- Wallet Rotation
- External Partitioned Tables
- Hybrid Partitioned Tables
- Instance Wallet

SEPTEMBER
- Data Safe
- OCI Metrics
- ADW on Dedicated
- $$$ Free Service

AUGUST
- Events Service
- Work Requests

JULY
- Perf Hub
- ODI on OCI Marketplace
- Spatial Studio

JUNE
- Auto Scaling
- SQL Developer Web
- Application Express
- ORDS-SODA
- ATP on Dedicated
- Fleet Mgmt **
- Private IP
- Database Vault

MAY
- HIPAA Compliance
- Text
- Spatial
- XML
- CPU-IO Shares
- Full Support For DB Links
- Oracle Mgmt Cloud

APRIL
- Network ACLs *
- Avro Files
- Change License

MARCH
- Cloning
- Service Gateway *

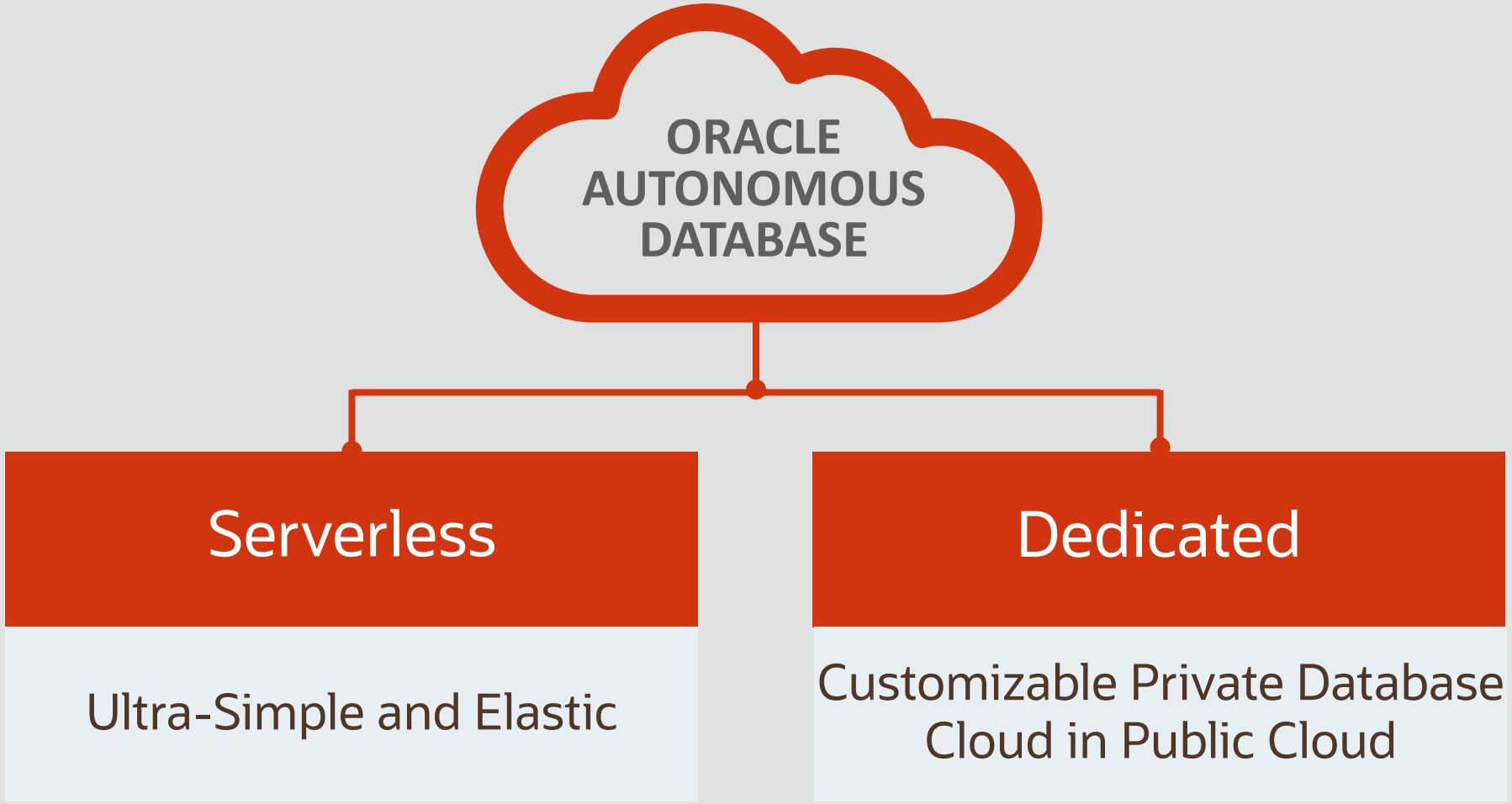
FEBRUARY
- Application Continuity
- SOC 1 and SOC 2 Compliance

JANUARY
- Support For Parquet Files
- Schema Advisor

* Serverless exclusive

** Dedicated exclusive

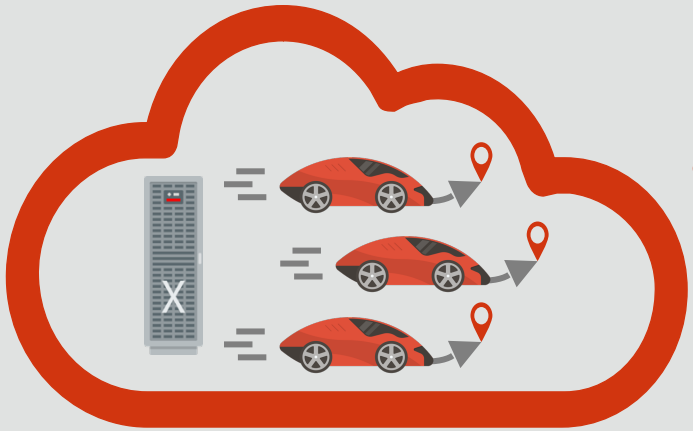
One Autonomous Database – Two Deployment Choices



Autonomous Database Serverless – Primary Benefits

- Simple
  - Oracle automates and manages everything
    - Deployment, lifecycle, software updates, etc.
  - Customer just chooses database compute, storage, and region
- Elastic
  - Low minimum size - 1 OCPU
  - Low minimum time commitment - 1 hour
  - Automatically scales online for true pay-per-use

Autonomous Database Dedicated – Primary Benefits



- Provides your own Database Cloud running on dedicated Exadata Infrastructure
  - Runs all your databases - any size, scale, or criticality
- Highest Isolation
  - Runs inside Secure Isolation Zone for highest protection from other tenants
  - Configure multiple Exadatas or Container Databases for intra-company isolation
- Customizable Operational Policies
  - Control of provisioning, updates, availability, density

One Autonomous Database – Optimized by Workload

Autonomous Data Warehouse - ADW

Best for all Analytic Workloads:

- Data Warehouse, Data Mart
- Data Lake, Machine Learning

Autonomous Transaction Processing - ATP

Best for TP and Mixed Workloads:

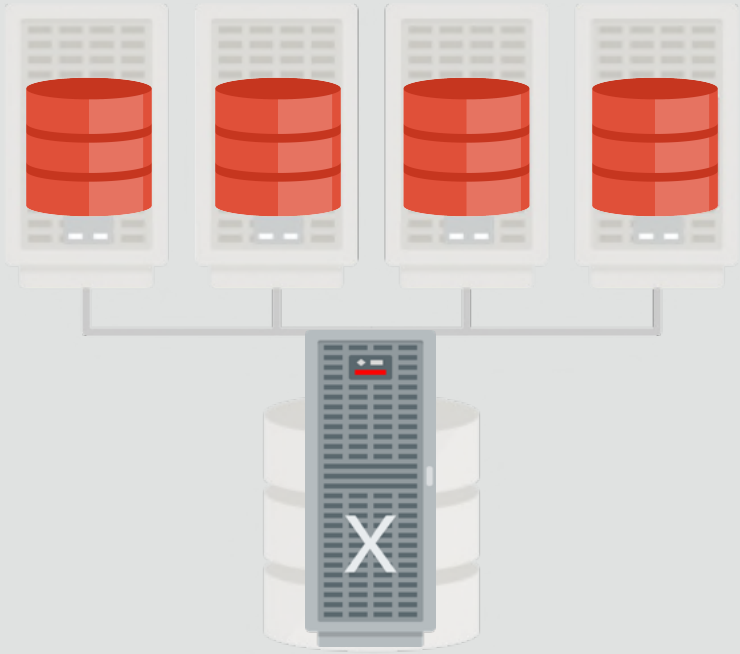
- Transactions, Batch, Reporting
- IoT, Machine Learning

Under the Hood

Database Configuration

Autonomous Database Platform

- RAC on Exadata
- Autonomous Database decides where to place each database during provisioning
- Fewer number of RAC nodes preferred when possible
- Databases may be open on one node
  - Still RAC enabled



Database Parameters

- All parameters set to optimal values based on workload type
  - May be different than regular database defaults
- Users can only change a limited number of parameters

Allowed Parameters		
APPROX_FOR_AGGREGATION	NLS_ISO_CURRENCY	OPTIMIZER_IGNORE_HINTS
APPROX_FOR_COUNT_DISTINCT	NLS_LANGUAGE	OPTIMIZER_IGNORE_PARALLEL_HINTS
APPROX_FOR_PERCENTILE	NLS_LENGTH_SEMANTICS	PLSCOPE_SETTINGS
FIXED_DATE	NLS_NCHAR_CONV_EXCP	PLSQL_CCFLAGS
MAX_IDLE_TIME	NLS_NUMERIC_CHARACTERS	PLSQL_DEBUG
NLS_CALENDAR	NLS_SORT	PLSQL_OPTIMIZE_LEVEL
NLS_COMP	NLS_TERRITORY	PLSQL_WARNINGS
NLS_CURRENCY	NLS_TIMESTAMP_FORMAT	STATISTICS_LEVEL
NLS_DATE_FORMAT	NLS_TIMESTAMP_TZ_FORMAT	TIME_ZONE
NLS_DATE_LANGUAGE	OPTIMIZER_CAPTURE_SQL_PLAN_BASELINES	
NLS_DUAL_CURRENCY		

Optimizer Hints

- Optimizer and *PARALLEL* hints work differently based on workload type

ADW	Ignores optimizer and PARALLEL hints
ATP	Honors optimizer and PARALLEL hints

- Users can override by changing two parameters

	TRUE	**FALSE**
optimizer_ignore_hints	Ignores optimizer hints	Honors optimizer hints
optimizer_ignore_parallel_hints	Ignores PARALLEL hints	Honors PARALLEL hints

Optimizer Statistics

- Stats are gathered automatically for direct load operations
  - create table … as select …;
  - insert /*+ append */ into … select …;
  - Parallel inserts with or without the append hint
  - Data Pump Import loads
  - dbms_cloud loads

Optimizer Statistics

- ATP gathers stats with a nightly auto stats job
- If your workload does conventional DML in ADW gather stats manually with the *GATHER AUTO* option

```
BEGIN
  DBMS_STATS.GATHER_SCHEMA_STATS('SH', options=>'GATHER AUTO');
END;
/
```

Optimizer Statistics in 19c

NEW IN 19c

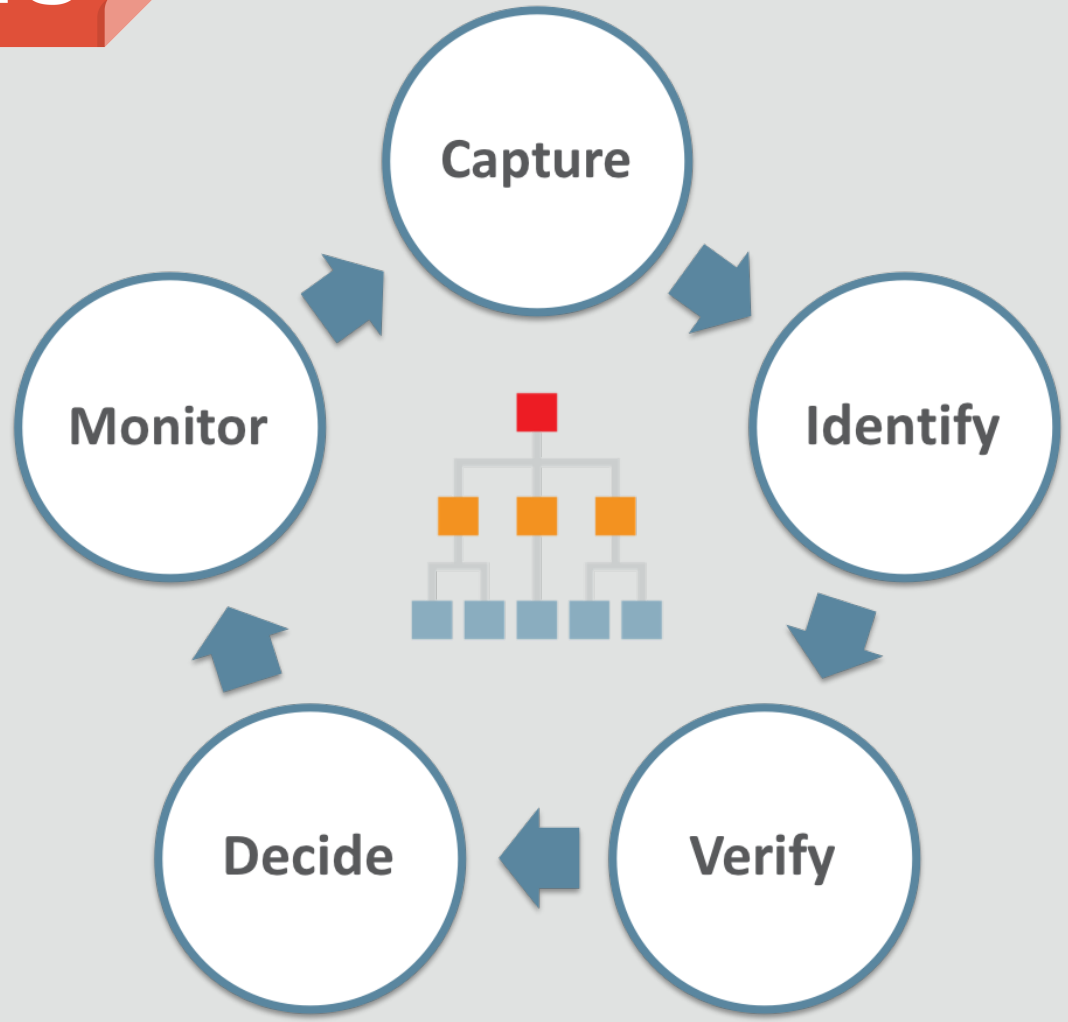
- Real-time Statistics Collection
  - Gathers a subset of optimizer statistics for conventional DML operations
    - Number of rows, MAX and MIN column values, etc.

- High-frequency Statistics Collection
  - Gathers full optimizer statistics every 15 minutes if statistics are stale

Automatic Indexing

NEW IN 19c

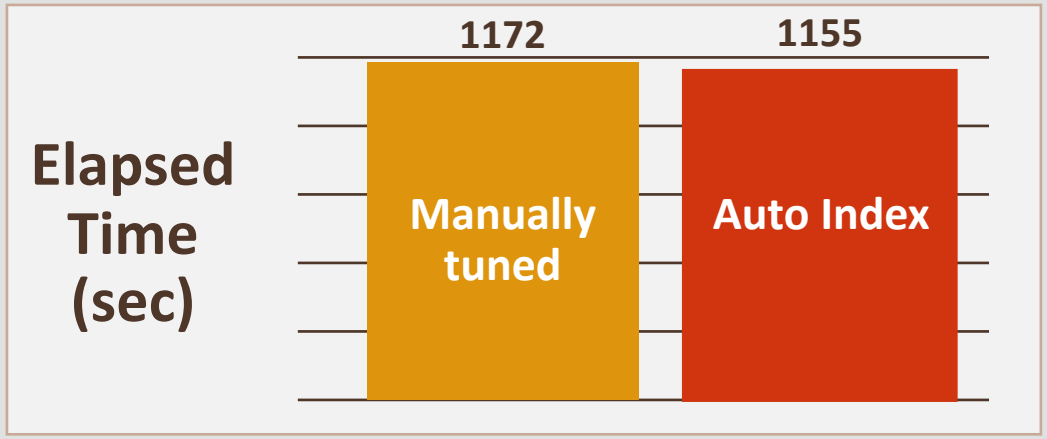
- Fully automated index creation based on continuous analysis of the workload
- Expert system with reinforcement learning
  - Learns from its own actions as all candidate indexes are validated before being implemented

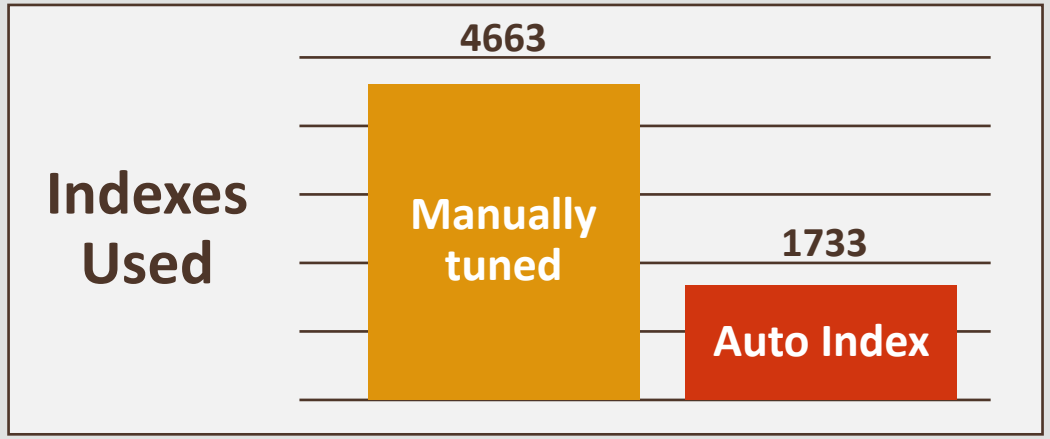


Auto Indexing On Netsuite

NEW IN 19c

- Ran a complex Netsuite workload, and compared Auto Indexing to tuned system
- 17,542 SQL statements, 1,852 tables, 8,151 indexes - years of tuning to create these indexes
  - Before running on Auto Indexing, all indexes were dropped





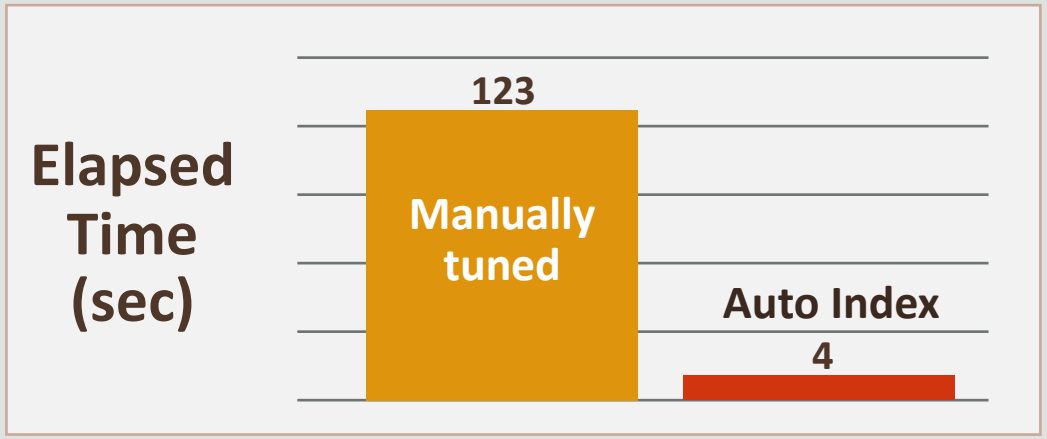
Auto Indexing achieved near-identical performance to manual tuning

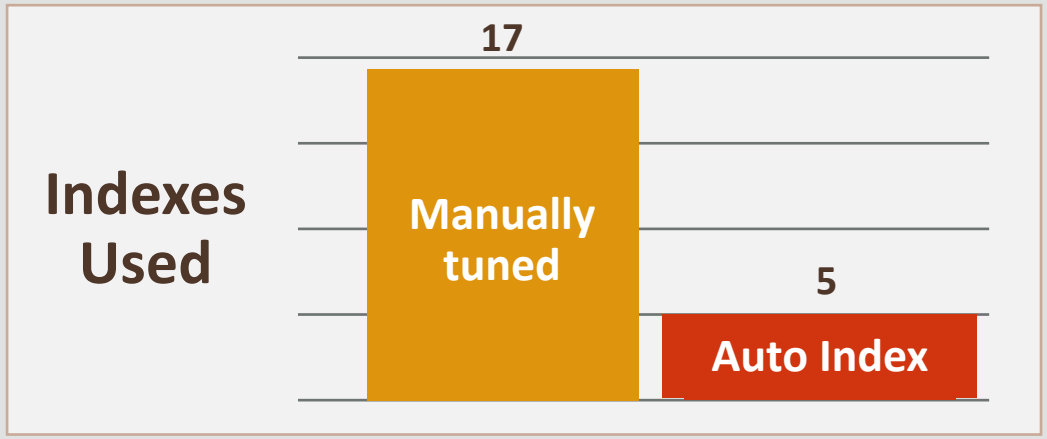
Auto Index DB stays tuned as workload changes

Auto Indexing On Accounts Receivable

NEW IN 19c

- Workload: 4,889 SQL statements running against 35 tables
- Indexes:
  - Application code created 49 indexes of which 17 were used
  - Automatic indexing created 5 indexes, *all* of which were used

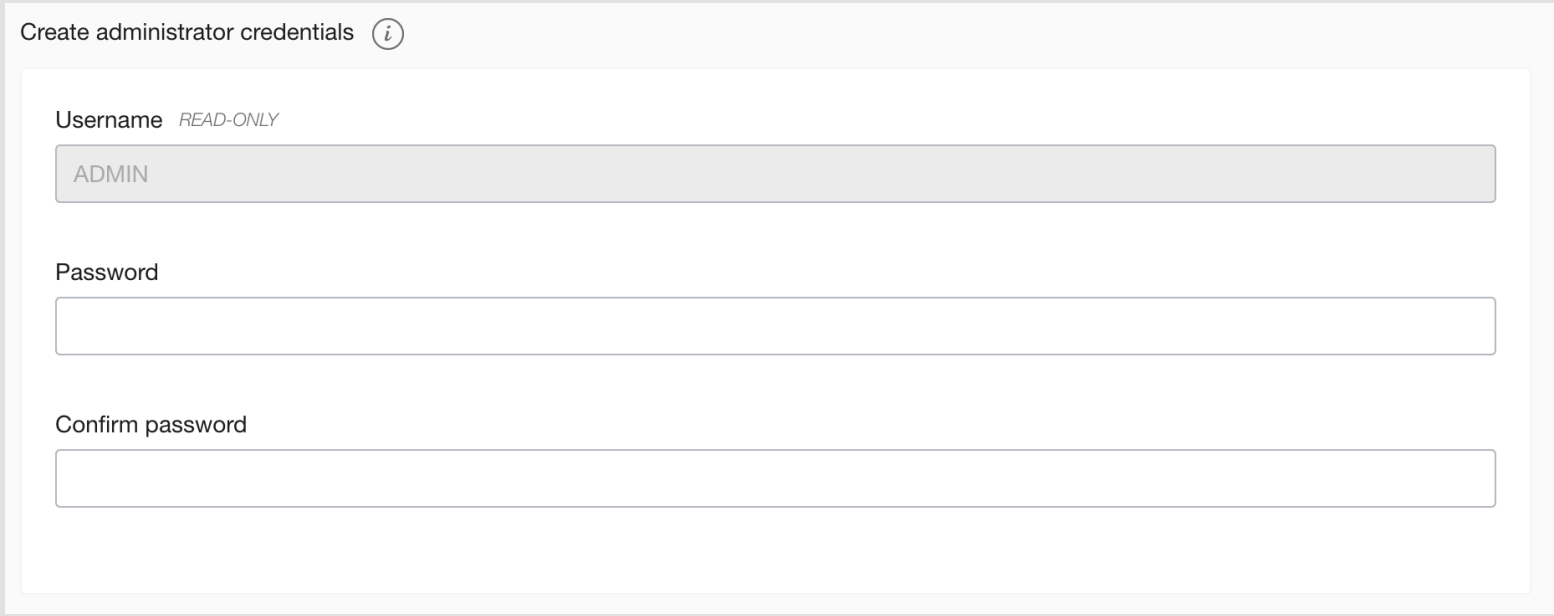




User Management

User Management

- Pre-defined ADMIN user for database management
- Subset of SYSDBA privileges
- No SYS, SYSTEM access for users



User Management

- Pre-defined role, DWROLE, for DW developers
- Includes common developer privileges

```
grant dwrole to sales identified by WelcomeSalesADW19;
```

DWROLE Privileges	
CREATE ANALYTIC VIEW	CREATE VIEW
CREATE TABLE	CREATE PROCEDURE
CREATE HIERARCHY	CREATE SESSION
CREATE JOB	CREATE SEQUENCE
ALTER SESSION	CREATE MINING MODEL
CREATE ATTRIBUTE DIMENSION	CREATE TRIGGER
CREATE TYPE	CREATE SYNONYM

Secure Password Policies

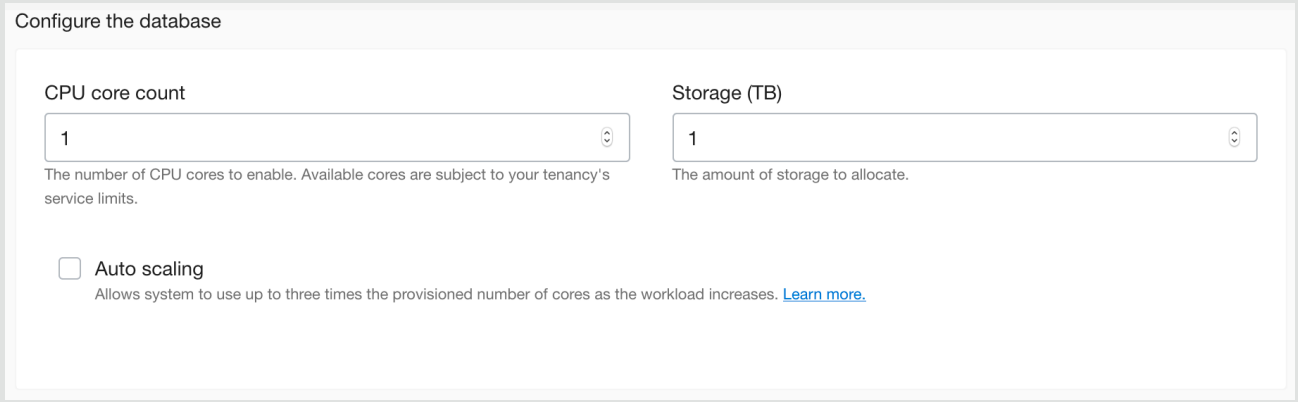
- Pre-defined unchangeable password rules
- Passwords must be:
  - Minimum 12 characters with at least one uppercase and one lowercase letter, and one numeric character
  - Cannot be one of the last 4 used passwords
  - Cannot be the same as the username
  - Must be changed every 360 days

Storage Management

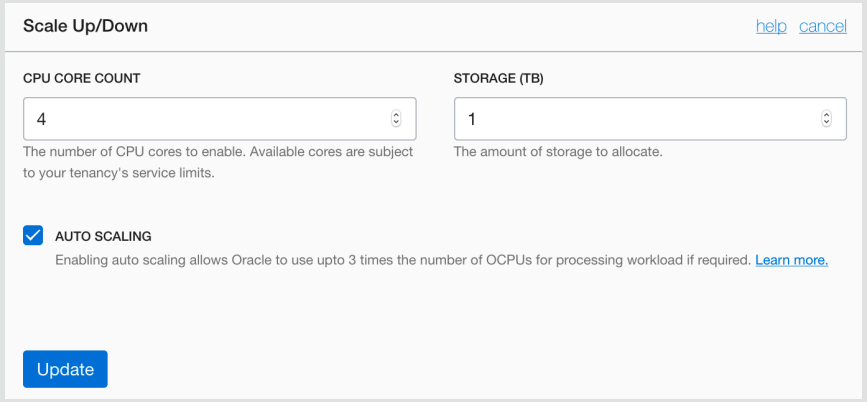
Storage Management

- Provisioned storage size is net usable space with 3x redundancy
- Includes system tablespaces and the local filesystem
- 10% overage allowed
- Exadata flash size is proportional to the storage size

Set storage size at provisioning time



Scale up/down any time without downtime



Tablespace Management

- All tablespaces created and managed automatically
  - Tablespace sizes depend on the provisioned storage size
  - All tablespaces auto extend when needed
- Users cannot create or drop tablespaces
- All objects are created in DATA automatically
  - Multiple DATA tablespaces created when storage size exceeds 32 TB

Tablespaces from a Sample Autonomous Database	
SYSTEM	DATA
SYSAUX	DBFS_DATA
UNDOTBS1	SAMPLESCHEMA
TEMP	UNDO_8

Tablespace Management

- No quota granted to users by default for security purposes
- Grant quota to users as needed

```
BEGIN
DBMS_CLOUD_ADMIN.GRANT_TABLESPACE_QUOTA(
   username => 'ADBUSER', tablespace_quota => '10G' );
END;
/
```


Tablespace Management

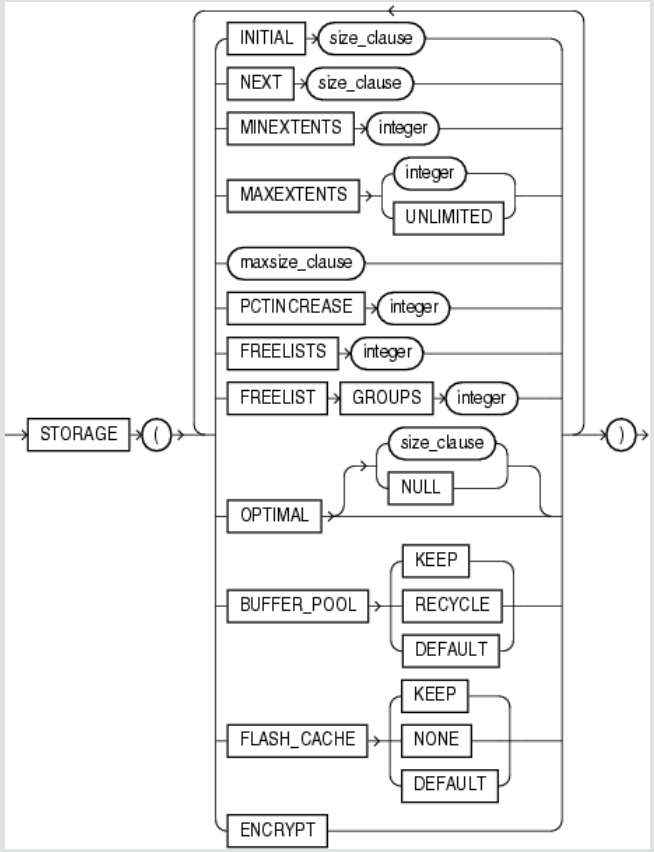
- TEMP and UNDO limited by default
  - TEMP → 30% of storage size
  - UNDO → 5% of storage size on each RAC instance

- Scale up the storage size if you need more
  - Or, manually resize data and temp files

```
alter database tempfile '…' resize 200G;
```

Table/Index Storage Attributes

- No need to worry about storage attributes
- Optimized and managed by Autonomous Database
- Table/index storage attributes ignored
  - Tablespace, INITIAL, NEXT, PCTFREE, PCTUSE, etc.



Compression

- Compression configured automatically based on ADB type

ADW	Hybrid Columnar Compression, Query High
ATP	No compression

- Users can override using create/alter table commands, all compression types available

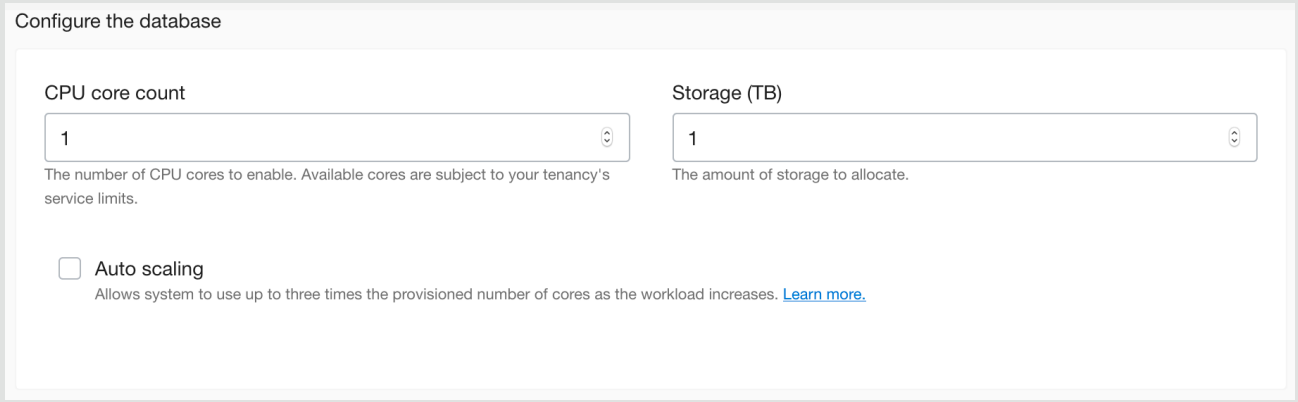
```
create table orders_history … column store compress for archive high;
```

Resource Management

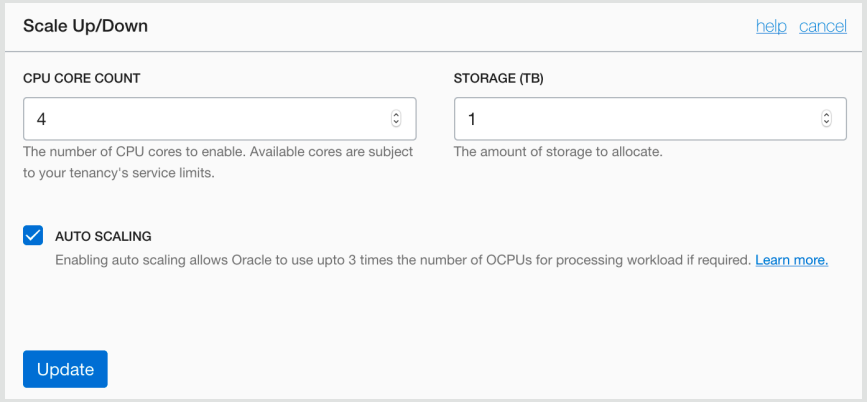
Resource Allocation

- System resources allocated based on number of OCPUs dynamically
  - CPU, IO, number of sessions, SGA, PGA, etc.
- More OCPUs provide more resources

Set CPU core count at provisioning time



Scale up/down any time without downtime

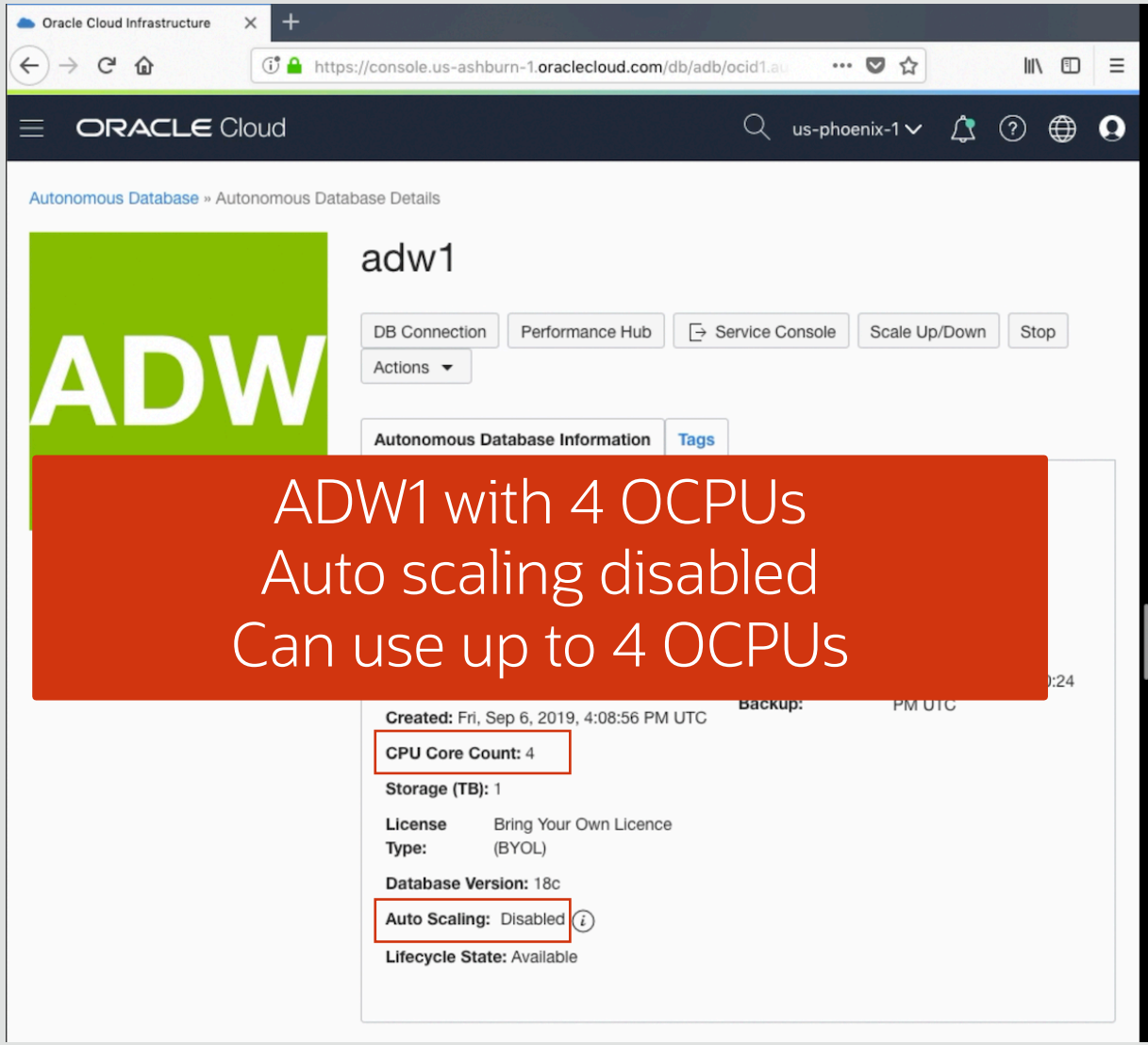


Auto Scaling

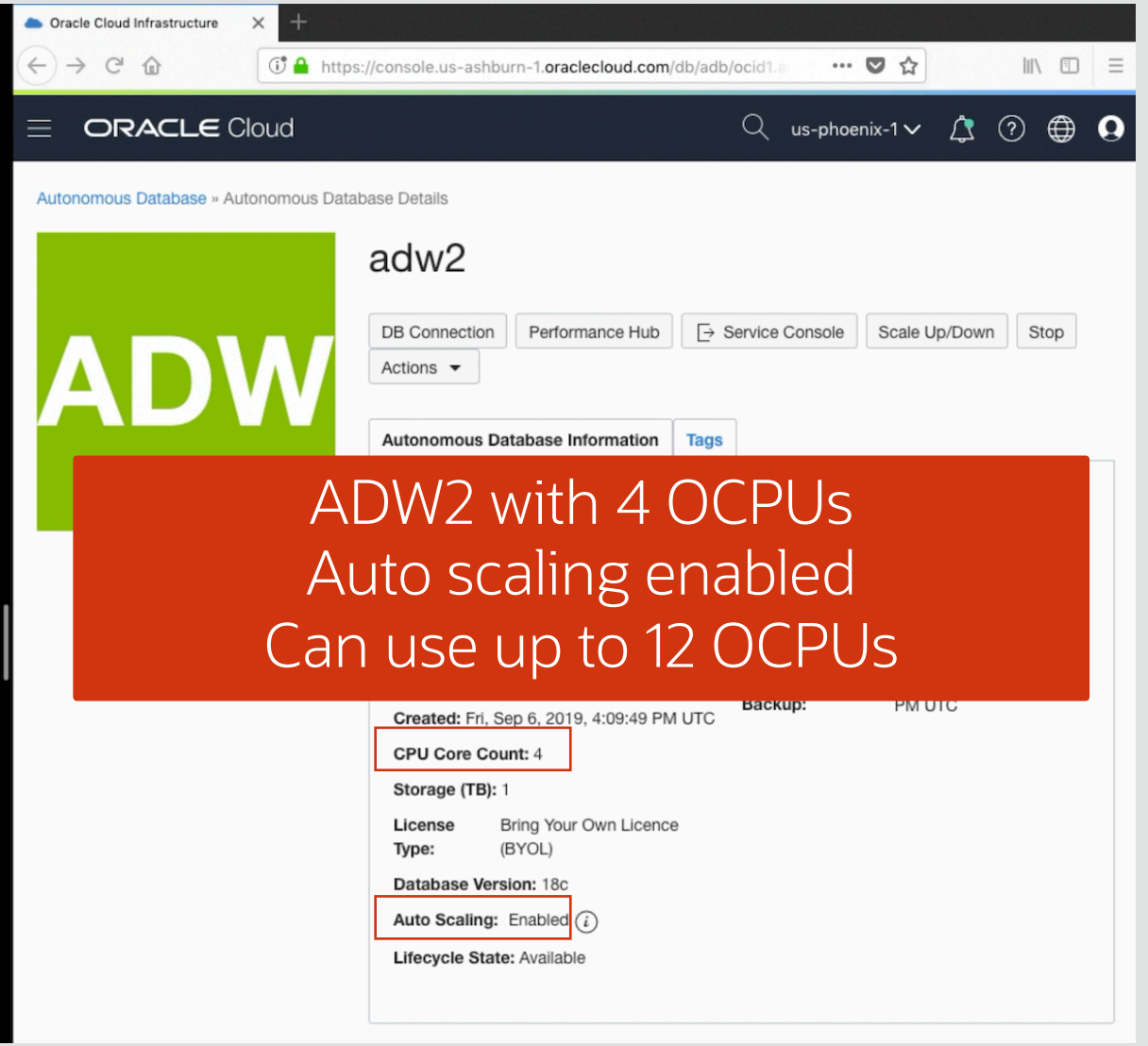
- Enables the database to use up to 3x CPU/IO resources immediately when needed by the workload
- Pay for exactly what you use
- Helps CPU or IO bound workloads
- Does not scale up all other resources. Provision more OCPUs to scale up these.
  - Number of sessions
  - Concurrency
  - PGA, SGA, etc.

Auto Scaling Walkthrough

- Two databases running the same workload with the same number of OCPUs with and without auto scaling
- Workload starts with 8 concurrent queries
- Adds 16 more queries later

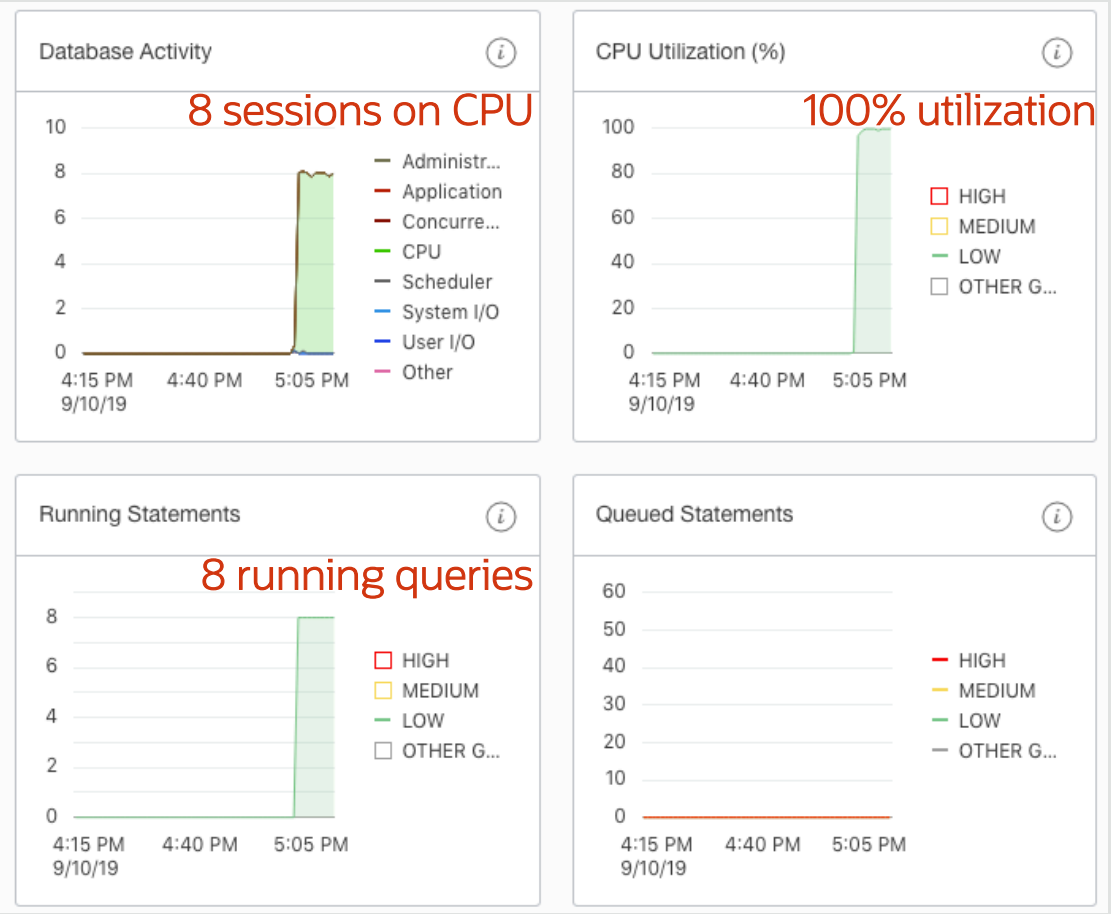


ADW1 with 4 OCPUs
Auto scaling disabled
Can use up to 4 OCPUs

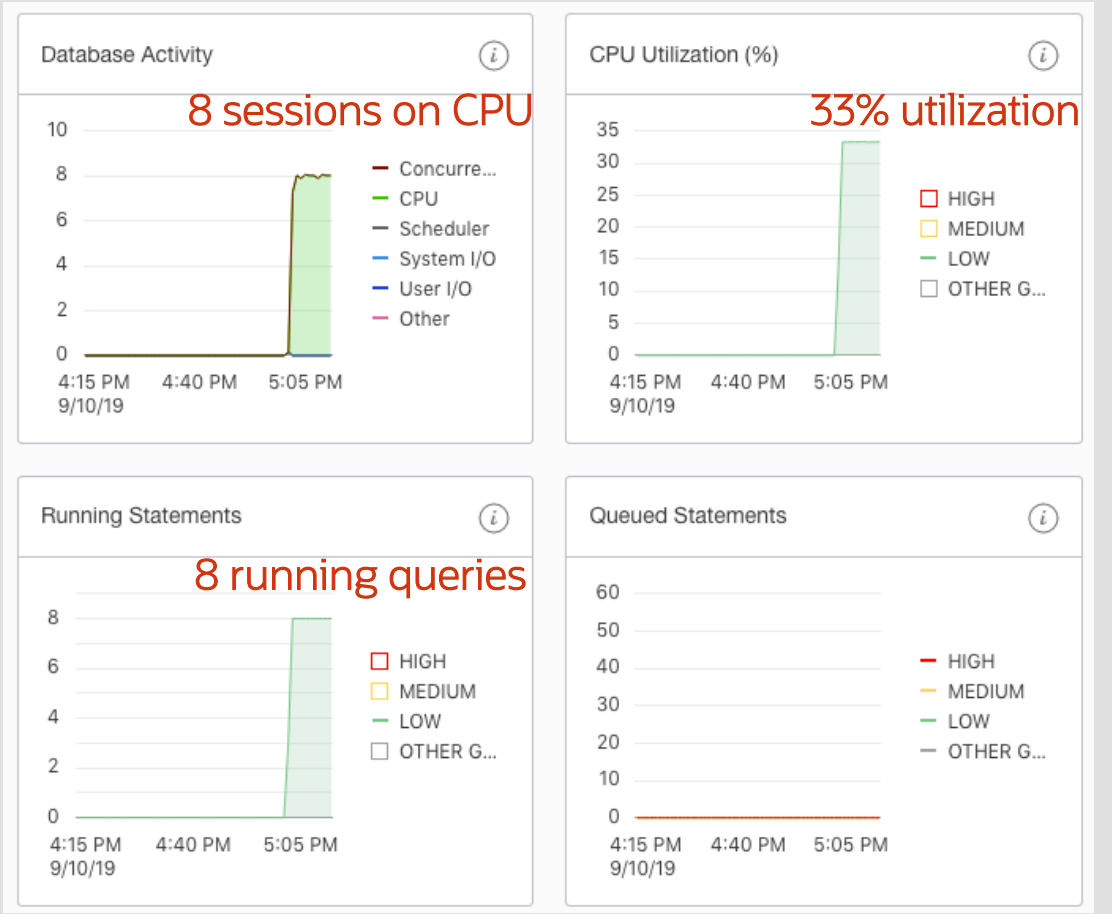


ADW2 with 4 OCPUs
Auto scaling enabled
Can use up to 12 OCPUs

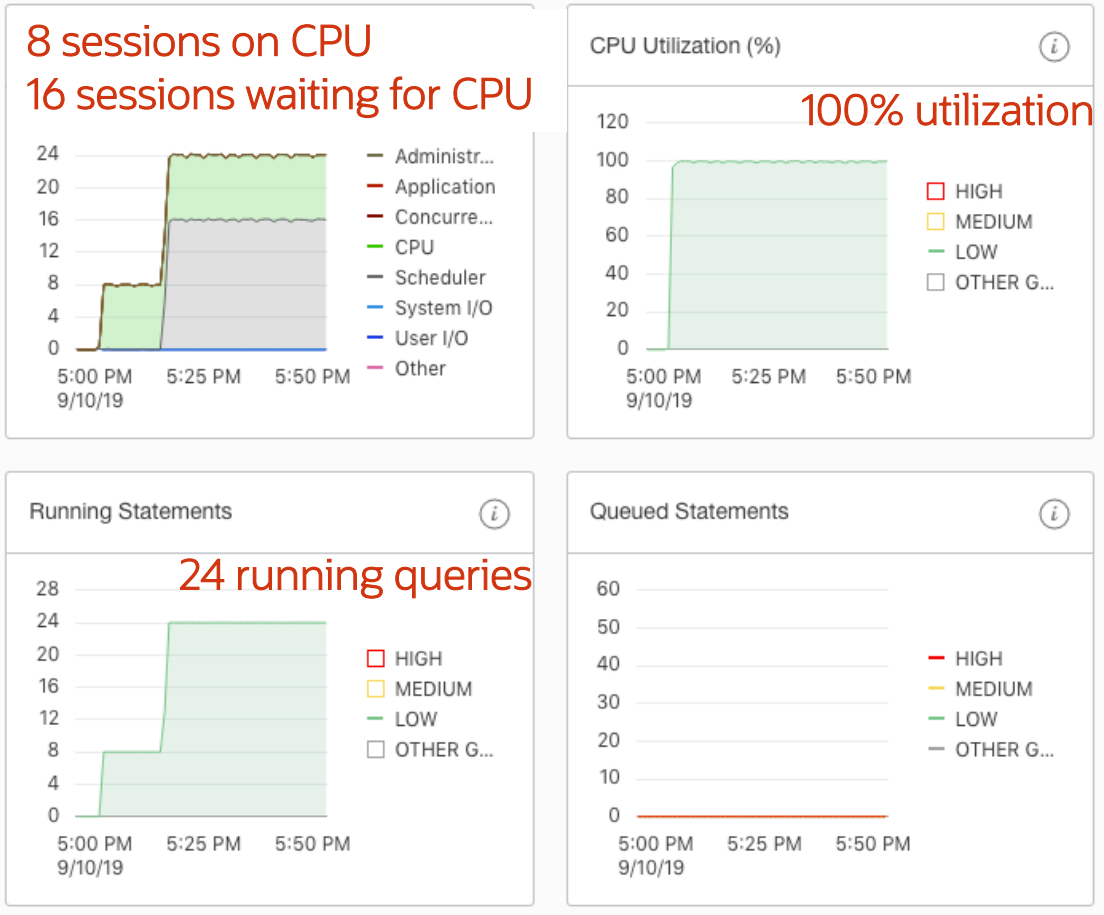
ADW1 with 4 OCPUs
Auto scaling disabled



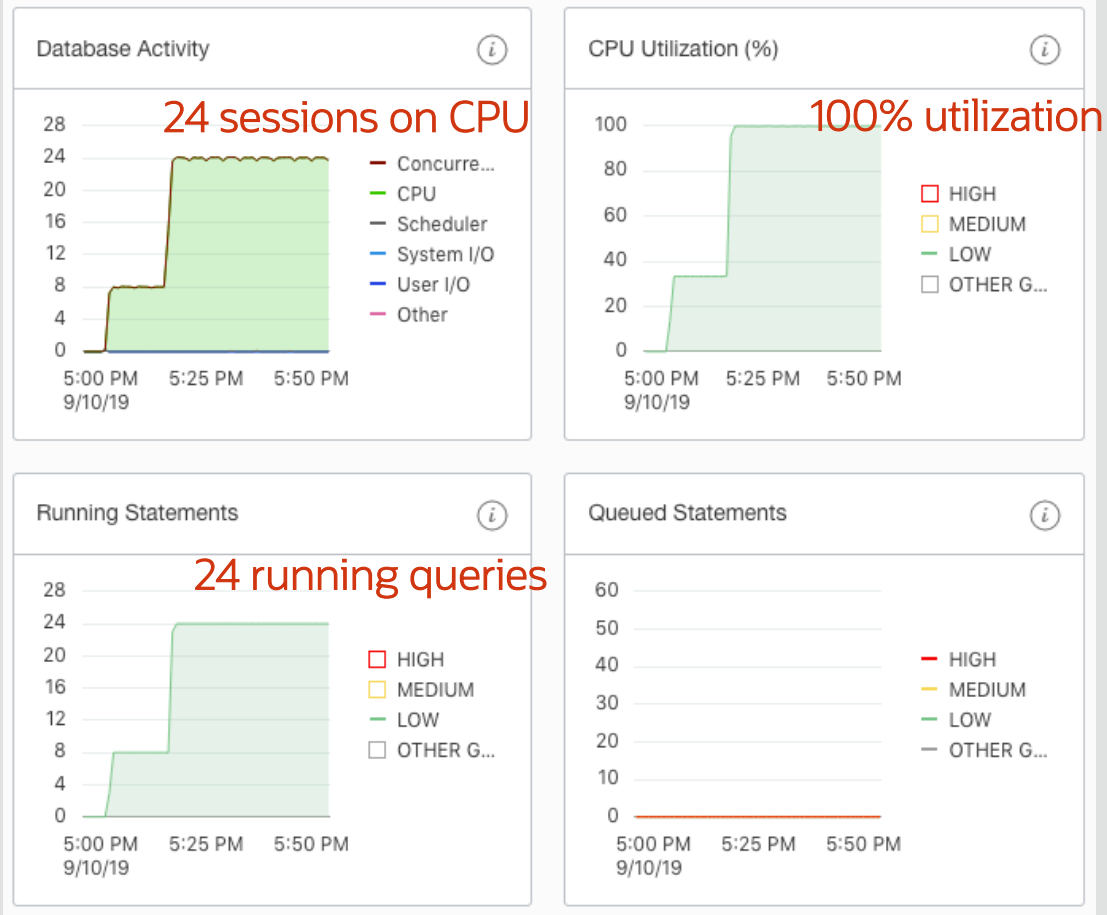
ADW2 with 4 OCPUs
Auto scaling enabled



ADW1 with 4 OCPUs
Auto scaling disabled

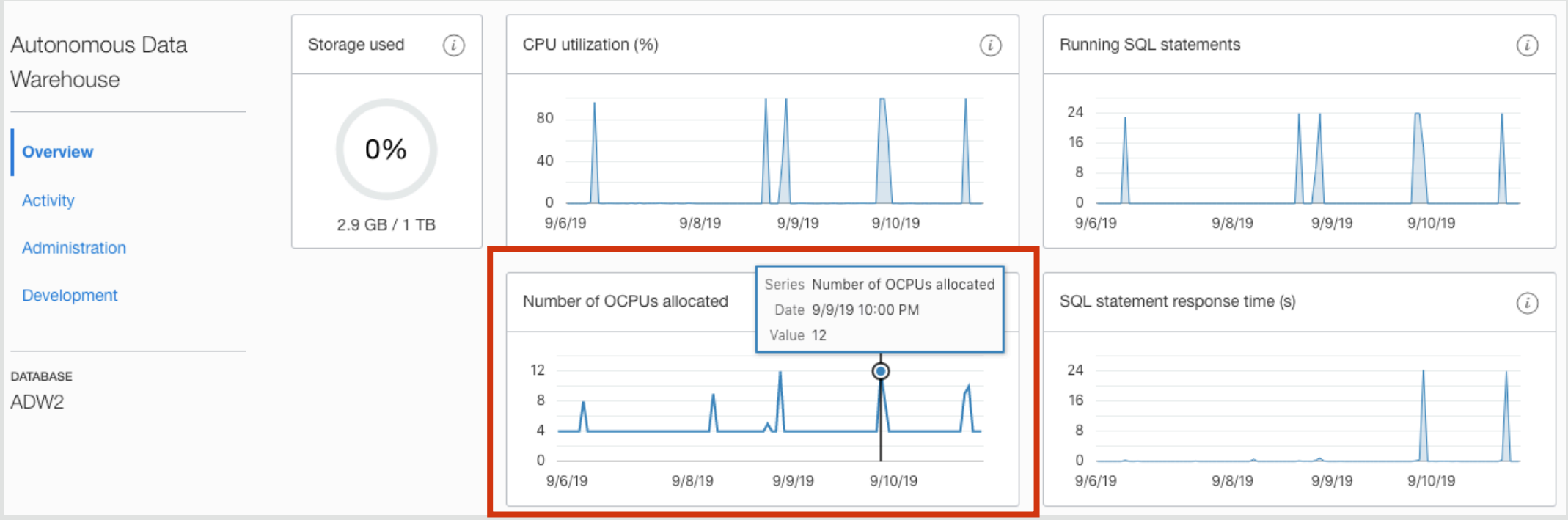


ADW2 with 4 OCPUs
Auto scaling enabled



Auto Scaling

- Historical view of the number of OCPUs used each hour



Pre-Defined Database Services

- Applications connect to a pre-defined database service
  - e.g. jdbc:oracle:thin:@dbname_high?TNS_ADMIN=/Users/test/wallet_dbname
- Database services control resource usage
  - SQL parallelism, CPU/IO shares, max concurrent queries/DML

	SERVICE	DEFAULT SQL PARALLELISM	SHARE OF RESOURCES	CONCURRENT NO OF QUERIES/DML
OLTP	TPURGENT	MANUAL	12	100 X OCPUs
	TP	1	8	100 X OCPUs
DW, Batch, Reporting	HIGH	OCPUs	4	3
	MEDIUM	4	2	1.25 X OCPUs
	LOW	1	1	100 X OCPUs

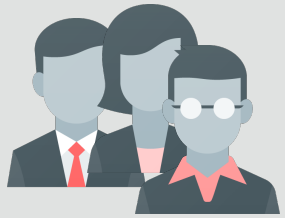
Which Service to Use

- OLTP
  - Connect to TP or TPURGENT based on priority requirements
- DW
  - Connect to HIGH, MEDIUM, LOW based on concurrency requirements

HIGH

- Low concurrency
- More resources per user

MEDIUM



- Higher concurrency
- Fewer resources per user

LOW

- Highest concurrency
- Fewest resources per user

Monitoring and Notifications

Monitoring and Notifications

- Performance monitoring
- Notifications and alerts

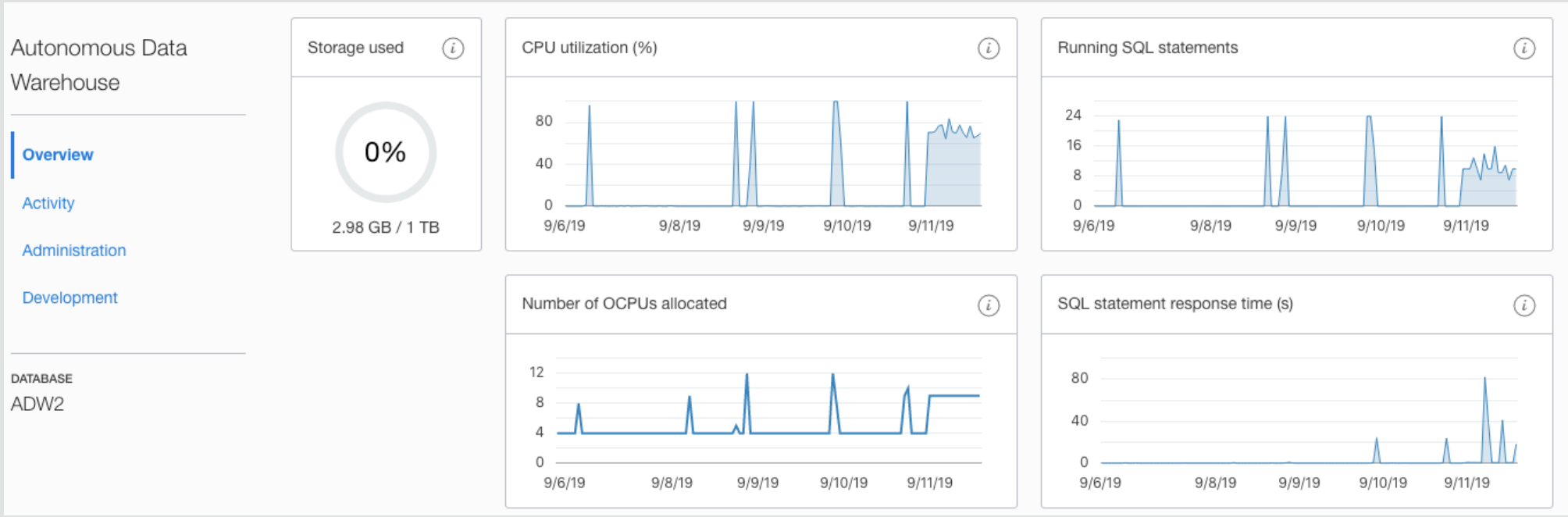
Performance Monitoring Tools

- Service Console
- Performance Hub
- Automatic Workload Repository (AWR)
- Active Session History (ASH)
- Real-Time SQL Monitoring
- SQL Test Case Builder
- Enterprise Manager (Currently available for ATP-D, coming soon to others)

- No direct access to events, tracing, hang analyzer

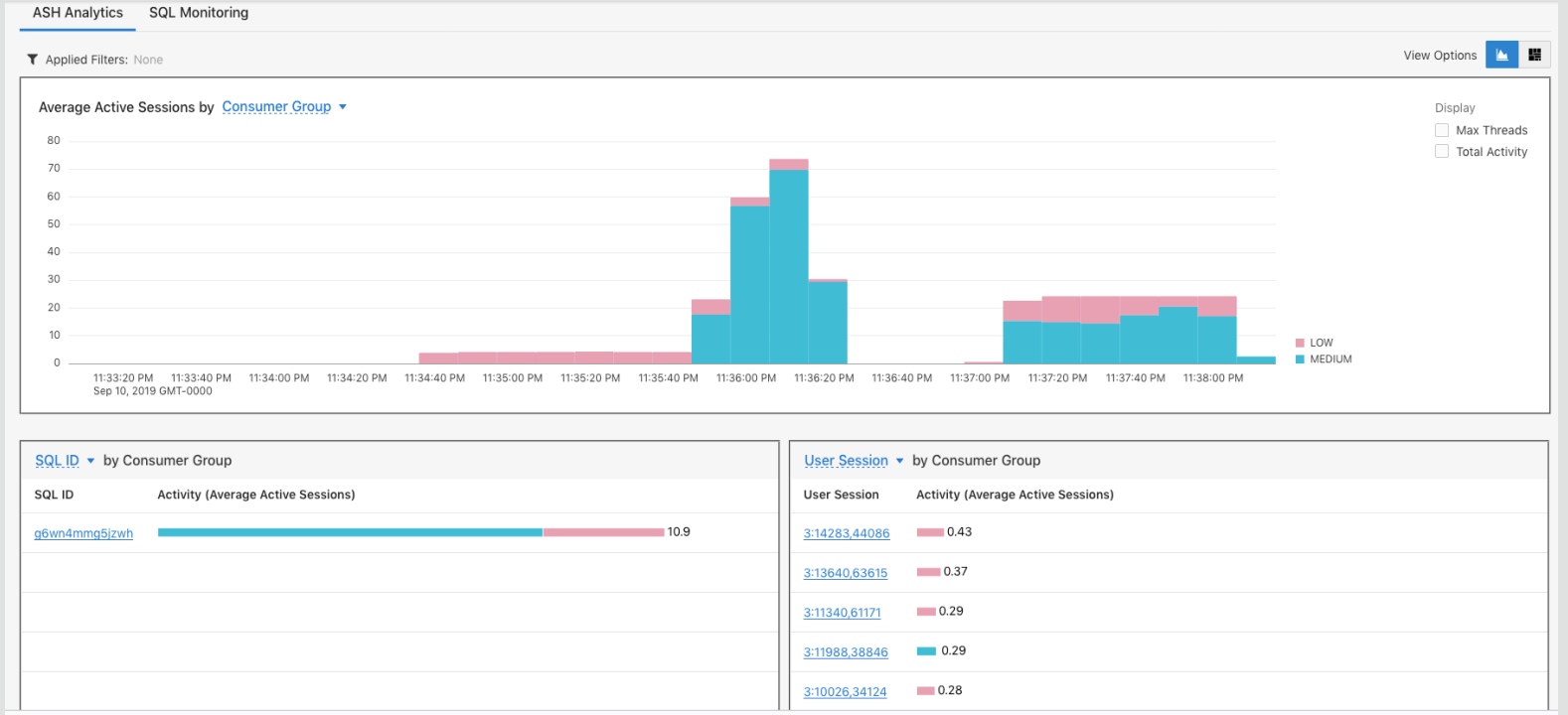
Service Console

- Simple monitoring graphs for key service metrics
- Accessible by database users without a cloud account



Performance Hub

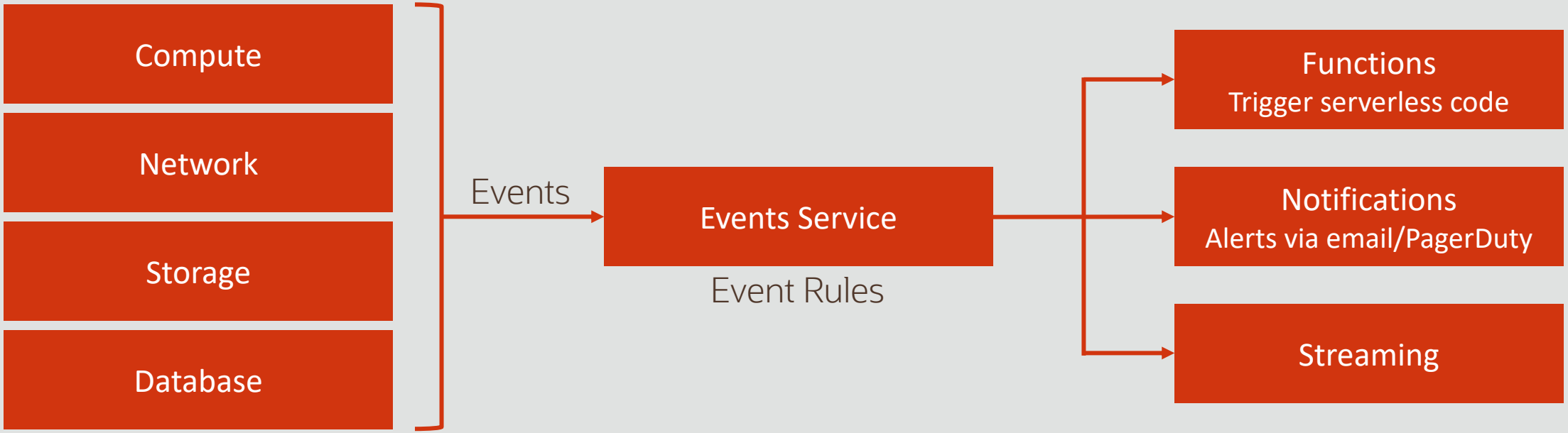
- ASH Analytics and SQL Monitoring
- Accessible by users with cloud accounts



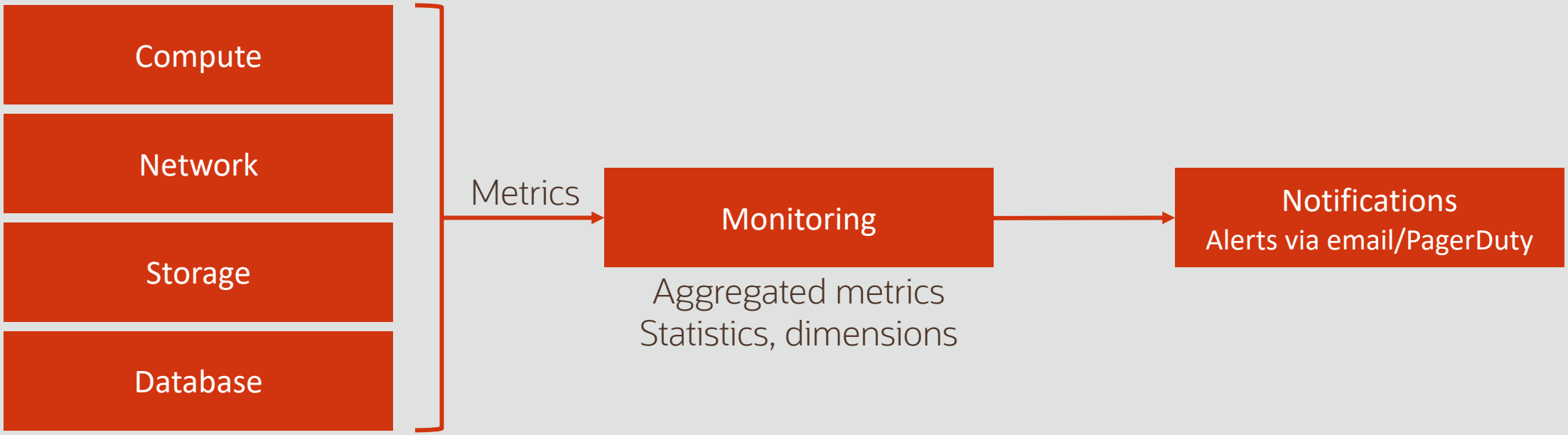
Notifications and Alerts

- Oracle Cloud Infrastructure Events Service
- Oracle Cloud Infrastructure Monitoring Service

Oracle Cloud Infrastructure Events Service

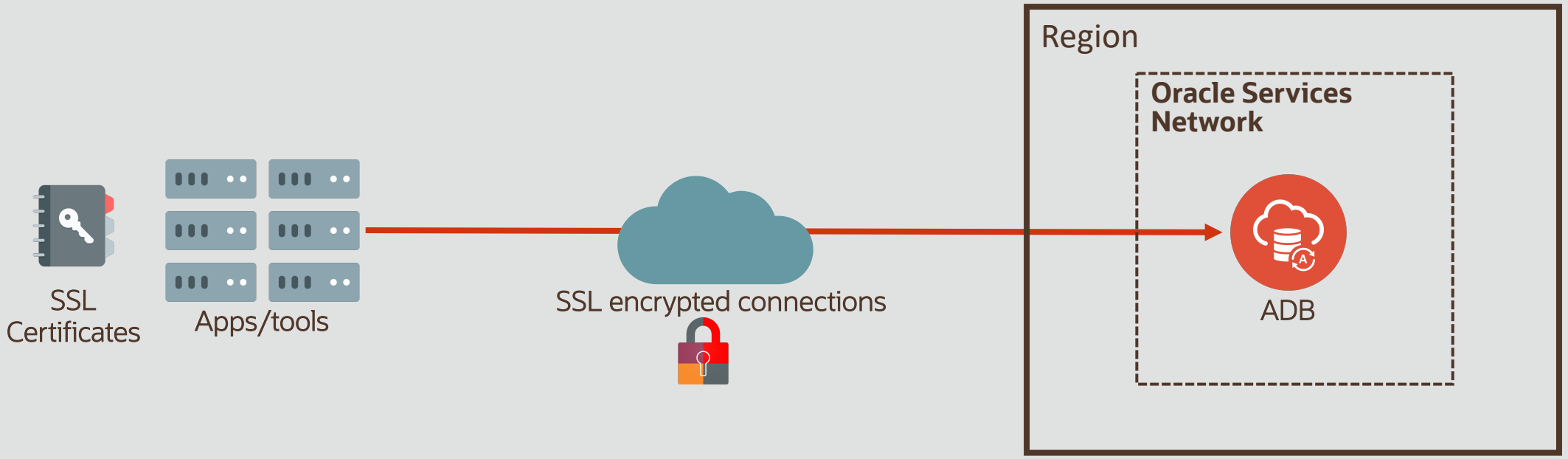


Oracle Cloud Infrastructure Monitoring



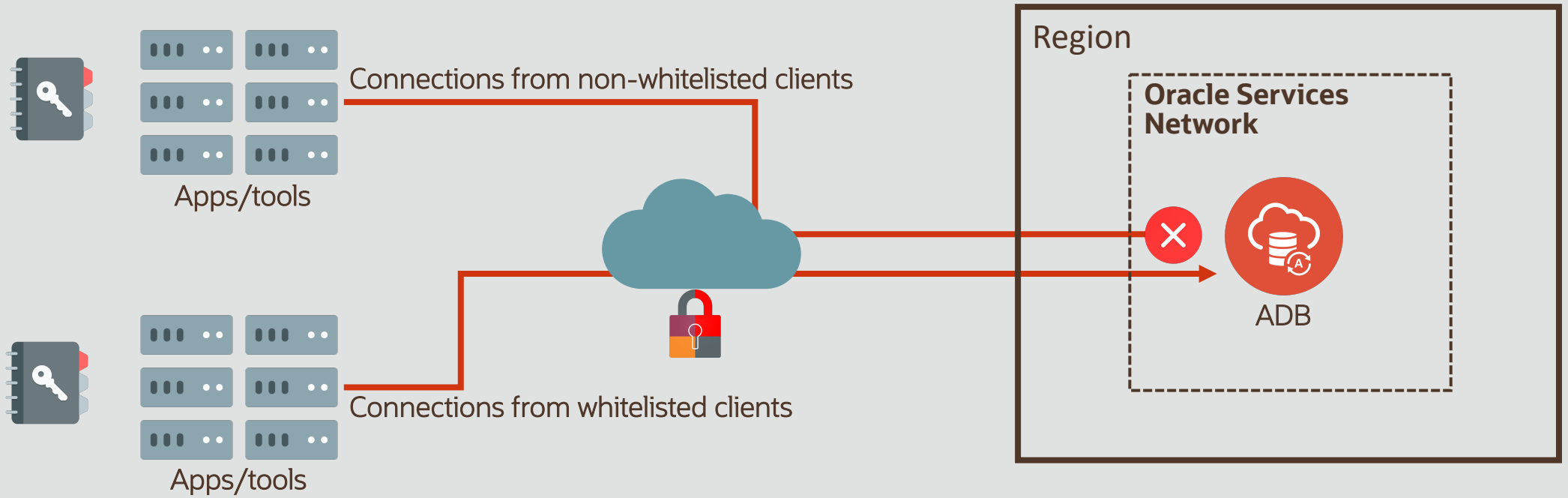
Networking

Connecting from the Internet



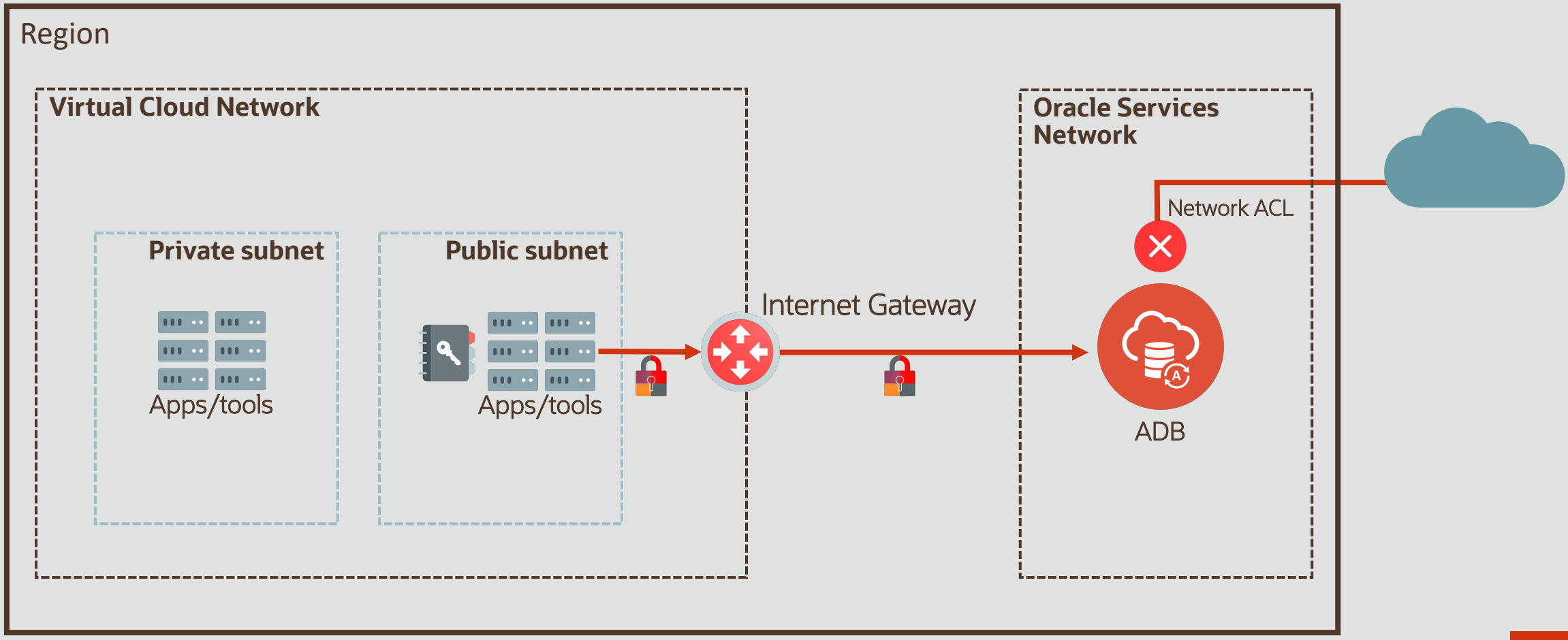
Connecting from the Internet

Network ACLs (whitelisting) to restrict connections from unknown clients



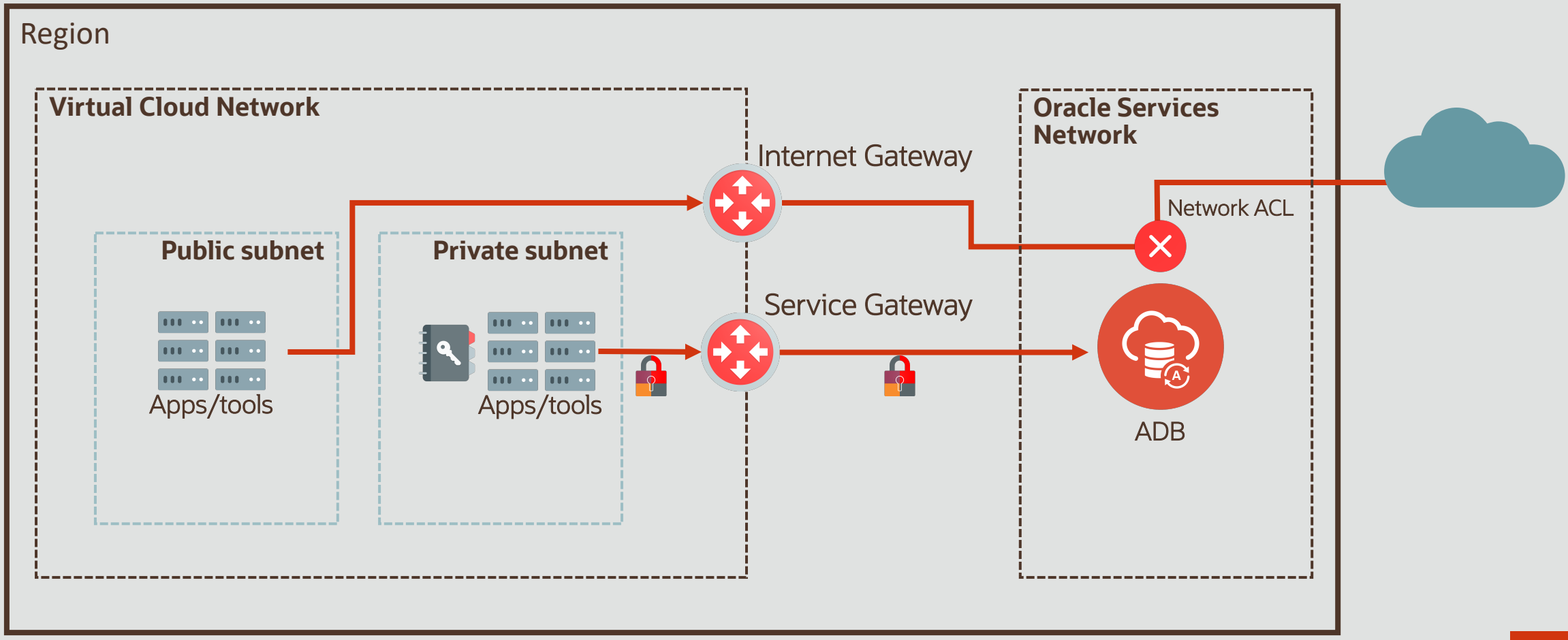
Connecting from Clients in OCI

Clients with public IP addresses



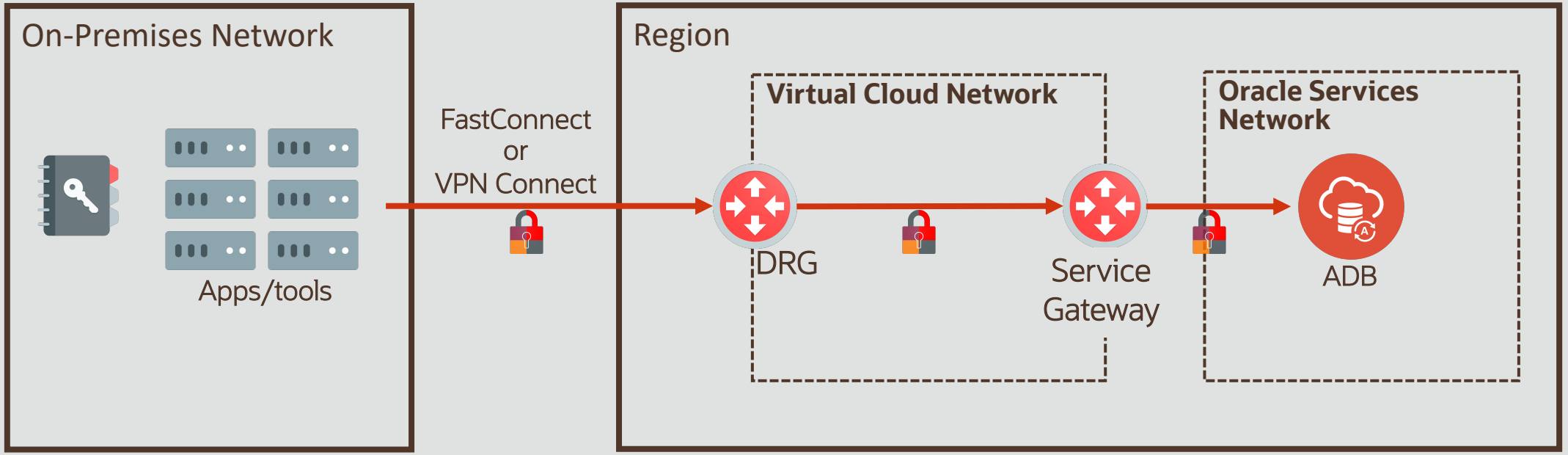
Connecting from Clients in OCI

Clients with private IP addresses



Connecting from On-Premises Networks

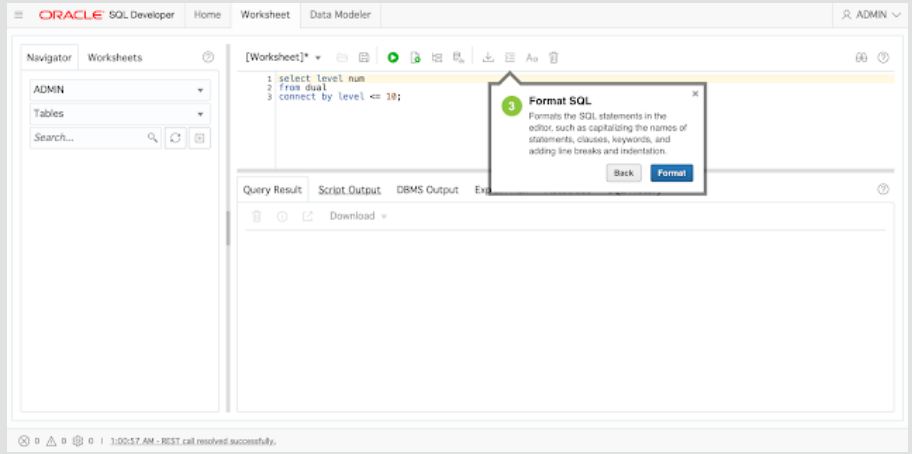
FastConnect, VPN Connect



Learn More about Autonomous Database

Developer Tools

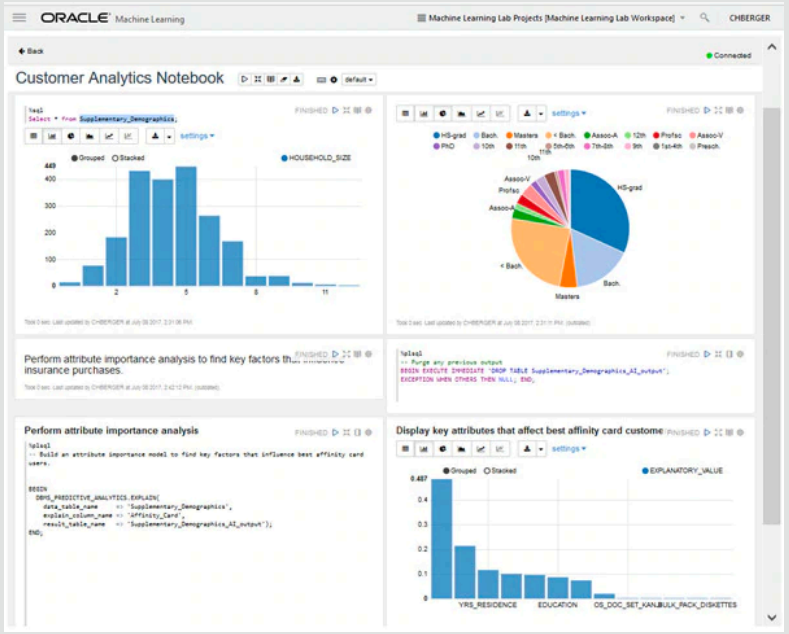
Application Express (APEX)



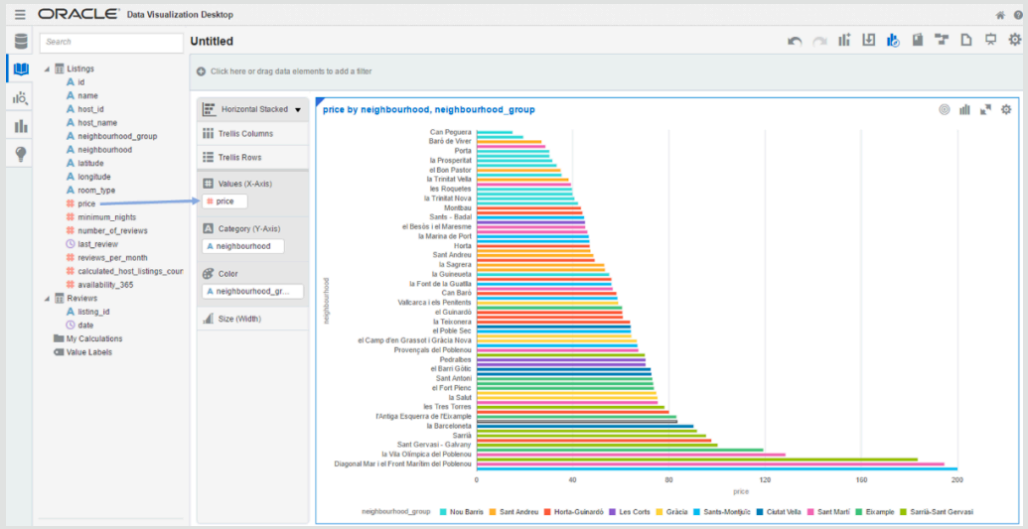
SQL Developer Web

REST Services (ORDS)

Data Science and Analytics Tools



Oracle Machine Learning (OML)



Oracle Analytics Desktop (OAD)

Formerly Data Visualization Desktop (DVD)

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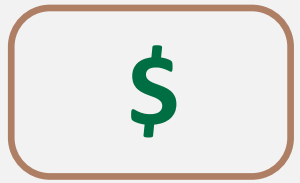

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Q&A

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