



ORACLE

Oracle Autonomous Database Under the Hood

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Safe harbor statement

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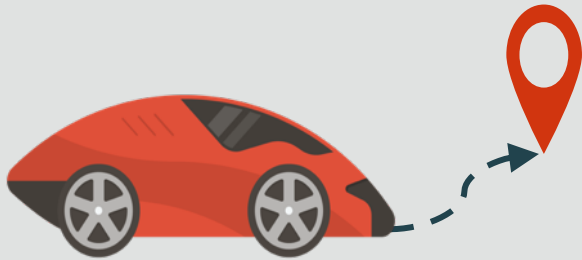
ORACLE



Part 1

Autonomous Database Overview

Oracle Autonomous Database **Key Attributes**



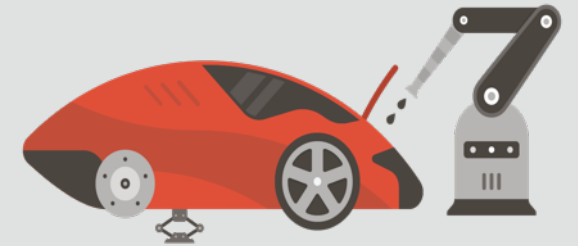
Self-Driving

Automates all database and infrastructure management, monitoring, tuning



Self-Securing

Protects from both external attacks and malicious internal users

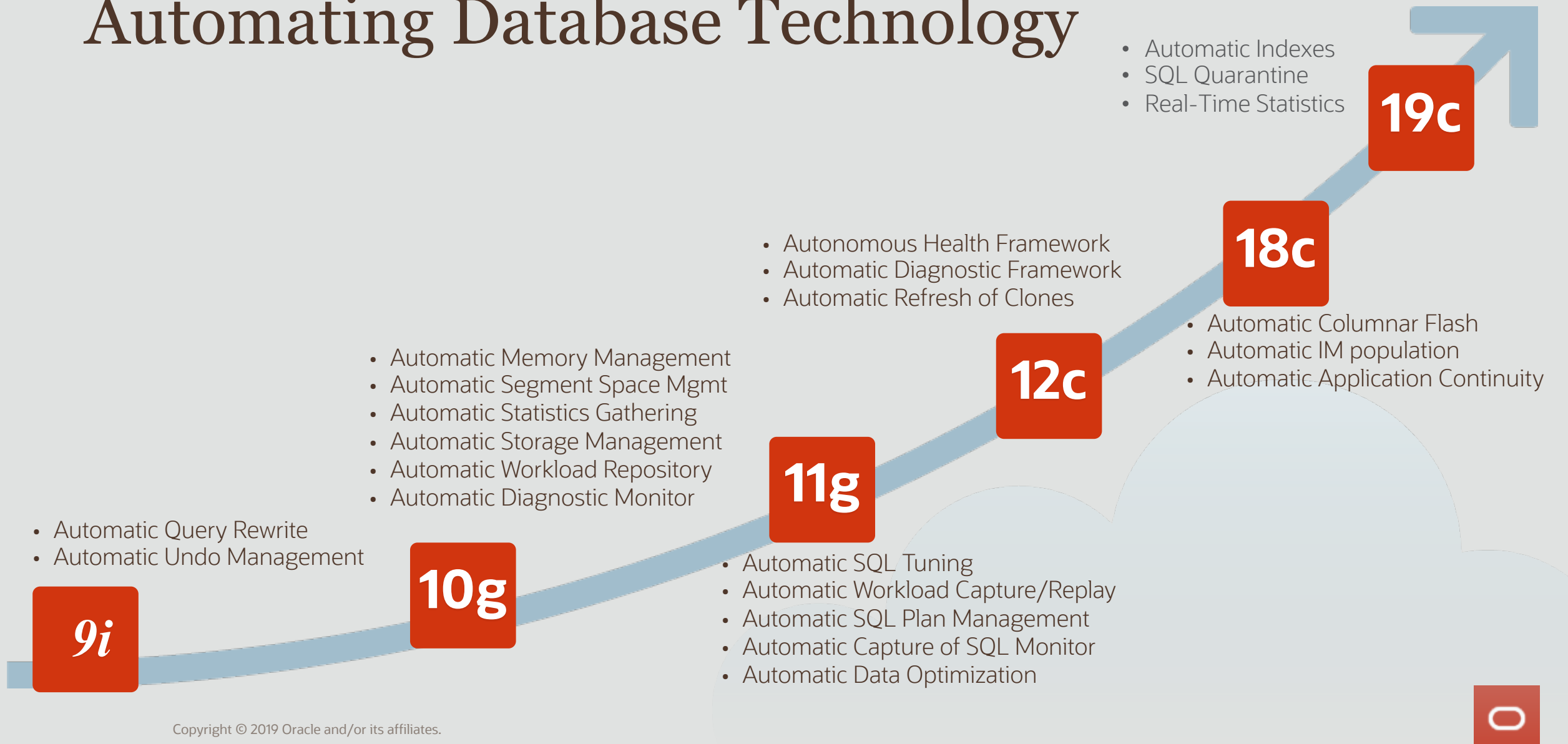


Self-Repairing

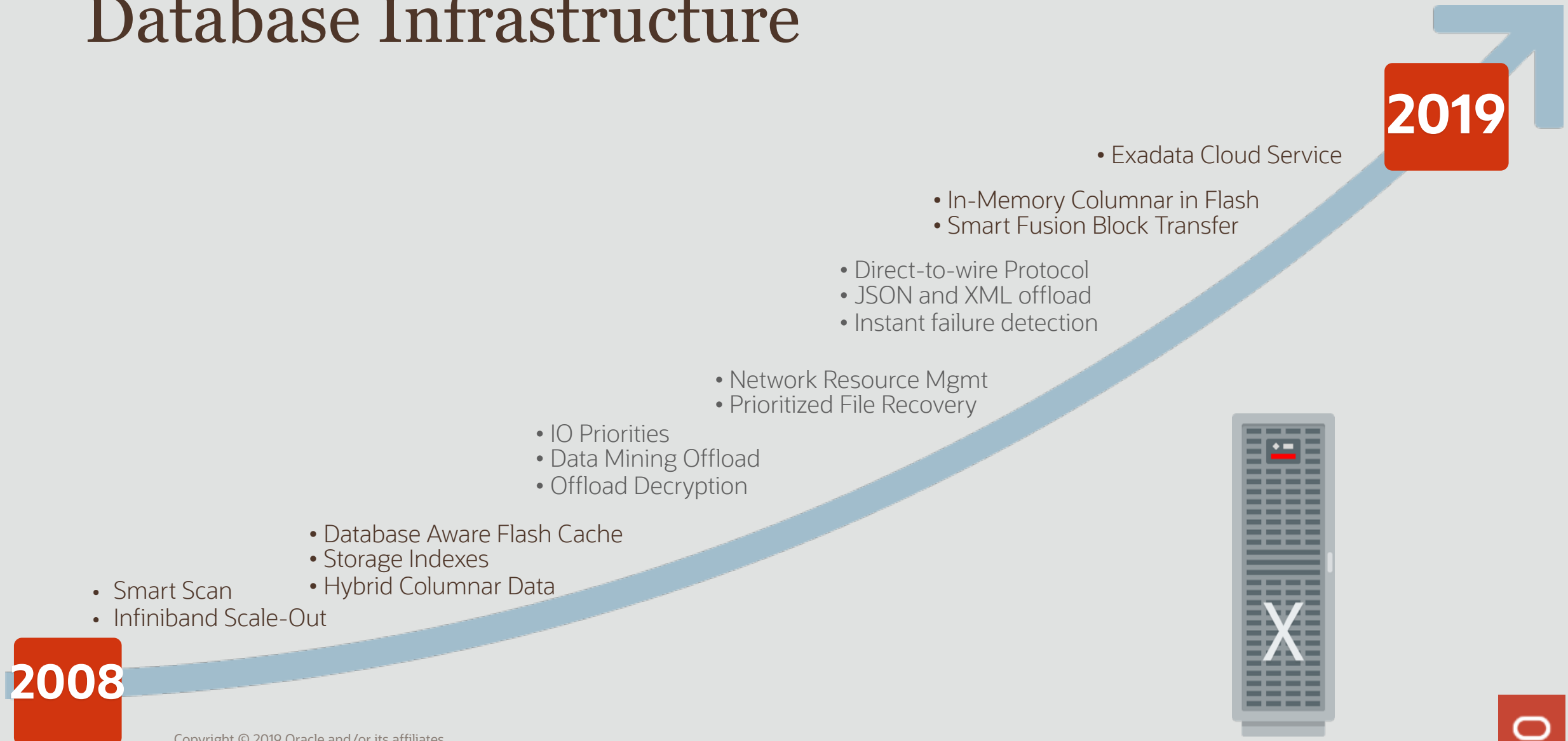
Protects from all downtime including planned maintenance

Spend Less, Reduce Risk, Innovate More

Oracle Spent Last 20 Years Automating Database Technology

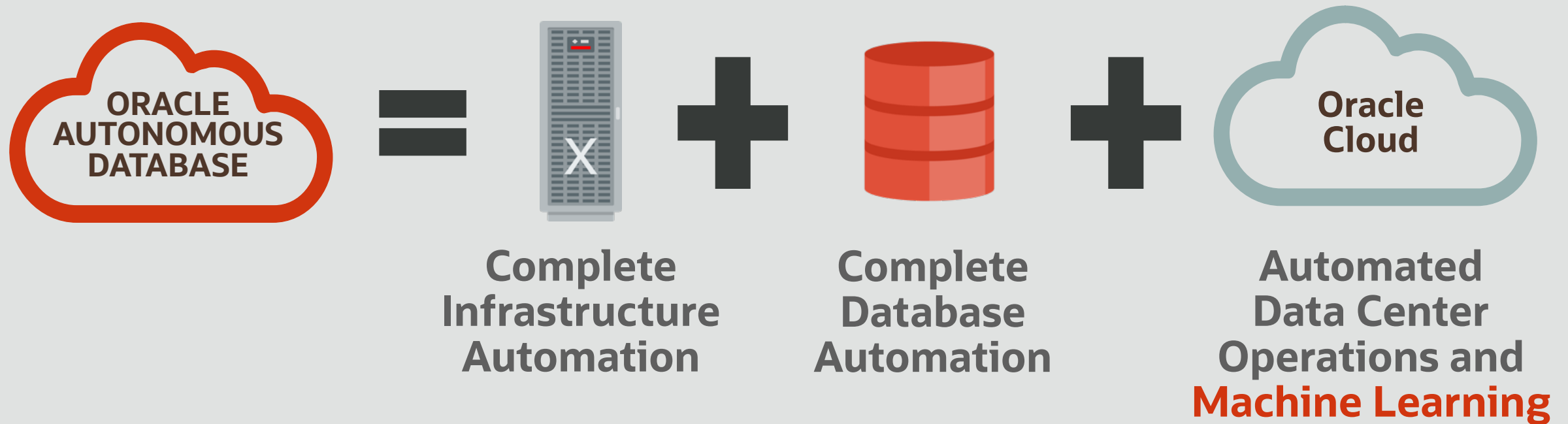


Oracle Spent Last 10 Years Automating Database Infrastructure

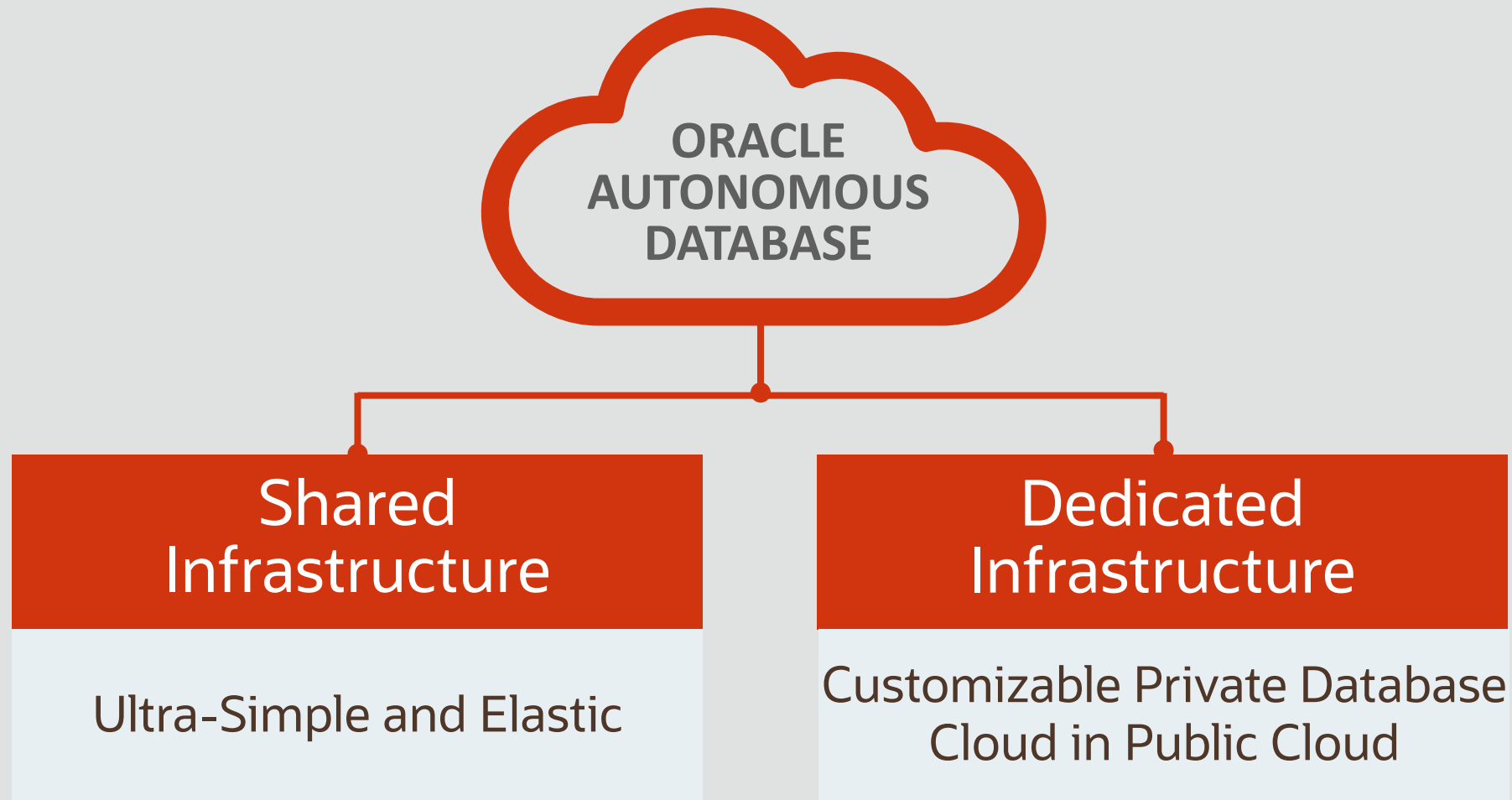


Autonomous Database Completes the Job

Eliminates All the Complexity of Mission Critical Databases



One Autonomous Database – Two Deployment Choices



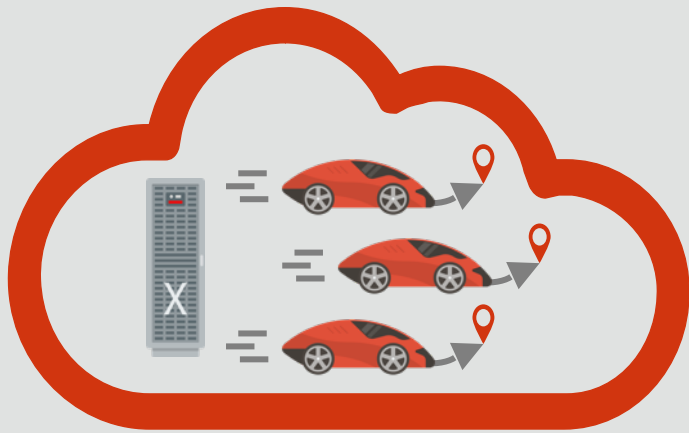
Autonomous Database Shared Infrastructure – Primary Benefits

- 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**

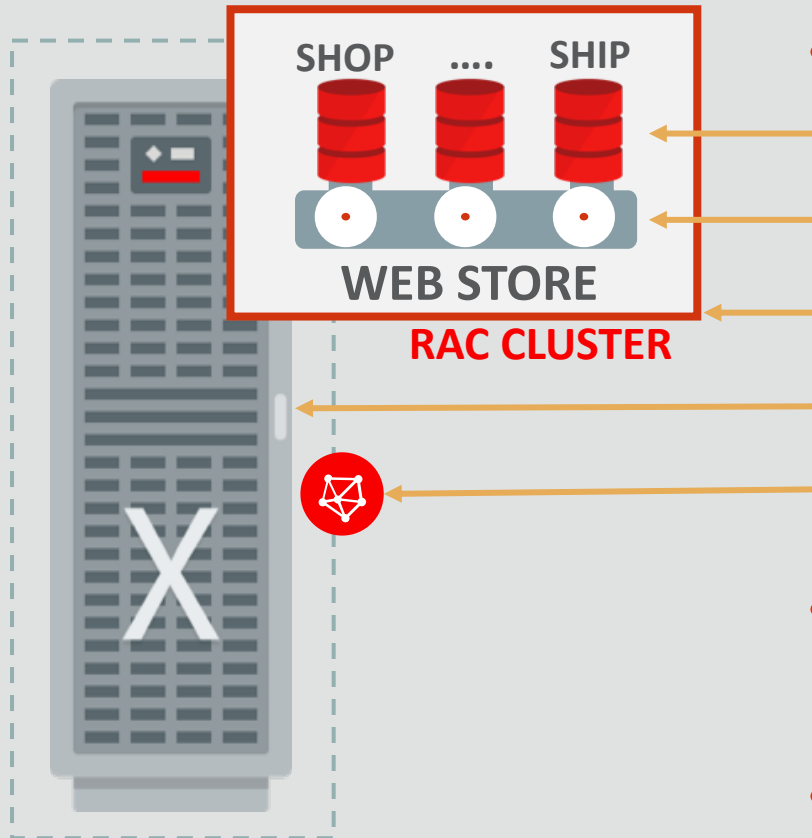


Autonomous Database **Dedicated Infrastructure** – Primary Benefits

- 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

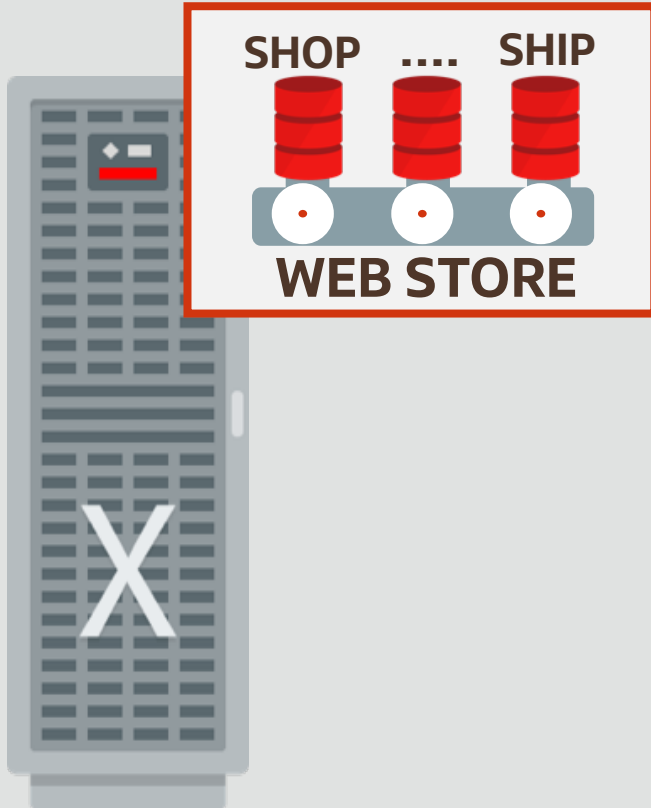


Autonomous Dedicated Isolation



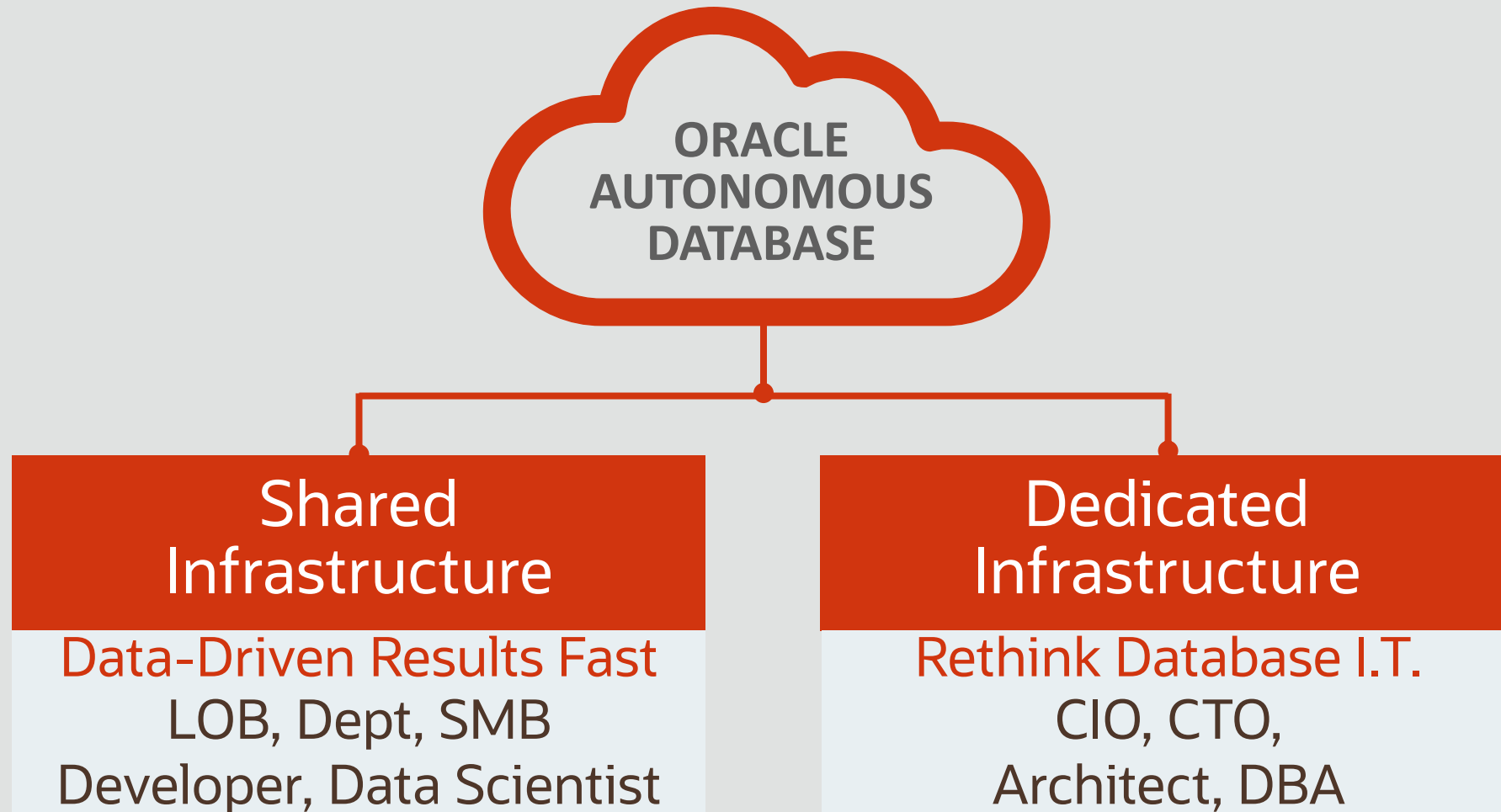
- Dedicated allows multiple levels of isolation
 - Database (DB)
 - Container database (CDB)
 - Cluster of VMs
 - Separate Hardware (Exadata Infrastructure)
 - Hardware Enforced Private Network (VCN)
- The level of security and performance isolation can be tailored to the needs of each database
- Implementing isolation is normally complex but in autonomous you just specify what you want

Autonomous Dedicated – Customizable Policies



- Customizable database separation policies:
 - Separate critical, general purpose, and test databases
 - Separate databases by organization (sales, HR, marketing)
- Customizable software update and upgrade policies:
 - Deploy new versions on test/dev database before production
 - Avoid updates during peak periods (e.g. sale, quarter close)
 - Control upgrade to conform to application certified version
- Customizable availability policies (SLA):
 - Specify level of HA and DR needed for each container DB
- Customizable overprovisioning and peak usage policies

One Autonomous Database – Primary Use Cases



Part 2

How it Works

A Look Under the Hood

Key Capabilities of **Self-driving**, Self-Securing, Self-Repairing



Self Driving

Rapid Provisioning

Self Scaling

Automatic Indexing

Cloning



Self Securing

Self Patching

Encryption by Default

Separation of Duties

Auditing



Self Repairing

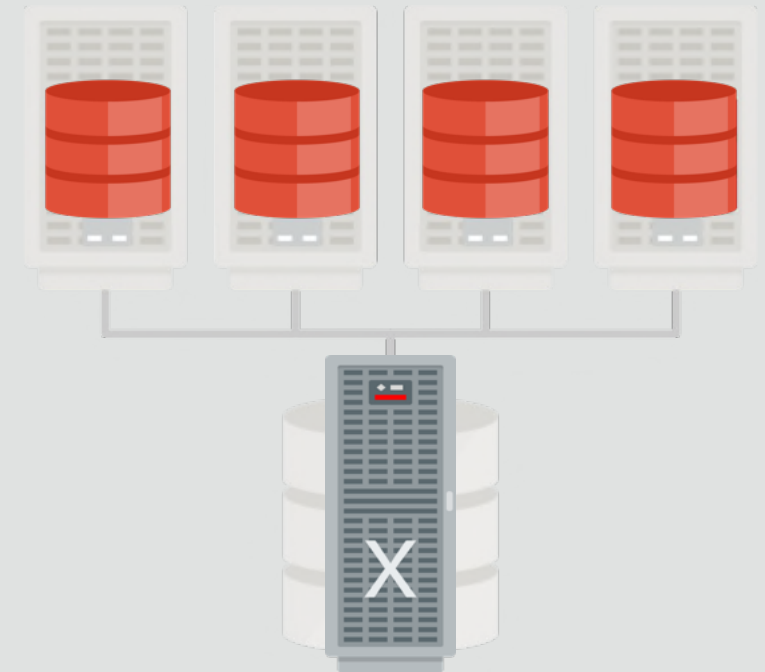
Maximum Availability
Architecture

Self-Healing Hardware

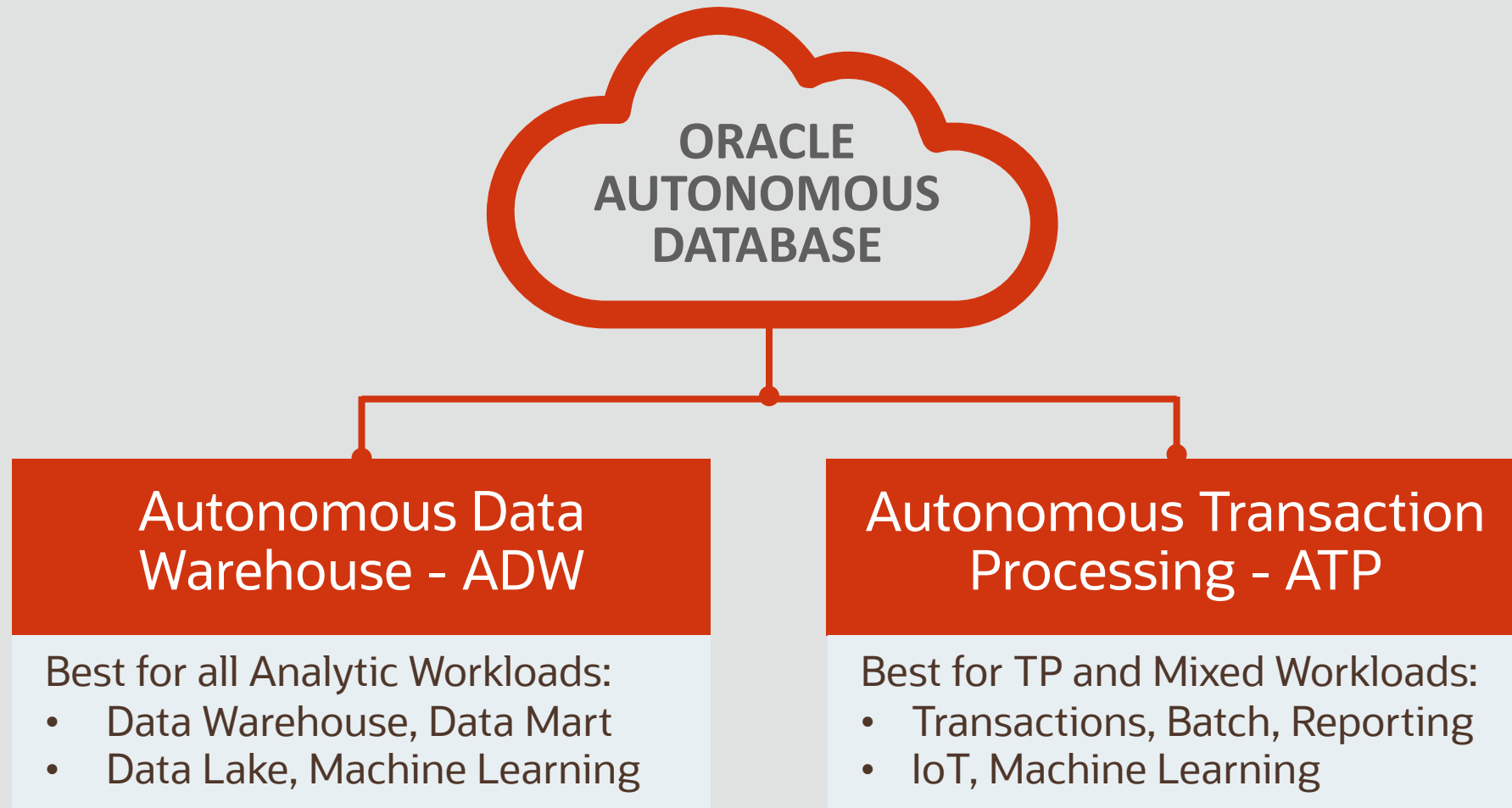
Self-Healing Software

Self-Driving | Database Provisioning

- Quickly deploys a RAC Database on Exadata
 - Provides a HA configuration
 - Ensures seamless scale-out
 - Enables online patching
- Autonomous Database decides where to place each database during provisioning
 - Fewer number of instances preferred
 - Databases may be open on one node
 - Still RAC enabled



One Autonomous Database – Optimized by Workload



Self-Driving | Automatic Tuning

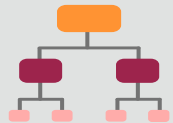
Autonomous Data Warehouse



Optimizes Complex SQL



Columnar Format



Creates Data Summaries



Memory Speeds Joins, Aggs



Statistics updated in real-time while preventing plan regressions

Autonomous Transaction Processing

Optimizes Response Time

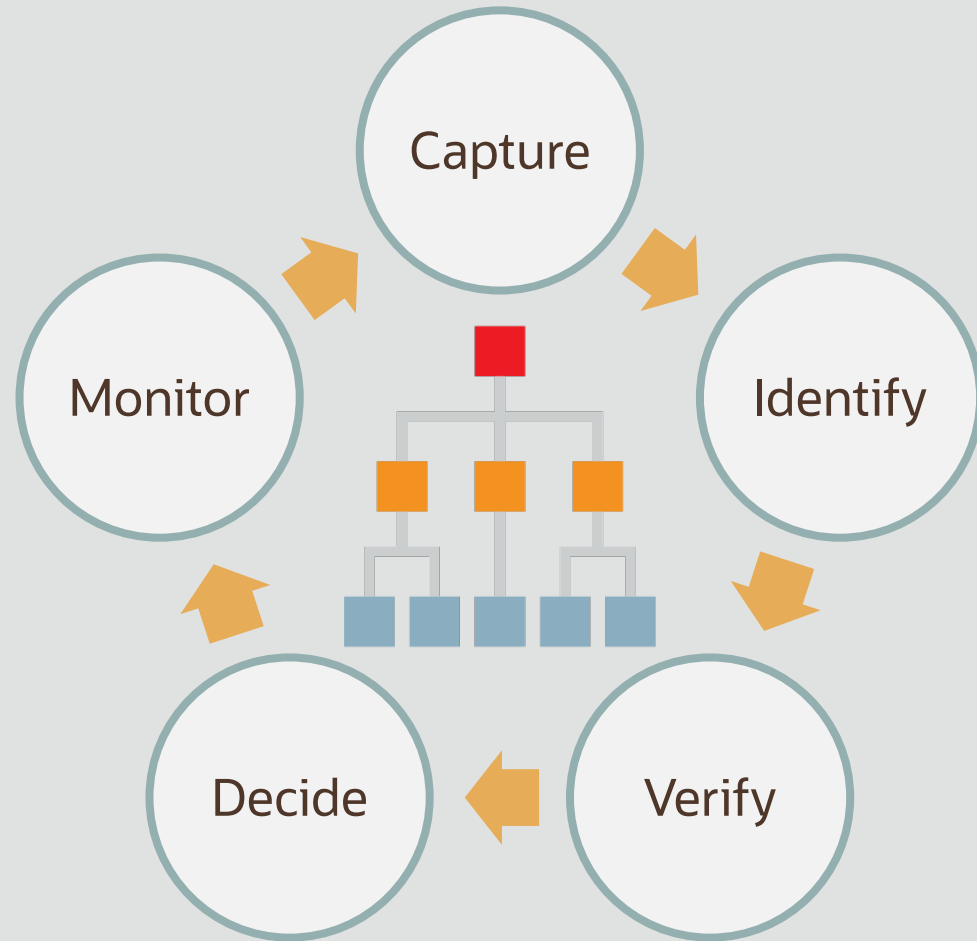
Row Format

Creates Indexes

Memory for Caching, No IO



Self-Driving | Automatic Indexing



An **expert system** that implements indexes based on what a skilled performance engineer would do

Reinforcement Learning allows it to learn from its own actions as all candidate indexes are **validated** before being **implementing**

The entire process is fully automatic
Transparency is equally important as sophisticated automation

All tuning activities are auditable

Self-Driving | Optimizer Statistics

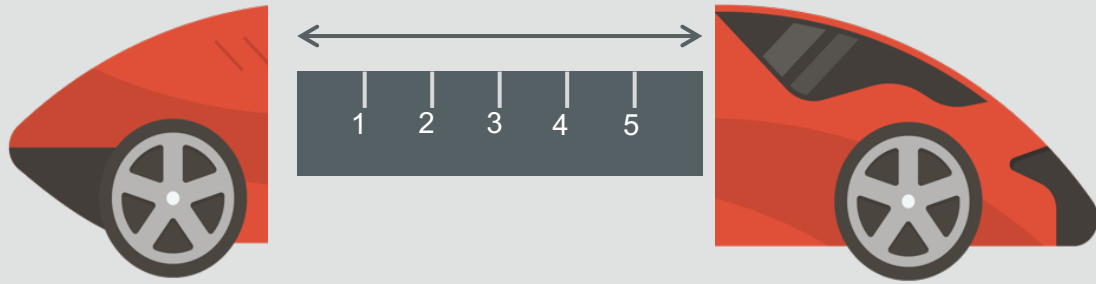
- Stats are gathered automatically for direct load operations
 - `CREATE TABLE ... AS SELECT ...; INSERT /*+ append */ INTO ... SELECT ...;`
 - Data Pump Import loads
 - DBMS_CLOUD loads
- Real-time Statistics Collection
 - Gathers a subset of optimizer statistics for conventional DML operations
 - Number of rows, MAX and MIN column values, etc.
- High-frequency Statistics Collection
 - Gathers full optimizer statistics every 15 minutes if statistics are stale

Pre-defined **Services** to Control Workload Priority

- Applications connect to a pre-defined database **service** to control:
 - Relative priority, max concurrently executing users, SQL parallelism
 - E.g. OLTP applications connect to “TP” service, most Batch to “LOW” service

		SERVICE	SHARE OF RESOURCES	CONCURRENCY BEFORE QUEUING	DEFAULT SQL PARALLELISM
OLTP	{	TPURGENT	12	100 X CPUs	MANUAL
		TP	8	100 X CPUs	1
DW, Batch, Reporting	{	HIGH	4	3	CPUs
		MEDIUM	2	1.25 X CPUs	4
		LOW	1	100 X CPUs	1

Self-Driving | Elastic Scaling



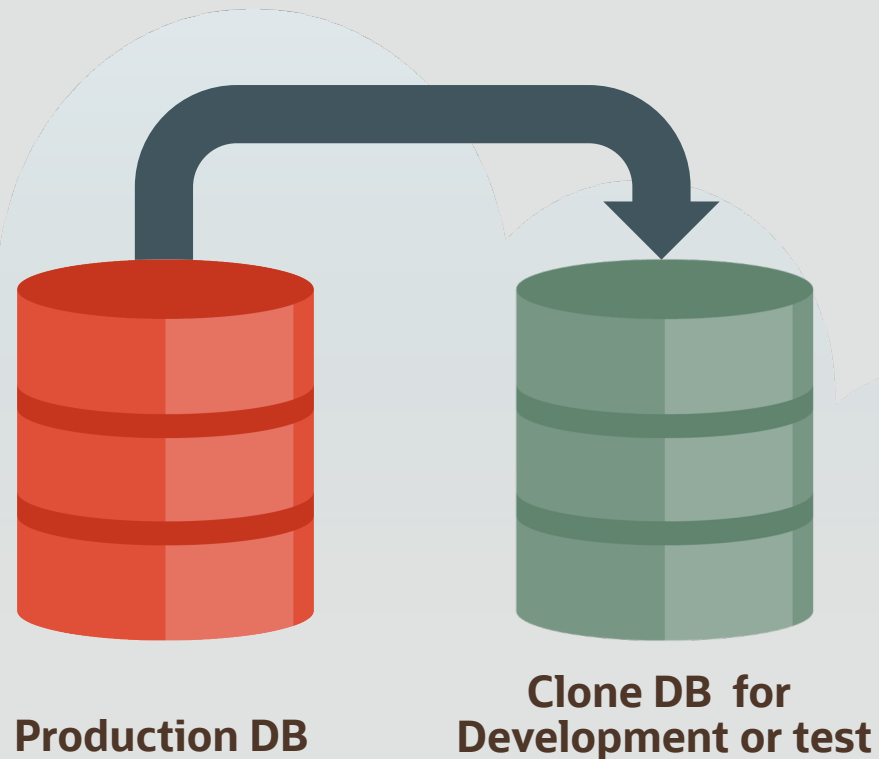
- Instant scaling online for highest performance and lowest cost
- Scale compute or storage completely independent of one another
- All scaling operation occur online – while the application continuous to run
- Scaling actions are exposed through Cloud UI and REST APIs

Self-Driving | 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 other resources
 - Number of sessions
 - Concurrency
 - PGA, SGA, etc.
- Need to provision more OCPUs to scale up these resources

Self-Driving | Cloning



- Cloning creates a point-in-time copy of an ADB
- Two types of clone can be created:
 - A full database clone
 - A metadata clone (Schema but no data)
- Easy and fast as user only has to decide:
 1. Compartment for the clone
 2. Name of the clone
 3. CPU and storage
 4. New ADMIN password



AVAILABLE

SwingBench_ATP

- DB Connection
- Performance Hub
- 🔗 Service Console
- Scale Up/Down
- Stop
- Actions ▼

Autonomous Database Information

Tags

General Information

Database Name: swingbenchatp

Workload Type: Transaction Processing

Compartment: oradbclouducm (root)/MColgan

OCID: ...wkhqca [Show](#) [Copy](#)

Created: Tue, Sep 10, 2019, 6:58:04 PM UTC

CPU Core Count: 8

Storage (TB): 1

License Type: Bring Your Own Licence (BYOL)

Database Version: 18c

Auto Scaling: Disabled ⓘ

Lifecycle State: Available

Infrastructure

Dedicated Infrastructure: No

Backup

Last Automatic Backup: Wed, Sep 11, 2019, 10:14:44 PM UTC

A Look Under the Hood

Key Capabilities of Self-driving, **Self-Securing**, Self-Repairing



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Automatic Indexing

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Self Securing

Encryption by Default

Self Patching

Separation of Duties

Auditing



Self Repairing

Maximum Availability
Architecture

Self-Healing Hardware

Self-Healing Software

Self-Securing | Encryption by Default

Encryption for Data at Rest



- Automatically configured – all application data is encrypted within the database
- Database Backups are also encrypted

Encryption for Data in Motion



- Automatically configured – all network access is encrypted to and from the database
- Choice of two methods
 - Oracle Native Network Encryption
 - Transport Layer Security (TLS) v1.2 (default)
- Oracle client credentials can be downloaded via encrypted wallet files

Self-Securing | Self Patching

- Automatic Patching of all components (on-demand for critical security issue)
 - Firmware, OS, Hypervisor, Clusterware, Database
- Patches applied in a rolling fashion across RAC nodes and Exadata storage servers
 - Database is continuously available to application
 - Applications using Application Continuity best practices, run without interruption
- Patching is automatically scheduled
 - Customer can adjust patching window within a time range on Dedicated deployments*

Self-Securing | Separation of Duties

Security Managed by Oracle



- Network security and monitoring
- OS and platform security
- Database patches and upgrades
- Administrative separation of duties
- Data encryption by default

Security Managed by the Customer



- Ongoing security assessments
- Users & Privileges
- Sensitive data discovery
- Data protection
- Activity auditing

But Remember, In the Cloud... Security Is a **Shared** Responsibility

Announcing:

Oracle Data Safe

Unified Database Security Control Center

- Security Configuration Assessment
- User Risk Assessment
- User Activity Auditing
- Sensitive Data Discovery
- Data Masking

Saves time and mitigates security risks

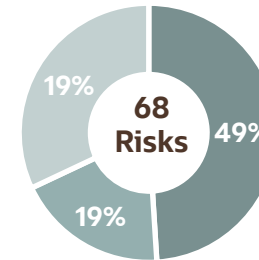
Defense in Depth for all customers

No special security expertise needed

Available in the Oracle Cloud at no additional cost

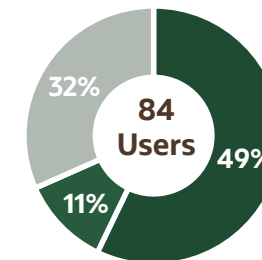
Availability: **OOW 2019**

Security Assessment



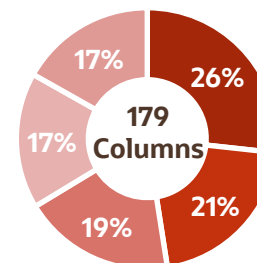
- High Risk: 33
- Medium Risk: 22
- Low Risk: 13

User Assessment



- Critical Risk: 47
- High Risk: 9
- Medium Risk: 2
- Low Risk: 26

Data Discovery



- Employee Basic Data...27%
- Public Identifier: 37
- Address:34
- Compensation data...
- Organization Data: 30



Self-Securing | Auditing

- Autonomous Database leverages Oracle Unified Audit to capture security-relevant activity
 - Login failures
 - Changes to users, including creation of new accounts, grants of privileges or roles
 - Changes to database structures, including tables, procedures, and synonyms
- Customers have access to all of the audit data via the `UNIFIED_AUDIT_TRAIL` view
- The `DBMS_FGA` package can be used to add more policies



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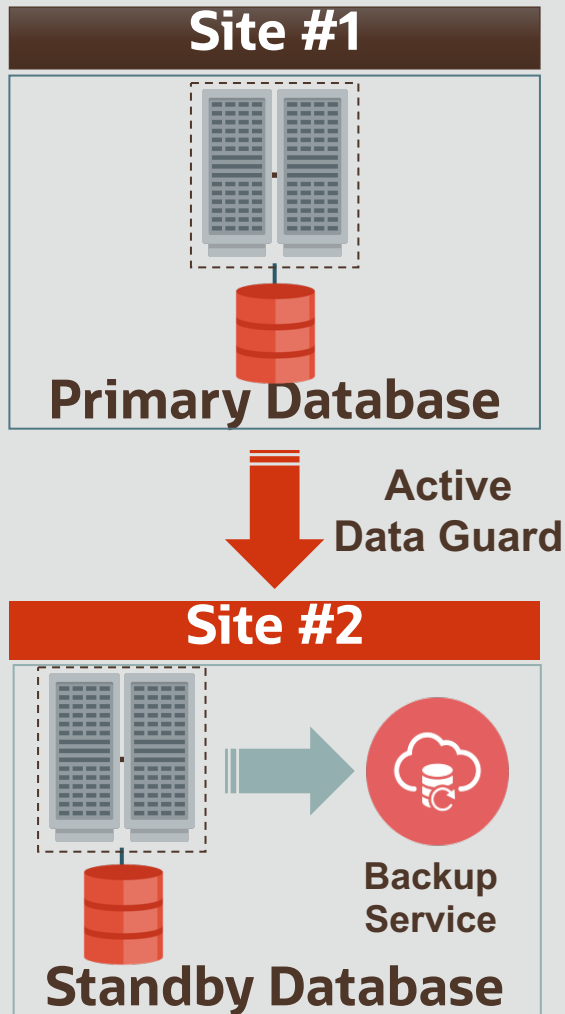
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Self-Healing Software

Self-Repairing | Availability Policies

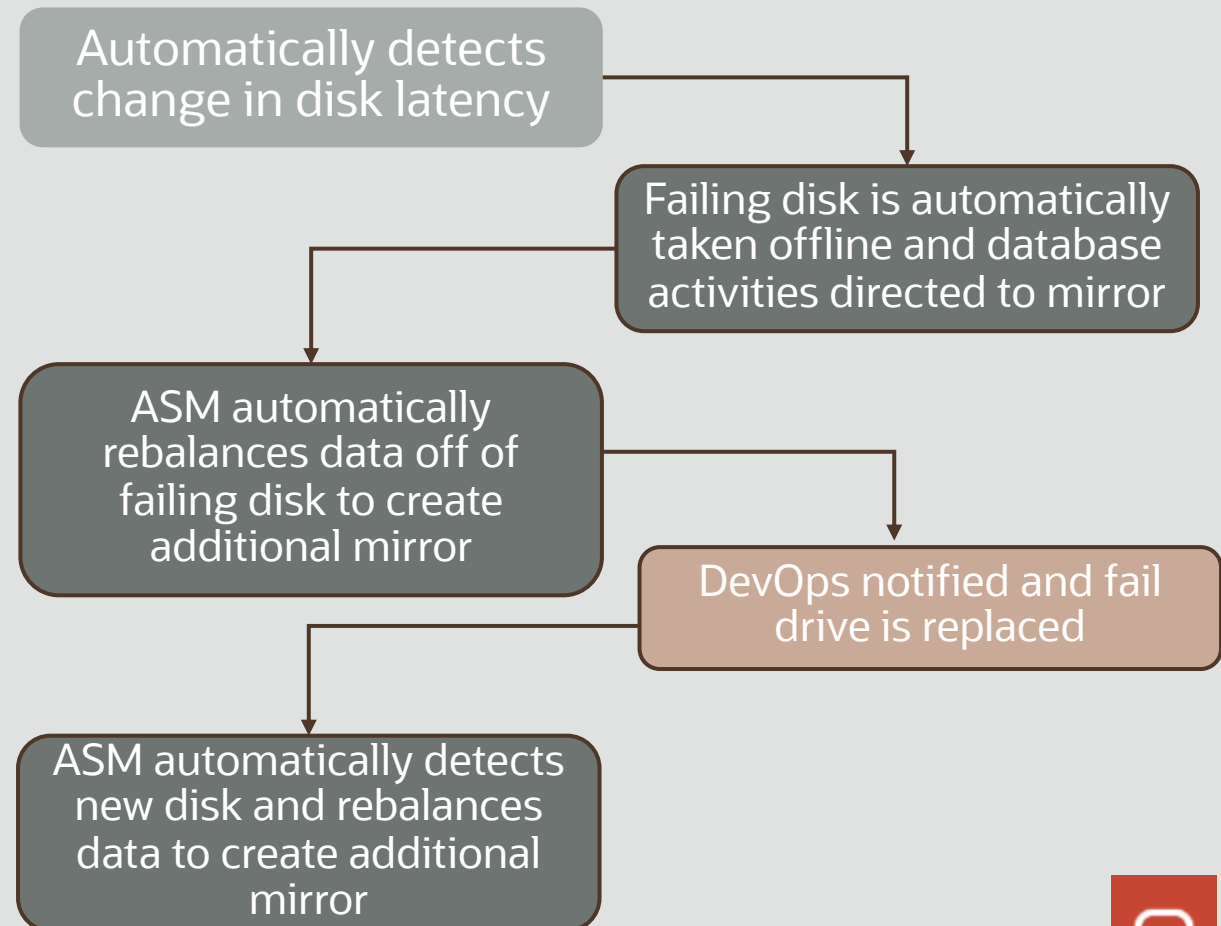


- **High Availability** – Protection from hardware failures, software crashes, software updates
 - Uses RAC Database, App continuity, Flashback DB, redundant network, triple mirrored storage, and daily backup
 - Fully automated daily backup, or on-demand backup
- **Extreme Availability** – Adds protection from site outages and data corruptions (coming soon)
 - Uses Active Data Guard Standby
- Goal is **less than 20 seconds** application impact from any availability event

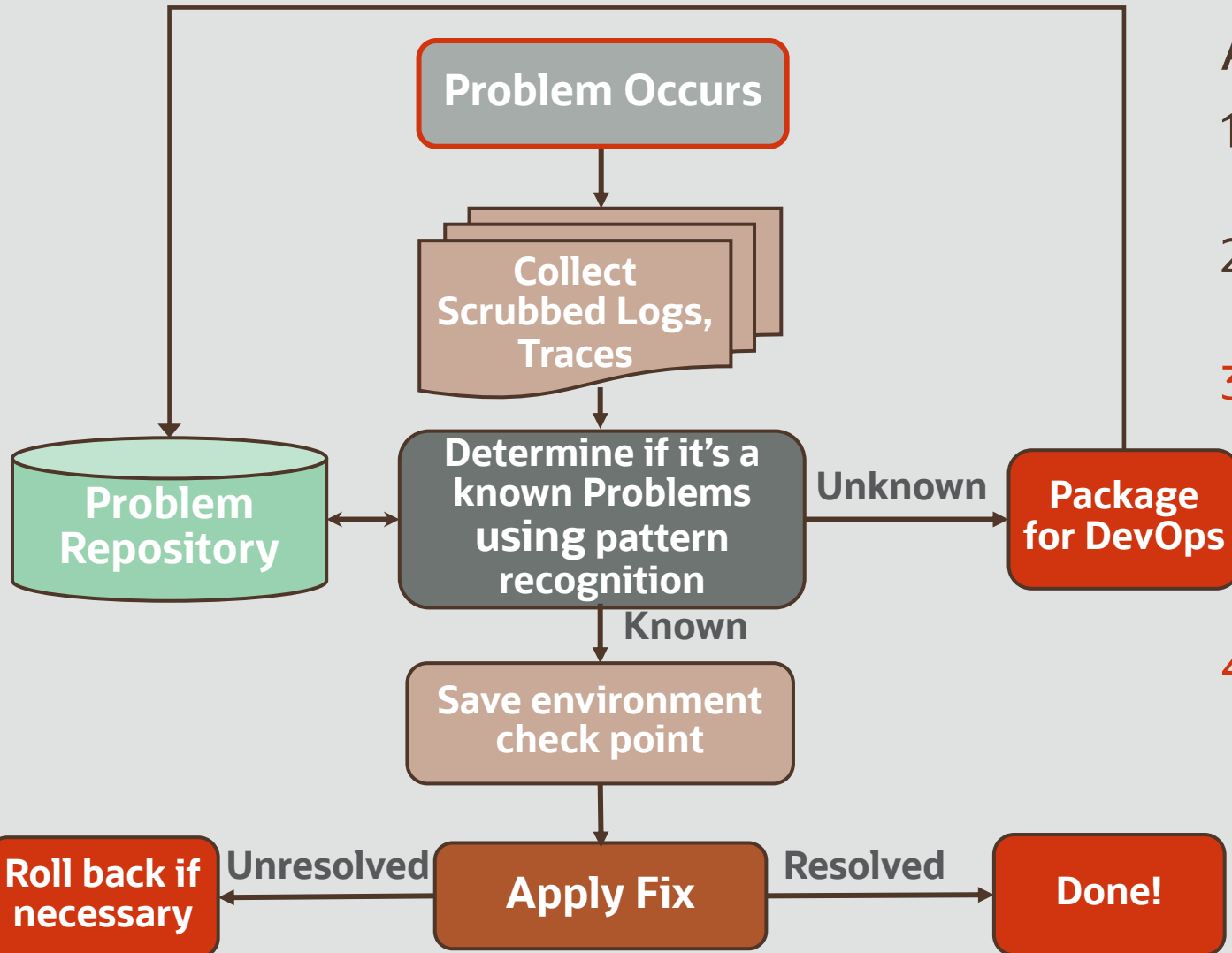
Self-Repairing | Self-Healing Hardware

- Database Infrastructure for Autonomous is provided by Exadata
- Exadata Provides advanced predictive failure capabilities
- **Unique** detection of server failures without a long timeout avoids system hangs
- **Unique** sub-second redirection of IOs around sick devices avoid database hangs

Continuously monitors for sick devices



Self-Repairing | Self-Healing Software



Automatically detect problems/issues:

1. Collect diagnostics info to establish an **anomaly timeline** or **signature**
2. Use **Pattern Recognition** to determine if it's a known problems
3. **If known problem**
 - a. Explain what will be done to fix
 - b. Save environment checkpoint
 - c. Apply Fix and do root cause analysis
 - d. Roll back fix if required
4. **If a new problem**
 - a. Package up all diagnostic information
 - b. Hand off to DevOps

Summary

Benefits of Autonomous Database



- Spend Less

- Reduce Admin Cost: Eliminates expensive, tedious, unsafe manual database management
- Reduce Runtime Cost: Cloud pay-per-use, Exadata speed, and self-tuning cuts costs up to 90%

- Reduce Risk

- Prevent cyber-attacks: Secure configurations, fully automatic and online security updates
- Always Available: protects from all downtime including maintenance and DR
- Proven: Runs all your enterprise workloads, easy migration of existing databases

- Innovate More

- Refocus talent: Focus on new projects, user experience, analytics, ML, instead of admin
- Develop faster: Instant provisioning, self-tuning, integrated database app development

Always Free – oracle.com/cloud/free



**Autonomous
Database**

*2 x Databases
20 GB each*



Compute

*2 x VMs
1 GB Memory each*



Storage

*100 GB Block
10 GB Object
10 GB Archive*



**Networking/
Load Balancing**

*10 Mbps LB
10 TB Outbound
Data Transfer*



**Monitoring /
Notifications**

*500M Metrics Ingestion
1B Metrics Retrieval
1M Notifications
1K Emails*

Available to All New and Existing Cloud Accounts

