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Headline Cyber Attacks
Data Stolen: Google, Facebook, Amazon...Pentagon...

• Current ‘State-of-the-Art’ Cloud Defenses Defeated
  – Top Technology Companies and Government Agencies Penetrated

• New Generation of Secure Cloud Computing is Needed
  – Required Fundamental Re-Architecture of the Oracle Cloud – Hard to Do
  – Star Wars Cyber Defenses: Required Hardware Changes, Software Changes...AI/ML
  – Impenetrable Barriers: Block Threats
  – Autonomous Robots: Kill Threats
Cloud Computing Generation 2 – New Architecture

Secure Infrastructure Requires New Hardware and New Software

• Impenetrable Barrier: Dedicated Network of Cloud Control Computers
  – Barrier: Cloud Control Computers Protect Cloud Perimeter and Customer Zones
  – Impenetrable: No Customer Access to Cloud Control Computers and Memory

• Autonomous Robots: AI/ML RoBots Find and Kill Threats
  – Database Immediately Patches Itself while Running – Stops Data Theft
  – No Delay for Human Process or Downtime Window
  – No Longer Our People versus Their Robots – Our Robots versus Their Robots
Gen 1 Clouds


- Oracle Cannot See Customer Data
- No User Access to Cloud Control Computer or Code

Shared Cloud Control Computer Vulnerabilities
- Cloud Provider Can See Customer Data
- User Code Can Access Cloud Control Code

Gen 2 Cloud

Separate Cloud Control Computers: No User Code

- Oracle Cannot See Customer Data
- No User Access to Cloud Control Computer or Code
Generation 2 Cloud: Separate Cloud Control Computers

*Impenetrable Barrier: Protects Cloud Perimeter and Customer Zones*

Threats can’t enter                               Threats can’t spread
Generation 2 Oracle Cloud Infrastructure – OCI

Generation 2 Cloud, Generation 2 Cloud Infrastructure OCI, Bare Metal

COMPUTE, STORAGE, DATABASE, LBs, ...

VIRTUAL NETWORK

PHYSICAL NETWORK

REGION

DATACENTERS

Availability Domain 1

Availability Domain 2

Availability Domain 3

Bare Metal, NVMe storage, VMs, Exadata, RAC, Load Balancers, …
Primary Advantages of Oracle’s Generation 2 Cloud

• New Cloud Architecture with Security Built-in from Core to Edge
• Easy to Move Enterprise Workloads to Cloud: Protect Investment
• Superior Economics: Automation & Price Performance
First Generation Clouds Built on Decade Old Technology

- Designed for building “angry birds”
- Not meant to run your mission critical business applications
- Security was an afterthought
- Pay significantly more for higher performance
- Cloud way or no way - Not meant to move your datacenter to the cloud
Oracle Generation 2 Cloud
One Unified Architecture: A Secure Platform for all your Applications

• Foundation for Autonomous Database
• Extensible Platform for SaaS Applications
• Runs Enterprise Applications and Cloud Native Applications
• Gen 2 Public Cloud Available Now – Gen 2 Cloud@Customer 2019
• Easy Free Push Button Upgrade from Gen 1 to Gen 2 Database@Customer
Oracle Generation 2 Cloud: Other Design Goals

• Support better functionality and performance than on-premises
  – Run the Autonomous Database, Exadata, and tools like RAC, Data Guard, GoldenGate
  – Run bare metal, VMs, GPUs, containers with no resource over subscription

• Improve automation
  – Eliminate mundane tasks, managing upgrades, security patches
  – Automate migration without risk and high cost

• Easily connect between your datacenter and ours securely
  – Deliver massive interconnect bandwidth, without hidden costs

• Guarantee consistent enterprise performance
  – Industry first SLA that covers availability, performance, and manageability
Oracle Generation 2 Cloud Infrastructure: Price/Performance

• Performance Advantage
  – Gen 2 OCI Bare Metal compute and block storage outperforms other clouds
  – Eliminates resource oversubscription from compute, memory, network
  – Delivers highest performance for enterprise, cloud native and HPC workloads

• Pricing Strategy
  – Aggressive low pricing delivers savings versus other clouds
  – Low rates include data transfer – eliminating hidden charges
  – Universal Cloud Credits provides buying flexibility and consistent discounts
Oracle Gen2 Offers the Best **Performance**

<table>
<thead>
<tr>
<th></th>
<th>OCI</th>
<th>AWS</th>
<th>OCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute</td>
<td>2.57 TFLOPs</td>
<td>1.77 TFLOPs</td>
<td>45% Faster</td>
</tr>
<tr>
<td>Memory</td>
<td>153 GB/s</td>
<td>134 GB/s</td>
<td>14% Faster</td>
</tr>
<tr>
<td>Block Storage</td>
<td>500,000 IOPS</td>
<td>80,000 IOPS</td>
<td>525% Faster</td>
</tr>
<tr>
<td>Network</td>
<td>50 Gbps</td>
<td>25 Gbps</td>
<td>100% Faster</td>
</tr>
</tbody>
</table>
# Oracle Gen2 Has the Most Aggressive Pricing

<table>
<thead>
<tr>
<th>Service</th>
<th>OCI</th>
<th>AWS</th>
<th>AWS Cost Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute</td>
<td>$0.03</td>
<td>$0.096</td>
<td>3x More $</td>
</tr>
<tr>
<td>Standard compute core/hour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block Storage</td>
<td>$43</td>
<td>$1,750</td>
<td>30x More $</td>
</tr>
<tr>
<td>1TB @ 25K IOPS, per month</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network</td>
<td>$765</td>
<td>$7,800</td>
<td>10x More $</td>
</tr>
<tr>
<td>100TB egress, per month</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Amazon US-East region pricing and Oracle pricing as of October 22, 2018.
Oracle Block Storage: Best Performance and Best Value

Oracle 6X Performance
Maximum IOPS

Oracle: 500,000
AWS: 80,000

Oracle 97% Lower Cost
1TB with 25,000 IOPS

Oracle: $1,750
AWS: $42.50
Big Data Workloads

Oracle OCI 3x Faster
10TB Terasort
BM.HPC2.36 (OCI) vs AWS.M524xLarge

Oracle OCI 82% Lower Cost
10TB Terasort
BM.HPC2.36 (OCI) vs AWS.M524xLarge
Revolution in Cloud Network:
Low Latency, High Bandwidth RDMA Cluster Networking

1.5 µs latency, 100Gb/s network

- Industry first production ready, bare metal RDMA network
- Built for performance sensitive use cases such as Exadata and HPC
- Available with high frequency processors to support HPC workloads
Oracle Performance Scales Linearly

Engineering Simulations: **4X Better**

- No virtualization to inhibit scaling; RDMA for 1.5µs internode latency

*4M cell CFD model, 26 nodes 24 hours, ANSYS Fluent*
HPC Workloads

Engineering Simulations per Day

- AWS: 20,733
- OCI: 80,370

Cost of 10,000 simulations

- AWS: $71.72
- OCI: $9.41

Oracle Gen2 runs 4X Faster

Oracle Gen2 is 87% cheaper
Gen2 Cloud Core-to-Edge Security: Defense in depth
Threats can’t get in or spread – Autonomous robots find & kill threats

<table>
<thead>
<tr>
<th>Compliance</th>
<th>Services, tools, AI/ML to monitor your cloud infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge Security</td>
<td>DDoS, DNS, WAF</td>
</tr>
<tr>
<td>Access Security</td>
<td>Identity, resource access management</td>
</tr>
<tr>
<td>Autonomous Database</td>
<td>Autonomous database: self-patching, self-repairing</td>
</tr>
<tr>
<td>Data Security</td>
<td>At-rest and in-transit encryption, key management</td>
</tr>
<tr>
<td>Network Security</td>
<td>Cloud Control Computers: private encrypted backbone</td>
</tr>
<tr>
<td>Isolation</td>
<td>Full physical isolation from other tenants and Oracle</td>
</tr>
</tbody>
</table>
Announcing***Gen2 Cloud Infrastructure Security Services

Automated Detection, Prevention, Prediction, Response

• Key Management Service
  – Customer control of all encryption keys for all storage layers
  – Manages entire lifecycle of keys to protect sensitive data
  – Backed by Hardware Security Module (HSM)
  – Manages keys for heterogeneous hybrid/multi-cloud environments

• Cloud Access Security Broker (CASB)
  – Automatically and continuously monitors and remediates changes and threats
  – Automated capabilities for threat detection across entire cloud stack
  – Predictive analytics and incident response, security configuration management
Announcing***Gen2 Cloud Infrastructure Security Services
Secure your Users, Apps, Data, and Infrastructure

• Web Application Firewall
  – Protects all Oracle Cloud Infrastructure based applications
  – Inspects all traffic destined for web apps, identifies and blocks any malicious traffic

• Distributed Denial of Service Protection
  – Automated DDoS attack detection and mitigation of high volume layer 3 & 4 attacks
  – Ensures availability of network resources even under sustained attack
Oracle Generation 2 Public Cloud Global Footprint 2019
Announcing*** Gen2 Cloud@Customer 2019

• Private, Dedicated Generation 2 Cloud@Customer
  – Same capabilities as public regions - no caveats, we build a full region just for you
  – Complete Gen 2 Cloud on your premise, under your control
• Powerful automated cloud security, on your premises – Keep your data safe
  – Automated threat detection and remediation – Autonomous DB + full security stack
  – Powered by continuous threat intel fed from Oracle’s global cloud network
• Fast, local interop with your existing on-premise systems
  – Low cost, low latency, local access from existing applications to private cloud
Oracle’s Secure Generation 2 Cloud – Availability

• New Infrastructure and Database Customers get Gen2 NOW
• Database Cloud@Customer upgraded to Gen2: Summer 2019
  – Database Cloud@Customer Free Upgrade Autonomous Database Cloud@Customer
• Full OCI Cloud@Customer: Calendar 2019
  – Complete Gen 2 Cloud on your premise, under your control
Oracle Autonomous Database

Everything is Automated: Nothing to Learn, Nothing to Do

• Automatic Provisioning
• Automatic Scaling
• Automatic Tuning
• Automatic Security
• Automatic Fault Tolerant Failover
• Automatic Backup and Recovery
• And more...

Easiest to Use & Lowest Cost to Operate
Oracle Autonomous Database

Serverless and Truly Elastic: Only Pay for What You Use

• Automatic Provisioning and Scaling
  – Sizes and allocates infrastructure
  – Adds and deletes CPUs, servers, storage while running
  – **Serverless**: Pay for Zero Servers when not running
  – **Truly Elastic**: Only pay for infrastructure you use

• Just one reason we can...

  **Cut your Amazon bill in half GUARANTEED**
Oracle Autonomous Database
Prevents Data Theft: Applies Security Patches while Running

• Automatic Security
  – Automatic continuous threat monitoring and detection
  – Immediate security patching and remediation while running
  – 99.995% Availability: total downtime less than 2.5 minutes per month
  – Amazon can’t patch their database while they are running

• One reason why Oracle is...

  25x more reliable than Amazon
Oracle Autonomous Database
Eliminates Human Errors, Tolerates Hardware and Software Errors

- Automatic Fault Tolerant Failover, Backup & Recovery
  - Eliminates human errors: No human labor – no human error
  - Oracle continues to run during database server failure
  - Oracle continues to run during a database software failure
  - **99.995% Availability**: total downtime less than 2.5 minutes per month
  - Amazon databases stop running during these failures

- Another reason why Oracle is...
  
  **25x more reliable than Amazon**
Oracle Autonomous Database

Stop Administering, Start Innovating

• Enables I.T. and Database Administrators to innovate more
  – Eliminates all system, storage, network management
  – Eliminates database operational drudgery
  – Use talent to implement more projects, get more value from data

• Empowers developers to innovate faster
  – Create databases instantly with no manual tuning needed
  – Continuously adapts to changing workload
  – Advanced SQL accelerates developer productivity
Journey to Autonomous Database
Automating and Optimizing Database Software

- Automatic Query Rewrite
- Automatic Undo Management
- Automatic SQL Tuning
- Automatic Workload Capture/Replay
- Automatic SQL Plan Management
- Automatic Data Optimization
- Automatic Memory Management
- Automatic Segment Space Management
- Automatic Statistics Gathering
- Automatic Storage Management
- Automatic Workload Repository
- Automatic Diagnostic Monitor

9i
10g
11g
12c
18c

- Automatic Health Framework
- Automatic Diagnostic Framework
- Automatic Refresh of Clones
- Automatic Columnar Flash
- Automatic IM population
- Automatic Application Continuity
Journey to Autonomous Database

Automating and Optimizing Database Infrastructure

- 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
- Exadata Cloud Service
- In-Memory Columnar in Flash
- Smart Fusion Block Transfer
- Direct-to-wire Protocol
- JSON and XML offload
- Instant failure detection
- Direct-to-wire Protocol
- Smart Fusion Block Transfer
- Exadata Cloud Service

2008

2018
Autonomous Completes the Journey
Brings Full Automation to Entire Database Lifecycle

World’s First Autonomous Database
How It Works
Autonomous Database Addresses the Complete Lifecycle

Provisioning
Rapidly creates scalable mission critical databases
- Creates Exadata\(^+\), Cloud Infrastructure, RAC\(^+\) scale-out database, Active Data Guard\(^+\) standby

Security
Protects from external and internal threats
- Monitors threats, applies security updates online\(^+\), stops admin snooping with DB Vault\(^+\), encrypts all data

Management
Automates all infrastructure and database management
- Performs all OS and SYSDBA operations, tunes settings, patches all software online\(^+\), diagnoses errors\(^+\)

\(^+\) Unique to Oracle
Autonomous Database Addresses the Complete Lifecycle

Protection
Recovers from any failure without downtime

Scaling
Scales online for highest performance and lowest cost

Optimization
Machine Learning optimizes database for each workload

- **Protection**
  - Recovers from any failure without downtime
  - Automates backup, restore, application transparent failover in scale-out cluster or to active remote standby

- **Scaling**
  - Instant online elasticity of serverless compute and storage enables true pay-per-use

- **Optimization**
  - Continuously optimizes memory, data formats, indexes, parallelism, and plans for each workload

+ Unique to Oracle
Machine Learning Meets Mission Critical

- New approach **avoids performance regressions**
  - Even for difficult cases where new plan or index helps 99 SQL statements and hurts 1

- Changes are first **tested** in background

- Then the benefit is **validated** on first execute of every changed SQL
  - If performance regresses, then old SQL plan is used

* Coming soon
One Autonomous Database - Optimized by Workload

Autonomous Data Warehouse (ADW)
- Optimized for Analytics
  - Data Warehouse, Data Mart
  - Data Lake, Machine Learning

Autonomous Transaction Processing (ATP)
- Optimized for Transactions & Mixed
  - Transactions, Batch, Reporting, IoT
  - Application Development
Autonomous Optimizations - Specialized by Workload

**ADW**
- Optimizes Complex SQL
- Columnar Format
- Creates Data Summaries

**ATP**
- Optimizes Response Time
- Row Format
- Creates Indexes
ADW In Action On Customer Workloads

- Compared customer tuned real warehouse workloads to ADW
  - Customer-tuned systems used indexes, partitioning, compression etc.
  - ADW automatically optimized

<table>
<thead>
<tr>
<th>Elapsed Time (sec)</th>
<th>Exchange</th>
<th>Manufacturer</th>
<th>Bank</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>5137</td>
<td>4051</td>
<td>2831</td>
</tr>
<tr>
<td>Customer Tuned</td>
<td>2551</td>
<td>2835</td>
<td>2265</td>
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<tr>
<td>ADW</td>
<td></td>
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</tr>
<tr>
<td>Manufacturer</td>
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<tr>
<td>ADW</td>
<td></td>
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</tr>
</tbody>
</table>

ADW consistently exceeds hand-tuned performance
ADW stays tuned as workload changes
ATP In Action On Netsuite Workload

- Compared expert tuned complex Netsuite workload to ATP
- **17,542** SQL statements, **1,852** tables, **8151** indexes - years of tuning to create these indexes
  - Before running on ATP, all indexes and statistics were dropped

ATP achieved better performance than expert manual tuning
ATP stays tuned as workload changes
Deployment Options
Announcing Dedicated Exadata Cloud Infrastructure
ADW and ATP Now Runs on Dedicated Servers with Full Workload Isolation

• ADW and ATP Runs on Two Types of Exadata Cloud Infrastructure
  – Shared Serverless Infrastructure for Lowest Cost
  – Dedicated Infrastructure for Highest Isolation

• Complete stack is isolated from other tenants:
  – Compute, Storage, Cluster Interconnect
  – Virtual Cloud Network is Hardware Enforced

• Unique Fully Isolated Cloud in Public Cloud
  – Allows control over consolidation, updates
Announcing*** Autonomous Database Cloud @ Customer

- Autonomous Database is **Cloud Only** since it automates the entire stack:
  - Servers, storage, network, interconnect, OS, VM, GI, DB

- Some customers cannot move to public cloud
  - Regulations, corporate policies, network latency

- Autonomous Database in customer data center: **Summer 2019**
  - Managed by OCI public cloud control plane
  - **Same** Exadata hardware, software, interfaces, APIs as public cloud
  - **Same** pay-per-use subscription model
  - **Simple Free Upgrade from Gen1 Oracle Database Cloud @ Customer**
Lower Cost
Autonomous Database Guarantees Lower Running Cost

- **Bring Your Own License (BYOL)** Eliminates software costs
- **Exadata Speed with Self-Optimizing DB** Reduces runtime costs up to 80%
- **Online Elasticity with Pay-Per-Use** Cuts runtime costs up to another 90%

Written Guarantee:

Cost of Running Your Workload Will Be at Least 50% Lower than Amazon
Autonomous Database Cuts Total Costs

**More Importantly:**
- Eliminates full-stack administration costs
- Eliminates cost of downtime
- Accelerates development and time to market

---

Bring Your Own License (BYOL)
Eliminates software costs

Exadata Speed with Self-Optimizing DB
Reduces runtime costs up to 80%

Online Elasticity with Pay-Per-Use
Cuts runtime costs up to another 90%
Performance

Runs 5X to 10X Faster than Amazon Databases
Oracle Autonomous Database
Performance Benchmarks: 3 to 100 Times Faster than Amazon’s Databases

• Automatic Tuning
  – Continuous cost and performance tuning
  – Database adds and drops indexes, partitions, query plans...
  – Runs on Exadata Infrastructure

• Another reason reason we can...

  Cut your Amazon bill in half GUARANTEED
Oracle Autonomous Database: **Much Faster** thus **Lower Cost**

- Oracle Autonomous Data Warehouse vs Amazon Redshift
  - **9X FASTER and 8X CHEAPER**
- Oracle Autonomous Transaction Processing vs Amazon Aurora
  - **11X FASTER and 8X CHEAPER**
- Oracle Autonomous Transaction Processing vs Amazon Aurora mixed workloads
  - **100X FASTER and 80X CHEAPER**
- Autonomous Transaction Processing vs Oracle on RDS
  - **3X FASTER and 2X CHEAPER**
- Autonomous Transaction Processing vs Oracle on RDS while patching
  - **Infinitely FASTER and Infinitely CHEAPER**
A New Generation of Cloud Computing
New Hardware – New Software – Advanced Cyber Security Built-in

• **Impenetrable Barrier:** Network of Dedicated Cloud Control Computers
  – Barrier: Protects Cloud Perimeter and Users Zones
  – Impenetrable: No User Access to Cloud Control Computers and Memory

• **Autonomous RoBots:** Machine Learning RoBots Detect and Kill Threats
  – Database Immediately Patches Itself while Running – **Stops Data Theft**
  – No Delay for Human Process or Downtime Window

• **Autonomous Database:** Nothing to Learn, Nothing to Do
  – Eliminates Human Errors, Tolerates Hardware and Software Errors
  – Lowest Labor Costs, Lowest Operational Costs