AWS Solutions Architect Associate

Session 801

Databases: RDS/Aurora and Mgmt &Gov: Cloudformation

August/2024

Decisions about DB

Amazon RDS

Amazon RDS

Amazon Aurora

Amazon RDS instance

MySQL instance

MariaDB instance

Oracle instance

PostgreSQL instance

SQL server instance

Amazon Aurora instance

Relational Databases

Scalability

Total storage requirements

Object size and type

Durability

- strict schema rules and data quality enforcement
- ACID compliance
- Your database doesn't need extreme read/write capacity

Amazon DynamoDB

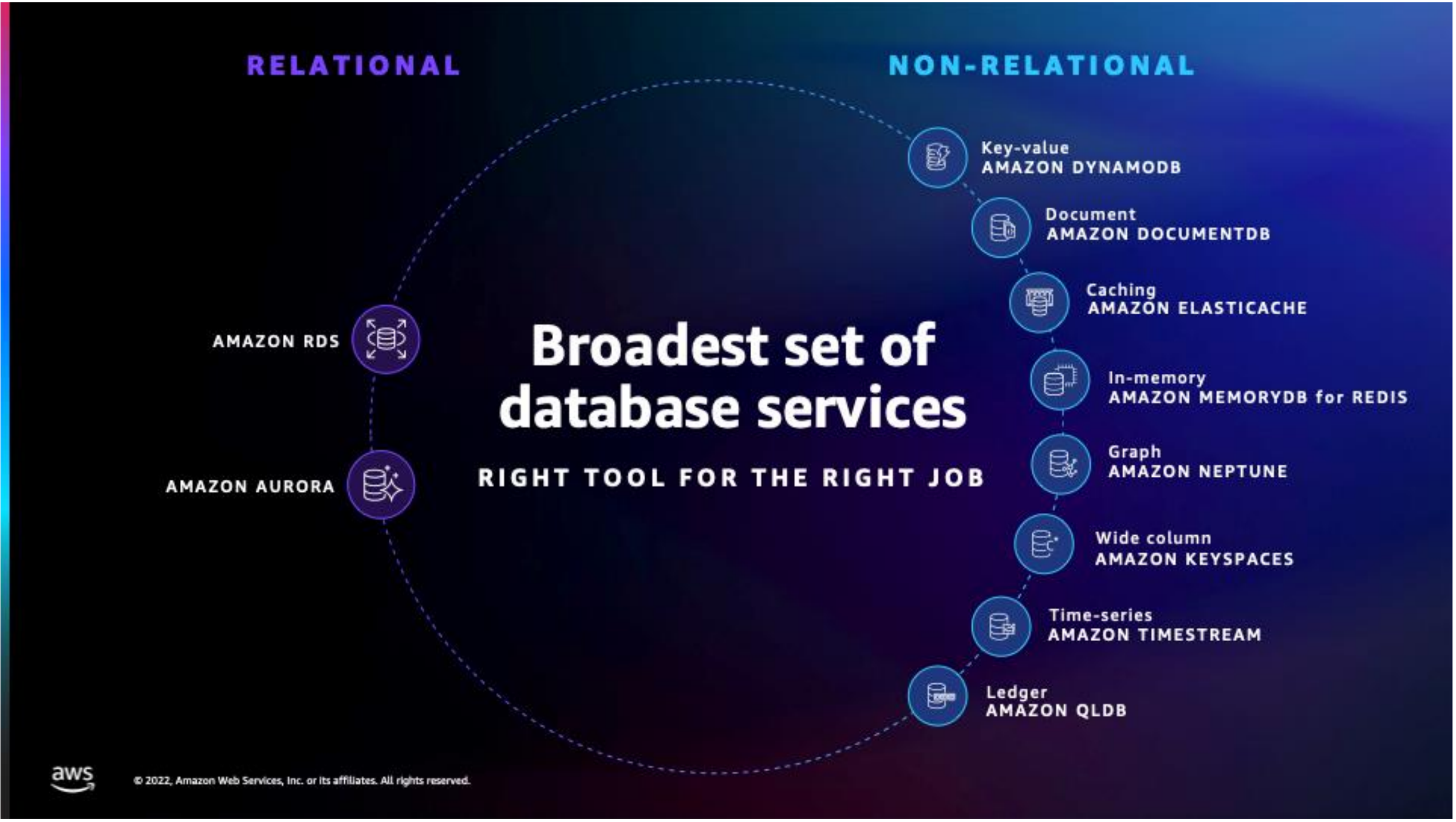
Amazon DynamoDB

…
DocumentDB
Neptune
QLDB

NoSQL Databases

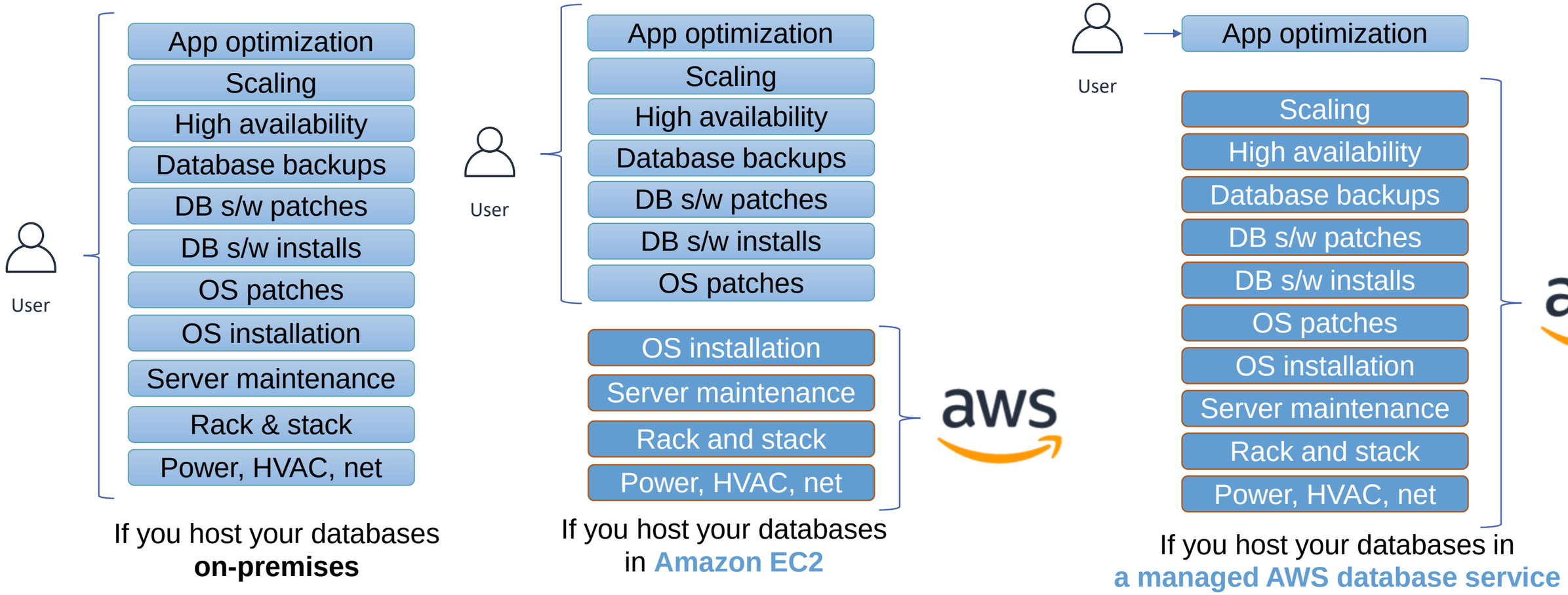
- Your data does not lend itself well to traditional schemas
- Your read/write rates exceed those that can be economically supported through traditional SQL DB

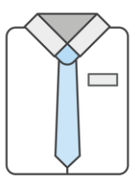
Decisions about Database



Adapted from https://docs.aws.amazon.com/decision-guides/latest/databases-on-aws-how-to-choose/databases-on-aws-how-to-choose.html (20/07/2024)

RDS as managed service



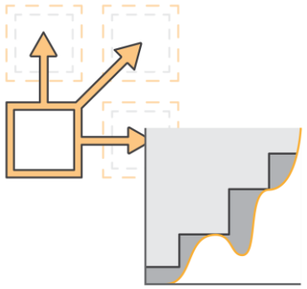


Fully managed relational database service. Full-Managed Service/Web Service to Operate DB. Easy and Simple Administration.

OnLine Transactional Processing – OLTP (RDS & DynamoDB).

Adapted from https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/Welcome.html (20/07/2024)

Features



Scale horizontal for storage.
Scale horizontal (Aurora) and vertical (for the rest of DBs).
RDS Proxy (Support FA and connection mgmt. - # of connections and reuse - Aurora, MySQL and PostgreSQL –).

Secure using IAM, VPC and End-User Groups.

Cost Optimized: Pay-as-you-go and Reserved Instances.
Cost depends on Instances.

Instances go to AZs.
Basic and Detailed Monitoring for Cloudwatch.
Performance Insights all RDS options, check versions of each engine.

Taken from https://aws.amazon.com/rds/proxy/ (30/07/2024)

Relational Database Service (RDS)

Engine type Info

- Aurora (MySQL Compatible)
- Aurora (PostgreSQL Compatible)

No Free-Tier

- MySQL

InnoDB, no MyISAM

5.7.44+
8.0.32+

- MariaDB

10.4.29+

- PostgreSQL

11.22.+
...
16.3

- Oracle

19c+

- Microsoft SQL Server

Express
Web
Standard
Enterprise

2016
2017
2019
2022

- IBM Db2

Standard
Advanced

11.5.9+

Taken from https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/Welcome.html. More info about InnoDB and MyISAM https://www.liquidweb.com/kb/mysql-performance-myisam-vs-innodb/ (03/08/2020)

Custom RDS

Amazon RDS Custom FAQs

FAQS

General

Q: What is Amazon RDS Custom?

Amazon RDS Custom is a managed database service for legacy, custom, and packaged applications that require access to the underlying operating system and database environment. Amazon RDS Custom automates setup, operation, and scaling of databases in the cloud while granting customers access to the database and underlying operating system to configure settings, install patches, and enable native features to meet the dependent application's requirements.

Taken from https://aws.amazon.com/rds/custom/ and https://aws.amazon.com/rds/custom/faqs/ (29/07/2024)

Capabilities

Automated backup vs Manual Snapshots
Multi-AZ (Single AZ is default) vs Read Replica

MySQL 16TB – MariaDB 16TB
Free-Tier up to 20GiB.
GiB ≠ GB (1024 Base for GiB/TiB instead of 1000 for GB/TB).
Failover including host replacements.
Maintenance Windows: patch minor-updates or changes. Usually take 5 minutes-
Encryption-at-rest: KMS and TDE (on Oracle and SQL Server option only)
SLA: 99,95 %

Quotas and Constraints for Amazon RDS

Name	Default	Adjustable	Description
Option groups	Each supported Region: 20	Yes	The maximum number of option groups
Parameter groups	Each supported Region: 50	Yes	The maximum number of parameter groups
Proxies	Each supported Region: 20	Yes	The maximum number of proxies allowed in this account in the current AWS Region
Read replicas per primary	Each supported Region: 15	Yes	The maximum number of read replicas per primary DB instance. This quota cant be adjusted for Amazon Aurora.
Reserved DB instances	Each supported Region: 40	Yes	The maximum number of reserved DB instances allowed in this account in the current AWS Region
Rules per security group	Each supported Region: 20	No	The maximum number of rules per DB security group
Security groups	Each supported	Yes	The maximum number of DB security groups

Taken from https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/CHAP_Limits.html and https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/CHAP_Storage.html (31/07/2024)

DB Instances

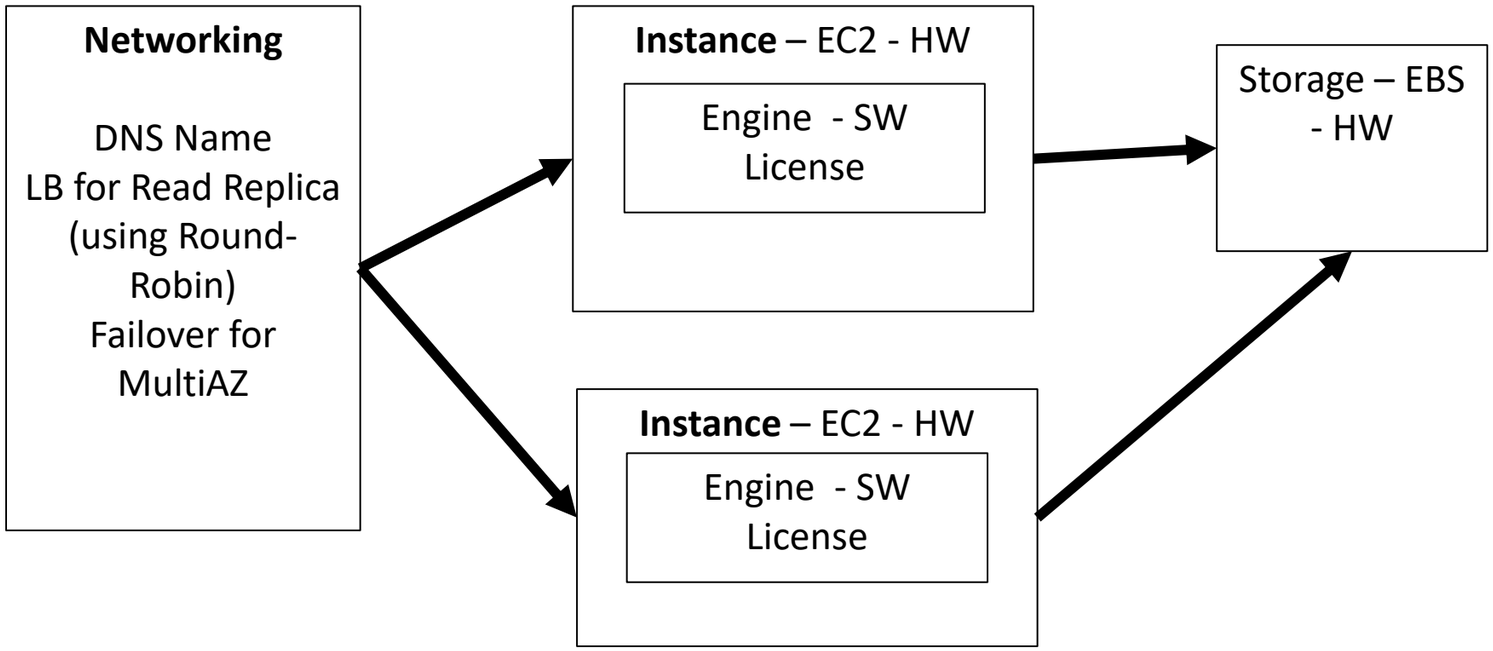
EC2 Optimized Instances for RDS: db.t2, db.m4, db.r4
EBS for allocated storage (min 20 GiB max 16TiB - 64TiB on AWS Doc – db.r5, db.r6). Options: Magnetic, SSD GP2 or PIOPS.
On a single DB can contain multiple user-created DB (Oracle multiple schemas). At creation moment, you define unique DB name per instances and master username, except PostgreSQL which don't need DB name.

Up to 40 instances for RDS, Aurora, Neptune, DocumentDB as:

- 10 for each SQL Server edition (Enterprise, Standard, Web, and Express) under the "license-included" model
- 10 for Oracle under the "license-included" model
- 40 for MySQL, MariaDB, or PostgreSQL
- 40 for Oracle and DB2 under the "bring-your-own-license" (BYOL) licensing model

A difference between DB instance and Endpoint are:

- Endpoint is behind a balancer/DNS Resolver, which use CNAME (Concept for DNS) to direct to right instances
- DNS Name for instance: <instance>.<specific_ account_id>.<region>.rds.amazonaws.com



Taken from https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/CHAP_Storage.html and https://jayendrapatil.com/aws-rds-storage/ (31/07/2024)

Groups

Parameter Group: Configuration Parameters (settings) depends on each DB Engines/instance. i.e. auto-commit mode and auto_increment value for MySQL.

Options Group: To able plugins (available features) depends on each DB engine (No PostgreSQL). i.e. TDE Transparent Data Encryption, Oracle Spatial Index for Oracle and Xtra DB Storage for MariaDB.

DB Subnet Group: Subnet group for Databases.

Security:

Access using DB Subnet Group and NACL for VPC

- Authentication using IAM (for MySQL /PostgreSQL / MariaDB) and Master DB User.
- Auditing using Logs, backups, encrypted snapshot
- Encryption using KMS or TDE (Oracle and SQL Server).

Encryption

Enable encryption Learn more

Select to encrypt the given instance. Master key ids and aliases appear in the list after they have been created using the Key Management Service(KMS) console.

Disable encryption

Auto minor version upgrade

Specifies if the DB instance should receive automatic engine version upgrades when they are available.

Yes

No

More info about IAM Authentication, see https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/UsingWithRDS.IAMDBAuth.html and https://aws.amazon.com/blogs/database/use-iam-authentication-to-connect-with-sql-workbenchj-to-amazon-aurora-mysql-or-amazon-rds-for-mysql/ (31/07/2024)

Storage and Availability

Automatic backup: From 0 (Disable) to 35 days of retention days. 7 days as default.
Manual snapshot: On S3, and managed via API. Can be copied on Cross-region to synch data and Recover Disaster.

Events: SNS or Email; configured by many events to subscribed, i. e. configured changes, backups, failover, etc.

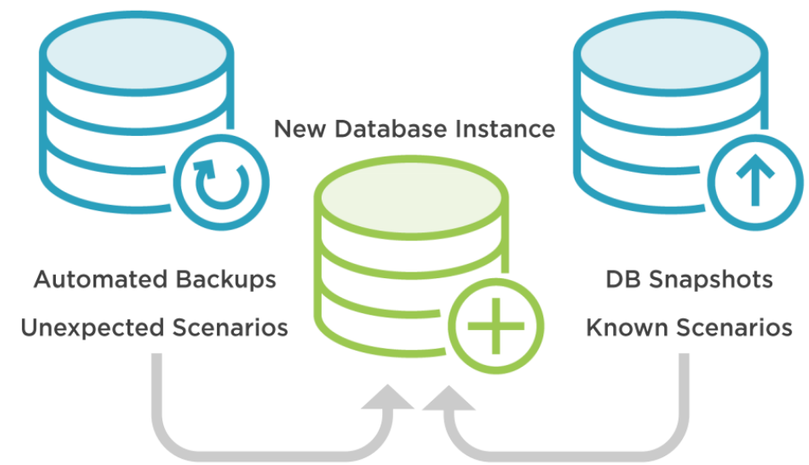
Multi-AZ: DR schema and used as HA using as standby instance. Using to avoid I/O suspension during high latency during backups/snapshots. It synchronized when has an AZ loss, network loss or storage issues.

Read Replica/RR: Horizontal Scaling and asynch replication. Can used for performance from be single or multi-region. Working on Maintenance Window. Except SQL Server.

Scaling: Vertical (on Next Maintenance Window or Immediately), Horizontal (Some DB) using Read Replica or Sharding-Partition, Storage Automatically.

Backup retention period Info
Select the number of days that Amazon RDS should retain automatic backups of this DB instance.
7 days
Create final snapshot?
Determines whether a final DB Snapshot is created before the DB instance is deleted.
Yes

Types of Database Backups



Pricing of Storage depends on size. Sometimes I/O Suspension on secs. Incremental.

Comparison to Multi-AZ Deployment

Read Replica	Multi-AZ
Manual Disaster Recovery	Automated Disaster Recovery
Read Only	Not Accessible
Asynchronous	Synchronous
Cross-region support	Single Region

Taken from Hopper, J. Creating, Connecting, and Monitoring Databases with Amazon RDS. Pluralsight, https://app.pluralsight.com/library/courses/aws-amazon-rds/table-of-contents (06/08/2020)

Performance Metrics

- **IOPS:** I/O Operations per second (Detailed monitoring upto 1 min).
- **Latency:** Average time from request to response. Usually on ms.
- **Throughput:** Transferred bytes per second from/to disks.
- **Queue Depth:** Amount of I/O requests to be attended.

Affected by:

- Replication (Multi-AZ or RR)
- Storage
- Instance

Taken from https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/CHAP_Storage.html (30/07/2024)

Read Replicas vs Multi-AZ Deploy

Aurora Global Database

Automatic Failover

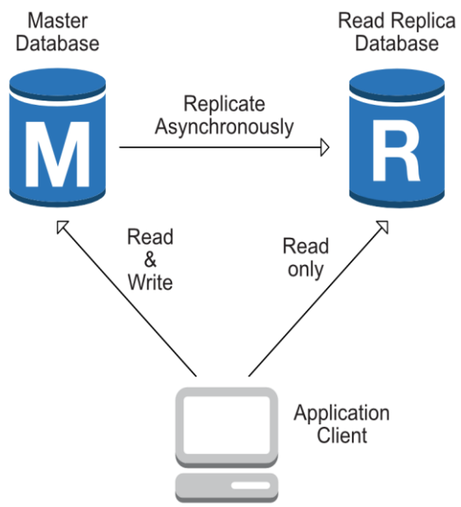
Multi-AZ deployments	Multi-Region deployments	Read replicas
Main purpose is high availability	Main purpose is disaster recovery and local performance	Main purpose is scalability
Non-Aurora: synchronous replication; Aurora: synchronous replication	Asynchronous replication	Asynchronous replication
Non-Aurora: only the primary instance is active; Aurora: all instances are active	All regions are accessible and can be used for reads	All read replicas are accessible and can be used for read scaling
Non-Aurora: automated backups are taken from standby; Aurora: automated backups are taken from shared storage layer	Automated backups can be taken in each region	No backups configured by default
Always span at least two Availability Zones within a single region	Each region can have a Multi-AZ deployment	Can be within an Availability Zone, Cross-AZ, or Cross-Region
Non-Aurora: database engine version upgrades happen on primary; Aurora: all instances are updated together	Non-Aurora: database engine version upgrade is independent in each region; Aurora: all instances are updated together	Non-Aurora: database engine version upgrade is independent from source instance; Aurora: all instances are updated together

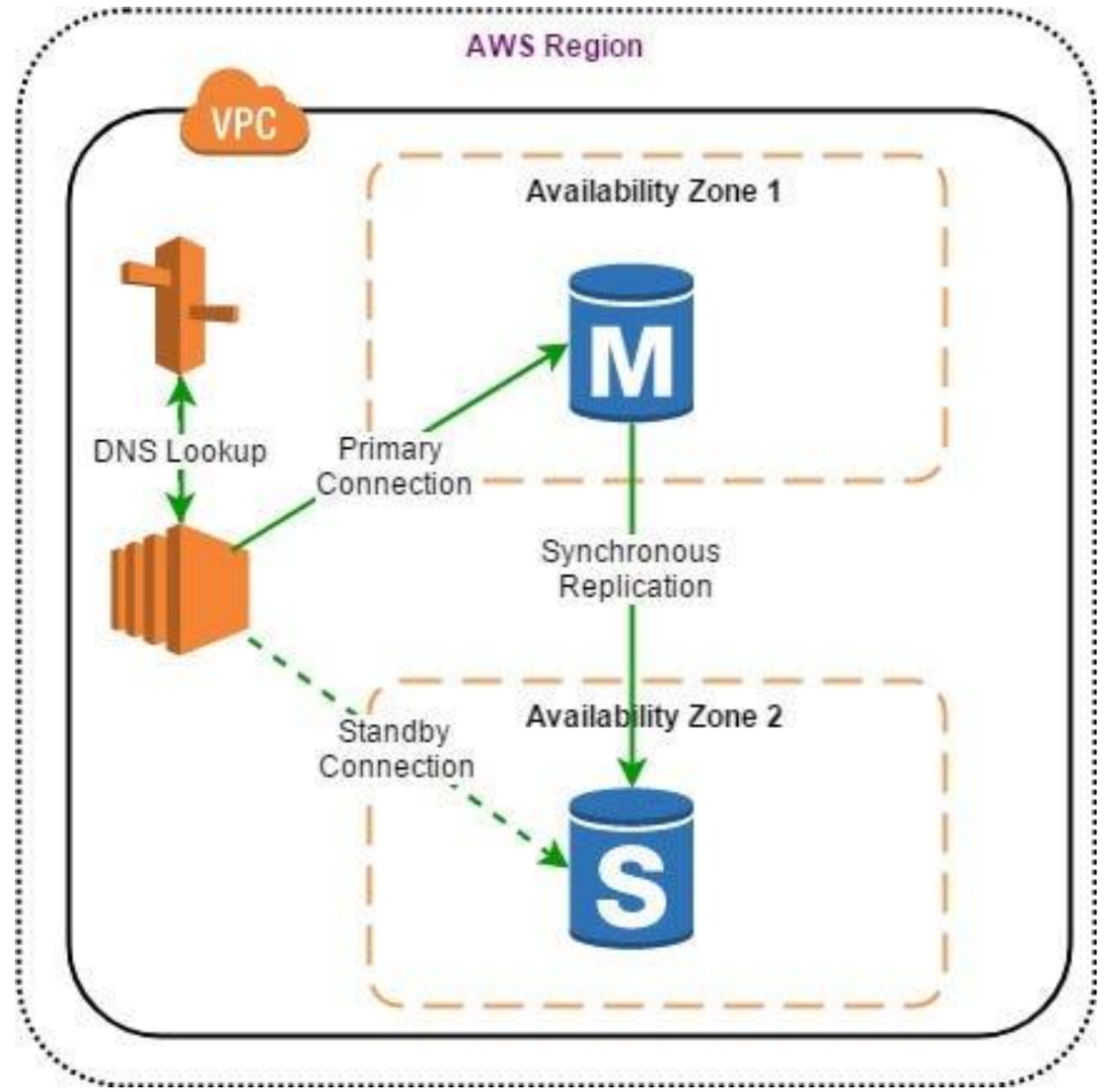
Feature	Amazon Aurora Replicas	MySQL Replicas
Number of replicas	Up to 15	Up to 5
Replication type	Asynchronous (milliseconds)	Asynchronous (seconds)
Performance impact on primary	Low	High
Replica location	In-region	Cross-region
Act as failover target	Yes (no data loss)	Yes (potentially minutes of data loss)
Automated failover	Yes	No
Support for user-defined replication delay	No	Yes
Support for different data or schema vs. primary	No	Yes

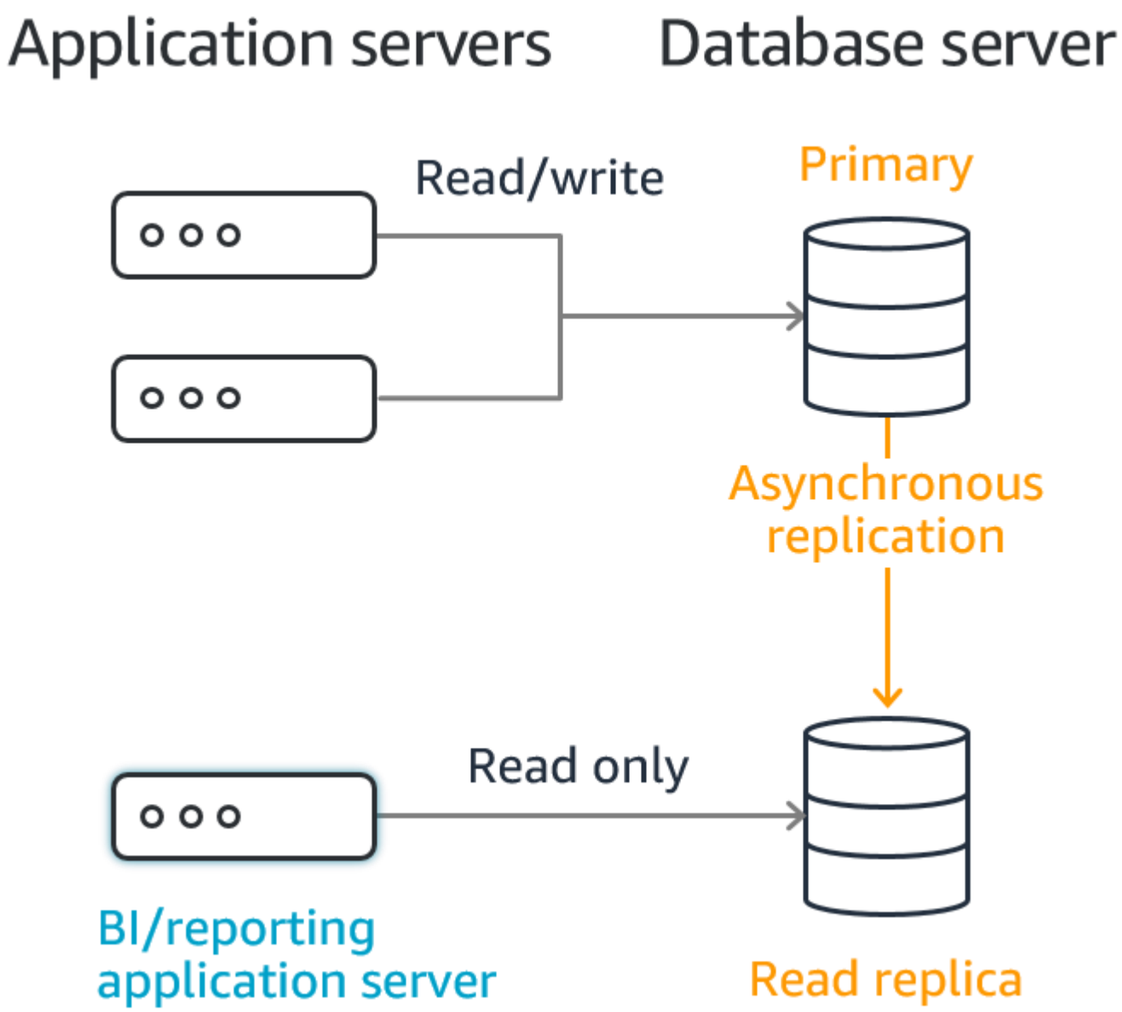
Can be a mixed solution or in-chain (i.e. RR of RR).

Taken from https://aws.amazon.com/rds/features/read-replicas/ and https://aws.amazon.com/rds/aurora/faqs/ (31/07/2024). More info at https://medium.com/awesome-cloud/aws-difference-between-multi-az-and-read-replicas-in-amazon-rds-60fe848ef53a (31/07/2024)

Read Replica vs Multi-AZ Deploy

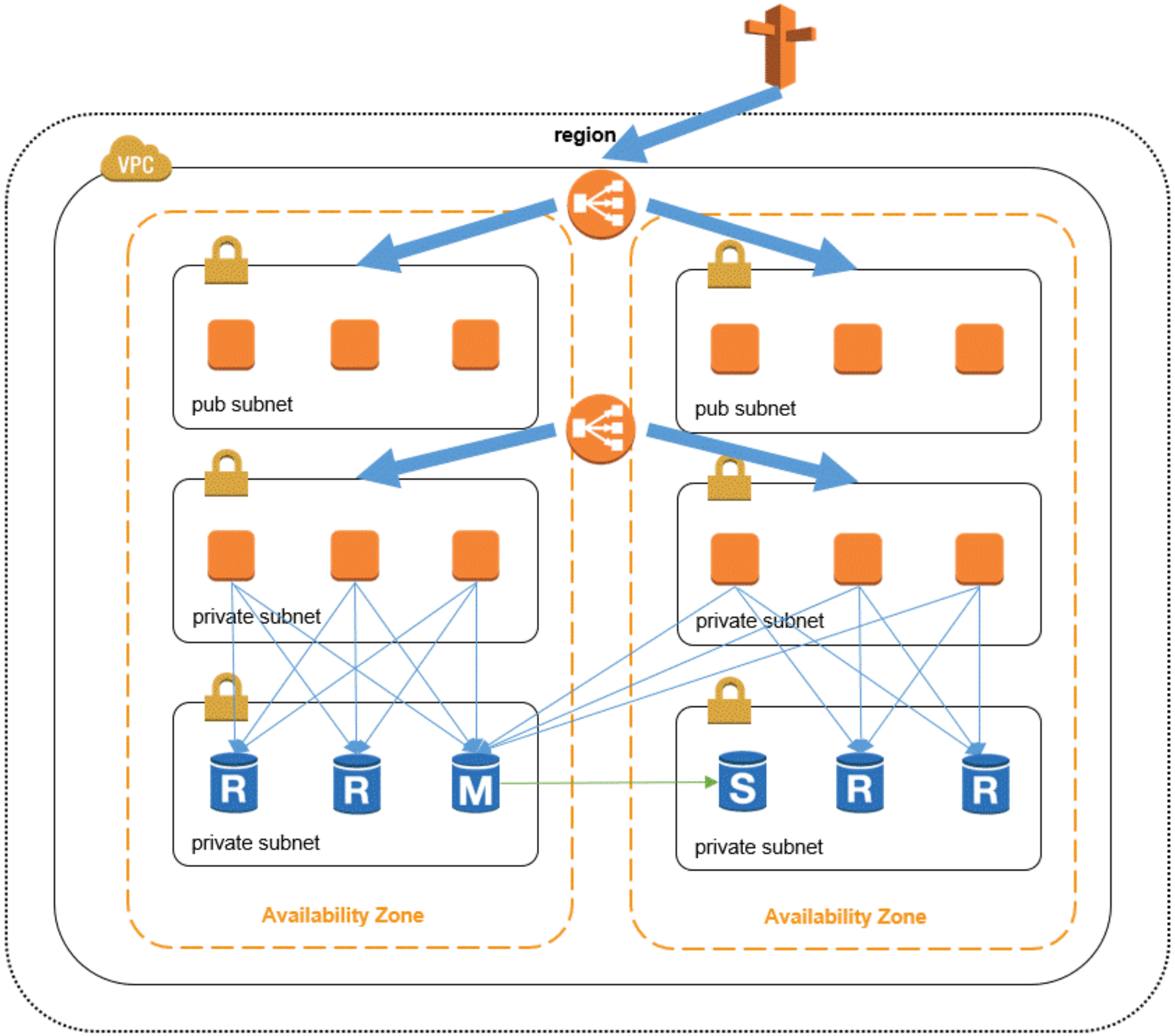




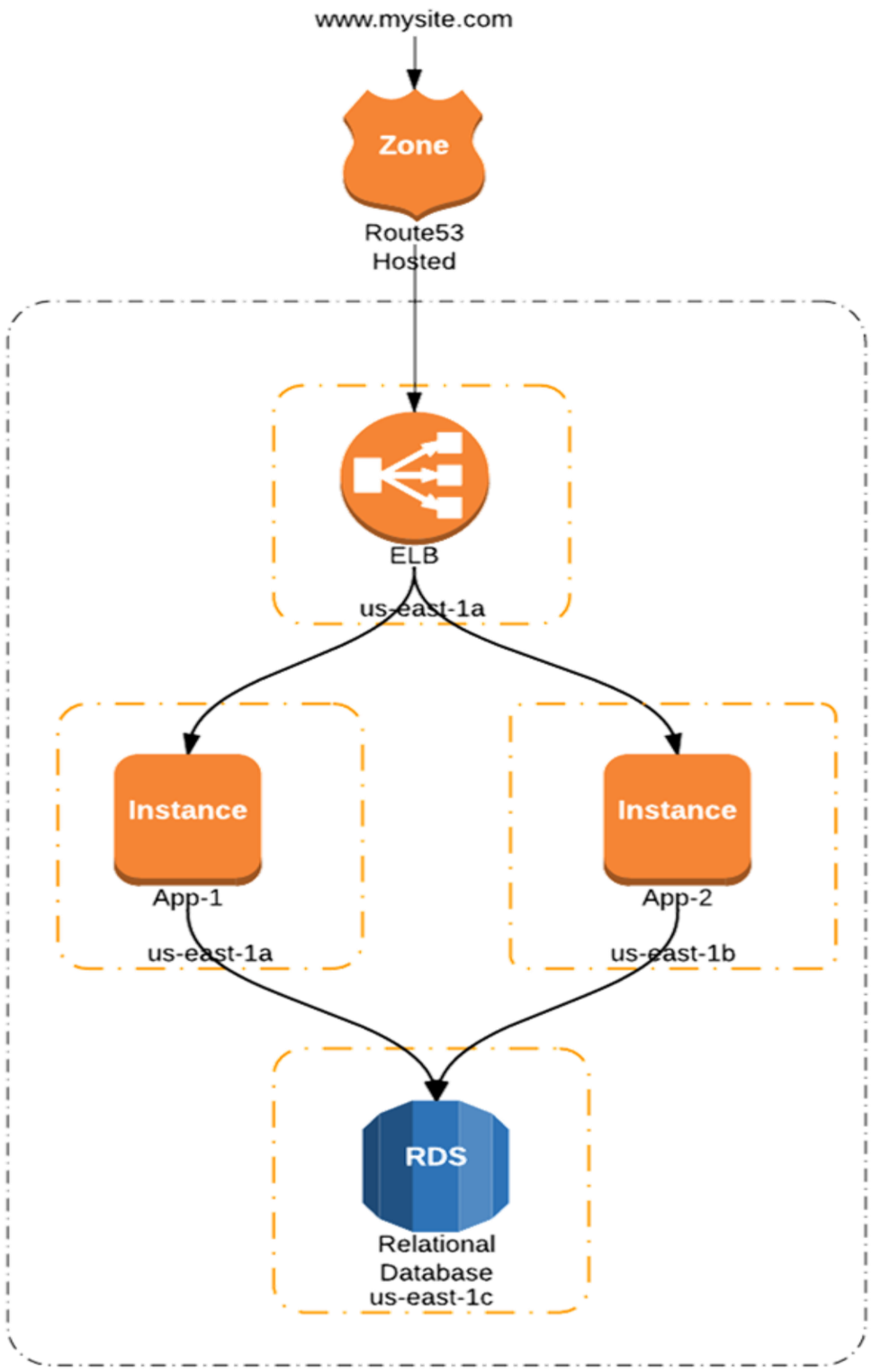


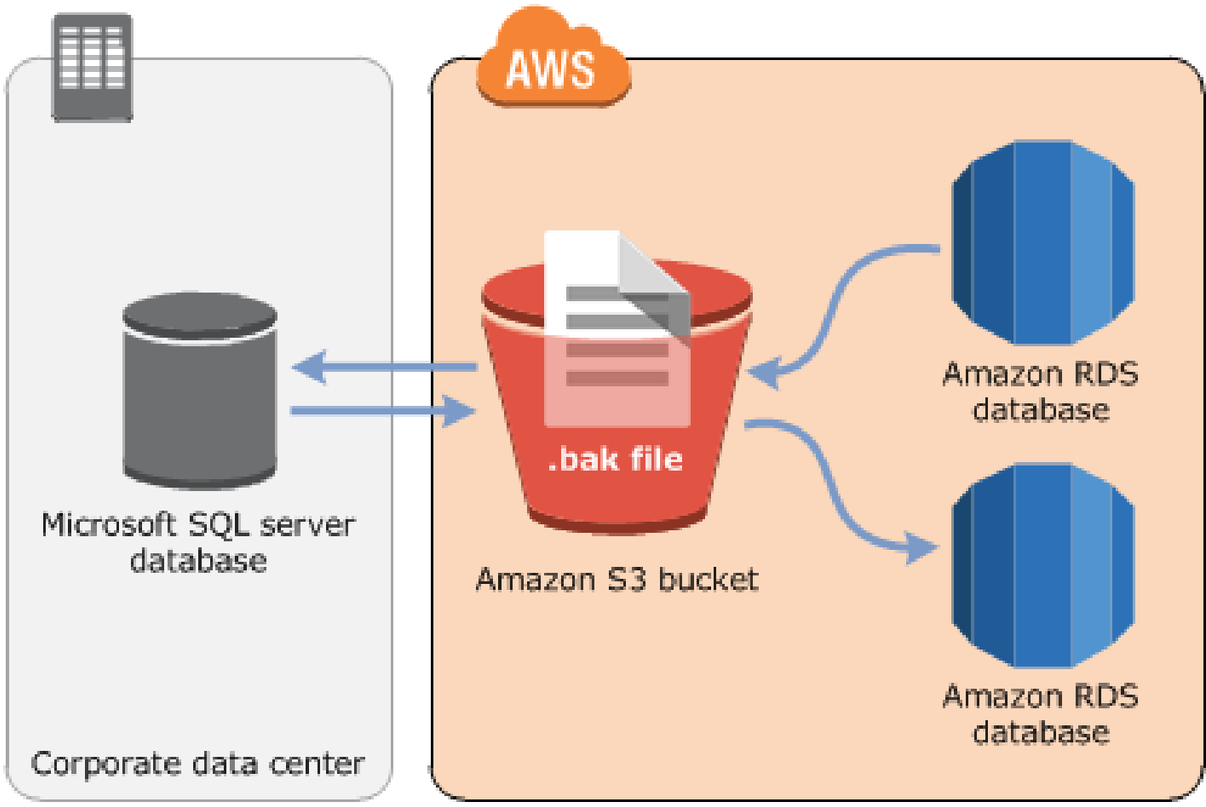
Taken from https://aws.amazon.com/rds/features/read-replicas/ and https://aws.amazon.com/rds/aurora/faqs/ (31/07/2024). More info at https://medium.com/awesome-cloud/aws-difference-between-multi-az-and-read-replicas-in-amazon-rds-60fe848ef53a (31/07/2024)

Use Case I



Use Case II





Aurora

Amazon Aurora

Full-Managed RDS Service.
MySQL and PostgreSQL Compability. Better performance 5x for MySQL and 3x for PostgreSQL.
Decrease to 1/10 pricing of using other DB, however is no Free-Tier option.
Up to 15 Read Replicas. Replication Lag < 100 ms.
128TiB in 10GB (min size-data chunk) Increments as RDS. Self-healing for storage.
Automatically create a 2 data copies (element as chunk) on each of 3 AZ in a region.
More integration with IAM.
Automatic Auto-failover for cluster. Using Cluster endpoint instead of instance endpoint.

Features

Amazon Aurora

Additional Features:

Global Database (Latency < 1 s)

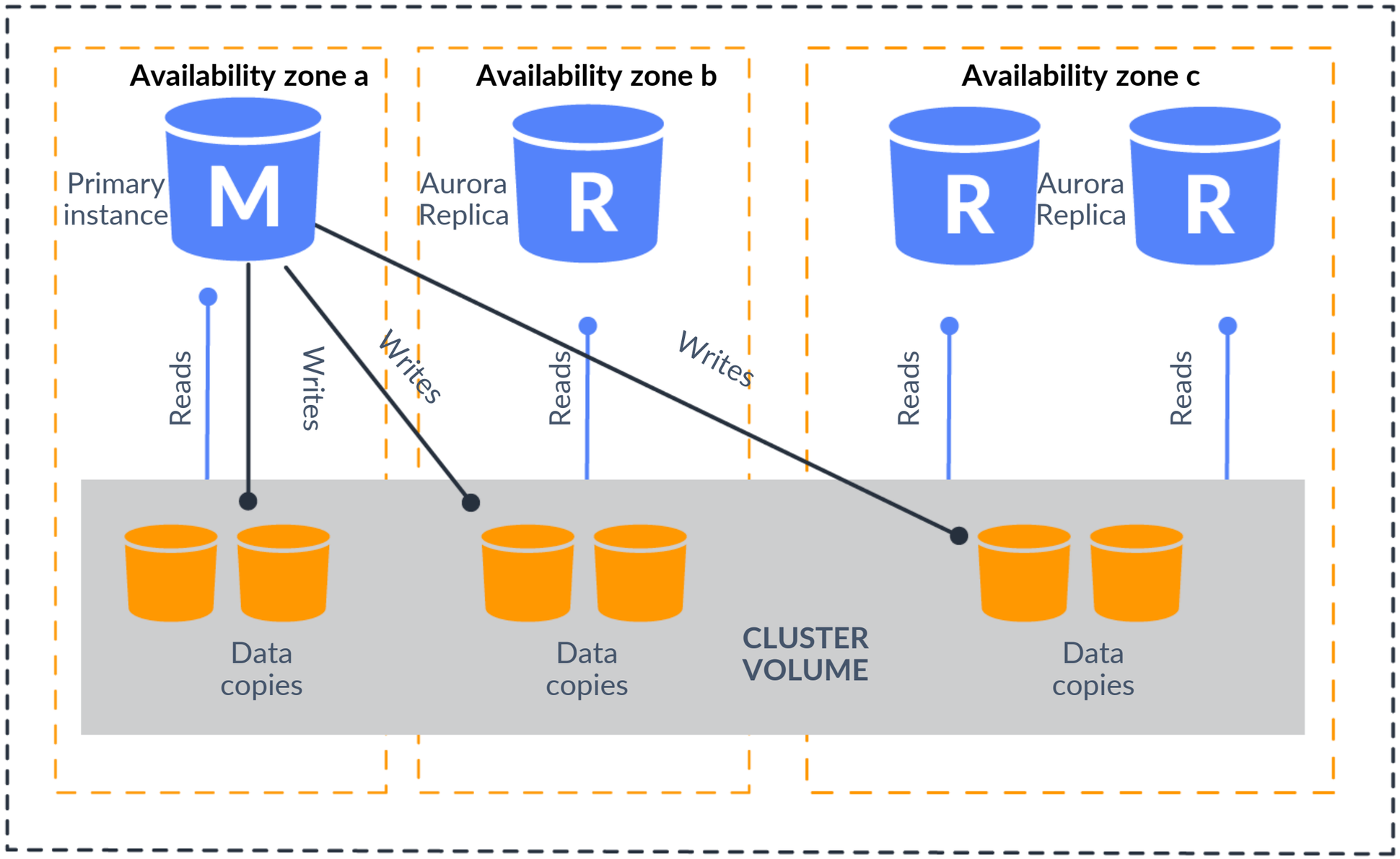
Serverless Configuration

Parallel Query (Make on storage instead of Engine/CPUs. Check conditions of DB and AWS Features).

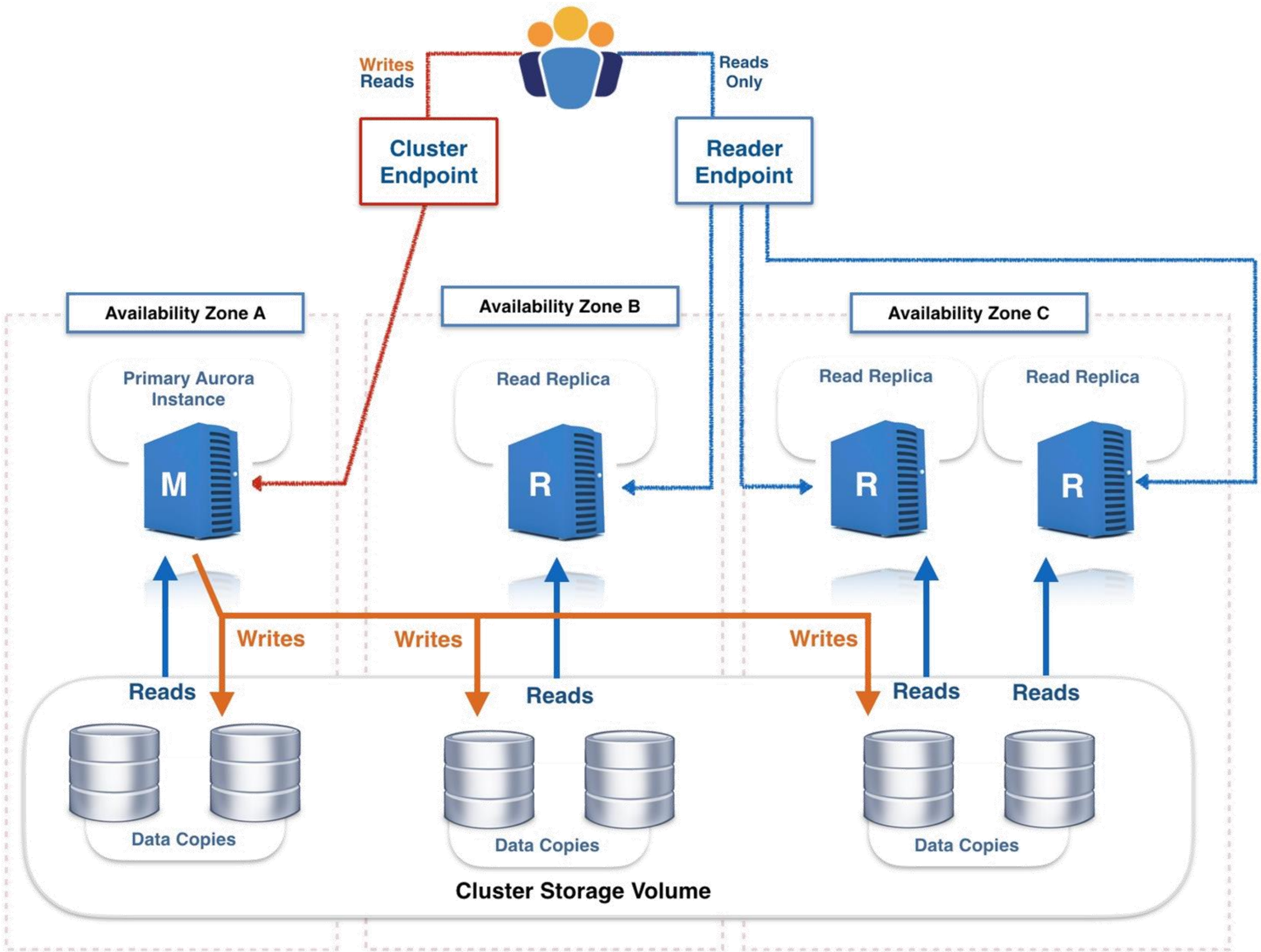
Backtrack (Up to 72 hours before, without new instance).

Custom Database Endpoints.

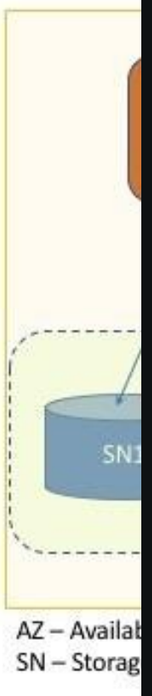
AMAZON AURORA DB CLUSTER



Aurora – Endpoints



Aurora Multi-Master Cluster



r/aws • 1 yr. ago
nullanomaly

What happened to Aurora MySQL multi-master option?

database

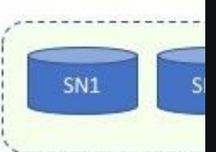
Am going through some tutorials and all blogs reference an outdated console screen which used to show multi master (multi read/write) for Aurora MySQL. Ive tried different versions to see if option would appear but no. Searching AWS docs for "multi-master" yields zero results. This link is often used: https://docs.aws.amazon.com/AmazonRDS/latest/AuroraUserGuide/aurora-multi-master.html but it redirects to replica with no mention of multi write. The version tab on the console says to pick "multimaster_10a" but I dont see that in dropdown.

Any ideas? how to enable multi writers for Aurora mySQL?

26 18 Share

Add a Comment

Sort by: Best Search Comments

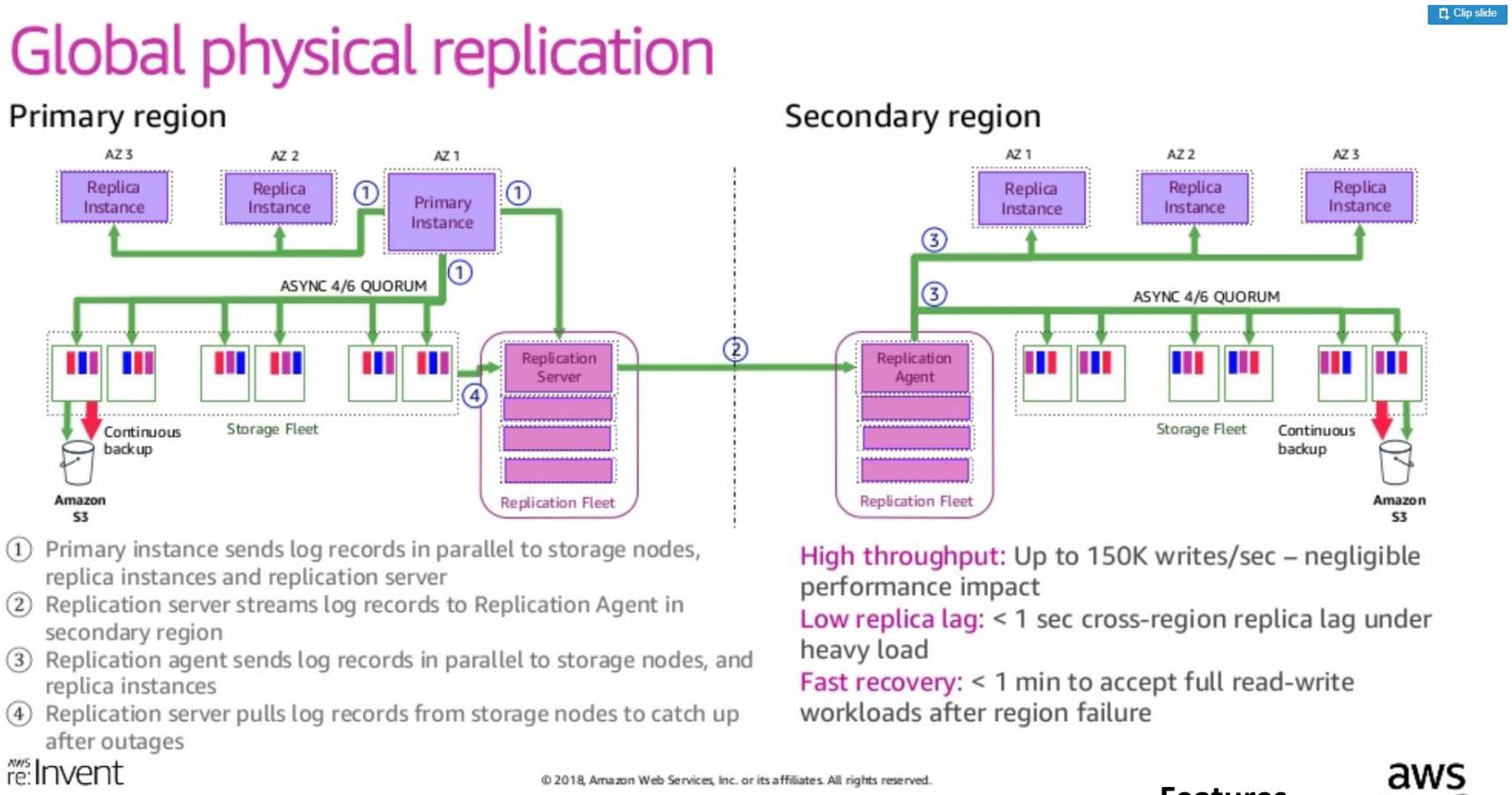


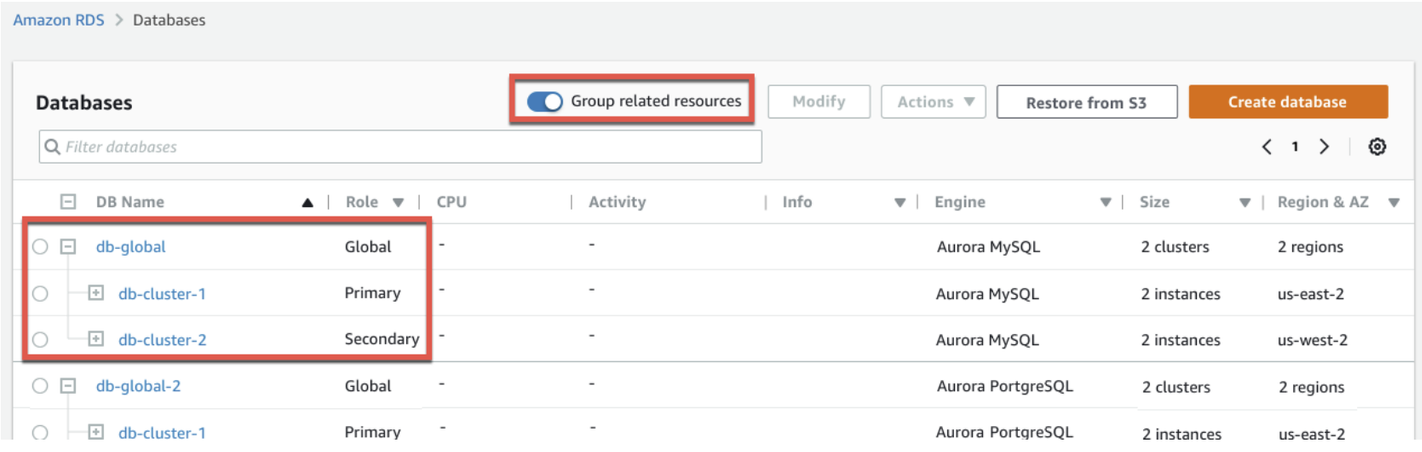
bofkentucky • 1y ago

It was aurora v1/mysql 5.6 feature only, went away with Aurora 2.0 and hasn't reappeared.

22 Reply Award Share

Aurora Global Database





Features

Best availability for DR.
Scaling reads on another region.
Low degradation on performance.
Lag Time < 1 seg.
Pricing similar to have another instance plus replication costs (i.e. U$10)

Limits

MySQL and PostgreSQL version
Only db.r4 and db.r5 instances
No General Available to All Regions.
No Parallel Query, Serverless or Global Databases
No Clone, no backtrack

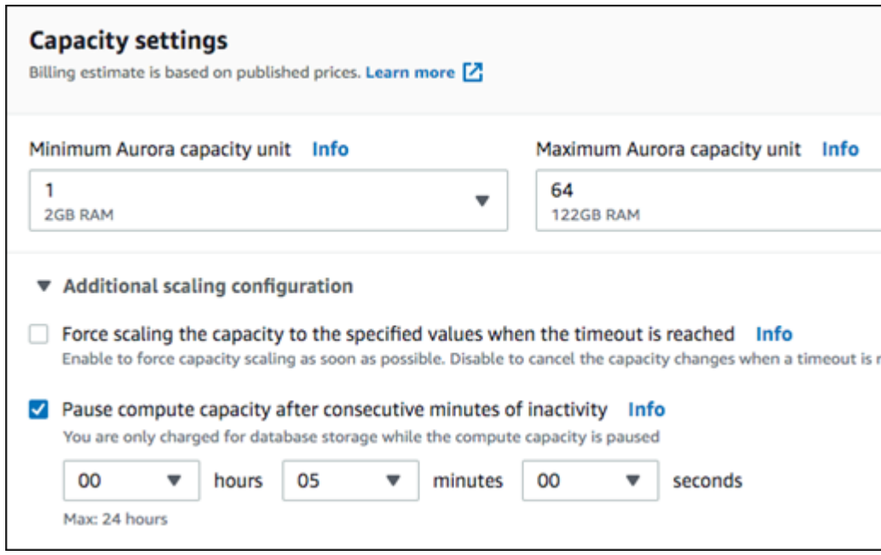
Taken from https://www.slideshare.net/AmazonWebServices/amazon-aurora-storage-demystified-how-it-all-works-dat363-aws-reinvent-2018 and https://docs.aws.amazon.com/AmazonRDS/latest/AuroraUserGuide/aurora-global-database.html (30/07/2024)

Aurora Serverless

Min and Max ACU (Aurora Capacity Unit)

Timeout for capacity changes: When you modify ACUs, Aurora Serverless try to fulfill otherwise rollback, possible actions: drop connections.

Pause after inactivity: Below of min ACUs.

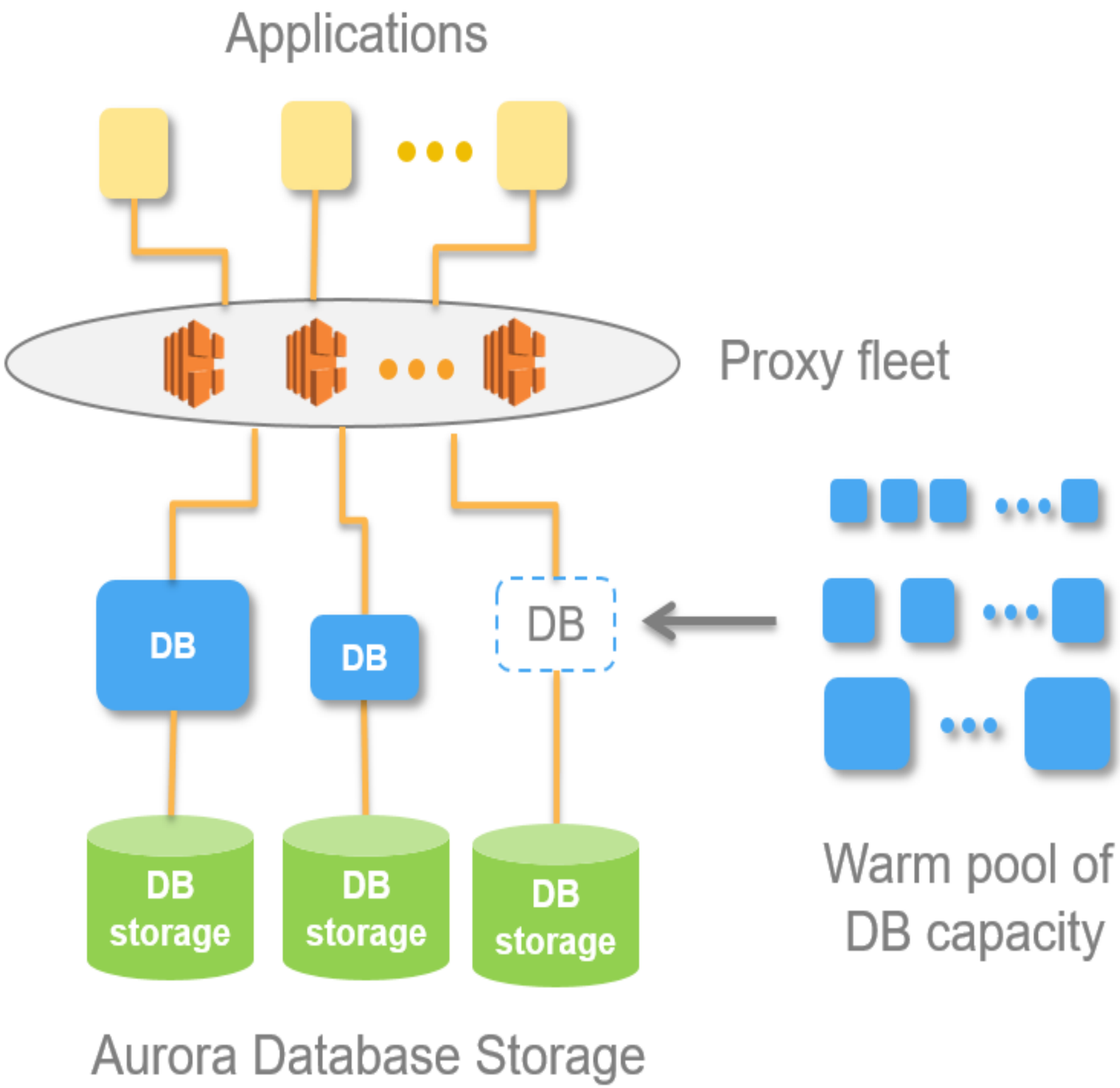


Use cases:

Unpredictable workload

PoCs because you pay-as-you-go processing and fixed expenses for storage

Serverless Architecture



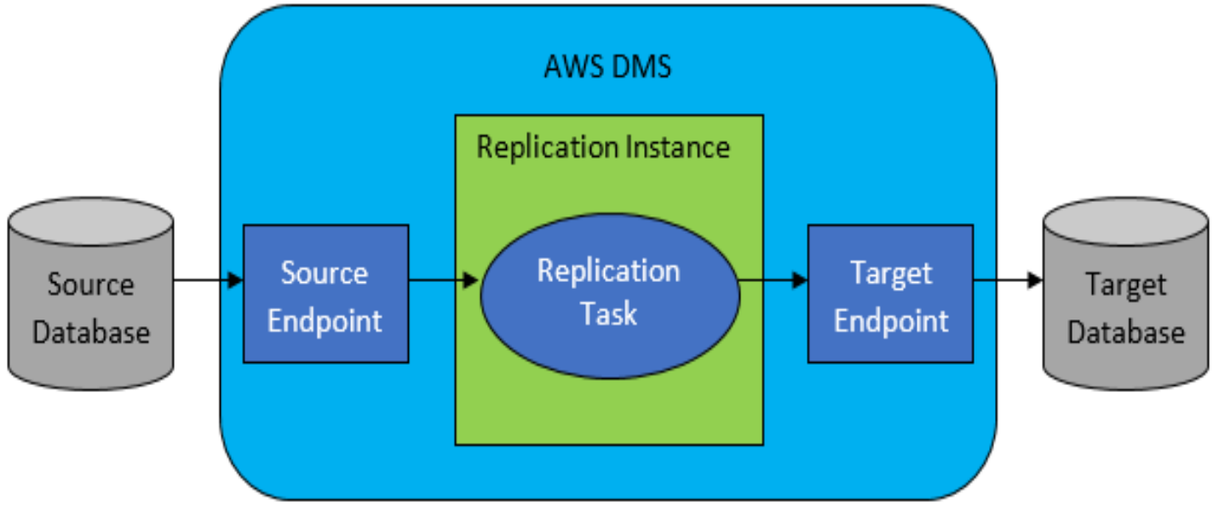
Taken from https://docs.aws.amazon.com/AmazonRDS/latest/AuroraUserGuide/aurora-serverless.how-it-works.html (30/07/2024)

Data Migration Service - DMS

AWS Database Migration Service

Database migration workflow/job

Migrate DB to AWS without downtime, can be continuously or not.
Low cost, up to U$3 per TB. Pay-as-you-go.
Free cost under 750h on 12 first month on dms.t2.micro (AWS Managed DB Only)
Security in-transit (SSL) and at-rest (KMS).
Failover switching.
Serverless Option.



Scenarios:

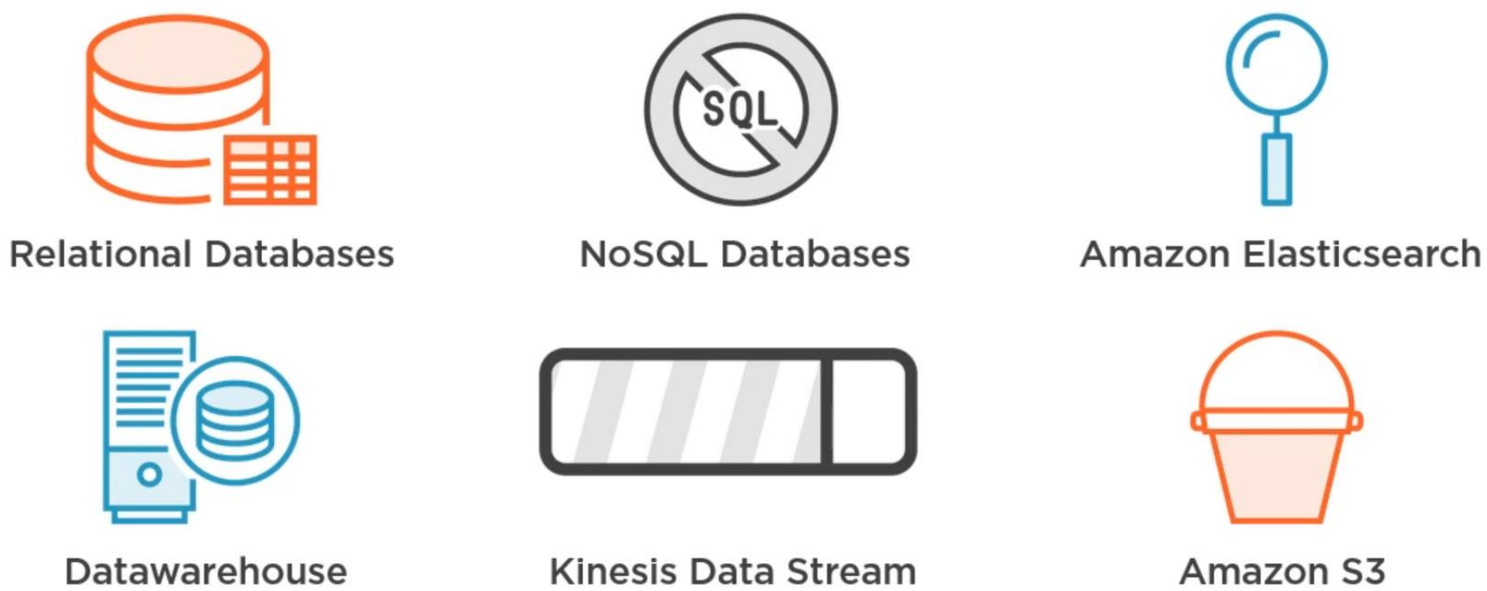
Homogeneous Database Migrations
Heterogeneous Database Migrations
Development and Test
Database Consolidation (Homogeneous and Heterogeneous Scenarios)
Continuous Data Replication

Taken from https://aws.amazon.com/dms/?nc=sn&loc=0 and https://aws.amazon.com/dms/pricing/ (30/07/2024)

DMS – Endpoints

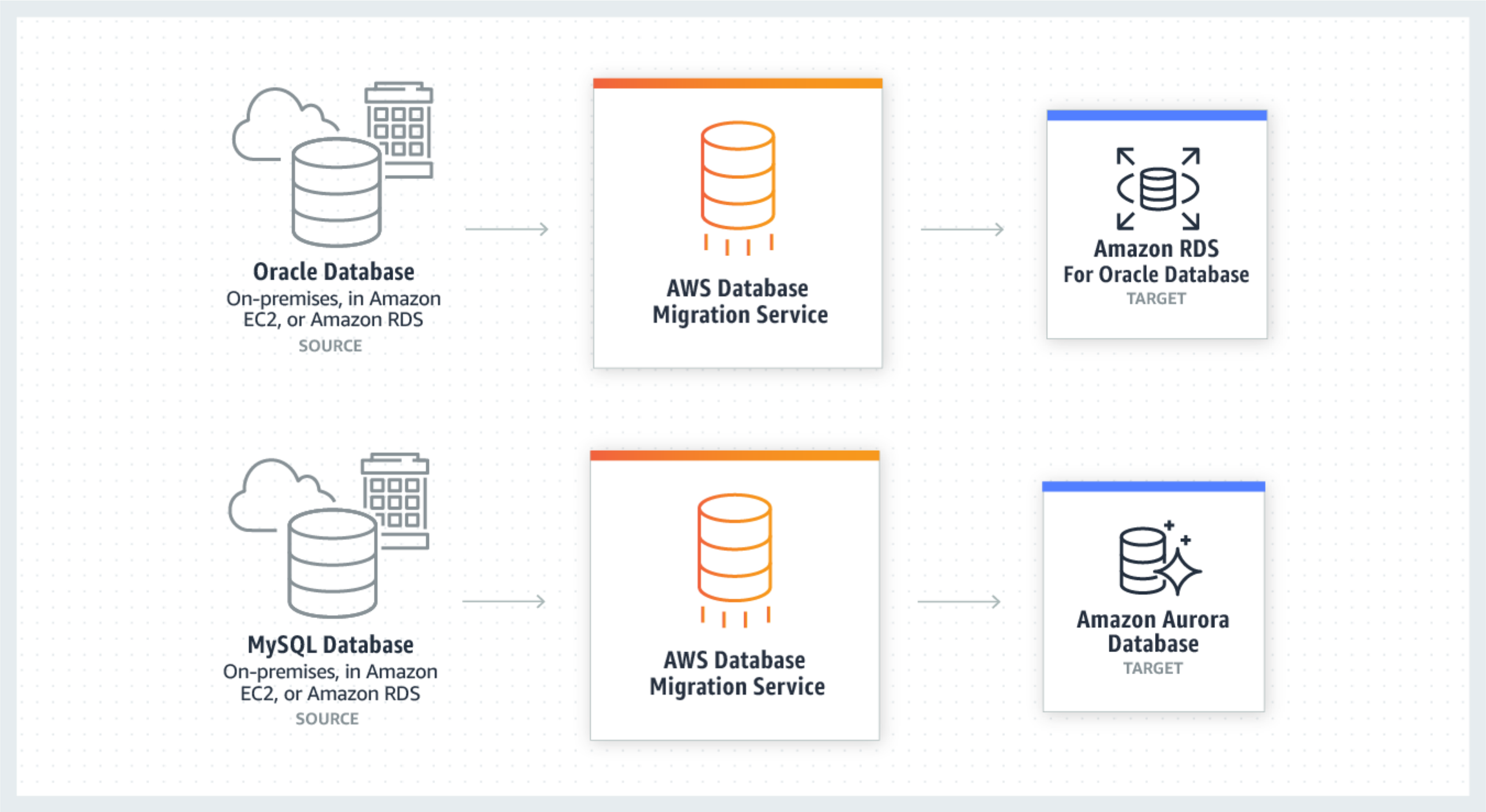
Source Endpoints

Target Endpoints



Taken from https://app.pluralsight.com/library/courses/aws-database-migration-service-migrating/table-of-contents (05/05)2021)

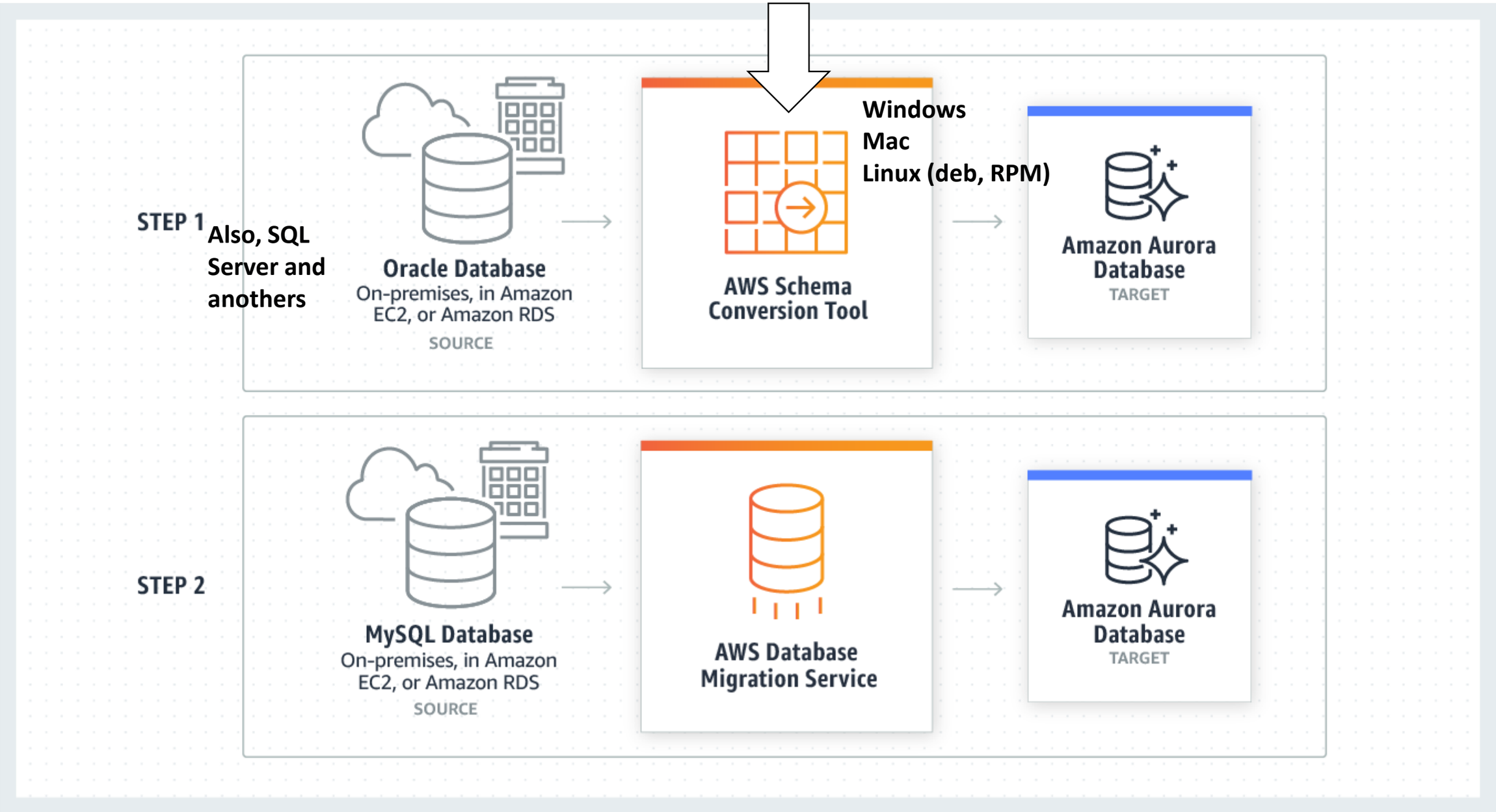
Homogeneous Database Migrations



Taken from https://aws.amazon.com/dms/?nc=sn&loc=0 (30/07/2024)

Heterogeneous Database Migrations

Views, SP, Functions and Data Object Formats > Native Code Optimization



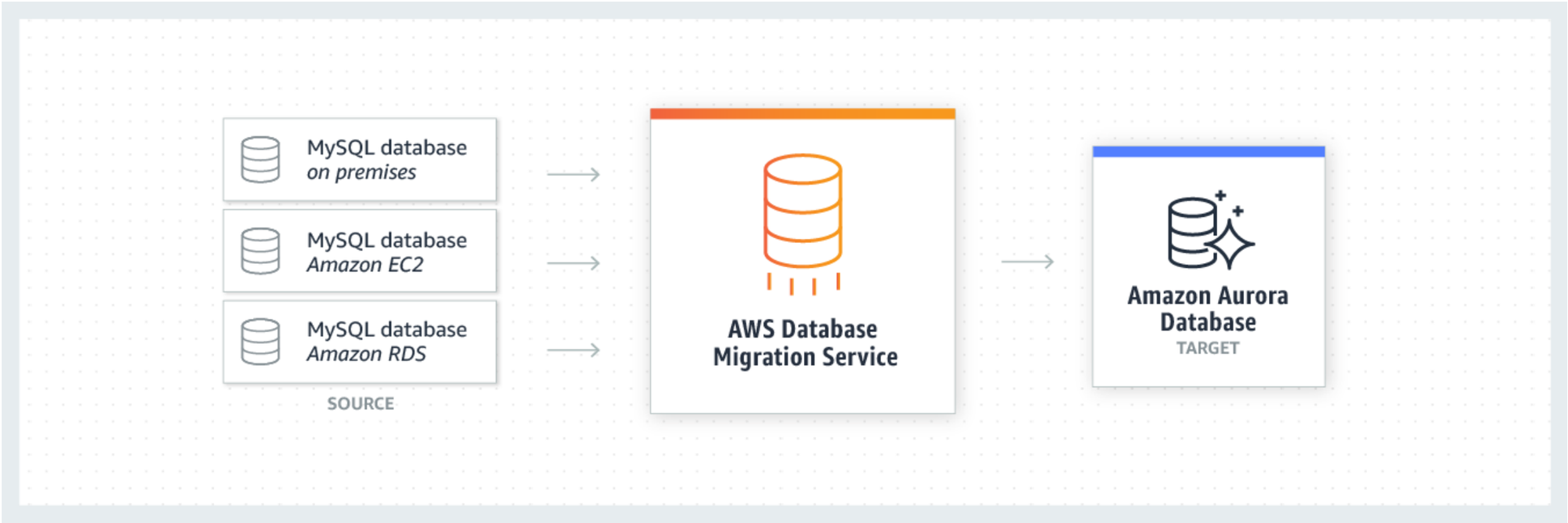
Taken from https://aws.amazon.com/dms/?nc=sn&loc=0 (06/08/2020)

Heteregenous Database Migrations

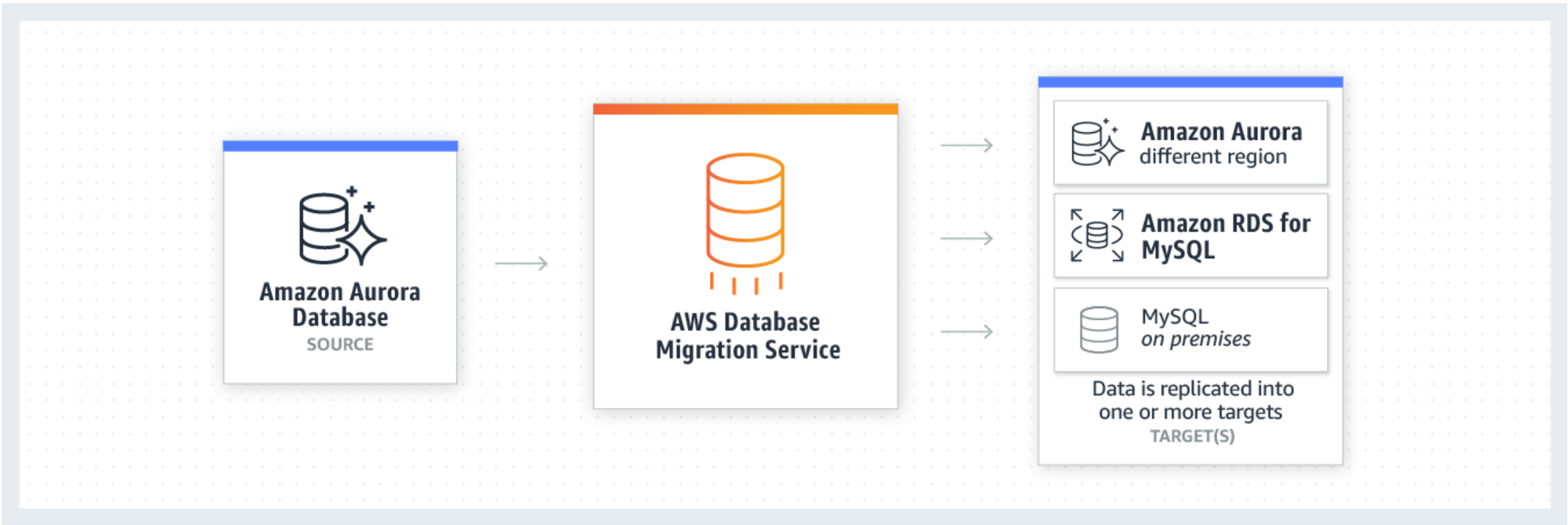
Source Database	Target Database on Amazon RDS
Oracle Database	Amazon Aurora, MySQL, PostgreSQL, Oracle
Oracle Data Warehouse	Amazon Redshift
Azure SQL	Amazon Aurora, MySQL, PostgreSQL
Microsoft SQL Server	Amazon Aurora, Amazon Redshift, MySQL, PostgreSQL
Teradata	Amazon Redshift
IBM Netezza	Amazon Redshift
Greenplum	Amazon Redshift
HPE Vertica	Amazon Redshift
MySQL and MariaDB	PostgreSQL
PostgreSQL	Amazon Aurora, MySQL
Amazon Aurora	PostgreSQL
IBM DB2 LUW	Amazon Aurora, MySQL, PostgreSQL
Apache Cassandra	Amazon DynamoDB
SAP ASE	RDS for MySQL, Aurora MySQL, RDS for PostgreSQL, and Aurora PostgreSQL

Taken from https://aws.amazon.com/dms/?nc=sn&loc=0 (06/08/2020)

DB Consolidation



Continuous Data Replication



Taken from https://aws.amazon.com/dms/?nc=sn&loc=0 (06/08/2020)

DMS - Migration Types

Full load

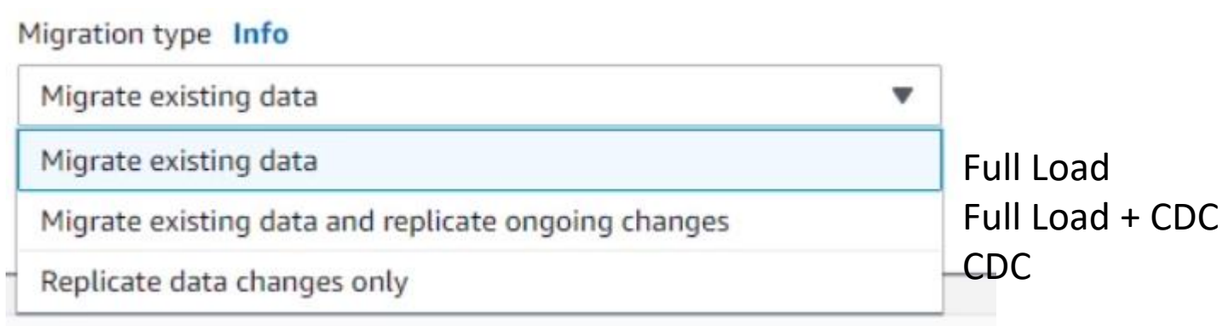
Migrates existing data from source to target

Full load + CDC

Migrates existing data plus ongoing changes (Change Data Capture)

CDC only

Replicate data changes only, copy existing data using another method



Taken from https://aws.amazon.com/dms/?nc=sn&loc=0 (06/08/2020)

DMS – Additional Tasks

Data Validation

Compares data on target with source

Table Mapping

Transformations, source schema etc. to be used during migration

Filters

Source filters to limit what is migrated

Monitoring

Console, Logs and CloudWatch

Reloading Tables

If there is an error during the task

Taken from https://aws.amazon.com/dms/?nc=sn&loc=0 (06/08/2020)

ElastiCache

Amazon ElastiCache

ElastiCache for Redis

ElastiCache for Memcached

- AWS Managed solution for in-memory cache.
- Amazon ElastiCache is a Web Service to run a in-memory cache to escalate cache and data store.
- Improve high-throughput and latency for real-time apps.

ElastiCache

Amazon EC implement 2 open-source engines:

- **Redis OSS:** Most loved database for developers – StackOverflow 2020.
- **Memcached:** Sub-millisecond responses.

Update and replace faulty nodes in that case resiliency and mitigate risk on DB. Port for Redis 6379/16379 for Cluster, Memcached 11211/TCP-UDP

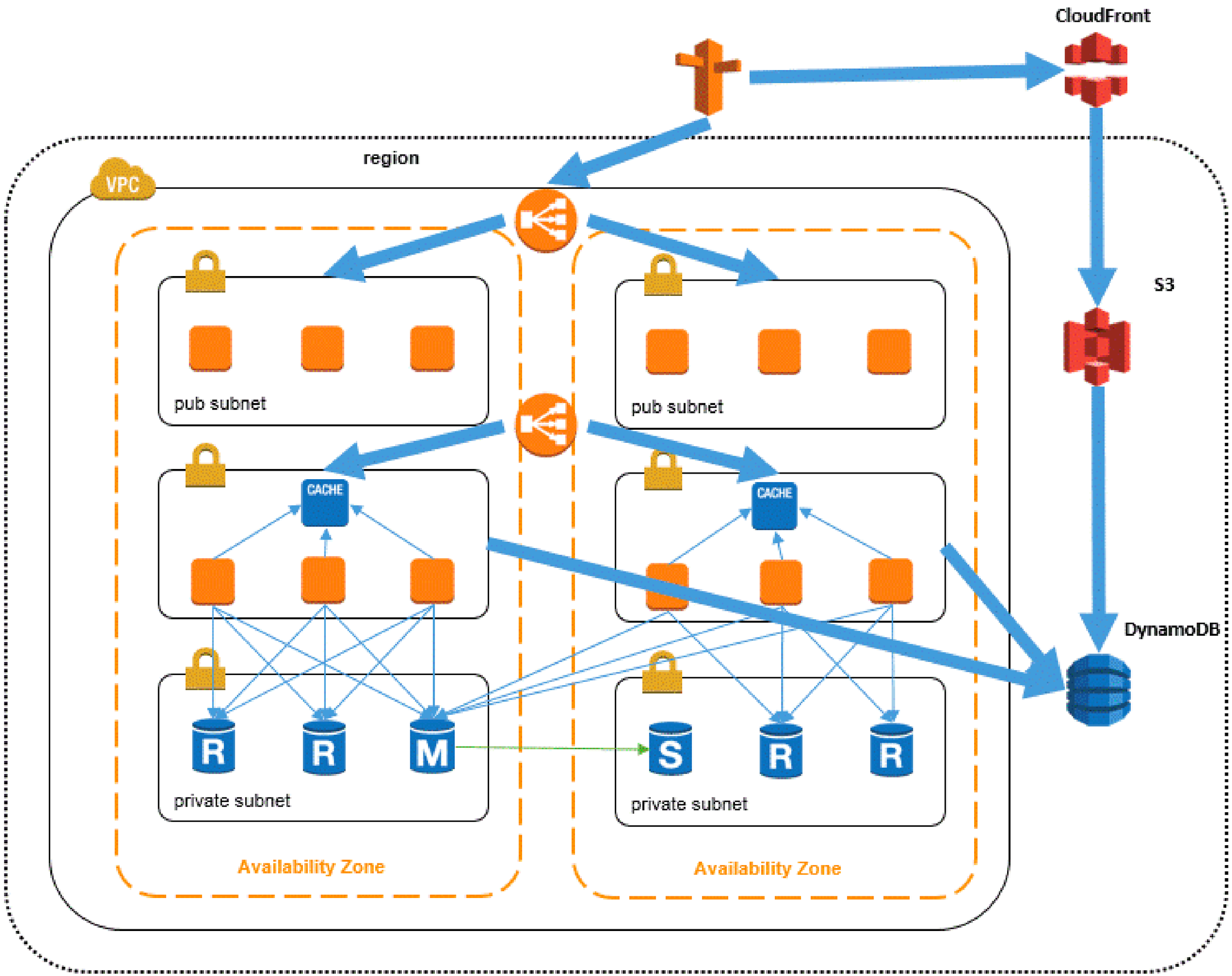
Key Terms: Cluster, Parameter Group, Sec Group, VPC , Subnet Group

ElastiCache - Comparison

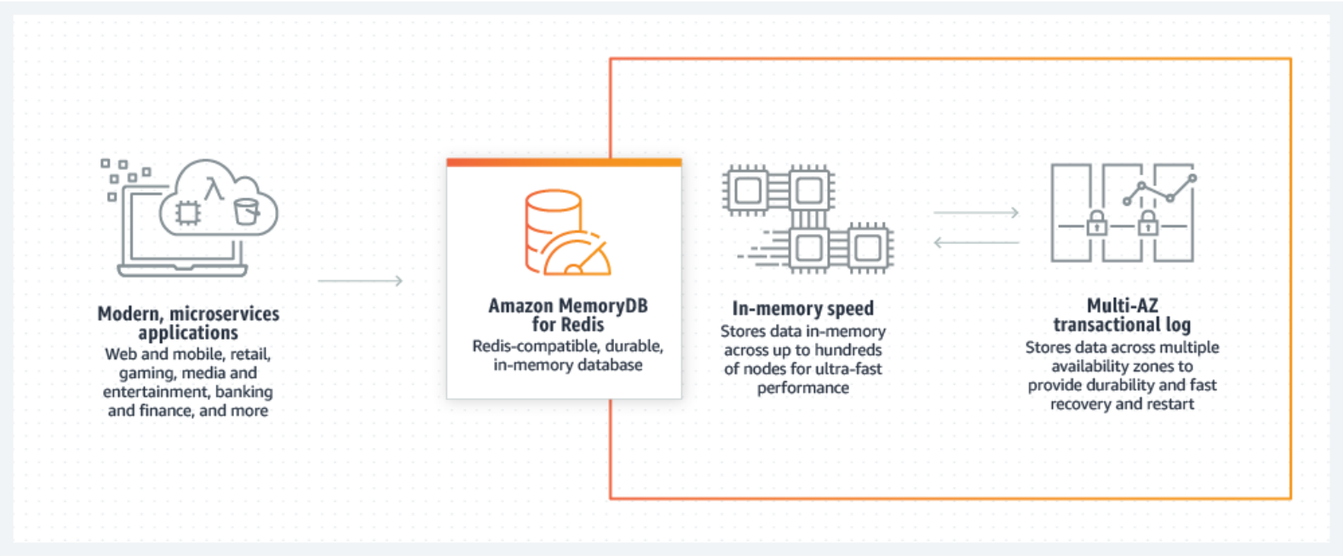
	Memcached	Redis OSS
Sub-millisecond latency	Yes	Yes
Developer ease of use	Yes	Yes
Data partitioning	Yes	Yes
Support for a broad set of programming languages	Yes	Yes
Advanced data structures	-	Yes
Multithreaded architecture	Yes	-
Snapshots	-	Yes
Replication	-	Yes
Transactions	-	Yes
Pub/Sub	-	Yes
Lua scripting	-	Yes
Geospatial support	-	Yes

More info on https://aws.amazon.com/elasticache/redis-vs-memcached/#:~:text=Although%20they%20are%20both%20easy,wide%20range%20of%20use%20cases. (30/07/2024)

EC Use Case



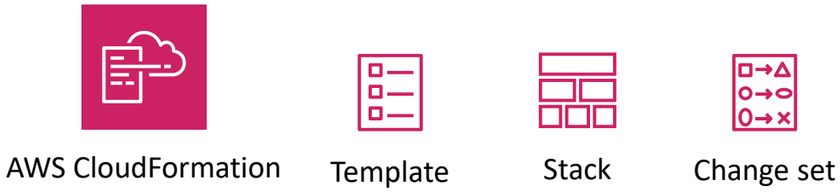
In-Memory Database



Data consistency	**Weakly consistent** with an unbounded inconsistency window. Redis allows writes and strongly consistent reads on the primary node of each shard and eventually consistent reads from read replicas. These consistency properties are not guaranteed if a primary node fails, as writes can become lost during a failover and thus violate the consistency model.	**Strong consistency** on the primary node, eventual consistency reads on replica nodes. The consistency model of MemoryDB is similar to ElastiCache for Redis. However, in MemoryDB, data is not lost across failovers, allowing clients to read their writes from primaries regardless of node failures. Only data that is successfully persisted in the multi-AZ transaction log is visible. Replica nodes are still eventually consistent.

More info on https://github.com/aws-samples/amazon-memorydb-for-redis-samples and https://cloudwellserved.com/amazon-elasticache-for-redis-vs-amazon-memorydb-for-redis (30/07/2024)

Cloudformation - CFmt



Infrastructure-As-A-Code Solution for AWS: Cornerstone for DevOps, Easy and Simplified Infra Admin; Replicate and change control tracking.
A file (Template) generate a Stack (Infrastructure), when a modification occurred create a change (Change set).
Template can be in YAML or JSON Format.
CFmt only make creation resources, you can use as you wish.
Integration with other tools such as CodePipeline.
The order of creation doesn’t matter instead of you instructed on the template.
Rollback in the case that you have problems.
A lot of sample templates and snippets on AWS or Internet.

More info on https://aws.amazon.com/cloudformation/resources/templates/ (06/08/2020)

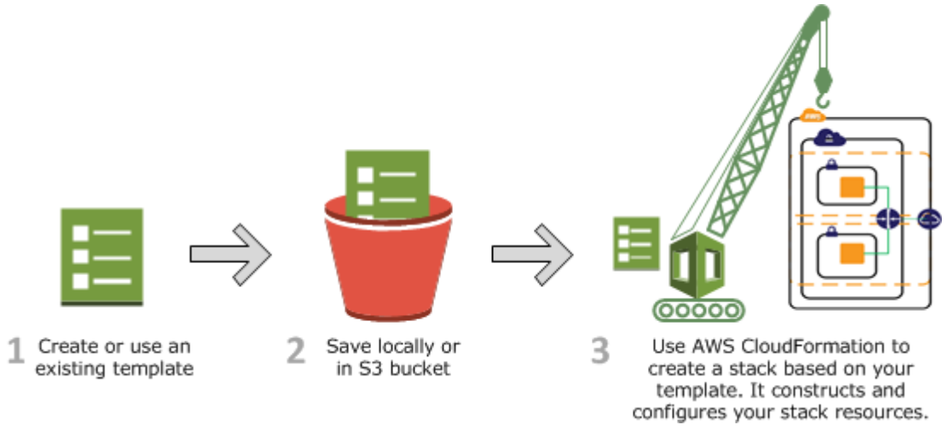
Free-use of Cloudformation, not for created services.
Need a role to created if you are not root user.
Service Limit:
200 stacks per account.
60 parameters/60 outputs.
4096 characters per description fields.
Designer: GUI to create and view templates.

Advanced concepts:
CloudFormation Registry (Creation of Private/Public Services/Actions using S3)
StackSet (Create stack to multiple Accounts)

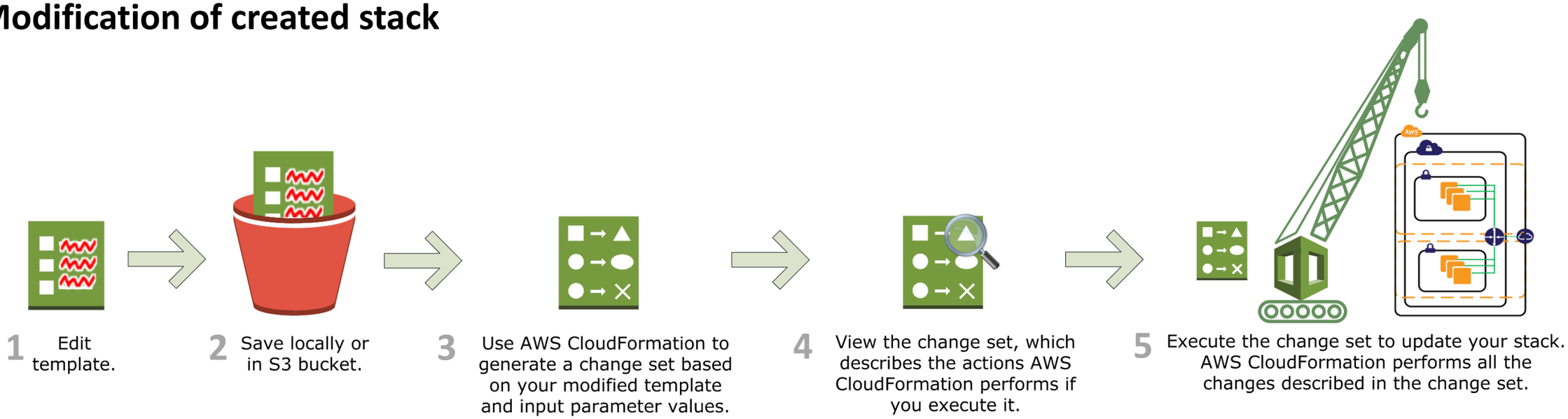
More info on https://aws.amazon.com/cloudformation/resources/templates/ and https://aws.amazon.com/blogs/aws/new-use-aws-cloudformation-stacksets-for-multiple-accounts-in-an-aws-organization/ (06/08/2020)

Key Concepts

Process at first time



Modification of created stack



Taken from https://docs.aws.amazon.com/AWSCloudFormation/latest/UserGuide/cfn-whatis-howdoesitwork.html (06/08/2020)

Template Anatomy


```yaml
---
AWSTemplateFormatVersion: "version date"

Description:
  String

Metadata:
  template metadata

Parameters:
  set of parameters

Mappings:
  set of mappings

Conditions:
  set of conditions

Transform:
  set of transforms

Resources:
  set of resources

Outputs:
  set of outputs
```

YAML – Space sensitive

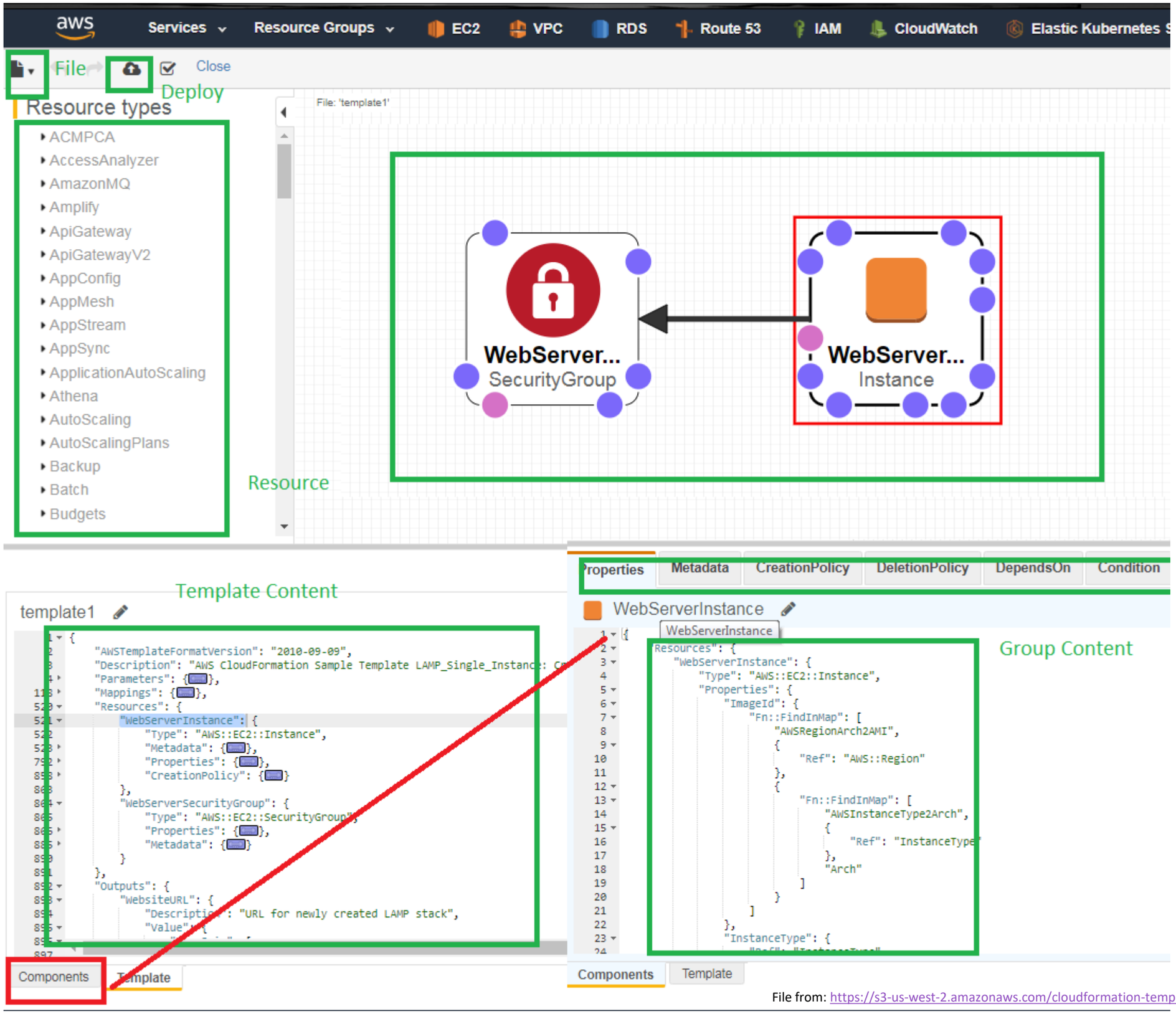
```json
{
  "AWSTemplateFormatVersion" : "version date",

  "Description" : "JSON string",

  "Metadata" : {
    template metadata
  },

  "Parameters" : {
    set of parameters
  },

  "Mappings" : {
    set of mappings
  },

  "Conditions" : {
    set of conditions
  },

  "Transform" : {
    set of transforms
  },

  "Resources" : {
    set of resources
  },

  "Outputs" : {
    set of outputs
  }
}
```

JSON

Resources is the mandatory section only.

Version is the CF Format, specifying by AWS.
Description is free-text about this stack.
Metadata are additional info, are there 3 important tags: cfn-init for user data for EC2 Bootstrap script, auth for previous run scripts and Interface for grouping.
Parameters are defined variables and its possible options to be used inside this file.
Mappings are like database to be used as finding reference similar as VLOOKUP in Excel English or buscarv in Excel Spanish.
Conditions are conditionals to define variables.
Transform are a special section to be used for SAM – Serverless Application Model. Its like a macro to be used.
Resources are every infrastructure element to be created/modified in this file.
Outputs are defined elements to be show are in special section.

CFn Designer



Sample Stack from AWS
Simple LAMP Stack

File from: https://s3-us-west-2.amazonaws.com/cloudformation-templates-us-west-2/LAMP_Single_Instance.template (09/08/2020)

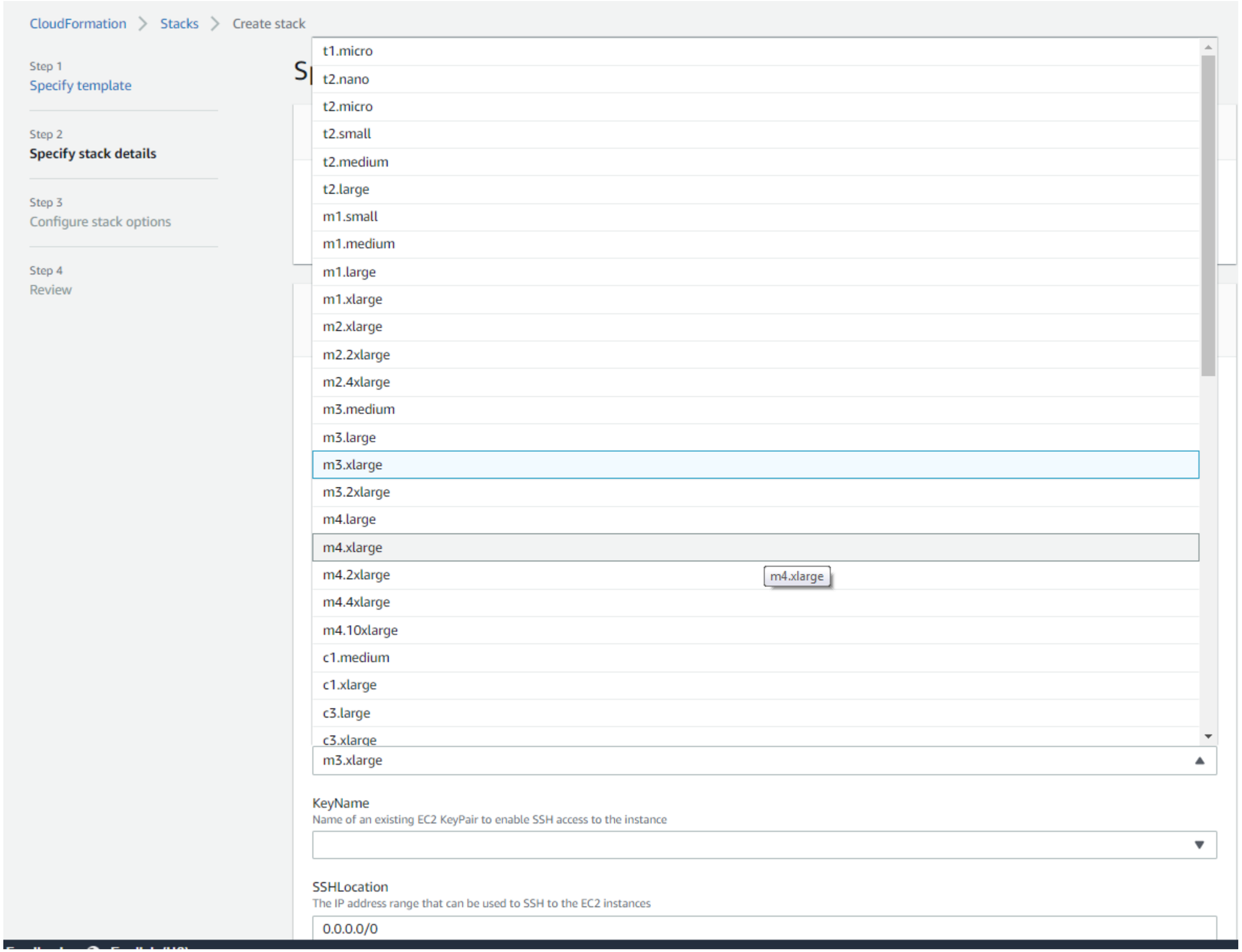
CFn Deploy

Load Template File or using Designer

Insert parameters

Additional configuration such as CF IAM Role, Rollback, Notification

Final review



File from: https://s3-us-west-2.amazonaws.com/cloudformation-templates-us-west-2/LAMP_Single_Instance.template (09/08/2020)