Report

Assignment 4

“Cloud Application Development”

Application Security Best Practices and Scaling Applications on Google Cloud

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Executive Summary

This report explores the implementation of security best practices and scalability strategies in Google Cloud applications. It covers critical aspects of Identity and Access Management (IAM), data protection, monitoring, and incident response. Additionally, it delves into scalable application design using Google Cloud services, comparing horizontal and vertical scaling, and implementing load balancing and auto-scaling policies. The findings emphasize the importance of a secure, scalable architecture and provide actionable recommendations for improvement.

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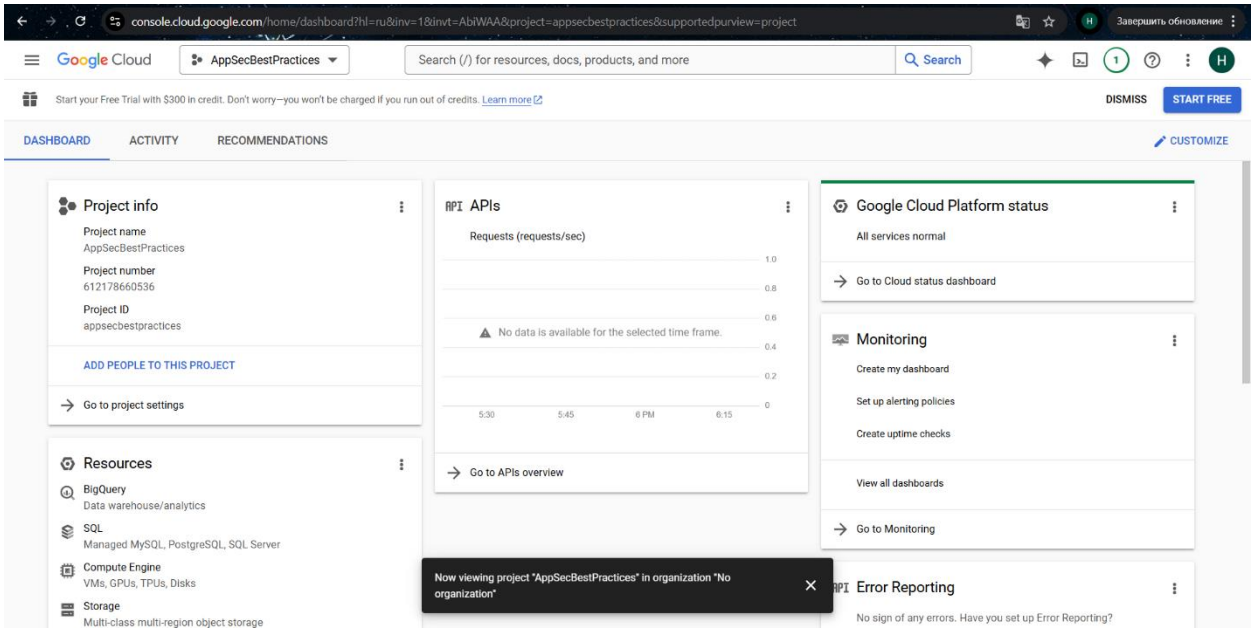
1. Introduction

Overview of Google Cloud and the Significance of Security and Scalability

Google Cloud is a leading cloud platform offering a wide range of services to build, deploy, and scale applications. As businesses increasingly rely on cloud solutions, securing applications and ensuring their scalability are paramount for maintaining reliability, performance, and cost-efficiency.



2. Application Security Best Practices

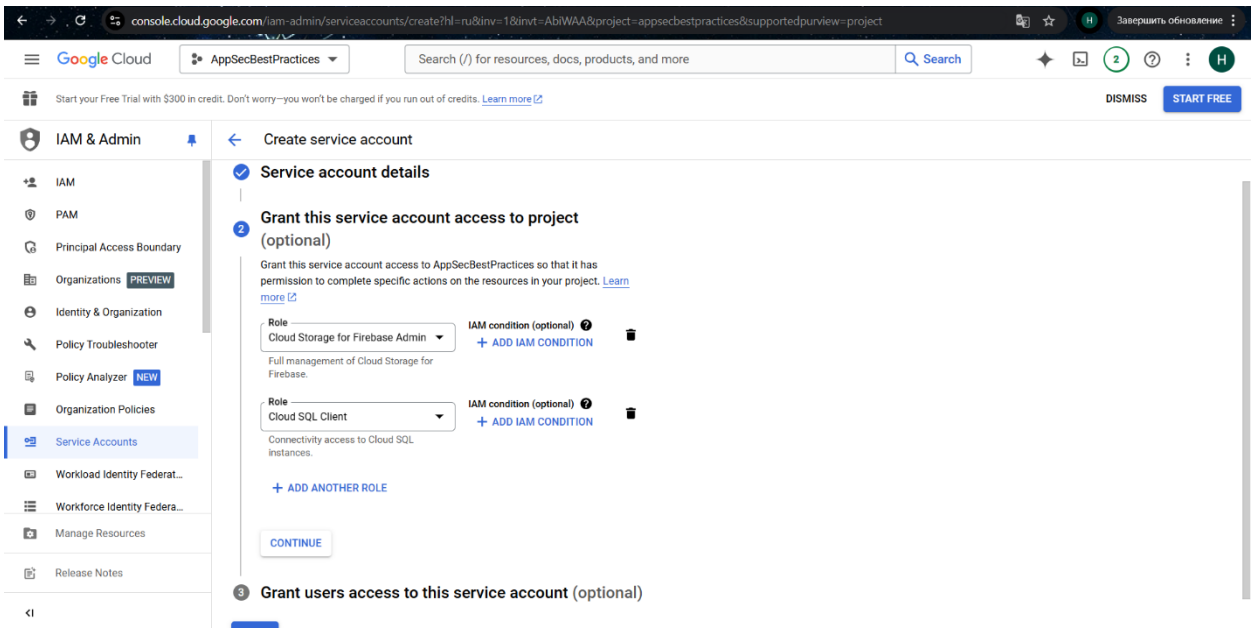
2.1 Overview of Cloud Security

Google Cloud operates on the shared responsibility model, where Google manages the security of the cloud infrastructure while users are responsible for securing their applications and data.

2.2 IAM Configuration

Principle of Least Privilege

- Broad roles like **Owner** and **Editor** were avoided to limit excessive access.
- Service accounts were created with minimal roles such as:
    - **Cloud Storage Object Viewer** for read-only access to specific buckets.
    - **Cloud SQL Client** for database interactions.



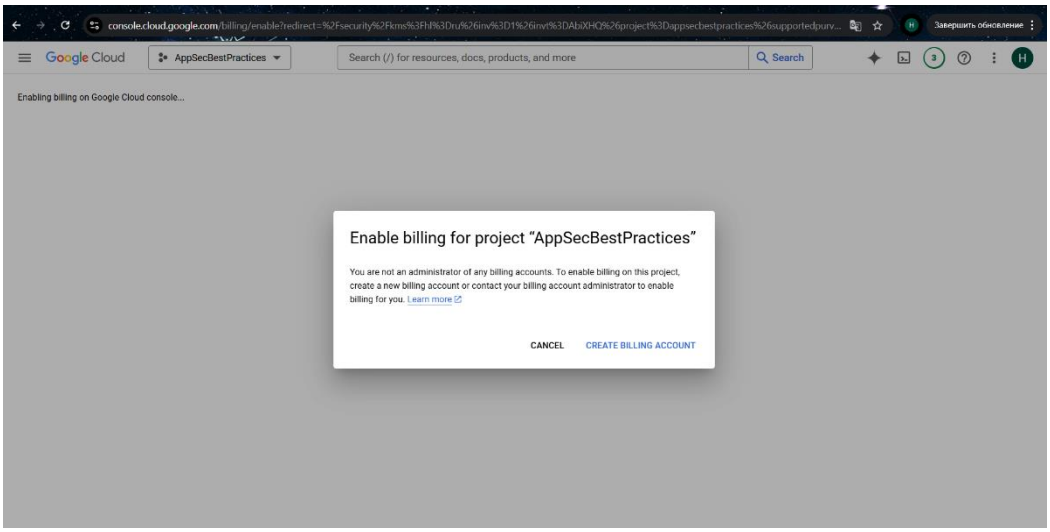
IAM Conditions

- **IP Restrictions**: Access was restricted to a specific IP range (e.g., 192.168.1.0/24).
- **Time Restrictions**: Access allowed only during business hours using CEL expressions.
- **Resource-Specific Restrictions**: Permissions scoped to particular buckets using resource attributes.

2.3 Data Protection

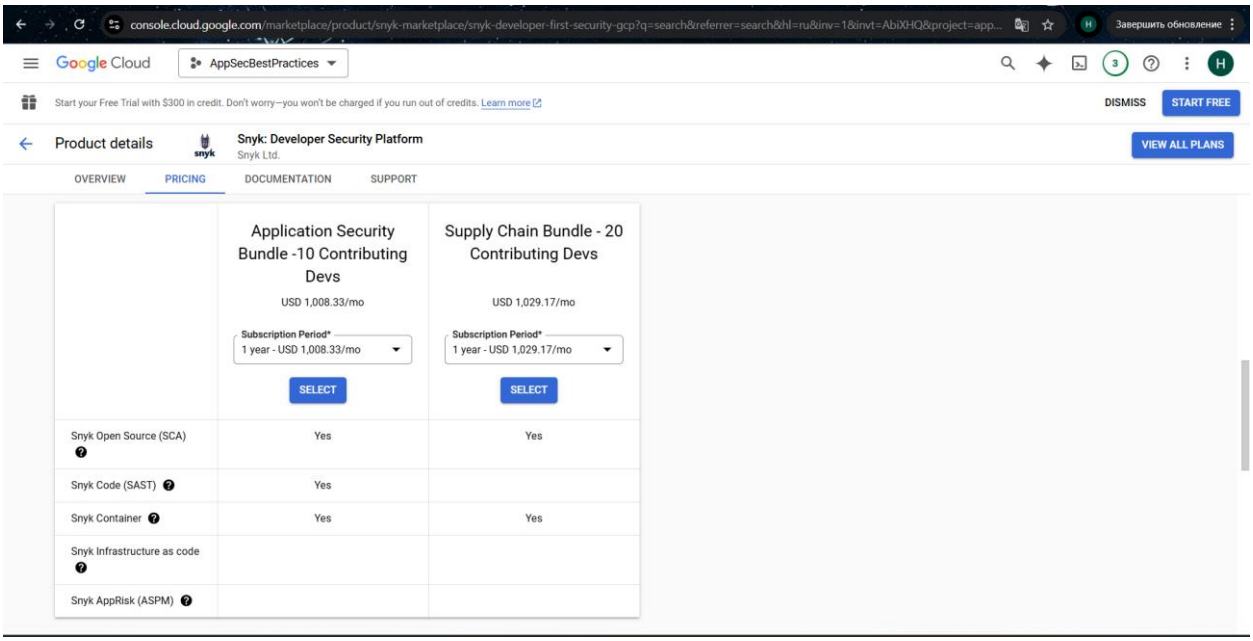
- **Encryption at Rest**: Configured using Google Cloud KMS with customer-managed encryption keys.
- **Encryption in Transit**: HTTPS enforced for all data transmission using load balancers with SSL certificates.

For this needing billing account:



2.4 Security Testing

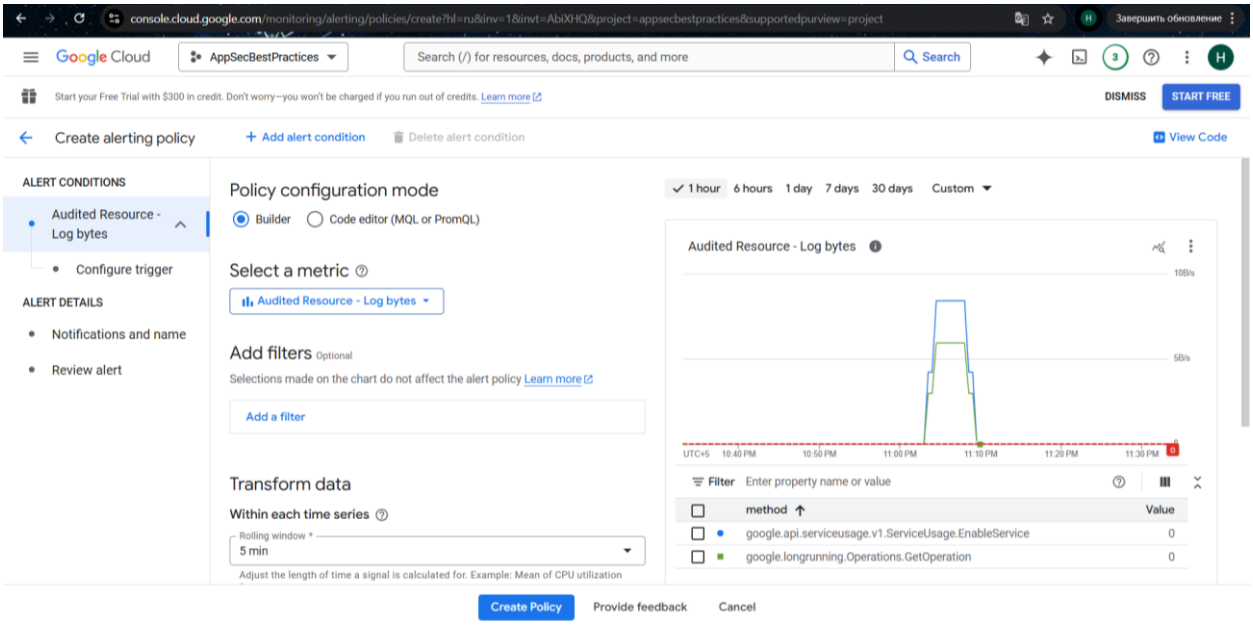
- **Tools**: Integrated **Snyk** into the CI/CD pipeline for automated security testing.



- **Findings**: Minor vulnerabilities like outdated dependencies were identified and mitigated.

2.5 Monitoring and Logging

- **Google Cloud Audit Logs**: Enabled for all services to track changes and detect anomalies.
- **Alerts**: Configured to trigger notifications for failed login attempts and unusual traffic patterns.



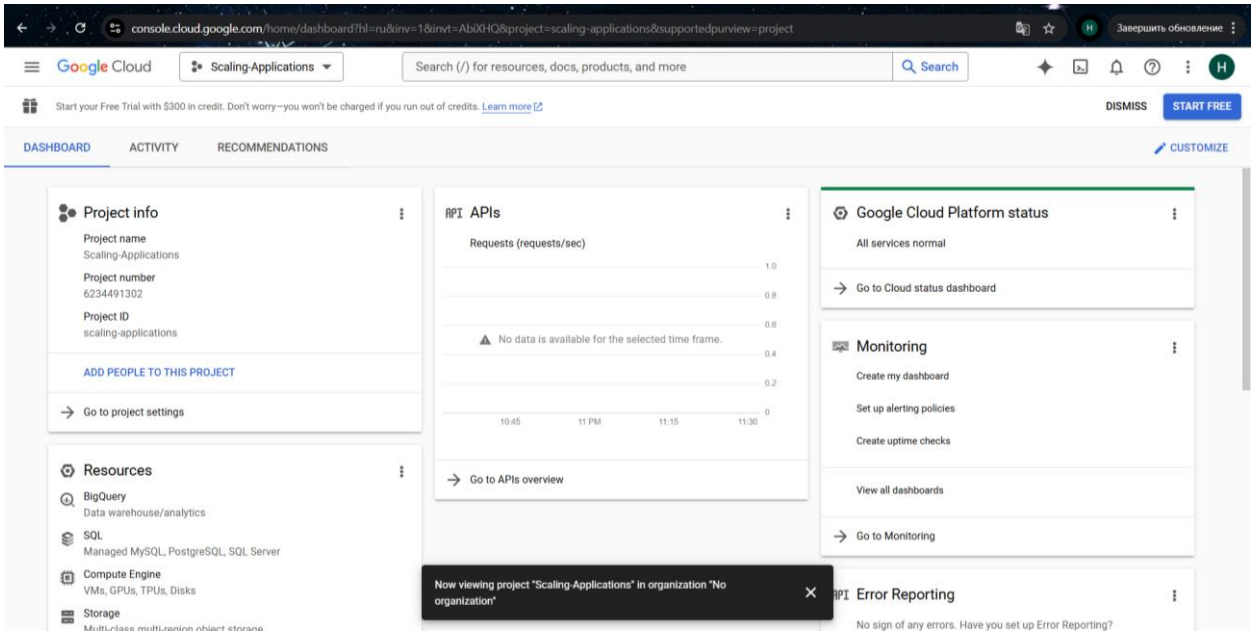
2.6 Incident Response

- **Incident Response Plan**: Defined roles, communication channels, and procedures for handling security breaches.
- **Simulation**: Conducted a mock phishing attack and validated response protocols, including access revocation and log analysis.

3. Scaling Applications on Google Cloud

3.1 Overview of Scalability

Scalability ensures that applications can handle varying traffic loads while maintaining performance and reliability. Cloud-native solutions simplify scaling through automation.



3.2 Application Design

A lightweight web application (to-do list) was built using **Google Kubernetes Engine (GKE)** for containerized deployment.

3.3 Scaling Methods

Horizontal Scaling

- Additional instances of the application were added during peak load.

Vertical Scaling

- Upgraded Compute Engine instance types to handle increased processing demands.

Comparison:

- Horizontal scaling proved more cost-effective and reliable for high-traffic scenarios.

3.4 Load Balancing

- **Google Cloud Load Balancer**: Configured to distribute traffic across multiple application instances.
- **Health Checks**: Ensured traffic was routed only to healthy instances.

3.5 Auto-Scaling Implementation

Auto-scaling policies were defined for:

- **GKE**: Based on CPU and memory usage thresholds.
- **Compute Engine**: Scaled based on HTTP request load.

3.6 Performance Monitoring

- **Google Cloud Monitoring**: Set up dashboards to track CPU usage, memory consumption, and request latencies.
- Alerts triggered for performance anomalies ensured quick remediation.

3.7 Cost Optimization Strategies

- Reserved instances and committed use discounts were utilized to lower costs.
- Load testing identified underutilized resources, which were scaled down to reduce expenses.

4. Conclusion

Implementing robust security measures and scalable architecture on Google Cloud is critical for modern applications. The steps taken enhanced the security posture while ensuring the application could handle varying loads efficiently. Continuous monitoring and optimization are essential for maintaining performance and cost-effectiveness.

5. Recommendations

- Regularly review IAM permissions and remove unused service accounts.
- Integrate real-time vulnerability scanning tools into CI/CD pipelines.
- Monitor auto-scaling configurations to avoid unnecessary cost increases.

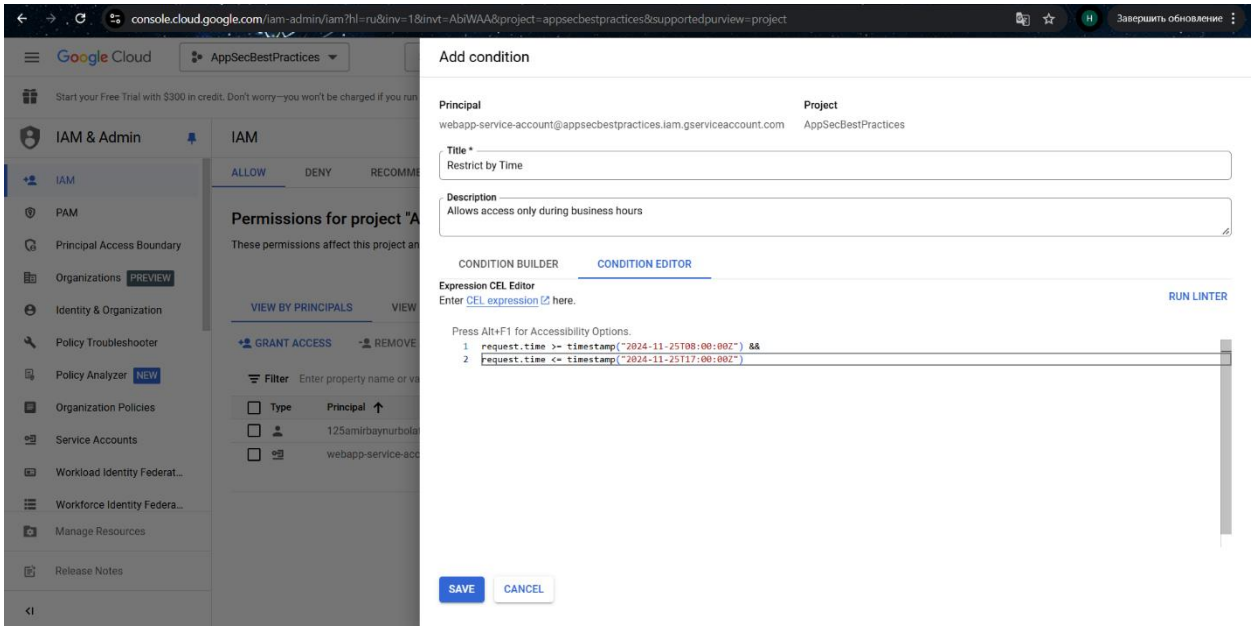
- Adopt a proactive approach to incident response with frequent simulations.

6. References

- Google Cloud Documentation. https://cloud.google.com/docs
- OWASP ZAP Documentation. https://owasp.org/www-project-zap/
- Security Best Practices on Google Cloud. https://cloud.google.com/security

7. Appendices

Appendix A: IAM Conditions Example



Example CEL condition for time-based restrictions:

request.time >= timestamp("2024-11-24T08:00:00Z") &&

request.time <= timestamp("2024-11-24T17:00:00Z")

Appendix B: Security Testing Results

Vulnerability	Severity	Mitigation
Outdated Library	Medium	Upgraded dependency to latest version.
Missing CSP Headers	Low	Implemented Content Security Policy.

Appendix C: Auto-Scaling Policy

Compute Engine Policy:

- Scale out when CPU usage > 70%.
- Scale in when CPU usage < 30%.