Migrating Oracle Databases to Amazon Aurora

Blair Layton,
Business Development, Database, AWS APAC
How to Migrate Databases to AWS?
Customers Want to Migrate to AWS, but…

- They can’t afford long periods of application downtime
- Tools that enable minimal downtime are expensive
- It seems too complex and expensive to migrate
- They still need a copy of the data on-premises
- They want to migrate to an open source database
- Sending large volumes of data to AWS requires an expensive international network link
- They don’t have the skills inside their organization
Traditional Approach to Migrate to AWS

1. Create your AWS account
2. Setup your Virtual Private Cloud (VPC) in AWS
3. Connect to AWS with a VPN or Direct Connect
4. Shutdown and backup your database
5. Transmit the backup to S3
6. Configure an EC2 instance with the DB software
7. Restore the backup
8. Configure EC2 instances for the application
9. Switch the users to use AWS
Traditional Approach to Migrate to AWS

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Steps 4-9 could take a week or more!
Now There is a Better Way!
AWS Database Migration Service (AWS DMS)

DMS migrates databases to AWS easily and securely with minimal downtime. It can migrate your data to and from most widely used commercial and open-source databases.
AWS Schema Conversion Tool (AWS SCT)

SCT helps automate many database schema and code conversion tasks when migrating between database engines or data warehouse engines.
Database Migration the Easier Way

Step 1: Convert or copy your schema

Source DB or DW — Copy or convert — Native tool — Copy — Destination DB or DW

Step 2: Move your data

Source DB or DW — Database — AWS SCT — Data warehouse — AWS SCT — AWS DMS — Destination DB or DW

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How Does DMS Work?
Source Databases for DMS

On-premises, Cloud and Amazon EC2 instance databases:
- Oracle Database 10g–12c
- Microsoft SQL Server 2005–2017
- Azure SQL Database (CDC operations are not supported)
- Db2 LUW versions 9.7 Fix Pack 1, version 10.1, and version 10.5. Db2 LUW version 10.5 with Fix Pack 5 is not supported.
- MySQL 5.5–5.7
- MariaDB (MySQL-compatible data source)
- PostgreSQL 9.4+
- SAP ASE 12.5+
- MongoDB 2.6.x – 3.x+

RDS instance databases:
- Oracle Database 11g–12c
- Microsoft SQL Server 2008R2–2017
- MySQL versions 5.5–5.7
- MariaDB (MySQL-compatible data source)
- PostgreSQL 9.4+. CDC only on 9.4.9+, 9.5.4+, 9.6+, 10+
- Amazon Aurora (MySQL-compatible data source)
- Amazon S3
Target Databases for DMS

On-premises and EC2 instance databases:
• Oracle Database 10g–12c
• Microsoft SQL Server 2005–2016
• MySQL 5.5–5.7
• MariaDB (MySQL-compatible data source)
• PostgreSQL 9.4+
• SAP ASE 15+

RDS instance databases:
• Oracle Database 11g–12c
• Microsoft SQL Server 2008 R2 - 2017
• MySQL 5.5–5.7
• MariaDB (MySQL-compatible data source)
• PostgreSQL 9.4+
• Amazon Aurora (MySQL-compatible and PostgreSQL-compatible data source)

• Amazon Redshift, Amazon DynamoDB, Amazon S3
Keep Your Apps Running During the Migration

Start a replication instance
Connect to source and target databases
Select tables, schemas, or databases

Let AWS DMS create tables, load data, and keep them in sync
Switch applications over to the target at your convenience

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For less than $10 per TB!
AWS Schema Conversion Tool (AWS SCT)

SCT helps automate many database schema and code conversion tasks when migrating between database engines or data warehouse engines.
SCT Helps with Converting Tables, Views & Code

Sequences
User-Defined Types
Synonyms
Packages
Stored Procedures
Functions
Triggers
Schemas
Tables
Indexes
Views
Sort and distribution keys
SCT can tell you how hard the migration will be

1. Connect SCT to Source and Target databases.

2. Run Assessment Report.

3. Read Executive Summary.

4. Follow detailed instructions.
Pricing and Terms and Conditions

$0
for software license

Pricing
- Free software license
- For active AWS customers with accounts in good standing

Allowed Use
- Use SCT to migrate database schemas to Amazon RDS, Amazon Redshift, or Amazon EC2-based databases
- To use SCT to migrate schemas to other destinations, contact for special pricing
When to use DMS and SCT?
Tools for Migration Project Phases

<table>
<thead>
<tr>
<th>Phase</th>
<th>Service/Tool</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment</td>
<td>AWS Schema Conversion Tool</td>
<td>Reports on the database objects, complexity and types of migration issues</td>
</tr>
<tr>
<td>Schema Migration</td>
<td>AWS Schema Conversion Tool</td>
<td>Copies a schema or migrates a schema depending on whether it is a homogeneous or heterogeneous migrations</td>
</tr>
<tr>
<td>Data Migration</td>
<td>AWS Database Migration Service, AWS Schema Conversion Tool</td>
<td>Bulk load and change data capture (CDC) options Extraction and load for large data warehouses, including AWS Snowball integration</td>
</tr>
<tr>
<td>Application Migration</td>
<td>AWS Schema Conversion Tool</td>
<td>SQL statement migration in application code</td>
</tr>
<tr>
<td>Data Validation</td>
<td>AWS Database Migration Service</td>
<td>Ensure data is the same on source and target</td>
</tr>
<tr>
<td>Functional Testing</td>
<td>Various Tools on Marketplace</td>
<td>Ensure the application runs as intended</td>
</tr>
<tr>
<td>Performance Testing</td>
<td>Various Tools on Marketplace</td>
<td>Ensure the application performance as intended</td>
</tr>
<tr>
<td>Scenario</td>
<td>Example</td>
<td>Recommendation</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Homogeneous migration to the same database version and edition</td>
<td>Migration of Oracle Database 11gR2 Enterprise Edition from on-premises to EC2</td>
<td>Use the native replication technology to create a standby database and then failover to the standby database</td>
</tr>
<tr>
<td>Homogeneous migration to a different version</td>
<td>Migration of Oracle 11gR2 to Oracle 12c</td>
<td>AWS Schema Conversion Tool and AWS Database Migration Service</td>
</tr>
<tr>
<td>Homogeneous migration to a different edition</td>
<td>Migration of Oracle Enterprise Edition to Standard Edition</td>
<td>AWS Schema Conversion Tool and AWS Database Migration Service</td>
</tr>
<tr>
<td>Heterogeneous migration</td>
<td>Migration from Oracle Database to PostgreSQL</td>
<td>AWS Schema Conversion Tool and AWS Database Migration Service</td>
</tr>
</tbody>
</table>
Migration Target – Amazon Aurora
What is Amazon Aurora?
Database reimagined for the cloud

- **Speed** and availability of high-end commercial databases
- **Simplicity** and cost-effectiveness of open source databases
- Drop-in **compatibility** with MySQL and PostgreSQL
- Simple **pay as you go** pricing

Delivered as a **managed** service
Re-imagining the relational database

1. Scale-out, distributed architecture

2. Service-oriented architecture leveraging AWS services

3. Automate administrative tasks – fully managed service
**Scale-out, distributed architecture**

- Purpose-built log-structured distributed storage system designed for databases

- Storage volume is striped across hundreds of storage nodes distributed over 3 different availability zones

- Six copies of data, two copies in each availability zone to protect against AZ+1 failures

- Plan to apply same principles to other layers of the stack
5x more throughput than MySQL; 3x more than PostgreSQL
Aurora MySQL performance

MySQL SysBench results; R4.16XL: 64cores / 488 GB RAM

Aurora read write throughput compared to MySQL 5.6 based on industry standard benchmarks.
Aurora PostgreSQL performance

While running pgbench at load, throughput is 3x more consistent than PostgreSQL
Monitoring Database Performance
Performance Insights

Dashboard showing load on DB

- Easy
- Powerful

Identifies source of bottlenecks

- Top SQL

Adjustable time frame

- Hour, day, week, month
- Up to 35 days of data
Performance Insights

What if you could find out what your databases were doing, or had been doing?

Performance Insights is the answer:

- Lets you see your overall instance load
- Drill down by SQL statement, by time, or by calling host
Recent Innovation
Availability is about more than HW failures
Aurora solutions for availability disruptions

1. Patching your database software
   → Zero Downtime Patching

2. Large-scale copying and reorganizations
   → Fast Cloning

3. DBA errors requiring database restores
   → Backtrack

4. Disasters
   → Global replication
Aurora Serverless

- Starts up on demand, shuts down when not in use
- Scales up & down automatically
- No application impact when scaling
- Pay per second, 1 minute minimum
Multi-region Multi-Master

Write accepted locally

Optimistic concurrency control – no distributed lock manager, no chatty lock management protocol

Conflicts handled hierarchically – at head nodes, at storage nodes, at AZ and region level arbitrators

Near-linear performance scaling when there is no or low levels of conflicts
Parallel query processing

Aurora storage has thousands of CPUs

- Presents opportunity to push down and parallelize query processing using the storage fleet
- Moving processing close to data reduces network traffic and latency
Migration Project – Planning and Managing
AWS Migration Framework

**READINESS AND PLANNING**
- Project Control
  - Strategy (business driver)
  - Key Stakeholders and Team
  - Plan (Scope, Schedule, Resources)
- Cost Estimation
- Portfolio discovery
- Migration plan
- Operations Integration
- Security

**EXECUTE**
- Prioritized Backlog (PLAN)
  - Discover
  - Cutover
  - Design
  - Build
  - Validate
  - Integrate

**ACTIVATE**
- Prioritized Backlog
  - Application groups
  - Migration strategy
  - Success criteria
- Ops Integration – Foundation and Landing Zone (target zone setup)
- Setup Factory (Tools, Teams, Processes)
- Pilot Migration

**OPTIMIZE**
- Application optimization
- Process optimization
- Operational optimization
- Cost optimization

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The 6Rs of Migration Planning
Common Customer Decisions

- Assessment project - understand what you have
- Internal licensing audit
- Migrate existing Oracle Database workloads to AWS
- Run POCs with migration targets to understand how to manage a migration project
- Obtain training on the target environment and database (AWS, MySQL, PostgreSQL)
- Use specialist partners and AWS Professional Services
Oracle on AWS
Amazon RDS

Relational Databases
Managed Service
Simple and fast to scale
Fast, predictable performance
Low cost, pay for what you use
Key Features

Provision a database in 6 minutes
Provision a MAZ database with a few mouse clicks
Scale a database up/down with 60-90 seconds downtime
Apply patches with 60-90 seconds downtime
Add read replicas with a few mouse clicks
Protect your backups and logs with 11 9’s of durability
Recover to any point in time from nightly backups + logs
Detailed metrics, down to 1 second intervals
Secure your data with single click encryption at rest
License included options for SQL Server EE/SE and Oracle SE1/SE2
Stop/Start
Recently Shipped Features for RDS Oracle

- OEM Agent 13c
- Oracle Spatial/Locator/Multimedia
- Customer Initiated Snapshot Upgrade
- Support for APEX 5.0
- R4, db.t2.xlarge, db.t2.2xlarge, db.m4.16xlarge and X1/X1e instances
- Support for up to 16TB storage per instance
# RDS Oracle – Supported Features

<table>
<thead>
<tr>
<th>Features</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>XML DB</td>
<td>Partitioning</td>
</tr>
<tr>
<td>Oracle AQ</td>
<td>Advanced Compression</td>
</tr>
<tr>
<td>Materialized Views</td>
<td>Advanced Security Option (TDE/NNE)</td>
</tr>
<tr>
<td>Online Redefinition</td>
<td>Oracle Enterprise Manager – DB Control</td>
</tr>
<tr>
<td>Oracle Application Express</td>
<td>Diagnostics Pack</td>
</tr>
<tr>
<td>Data Pump (Network Mode)</td>
<td>Tuning Pack</td>
</tr>
<tr>
<td>Flashback and Total Recall</td>
<td>Locator</td>
</tr>
<tr>
<td>Virtual Private Database</td>
<td>Spatial</td>
</tr>
<tr>
<td>Statspack/AWR</td>
<td>Oracle Enterprise Manager Grid Control</td>
</tr>
<tr>
<td>UTL_HTTP, TCP, SMTP, MAIL</td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Features</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated Storage Management</td>
<td>Real Application Clusters (RAC)</td>
</tr>
<tr>
<td>Streams</td>
<td>Real Application Testing</td>
</tr>
<tr>
<td>Java Support*</td>
<td>Data Guard / Active Data Guard</td>
</tr>
<tr>
<td>XML DB Protocol Server</td>
<td>Database Vault</td>
</tr>
</tbody>
</table>
## RDS Oracle – Supported Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Aurora</th>
<th>MySQL</th>
<th>MariaDB</th>
<th>PostgreSQL</th>
<th>Oracle</th>
<th>SQL Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPC</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>High availability</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Instance Scaling</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Encryption</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Read replicas</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Cross region replicas</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Oracle Golden Gate / DMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>DMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max Storage</td>
<td>64 TB</td>
<td>16 TB</td>
<td>16 TB</td>
<td>16 TB</td>
<td>16 TB</td>
<td>16 TB</td>
</tr>
<tr>
<td>Scale Storage</td>
<td>Auto scaling</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Provisioned IOPS</td>
<td>NA</td>
<td>40,000</td>
<td>40,000</td>
<td>40,000</td>
<td>40,000</td>
<td>32,000</td>
</tr>
<tr>
<td>Largest Instance</td>
<td>64 vCPUs 488 GiB</td>
<td>64 vCPUs 488 GiB</td>
<td>64 vCPUs 488 GiB</td>
<td>64 vCPUs 488 GiB</td>
<td>128 vCPUs 3902 GiB</td>
<td>64 vCPUs 488 GiB</td>
</tr>
</tbody>
</table>
Choosing the Right Amazon EC2 Instances

• EC2 Instance types are optimized for different use cases, workloads & come in multiple sizes. This allows you to optimally scale resources to your workload requirements.

• AWS utilizes Intel® Xeon® processors for EC2 Instances providing customers with high performance and value.

• Consider the following when choosing your instances: core count, memory size, storage size & type, network performance, I/O requirements & CPU technologies.

• Hurry Up & Go Idle - A larger compute instance can save you time and money, therefore paying more per hour for a shorter amount of time can be less expensive.
EC2 Instances Powered by Intel Technologies

<table>
<thead>
<tr>
<th>EC2 Instance Type</th>
<th>Compute Optimized</th>
<th>General Purpose</th>
<th>Memory Optimized</th>
<th>Storage Optimized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C5</td>
<td>C4</td>
<td>M5</td>
<td>M4</td>
</tr>
<tr>
<td>Intel Processor</td>
<td>Xeon Platinum 8175M</td>
<td>Xeon E5 2666 v3</td>
<td>Xeon Platinum 8175M</td>
<td>Xeon E5 2686 v4</td>
</tr>
<tr>
<td>Intel Processor Technology</td>
<td>Skylake</td>
<td>Haswell</td>
<td>Skylake</td>
<td>Broadwell</td>
</tr>
<tr>
<td>Intel AVX</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Intel AVX2</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Intel AVX-512</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>Intel Turbo Boost</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Storage</td>
<td>EBS-only</td>
<td>EBS-only</td>
<td>EBS-only</td>
<td>EBS-only</td>
</tr>
</tbody>
</table>

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M5: Next-Gen General Purpose instance

- Powered by 2.5 GHz Intel Xeon Scalable Processors *(Skylake)*
- New larger instance size—m5.24xlarge with **96 vCPUs** and **384 GiB of memory** (4:1 Memory:vCPU ratio)
- Improved network and EBS performance on smaller instance sizes
- Support for Intel **AVX-512** offering up to twice the performance for vector and floating point workloads

14% price/performance improvement With M5
X1e Instance - Tons of Memory

• Designed for large-scale, in-memory applications in the cloud

• Ideal for large Oracle Databases, in-memory databases like SAP HANA and big data processing apps like Spark and Presto

• Powered by Intel® Xeon® E7 8880 v3 Haswell processors

• Features up to 4TB of memory and up to 128 vCPUs per instance
Oracle License Portability to AWS

All Oracle Software licenses are fully portable to Amazon Web Services EC2 and RDS

• Enterprise License Agreement (ELA)
• Unlimited License Agreement (ULA)*
• Business Process Outsourcing (BPO)
• Oracle Partner Network (OPN)

* Licenses acquired under unlimited license agreements (ULAs) may be used on AWS, but customers may not include those licenses in the certification at the end of the ULA term.

Oracle Cloud Licensing Policy
Licensing (LI and BYOL)

Processor & Socket Licensing:

- Standard Edition/ SE1/SE2 Licenses
  - 1 license for 4 vCPUs on EC2 and RDS
  - Maximum 16 vCPUs for SE and SE1
  - Maximum 8 vCPUs for SE2

- Enterprise Edition Licenses
  - 1 license for 2 vCPUs with hyper-threading or 1 vCPU without on EC2 and RDS

- Named User Plus metric for Licensing
  - 10 NUP licenses per 8 vCPUs for SE2
  - For EE - 25 NUP licenses per processor license or the total number of actual users, whichever is greater
Reduce Oracle Cost on AWS

- EC2 Optimize CPU
- Hardware modernization
- Migration to Oracle Database SE1/SE2 for EE workloads
- Removal of unnecessary EE options
- Docker deployments for dev/test workloads
- Migration to PostgreSQL for OLTP, spatial and reporting/basic BI
- New projects start on open source engines
Introducing Optimize CPUs for Amazon EC2 Instances

Amazon EC2

a) specify a custom number of vCPUs for new instances, while enjoying the same memory, storage, and bandwidth of a full-sized instance

b) disable Intel Hyper-Threading Technology (Intel HT Technology) for workloads that perform well with single-threaded CPUs

Enables Bring Your Own license (BYOL) customers to optimize their vCPU-based licensing costs!
Hardware Modernization

- AWS instances run the latest Intel platforms
- Cost effective SSD storage for high IOPS at low latency
- Target older hardware to use more powerful cores and faster storage
- Overall reduction in cores by using new hardware
- Redeploy licenses to existing or new systems
- Retire excess licenses
Migration from Oracle DB EE to SE1/SE2

- Many customers use Enterprise Edition for ALL systems
- Identify the systems that need EE and associated options
- Identify the systems that can move to SE1/SE2
- SE1 licenses can be purchased on demand from AWS
- SE2 license discussion ongoing
- Redeploy licenses to existing or new systems
- Retire excess licenses
Removal of Unnecessary EE Options

- RAC requirements may be met by RDS MAZ (60-90s)
- Partitioning may not be required (faster storage)
- Advanced Security is not needed for secure connections and RDS offers encryption at rest
- Tuning and Diagnostics Packs not needed for all systems
- Helps to identify systems that can use SE1/SE2
- Redeploy licenses to existing or new systems
- Retire excess licenses
Docker Deployments for Dev/Test Workloads

- Achieve high levels of virtualization to allocate fractions of cores to dev/test environments
- Similar to AIX/LPAR, Solaris/Zones, VMware
- Dev/Test environments can use all cores available on the instance, but will fall back to their limits when the system is busy
- Redeploy licenses to existing or new systems
- Retire excess licenses
Migration to PostgreSQL

• PostgreSQL is managed by a community, not a company
• PostgreSQL has more features and performs better than MySQL for many use cases
• Easier to migrate from commercial databases to PostgreSQL than MySQL because of closer mappings
Migrating Oracle Databases
Oracle to Aurora Migration Playbook

- Topic-by-topic overview of Oracle to Aurora PostgreSQL migrations and “hands-on” best practices
- How to migrate from proprietary features and the different database objects
- Migration best practices

https://aws.amazon.com/dms/getting-started/
<table>
<thead>
<tr>
<th>Oracle Feature</th>
<th>Aurora PostgreSQL Feature</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link Anonymous Block</td>
<td>Do</td>
<td>Yes</td>
</tr>
<tr>
<td>Link Execute Immediate</td>
<td>Execute &amp; Prepare</td>
<td>Yes</td>
</tr>
<tr>
<td>Link DBMS_RANDOM</td>
<td>random()</td>
<td>Yes*</td>
</tr>
<tr>
<td>Link DBMS_OUTPUT</td>
<td>RAISE</td>
<td>Yes</td>
</tr>
<tr>
<td>Link Procedures &amp; Functions</td>
<td>Functions</td>
<td>Yes*</td>
</tr>
<tr>
<td>Link User Defined Functions</td>
<td>Functions</td>
<td>Yes*</td>
</tr>
<tr>
<td>Link UTL_FILE</td>
<td>N/A</td>
<td>None</td>
</tr>
<tr>
<td>Link JSON Document Support</td>
<td>JSON Document Support</td>
<td>Yes*</td>
</tr>
<tr>
<td>Link OLAP Functions</td>
<td>Window Functions</td>
<td>Yes</td>
</tr>
<tr>
<td>Link PL/SQL Cursors</td>
<td>Cursors</td>
<td>Yes</td>
</tr>
<tr>
<td>Link Single Row &amp; Aggregate Functions</td>
<td>Single Row &amp; Aggregate Functions</td>
<td>Yes</td>
</tr>
<tr>
<td>Link Merge</td>
<td>SQL Merge</td>
<td>Yes</td>
</tr>
<tr>
<td>Link Create Table As Select (CTAS)</td>
<td>Create Table As Select (CTAS)</td>
<td>Yes</td>
</tr>
<tr>
<td>Link Common Table Expression (CTE)</td>
<td>Common Table Expression (CTE)</td>
<td>Yes</td>
</tr>
<tr>
<td>Link Insert From Select</td>
<td>Insert From Select</td>
<td>Yes</td>
</tr>
<tr>
<td>Link Inline Views</td>
<td>Inline Views</td>
<td>Yes</td>
</tr>
<tr>
<td>Link DB Hints</td>
<td>Query Planning</td>
<td>Yes*</td>
</tr>
<tr>
<td>Oracle Feature</td>
<td>Aurora PostgreSQL Feature</td>
<td>Compatibility</td>
</tr>
<tr>
<td>----------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Index Organized Tables (IOTs)</td>
<td>PostgreSQL “Cluster” Tables</td>
<td>Yes*</td>
</tr>
<tr>
<td>Common Data Types</td>
<td>Common Data Types</td>
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<tr>
<td>Table Constraints</td>
<td>Table Constraints</td>
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<tr>
<td>Table Partitioning including: RANGE, LIST, HASH, COMPOSITE, Automatic LIST</td>
<td>Table Partitioning including: RANGE, LIST</td>
<td>Yes*</td>
</tr>
<tr>
<td>Exchange and Split Partitions</td>
<td>N/A</td>
<td>None</td>
</tr>
<tr>
<td>Temporary Tables</td>
<td>Temporary Tables</td>
<td>Yes*</td>
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<tr>
<td>Unused Columns</td>
<td>ALTER TABLE DROP COLUMN</td>
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<tr>
<td>Virtual Columns</td>
<td>Views and/or Function as a Column</td>
<td>Yes*</td>
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<tr>
<td>User Defined Types (UDTs)</td>
<td>User Defined Types (UDTs)</td>
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<tr>
<td>Read Only Tables and Table Partitions</td>
<td>Read Only Roles and/or Triggers</td>
<td>Yes*</td>
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<tr>
<td>Index Types</td>
<td>Index Types</td>
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<td>B-Tree Indexes</td>
<td>B-Tree Indexes</td>
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<tr>
<td>Composite Indexes</td>
<td>Multi-Column Indexes</td>
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<tr>
<td>BITMAP Indexes</td>
<td>BRIN Indexes</td>
<td>Minimal</td>
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<tr>
<td>Function-Based Indexes</td>
<td>Expression Indexes</td>
<td>Yes</td>
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<tr>
<td>Local and Global Partitioned Indexes</td>
<td>Partitioned Indexes</td>
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<td>Identity Columns</td>
<td>Serial Data Type</td>
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<tr>
<td>MVCC (Table and Row Locks)</td>
<td>MVCC (Table and Row Locks)</td>
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<tr>
<td>Character Sets</td>
<td>Encoding</td>
<td>Yes*</td>
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<tr>
<td>Transaction Model</td>
<td>Transactional Model</td>
<td>Yes*</td>
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<tr>
<td>LOBs and SecureFile LOBs</td>
<td>LOBs</td>
<td>Yes*</td>
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<tr>
<td>Oracle Feature</td>
<td>Aurora PostgreSQL Feature</td>
<td>Compatibility</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------------------------------------</td>
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<tr>
<td>Materialized Views</td>
<td>Materialized Views</td>
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<tr>
<td>Common Data Types</td>
<td>Common Data Types</td>
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<tr>
<td>Oracle Triggers</td>
<td>PostgreSQL Trigger Procedure</td>
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<td>Views</td>
<td>Views</td>
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<tr>
<td>Sequences</td>
<td>Sequences</td>
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<tr>
<td>Database Links</td>
<td>PostgreSQL DBLink and FDWrapper</td>
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## PostgreSQL vs. Oracle

<table>
<thead>
<tr>
<th>Property</th>
<th>PostgreSQL</th>
<th>Oracle</th>
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<tbody>
<tr>
<td>Schema and Pre-defined Data Types</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Secondary Indexes</td>
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<tr>
<td>SQL</td>
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<tr>
<td>API Framework</td>
<td>C, ADO.NET, JDBC, ODBC</td>
<td>ODP.NET, Oracle Call Interface (OCI), JDBC, and ODBC</td>
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<tr>
<td>Triggers</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Partitioning</td>
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<td>Replication</td>
<td>Master-Slave</td>
<td>Master-Slave and Master-Master</td>
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<td>MapReduce APIs</td>
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<td>Foreign Keys</td>
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<td>Transactions</td>
<td>ACID</td>
<td>ACID</td>
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<td>In-Memory</td>
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<td>XML Support</td>
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<td>Reporting</td>
<td>Reporting Available</td>
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<tr>
<td>Spatial</td>
<td>PostGIS</td>
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</table>
Customer Successes
>65,000 Databases Migrated with DMS
Trimble Migrated From Oracle to Amazon RDS PostgreSQL

"The SCT Assessment Report was the key enabler to allow us to understand the scope of effort required to complete an Oracle to PostgreSQL migration.

What was originally thought to be a largely manual task that no one was particularly excited about having to do became a very straight-forward quick and easy process."

- Todd Hofert, Director of Infrastructure Operations, Trimble
Verizon – Major Enterprise Migration to AWS

Data Centre + Cloud

Verizon commits to AWS after buying and selling its own cloud

Can anyone catch the cloud deluge? (IBM?)

By Simon Sharwood, APC Editor

Amazon Web Services has signed a new five-year deal with customer Verizon.

The US telco is significant here because it has its own cloud caper itself. Way back in 2006, it announced it had no choice but to buy cloud to IBM.

It was wrong. Verizon had nothing to do with cloud and no need for IBM. It was just a bunch of data centres selling services to customers.

But even before those sales been closed, it was quite a vote of confidence in its own cloud.

Under the new agreement, Verizon Communications' global cloud services business will partner with AWS (Amazon Web Services) to deliver cloud workloads and other services.

AWS re:Invent 2017: How Verizon is Adopting the Amazon Aurora PostgreSQL-compatible (DAT332)
Discover Database Freedom with AWS

**Innovation**
- Database Migration Service and Schema Conversion Tool
- Aurora MySQL and Aurora PostgreSQL, RDS for Open Source databases
- DynamoDB with DAX, EMR, Redshift and Spectrum, and other services
- New EC2 instance types

**Expertise**
- Professional Services, Partners, Service Teams
- Workload Qualification Framework
- Patterns and Recommendations

**Programs**
- Workshops
- Proofs-of-Concepts
- Incentives (e.g. MAP)
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- Application portfolio discovery
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- Application migration
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AWS Migrating to the Cloud Webinar Series.

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