

# EASTERN INTERNATIONAL UNIVERSITY

**SCHOOL OF COMPUTING AND INFORMATION TECHNOLOGY**

## DEPARTMENT OF COMPUTER NETWORKS AND DATA COMMUNICATIONS

**CSE 420**

**INTERNSHIP PROJECT REPORT**

Integrated System Management: Combining Local Networks and Cloud Platforms

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**Binh Duong, SEPTEMBER, 2025**

EASTERN INTERNATIONAL UNIVERSITY

## SCHOOL OF COMPUTING AND INFORMATION TECHNOLOGY

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# PROJECT EVALUATION FORM

### General information

* Project title: Integrated System Management: Combining Local Networks and Cloud Platforms
* Student name and ID:
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* Supervisor name: **Dr. Phan Van Vinh**

### Descriptive comments

* 1. *Presentation (layout, format, style, confidence)*

This report has been written with good layout and format effectively.

* 1. *Content (Originality and contribution)*

The content of this report has satisfied the requirement of the first project.

* 1. *Outcome (Creativity and practice)*

This project has good achievements and expected outcomes.

* 1. *Performance during questions and answers*

During the time of this project, this student have shown there strong interest and good working attitude to complete the requirements of the project.

### Suggestion for improvement

Need to enhance the web interface design and database design to get better performance in data visualization.

**Total Score: …/100 Binh Duong, Date:**

**Phan Van Vinh**

# ABSTRACT

This report is about finding out how to mix local network tools with cloud services in a basic IT system. I mainly worked with **pfSense** for firewall and routing, where I tried basic setups like assigning IP addresses, creating firewall rules, and enabling DHCP. For monitoring, I used **Zabbix** with **Grafana** to track CPU, bandwidth, and uptime, and to build simple dashboards. On the cloud side, I tested free-tier services from **AWS, Google Cloud, and Microsoft Azure**, where I created small virtual machines and practiced adjusting basic security rules.

To make things more like a real-life situation, I created a small mixed setup with a pretend client called Athena. Since I didn’t have access to real company systems, I learned mainly by researching and building practice labs. Although I didn’t get to fully put the system into action, this project showed me a lot about how to organize IT systems using both local hardware and cloud platforms, this experience gave me a clear view of how system management can be planned in both local and cloud contexts**.**

# ACKNOWLEDGEMENT

I want to thank my supervisor, Dr. Phan Van Vinh, for his support and advice throughout my internship. His feedback helped me stay on track with my research and practice. I’m also thankful to the School of Computing and Information Technology at **Eastern International University** for letting me do this project and for providing the resources I needed.

I appreciate my classmates and friends as well, who shared ideas with me and helped me test out lab setups on my own computer. Even though this project isn’t perfect, working on it was a valuable experience for me, and I’m grateful for all the help and encouragement I got along the way.

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# LIST OF ABBREVIATIONS

|  |  |
| --- | --- |
| **Abbreviation** | **Meaning** |
| AWS | Amazon Web Services |
| Azure | Microsoft Azure |
| pfSense | An open-source firewall/router software |
| Zabbix | A monitoring tool for IT infrastructure |
| Grafana | A tool for visualizing metrics & logs |
| VM | Virtual Machine |
| LAN | Local Area Network |
| IP | Internet Protocol |
| DNS | Domain Name System |
| NAT | Network Address Translation |
| GUI | Graphical User Interface |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# CHAPTER 1: INTRODUCTION

## 1.1 Background and Motivation

These days, most companies no longer rely only on their own servers. Instead, they use a hybrid setup where some parts of their IT are on local machines, and others are on the cloud. This approach gives more flexibility, but also creates new issues, especially for monitoring, configuration, and security **[1], [2].**

During my internship, I wanted to see how different tools could work together in this kind of environment. I mainly used pfSense for firewalls and routing, Zabbix and Grafana for monitoring, and I tested free options from AWS, and Microsoft Azure. My goal was simply to get real-world experience with these tools and understand how they can be used in a basic hybrid setup, not to become an expert.

A diagram of cloud computing

Description automatically generated

Figure : Local Network Diagram

Figure 1 illustrates the basic architecture of a hybrid IT system connecting a local network with major cloud platforms like AWS and Microsoft Azure. Inside the local network, there is a pfSense firewall, a monitoring system (Prometheus/Grafana), local servers, and various user devices. The diagram uses dashed lines to show secure connectivity (VPN/Direct Connect) and solid lines to indicate data flows or management tasks, simply demonstrating how internal resources interact and exchange data with cloud services.

## 1.2 Problem statement

A common challenge for many small and medium-sized businesses is that their IT systems can be difficult to monitor and manage. While there are tools available, choosing the right ones and integrating them effectively is often unclear. Small teams with limited budgets or expertise frequently find it hard to keep an overview of both their local and cloud environments **[3].**

To tackle this in a straightforward way, I created a simulated client named Athena to represent a medium-sized business. Using Athena’s basic requirements, this project suggests a simple hybrid model that links local network tools with cloud services, aiming to create a system that is easier to manage and maintain.

## 1.3 Objectives

The project was never intended to create a fully operational system. Instead, its main goal was to learn the fundamentals and understand how various tools can be combined. The key objectives included:

* Gaining hands-on experience with local network management by using pfSense for routing and firewall, along with Zabbix and Grafana for monitoring.
* Exploring the essential features of cloud platforms by experimenting with AWS and Microsoft Azure for small-scale setups.
* Building small-scale simulations using VMware to create a test environment resembling a real business scenario.
* Designing a simple hybrid model to propose a basic system management approach suitable for small or medium-sized companies like Athena.

By the end of the project, the goal was not to become an expert, but to have a clearer picture of how local and cloud systems can fit together for SMEs.

## 1.4 Scope & Limitations

This project was mainly research-based, supported by several small lab simulations done on my personal computer. The primary goal was to understand how the tools function rather than build a system ready for production use.

* + - **Scope:**
    - Learn and experiment with open-source tools like **pfSense, Zabbix, and Grafana,** and practice network scenarios using Packet Tracer.
    - Explore basic features of cloud platforms such as **AWS and Azure** through free-tier accounts.
    - Setup a small lab environment on my laptop using **VMware** to mimic real-world conditions as closely as possible.
    - Analyze the requirements of a simulated SME client named Athena and propose a high-level hybrid model that integrates local and cloud tools.
      * **Limitations:**
      * No direct access to real company infrastructure, so all environments had to be recreated in the lab.
      * Cloud usage was limited to **free-tier services**, restricting the scope of testing.
      * Security enhancements and performance testing were beyond the project’s scope due to limited resources and access.

A screenshot of a computer

Description automatically generated

Figure : pfSense VM

A diagram of a router

Description automatically generated

Figure : Setup a small lab from Athena

Figure 3 shows a simple network diagram for a small office or lab setup. It includes several servers (such as DC, ADC/FS, and WSUS), a router, a network printer, a WiFi access point, and a group of user computers connected through a switch. The diagram helps explain the basic arrangement and connectivity between servers, network devices, and user endpoints in the system

# CHAPTER 2: TOOLS AND TECHNOLOGIES OVERVIEW

This chapter summarizes the main tools and platforms used during my internship. Since the focus was on learning rather than creating a large system, I explored each tool with basic, hands-on practice. Most were tested in a VMware lab setup or through free-tier cloud accounts.

## 2.1 pfSense

**pfSense** is a popular open-source firewall and router system commonly used in small and medium business networks. It supports routing, NAT, VPN, and firewall rules.  
In this project, I installed pfSense as a virtual machine on VMware Workstation. I practiced tasks such as assigning static IP addresses, setting up port forwarding, and creating simple firewall rules. The aim was not advanced security, but to learn how pfSense can serve as the main control point in a local network.

A screenshot of a computer

Description automatically generated

Figure : Firewall rules on pfSense

Figure 4 is a screenshot of the pfSense firewall web interface, showing the WAN firewall rules configuration page. It displays two default rules designed to block private networks and bogon networks from reaching the WAN interface. The warning and instructions at the top indicate that the admin password is still set to default, and new rules can be added or modified using the buttons below the rule list.

A screenshot of a computer

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Figure : pfSense Dashboard

A screenshot of a computer

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Figure : Showing information via pfSense

In the Figure 5 and 6, the pfSense dashboard, displaying system information and basic performance metrics for the firewall device. The details include hardware specs, uptime, DNS servers, and recent configuration changes, along with current CPU, memory, and swap usage statistics in a simple format. It helps provide an overview of the device’s status and resource consumption during operation.

## 2.2 Zabbix and Grafana

**Zabbix** is an open-source monitoring tool that collects data on system performance like CPU usage, memory, and network traffic**.** Grafana is a visualization platform that works with Zabbix to display the data in clear dashboards.

I set up a small **Zabbix server** on a VM and connected it to pfSense for monitoring. Then, **Grafana** was linked to **Zabbix** to display real-time charts of CPU and network activity. Though a small setup, it demonstrated how monitoring tools help IT teams maintain system control.

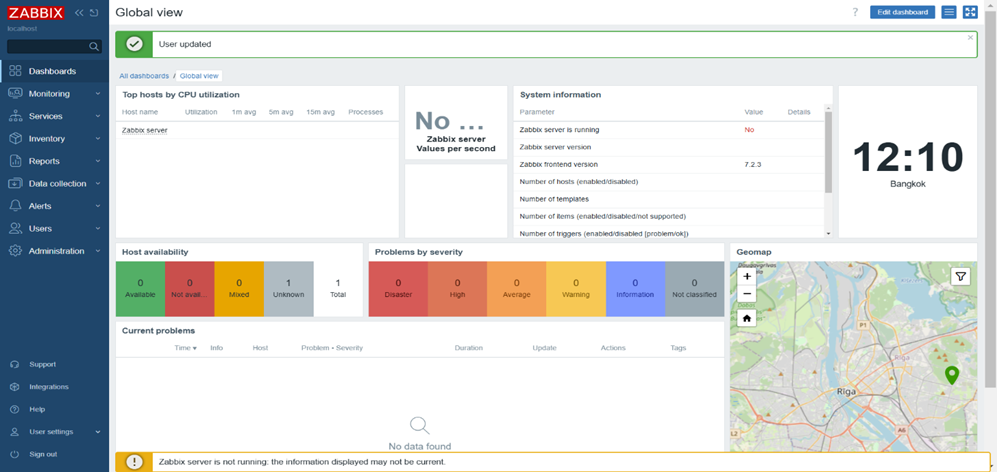


Figure : The interface Zaabix

Figure 7, this image displays the Zabbix global view dashboard, which is used for system monitoring and visualization. On the screen, there are sections showing host availability, problems by severity, system information, a local map, and a summary of current issues. The dashboard helps users check overall system health and monitor active alerts or statuses in a straightforward way.

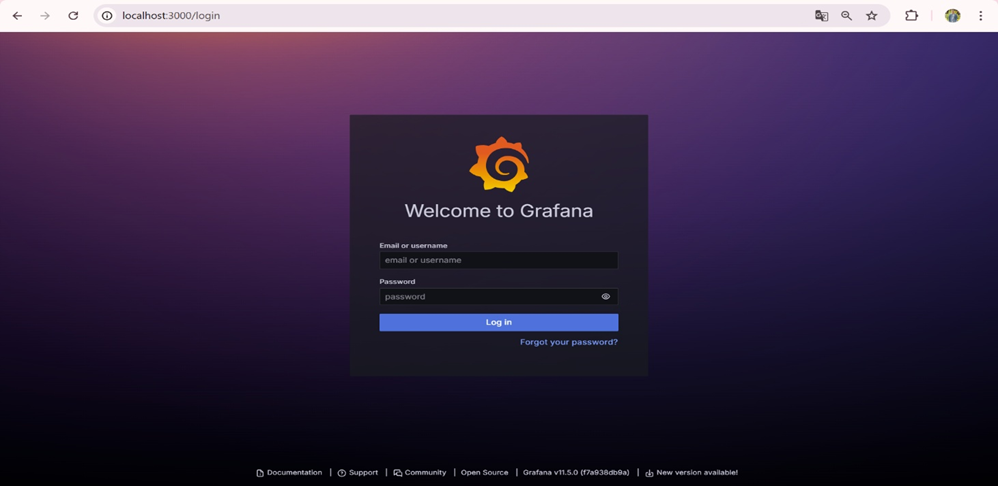


Figure : The interface Grafana

## 2.3 Cloud Platforms (AWS, Microsoft Azure)

AWS and Microsoft Azure are leading cloud providers offering compute, storage, networking, and monitoring services.

For this project, I created free-tier accounts on each platform to compare their dashboards, explore virtual network setups, and test basic monitoring features. The goal was to understand usability differences and find a good fit for the simulated client, Athena.

A screenshot of a computer

Description automatically generated

Figure : AWS tests

The Figure 9 is a screenshot from the AWS Lambda management console, focusing on the configuration tab of a function named "LambdaAccessRDS". It highlights the execution role details, showing permissions for Amazon CloudWatch Logs, and provides options to edit the role or view the role document. The page layout helps users check function access settings and manage resources in AWS Lambda straightforwardly.

A screenshot of a computer

Description automatically generated

Figure : Microsolf Azure Experiment

**In the figure 10**, this image is a screenshot of the Quick Start Center in the Microsoft Azure portal, showing introductory options for new users. The interface includes a checklist for getting started, suggestions for popular services like creating a web application, deploying containers, and running virtual machines. The content is mostly in French and is designed to help users navigate Azure and begin their first project easily.

## 2.5 Vmware Workstation

**VMware Workstation** is a virtualization tool that allows running multiple operating systems on one physical computer **[8].**

I used VMware to build my lab environment, running pfSense, Zabbix, Grafana, and a client-server test setup together without affecting my main system. This enabled me to simulate a small business network entirely on my laptop.

A screenshot of a computer

Description automatically generated

Figure : Vmware ruuning

The figure 11, This image shows the pfSense console interface running on a FreeBSD virtual machine in VMware. The screen lists available management options like assigning interfaces, changing IP addresses, rebooting, and accessing system logs or pfTop. This basic terminal view helps users perform initial setup or troubleshooting tasks directly on the firewall system

# CHAPTER 3: METHODOLOGY

This chapter outlines the step-by-step approach I used during the internship project. Since the focus was on learning and testing, I combined research with small lab simulations on my laptop.

## 3.1 Research Content

At the start, I spent time studying books, documentation, and tutorials to build a solid foundation. My research covered how pfSense works as a firewall and router , how Zabbix and Grafana manage system monitoring, the core features of cloud platforms like AWS and Azure , as well as general ideas about hybrid IT infrastructure.

This preparation gave me a clear overview before starting lab configurations

## 3.2 Lab Setup Using VMware

After researching, I built a small lab environment with VMware Workstation on my personal laptop. The setup included a VM running pfSense as firewall/gateway, a Zabbix server on Ubuntu, and a client VM to generate test traffic. All the VMs were connected via a virtual network, enabling me to test routing, firewall rules, and monitoring as a single system.

## 3.3 Network Simulation with Packet Tracer

Before setting up the VMs, I used Cisco Packet Tracer to design the network for the simulated client Athena. This helped me plan IP addressing, where to place firewalls and servers, and how to separate internal and external zones. Though Packet Tracer doesn’t provide real performance tests, it was useful to visualize the system design.

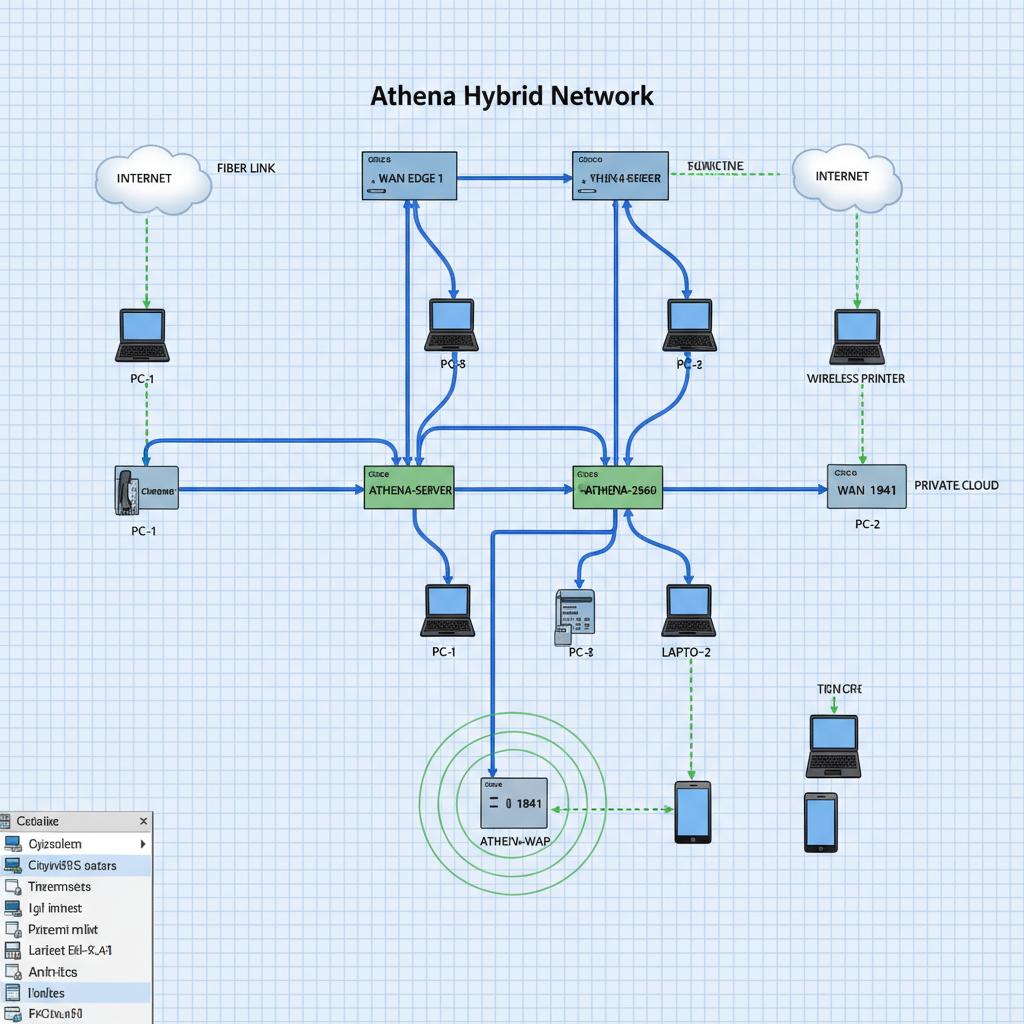


Figure : Athena Hybrid Network Diagram

## 3.4 pfSense Configuration

In pfSense, I practiced several important configurations:

* **Assigning static IPs** for WAN (e.g., 192.168.74.158) and LAN (e.g., 192.168.1.5).
* **Enabling DHCP** on the LAN interface so that client VMs could automatically receive IPs in a range I defined (192.168.10.100–192.168.10.200).
* **Creating firewall rules**: for example, allowing HTTP/HTTPS but blocking ICMP (ping) to test filtering.
* **Setting up NAT and port forwarding**: I redirected traffic from the WAN port 8080 to the internal client’s port 80, which allowed me to test web service access.

These activities showed how pfSense can act as the **central control point** for traffic in a small business network.

A screenshot of a computer

Description automatically generated

Figure : pfSense firewall rules

A screenshot of a computer

Description automatically generated

Figure : pfSense DHCP Server configuration

Figure 14 is a screenshot of the pfSense DHCP server configuration page for the LAN interface. It shows how the DHCP service is enabled, with options set for client handling, subnet settings, and available IP address range from 192.168.1.100 to 192.168.1.200. The page provides a clear view of the basic steps for setting up IP address distribution within the local network using pfSense.

## 3.5 Zabbix and Grafana Integration

Next, I set up **Zabbix** on an Ubuntu VM and added both pfSense and a client VM as monitored hosts. The metrics I tracked included:

* CPU usage of the firewall VM,
* network bandwidth (incoming/outgoing),
* and uptime status of the client VM.

After this, I installed the **Grafana Zabbix plugin** and connected Grafana to Zabbix. I created simple dashboards with panels showing CPU load, memory usage, and network graphs. Even though this was a small setup, it made the monitoring results much clearer and closer to what IT managers would expect to see.

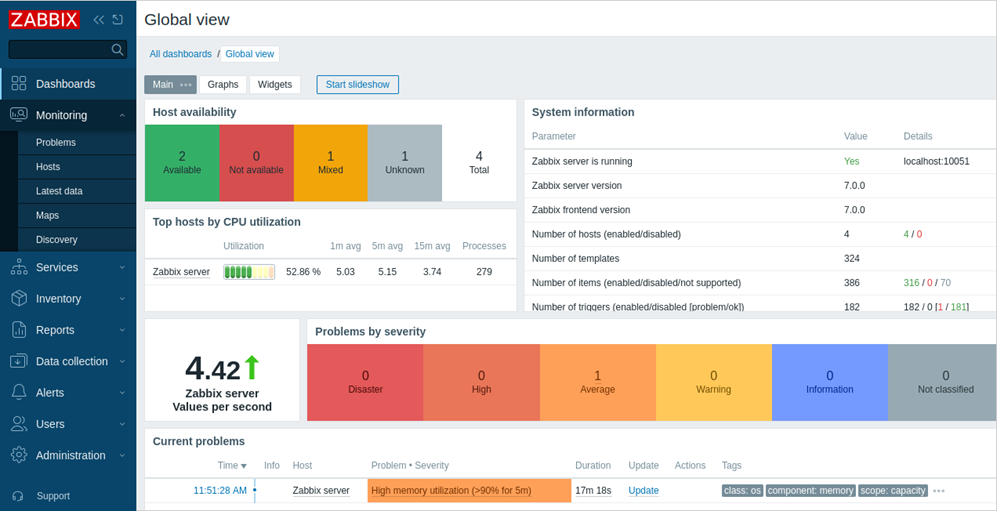


Figure : Zabbix Dashboard

**Figure 15** shows the Zabbix global dashboard, providing an overview of host availability, system information, CPU utilization, and current problems. The dashboard reports the server status, versions, monitored hosts, and triggers, while highlighting a warning about high memory usage on the Zabbix server. It helps administrators monitor overall system health and quickly identify alerts that may need attention.

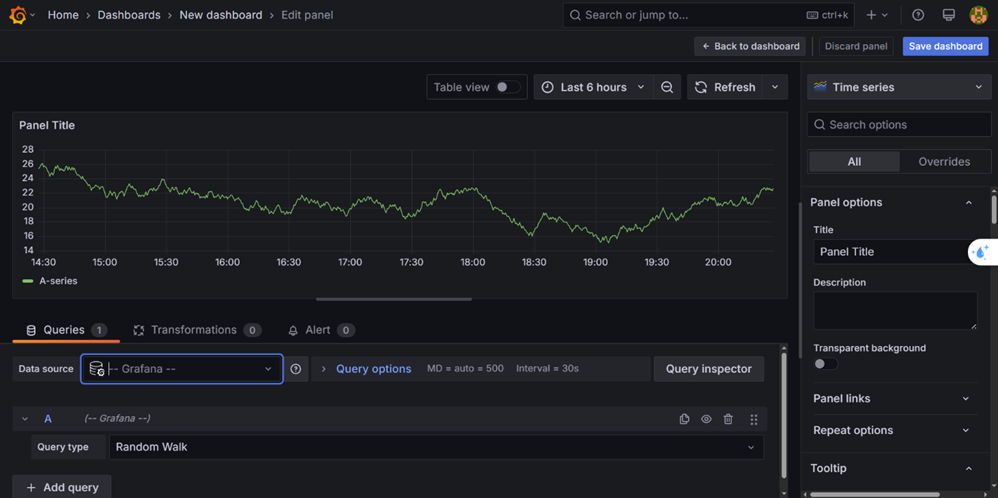


Figure : Grafana Dashboard

The figure 18 is a screenshot of the Grafana dashboard editing interface, displaying a time series graph panel with data sourced from a query called "Random Walk". The screen shows configuration options for panel settings, data source selection, and query adjustments, allowing users to customize how metrics are visualized. This helps in monitoring trends and building informative charts in Grafana for system data analysis.

## 3.6 Exploring Cloud Platforms

To cover the cloud aspect, I created trial accounts on AWS and Microsoft Azure. I experimented with launching basic VMs, configuring virtual network settings, and exploring monitoring tools such as AWS CloudWatch and Azure Monitor**.** Due to free-tier limitations, I couldn’t run full setups, but this comparison helped me see how the providers differ.

A screenshot of a computer

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Figure : Creating a new user from Microsoft Azure

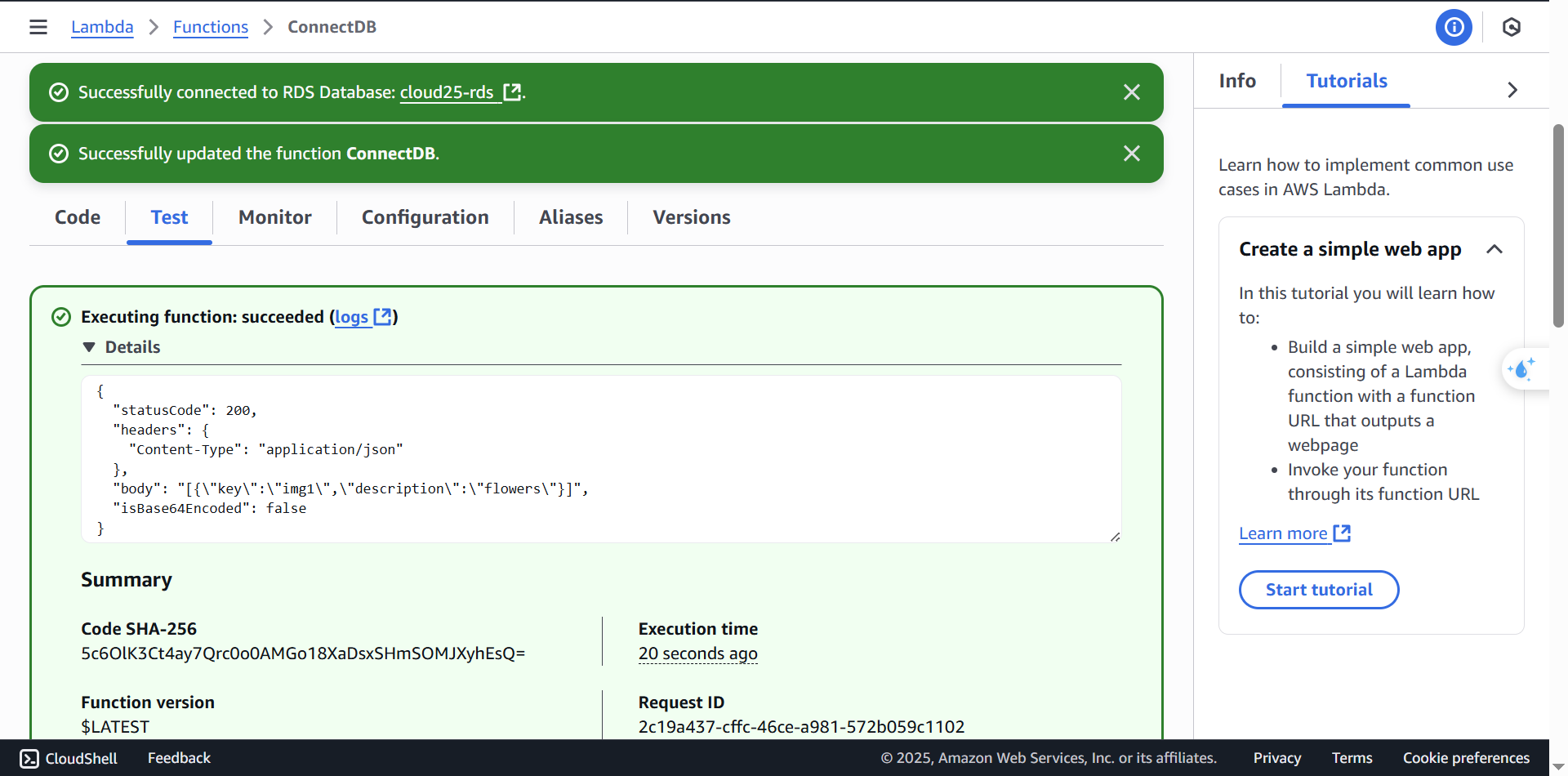


Figure : Connect Database via AWS:

# CHAPTER 4: SYSTEM DESIGN AND ANALYSIS

This chapter describes how I designed the system for the simulated company Athena. Since I didn’t have access to a real system, the requirements were based on typical needs of a mid-sized business. The goal was to propose a simple hybrid setup that combines local tools with cloud services, supported by small test environments and diagrams.

## 4.1 Assumed Requirements of Athena

For the design, I imagined Athena needing:

* Firewall and basic network segmentation
* Simple monitoring for servers and devices
* Secure internet access with NAT and port control
* Easy-to-understand dashboards for system status
* The ability to migrate some services to the cloud in the future

The solution should be low-cost, easy to manage, and suitable for a small IT team.

## 4.2 Proposed Hybrid System Architecture

Based on these requirements, I proposed a hybrid model that includes:

* **pfSense** as the main firewall and router in the local network,
* **Zabbix** and **Grafana** for monitoring and visualization,
* **Cloud integration** (AWS/Azure) for:
  + Off-site log backups
  + Optional cloud-based VM for remote access or failover
  + Monitoring cloud-side resources if needed later.

This model allows Athena to keep core services local while starting to integrate cloud solutions gradually.

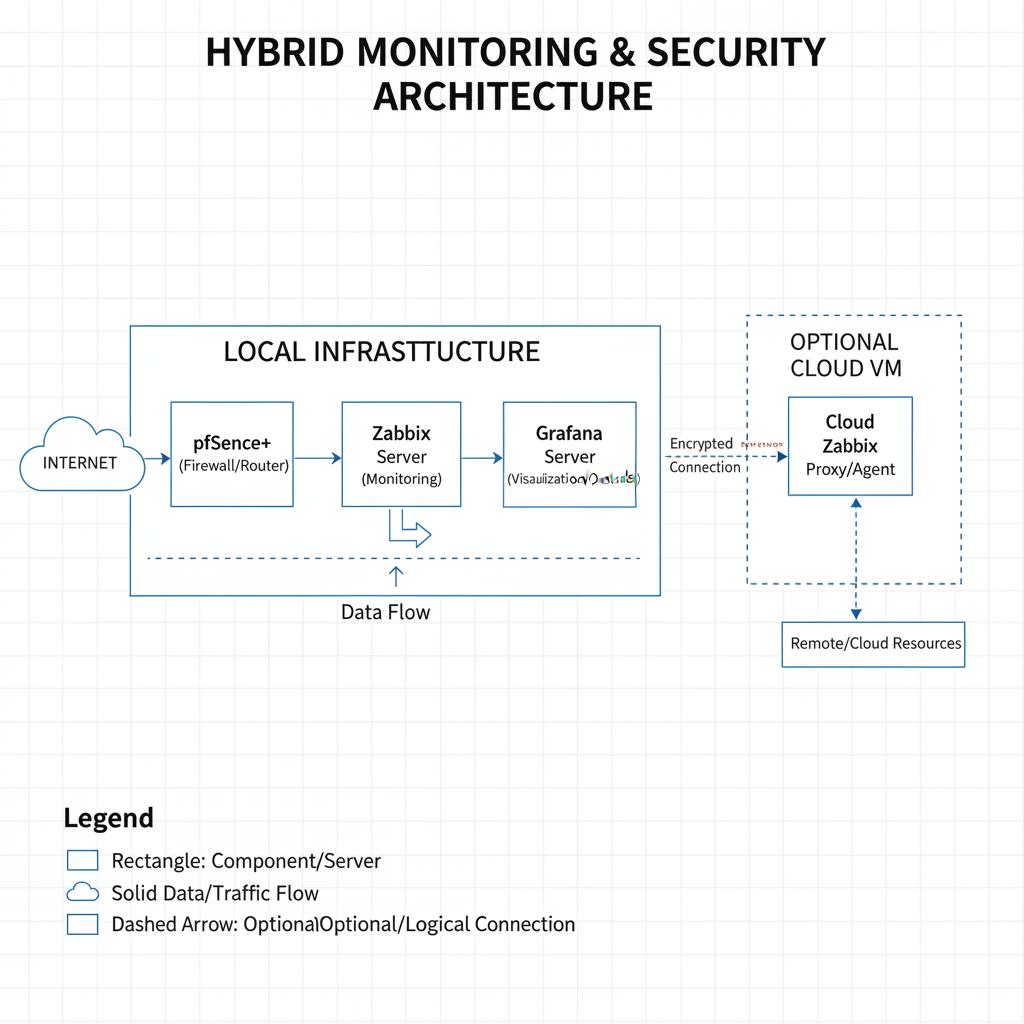
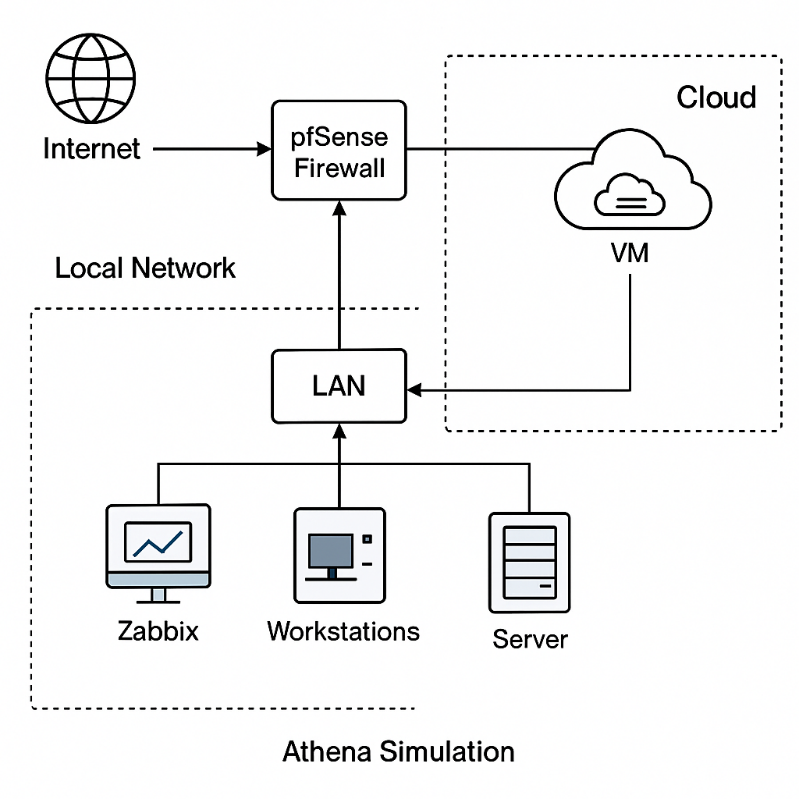


Figure : Hybrid Architecture

## 4.3 Network Design Diagram

To clarify the structure, I created a sample network diagram in Cisco Packet Tracer showing:

* A pfSense firewall between the internet and internal LAN
* A Zabbix server for monitoring internal systems
* Endpoints such as workstations and local servers
* And an optional cloud VM segment connected to the system



## 4.4 Summary of Tools and Their Roles

To measure the impact of the applied methodology, we define several evaluation criteria:

**Table 1: Tools and their roles in the system.**

|  |  |
| --- | --- |
| **Tool** | **Role in the System** |
| PfSense | Firewall, routing, NAT, and port rules |
| Zabbix | Monitoring of system performance |
| Grafana | Visual dashboard for Zabbix data |
| Packet Tracer | Network design and planning |
| Vmware | Virtual lab environment |
| AWS / Azure | Optional cloud services (backup, VM) |

Each tool was tested or studied at a basic level to understand how it could support the proposed architecture.

## 4.5 Notes on Practicality

This model is not meant for production but as a learning example. Some features like cloud backups or deeper system integration were not implemented due to time and resource limits. Still, designing this system showed how different tools can work together, even on a small scale.

# CHAPTER 5: RESULTS AND DISCUSSION

This chapter reviews what I achieved during the internship, including successes, challenges, and key lessons learned. Since the project was mostly research-focused with small lab tests, the results are more about personal growth than production-ready outcomes.

## 5.1 What Was Done

During the internship, I was able to:

* Study how **pfSense, Zabbix, and Grafana** work in system management,
* Set up a virtual lab on VMware including pfSense firewall, a Zabbix server, and a client VM to generate traffic,
* Athena’s network using Cisco Packet Tracer,
* Explore basic features of AWS and Azure**.** On Azure, I went further by practicing:
  + Creating and configuring user accounts.

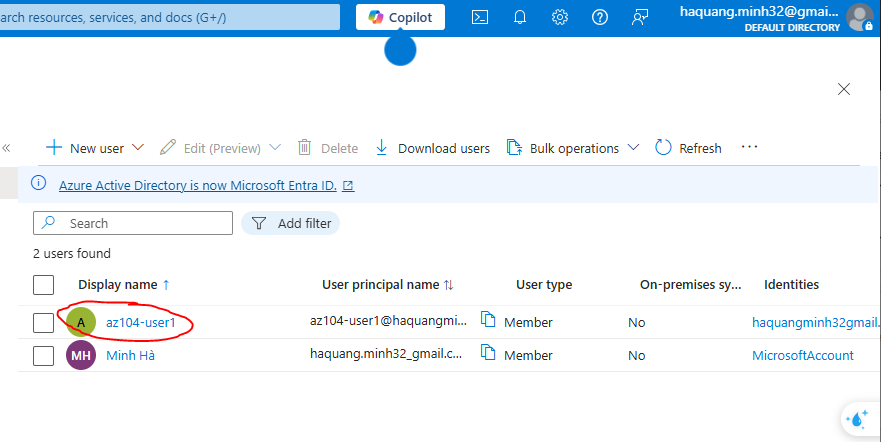


Figure : Creating a new user

* + Inviting external users and adding them into groups.

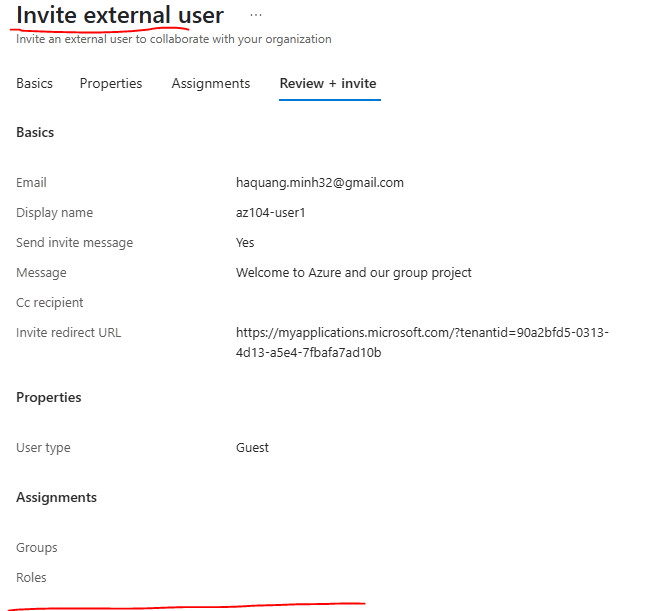


Figure : Invite external user

* + Create groups and add members

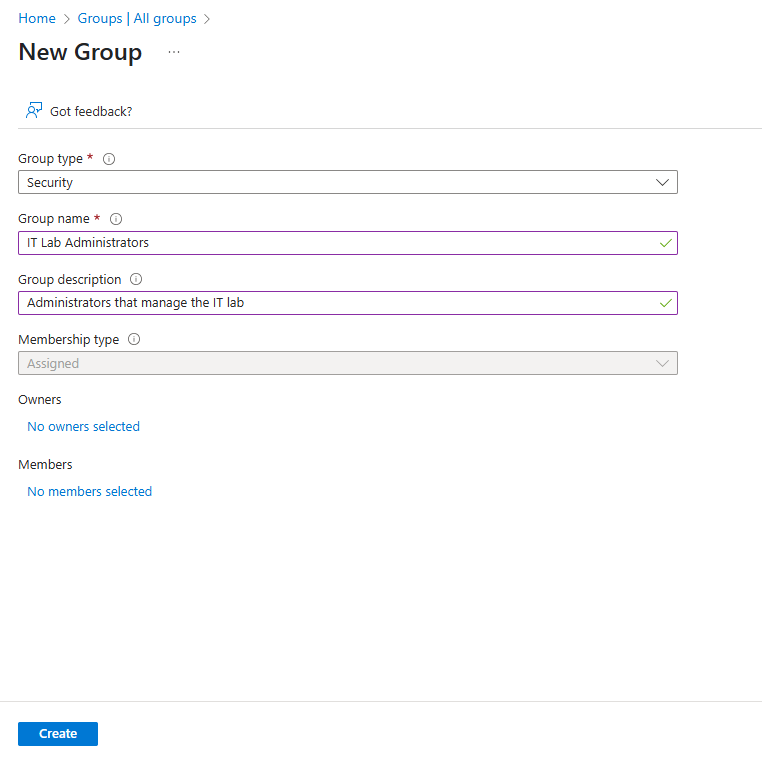


Figure : Creating a new group

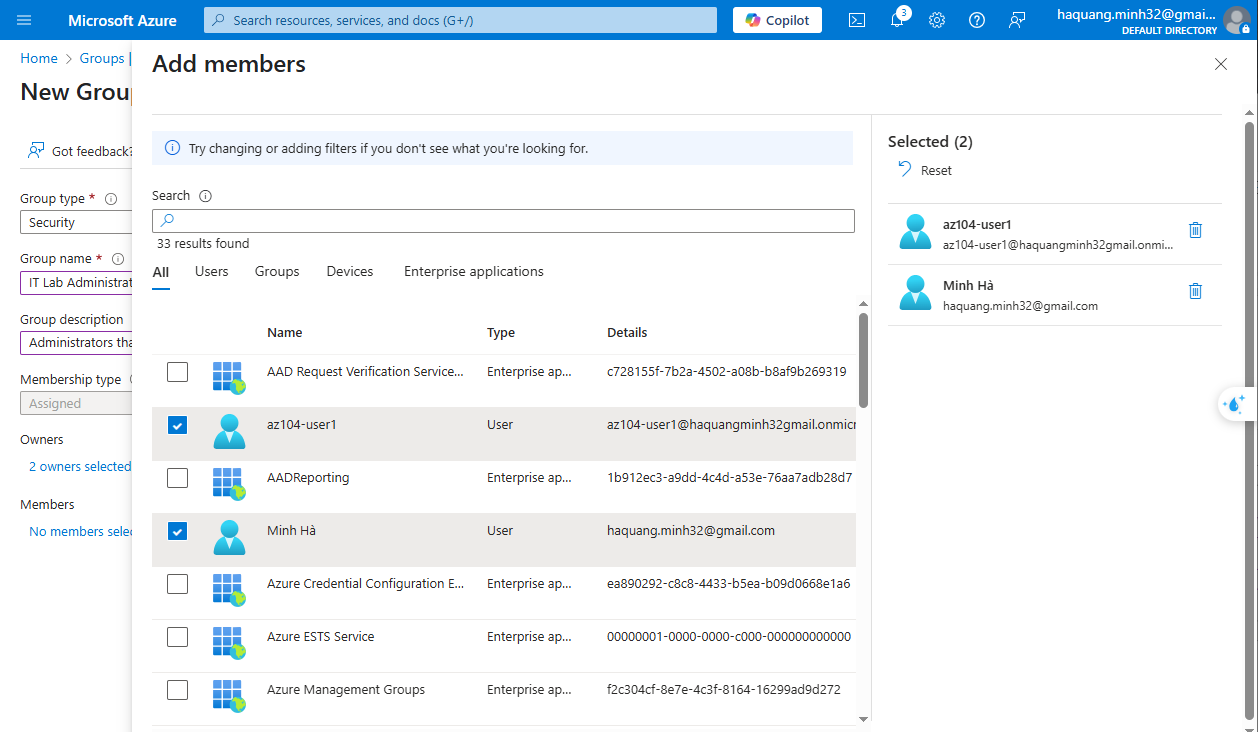


Figure : Add members

* + Reviewing and assigning built-in roles, and even creating a custom RBAC role.

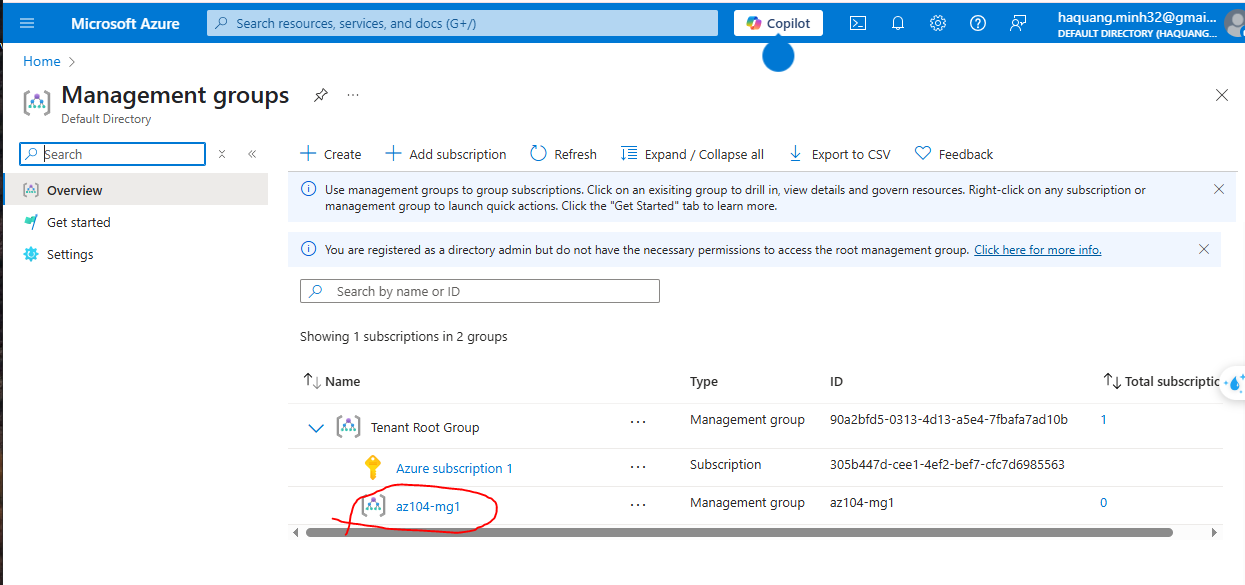


Figure : Implement Management Groups

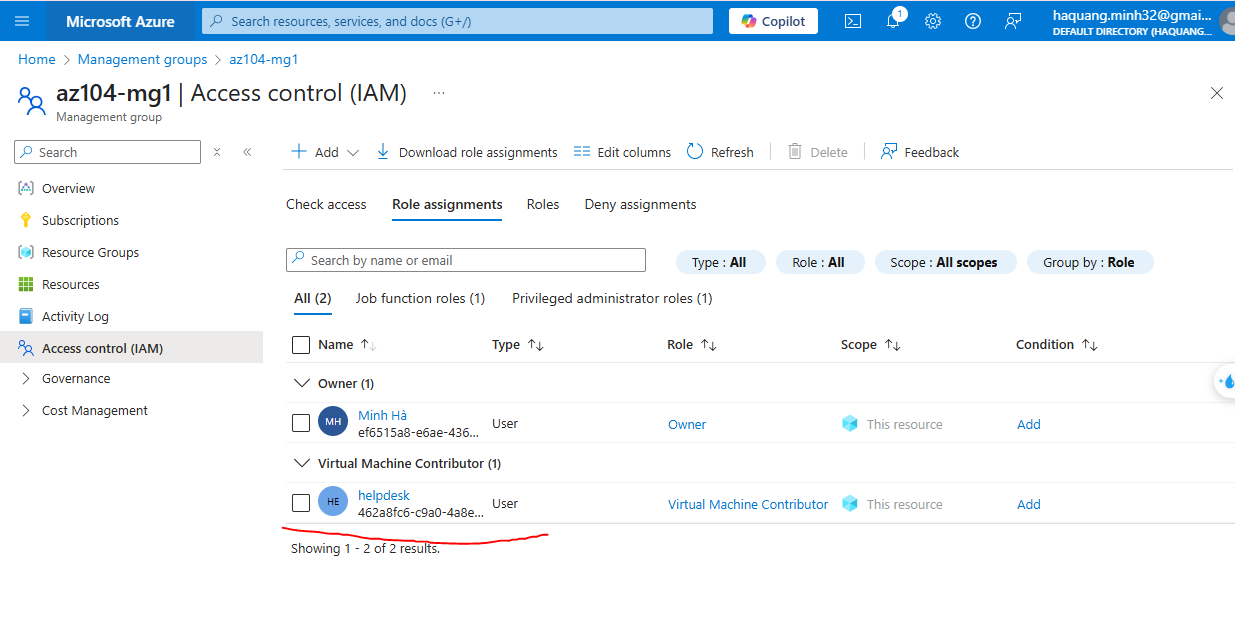


Figure : Assign a built-in Azure role

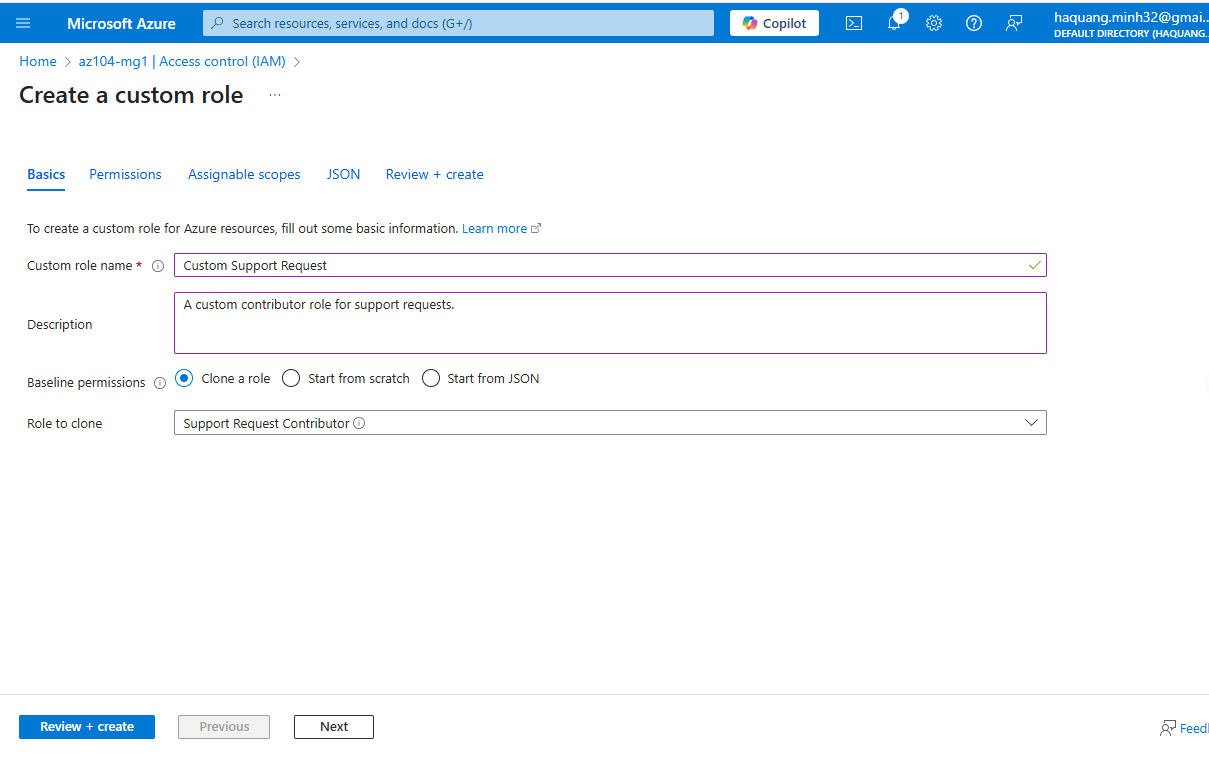


Figure : Create a custom RBAC role

* + Monitoring role assignments using the Activity Log.

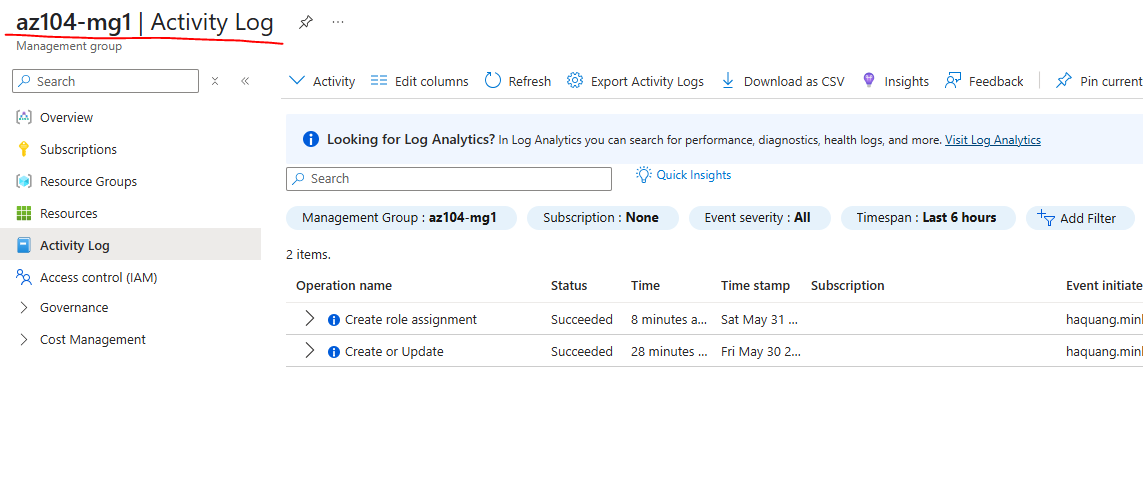


Figure : Activity Log Display

* + Assigning tags via the Azure portal and enforcing tagging with an Azure Policy.

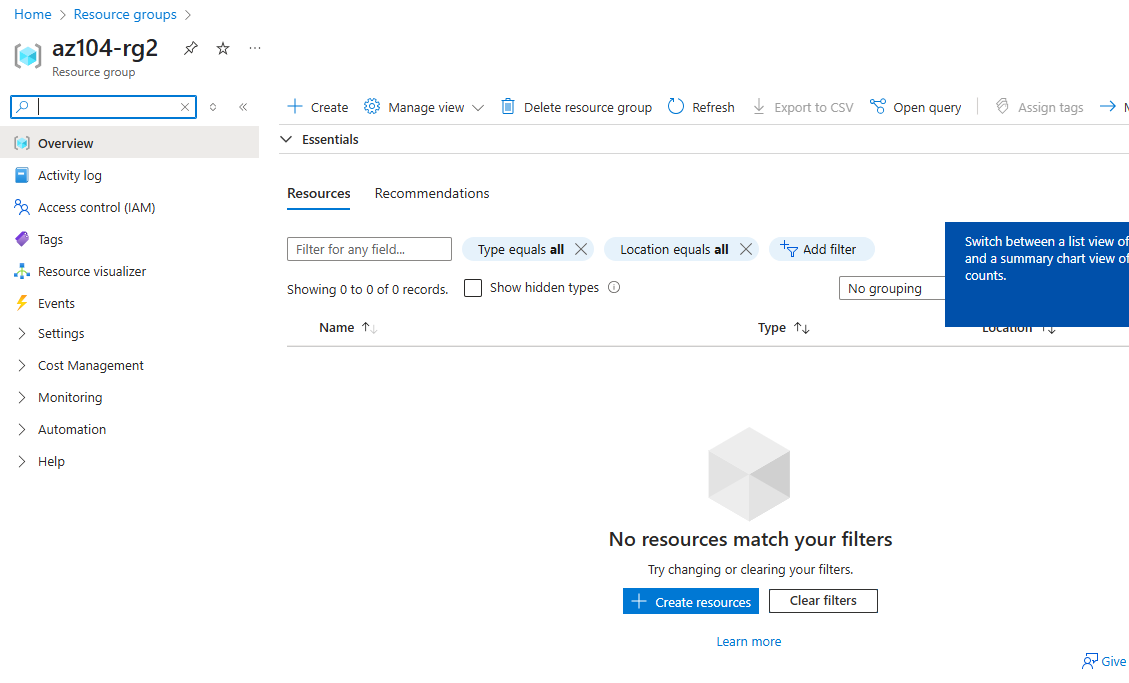


Figure : Assign Tasg via the Azure portal

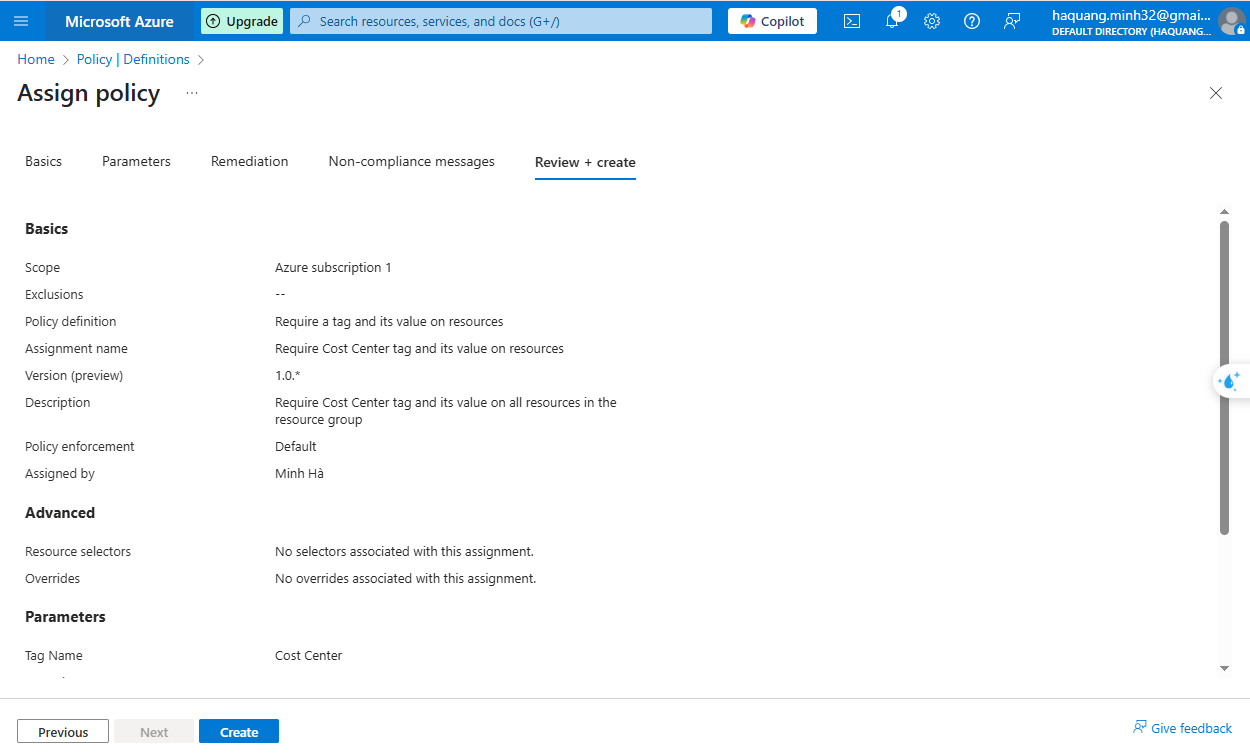


Figure : Assign policy

* + Creating a **storage account** and applying tags through policy.

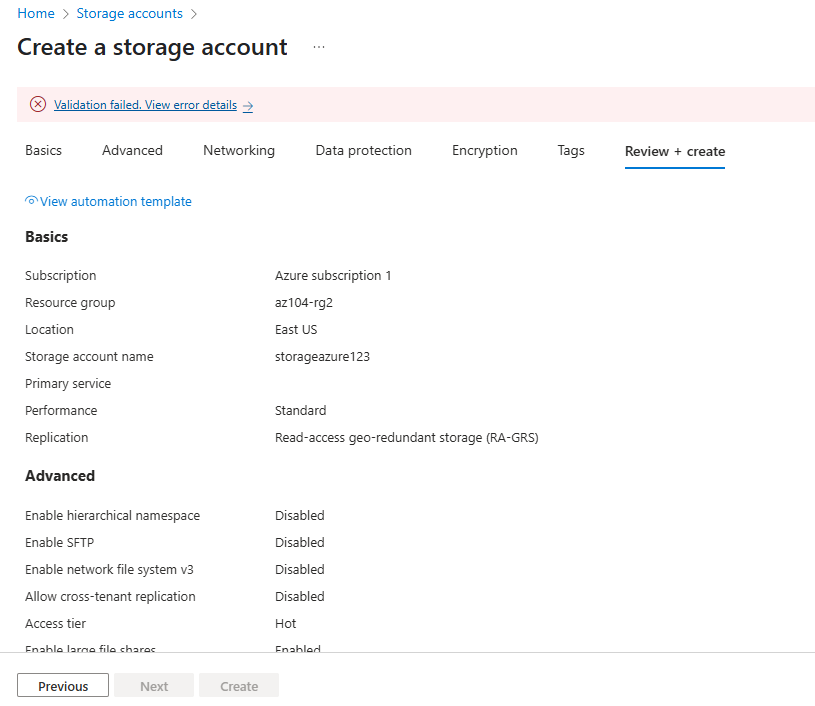


Figure : Creating a storage account

* + Configuring and testing **resource locks** for protection.

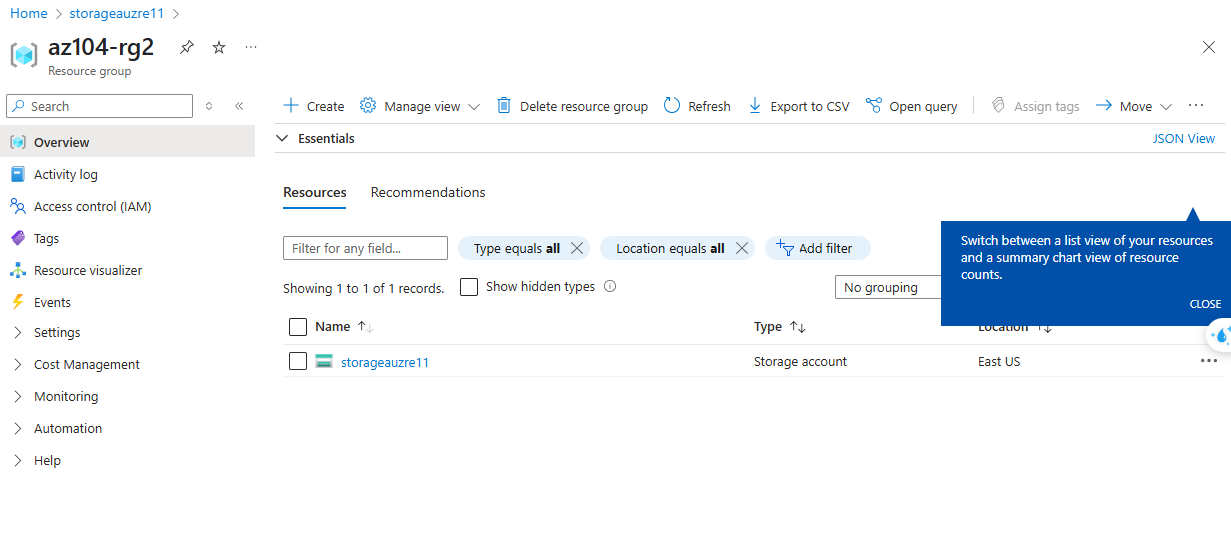


Figure : Resource Locks

* Create two Grafana and Zabbix dashboards linked to Zabbix data

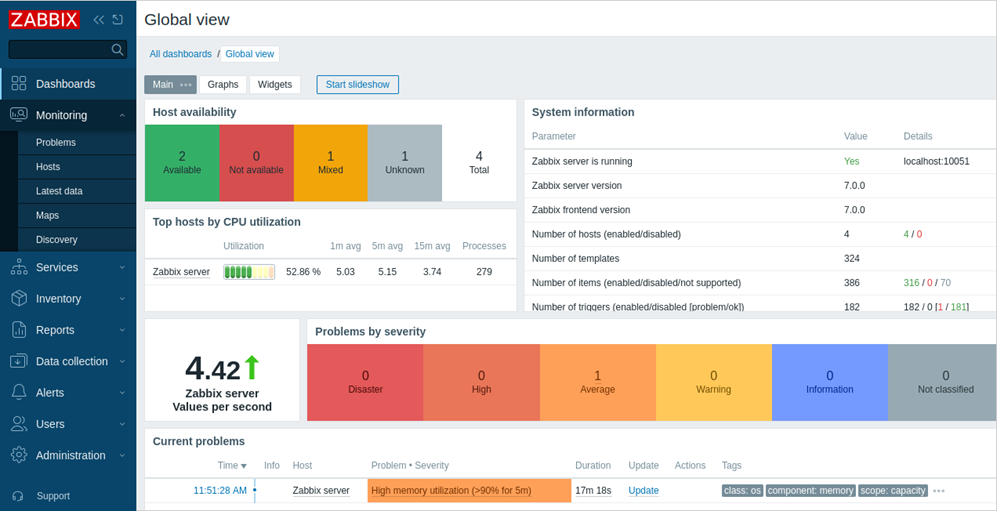


Figure : Main menu of Zabbix

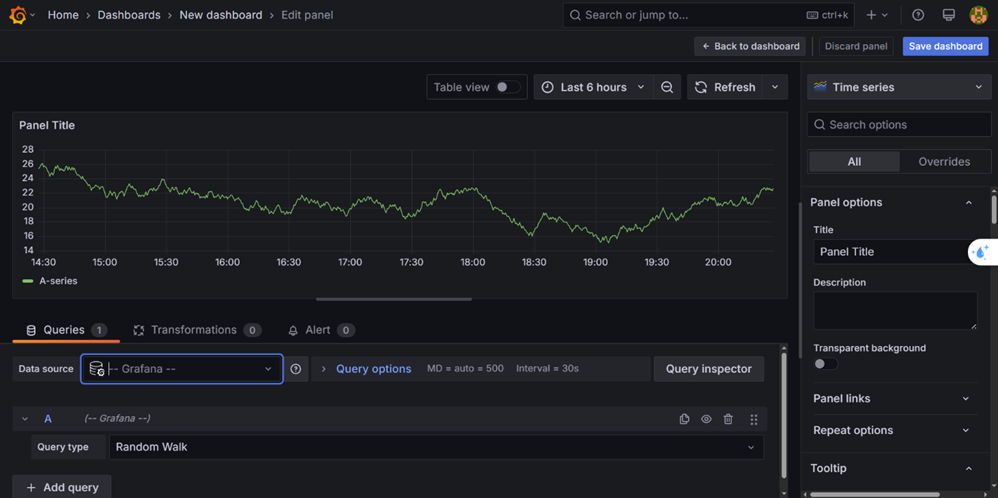


Figure : Grafana Dashboard

* Propose a hybrid system architecture combining local and cloud services

All of these activities were done at a beginner level and were mainly focused on learning rather than deep technical implementation.

## 5.2 What Worked and What Didn’t

**What worked well:**

* pfSense setup and basic firewall rules within the Vmware lab.
* Zabbix monitoring between virtual machines
* Grafana dashboards for data visualization
* Network diagram design using Packet Tracer for Athena
* Comparing the interfaces of AWS and Azure.

**What was limited or did not work::**

* Free-tier cloud accounts restricted advanced testing
* Zabbix configuration was sometimes complicated and required troubleshooting.
* Some integration ideas, such as remote logging to the cloud, were not completed due to time and resource limitations.

## 5.3 Lessons learned

* System management involves not just tools but also planning based on business needs.
* Even small lab setups provide valuable insights on how tools connect.
* pfSense is powerful but takes time and patience to master.
* Zabbix and Grafana work well together, though their setup can be complex.
* Cloud platforms share similarities but each handles networking and resources in unique ways.
* Creating diagrams early helped avoid confusion during implementation.

## 5.4 Challenges Faced

* Limited hardware: My personal laptop (8GB RAM) made it hard to run many VMs at once.
* Learning curve: Tools like Zabbix and pfSense had many settings and required time to learn.
* Time management: Balancing between learning theory and doing hands-on tasks was sometimes difficult.
* No real company access: Since Athena was a simulated client, all assumptions had to be made without real data.

# CHAPTER 6: CONCLUSION AND FUTURE WORKS

## 6.1 Conclusion

This internship gave me the chance to learn the basics of system and network management using both local tools and cloud platforms. Most of the work involved small labs and simulations, through which I was able to:

* Understand key functions of pfSense as a firewall and route.
* Learn how Zabbix and Grafana work together for monitoring and visualization.
* Explore networking concepts on cloud platforms like AWS and Azure.
* Design a simple hybrid architecture for a simulated company (Athena).
* Practice using tools like VMware and Cisco Packet Tracer to test ideas in a safe environment.

Although the project did not involve real production deployment, it highlighted the importance of planning, visibility, and monitoring in IT systems. Overall, I gained a clearer understanding of how local and cloud tools can complement each other.

## 6.2 Recommendations

For students taking on similar internship projects, my advice is:

* Start with simple goals and build up gradually.
* Spend time reading official documentation — it really helps.
* Use diagrams to organize your ideas before building anything.
* Don’t worry about mastering every feature — focus on understanding the basics first.
* Use free-tier cloud services wisely to avoid unexpected charges.

## 6.3 Future Works

With more time and resources, I would like to:

* Explore automation tools like Ansible or Terraform to simplify system configuration.
* Try integrating cloud monitoring services (e.g., AWS CloudWatch) with local tools like Zabbix.
* Build a more complete demo that includes real-time alerting and log management.
* Study more about network security, including VPN, IDS/IPS, and zero-trust models.
* Combine this internship knowledge with future Capstone projects to build a more advanced system.

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