

Assessment Title
AWS Theoretical and Practical Concepts Evaluation

CCC601 | Assessment-1

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Programme
Diploma in Cloud Engineering and Cyber Security (120 Credits)

Course
CCC601: Public Cloud Administration
(Level 6, 30 Credits)

Date: 24th October 2025

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Task 1: Theoretical Evaluation: Cloud-Based Virtualization Solution.

Question 1: Identify Yoobee College's Key Cloud Infrastructure Requirements

Key Cloud Infrastructure Requirements

Cost:

- Optimizing cloud costs by choosing appropriate pricing models is standard practice.
- Auto scaling helps match compute resources to actual demand, preventing over provisioning.
- Idle resources in the disaster recovery region are minimized by using On-Demand or stopped instances.

Scalability:

- The system can handle growth in student enrolments and seasonal peaks in usage.
- Horizontal scaling of EC2 instances ensures LMS and faculty applications keep up with user demand.
- AWS services offer flexibility, which makes future expansion easier.

Security:

- Sensitive student and staff data is protected using IAM roles, security groups, and encryption.
- Private subnets are used to block direct internet access to critical resources.
- CloudWatch allows auditing and monitoring to maintain oversight of system security.

High Availability:

- Continuous access to LMS, faculty apps, and student databases is maintained.
- Redundancy through ELB, EC2 instances, and RDS replication helps prevent downtime.
- The Sydney region serves as a disaster recovery site, with replicated EC2 and RDS resources ready for activation if needed.

Question 2: Compare AWS Pricing Models and Recommend Most Cost-Effective Option

On-Demand Instances:

- Pay only for usage.
- Flexible with no long-term commitments.

Reserved Instances (RIs):

- Commit for 1-3 years to save significantly compared to On-Demand.
- Ideally for core workloads like LMS and Faculty applications.

Spot Instances:

- Very low-cost solution for non-critical workloads.
- Risk of interruptions if AWS reclaims capacity.

My Recommendation:

- Virginia (Primary region): Reserved Instances for core workloads.
- Sydney (DR region): On-Demand for standby workloads.
- Spot Instances for internal purposes (e.g., testing).

Question 3: Analyse How AWS Auto Scaling and Load Balancing Improve Availability and Performance

Auto Scaling:

- Automatically adjusts the number of EC2 instances based on demand.
- Ensures optimal performance without manual intervention.
- Helps to prevent over-provisioning and reduces cost.

Elastic Load Balancer (ELB):

- Distributes traffic evenly across multiple EC2 instances.
- Prevents any instance overload with the request load.
- Improves fault tolerance and ensures a consistent user experience.

Impact for Yoobee College:

- LMS and Faculty applications stay responsive during peak periods.
- Infrastructure automatically adjusts to traffic, maintaining performance and cost efficiency.

Question 4: Comprehensive Report

Overview of the Proposed Architecture

For Yoobee College, the proposed cloud solution is a three-tier virtualized infrastructure built entirely on Amazon Web Services (AWS). It balances reliability, security, and cost efficiency, ensuring that the university's Learning Management System (LMS) and faculty applications operate smoothly at all times.

The architecture follows a clear three-tier pattern:

- Web Layer – Handles user access and provides front-end content.
- Application Layer – Manages all business logic and connects the user interface to the data layer.
- Database Layer – Stores all critical academic and student data.

Each tier resides in separate subnets within a Virtual Private Cloud (VPC). Public subnets host external access points like load balancers, while private subnets contain core systems, including EC2 instances and databases. This setup runs across two AWS regions in an Active-Passive configuration:

- Virginia (US East) as the primary production environment.
- Sydney (Asia-Pacific Southeast-2) as the disaster recovery (DR) site.

This multi-regional design ensures that Yoobee's systems remain available even if an entire region is unavailable due to a power outage or major disruption.

Regional Deployment Strategy

Primary Region - Virginia (US East)

- Virginia acts as the active environment, hosting all real-time workloads.
- The LMS Web layer runs on two EC2 instances, managed by an Elastic Load Balancer (ELB) that automatically distributes incoming user traffic.

- The faculty application layer also runs on two EC2 instances, responsible for handling internal business logic and data processing.
- The MySQL RDS database stores all data, including student information, course materials, and logs.
- The environment is built with Auto Scaling Groups (ASG) so that EC2 instances can automatically scale up or down according to real-time demand. This means the university only pays for the necessary resources, while maintaining fast response times during busy periods (such as student enrolment or assignment submission).

High availability is ensured with multiple availability zones, Auto Scaling Groups, and the ELB. The Sydney region serves as a standby disaster recovery site, with EC2 instances maintained in on-demand mode and RDS using a read-only replica for data synchronization. This approach balances high availability with cost efficiency.

Disaster Recovery Region - Sydney (Asia-Pacific Southeast-2)

- The Sydney region mirrors the same three-tier setup as Virginia, but remains in standby mode to minimize costs.
- Standby EC2 instances are pre-configured and can be started immediately during failover.
- The RDS read-only replica continuously synchronizes data from the primary database in Virginia.
- Backups and static content are replicated through S3 cross-region replication.
- If the primary region goes offline, administrators can manually promote the Sydney region to take over operations. This strategy provides a reliable DR solution without the high cost of running a fully active environment in two regions.

Network Design and Segmentation

Each region contains its own VPC, divided into public and private subnets. The design follows a layered approach to limit exposure:

- Public Subnets: Host the ELB, which is the only component open to the Internet.
- Private Subnets: Host EC2 instances and RDS databases that should never be directly accessible from the outside.

Security groups are carefully defined:

- The ELB allows incoming web traffic (HTTP/HTTPS) from anywhere.

- The Web layer only accepts requests from the ELB.
- The Application layer only communicates with the Web layer.
- The database only accepts connections from the Application layer.

This simple but strict chain

ELB → Web → Application → Database

ensures that each layer only communicates with the layer directly above or below it. This way, even if one layer is compromised, the rest of the system remains protected.

Computing and Storage Components

- **EC2:** Provides the virtual servers that run the LMS and faculty applications. Its flexibility allows Yoobee to choose instance sizes based on demand and cost. Combined with auto scaling, it maintains high performance and low cost.
- **ELB:** The ELB distributes incoming traffic among multiple EC2 instances, checks their health status, and redirects requests if an instance fails. This ensures that students and staff always access a working application without noticing any interruption.
- **RDS:** Manages database operations automatically, including backups, patches, and replication. Virginia hosts the primary database, with a read-only replica in Sydney..
- **S3:** Stores application backups. Cross-region replication ensures that backups exist in both regions, and versioning provides an additional layer of protection against accidental deletion or modification.

Identity and Access Management (IAM)

IAM defines roles, users, and groups with specific permissions:

- Administrators have full AWS access.
- Network admins manage VPCs, subnets, and ELB configurations.
- Developers deploy and manage EC2 applications.
- Database admins handle RDS and backups.
- Auditors and support teams have limited, read-only, or operational access.

IAM roles are also assigned to services like EC2 and RDS, allowing them to securely access S3 for backups or CloudWatch for logging, without hardcoded credentials. This least-privilege approach ensures access is granted only where needed.

Security Policies

Network Security:

- All sensitive resources (EC2, RDS) are hosted in private subnets.
- Incoming and outgoing traffic is strictly controlled by security groups.
- HTTPS and SSL/TLS are enforced to encrypt data in transit.

Identity Security:

- Multi-factor authentication (MFA) is mandatory for administrative accounts.
- IAM policies are periodically reviewed and audited.
- AWS CloudTrail and Access Analyzer track all operations to ensure accountability.

Data Protection:

- Data at rest in RDS and S3 is using AWS KMS-managed keys.
- S3 buckets block all public access by default.
- RDS performs daily automatic backups, and S3 versioning protects historical data.

Monitoring and Compliance:

- CloudWatch monitors system health and performance metrics and sends critical event alerts, helping the IT team respond proactively.

Service Selection and Justification

Service	Purpose	Reason for Use
EC2	Host LMS and faculty applications	Flexible, scalable, and manageable with auto scaling.
ELB	Distribute web traffic	Improves fault tolerance and availability.
RDS (MySQL)	Database service	Fully managed, supports cross-region replication and automatic backups.
S3	Storage and backups	Durable, secure, and cost-effective for long-term storage.
VPC	Network isolation	Gives complete control over subnets, routing, and IP.

IAM	Access management	Enforces least privilege and centralizes identity control.
CloudWatch	Monitoring and logging	Enables proactive performance monitoring and compliance tracking.

All these services align with the AWS Well-Architected Framework, ensuring security, reliability, and cost management best practices.

Why This Architecture Works

This design meets all the correct requirements for Yoobee College's needs: it is reliable, scalable, cost-effective, and secure.

- **High Availability:** Multiple region deployment ensures minimal downtime even during regional failures.
- **Scalability:** Auto scaling dynamically adjusts resources to match traffic, maintaining a smooth experience for students and staff.
- **Disaster Recovery:** The standby environment in Sydney guarantees business continuity during power outages without doubling the cost.
- **Cost Efficiency:** Using reserved instances in the primary region and on-demand in DR avoids paying for idle resources.
- **Security:** Layered security controls, IAM governance, and encryption at all levels ensure robust protection of sensitive data.

In summary, this architecture provides a stable, scalable, and secure foundation for Yoobee's digital learning systems. It supports growth, handles failures gracefully, and ensures uninterrupted teaching and learning, making AWS capabilities into a reliable environment.

Task 2: Theoretical and Practical Evaluation – Virtualization Architecture

Question 1: Design and deploy a cloud-based server virtualization infrastructure for Yoobee using AWS services

Proposed Architecture Overview:

Yoobee College will deploy a three-tier cloud architecture using AWS services. The design includes an Active-Passive multi-region deployment with Virginia (US East) as the primary region and Sydney (AP-Southeast-2) as the disaster recovery region.

Compute:

- **EC2 Instances:**
 - LMS Web Tier: 2 EC2 instances in Virginia, 2 standby instances in Sydney.
 - Faculty Application Tier: 2 EC2 instances in Virginia, 2 standby in Sydney.

Instances are placed in private subnets to enhance security.

Database:

- **RDS (MySQL):** Primary database in Virginia, with a read replica in Sydney.

RDS handles automated backups, multi-region replication, and failover.

Networking:

- **VPC:** Separate Virtual Private Cloud per region, with public and private subnets.
- **Security Groups:**
 - **ELB:** inbound HTTP/HTTPS from Internet.
 - **Web:** only allows traffic from ELB.
 - **App:** only allows traffic from Web tier.
 - **DB:** only allows traffic from App tier.

Load Balancing & Scaling:

- **ELB:** Distributes traffic among EC2 instances in each tier.

- **Auto Scaling Groups:** Automatically increase/decrease EC2 instances based on traffic demand.

Storage & Backups:

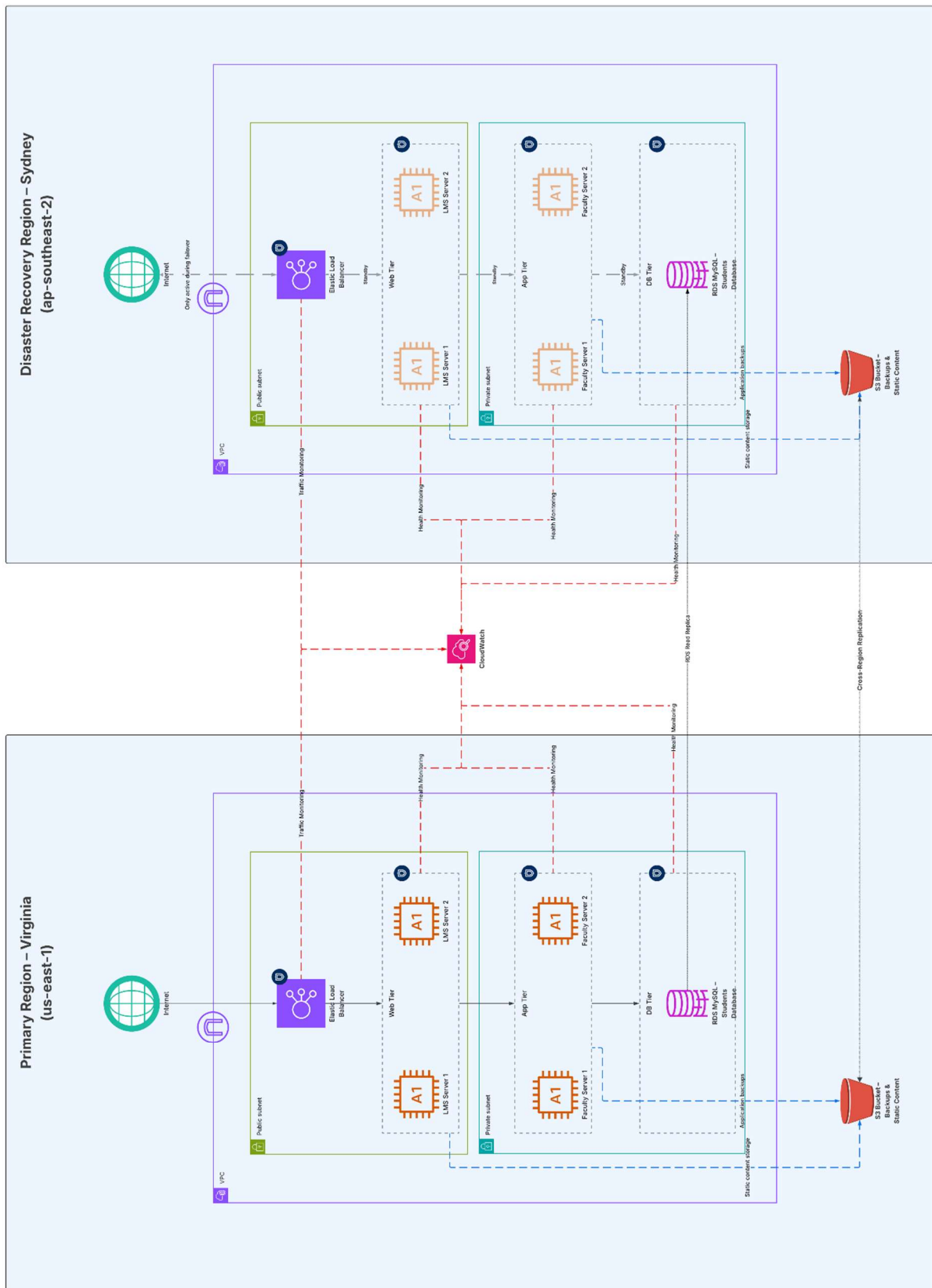
- **S3 Buckets:** Store backups and replicate across regions for disaster recovery.

Traffic Routing:

- In case of an outage in the Virginia region, administrators can activate the Sydney environment manually.

Although the Sydney region is preconfigured for disaster recovery, it remains in standby mode during normal operations. High availability is achieved primarily within the Virginia region through the use of auto scaling and ELB. Manual activation of the Sydney environment ensures cost-effective recovery without the need to continuously run duplicate production workloads.

Question 2. Include a diagram illustrating the architecture, depicting security groups, subnets, and network access control



Question 3. Define user roles and permissions using AWS Identity and Access Management (IAM)

IAM Roles:

Role	Purpose	Permissions
Admins	Manage all AWS resources	Full access in both regions
NetworkAdmins	Manage VPC, subnets, ELB	AmazonVPCFullAccess, ELBFullAccess
LMS-EC2	EC2 LMS instances	CloudWatchLogsFullAccess, S3 read/write for backups
Faculty-EC2	EC2 Faculty instances	Access RDS, S3FullAccess for backups
RDS	Manage database operations	AmazonRDSFullAccess, S3FullAccess (backup)

IAM User Groups:

Group	Purpose	Permissions
Developers	Manage EC2 applications	EC2FullAccess, S3FullAccess
DatabaseAdmins	Manage RDS & backups	AmazonRDSFullAccess, S3FullAccess (backup bucket)
Auditors	View resources for compliance	ReadOnlyAccess, CloudWatchReadOnlyAccess
SupportTeam	Monitor & restart EC2 instances	EC2ReadOnlyAccess, CloudWatchFullAccess

Security Principle:

- Each role and group get only necessary permissions.
- IAM policies ensure **secure operations** across regions.

Question 4. Provide a document explaining the architecture, security policies, and service choices

Architecture:

Yoobee College uses a **three-tier architecture (Web → App → DB)** deployed across two regions: Virginia (primary) and Sydney (disaster recovery). EC2 instances host LMS and Faculty applications, and RDS stores the student database with cross-region replication. This setup ensures high availability and quick failover in case of regional outages.

Security Policies:

- **Security Groups:** Each tier only accepts traffic from the tier above (ELB → Web → App → DB).
- **Private Subnets:** EC2 and RDS instances are not directly accessible from the Internet.
- **IAM Roles and Groups:** Users and services are given only the permissions they need.
- **Monitoring:** CloudWatch provides performance monitoring.

Service Choices and Justifications:

- **EC2:** Flexible compute, paired with Auto Scaling for dynamic load handling.
- **ELB:** Distributes traffic across instances to avoid overload and improve availability.
- **RDS:** Managed database service with automatic backups and read replicas for DR.
- **S3:** Secure object storage for backups with versioning and cross-region replication for durability.

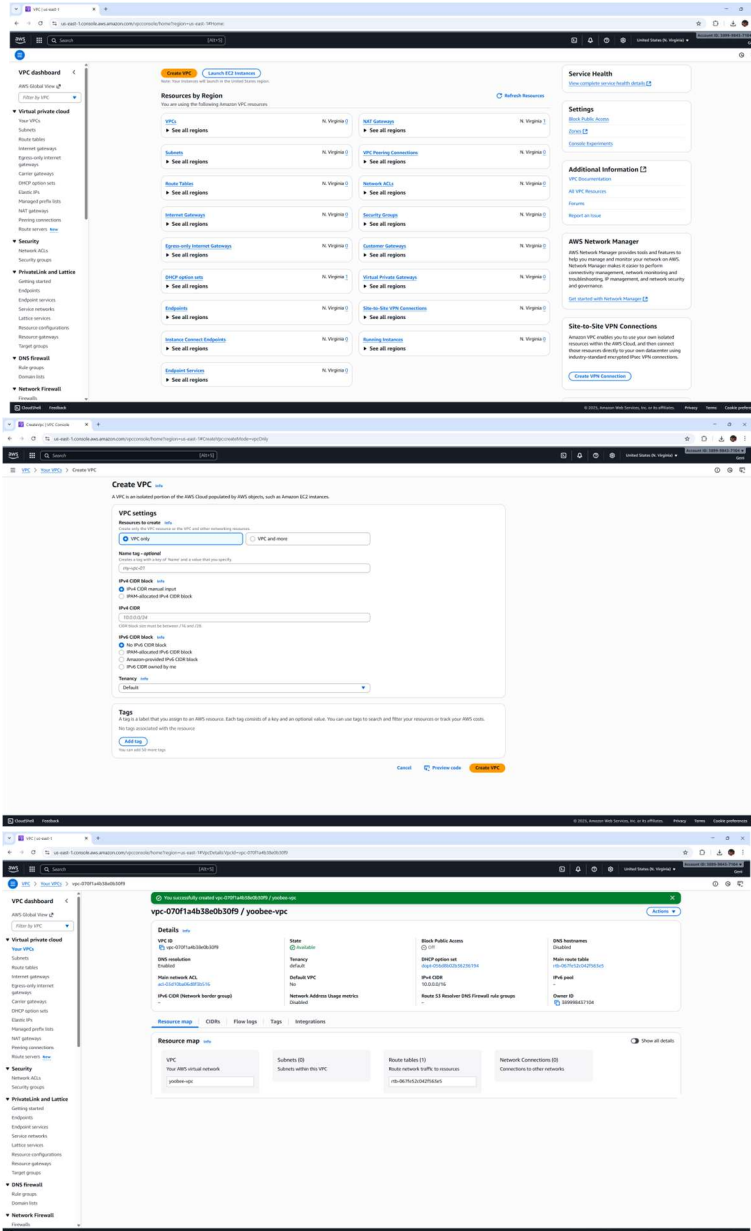
Why This Works:

- **High Availability:** High availability is ensured in Virginia, with Sydney as a standby DR site manually activated if needed, balancing uptime and cost.
- **Scalability:** This allows Auto Scaling to adapt to traffic spikes efficiently.
- **Cost Efficiency:** Reserved Instances in Virginia reduce cost; On-Demand standby in Sydney avoids paying for idle resources.
- **Security:** Least-privilege IAM roles, private subnets, Security Groups, and encryption protect sensitive data.

Task 3: Practical Implementation: Virtual Machines and Storage Services

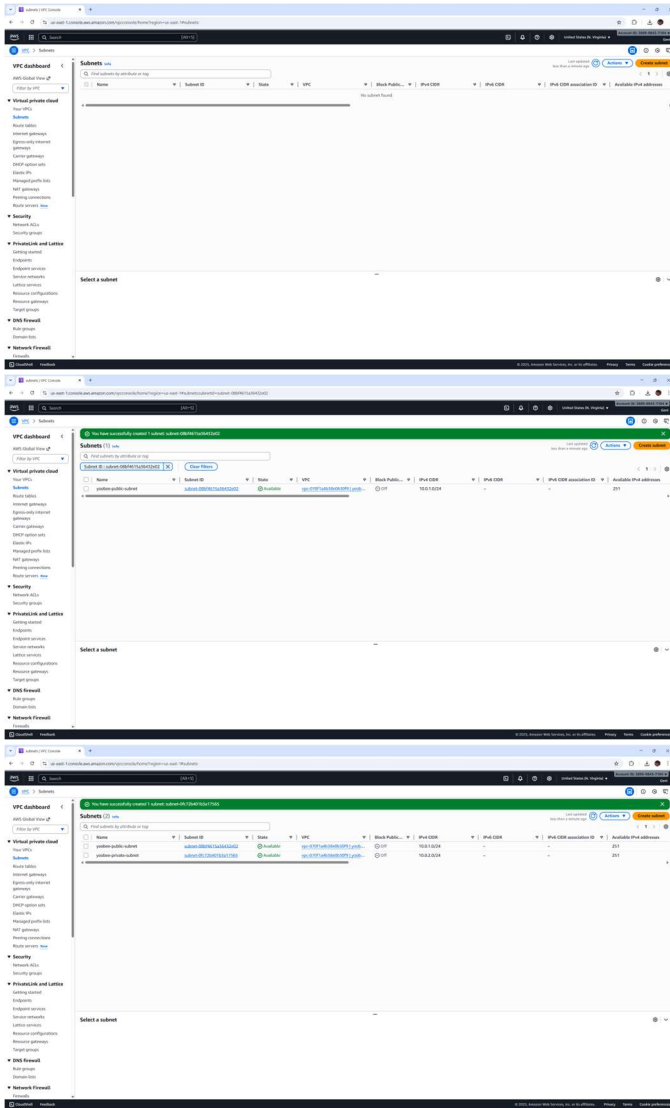
Virtual Private Cloud (VPC) Setup

Created a custom VPC

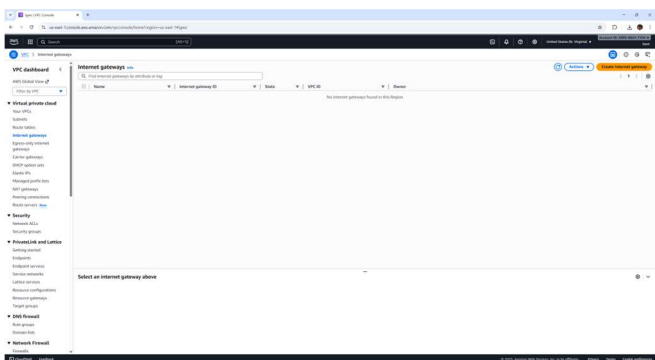


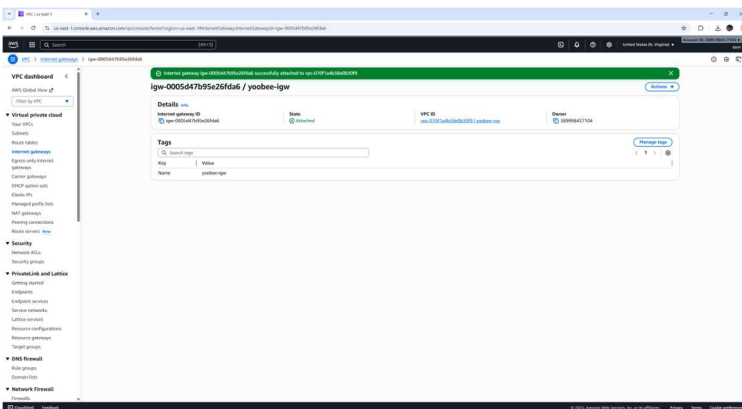
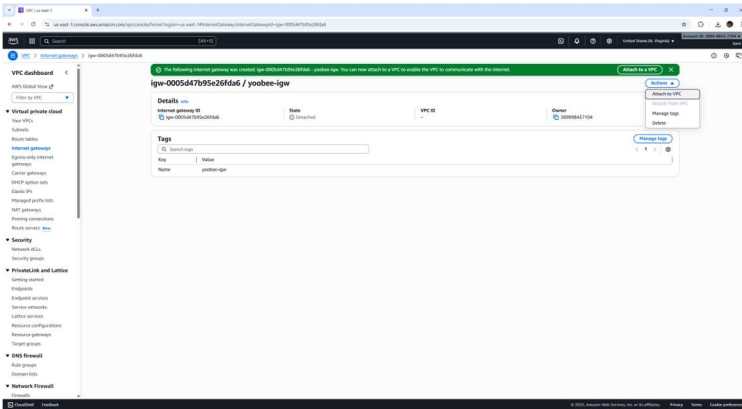
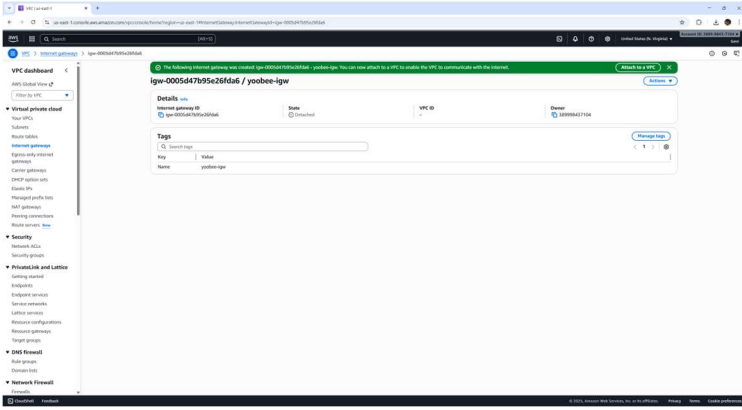
Two subnets were configured

- yoobee-public-subnet (10.0.1.0/24)
- yoobee-private-subnet (10.0.2.0/24)

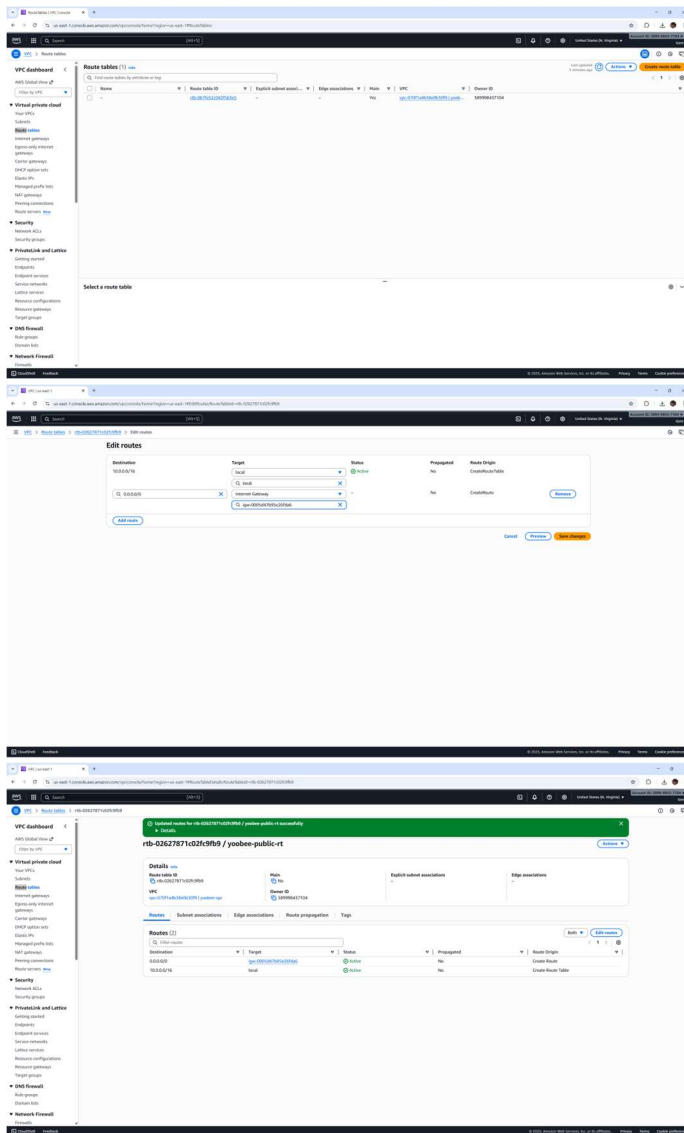


Attached an Internet Gateway



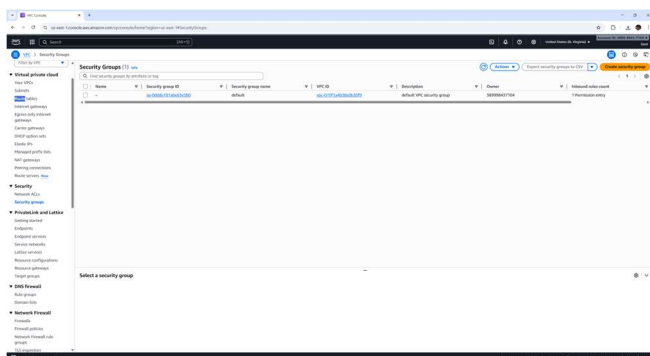


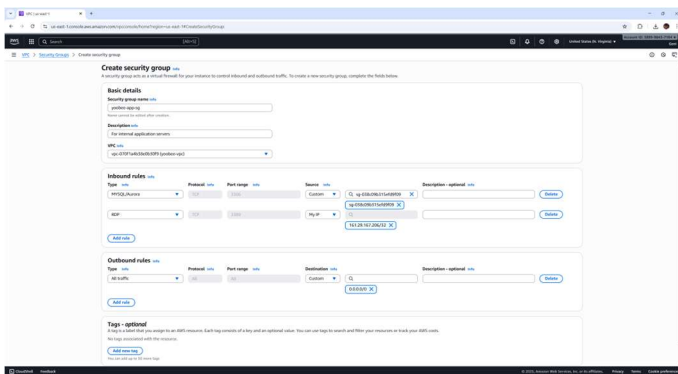
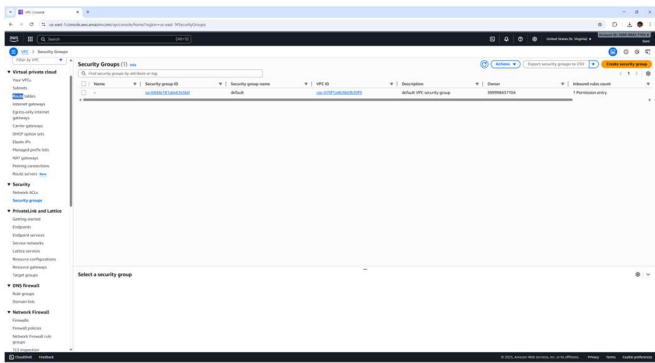
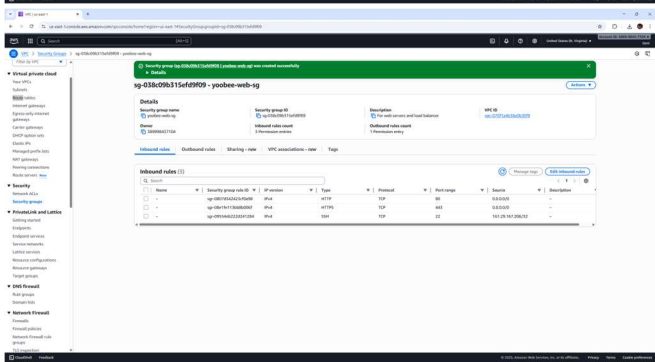
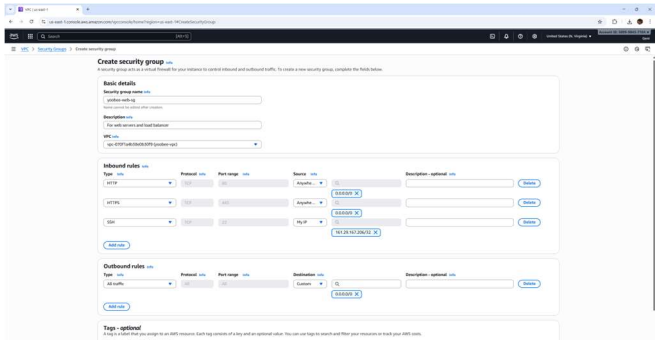
Configured a public route table

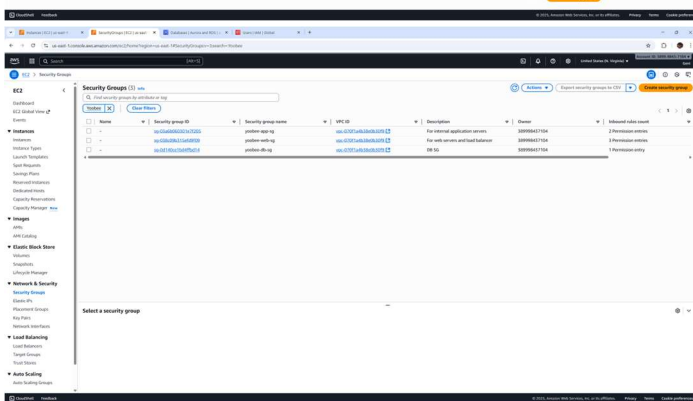
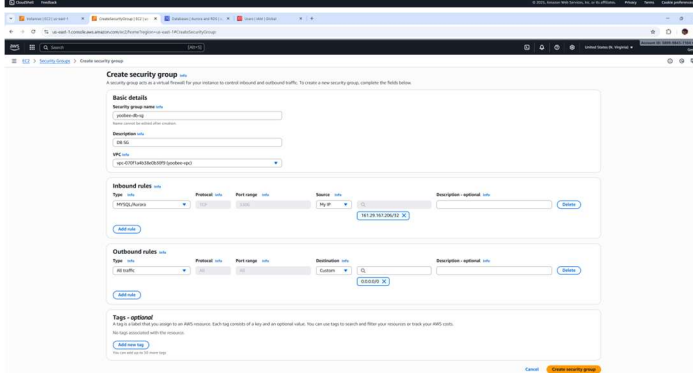
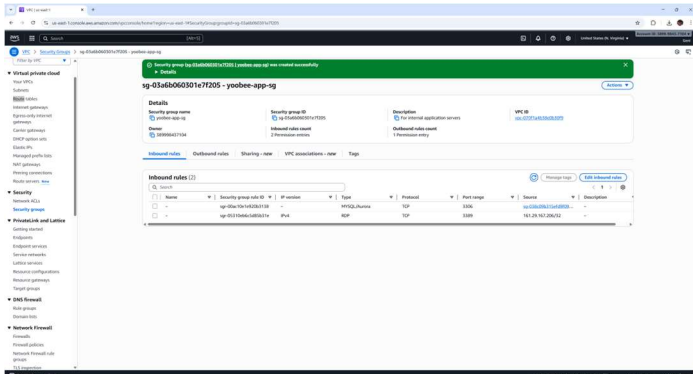


Created security groups

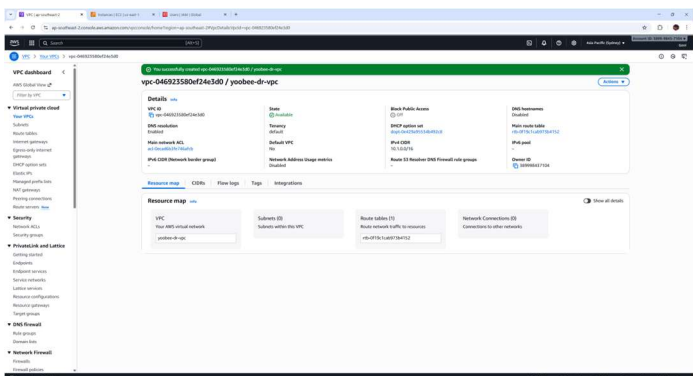
- yoobee-web-sg
- yoobee-app-sg
- yoobee-db-sg

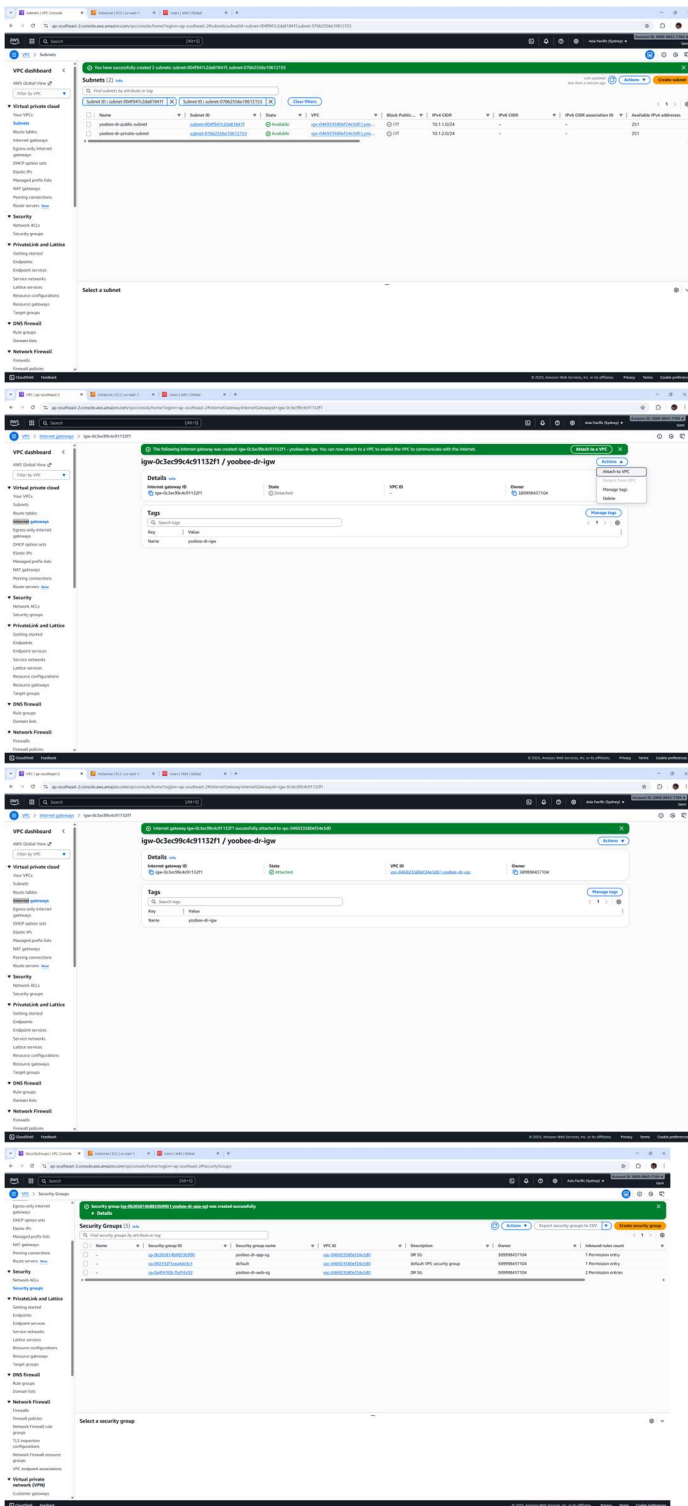






Parallel configured DR environment





EC2 Instances Configuration

Launched two EC2 instances

- yoobee-linux-lms: Amazon Linux 2, Public Subnet.
- yoobee-windows-faculty: Windows Server 2019, Private Subnet.

The image displays four sequential screenshots from the AWS Management Console, illustrating the process of creating and configuring an Amazon EC2 instance.

- Top Screenshot:** Shows the 'Instances' overview page. The 'Instances' section is empty, and the 'Select an instance' dropdown is visible.
- Second Screenshot:** Shows the 'Configure Instance' wizard. The 'Network settings' section is expanded, showing options for 'Subnet' (us-east-1-us-east-1a-us-east-1a-subnet) and 'Auto-assign public IP' (On). The 'Advanced configuration' section is also visible.
- Third Screenshot:** Shows the 'Next Steps' dashboard. It provides a 'Launch by' button and a 'Next Steps' section with various tasks such as 'Create billing usage alerts', 'Connect to your instance', 'Connect to RDS database', 'Create EBS snapshot policy', 'Manage detailed monitoring', 'Create Load Balancer', 'Create AWS budget', 'Manage CloudWatch alarms', 'Disaster recovery for your instances', 'Monitor for suspicious activities', 'Get instance console', and 'Get system log'.
- Bottom Screenshot:** Shows the 'Configure Instance' wizard. The 'Key pair (Optional)' section is expanded, showing the 'Key pair name' (us-east-1-us-east-1a-us-east-1a-key-pair) and the 'Auto-assign public IP' (On) option. The 'Network settings' section is also visible.

This screenshot shows the 'Next Steps' section of the AWS console for a newly launched EC2 instance. It provides a series of guided actions to optimize the instance's performance and security. The steps include:

- Create billing alerts:** Set up alerts for billing anomalies.
- Connect to your instance:** Learn how to connect via SSH or RDP.
- Connect an EFS database:** Configure an Amazon ElastiCache database.
- Create EFS support policy:** Create a policy for EFS instances.
- Manage detailed monitoring:** Enable or disable detailed monitoring for the instance.
- Create Load Balancer:** Create a Load Balancing Group to distribute traffic.
- Create AWS Budget:** Set a budget to monitor and control costs.
- Manage CloudWatch alarms:** Create alarms for system metrics.
- Disaster recovery for your instances:** Review recovery options for your instances.
- Monitor for suspicious runtime activities:** Use Amazon GuardDuty to monitor for suspicious activity.
- Get instance screenshot:** Take a screenshot of the instance.
- Get system log:** View the system log to troubleshoot issues.

This screenshot shows the 'Instances' page in the AWS console. It displays a table of EC2 instances with the following columns:

Name	Instance ID	Instance state	Instance type	Status checks	Alarm status	Availability Zone	Public IP DNS	Public IP	Elastic IP	IPv4 IPs	Monitoring	Security groups
ipooe-bd-ec2-1	i-09469462642944000	Running	t3.medium	OK	OK	us-east-1a	ec2-44-222-223-111.us-east-1.compute.amazonaws.com	44.222.223.111	-	-	disabled	sg-1a1b2c3d
ipooe-bd-ec2-2	i-09469462642944001	Running	t3.medium	OK	OK	us-east-1a	ec2-44-222-223-112.us-east-1.compute.amazonaws.com	44.222.223.112	-	-	disabled	sg-1a1b2c3d

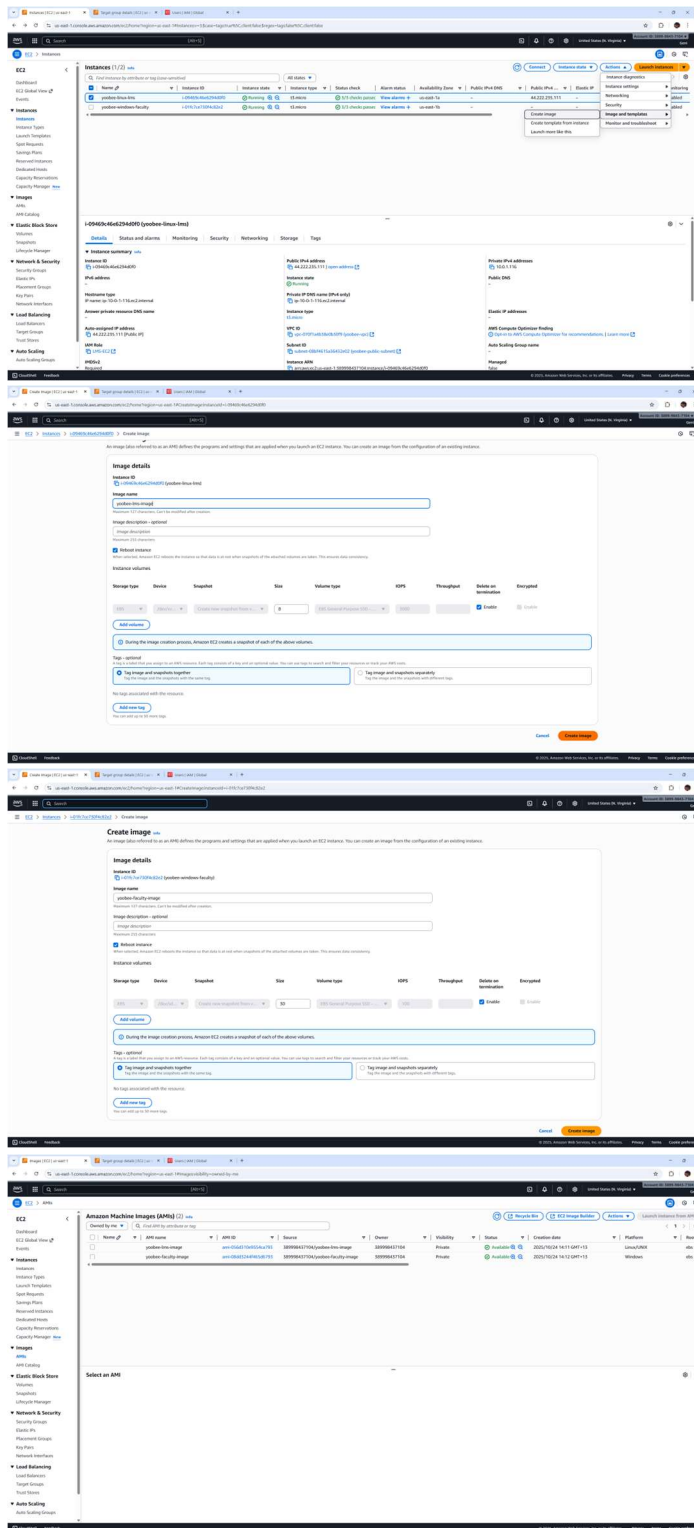
This screenshot shows the 'Instance details' page for the EC2 instance i-09469462642944000. The instance is a Linux-based t3.medium instance. Key details include:

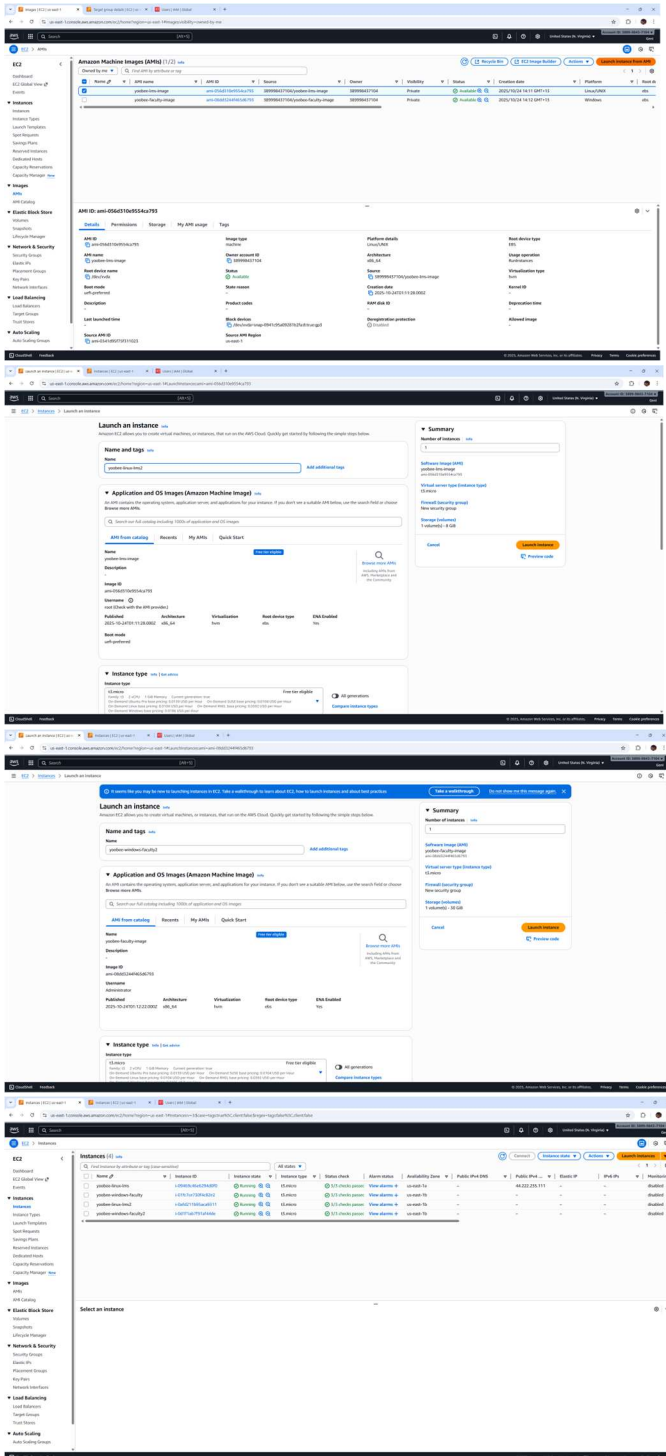
- Instance ID:** i-09469462642944000
- Instance type:** t3.medium
- Platform:** Linux
- Operating System:** Amazon Linux 2
- Public IP address:** 44.222.223.111
- Private IP address:** 10.0.0.1
- Subnet:** subnet-1a1b2c3d
- Security Groups:** sg-1a1b2c3d
- Monitoring:** Disabled
- Auto Scaling Group:** Not associated

This screenshot shows the 'Instance details' page for the EC2 instance i-09469462642944001. The instance is a Windows-based t3.medium instance. Key details include:

- Instance ID:** i-09469462642944001
- Instance type:** t3.medium
- Platform:** Windows
- Operating System:** Microsoft Windows Server 2019 English Full Base
- Public IP address:** 44.222.223.112
- Private IP address:** 10.0.0.2
- Subnet:** subnet-1a1b2c3d
- Security Groups:** sg-1a1b2c3d
- Monitoring:** Disabled
- Auto Scaling Group:** Not associated

Duplicated instances with images

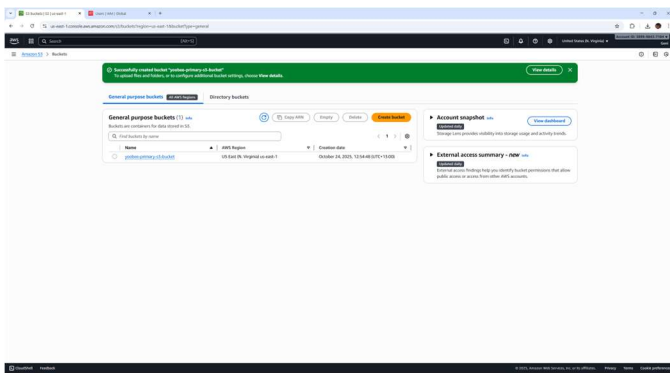
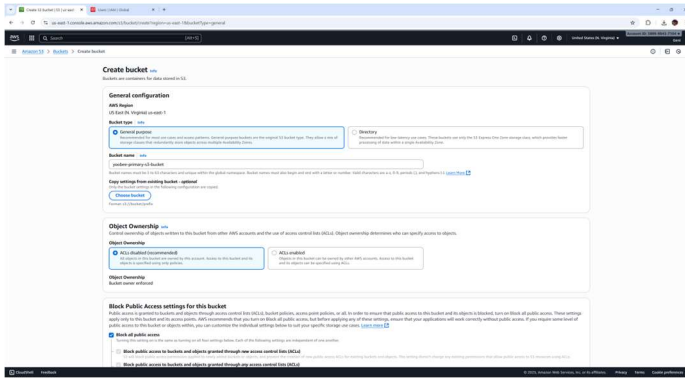




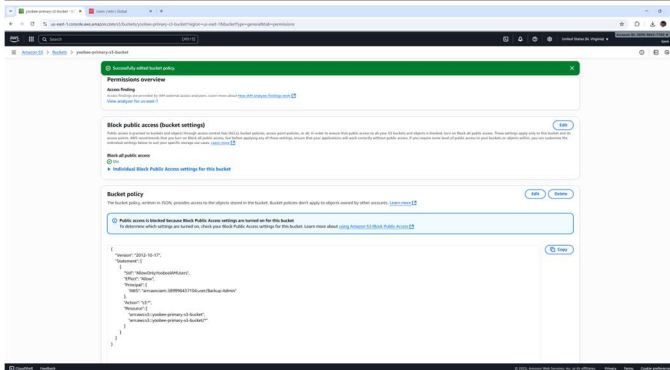
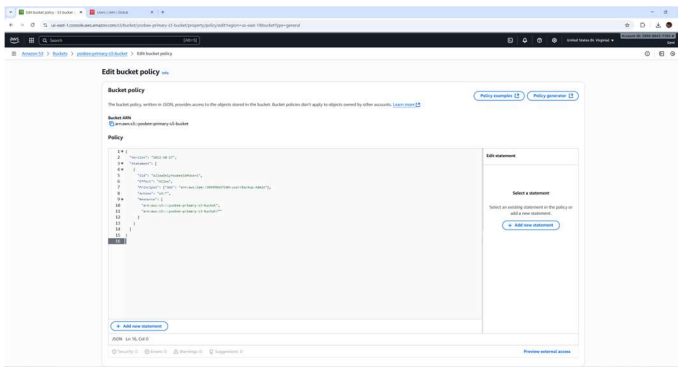
S3 Bucket and Cross-Region Replication

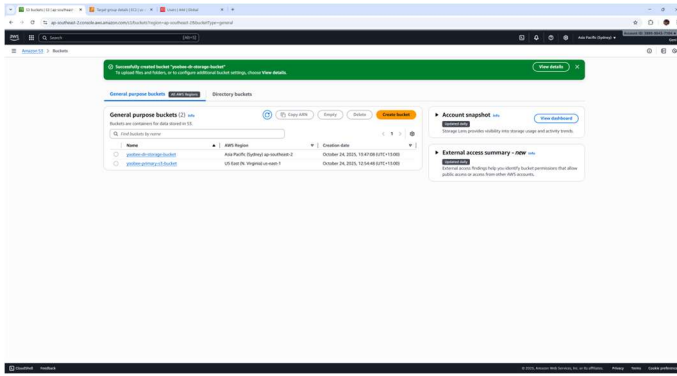
Created two S3 buckets

- yoobee-primary-s3-bucket (Region: us-east-1)
- yoobee-dr-storage-bucket (Region: ap-southeast-2)

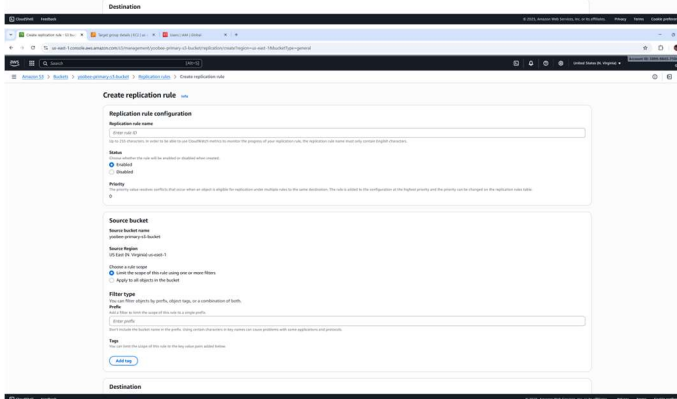
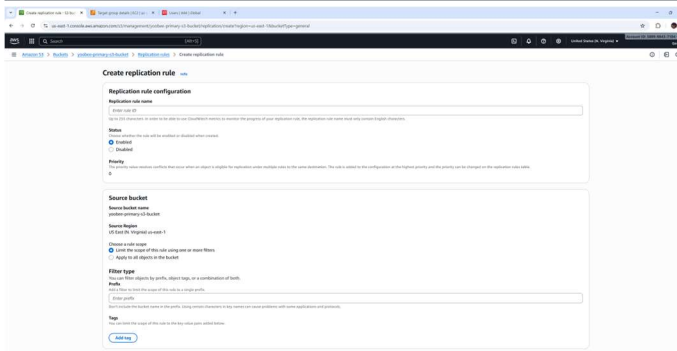
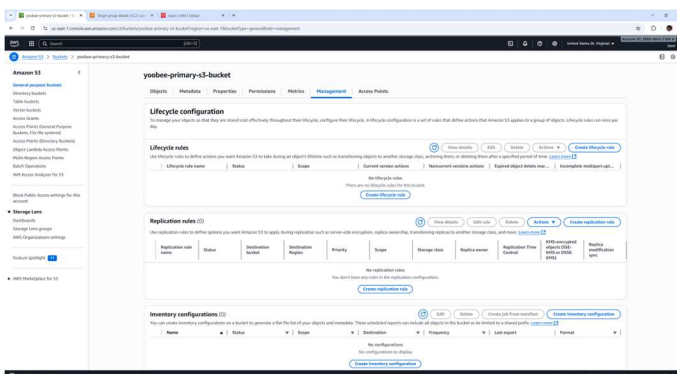


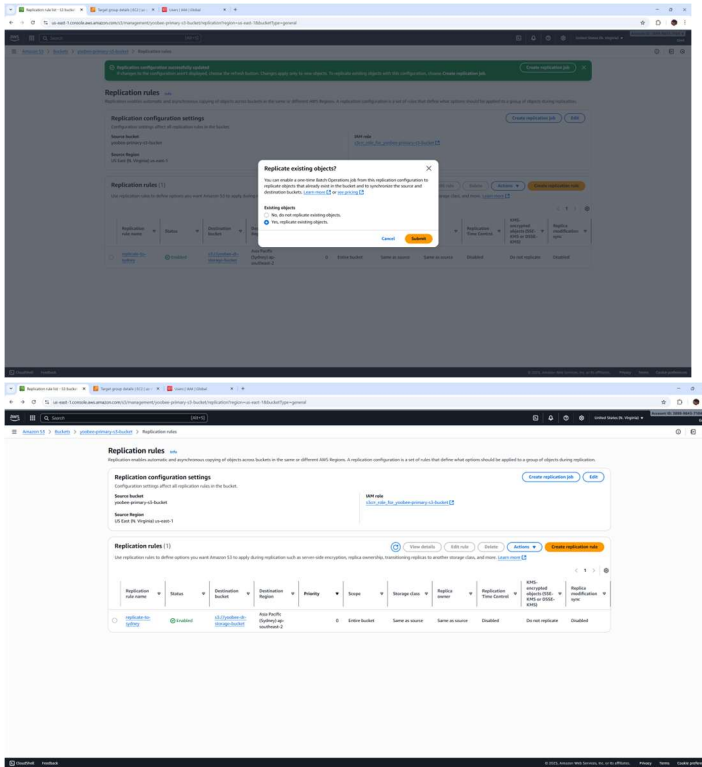
Restricted bucket access by IAM-based using policies



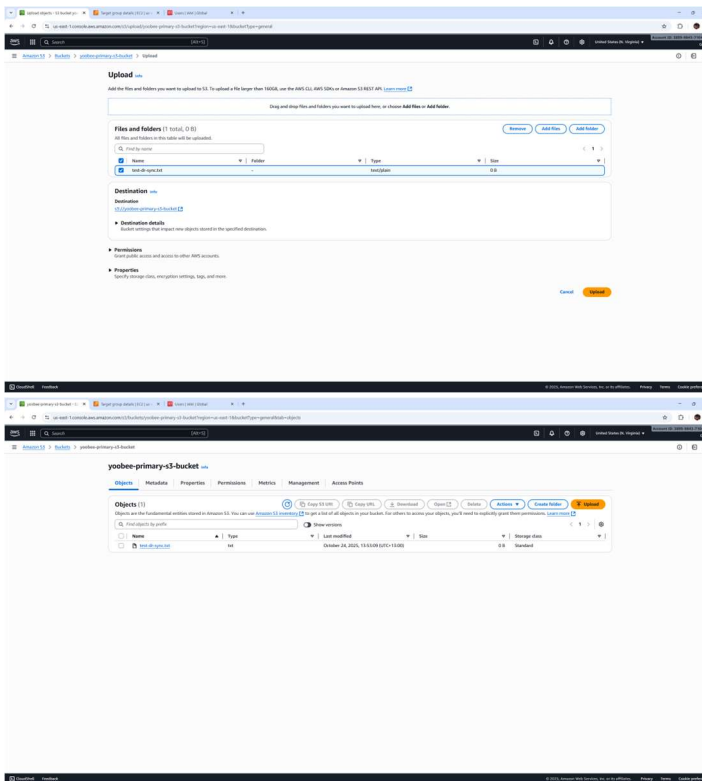


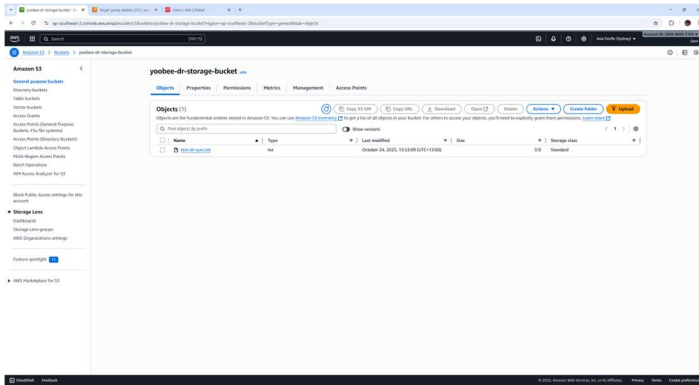
Configured a replication rule





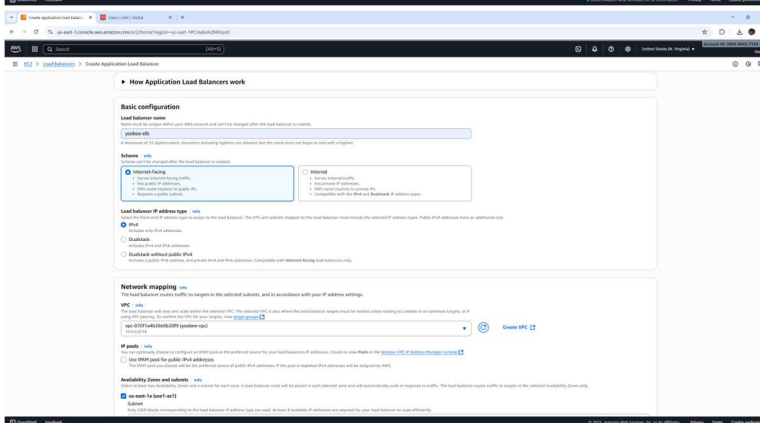
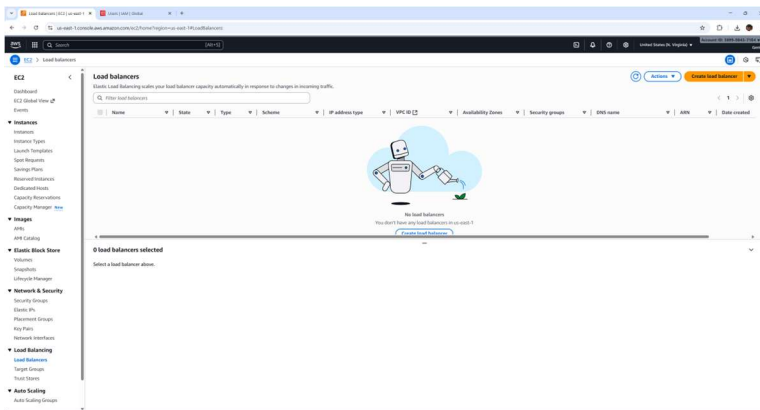
Verified replication using test file

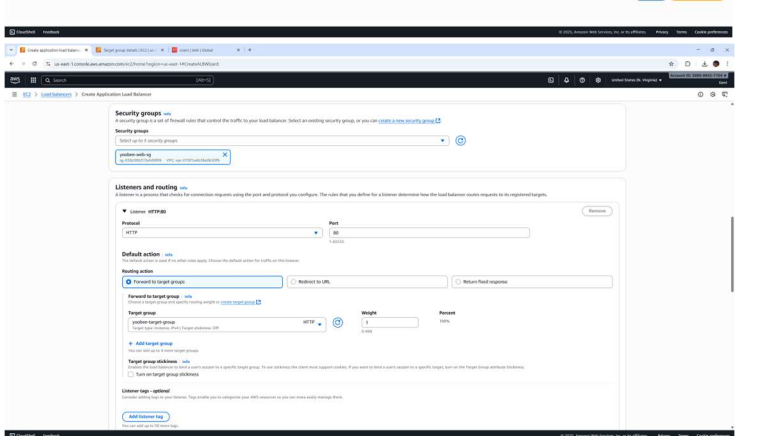
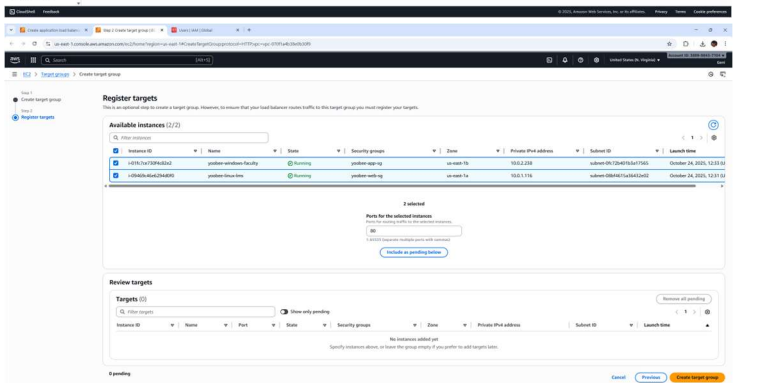
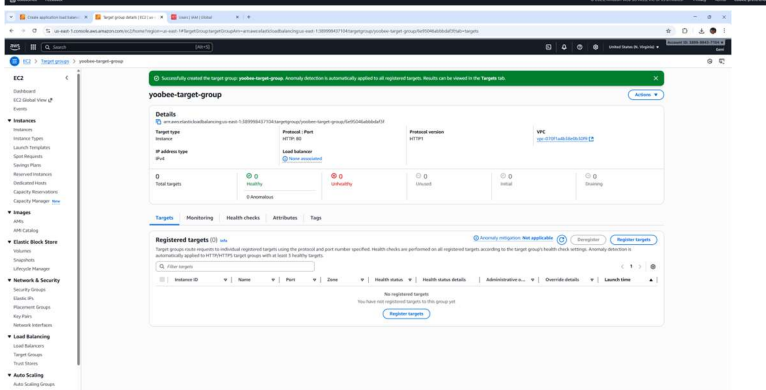
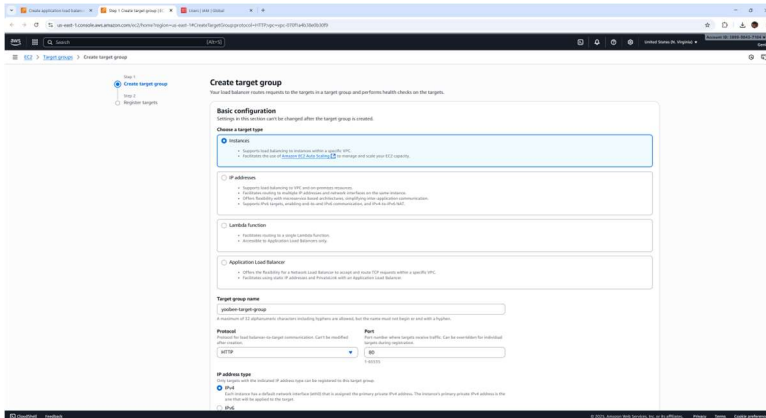


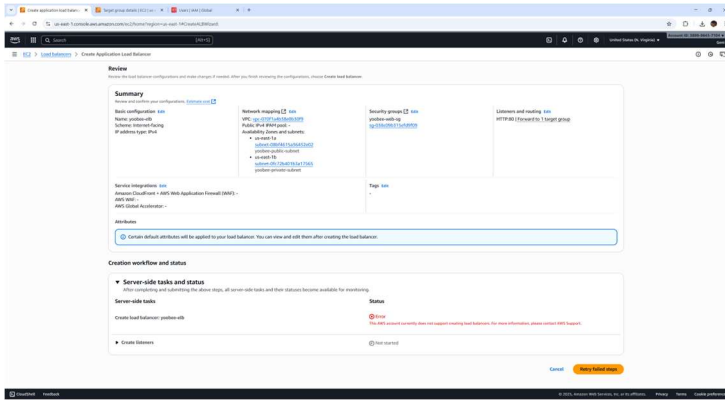


Elastic Load Balancer (ELB)

Created an Application Load Balancer







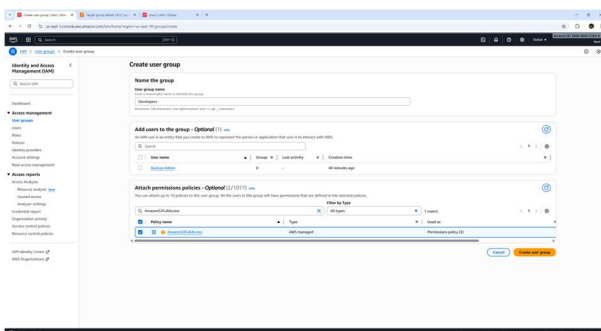
Due to the limitations of the AWS Free Tier subscription, the Elastic Load Balancer (ELB) service could not be deployed; however, all required configuration steps have been documented to demonstrate the setup process.

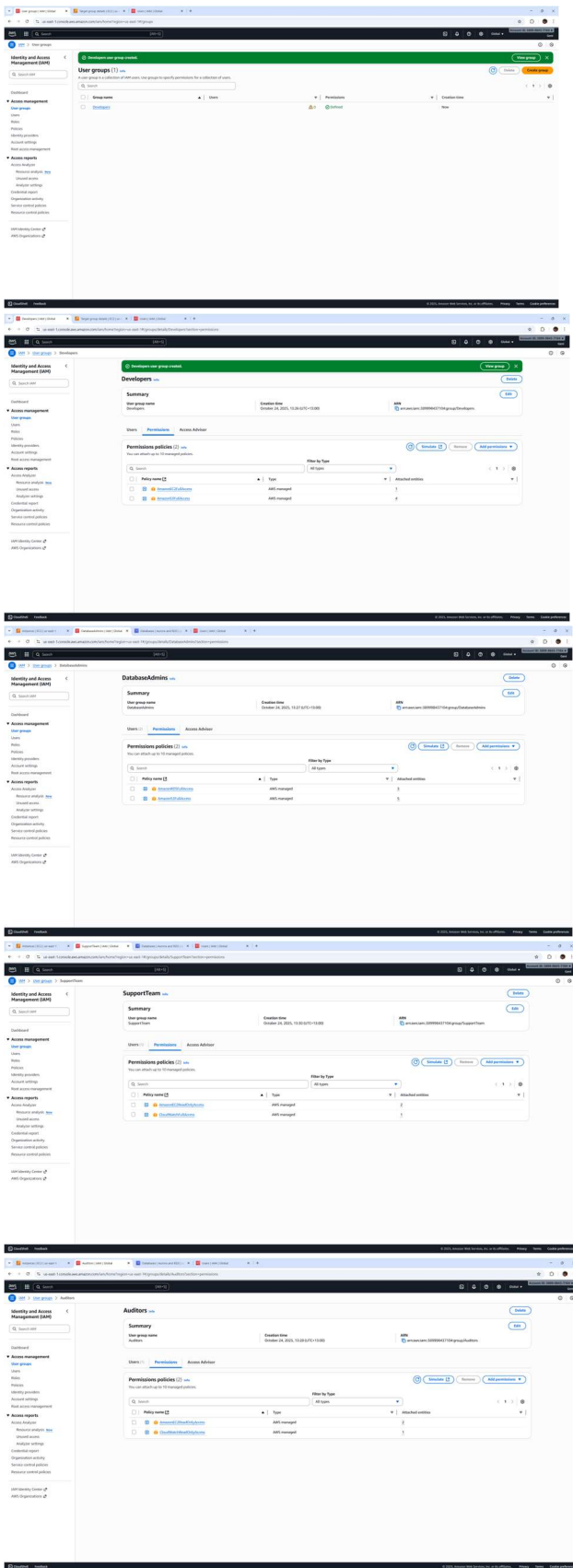
Task 4: Theoretical and Practical Evaluation – Optimization and Security

IAM Configuration and Security Controls

Created IAM User Groups with permission policies

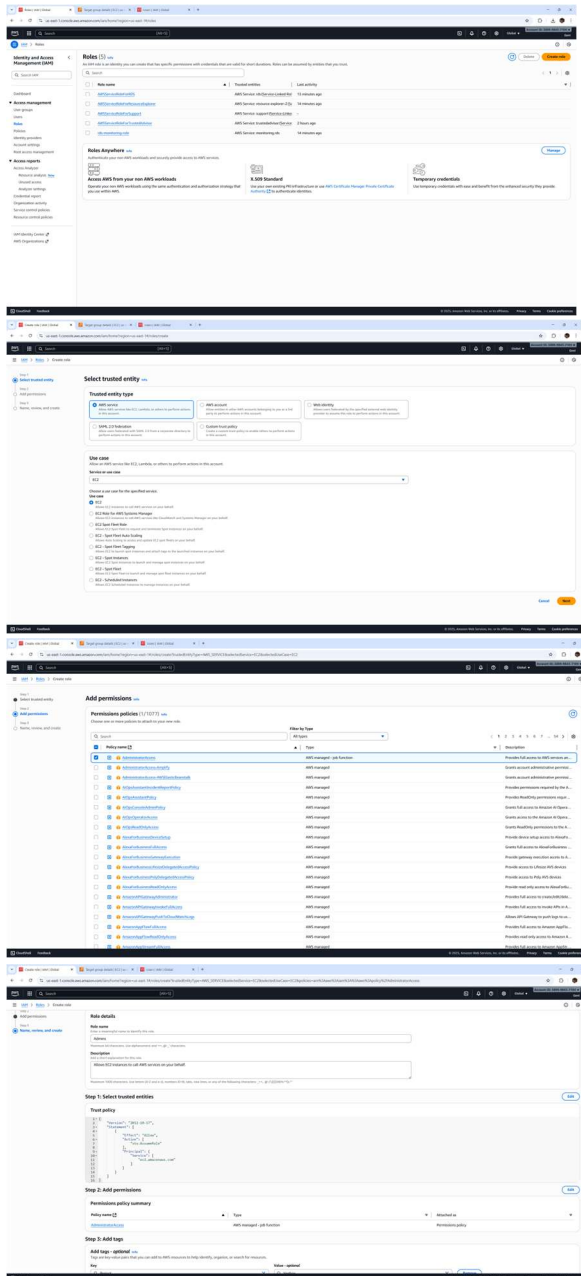
- Developers
- DataBaseAdmins
- SupportTeams
- Auditors

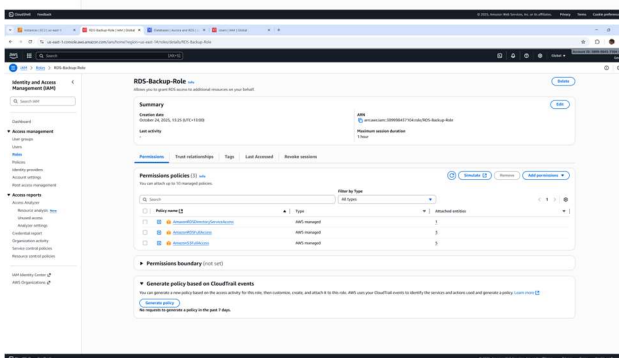
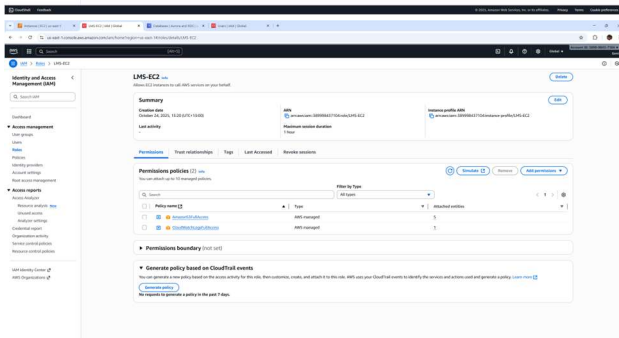
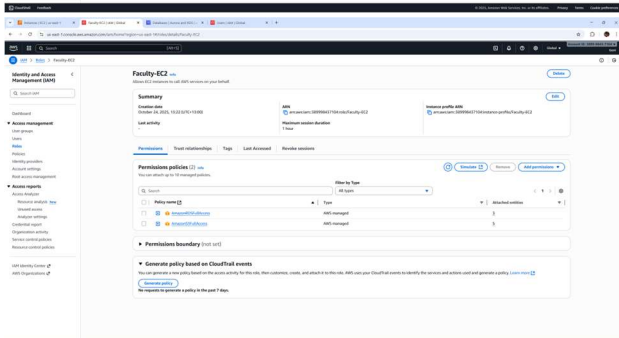
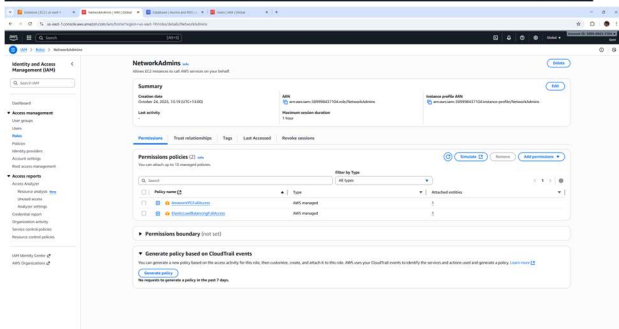
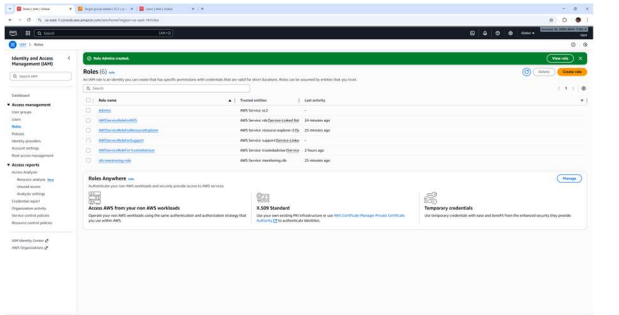




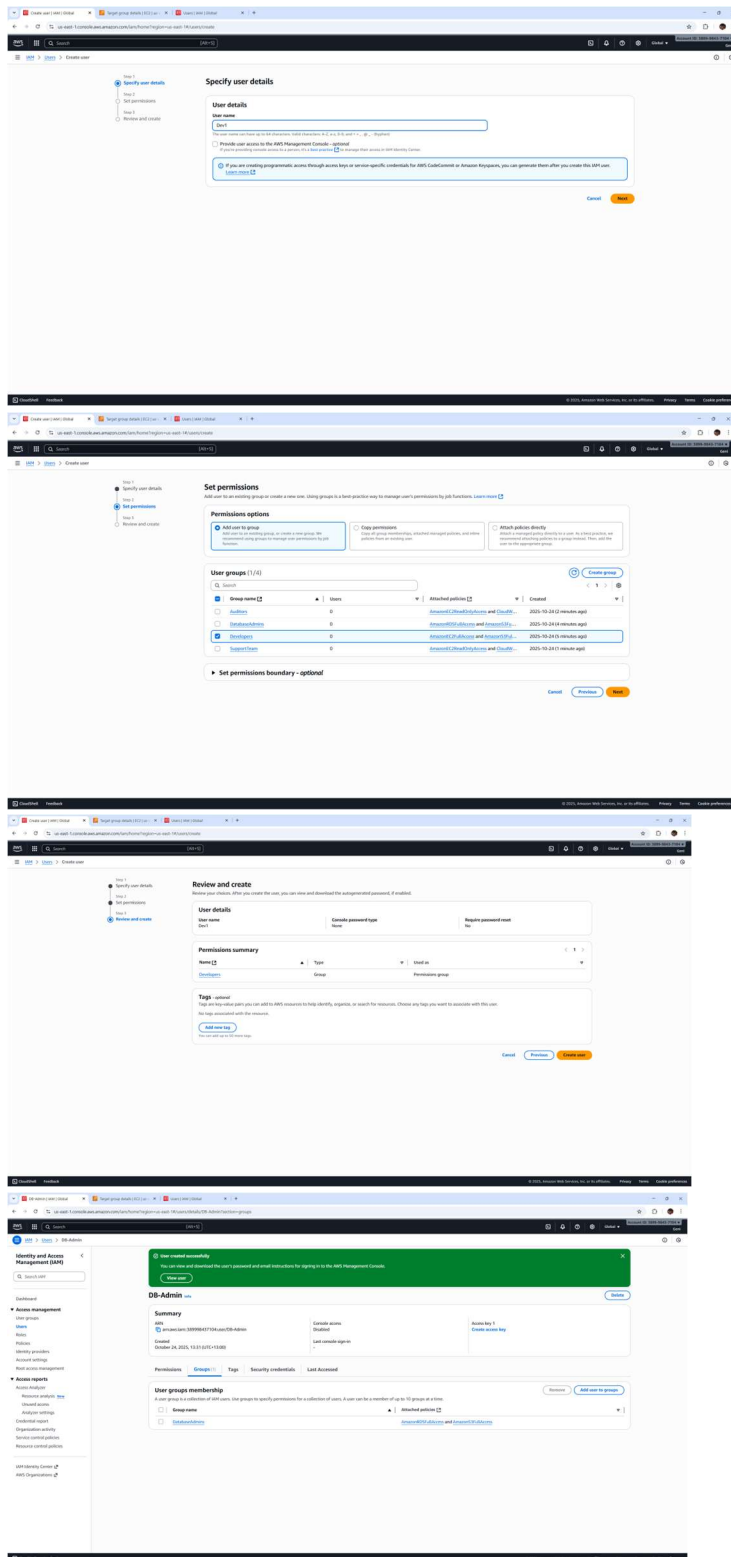
Created IAM User Roles with permission policies

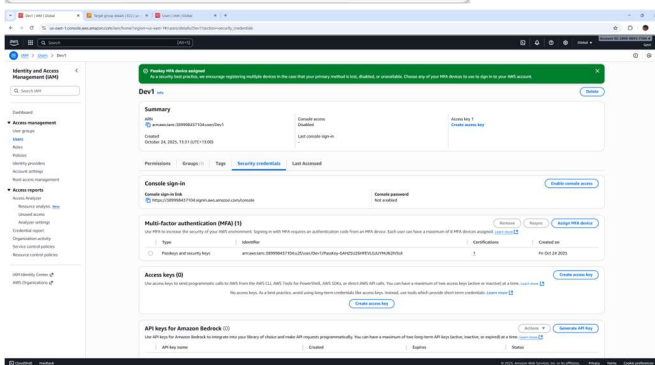
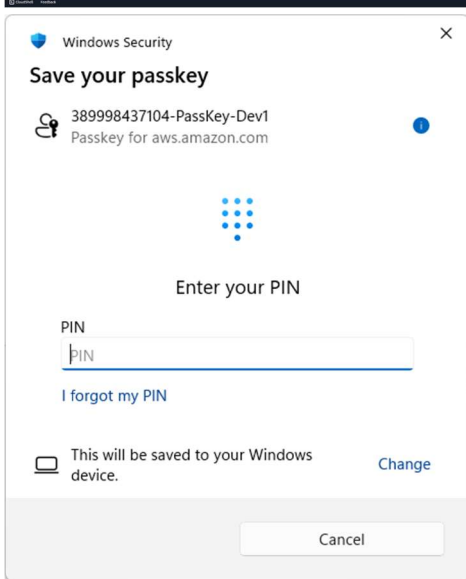
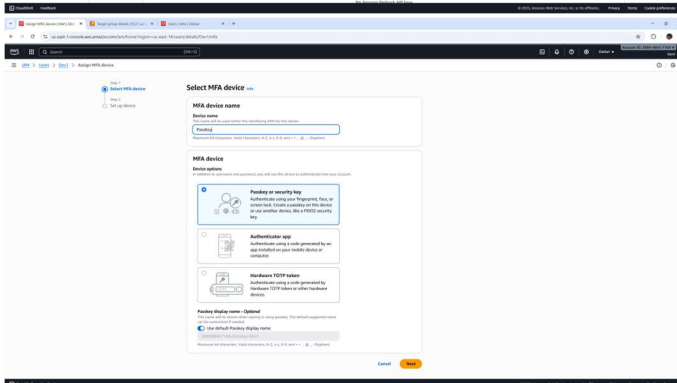
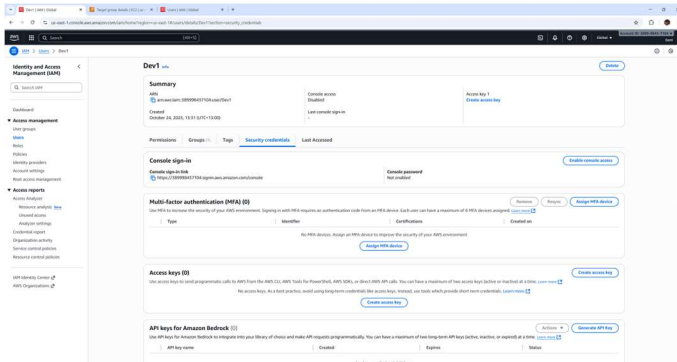
- Admins
- Facility-EC2
- LMS-EC2
- NetworkAdmins
- RDS-Backup-Role





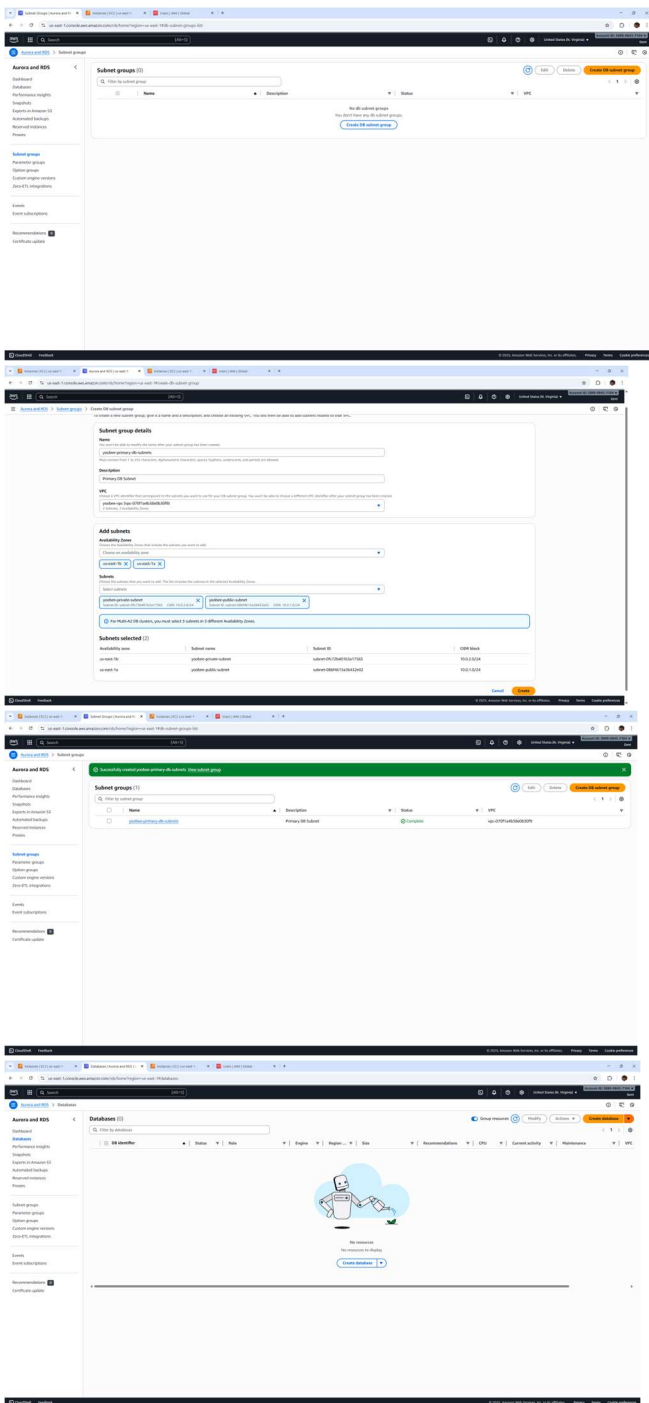
Added IAM Users and applied MFA for Dev1

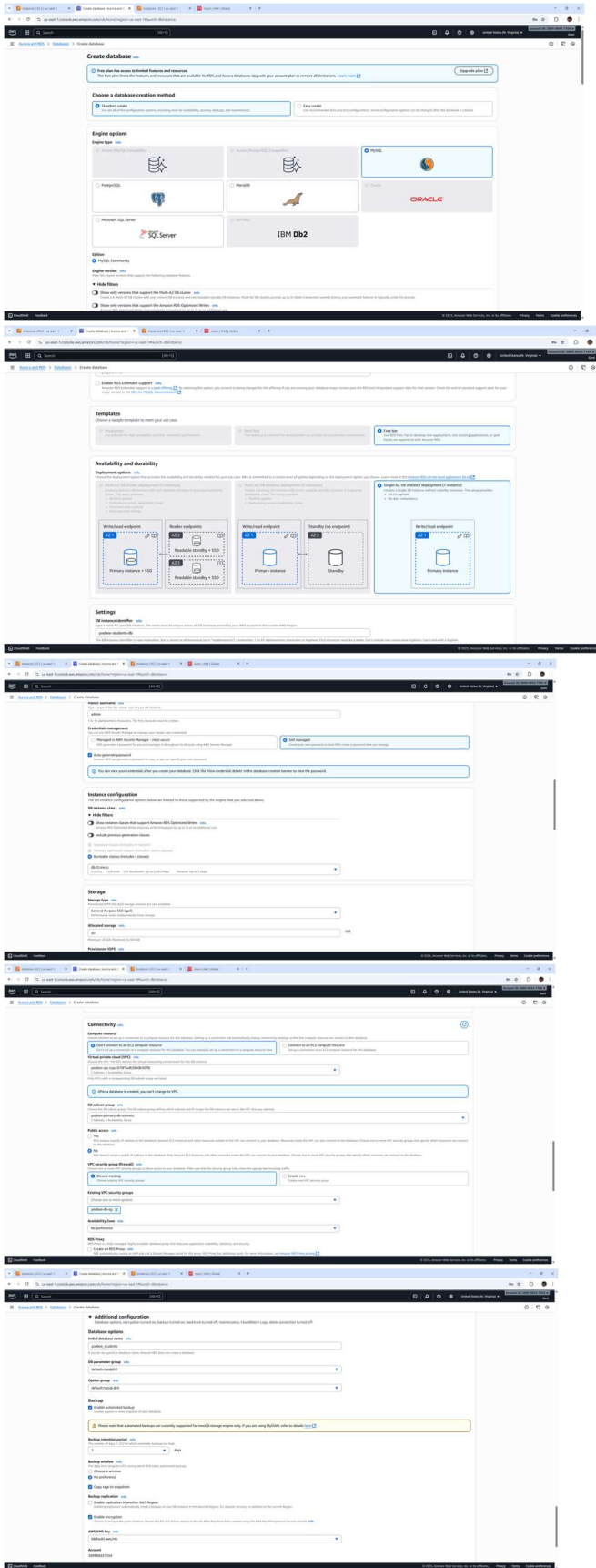


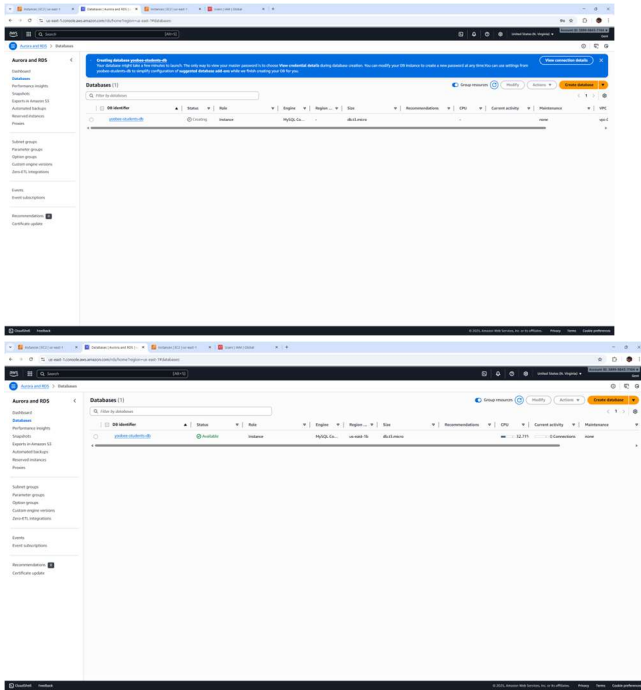


RDS Database and DR Configuration

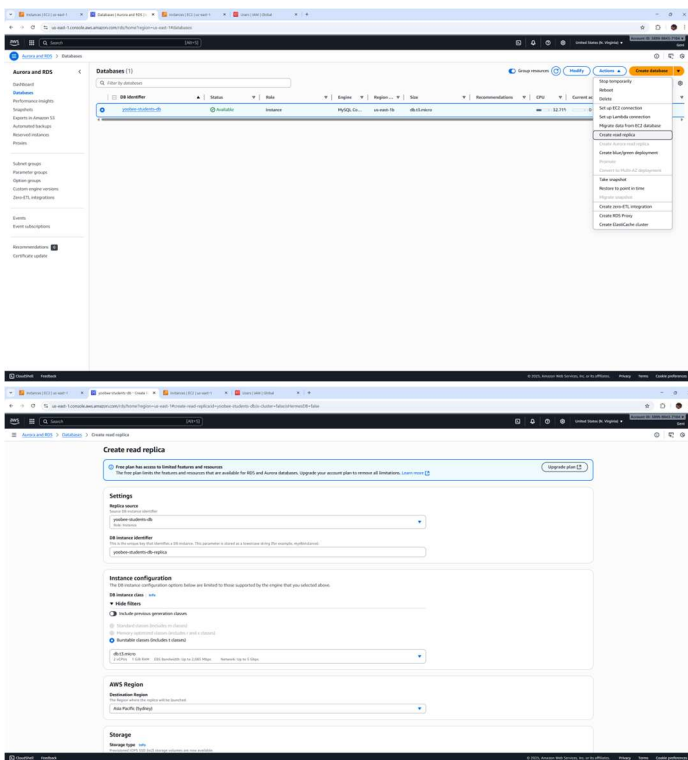
Created a Primary MySQL database

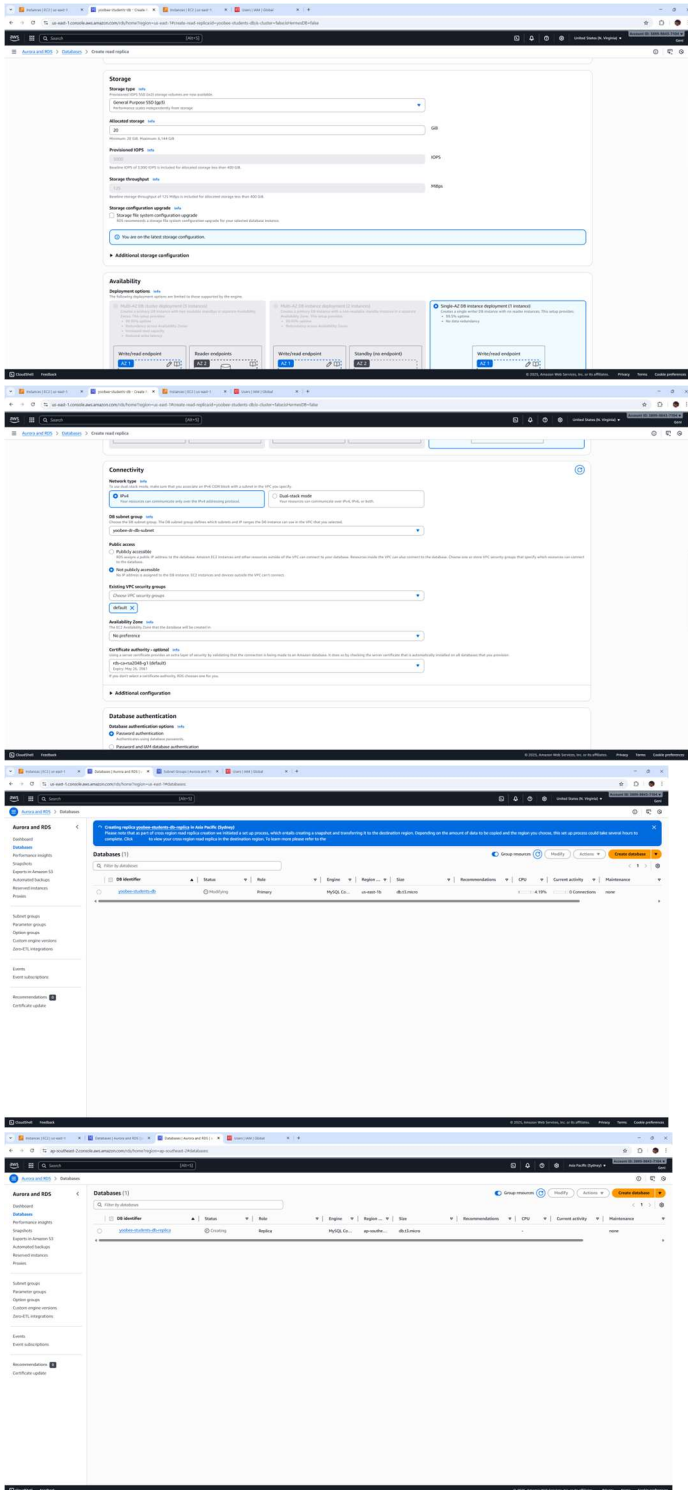






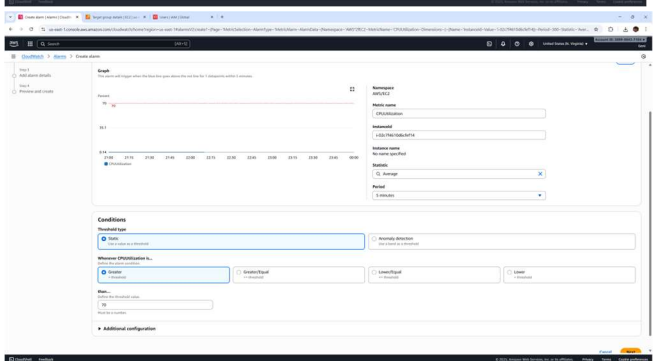
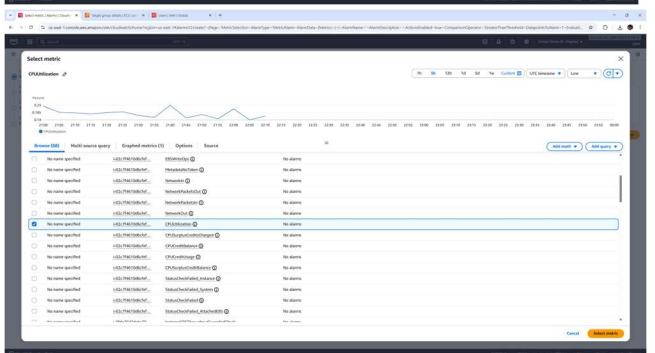
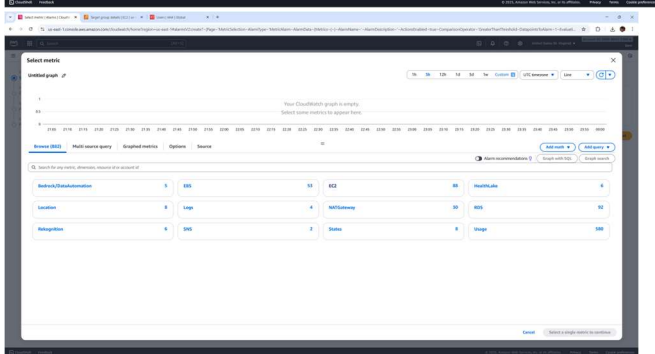
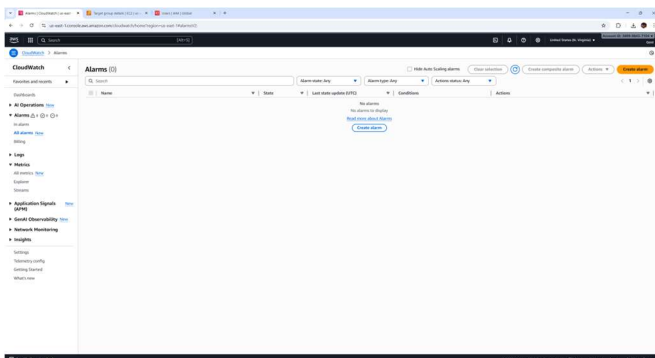
Created a cross-region Read Replica

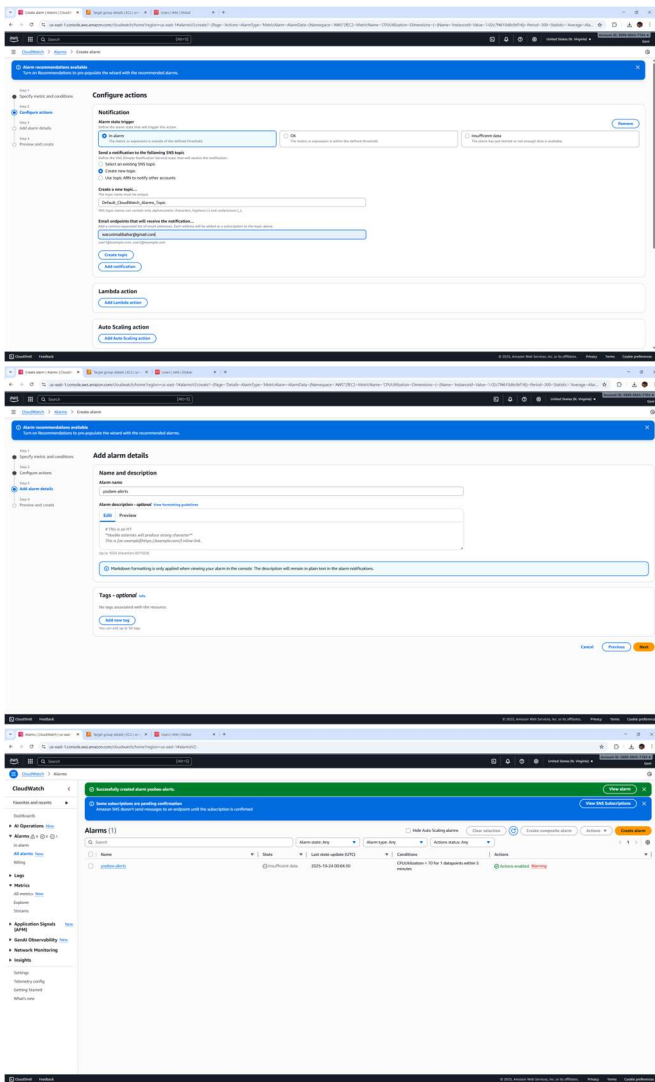




CloudWatch Monitoring and Alerts

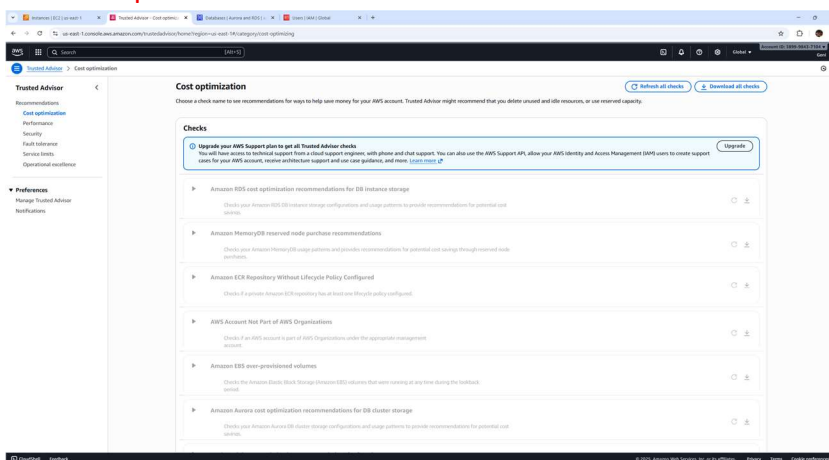
Configured CloudWatch Alarms





Cost Optimisation Using AWS Trusted Advisor

AWS Trusted Advisor is unavailable in the Free Tier, so cost-optimization was explored through AWS best-practices.



Possible Recommendations

- Turn off or resize idle EC2 instances - Basically, for our lab, the Linux LMS and Windows Faculty host systems only need to run during study hours. Stopping them after class time avoids paying for unused compute hours.
- Use cheaper storage tiers - S3 Lifecycle Rules can move old backups to Standard-IA after 30 days and delete them after a year. Use Auto Scaling and Load Balancing. This will keep services running smoothly without over-provisioning resources.
- Keep backups and DR lightweight - The RDS Read Replica in Sydney and the S3 replication bucket only store copies, so they can use the smallest and lowest-cost instance types.
- Watch usage limits - Monitoring quotas prevent surprise charges beyond the Free Tier.

Cost-Reduction Steps already taken in the project

- Used t2/t3-micro instance types that stay inside the Free Tier.
- Applied lifecycle rules on S3 buckets to reduce storage cost automatically.
- Kept the DR region passive, replica databases and storage only, no running compute.

Security and Cost-Optimisation Recommendations

Security Measures Implemented

Area	Already Implemented	Reasoning
IAM Roles and Groups	Created clear roles: <i>Admins</i> , <i>NetworkAdmins</i> , <i>LMS-EC2</i> , <i>Faculty-EC2</i> , <i>RDS-Backup-Role</i> and user groups like <i>Developers</i> and <i>Auditors</i> .	Follows least-privilege principle so each person only has the access they need.
Multi-Factor Authentication	Enabled passkey-based MFA for the root account and user Dev1.	Adds an extra layer of protection if a password is stolen.
Security Groups	Allowed only required ports: 22 (SSH), 80 (HTTP), 3389 (RDP) and 3306 (MySQL).	Minimises exposure to the internet.
Private Networking	RDS databases placed in private subnets; EC2 in public ones.	Separates sensitive data from public traffic.
Backups and Replication	Configured S3 Cross-Region Replication and RDS Read Replica in Sydney.	Provides recovery in case the main region fails.

Monitoring and Alerts	Set up CloudWatch alarms (CPU > 70%) and SNS topic “yoobee-alerts”.	Sends early warnings for unusual activity.
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Cost Optimisation Summary

- Run only the resources needed; stop or downsize idle servers.
- Use S3 lifecycle transitions and archive older backups.
- Keep DR components small and inactive until needed.
- Review AWS Billing Dashboard monthly.
- Stay within Free Tier where possible.

Overall Evaluation

While writing this report, I tried to keep the explanations clear and easy to follow. Each section connects directly to the AWS setup I completed, showing how the theory links with the practical work. The screenshots were added to prove that the tasks were actually implemented, not just described. The report covers all main requirements EC2 instances, S3 replication, RDS read replica, IAM security, CloudWatch monitoring, and cost optimisation with step-by-step evidence. All in all, I think the report gives a complete and realistic picture of the AWS setup for Yoobee’s cloud environment.

References

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<https://awsacademy.instructure.com/courses/138714>
- AWS Academy. (2024). AWS Academy Cloud Foundations [138711]
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<https://www.linkedin.com/learning/>