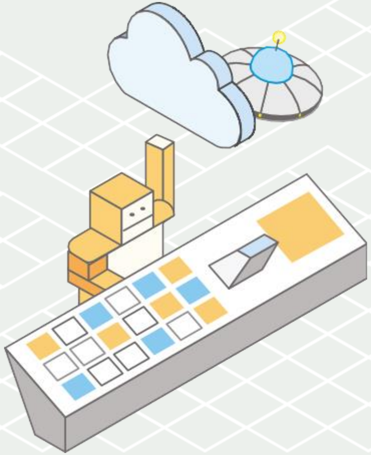
Pop-up Loft
LONDON

Deep Dive on Amazon RDS (Relational Database Service)

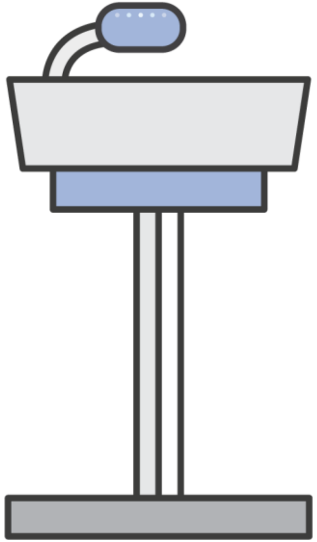


Richard Ainley, AWS Solutions Architect

18th September 2017

Agenda

- Quick intro to RDS
- Security
- Metrics and Monitoring
- High Availability
- Scaling
- Backups and Snapshots
- Migrating



Amazon Relational Database Service (RDS)

Launch

No infrastructure management

Application compatibility

Instant provisioning

Cost-effective

Scale up/down

Trade-offs with a managed service

Fully managed host and OS

- No access to the database host operating system
- Limited ability to modify configuration that is managed on the host operating system
- No functions that rely on configuration from the host OS

Fully managed storage

- Max storage limits
  - Microsoft SQL Server - 16 TB
  - MySQL, MariaDB, PostgreSQL, Oracle - 6 TB
  - Aurora - 64 TB

Amazon RDS engines

Commercial

ORACLE®

Microsoft® SQL Server®

Open source

MySQL®

PostgreSQL

MariaDB

Cloud native

Amazon Aurora

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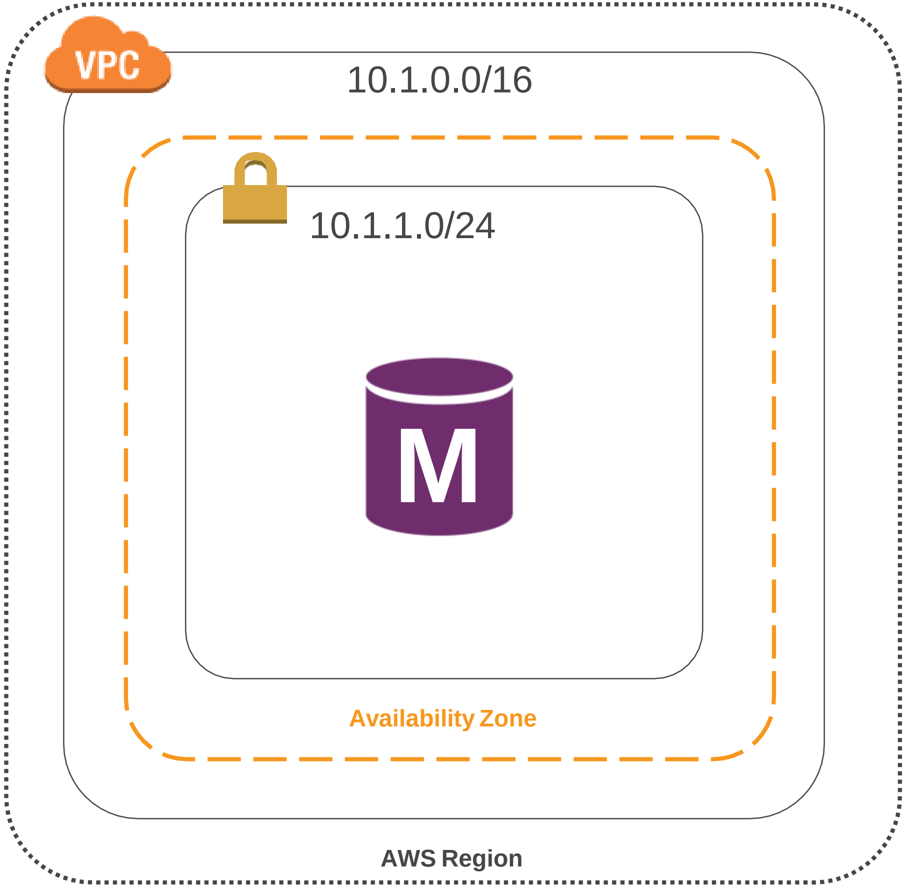
Security

Amazon Virtual Private Cloud (Amazon VPC)

Securely control network configuration



Amazon Virtual Private Cloud (Amazon VPC)

Securely control network configuration

Manage connectivity

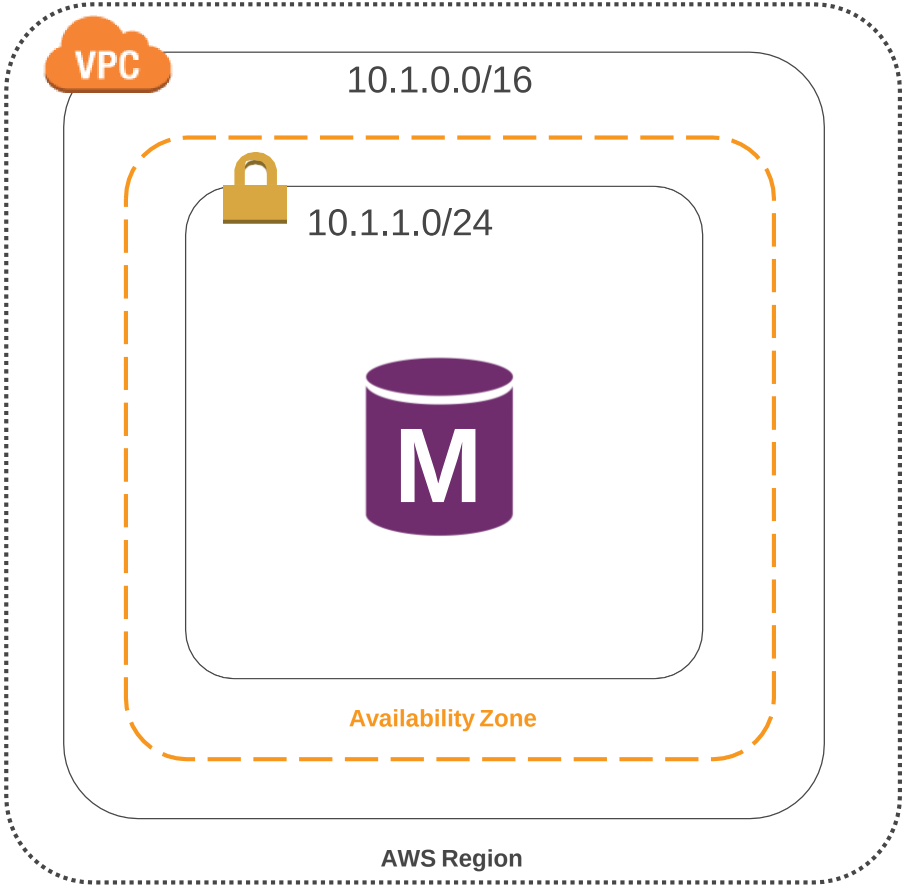
AWS Direct Connect

VPN connection

VPC peering

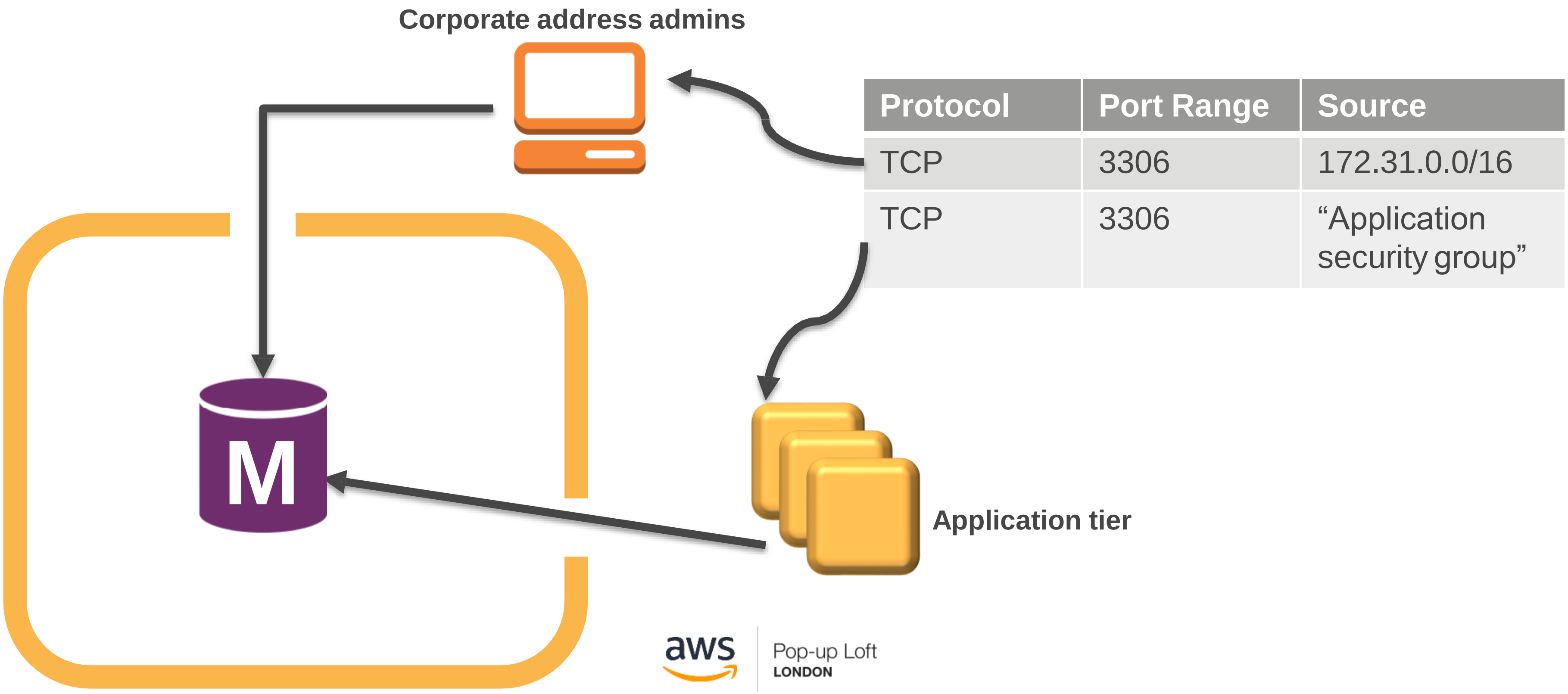
Routing rules

Internet gateway



Security groups

Database IP firewall protection

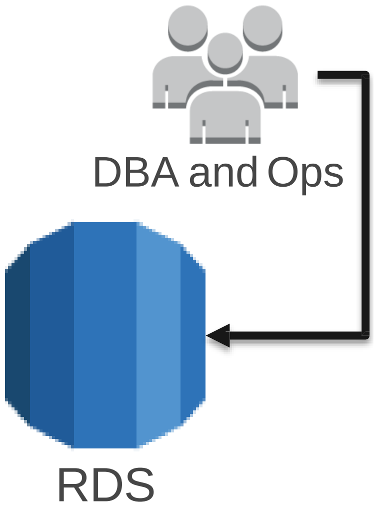


Protocol	Port Range	Source
TCP	3306	172.31.0.0/16
TCP	3306	“Application security group”

AWS IAM governed access

You can use AWS Identity and Access Management (IAM) to:

- Control who can perform actions on RDS
- Authenticate to your RDS MySQL / Aurora DB
    - MySQL 5.6.34 / 5.7.16 or higher
    - Aurora 1.10 or higher
    - Not available for db.t1.micro / db.m1.small

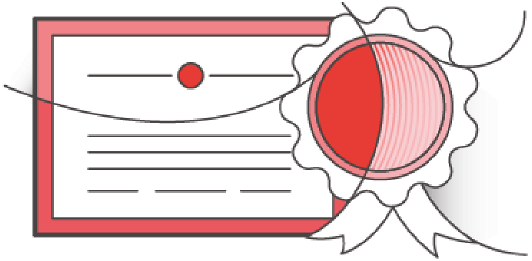


Compliance

AICPA Service Organization Control Reports
AICPA
SERVICE ORGANIZATIONS
SOC
aicpa.org/soc
Formerly SAS 70 Reports ®

FedRAMP
Federal Risk Authorization Management Program

GOV.UK



Singapore MTCS

PCI Security Standards Council ®
PARTICIPATING ORGANIZATION™

ITAR
International Traffic in Arms Regulations Compliant

HIPAA

ISO

27001/9001
27017/27018

Compliance

Aurora

SOC 1, 2, 3
ISO 20001/9001
ISO 27107/27018
PCI
HIPAA BAA

MariaDB

SOC 1, 2, 3
ISO 20001/9001
ISO 27107/27018
PCI
HIPAA BAA

MySQL

SOC 1, 2, 3
ISO 20001/9001
ISO 27107/27018
PCI
FedRamp
HIPAA BAA
UK Gov. Programs
Singapore MTCS

Oracle

SOC 1, 2, 3
ISO 20001/9001
ISO 27107/27018
PCI
FedRamp
HIPAA BAA
UK Gov. Programs
Singapore MTCS

PostgreSQL

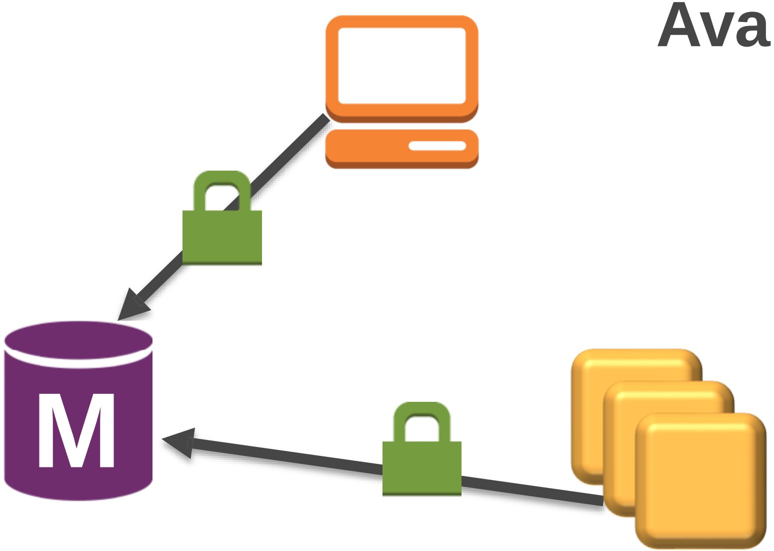
SOC 1, 2, 3
ISO 20001/9001
ISO 27107/27018
PCI
UK Gov. Programs
Singapore MTCS
HIPAA BAA

SQL Server

SOC 1, 2, 3
ISO 20001/9001
ISO 27107/27018
PCI
UK Gov. Programs
Singapore MTCS
HIPAA BAA

SSL

Database traffic encryption



Available for all six engines

At Rest Encryption

Transparent Data Encryption

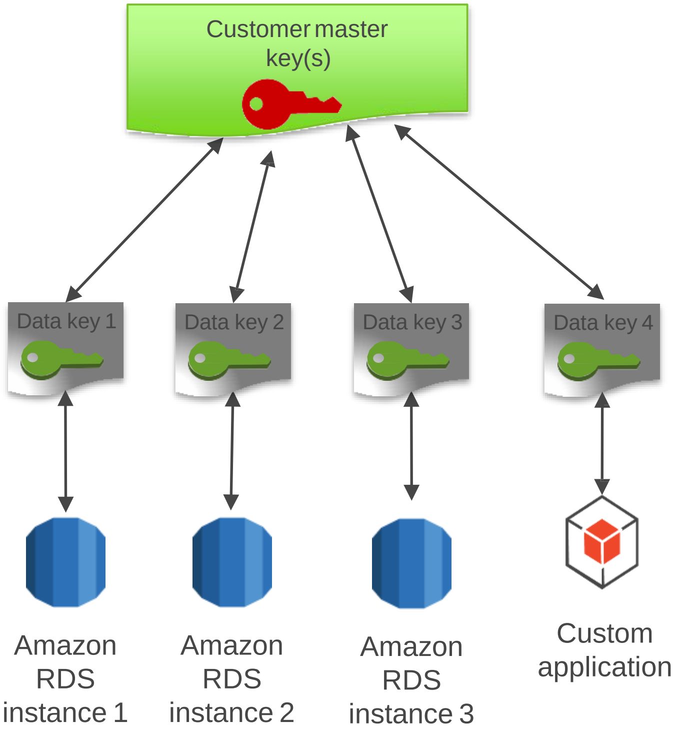
At Rest Encryption for all RDS Engines AWS Key Management Service (KMS)

Two-tiered key hierarchy using envelope encryption:

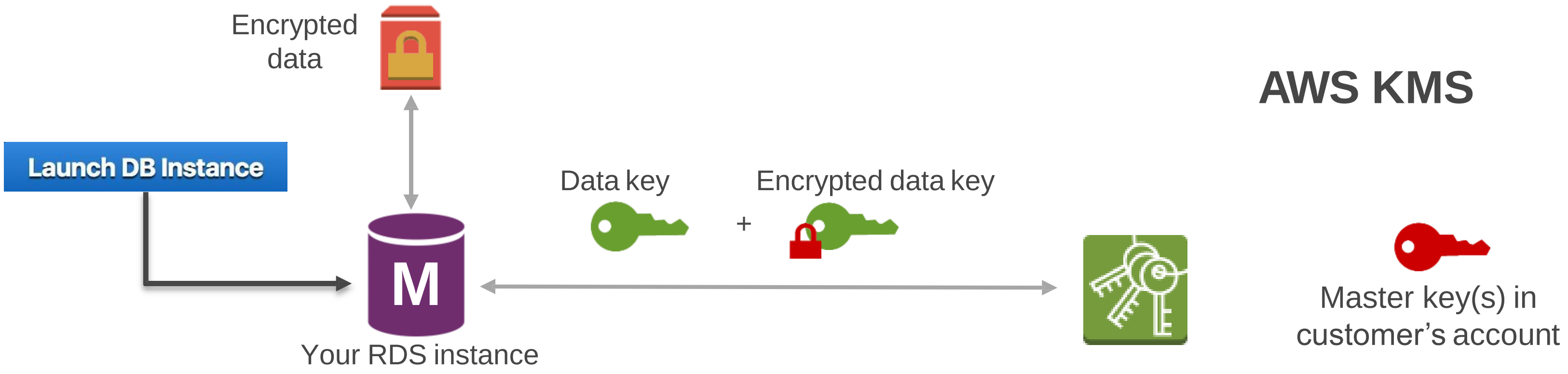
- Unique data key encrypts customer data
- AWS KMS master keys encrypt data keys
- Available for **ALL** RDS engines

Benefits:

- Limits risk of compromised data key
- Better performance for encrypting large data
- Easier to manage small number of master keys than millions of data keys
- Centralized access and audit of key activity



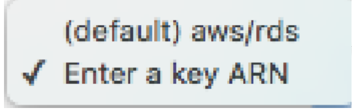
How keys are used to protect your data

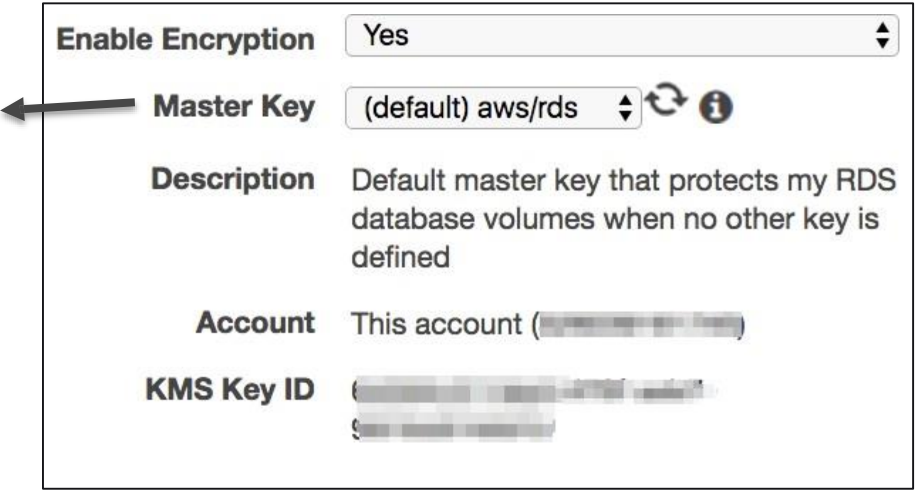


1. Launch your RDS instance
2. RDS instance requests encryption key to use to encrypt data, passes reference to master key in account
3. Client request authenticated based on permissions set on both the user and the key
4. A unique data encryption key is created and encrypted under the KMS master key
5. Plaintext and encrypted data key returned to RDS
6. Plaintext data key stored in memory and used to encrypt/decrypt RDS data

Enabling encryption

Console





Enable Encryption: Yes

Master Key: (default) aws/rds

Description: Default master key that protects my RDS database volumes when no other key is defined

Account: This account ([redacted])

KMS Key ID: [redacted]

AWS Command Line Interface (AWS CLI)

```
aws rds create-db-instance --region us-west-2 --db-instance-identifier sg-cli-test \
--allocated-storage 20 --storage-encrypted \
--db-instance-class db.m4.large --engine mysql \
--master-username myawsuser --master-user-password myawsuser
```

```
aws rds create-db-instance --region us-west-2 --db-instance-identifier sg-cli-test1 \ --
allocated-storage 20 --storage-encrypted --kms-key-id xxxxxxxxxxxxxxxxxxx \        --db-
instance-class db.m4.large --engine mysql \ --master-username myawsuser    --master-user-
password myawsuser
```

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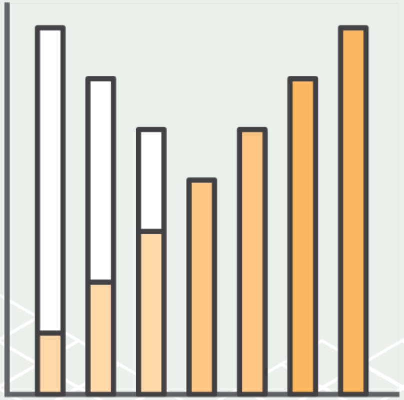
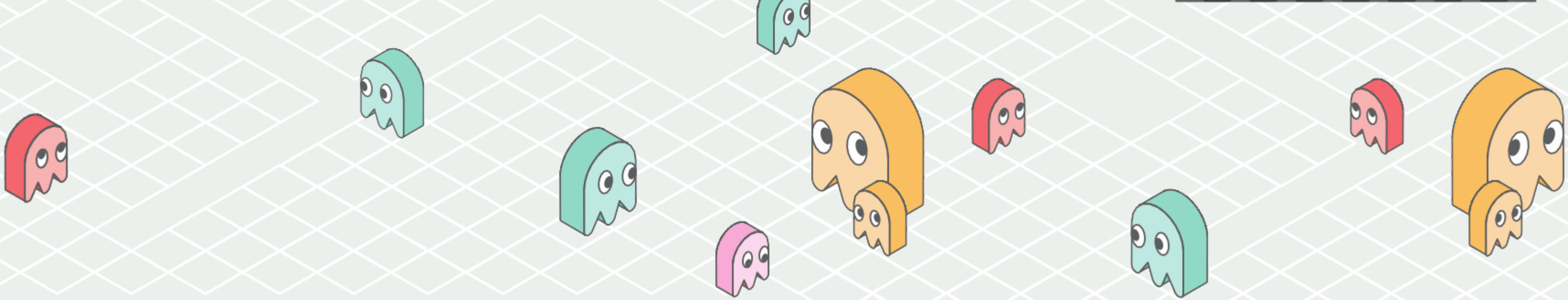
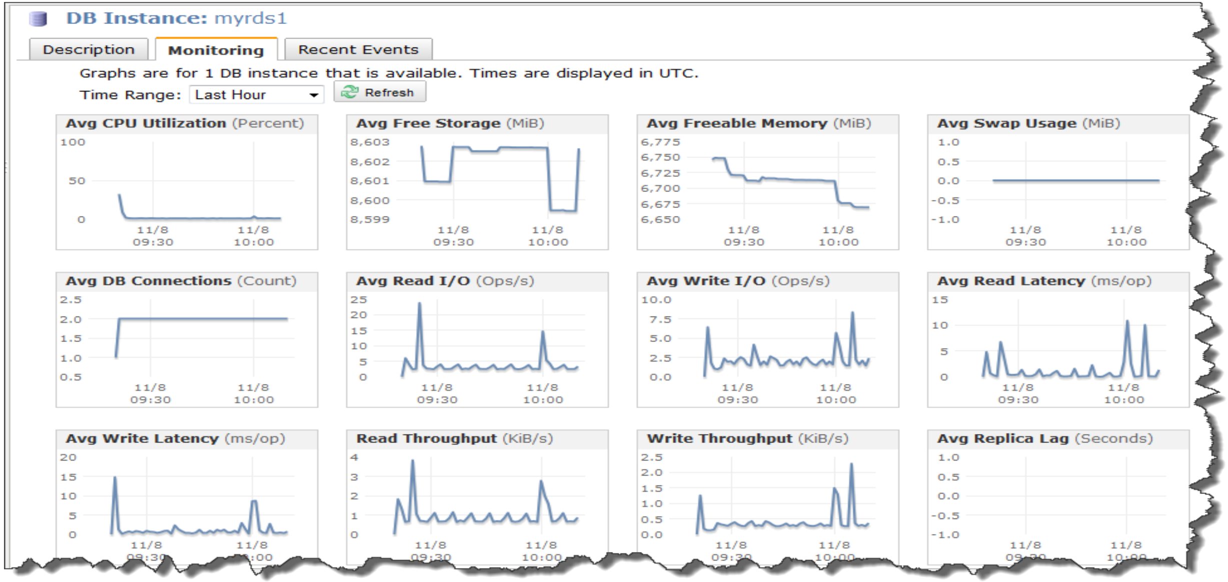
Metrics and Monitoring





Standard monitoring


DB Instance: myrds1

Graphs are for 1 DB instance that is available. Times are displayed in UTC.

Time Range: Last Hour

Amazon CloudWatch metrics for Amazon RDS

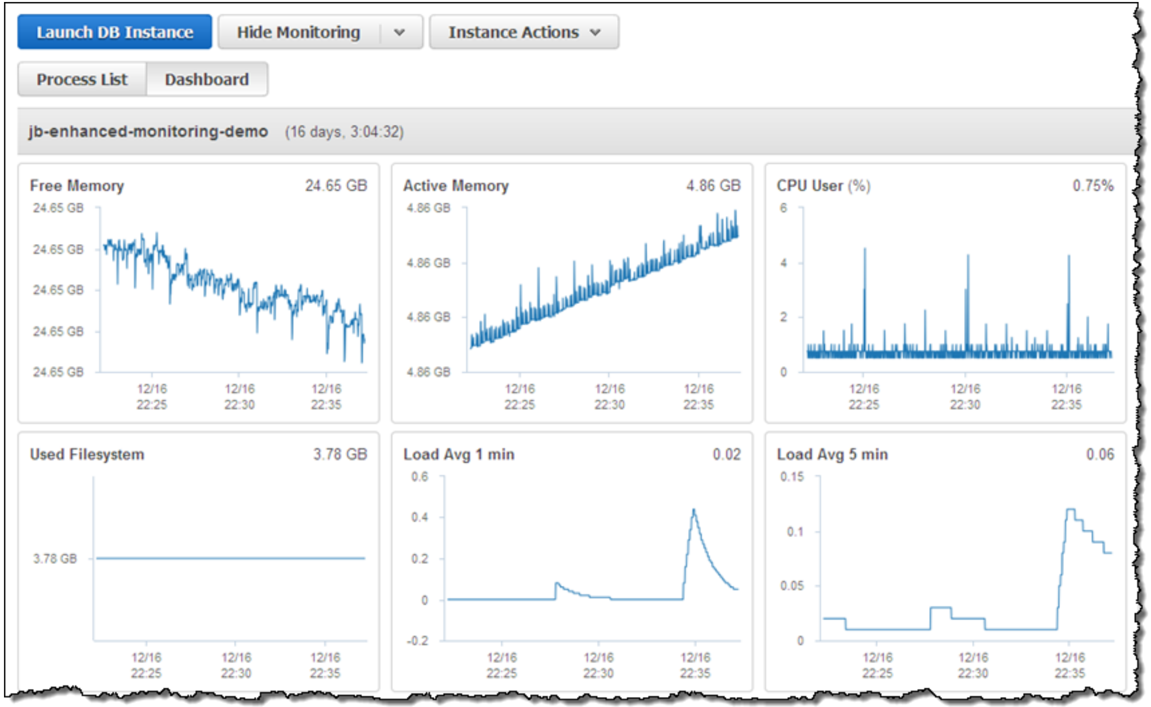
- CPU utilization
- Storage
- Memory
- Swap usage
- DB connections
- I/O (read and write)
- Latency (read and write)
- Throughput (read and write)
- Replica lag
- Many more

Amazon CloudWatch Alarms

- Similar to on-premises custom monitoring tools

Enhanced Monitoring

Access to over 50 new CPU, memory, file system, and disk I/O metrics as low as 1 second intervals



jb-enhanced-monitoring-demo (16 days, 3:04:32)

Free Memory 24.65 GB

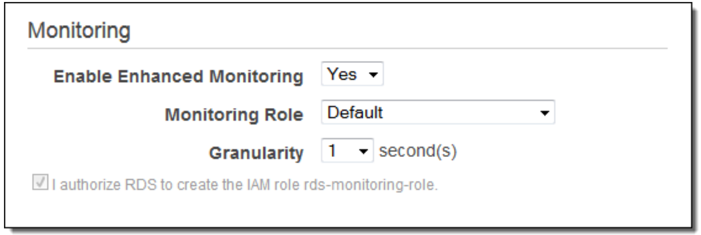
Active Memory 4.86 GB

CPU User (%) 0.75%

Used Filesystem 3.78 GB

Load Avg 1 min 0.02

Load Avg 5 min 0.06



Monitoring

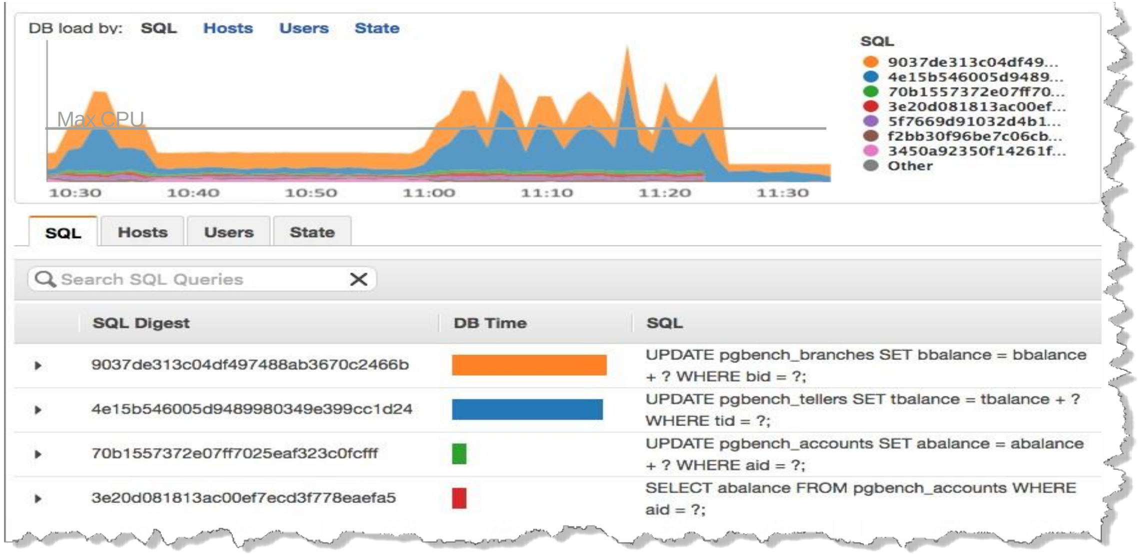
Enable Enhanced Monitoring: Yes

Monitoring Role: Default

Granularity: 1 second(s)

☑ I authorize RDS to create the IAM role rds-monitoring-role.

Simplify monitoring with AWS Management Console



SQL Digest	DB Time	SQL
9037de313c04df497488ab3670c2466b	🟧	UPDATE pgbench_branches SET bbalance = bbalance + ? WHERE bid = ?;
4e15b546005d9489980349e399cc1d24	🟦	UPDATE pgbench_tellers SET tbalance = tbalance + ? WHERE tid = ?;
70b1557372e07ff7025eaf323c0fcfff	🟩	UPDATE pgbench_accounts SET abalance = abalance + ? WHERE aid = ?;
3e20d081813ac00ef7ecd3f778eaefa5	🟥	SELECT abalance FROM pgbench_accounts WHERE aid = ?;

Amazon Performance Insights for RDS

- Database Load : Identifies database bottlenecks
  - Easy
  - Powerful
- Identifies source of bottlenecks
  - Top SQL
- Adjustable Time frame
  - Hour, day, week and longer

AWS re:Invent 2016 DAT206: https://youtu.be/ztmtJJTC8_Y?t=39m53s

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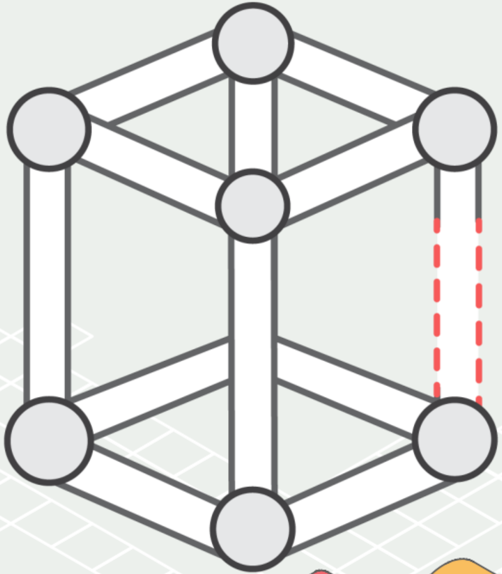
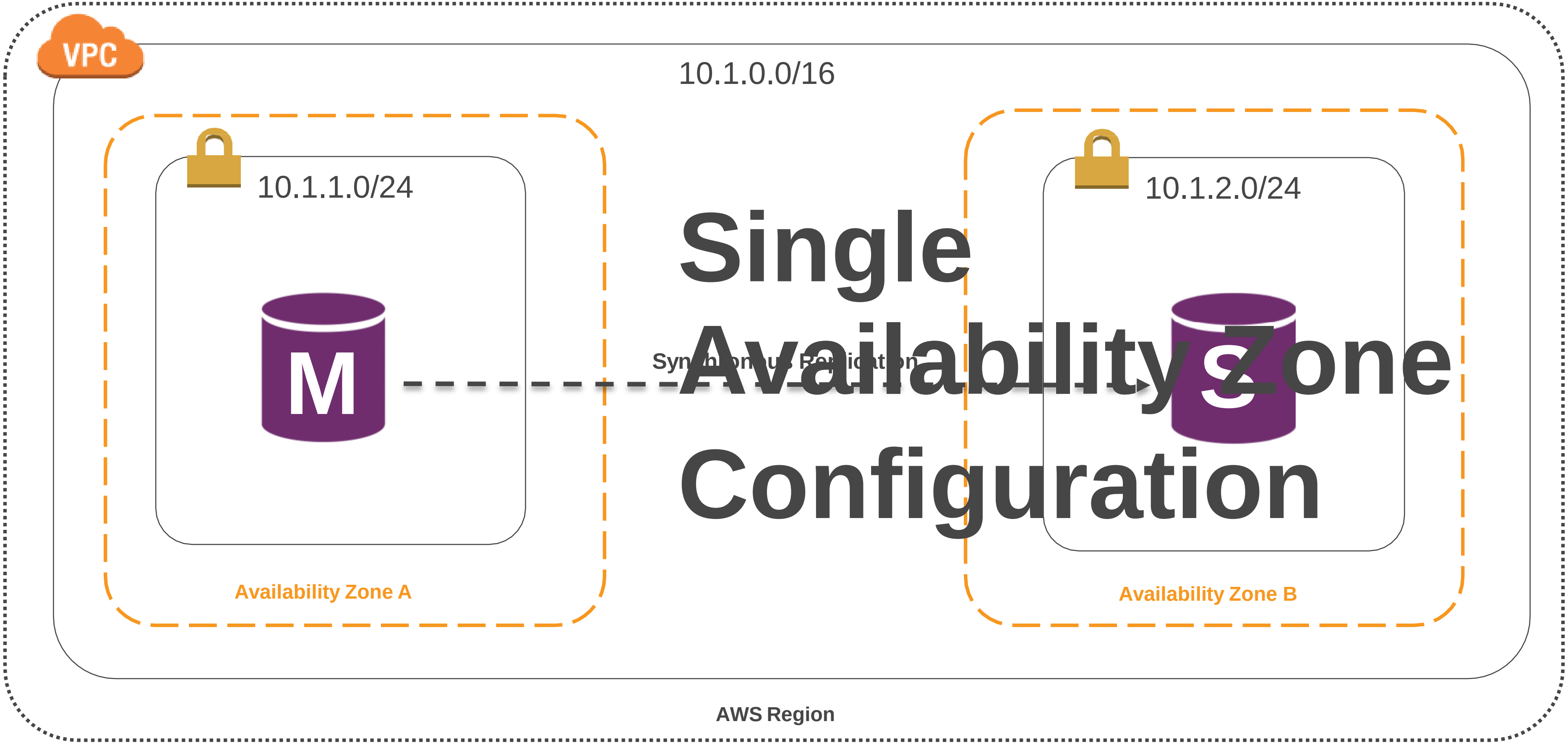
High Availability



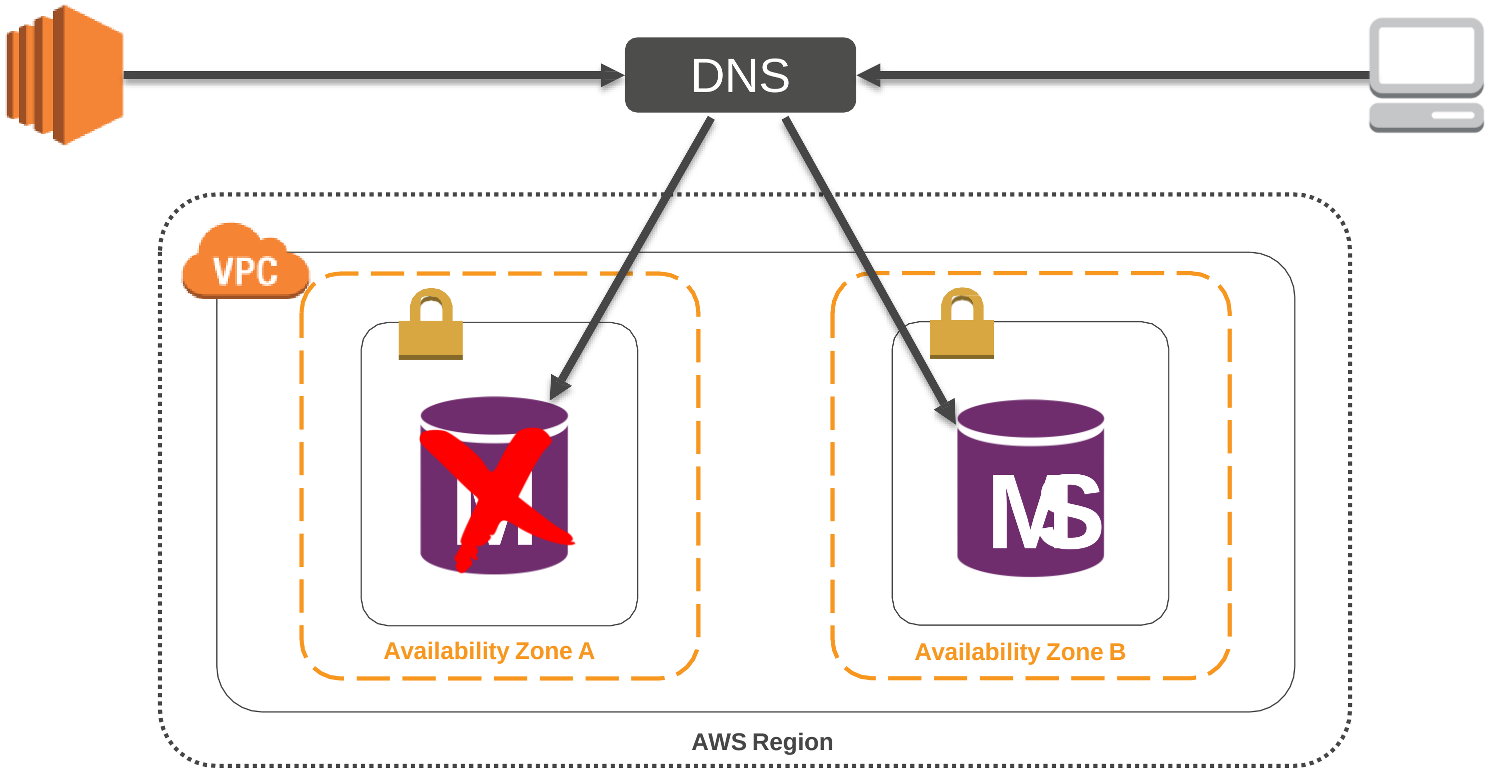
HA Multi Availability Zone Configuration



Single Availability Zone Configuration

High availability - Multi-AZ - DNS

mydatabase.us-west-2.rds.amazonaws.com:3306

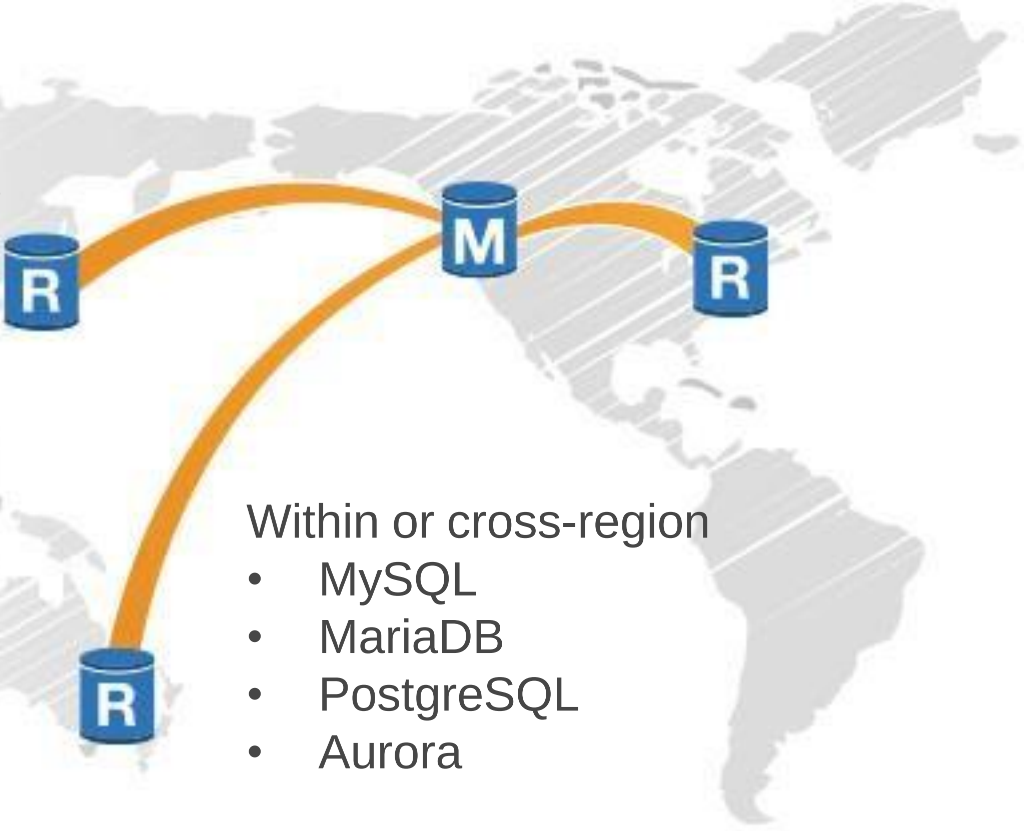


Read Replicas

Bring data close to your customer’s applications in different regions

Relieve pressure on your master node for supporting reads and writes

Promote a Read Replica to a master for faster recovery in the event of disaster

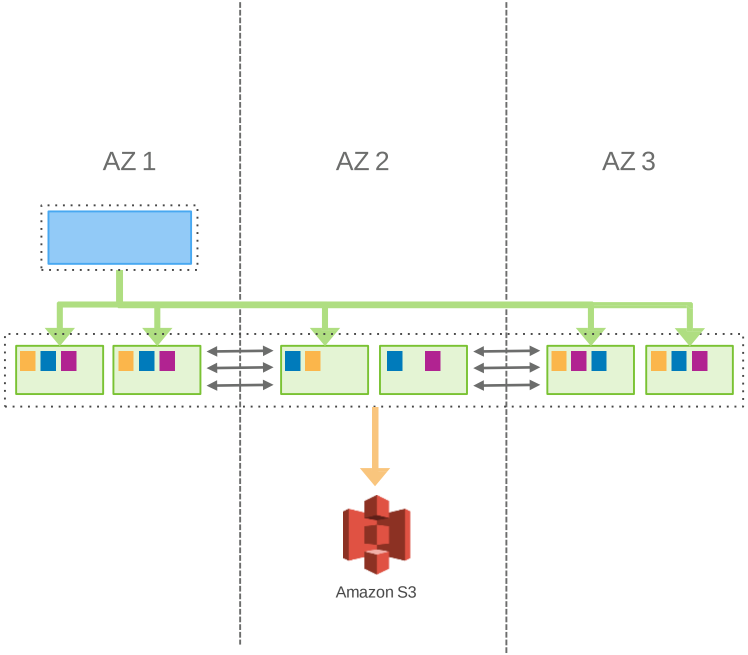


Within or cross-region

- MySQL
- MariaDB
- PostgreSQL
- Aurora

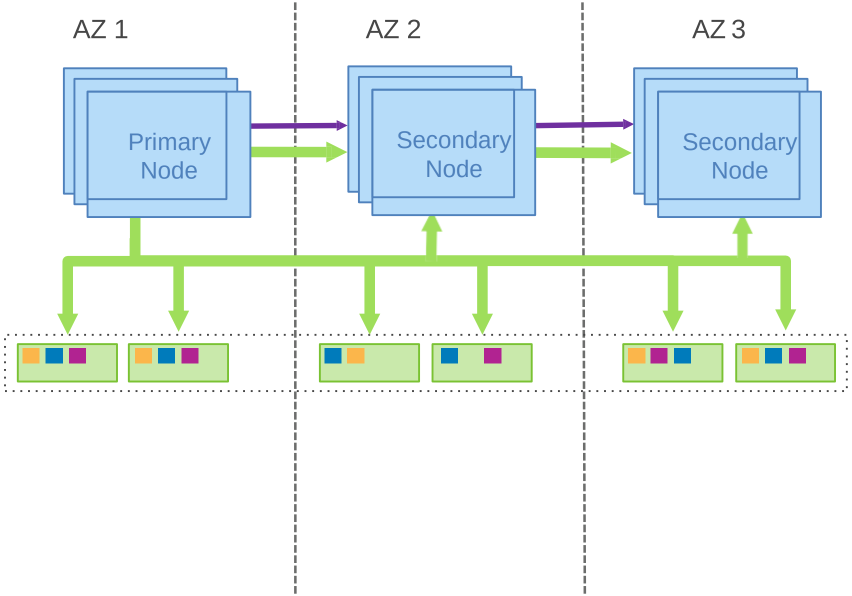
High availability - Amazon Aurora storage

- Storage volume automatically grows up to 64 TB
- Quorum system for read/write; latency tolerant
- Peer-to-peer gossip replication to fill in holes
- Continuous backup to Amazon S3 (built for 11 9s durability)
- Continuous monitoring of nodes and disks for repair
- 10 GB segments as unit of repair or hotspot rebalance
- Quorum membership changes do not stall writes



High availability - Amazon Aurora nodes

- Aurora cluster contains primary node and up to 15 secondary nodes
- Failing database nodes are automatically detected and replaced
- Failing database processes are automatically detected and recycled
- Secondary nodes automatically promoted on persistent outage, no single point of failure
- Customer application can scale out read traffic across secondary nodes



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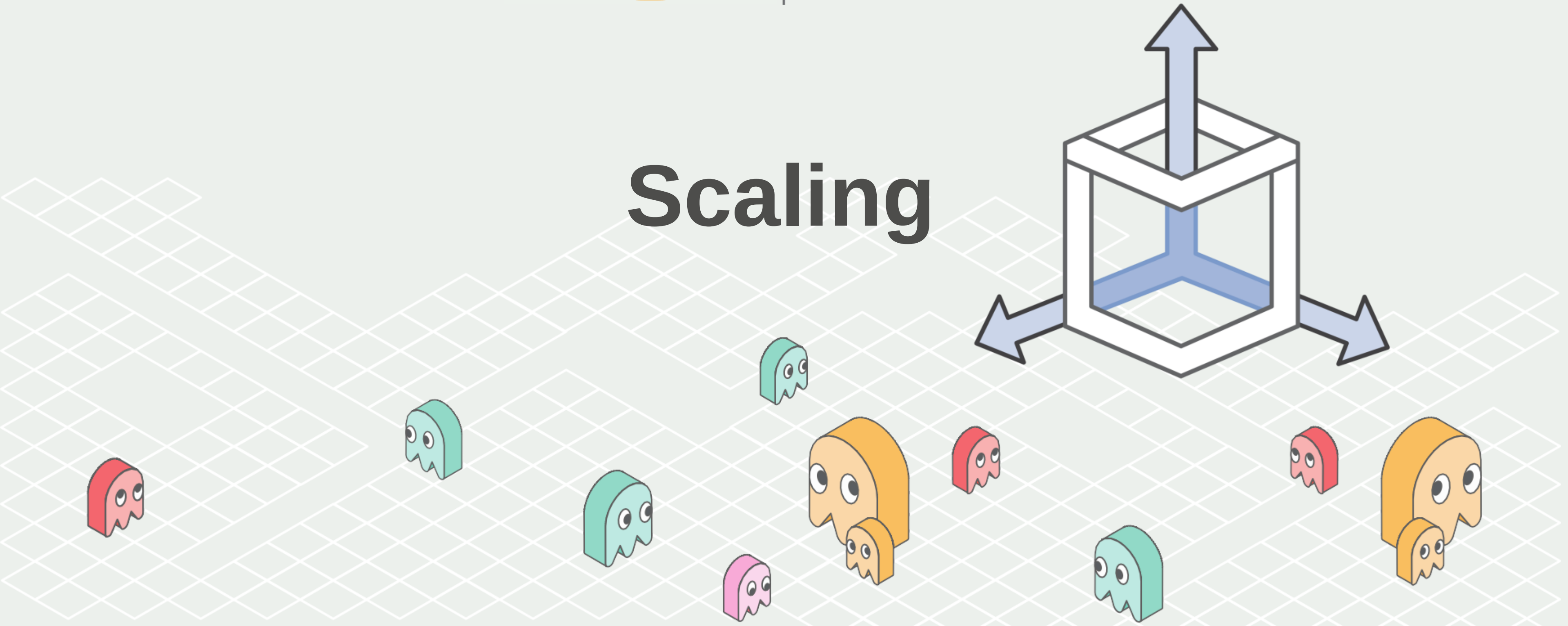
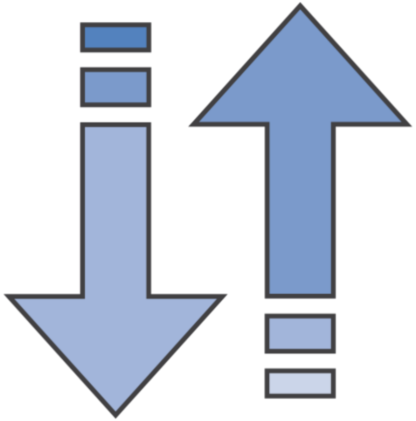
Scaling



Why Scale?

- Handle higher load or lower usage
- Naturally grow over time
- Control costs



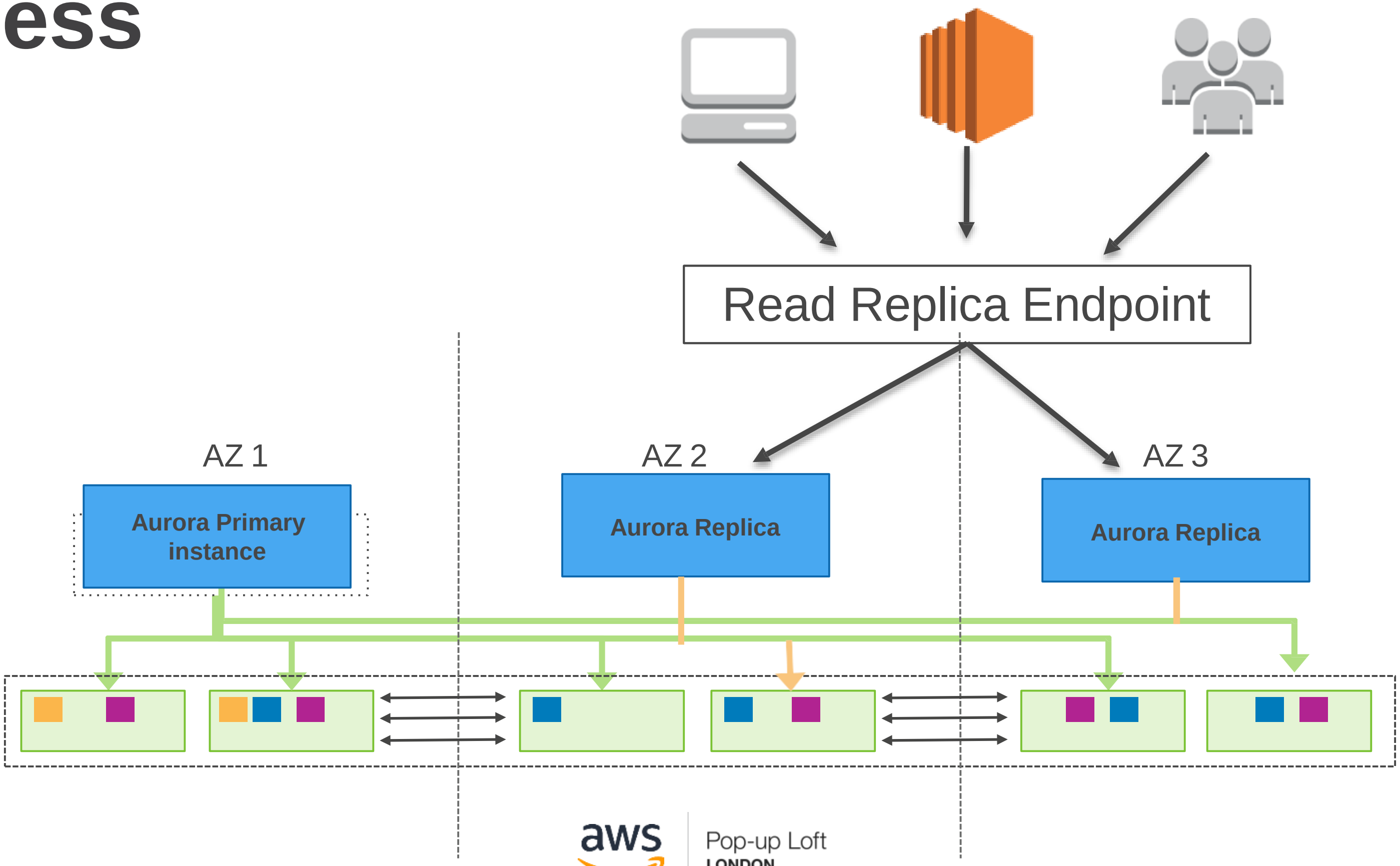
What can I scale?

Database Instance

Read Replicas

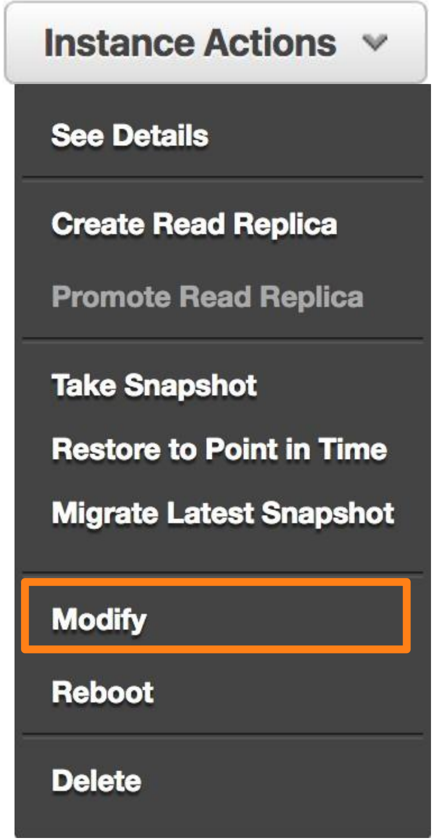
Storage

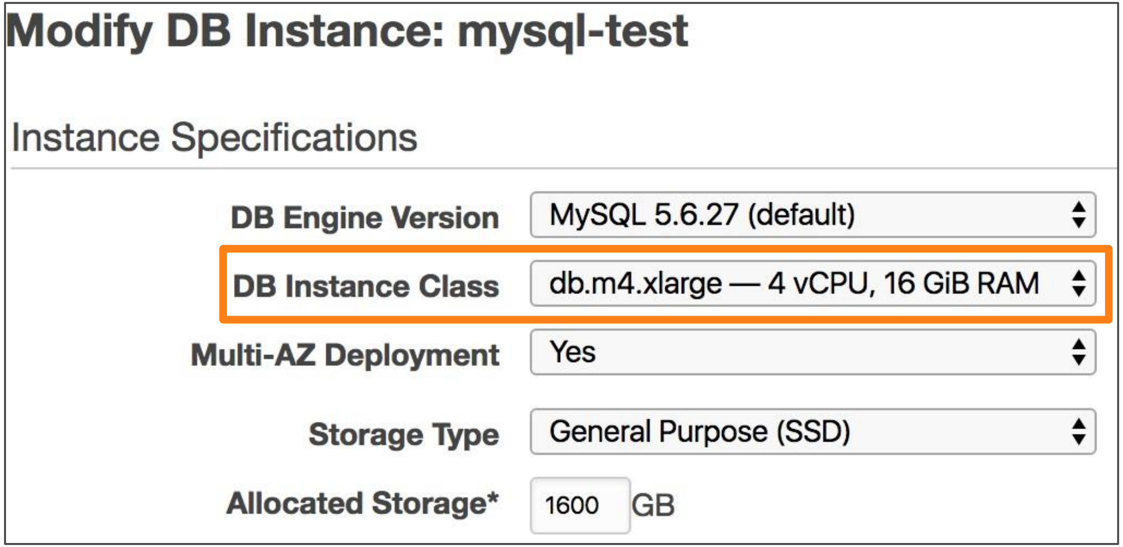
Amazon Aurora - Balanced Read Replica Access



Scaling your instance up/down

AWS Management Console

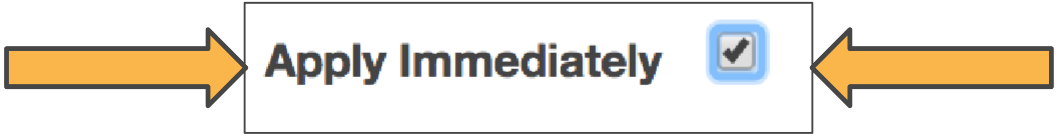




Modify DB Instance: mysql-test

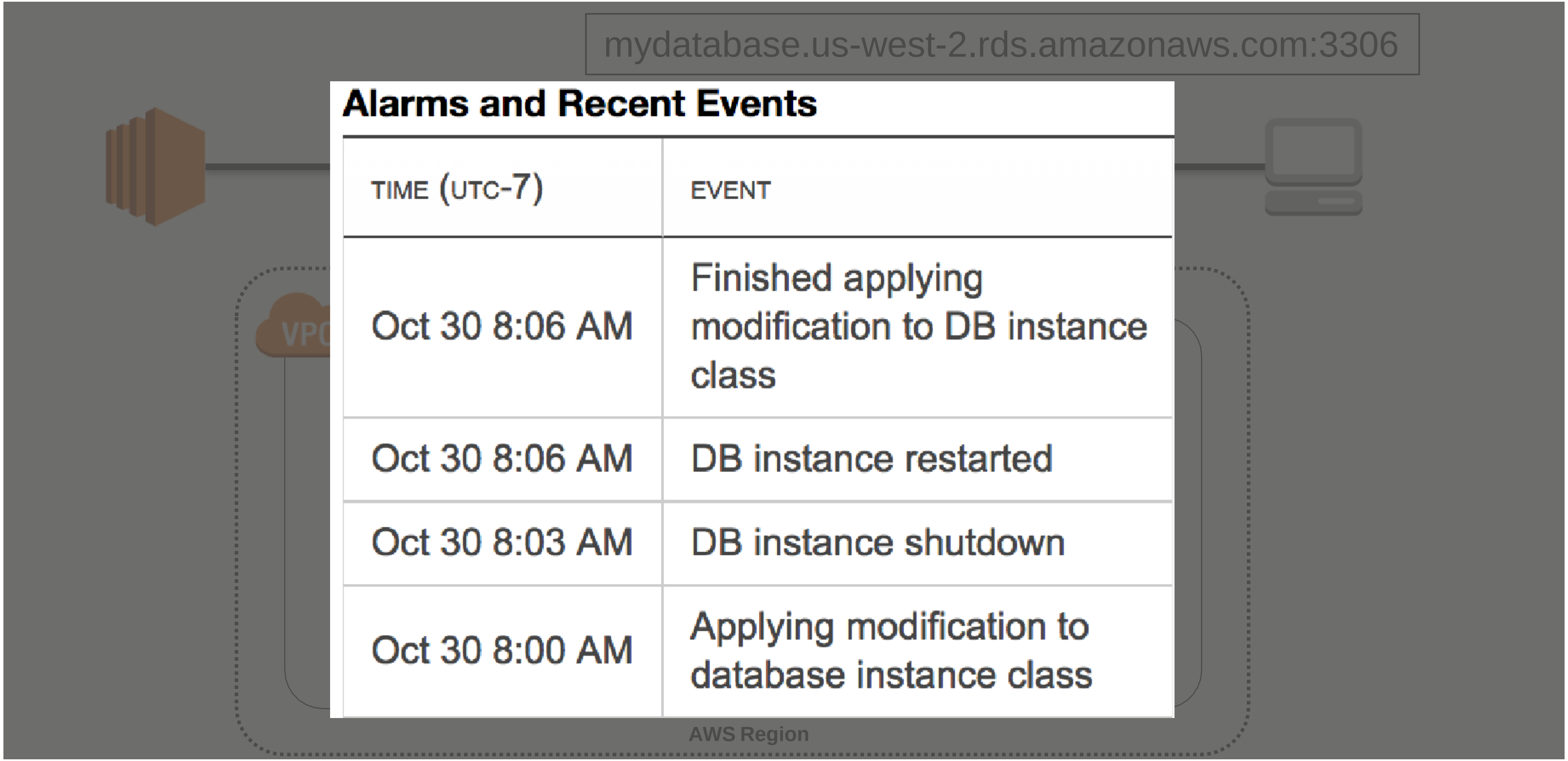
Instance Specifications

DB Engine Version	MySQL 5.6.27 (default)
DB Instance Class	db.m4.xlarge — 4 vCPU, 16 GiB RAM
Multi-AZ Deployment	Yes
Storage Type	General Purpose (SSD)
Allocated Storage*	1600 GB



Apply Immediately ☑

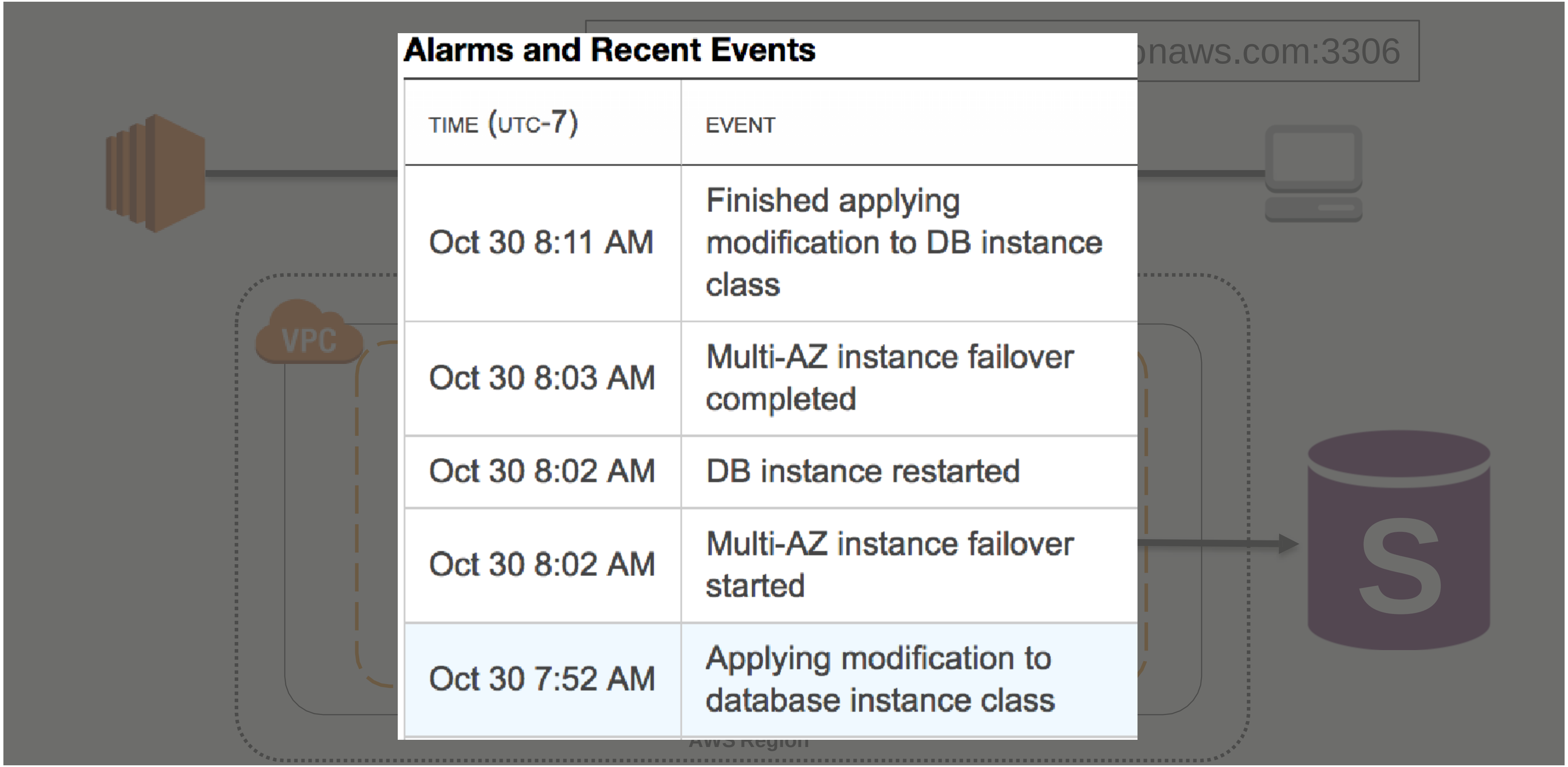
Scaling - single Availability Zone



Alarms and Recent Events

TIME (UTC-7)	EVENT
Oct 30 8:06 AM	Finished applying modification to DB instance class
Oct 30 8:06 AM	DB instance restarted
Oct 30 8:03 AM	DB instance shutdown
Oct 30 8:00 AM	Applying modification to database instance class

Scaling - Multi-AZ



Alarms and Recent Events

TIME (UTC-7)	EVENT
Oct 30 8:11 AM	Finished applying modification to DB instance class
Oct 30 8:03 AM	Multi-AZ instance failover completed
Oct 30 8:02 AM	DB instance restarted
Oct 30 8:02 AM	Multi-AZ instance failover started
Oct 30 7:52 AM	Applying modification to database instance class

Scaling - automation

AWS CLI

```
aws rds modify-db-instance --db-instance-identifier sg-cli-test --db-instance-class
db.m4.large --apply-immediately
```

Scheduled CLI—cron

```
#Scale down at 8:00 PM on Friday
0 20 * * 5 /home/ec2-user/scripts/scale_down_rds.sh

#Scale up at 4:00 AM on Monday
0 4 * * 1 /home/ec2-user/scripts/scale_up_rds.sh
```

Scaling - automation

Scheduled - AWS Lambda

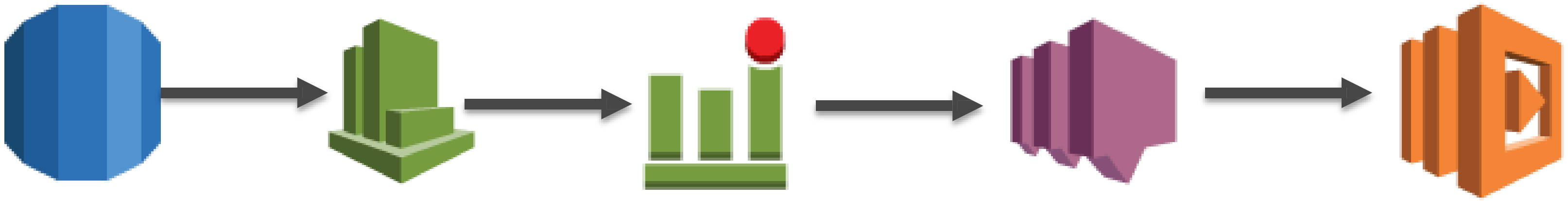
No server but still runs on a schedule!

```
import boto3

client=boto3.client('rds')

def lambda_handler(event, context):
    response=client.modify_db_instance(DBInstanceIdentifier='sg-cli-test',
                                       DBInstanceClass='db.m4.xlarge',
                                       ApplyImmediately=True)

    print response
```

Scaling - automation

Metrics-based scaling

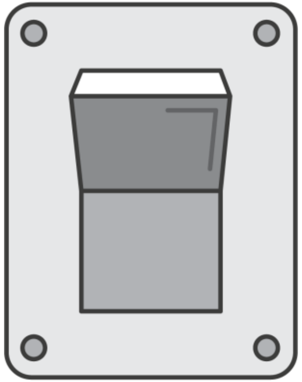
- Amazon CloudWatch and AWS Lambda!



Scaling - automation

```
import boto3
import json

client=boto3.client('rds')

def lambda_handler(event, context):

 message = event['Records'][0]['Sns']['Message']
parsed_message=json.loads(message)
db_instance=parsed_message['Trigger']['Dimensions'][0]['value']
print 'DB Instance: ' + db_instance

 response=client.modify_db_instance(DBInstanceIdentifier=db_instance,
                        DBInstanceClass='db.m4.large',
                        ApplyImmediately=True)

print response
```

Switch Off Dev Test Instances



MySQL

MariaDB

PostgreSQL

Oracle

SQL Server

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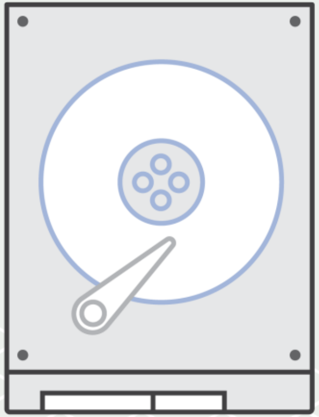
Backups and snapshots



Automated Backups

MySQL, PostgreSQL, MariaDB, Oracle, SQL Server

- Scheduled daily volume backup of entire instance
- Archive database change logs
- 35-day retention
- Taken from standby when running multi-AZ

Aurora

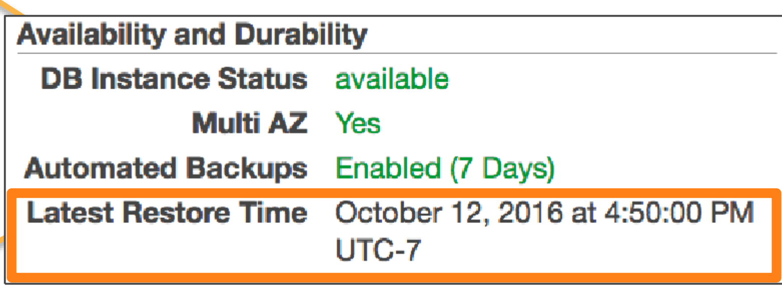
- Automatic, continuous, incremental backups
- No impact on database performance
- 35-day retention

How do automated RDS backups work?

Every day during your backup window, the RDS service creates a storage volume snapshot of your database

→ If database is Multi-AZ, the snapshot is taken from the standby

Every five minutes, RDS backs up the transaction logs of your database

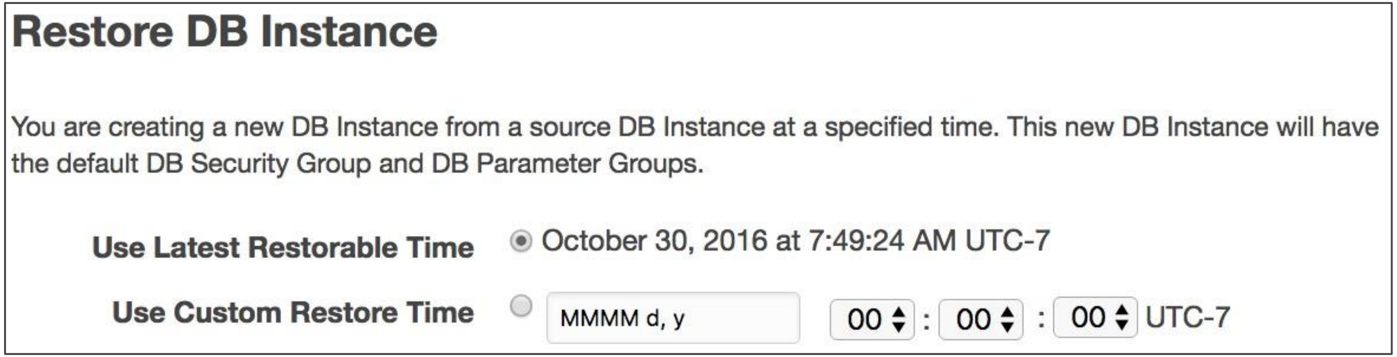


Availability and Durability

DB Instance Status	available
Multi AZ	Yes
Automated Backups	Enabled (7 Days)
Latest Restore Time	October 12, 2016 at 4:50:00 PM UTC-7

Restoring

- Creates an entire new database instance
- You define all the instance configuration, just like creating a new instance



Restore DB Instance

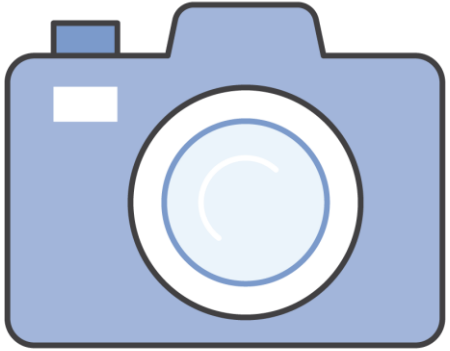
You are creating a new DB Instance from a source DB Instance at a specified time. This new DB Instance will have the default DB Security Group and DB Parameter Groups.

Use Latest Restorable Time ● October 30, 2016 at 7:49:24 AM UTC-7

Use Custom Restore Time ○ MMMM d, y 00 : 00 : 00 UTC-7

Snapshots

- Full copies of your RDS database
- Independent of scheduled backups
- Used to create a new RDS instance
- Taken from the standby when running multi-AZ



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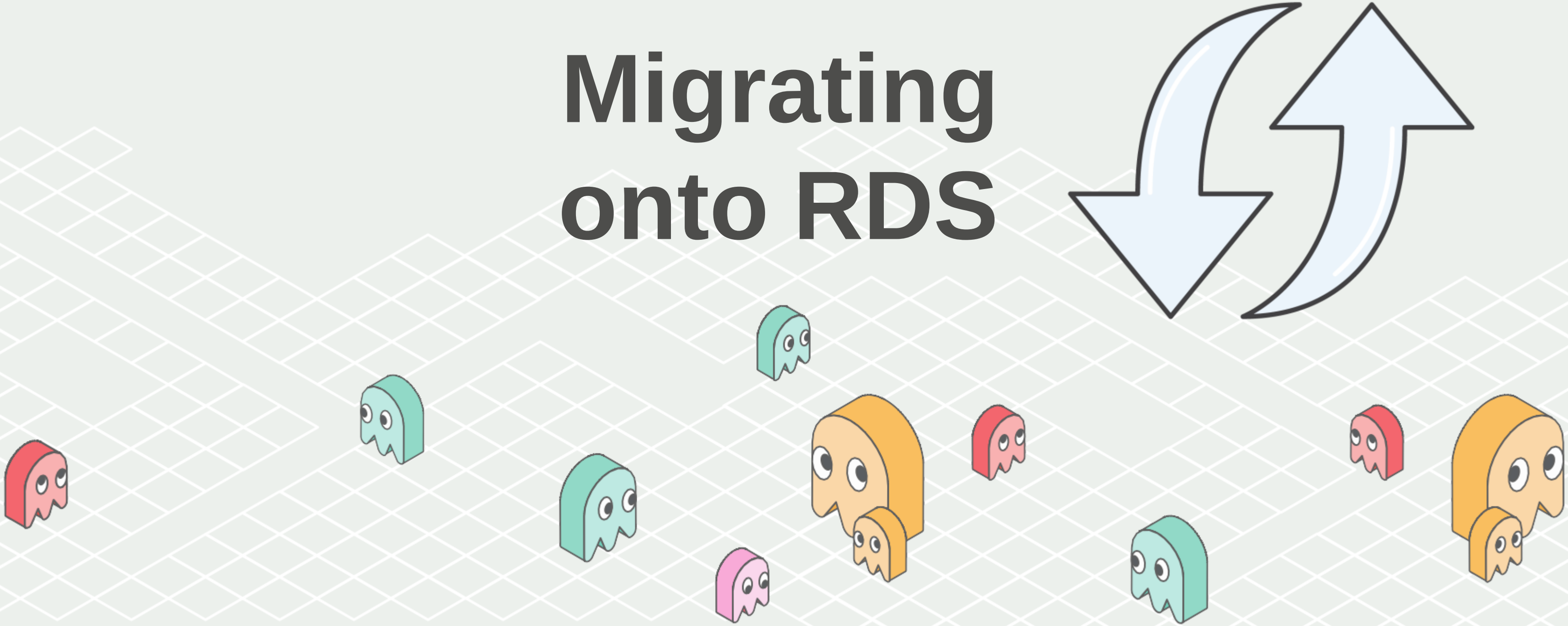
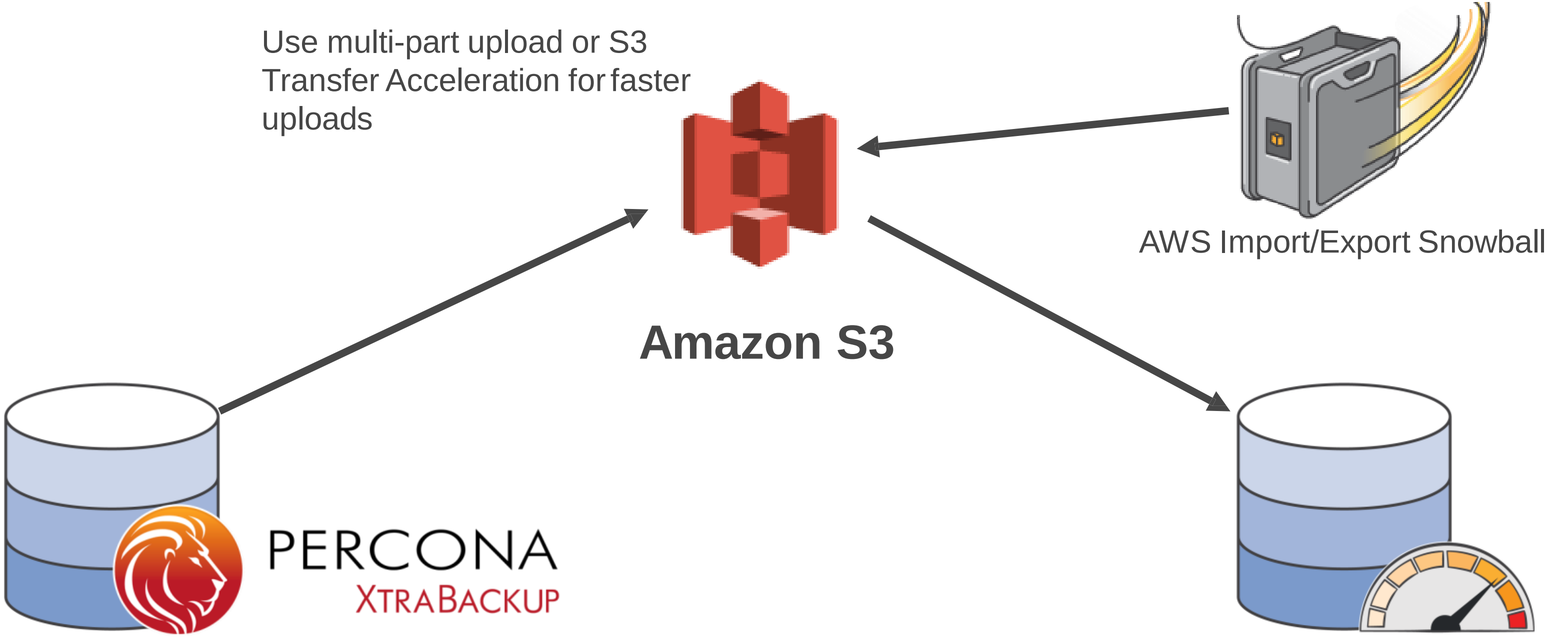
Migrating onto RDS



MySQL Backup to Aurora via S3

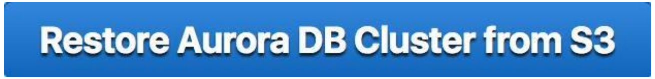


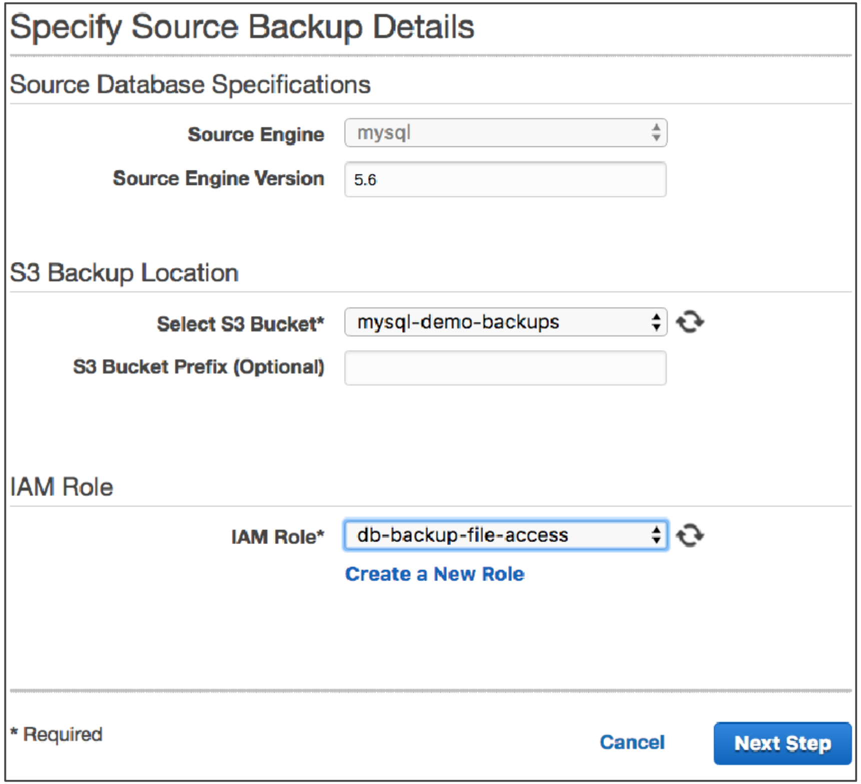
Use multi-part upload or S3 Transfer Acceleration for faster uploads

Source MySQL Database

Target Aurora Database

MySQL Backup to Aurora via S3





Specify Source Backup Details

Source Database Specifications

Source Engine: mysql

Source Engine Version: 5.6

S3 Backup Location

Select S3 Bucket*: mysql-demo-backups

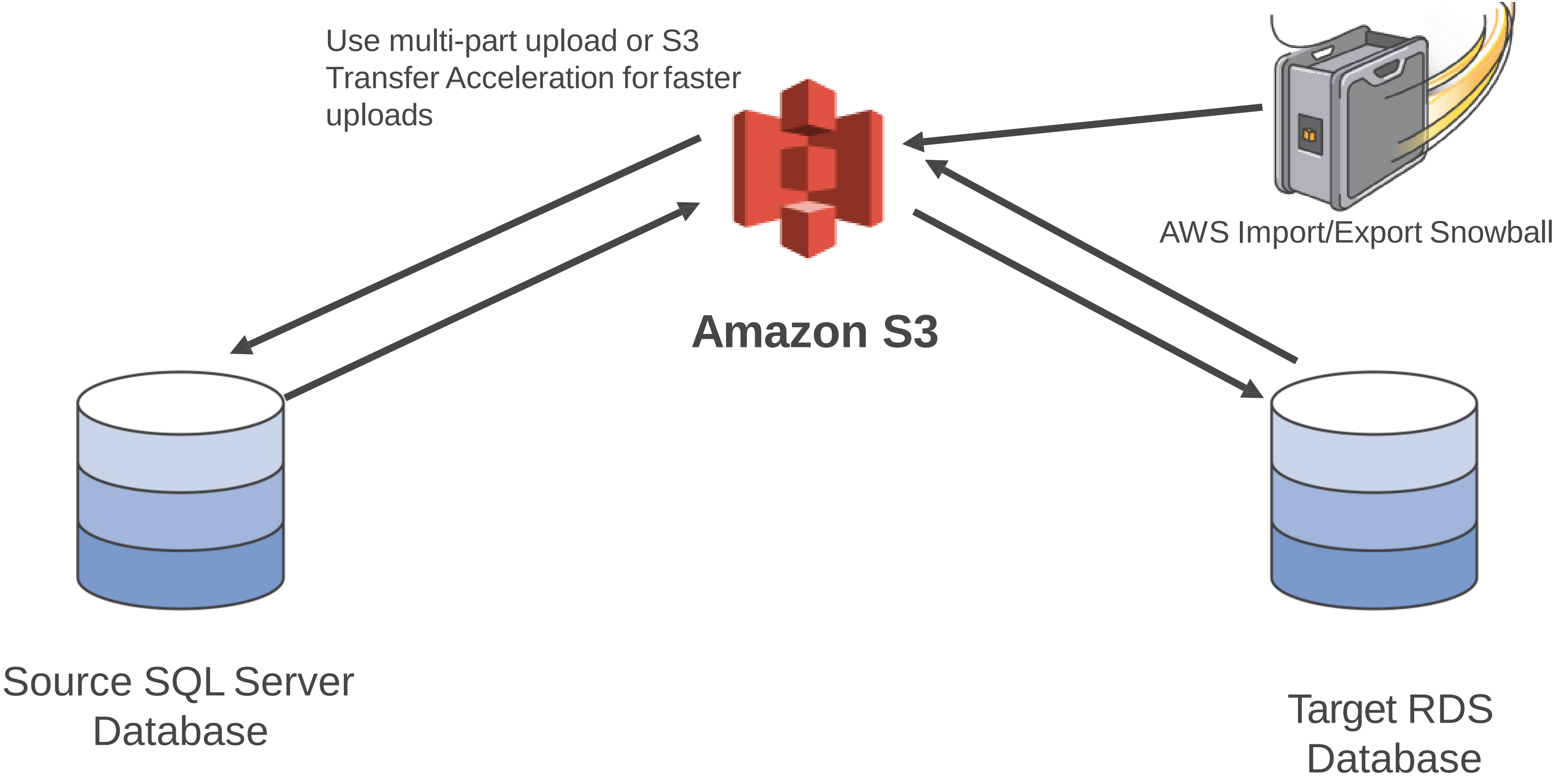
S3 Bucket Prefix (Optional):

IAM Role

IAM Role*: db-backup-file-access

* Required

SQL Server Backup to RDS SQL Server via S3



Use multi-part upload or S3 Transfer Acceleration for faster uploads

AWS Import/Export Snowball

Amazon S3

Source SQL Server Database

Target RDS Database

SQL Server Backup to RDS SQL Server via S3

Importing to RDS

No Encryption

```
exec msdb.dbo.rds_restore_database
        @restore_db_name=‘database_name’,
        @s3_arn_to_restore_from=‘arn:aws:s3:::bucket_name/file_name_and_extension’;
```

Encryption

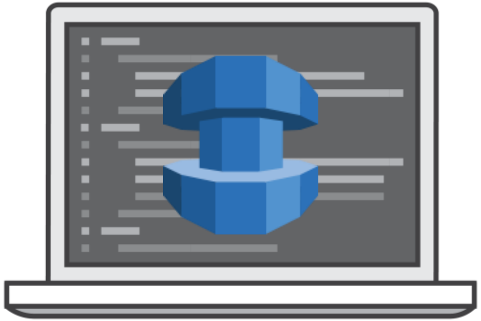
```
exec msdb.dbo.rds_restore_database
        @restore_db_name=‘database_name’,
        @s3_arn_to_restore_from=‘arn:aws:s3:::bucket_name/file_name_and_extension’,
        @kms_master_key_arn=‘arn:aws:kms:region:account-id:key/key-id’;
```

AWS Database Migration Service

PostgreSQL ORACLE Amazon Aurora

AMAZON REDSHIFT MySQL MariaDB Microsoft SQL Server

- ✓ Move data to the same or different database engine
- ✓ Keep your apps running during the migration
- ✓ Start your first migration in 10 minutes or less
- ✓ Replicate within, to, or from Amazon EC2 or RDS



AWS Schema Conversion Tool

- ✓ Migrate from Oracle and SQL Server
- ✓ Move your tables, views, stored procedures, and data manipulation language (DML) to MySQL, MariaDB, and Aurora
- ✓ Highlight where manual edits are needed

SCT supported OLTP conversions

Source Database	Target Database on Amazon RDS
Microsoft SQL Server (version 2008 and later)	Amazon Aurora (MySQL or PostgreSQL), Microsoft SQL Server, MySQL, PostgreSQL
MySQL (version 5.5 and later)	Amazon Aurora (PostgreSQL), MySQL, PostgreSQL
Oracle (version 10.2 and later)	Amazon Aurora (MySQL or PostgreSQL), MySQL, Oracle, PostgreSQL
PostgreSQL (version 9.1 and later)	Amazon Aurora (MySQL), MySQL, PostgreSQL

http://docs.aws.amazon.com/SchemaConversionTool/latest/userguide/Welcome.html

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Thank you!