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CSCI 5902 Adv. Cloud Architecting
Fall 2023
Instructor: Dr. Lu Yang

Module 5 Adding a Database Layer (Sections 1 - 3)
Oct 13, 2023

Housekeeping items and feedback

1. Start recording
2. Start working on challenge lab 3 from today.
   Late submissions on AWS Academy will result in a 0 of your grade on Brightspace. No excuse is accepted unless you have experienced emergencies or prolonged illnesses that have affected your ability to complete labs throughout the entire designated period.
   This is SERIOUS! Don't try to negotiate!
3. PIER tour next week

AWS Academy Cloud Architecting

Module 5: Adding a Database Layer

Module overview

Sections

1. Architectural need
2. Database layer considerations
3. Amazon RDS
4. Amazon DynamoDB
5. Database security controls
6. Migrating data into AWS databases

Labs

- Challenge Lab: Migrating a Database to Amazon RDS

Module objectives

At the end of this module, you should be able to:

- Compare database types
- Differentiate between managed versus unmanaged services
- Explain when to use Amazon Relational Database Service (Amazon RDS)
- Explain when to use Amazon DynamoDB
- Describe available database security controls
- Describe how to migrate data into Amazon Web Services (AWS) databases
- Deploy a database server

Module 5: Adding a Database Layer

Section 1: Architectural need

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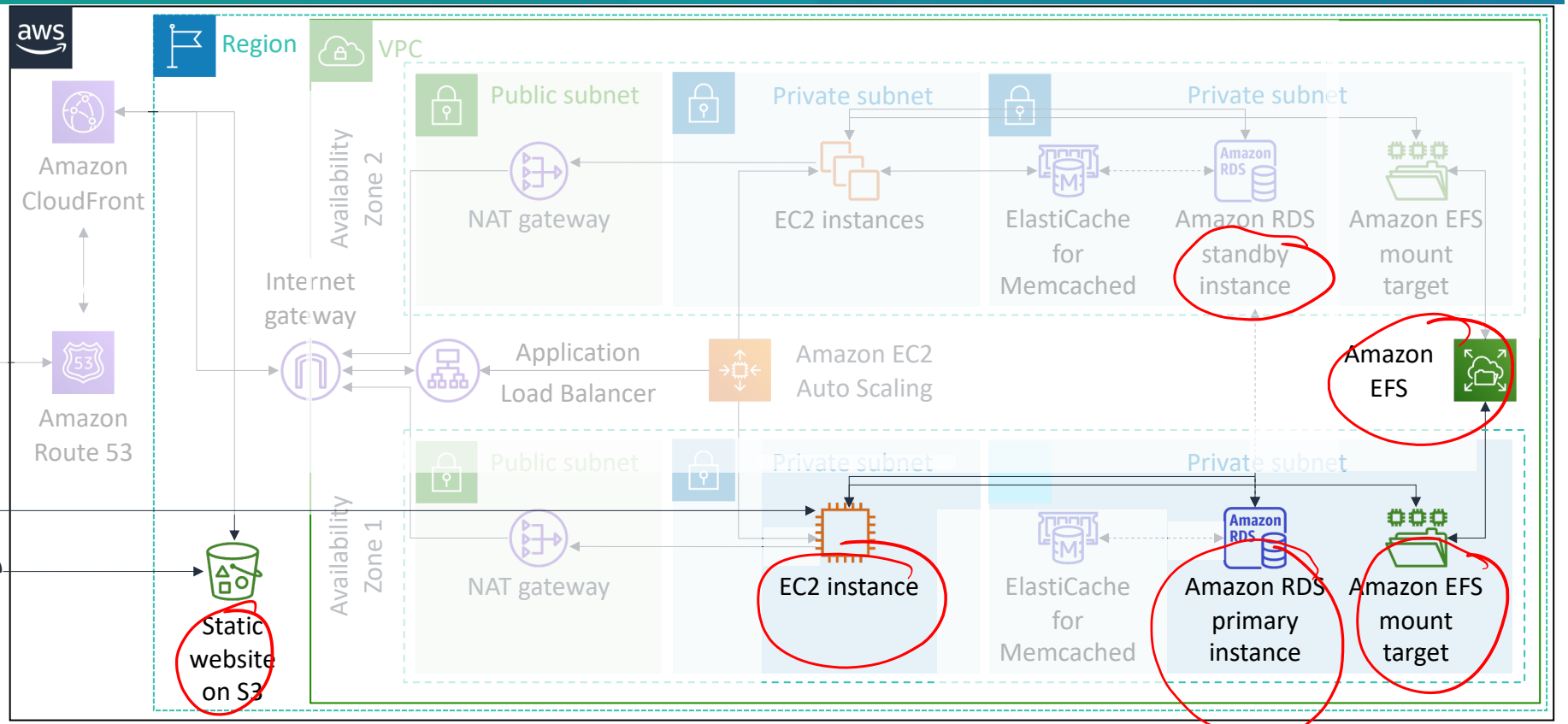
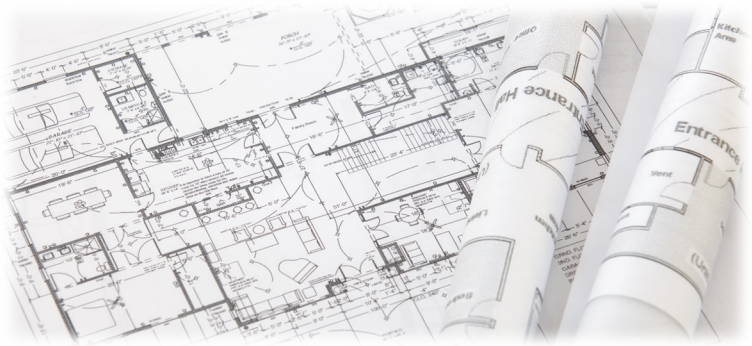
Databases as part of a larger architecture



Café business requirement

The café needs a database solution that is easier to maintain, and that provides essential features such as durability, scalability, and high performance.



Module 5: Adding a Database Layer

Section 2: Database layer considerations

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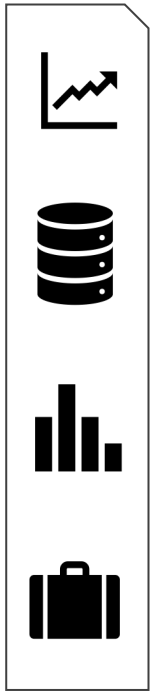
Database considerations: Scalability



Scalability

Total storage requirements

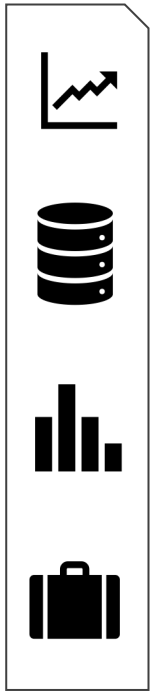
Object size and type

Durability

How much throughput is needed?

Will the chosen solution be able to scale up later, if needed?

Database considerations: Storage requirements



Scalability

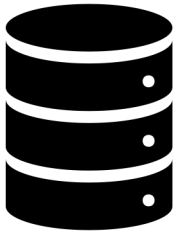
Total storage requirements

Object size and type

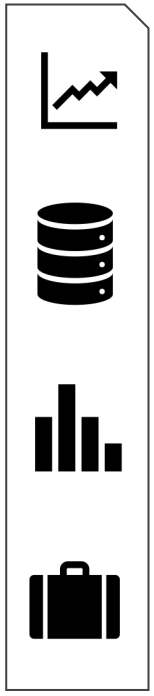
Durability

How large does the database need to be?

Will it need to store GB, TB, or petabytes of data?



Database considerations: Object size and type



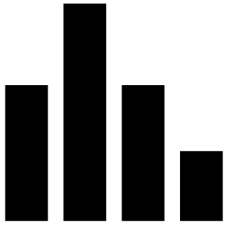
Scalability

Total storage requirements

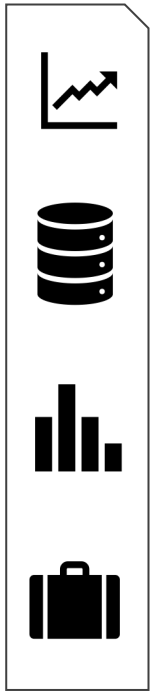
Object size and type

Durability

Do you need to store simple data structures, large data objects, or both?



Database considerations: Durability



Scalability

Total storage requirements

Object size and type

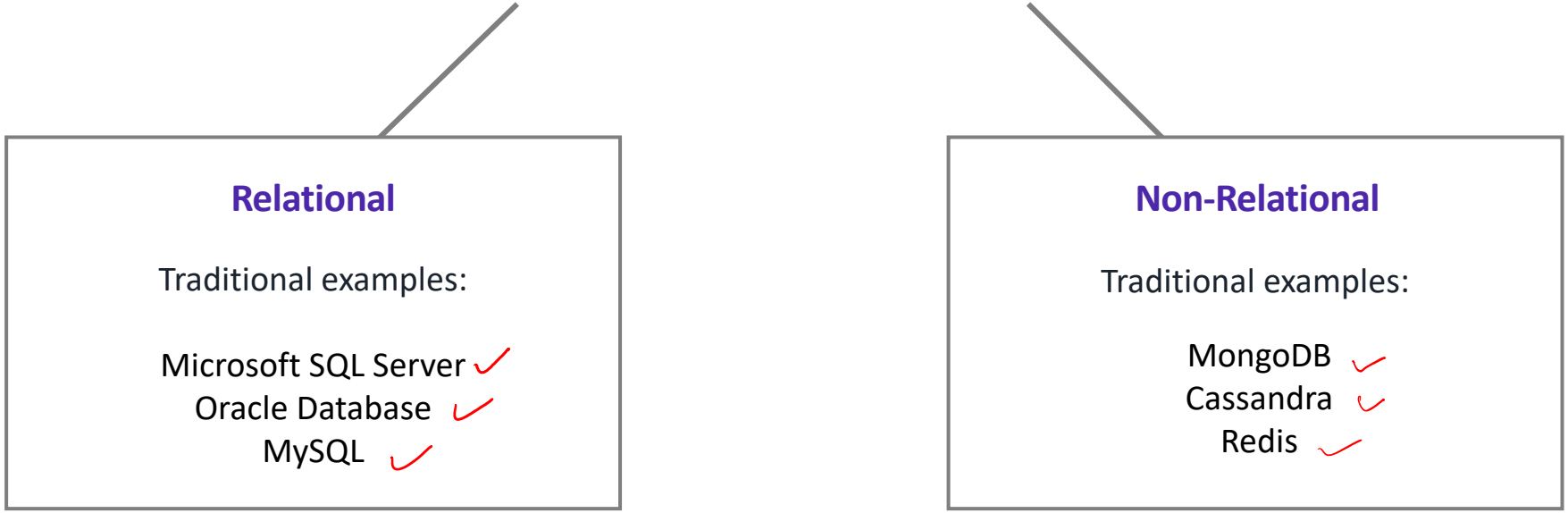
Durability

What level of **data durability**, **data availability**, and **recoverability** is required?

Do regulatory obligations apply?

Database types

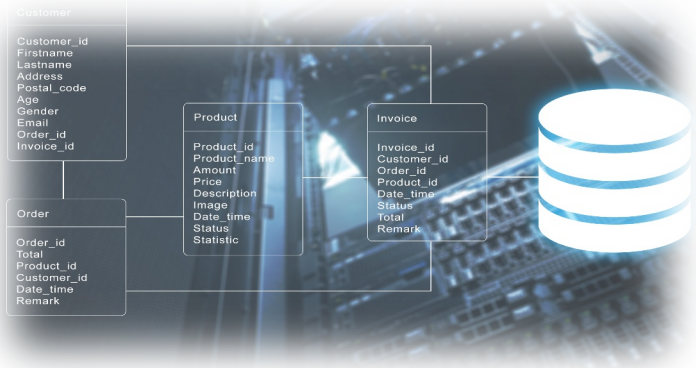
Now that you reviewed key considerations, consider the two categories of database options available:



Relational database type

Benefits:

- Ease of use
- Data integrity
- Reduced data storage
- Common language (structured query language, or SQL)

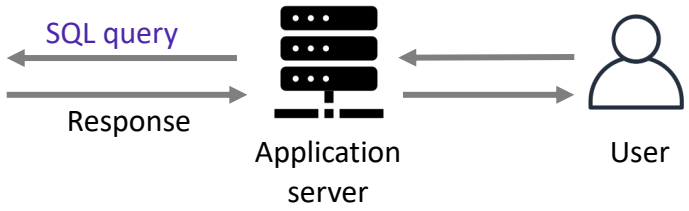


Relational database management system (RDBMS)

Relational is ideal when you:

- Need strict schema rules, ACID compliance, and data quality enforcement
- Do not need extreme read/write capacity
- Do not need extreme performance
  - An RDBMS can be the best, lowest-effort solution

lower TB



Non-relational database type

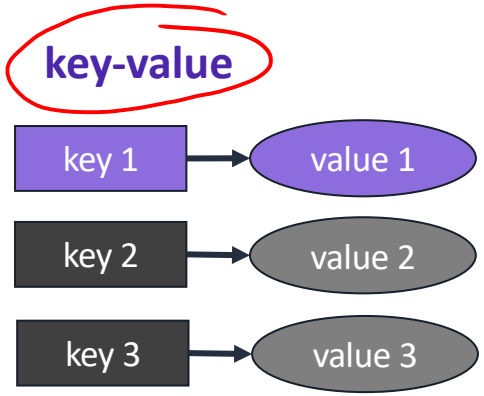
Benefits

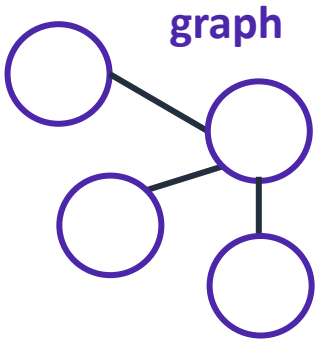
- Flexibility
- Scalability
- High performance
- Highly functional APIs

Non-relational is ideal when:

- Database scale horizontally to handle massive data volume
- Data does not lend itself well to traditional schemas
- Read/write rates exceed what can be economically supported through traditional RDBMS

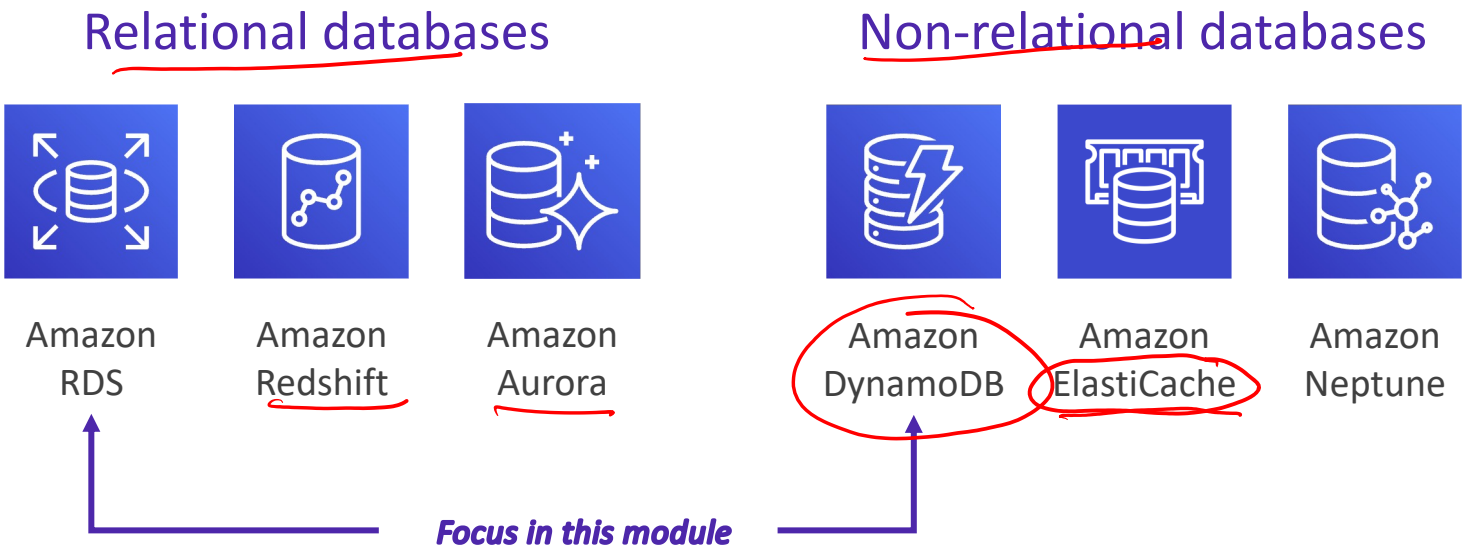
Example models





Amazon database options

More database options exist—these options are common examples



Section 2 key takeaways

- When you choose a database, consider scalability, storage requirements, the type and size of objects to be stored, and durability requirements
- Relational databases have strict schema rules, provide data integrity, and support SQL
- Non-relational databases scale horizontally, provide higher scalability and flexibility, and work well for semistructured and unstructured data

Module 5: Adding a Database Layer

Section 3: Amazon RDS

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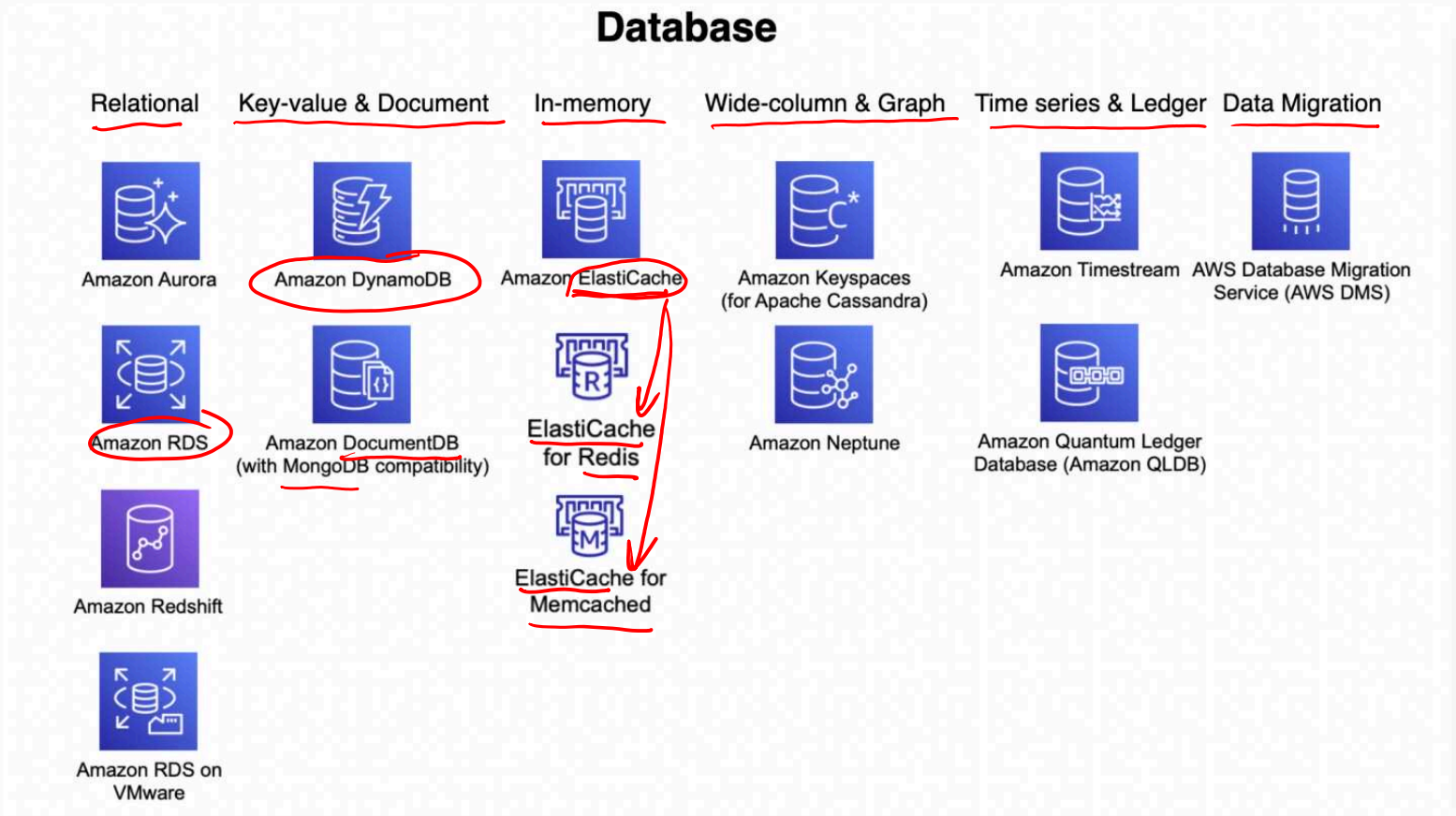
AWS Database Services



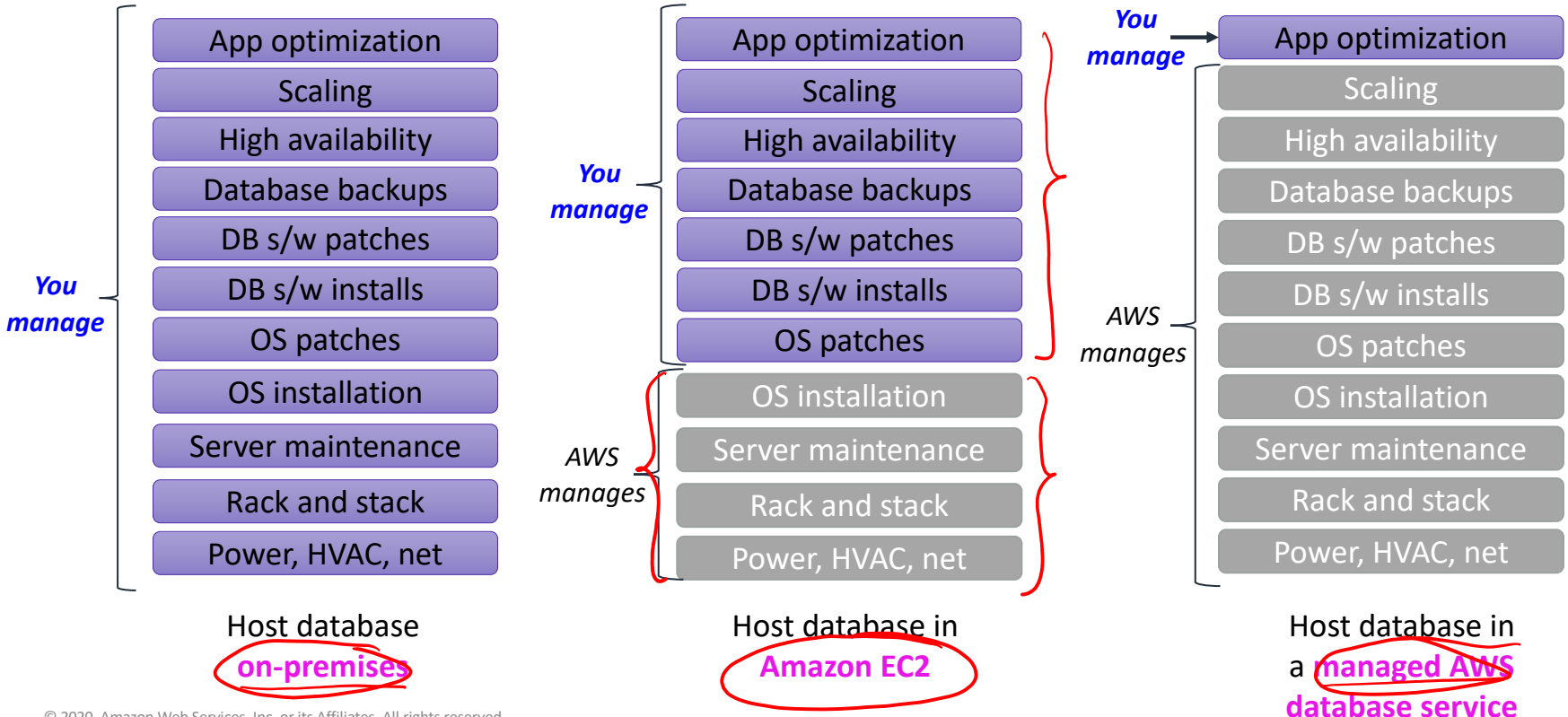
Amazon RDS

Relational

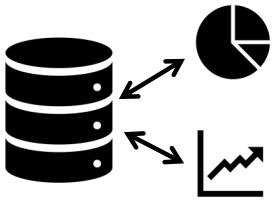
Amazon RDS

Amazon RDS is a fully managed relational database service.

Advantage of managed AWS database services



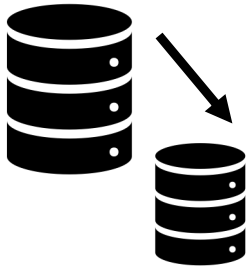
Amazon RDS characteristics



Access pattern

Transactional

Light analytics



Data size

Low-TB range

Performance

Mid to high throughput

Low latency

Business use cases

Transactional

OLTP

RDS

OLAP

Amazon RDS: Uses and database types

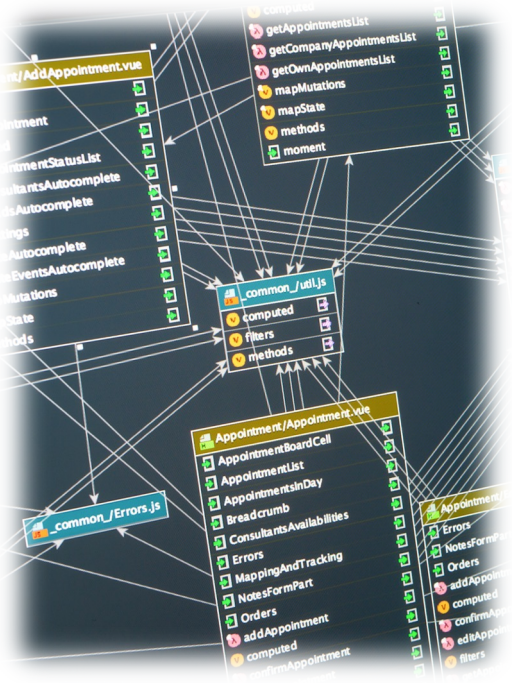
Amazon RDS

Works well for applications that:

- Have more complex and well-structured data
- Need to combine and join datasets
- Need enforced syntax rules

Support six database engines:

- Microsoft SQL Server
- Oracle
- MySQL
- PostgreSQL
- Aurora → AWS
- MariaDB



Question: is RDS a database engine?

RDS instance types (1/2)

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General Purpose

VM / Servers

Professional:

Aurora Serverless

T2 T3

T4g | T3 | T2 | M7g | M6i | M6g | M5 | M5d | M4

Model	Core Count	vCPU	CPU Credits/hour	Memory (GiB)	Network Performance (Gbps)
db.t2.micro	1	1	6	1	Low to Moderate
db.t2.small	1	1	12	2	Low to Moderate
db.t2.medium	2	2	24	4	Low to Moderate
db.t2.large	2	2	36	8	Low to Moderate
db.t2.xlarge	4	4	54	16	Moderate
db.t2.2xlarge	8	8	81	32	Moderate

https://aws.amazon.com/rds/instance-types/

The baseline performance and ability to burst are governed by CPU Credits. T2 instances receive CPU Credits continuously at a set rate depending on the instance size, accumulating CPU Credits when they are idle, and consuming CPU credits when they are active.

One CPU credit equals one vCPU running at 100% utilization for one minute or an equivalent combination of vCPUs, utilization, and time (for example, one vCPU running at 50% utilization for two minutes or two vCPUs running at 25% utilization for two minutes).

https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/burstable-performance-instances-monitoring-cpu-credits.html#

RDS instance types (2/2)

Memory Optimized

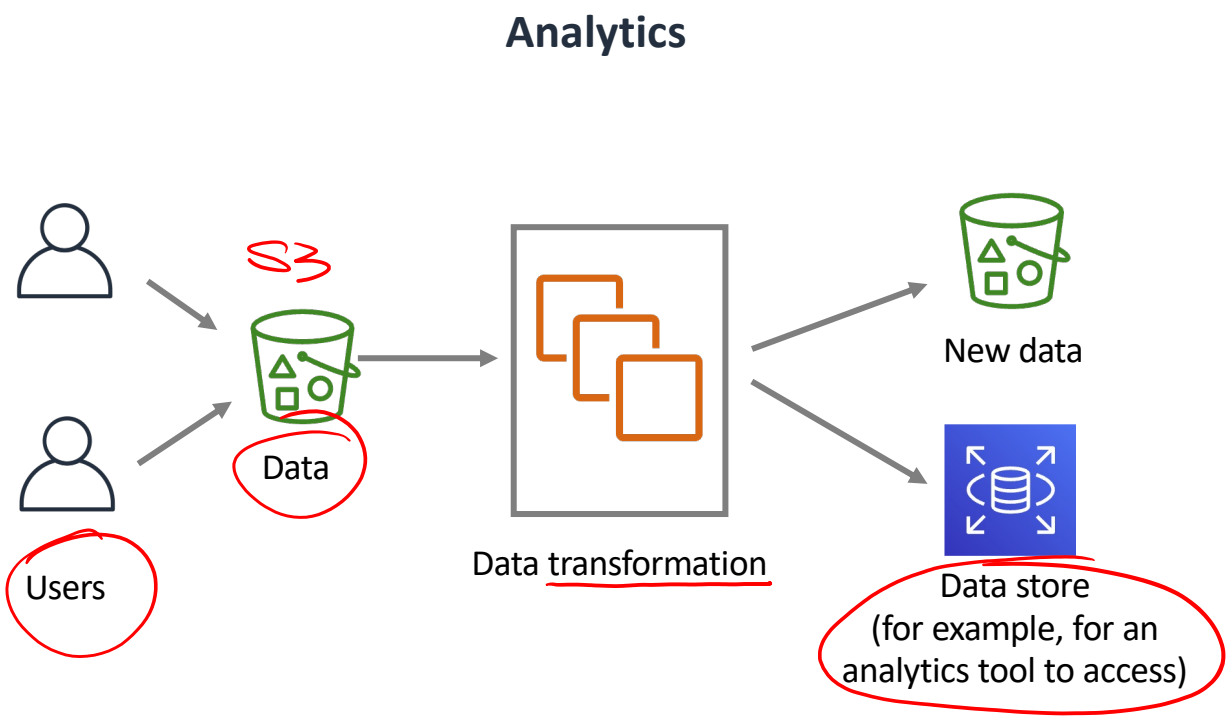
R7g | R6i | R6g | R5 | R5b | R5d | R4 | X2iedn | X2idn | X2g | X1e | X1 | Z1d

Model	Core Count	vCPU	Memory (GiB)	Storage	Dedicated EBS Bandwidth (Gbps)	Networking Performance (Gbps)
db.r7g.large	-	2	16	EBS-Only	Up to 10	Up to 12.5
db.r7g.xlarge	-	4	32	EBS-Only	Up to 10	Up to 12.5
db.r7g.2xlarge	-	8	64	EBS-Only	Up to 10	Up to 15
db.r7g.4xlarge	-	16	128	EBS-Only	Up to 10	Up to 15
db.r7g.8xlarge	-	32	256	EBS-Only	10	15
db.r7g.12xlarge	-	48	384	EBS-Only	15	22.5
db.r7g.16xlarge	-	64	512	EBS-Only	20	30

https://aws.amazon.com/rds/instance-types/

https://instances.vantage.sh/rds/

Amazon RDS: Example use case



AWS RDS Multi-AZ with One Standby (1/2) – Multi-AZ DB Instance Deployment

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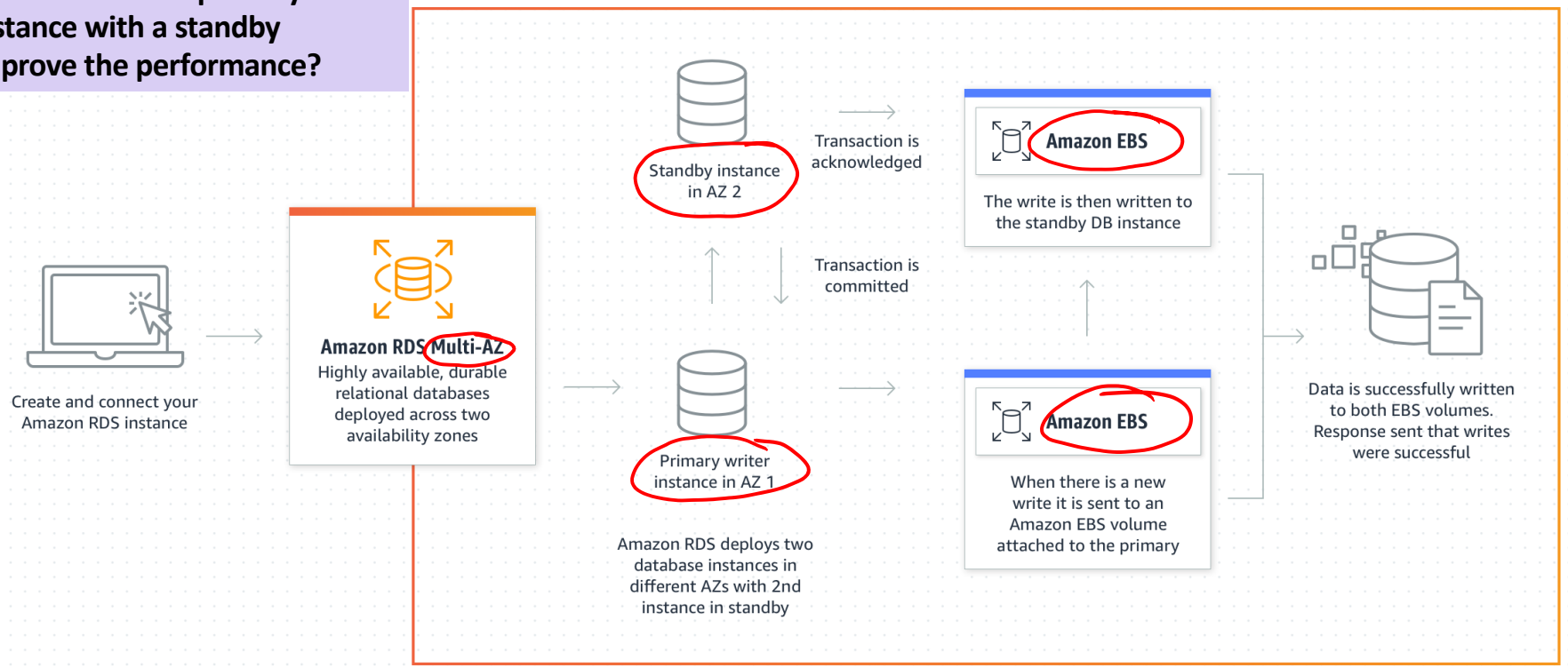
Automatic fail over	Protect database performance	Enhance durability	Increase availability
Support high availability for your application with automatic database failover that completes as quickly as 60 seconds with zero data loss and no manual intervention.	Avoid suspending I/O activity on your primary during backup by backing up from your standby instance.	Use Amazon RDS Multi-AZ synchronous replication technologies to keep data on your standby database instance up to date with the primary.	Enhance availability by deploying a standby instance in a second AZ, and achieve fault tolerance in the event of an AZ or database instance failure.

- Automated failover conditions
  - Loss of availability in primary Availability Zone
  - Loss of network connectivity to primary
  - Compute unit failure on primary
  - Storage failure on primary

DNS

AWS RDS Multi-AZ with One Standby (2/2)

Question: does a primary DB instance with a standby improve the performance?



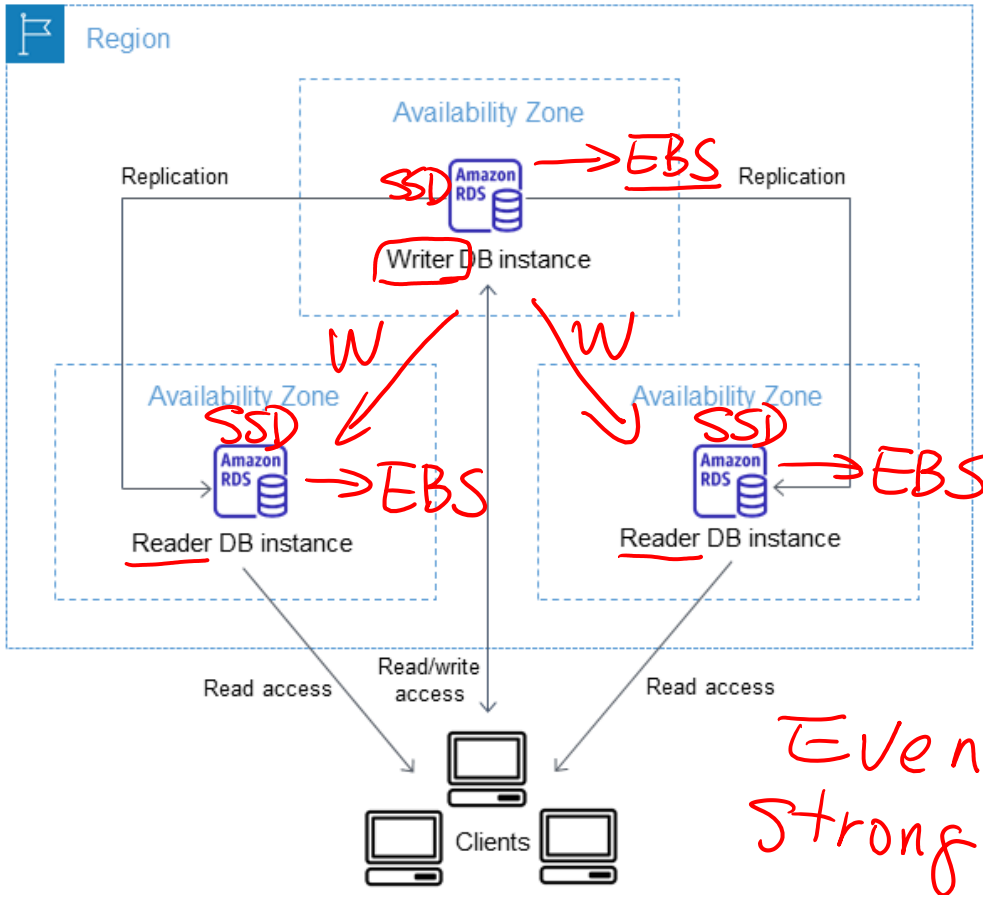
 https://aws.amazon.com/rds/features/multi-az/#:~:text=Use%20Amazon%20RDS%20Multi%2DAZ,AZ%20or%20database%20instance%20failure.

AWS RDS Multi-AZ with Two Readable Standbys (1/2) – Multi-AZ DB Cluster Deployment

Automatically fail over in typically under 35 seconds	Use separate endpoints for reads and writes	Gain up to 2x faster transaction commit latency	Increase read capacity
Automatically failover in typically under 35 seconds with zero data loss and with no manual intervention.	Route queries to write servers and appropriate read replica standby instances to maximize performance and scalability.	Achieve up to 2x improved write latency compared to Multi-AZ with one standby.	Gain read scalability by distributing traffic across two readable standby instances.

AWS RDS Multi-AZ with Two Readable Standbys (2/2)

Question: does a primary DB instance with two readable standbys improve the performance?



Multi-AZ Comparison

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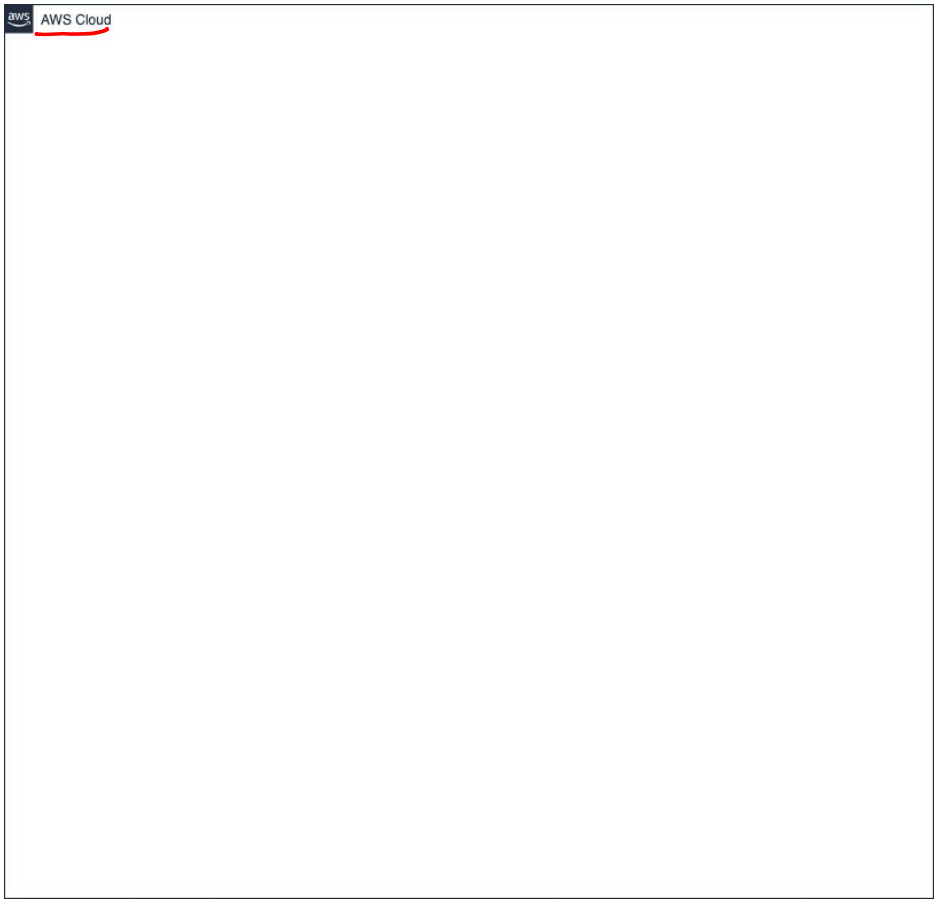
Feature	Single-AZ	Multi-AZ with one standby	Multi-AZ with two readable standbys
Available engines	MariaDB, MySQL, PostgreSQL, Oracle SQL Server	MariaDB, MySQL, PostgreSQL, Oracle, SQL Server	PostgreSQL, MySQL
Additional Read capacity	None: the read capacity is limited to your primary	None: Your standby DB instance is only a passive failover target for high availability	•Two standby DB instances act as failover targets and serve read traffic
Lower latency (higher throughput) for transaction commits			Up to 2x faster transaction commits compared to Amazon RDS Multi-AZ with one standby
Automatic failover duration	•Not available: a user, a user-initiated point-in-time-restore operation will be required. •This operation can take several hours to complete •Any data updates that occurred after the latest restorable time (typically within the last 5 minutes) will not be available	•A new primary is available to serve your new workload in as quickly as 60 seconds •Failover time is independent of write throughput	•A new primary is available to serve your new workload in typically under 35 seconds •Failover time depends on length of replica lag
Higher resiliency to AZ outage	•None: in the event of an AZ failure, your risk data loss and hours of failover time	•In the event of an AZ failure, your workload will automatically failover to the up-to-date standby	•In the event of a failure, one of the two remaining standbys will takeover and serve the workload

Demonstration: Create an Amazon RDS Database

https://www.youtube.com/watch?v=9L-gxoSDZv8

3-tier application architecture



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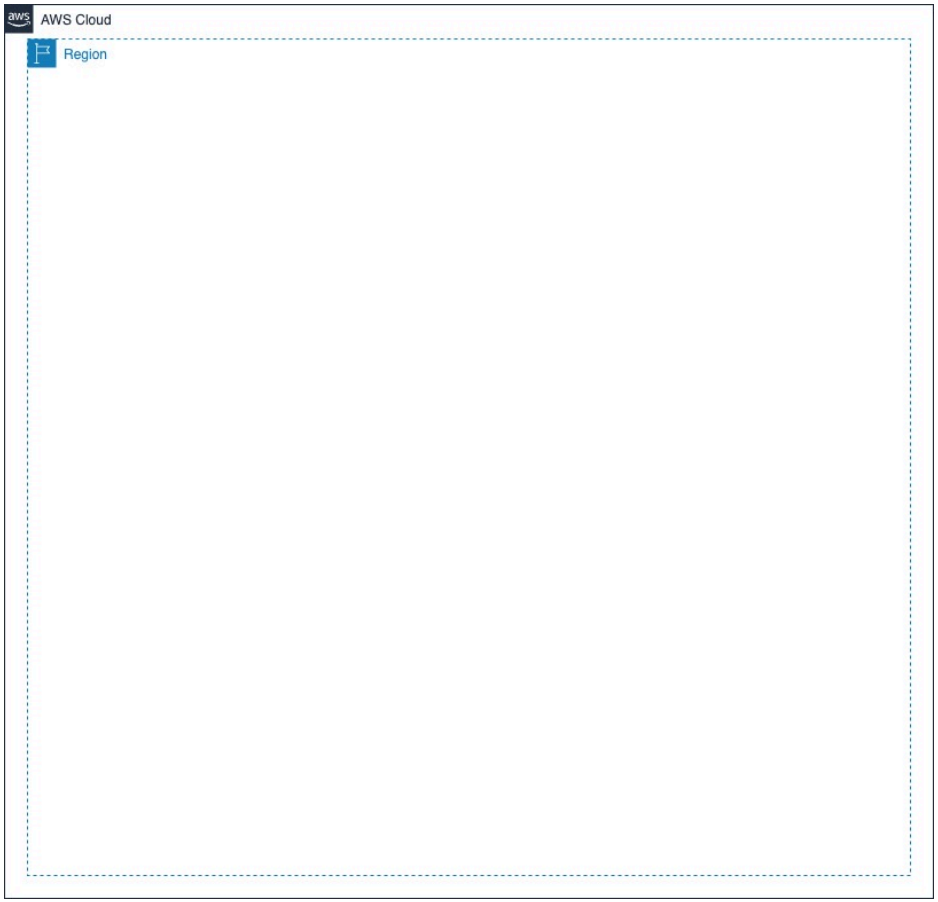

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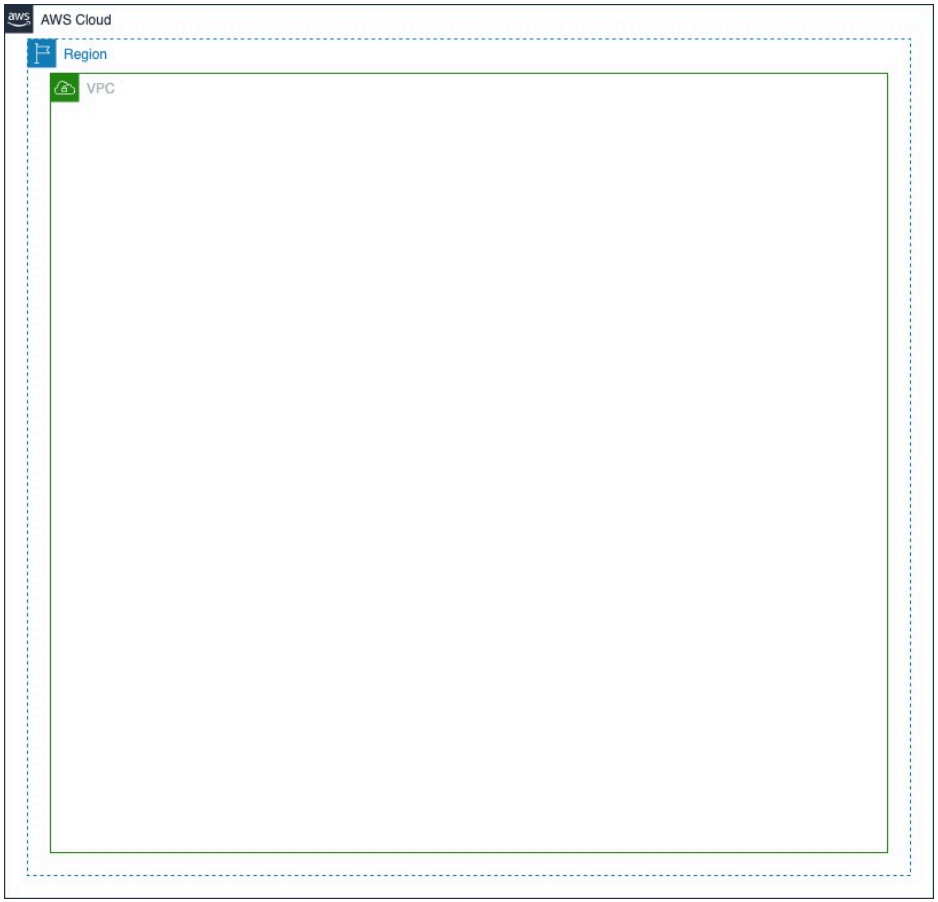

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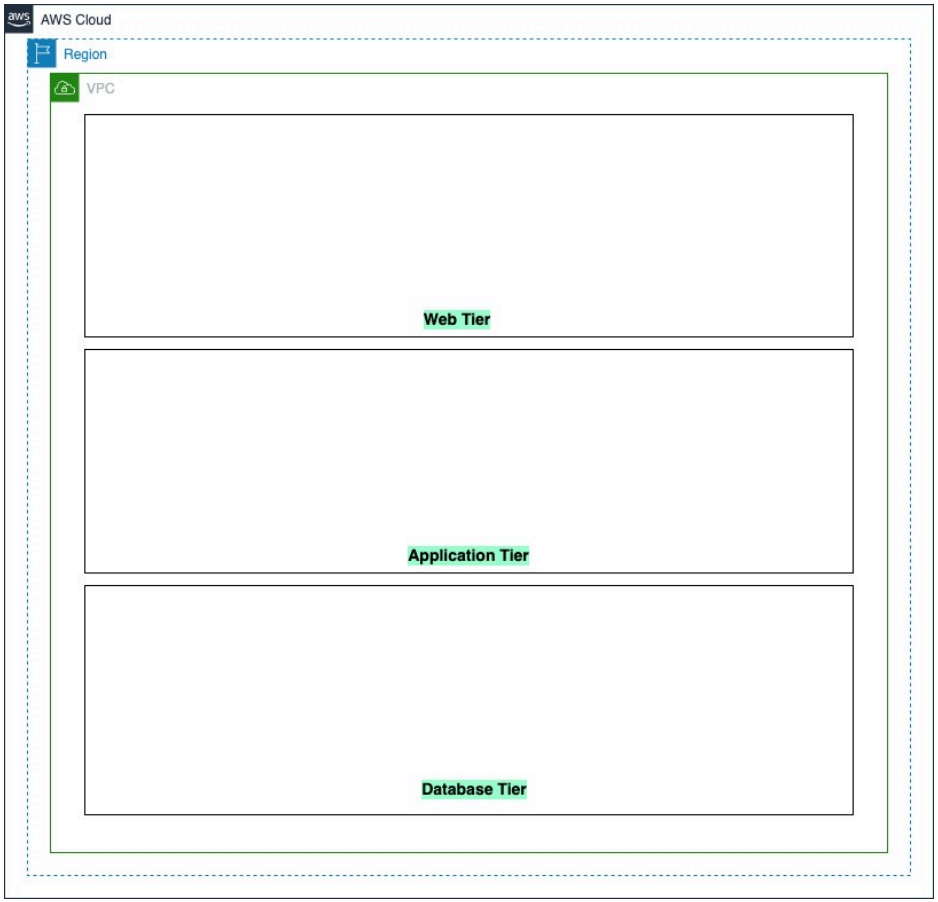

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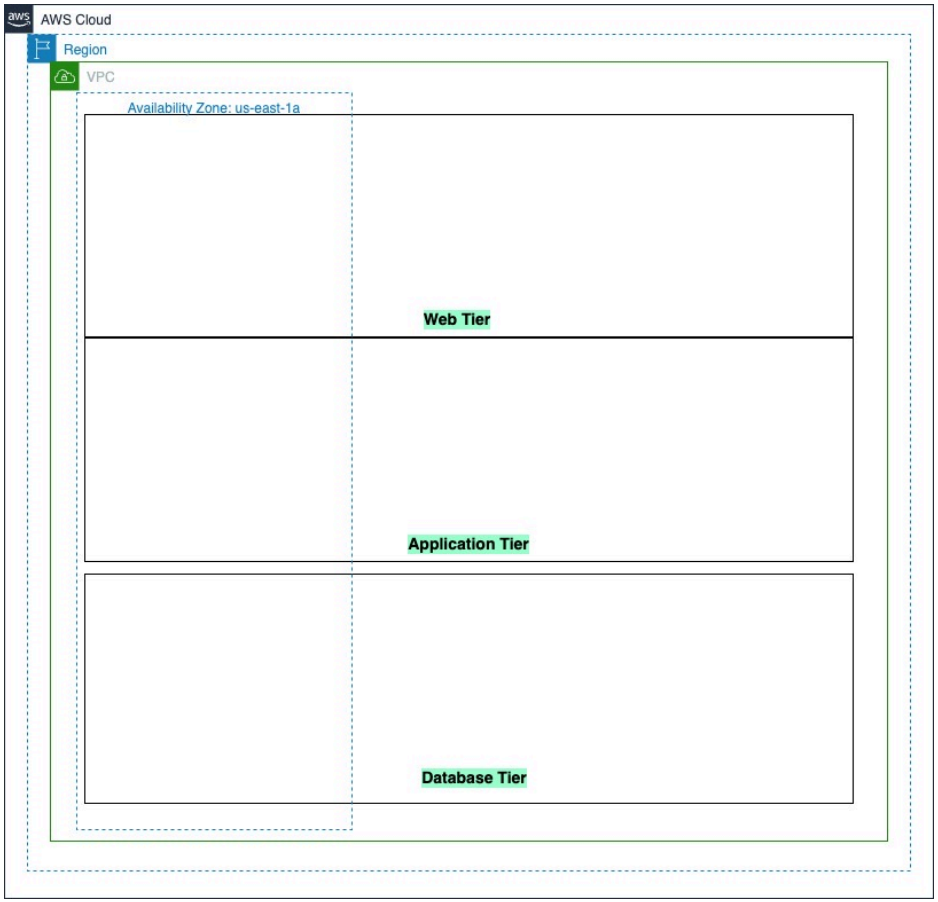

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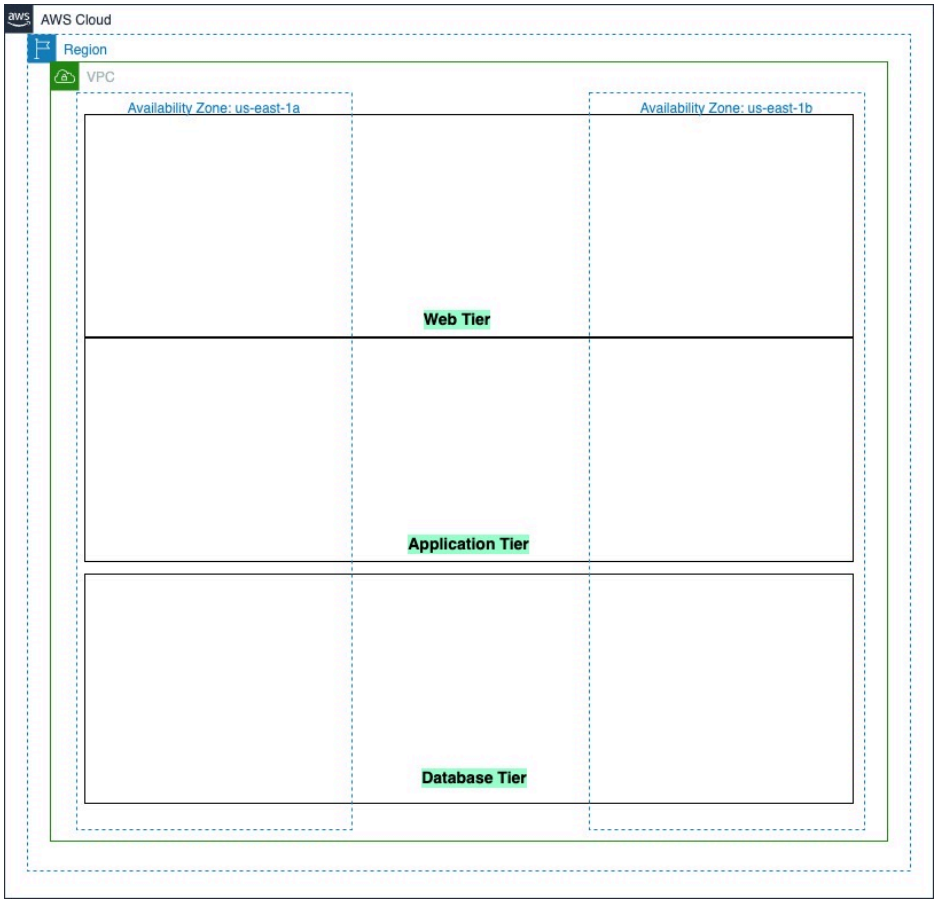

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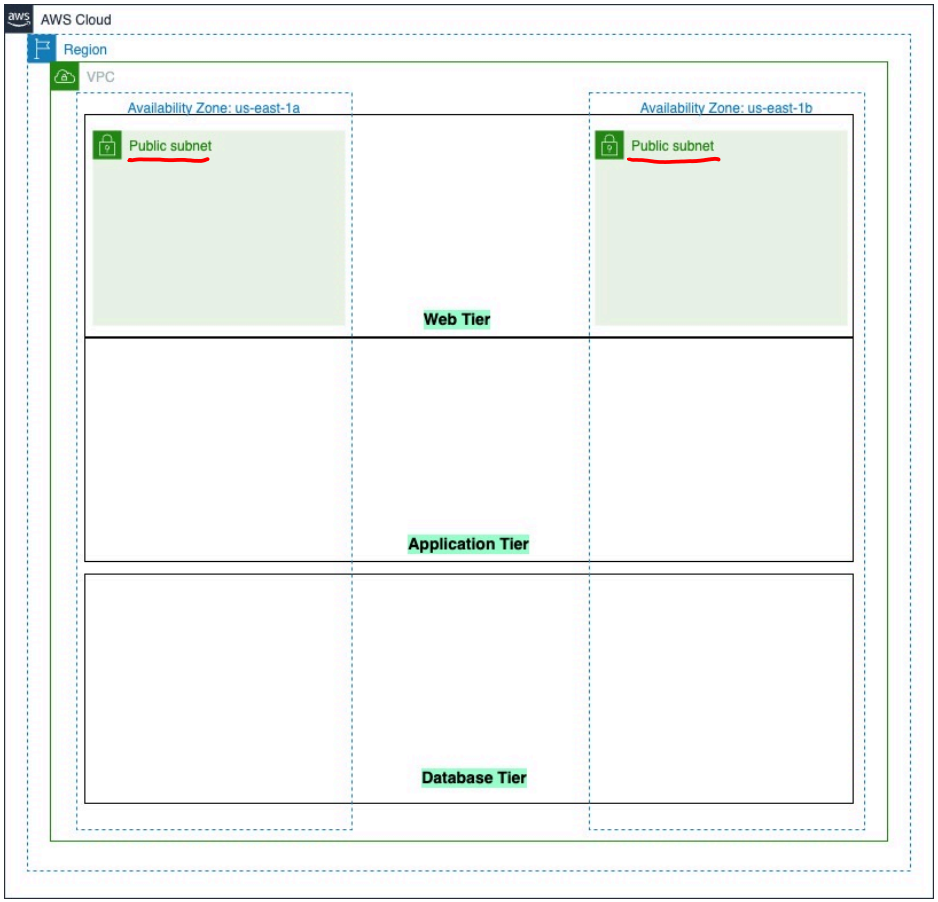

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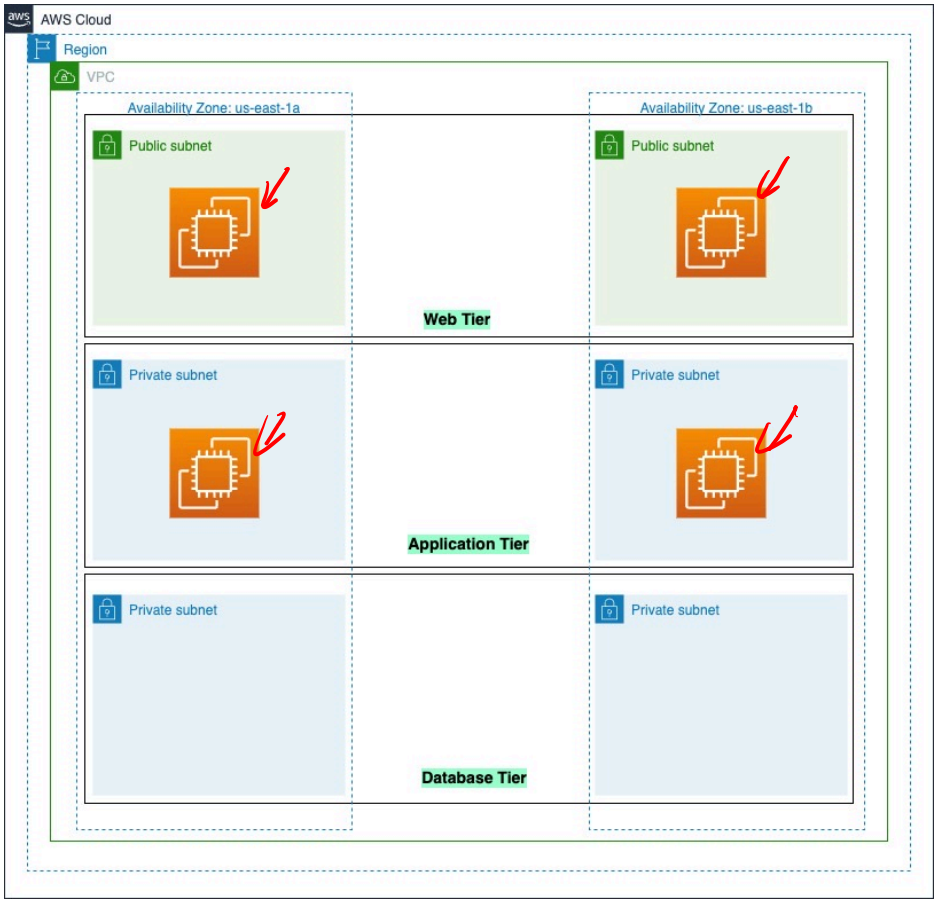

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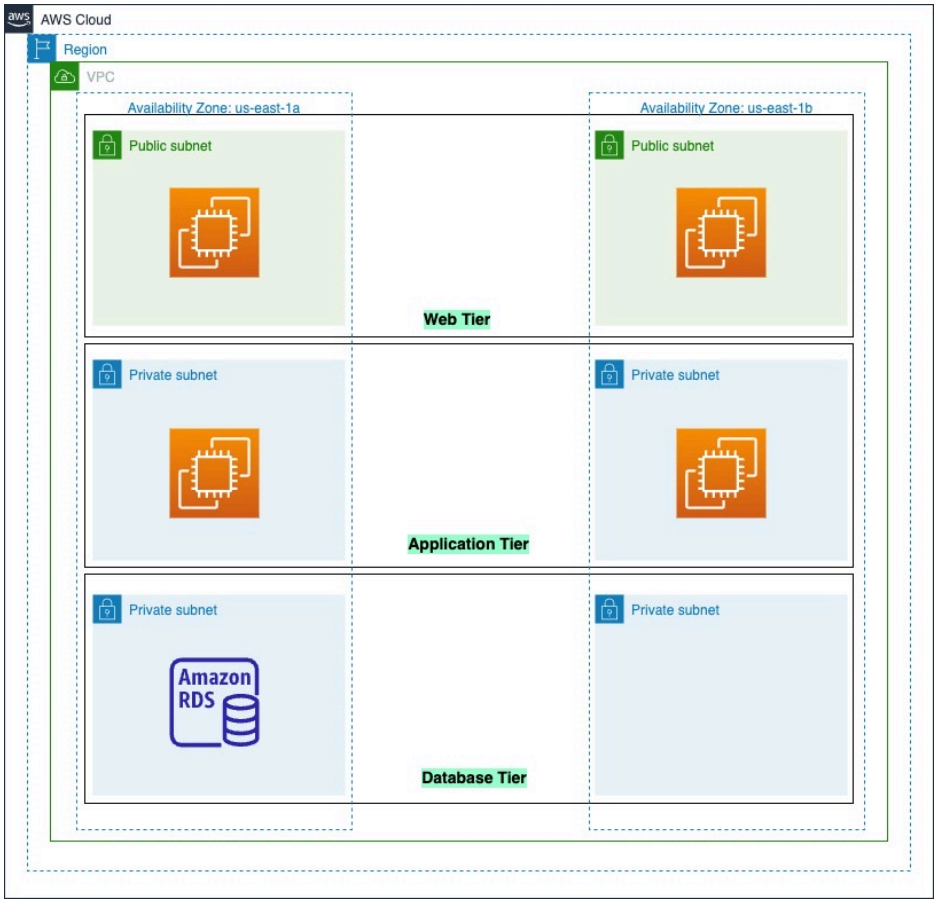

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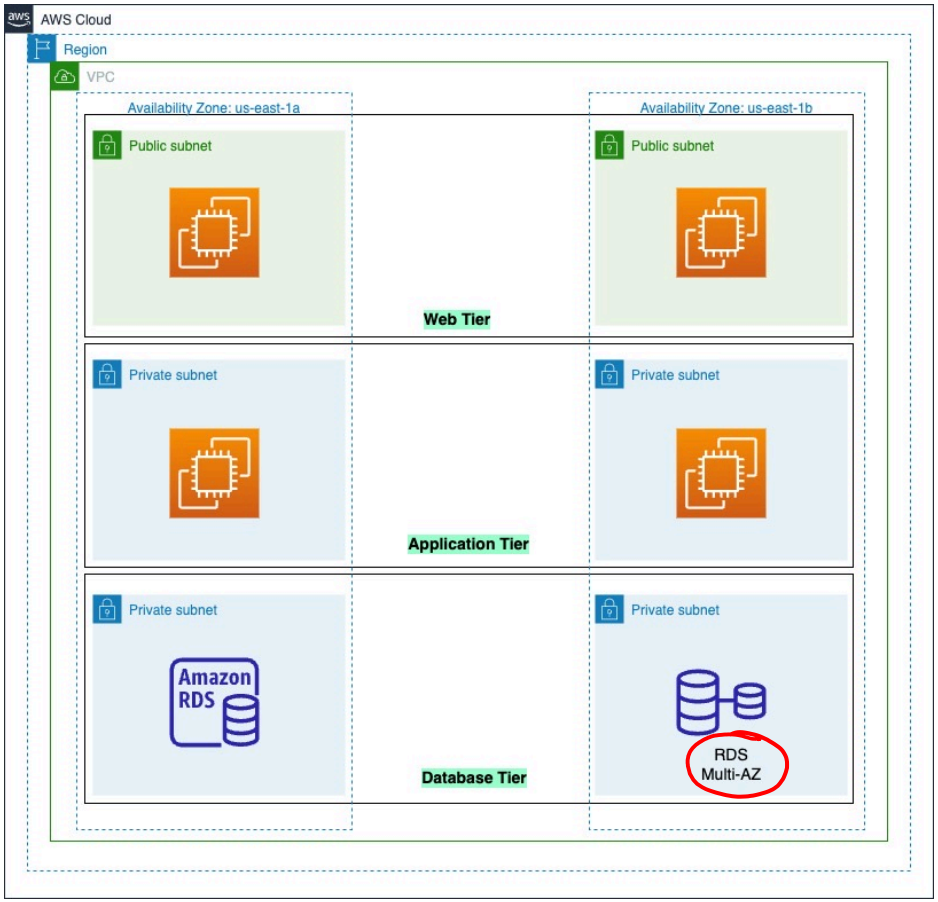

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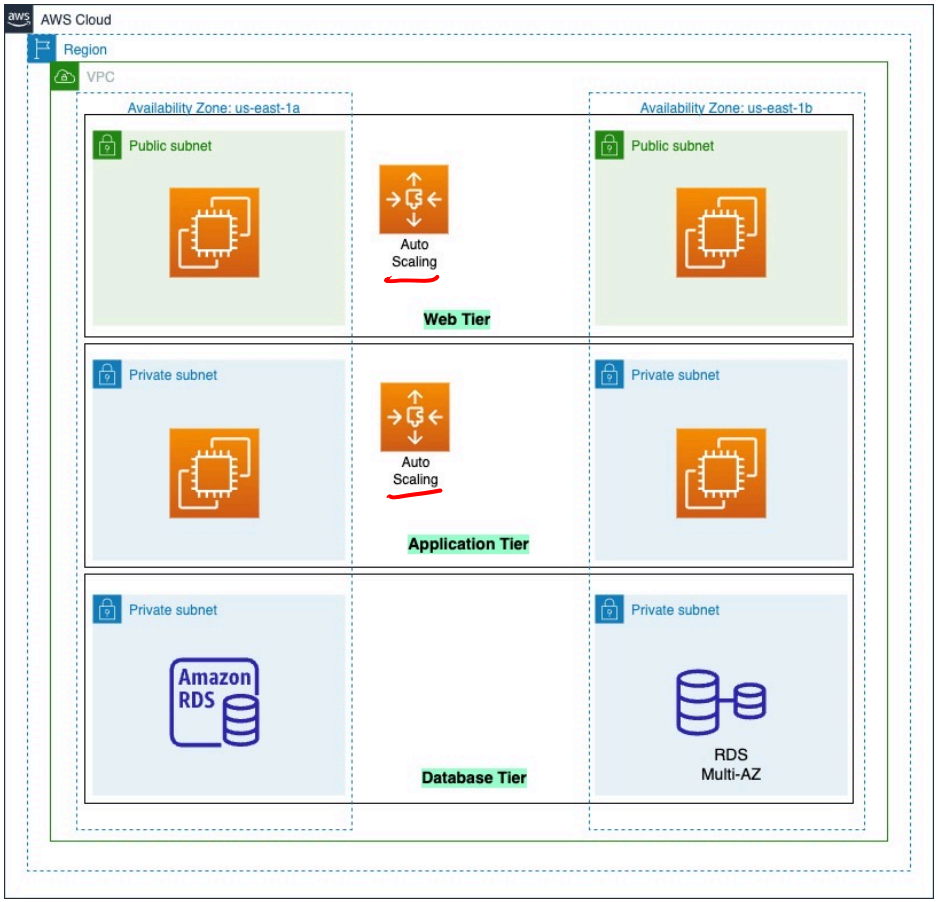

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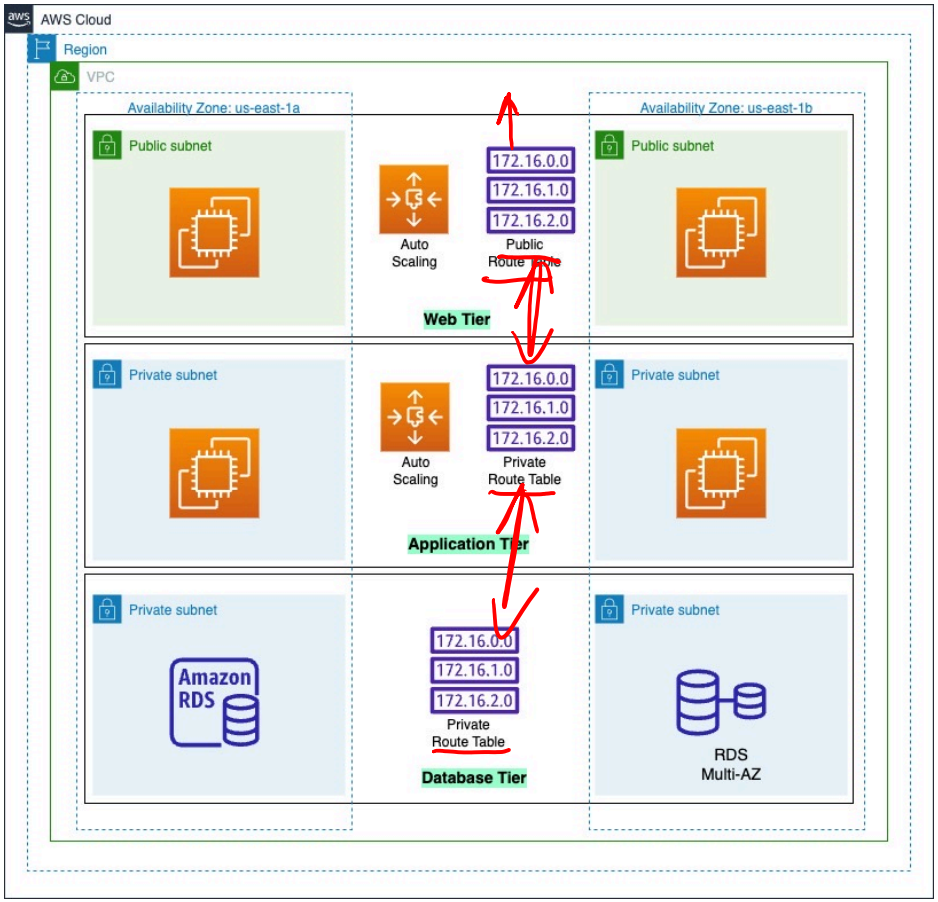

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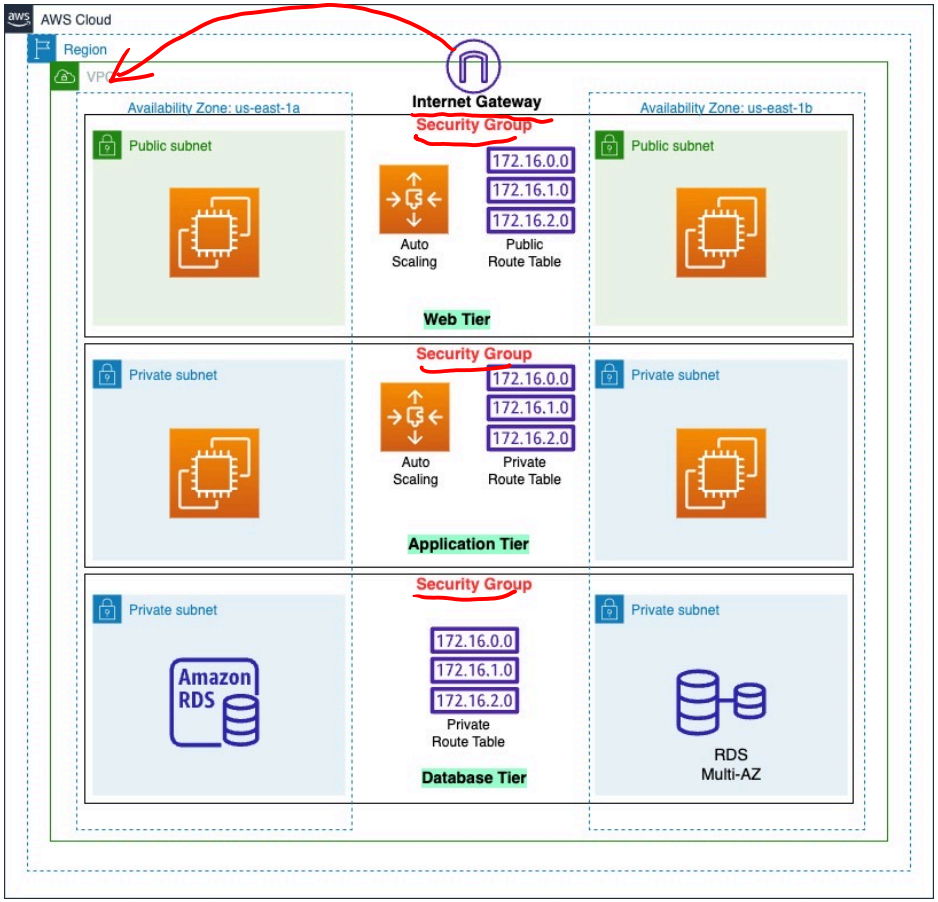
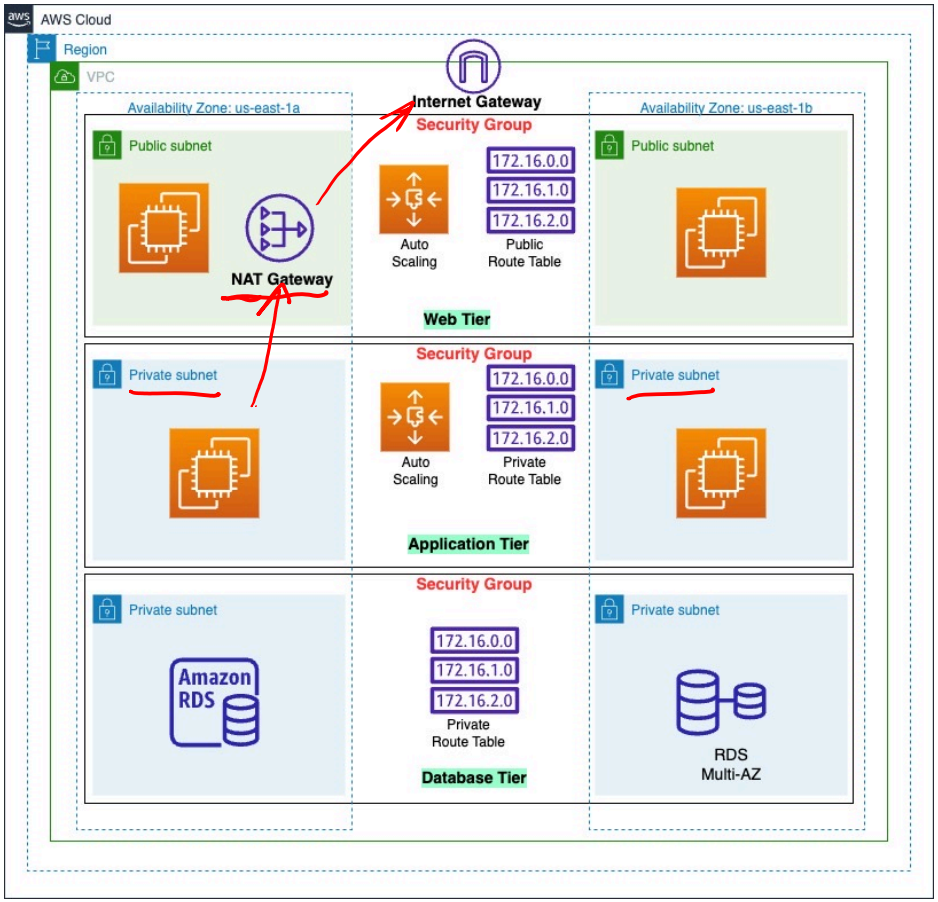
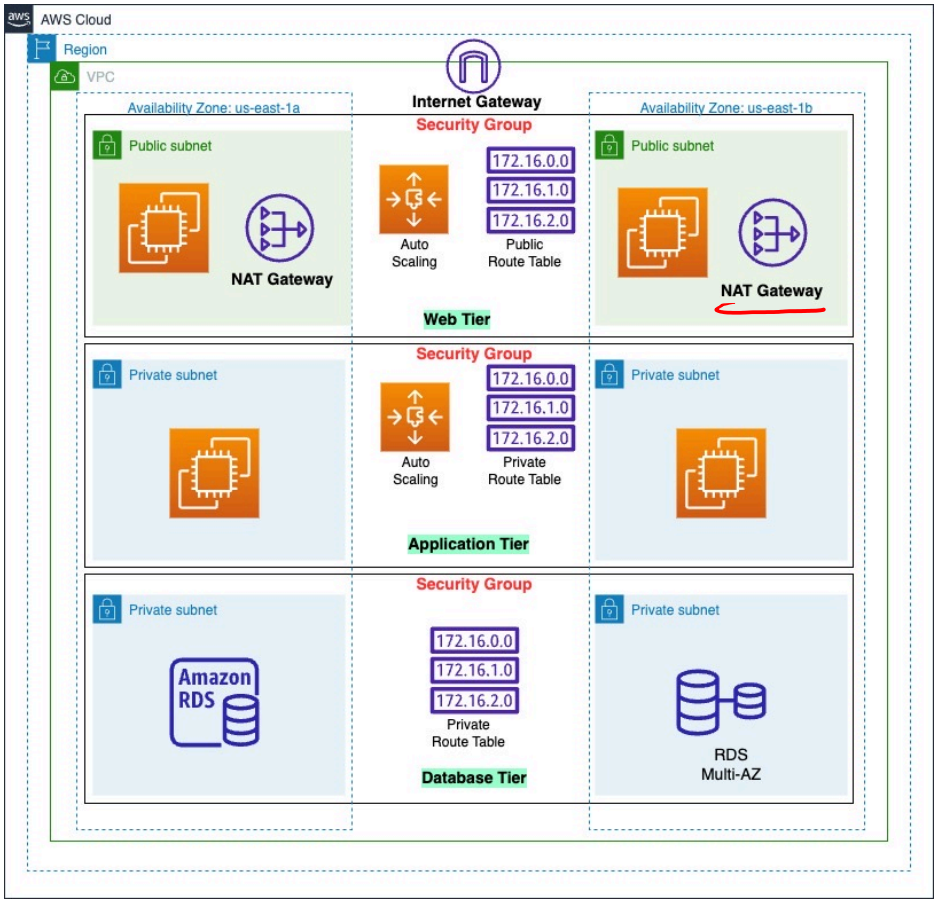


3-tier application architecture



3-tier application architecture



3-tier application architecture

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Optional lab:

https://medium.com/@emorancloud/designing-3-tier-architecture-in-aws-7c756cfc6e3c

Thank you, and Kahoot!

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