



Ministry of Communications  
and Information Technology



# Building a Highly Available, Scalable Web Application Project

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**Abstract:**

This project aims to develop a highly scalable and available web application using AWS services. The solution leverages Amazon EC2 for web hosting and Amazon RDS for data storage. It incorporates load balancing with an Application Load Balancer (ALB), automatic scaling with an Auto Scaling Group (ASG), and high availability through multi-AZ deployments. Security measures include the use of Amazon VPC, Security Groups, and AWS Secrets Manager to ensure robust, secure credential management.

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## **I. Introduction**

### **1. Overview of the project**

The goal of this project is to build a highly available, scalable, and secure web application using Amazon Web Services (AWS). The application is designed to handle high volumes of traffic while ensuring minimal downtime, robust performance, and optimal cost management.

To achieve this, the project utilizes Amazon EC2 for hosting the web application and Amazon RDS (MySQL) for managing the database. Traffic management is handled by an Application Load Balancer (ALB), ensuring even distribution of user requests across multiple instances. An Auto Scaling Group (ASG) is implemented to dynamically adjust the number of EC2 instances based on traffic demand, allowing the application to scale seamlessly during peak usage periods.

Additionally, the architecture is designed with security in mind, leveraging Amazon VPC for network isolation, Security Groups for access control, and AWS Secrets Manager for secure management of sensitive data such as database credentials. The solution also incorporates high availability by deploying resources across multiple Availability Zones (AZs), ensuring uptime and resilience in case of failures.

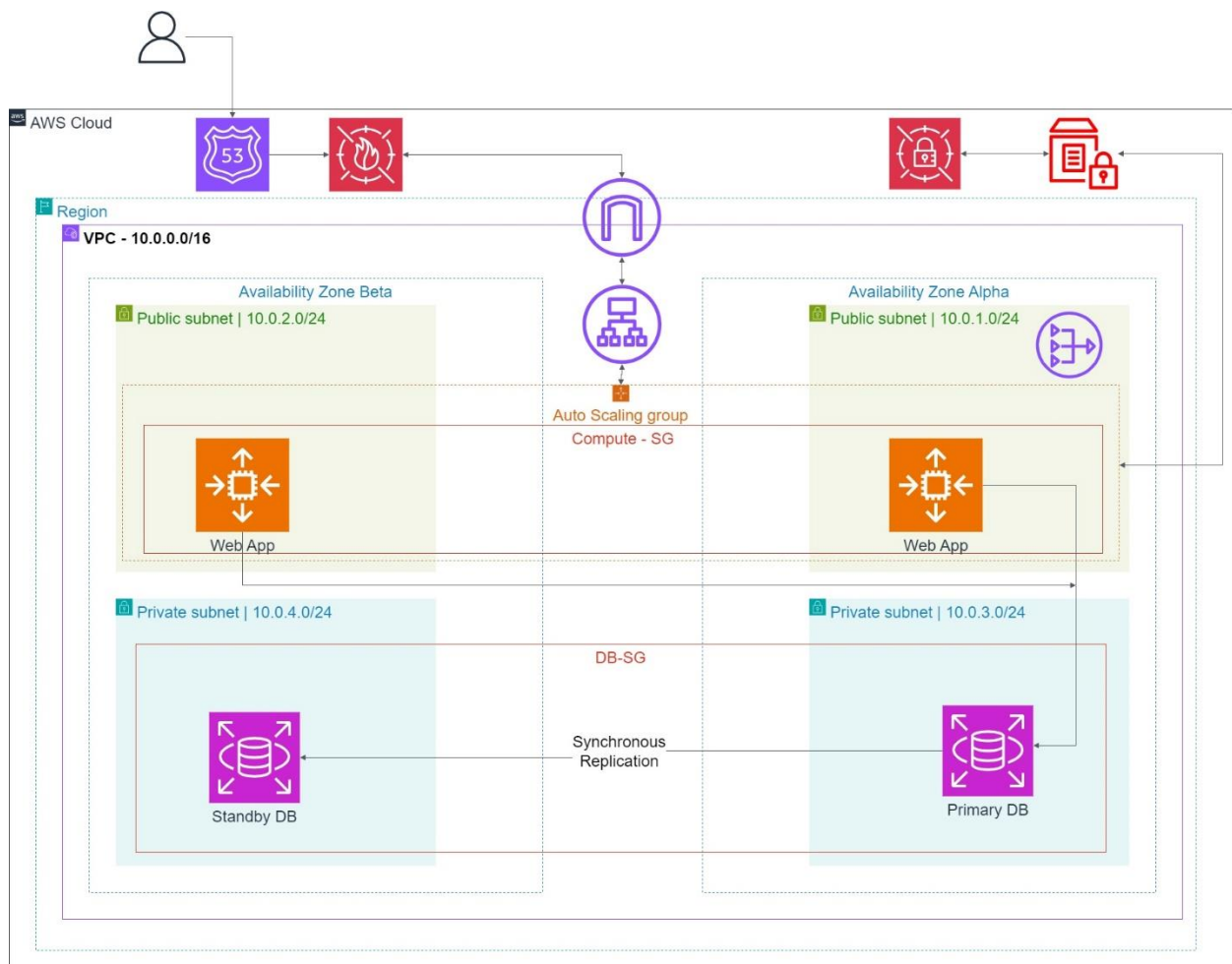
This project ensures that the web application is highly available, scalable, and cost-efficient while providing a secure environment for managing sensitive data and user interactions.

## **2. Objectives of the solution**

- a) High Availability: Ensure that the web application is accessible with minimal downtime by deploying resources across multiple Availability Zones (AZs). This design allows the application to remain operational even in the event of server or zone failures.
- b) Scalability: Implement dynamic scaling mechanisms that automatically adjust the number of running instances based on user demand. This ensures that the application can handle varying levels of traffic, especially during peak periods, without over-provisioning or underutilizing resources.
- c) Load Balancing: Use an Application Load Balancer (ALB) to evenly distribute incoming traffic across multiple EC2 instances. This helps prevent resource overload, optimizing performance and fault tolerance.
- d) Security: Ensure the application and database are secured using Amazon VPC for network isolation, Security Groups for controlling access, and AWS Secrets Manager for securely managing sensitive credentials like database login information.

- e) Cost Optimization: Use AWS services such as Auto Scaling and Amazon RDS to ensure cost efficiency by scaling resources only when necessary and reducing infrastructure costs during periods of low demand.
- f) Data Management: Deploy Amazon RDS (MySQL) to handle student or user records efficiently, providing reliable, managed database services that ensure data integrity, backup automation, and performance optimization.

### 3. Architecture Diagram



## 4. Functional Requirements

### 4.1 Web Hosting:

- **Amazon EC2:** Instances used to host the web application. The application is deployed on Linux (Ubuntu) servers within a Virtual Private Cloud (VPC).

### 4.2 Database Management:

- **Amazon RDS (MySQL):** Used to store and manage data. The database is deployed in a private subnet for enhanced security.

## 5. Load Balancing

- **Application Load Balancer (ALB):** Distributes incoming traffic evenly across multiple EC2 instances, ensuring fault tolerance and better scalability.

## 6. Scalability

- **Auto Scaling Group (ASG):** Automatically adjusts the number of EC2 instances based on real-time user traffic, scaling out during high traffic and scaling in during low traffic periods.

## 7. High Availability

- The application ensures high availability by using both ALB and ASG across multiple Availability Zones (AZs) to handle server or AZ failures without downtime.

## 8. Security

- **Amazon VPC:** Provides network isolation for secure hosting.
  - **Security Groups:** Regulate inbound/outbound traffic for EC2 and RDS instances.
  - **AWS Secrets Manager:** Manages database credentials, ensuring they are securely accessed by the application without hardcoding sensitive information.
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## II. Cost Analysis

A cost estimate for running the architecture on AWS for 12 months is calculated using the AWS Pricing Calculator.

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My Estimate - AWS Pricing Calculator

Contact your AWS representative: [Contact Sales](#)



Export date: 10/23/2024

Language: English

Estimate URL: <https://calculator.aws/#/estimate?id=a5efbed5dfa30698750b6845d07c4cc2e6239fe9>

### Estimate summary

Upfront cost	Monthly cost	Total 12 months cost
0.00 USD	611.78 USD	7,341.36 USD
		Includes upfront cost

### Detailed Estimate

Name	Group	Region	Upfront cost	Monthly cost
Amazon Virtual Private Cloud (VPC)	No group applied	US East (N. Virginia)	0.00 USD	36.68 USD
<b>Status:</b> -				
<b>Description:</b>				
<b>Config summary:</b> Number of NAT Gateways (1) Number of In-use public IPv4 addresses (1)				
Amazon EC2	No group applied	US East (N. Virginia)	0.00 USD	8.47 USD
<b>Status:</b> -				
<b>Description:</b>				
<b>Config summary:</b> Tenancy (Shared Instances), Operating system (Linux), Workload (Consistent, Number of instances: 2), Advance EC2 instance (t2.micro), Pricing strategy (Compute Savings Plans 3yr No Upfront), Enable monitoring (disabled), DT Inbound: Not selected (0 TB per month), DT Outbound: Not selected (0 TB per month), DT Intra-Region: (0 TB per month)				
Amazon RDS for MySQL	No group applied	US East (N. Virginia)	0.00 USD	358.80 USD
<b>Status:</b> -				
<b>Description:</b>				
<b>Config summary:</b> Storage amount (100 GB), Storage for each RDS instance (General Purpose SSD (gp2)), Nodes (1), Instance type (db.m1.large), Utilization (On-Demand only) (100 %Utilized/Month), Deployment option (Multi-AZ), Pricing strategy (OnDemand)				



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My Estimate - AWS Pricing Calculator

<b>AWS Secrets Manager</b>	No group applied	US East (N. Virginia)	0.00 USD	5.40 USD
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Status: -

Description:

**Config summary:** Number of secrets (1), Average duration of each secret (30 days), Number of API calls (1000000 per month)

<b>Amazon Route 53</b>	No group applied	US East (N. Virginia)	0.00 USD	40.00 USD
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Status: -

Description:

<b>Elastic Load Balancing</b>	No group applied	US East (N. Virginia)	0.00 USD	162.43 USD
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Status: -

Description:

**Config summary:** Number of Application Load Balancers (1)

#### Acknowledgement

AWS Pricing Calculator provides only an estimate of your AWS fees and doesn't include any taxes that might apply. Your actual fees depend on a variety of factors, including your actual usage of AWS services. [Learn more](#) 

This includes the costs for EC2, RDS, ALB, and other related services.

### III. Implementation Steps




#### 1. VPC Creation: Set up a Virtual Private Cloud with public and private subnets.

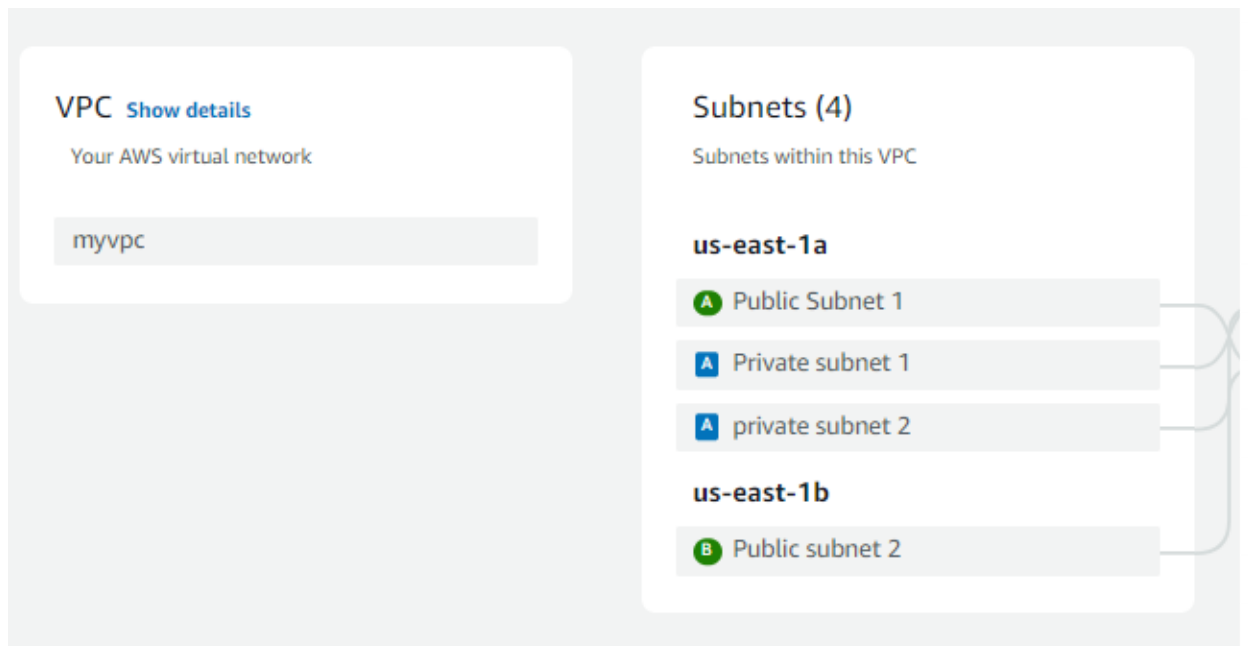
<input checked="" type="checkbox"/>	Name	VPC ID	State	IPv4 CIDR	IPv6 CIDR	DHCP option set	Main route table	Main network ACL
<input checked="" type="checkbox"/>	myvpc	<a href="#">vpc-04d9a5d2c464e6f05</a>	Available	10.0.0.0/16	-	<a href="#">dopt-06ab68cd50ff74e8e</a>	<a href="#">rtb-007185c6035228f54</a>	<a href="#">acl-08a22f807623b2ca0</a>
<input type="checkbox"/>	-	<a href="#">vpc-0f7a98e5ff598cf26</a>	Available	172.31.0.0/16	-	<a href="#">dopt-06ab68cd50ff74e8e</a>	<a href="#">rtb-005b0138d7701950c</a>	<a href="#">acl-0b479012c5a6e0d5f</a>

vpc-04d9a5d2c464e6f05 / myvpc

[Details](#) [Resource map](#) [CIDRs](#) [Flow logs](#) [Tags](#) [Integrations](#)

#### Details

VPC ID  vpc-04d9a5d2c464e6f05	State  Available	DNS hostnames Enabled	DNS resolution Enabled
Tenancy Default	DHCP option set <a href="#">dopt-06ab68cd50ff74e8e</a>	Main route table <a href="#">rtb-007185c6035228f54</a>	Main network ACL <a href="#">acl-08a22f807623b2ca0</a>
Default VPC No	IPv4 CIDR 10.0.0.0/16	IPv6 pool -	IPv6 CIDR (Network border group) -
Network Address Usage metrics Disabled	Route 53 Resolver DNS Firewall rule groups -	Owner ID  152141034264	



## 2. Security Group Configuration: Define Security Groups to control access to the EC2 and RDS instances.

### Security Groups (8) [Info](#)

Find resources by attribute or tag

<input type="checkbox"/>	Name ▾	Security group ID ▾	Security group name ▾
<input type="checkbox"/>	-	<a href="#">sg-0665b85f37db31c84</a>	ALB-SG
<input type="checkbox"/>	-	<a href="#">sg-02c032ba2067f4424</a>	launch-wizard-1
<input type="checkbox"/>	-	<a href="#">sg-02510beca681ab57b</a>	ec2-rds-1
<input type="checkbox"/>	-	<a href="#">sg-0781496be4b398163</a>	DBSG
<input type="checkbox"/>	aws-cloud9-CloudN...	<a href="#">sg-03e0ec4e247a5a85c</a>	aws-cloud9-CloudNineInstance-948de...
<input type="checkbox"/>	-	<a href="#">sg-0effbd33d38b42d77</a>	rds-ec2-1
<input type="checkbox"/>	-	<a href="#">sg-03afed581e3a4c9a2</a>	default
<input type="checkbox"/>	-	<a href="#">sg-029c1a2246c67397b</a>	default

Description ▾	Owner ▾	Inbound rules count
Allow internet traffic via ALB	152141034264	1 Permission entry
launch-wizard-1 created 2024-10-23T...	152141034264	5 Permission entries
Security group attached to instances t...	152141034264	0 Permission entries
DatabaseSecurityGroup	152141034264	1 Permission entry
Security group for AWS Cloud9 enviro...	152141034264	2 Permission entries
Security group attached to STUDENTS...	152141034264	1 Permission entry
default VPC security group	152141034264	1 Permission entry
default VPC security group	152141034264	1 Permission entry

### 3. EC2 Deployment: Launch EC2 instances for the web application in the public subnet.

The screenshot displays the AWS Management Console interface for the EC2 service. The left-hand navigation pane includes sections for 'Instances', 'Images', and 'Elastic Block Store'. The 'Instances' section is expanded, showing a list of instance types and templates. The main content area, titled 'Instances (4)', contains a search bar and a table of instances. The instance 'Public Website' is highlighted. Below the table, a 'Select an instance' button is visible. At the bottom of the console, the 'Instance summary for i-041e237c62a8555ee (Public Website)' is shown, providing detailed information about the instance's configuration and status.

**Instances (4)** Info

Find Instance by attribute or tag (case-sensitive)

<input type="checkbox"/>	Name
<input type="checkbox"/>	CapstoneAppServer
<input type="checkbox"/>	Public Website
<input type="checkbox"/>	
<input type="checkbox"/>	aws-cloud9-CloudNineInstance-948dedacf3514d6e9a98ba8a2d8ad8de

Select an instance

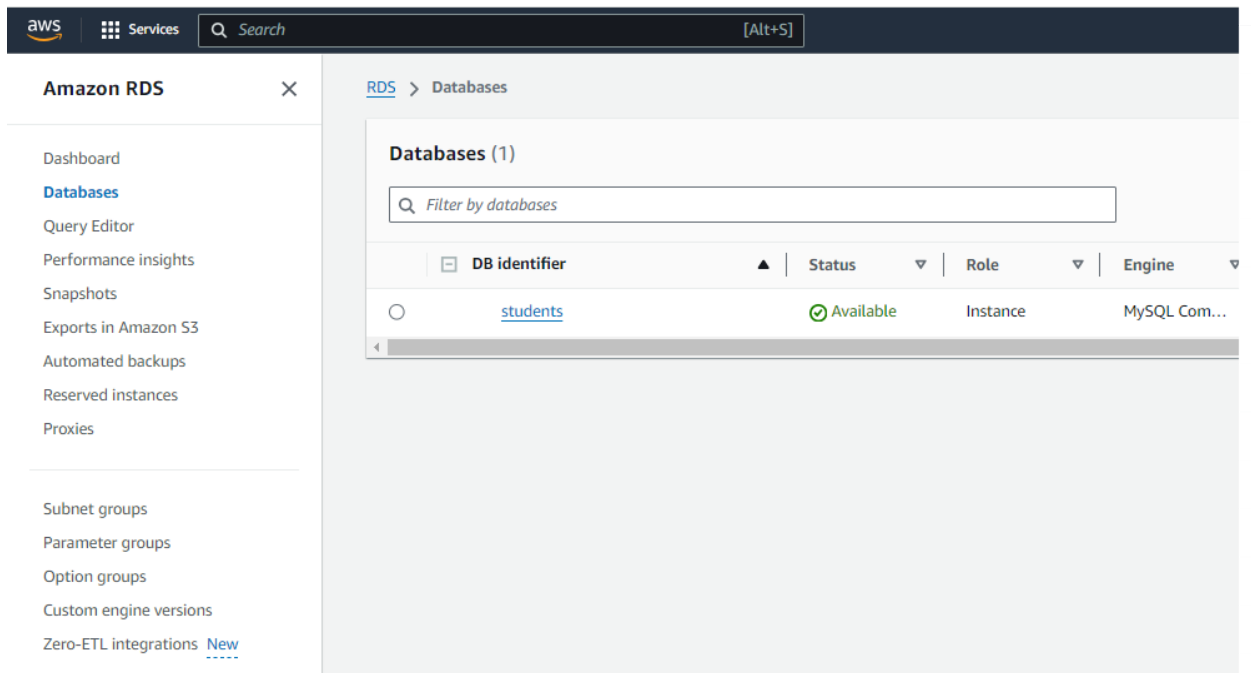
EC2 > Instances > i-041e237c62a8555ee

**Instance summary for i-041e237c62a8555ee (Public Website)** Info

Updated less than a minute ago

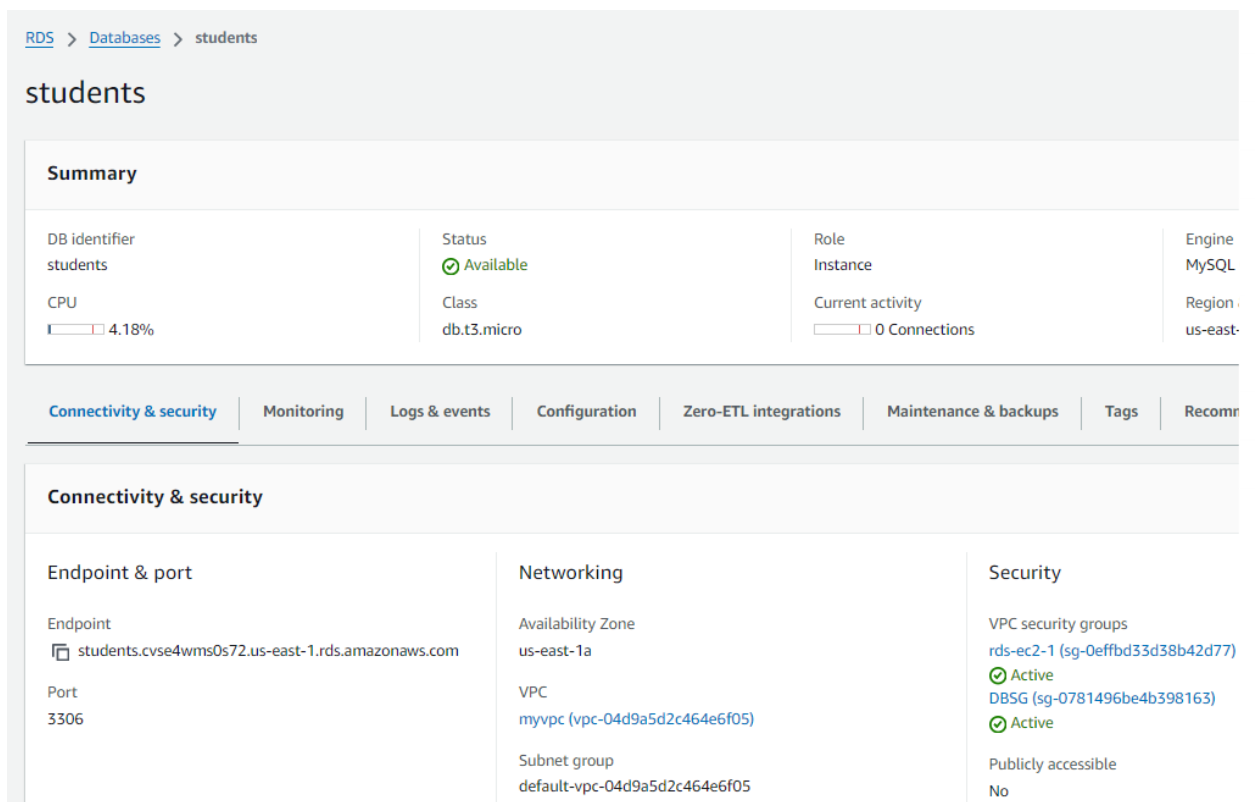
Instance ID i-041e237c62a8555ee	Public IPv4 address 98.82.171.135   <a href="#">open address</a>
IPv6 address -	Instance state Running
Hostname type IP name: ip-10-0-1-65.ec2.internal	Private IP DNS name (IPv4 only) ip-10-0-1-65.ec2.internal
Answer private resource DNS name -	Instance type t2.micro
Auto-assigned IP address 98.82.171.135 [Public IP]	VPC ID vpc-04d9a5d2c464e6f05 (myvpc)
IAM Role LabRole	Subnet ID subnet-047d1956691417e0c (Public Subnet 1)
IMDSv2 Required	Instance ARN arn:aws:ec2:us-east-1:152141034264:instance/i-041e237c62a8555ee

#### 4. Amazon RDS Setup: Deploy an RDS instance (MySQL) in the private subnet..



The screenshot shows the Amazon RDS console. The left sidebar lists navigation options: Dashboard, Databases, Query Editor, Performance insights, Snapshots, Exports in Amazon S3, Automated backups, Reserved instances, Proxies, Subnet groups, Parameter groups, Option groups, Custom engine versions, and Zero-ETL integrations. The main content area is titled 'Databases (1)' and contains a table with the following data:

DB identifier	Status	Role	Engine
<a href="#">students</a>	Available	Instance	MySQL Com...



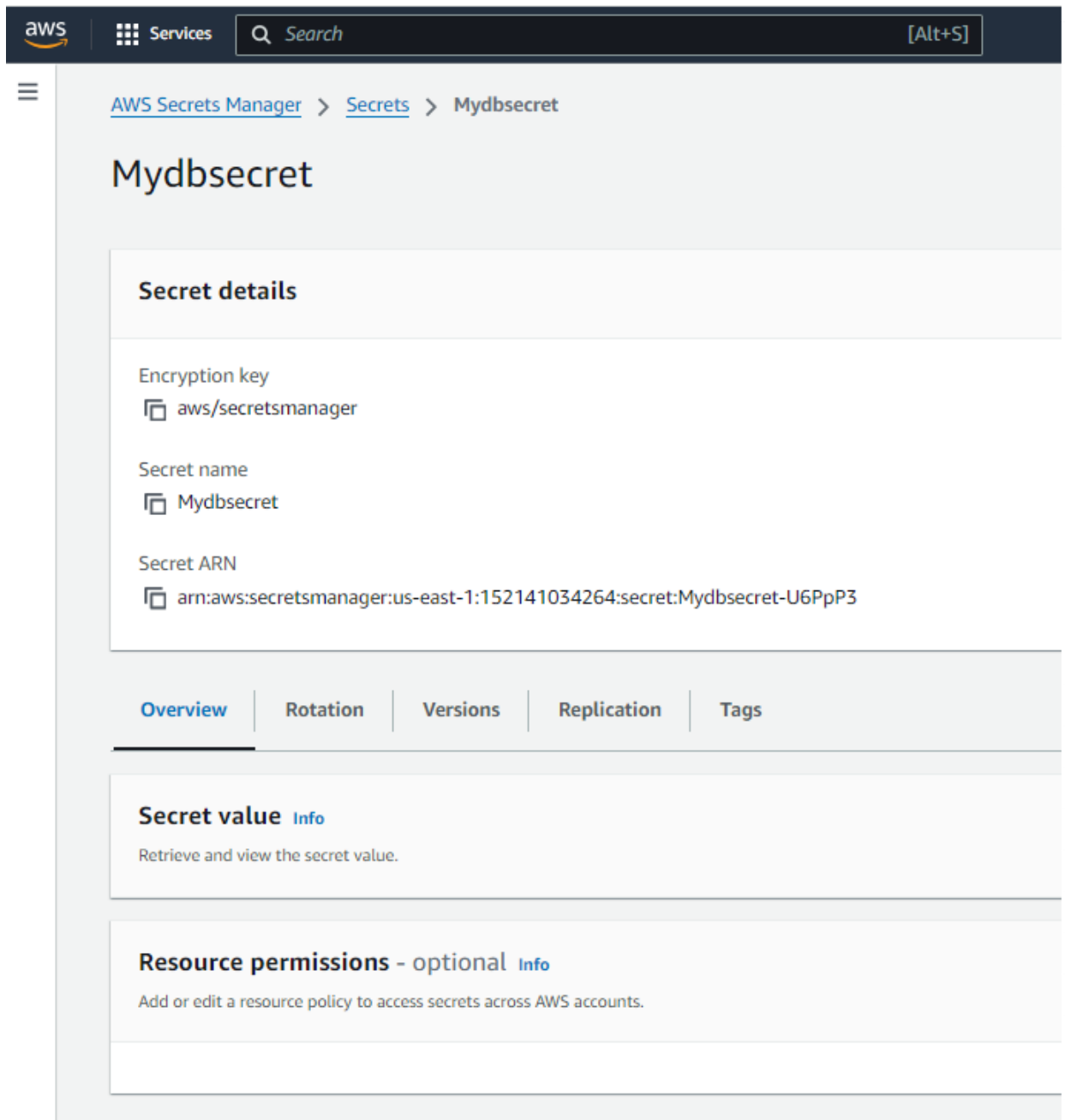
The screenshot shows the details page for the 'students' database instance. The 'Summary' section displays the following information:

DB identifier	Status	Role	Engine
students	Available	Instance	MySQL

The 'Connectivity & security' section is expanded, showing the following details:

Endpoint & port	Networking	Security
<b>Endpoint</b> students.cvse4wms0s72.us-east-1.rds.amazonaws.com	<b>Availability Zone</b> us-east-1a	<b>VPC security groups</b> rds-ec2-1 (sg-0effbd33d38b42d77)
<b>Port</b> 3306	<b>VPC</b> myvpc (vpc-04d9a5d2c464e6f05)	DBSG (sg-0781496be4b398163)
	<b>Subnet group</b> default-vpc-04d9a5d2c464e6f05	Publicly accessible No

## 5. AWS Secrets Manager Setup: Store and manage database credentials securely.



The screenshot displays the AWS Secrets Manager console interface. At the top, the navigation bar includes the AWS logo, a 'Services' menu, a search bar, and a keyboard shortcut '[Alt+S]'. Below the navigation bar, a breadcrumb trail shows the path: 'AWS Secrets Manager > Secrets > Mydbsecret'. The main heading 'Mydbsecret' is prominently displayed. Underneath, the 'Secret details' section provides key information: the encryption key is 'aws/secretsmanager', the secret name is 'Mydbsecret', and the secret ARN is 'arn:aws:secretsmanager:us-east-1:152141034264:secret:Mydbsecret-U6PpP3'. A horizontal tab bar below the details section allows switching between 'Overview' (the active tab), 'Rotation', 'Versions', 'Replication', and 'Tags'. The 'Overview' tab contains two main sections: 'Secret value' with an 'Info' link and a description 'Retrieve and view the secret value.', and 'Resource permissions - optional' with an 'Info' link and a description 'Add or edit a resource policy to access secrets across AWS accounts.'

aws Services Search [Alt+S]

AWS Secrets Manager > Secrets > Mydbsecret

### Mydbsecret

#### Secret details

Encryption key  
aws/secretsmanager

Secret name  
Mydbsecret

Secret ARN  
arn:aws:secretsmanager:us-east-1:152141034264:secret:Mydbsecret-U6PpP3

Overview Rotation Versions Replication Tags

#### Secret value [Info](#)

Retrieve and view the secret value.

#### Resource permissions - optional [Info](#)

Add or edit a resource policy to access secrets across AWS accounts.

## 6. Application Load Balancer Setup: Configure an ALB to balance traffic across multiple instances.

[EC2](#) > Load balancers

### Load balancers (1)

Elastic Load Balancing scales your load balancer capacity automatically in response to changes in incoming traffic.

<input type="checkbox"/>	Name	DNS name	State	VPC ID
<input type="checkbox"/>	<a href="#">IFALB</a>	IFALB-88981958.us-east-1...	Active	vpc-04d9a5d2c464e6f...

[EC2](#) > [Load balancers](#) > IFALB

## IFALB

▼ Details

Load balancer type  
Application

Scheme  
Internet-facing

Load balancer ARN  
 arn:aws:elasticloadbalancing:us-east-1:152141034264:loadbalancer/app/IFALB/ef7813774bdf1dbc

Status  
 Active

Hosted zone  
Z35XDOTRQ7X7K

VPC  
[vpc-04d9a5d2c464e6f0!](#)

Availability Zones  
[subnet-047d195669141](#)  
[subnet-0b9807ee9aec72](#)

DNS name [Info](#)  
 IFALB-88981958.us-

Listeners and rules

Network mapping

Resource map - new

Security

Monitoring

Integrations

Attributes

Tags

### Resource map [Info](#)

View, explore, and troubleshoot your load balancer's architecture.

Overview

Unhealthy target map

☒ Show resource details

#### IFALB

Listeners (1)

HTTP:80

1 rule

Rules (1)

Priority default  
→ Forward to target group

Conditions (If)  
If no other rule applies

Target groups (1) [Info](#)

Instance  
LBGroup

3 targets

3 0 0 0 0

## 7. Auto Scaling Group Setup: Set up an ASG to scale EC2 instances dynamically.

EC2 > Auto Scaling groups

Auto Scaling groups (1) [Info](#)

[Launch configurations](#) [Launch templates](#) [Actions](#)

<input type="checkbox"/>	Name	Launch template/configuration	Instances	Status	Desired capacity	Min	Max	Availability Zones
<input type="checkbox"/>	<a href="#">WebApp-ASG</a>	<a href="#">WebAppLT</a>   Version Default	1	-	1	1	4	us-east-1a, us-east-1b

EC2 > [Auto Scaling groups](#) > [WebApp-ASG](#)

### WebApp-ASG

[Details](#) | [Activity](#) | [Automatic scaling](#) | [Instance management](#) | [Monitoring](#) | [Instance refresh](#)

**i** Scaling policies resize your Auto Scaling group to meet changes in demand. With reactive dynamic scaling policies, you can track specific dynamic scaling policies in the following situations: when your application demand changes quickly, but with a recurring pattern, or when

#### Dynamic scaling policies (1) [Info](#)

##### Target Tracking Policy ☐

Policy type

Target tracking scaling

Enabled or disabled

Enabled

Execute policy when

As required to maintain Average CPU utilization at 50

Take the action

Add or remove capacity units as required

Instances need

300 seconds to warm up before including in metric

Scale in

Enabled



## IV. Conclusion

The AWS-based solution designed meets the project requirements for high availability, scalability, load balancing, and security. By leveraging a combination of Amazon EC2, RDS, ALB, Auto Scaling, and AWS Secrets Manager, the application handles high traffic, ensures resilience to server failures, and optimizes costs.

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## 5. Contact Information

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