# CIS 221 Group Project

Security Hardening of a Server

**Prepared by: Group #3**

Armaan Chima # 300211286

Derek Everard # 300126798

Zaid Al-Obaidi # 300225793

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# CIS 221 Group Project Proposal & Report

**Title: Security Hardening of a Server**

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## 1. Project Overview

**Objective:**
Deploy a vulnerable Ubuntu server and systematically secure it using industry best practices. This includes firewall configuration, intrusion detection, user and SSH hardening, regular patching, and continuous monitoring.

**Significance:**
Misconfigured or unpatched servers are common attack targets. This project demonstrates practical methods to secure a server against threats, aligning with CIS Benchmarks and standard security frameworks.

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## 2. Requirements

**Functional Requirements:**

- Deploy an Ubuntu server with default configurations.
- Conduct baseline vulnerability scans (Nmap, Nessus/OpenVAS).
- Configure a firewall (UFW).
- Install & configure an IDS (Snort).
- Disable unnecessary services and restrict user access.
- Set up automatic security updates.
- Document every step and configuration.

**Non-Functional Requirements:**

- **Security:** Compliance with CIS Benchmarks.
- **Performance:** Maintain normal server performance.
- **Usability:** Configurations are manageable by system admins.
- **Scalability:** Steps are repeatable for other servers.

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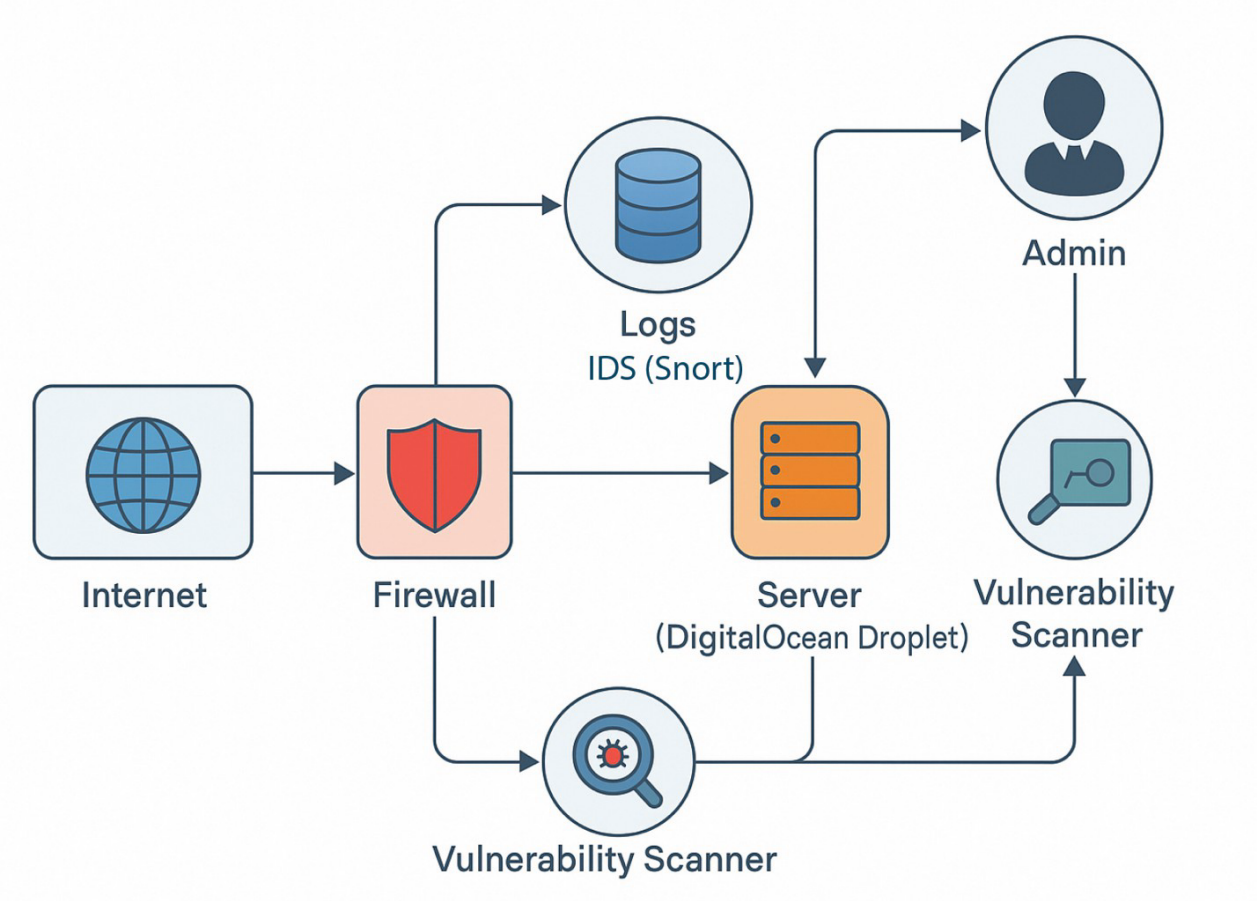
## 3. Design

### Data Flow Diagram (DFD):

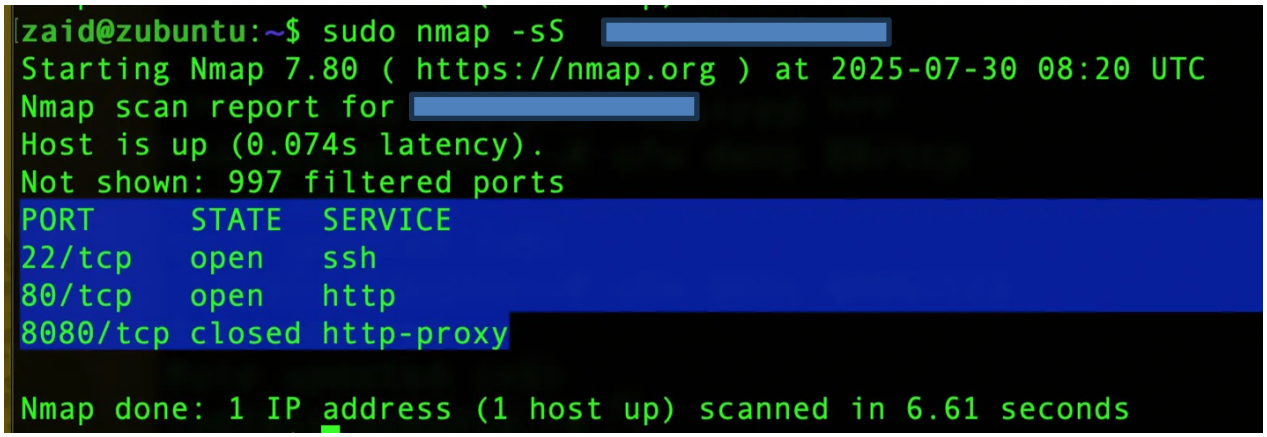



### Components of DFD:

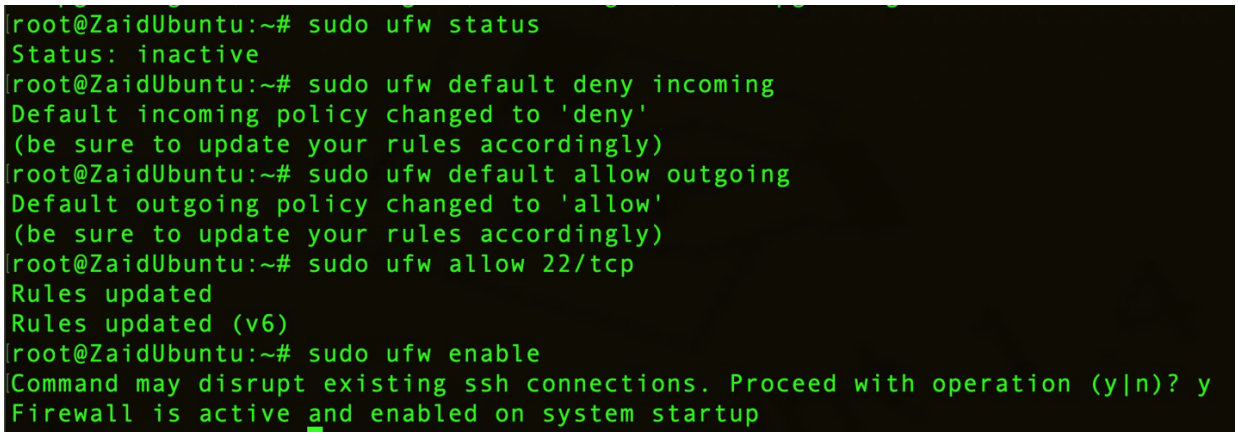
- **Internet:** Source of all incoming and outgoing traffic.
- **Firewall (UFW):** Controls and filters traffic.
- **Server (Ubuntu on DigitalOcean Droplet):** Runs services.
- **Intrusion Detection System (Snort):** Monitors network traffic.
- **Logs:** Stores IDS and firewall logs.
- **Admin:** Reviews logs, configures security, and manages patches.
- **Vulnerability Scanner:** Tools: **Nmap** (port scanning) and **Snort** (IDS with custom scanning rules).
- Installed **UFW**: `sudo apt install ufw`

## 4. Implementation

- **Set Up:**
  - Deployed Ubuntu Server on DigitalOcean Droplet.
  - Updated OS: `sudo apt update && sudo apt upgrade`
- **Initial Scan:**
  - Installed **Nmap** on a different machine: `sudo apt install nmap`
  - Scanned server: `sudo nmap -sS 192.168.10.10 (Placeholder IP)`
  - Port scan before firewall configuration:




  - Ports detected: **(22/tcp, 80/tcp, 8080/tcp)**
- **Firewall Configuration:**
  - Installed **UFW**: `sudo apt install ufw`
  - Set defaults: `sudo ufw default deny incoming` and `sudo ufw default allow outgoing`
  - Allowed SSH: `sudo ufw allow ssh`
  - Enabled UFW: `sudo ufw enable`



- Block all unnecessary ports detected in the Baseline Vulnerability Scan. Keep only the SSH port

```
root@ZaidUbuntu:~# ufw deny 80/tcp
Rule updated
Rule updated (v6)
root@ZaidUbuntu:~# ufw deny 8080/tcp
Rule updated
Rule updated (v6)
root@ZaidUbuntu:~#
```

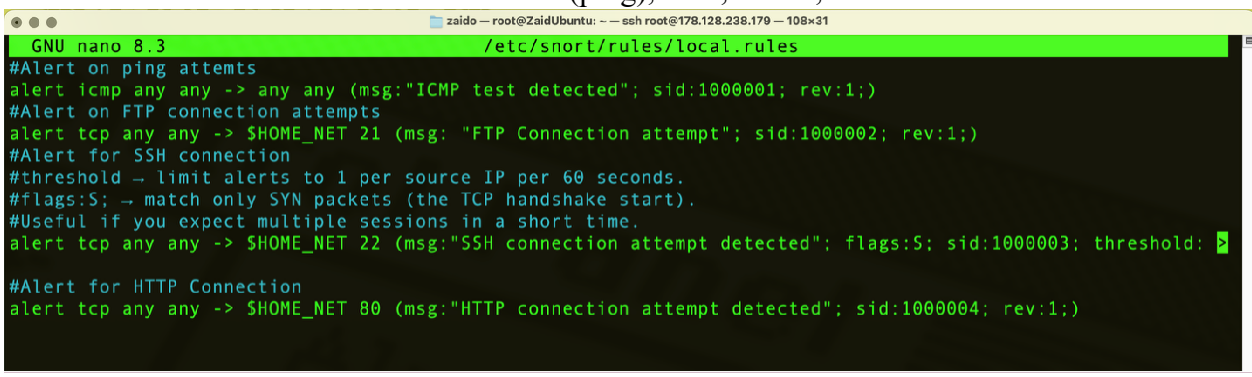
- **IDS (Snort) Installation & Setup:**
  - Installed Snort: `sudo apt install snort`

```
root@ZaidUbuntu:~# snort -V

   ,,_     -*> Snort! <*-
  o"  )~   Version 2.9.20 GRE (Build 82)
   ''''    By Martin Roesch & The Snort Team: http://www.snort.org/contact#team
           Copyright (C) 2014-2022 Cisco and/or its affiliates. All rights reserved.
           Copyright (C) 1998-2013 Sourcefire, Inc., et al.
           Using libpcap version 1.10.5 (with TPACKET_V3)
           Using PCRE version: 8.39 2016-06-14
           Using ZLIB version: 1.3.1

root@ZaidUbuntu:~#
```

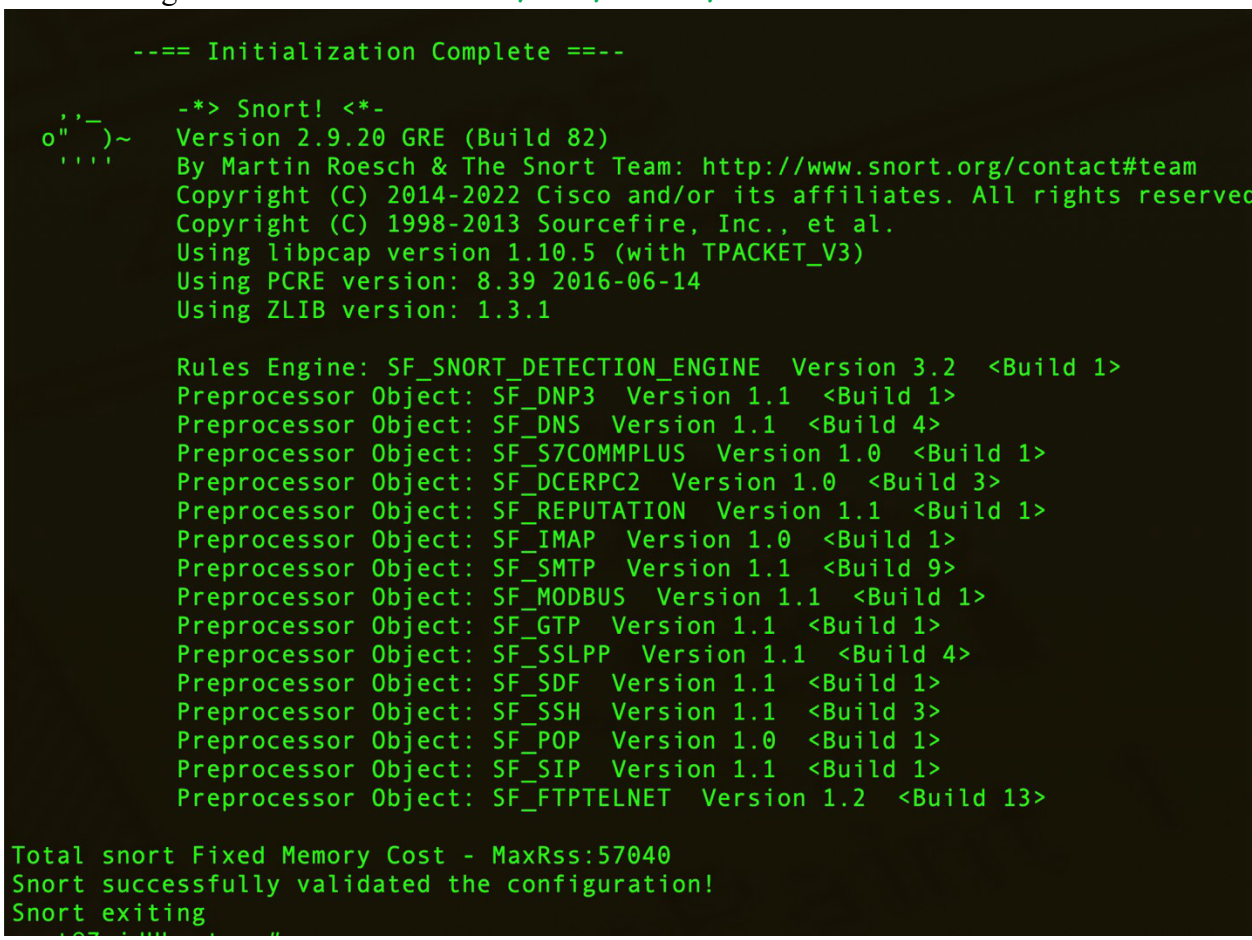
  - Downloaded Snort community rules, configured Snort paths and rules in **/etc/snort/snort.conf**

```
zaido — root@ZaidUbuntu: ~ — ssh root@178.128.238.179 — 82×22

community-rules.tar 100%[===================>] 333.39K  --.-KB/s    in 0.06s

2025-07-29 22:45:44 (5.68 MB/s) - 'community-rules.tar.gz' saved [341392/341392]

root@ZaidUbuntu:~# sudo tar -xzvf community-rules.tar.gz -C /etc/snort/rules
community-rules/
community-rules/community.rules
community-rules/VRT-License.txt
community-rules/LICENSE
community-rules/AUTHORS
community-rules/snort.conf
community-rules/sid-msg.map
root@ZaidUbuntu:~# ls -l /etc/snort/rules
total 8
-rw-r--r-- 1 root root    0 Jul 29 22:31 black_list.rules
drwxr-xr-x 2 1210 root 4096 Jul 29 11:31 community-rules
-rw-r--r-- 1 root root   78 Jul 29 06:28 local.rules
-rw-r--r-- 1 root root    0 Jul 29 22:31 white_list.rules
```

- Verified rules: Created rules to detect ICMP (ping), SSH, HTTP, and FTP.




- Tested config: `sudo snort -T -c /etc/snort/snort.conf`

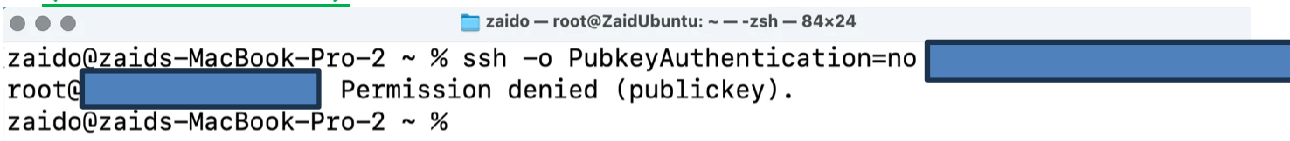



- **User & SSH Hardening:**

  Root login on my Ubuntu server (hosted on a DigitalOcean Droplet) is secured by allowing SSH access only through verified SSH public keys. Password authentication for SSH is disabled, ensuring that only clients with authorized keys can connect as root.

- **Edited SSH config:** `sudo nano /etc/ssh/sshd_config`
  - Set `PermitRootLogin prohibit-password`
  - Set `PasswordAuthentication no`

- Test using `-o PubkeyAuthentication=no root@192.168.10.10 (Placeholder IP)`

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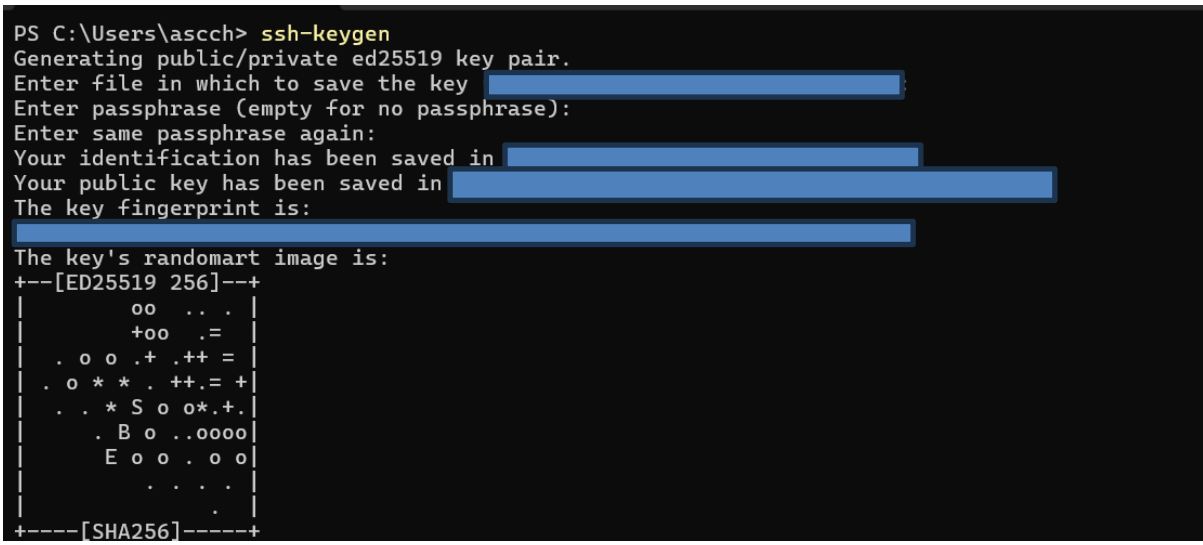
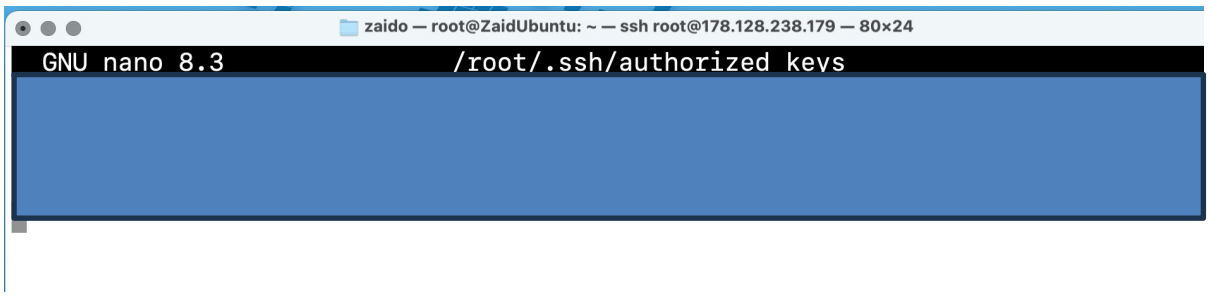
- **To Add Client's SSH keys:**
  - User runs `ssh-keygen` locally.




  - User sends public key to admin and Admin adds to `nano ~/.ssh/authorized_keys`

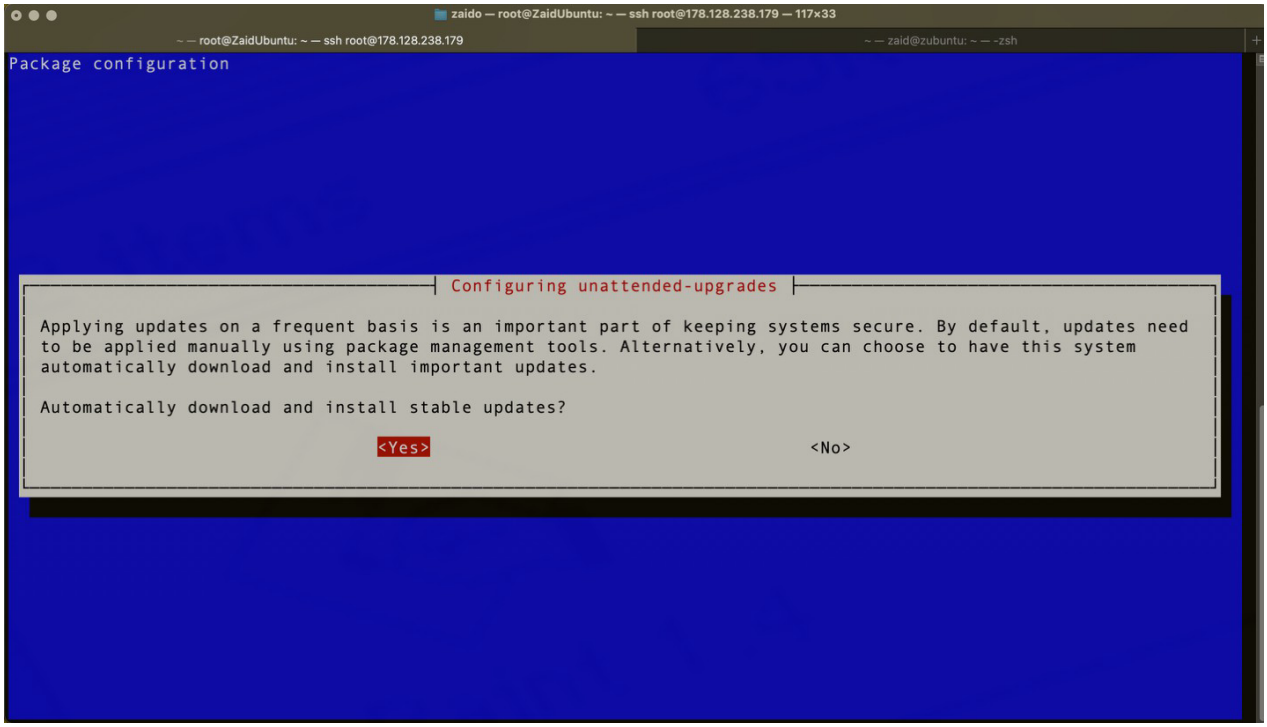



- Restarted SSH: `sudo systemctl restart ssh`

- **Automatic Updates:**

  The purpose is to keep your Ubuntu system secure by automatically installing security patches for the OS and installed packages without needing manual intervention. This helps (1) fix vulnerabilities quickly before attackers exploit them. (2) Reduce maintenance work — we don't have to remember to run apt update && apt upgrade manually every day.

  - Installed tool: `sudo apt install unattended-upgrades`
  - Configured: `sudo dpkg-reconfigure --priority=low unattended-upgrades`

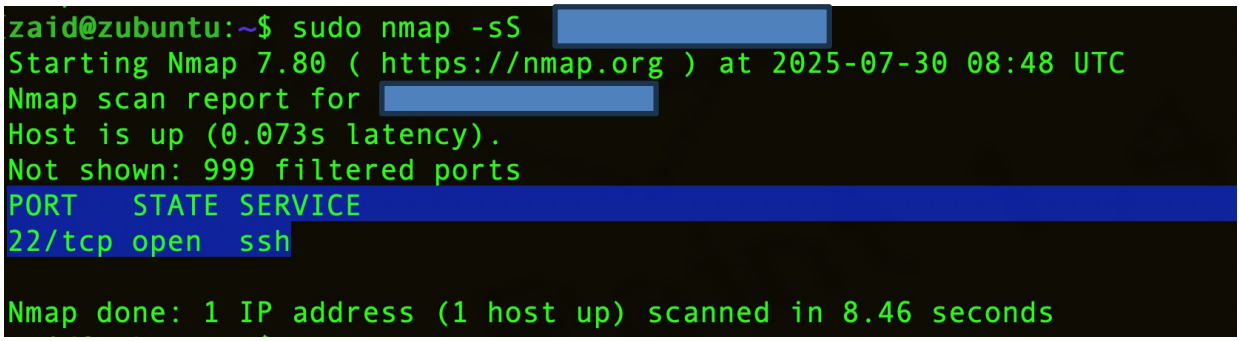



  - Confirming it's running automatically: `cat /var/log/unattended-upgrades/unattended-upgrades.logupgrades.`

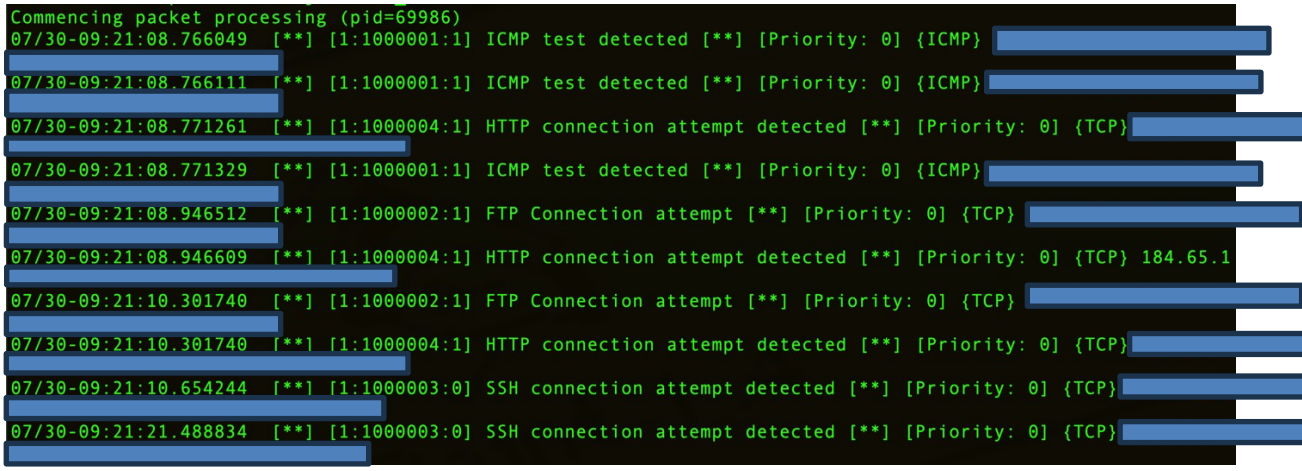
```
root@ZaidUbuntu:~# cat /var/log/unattended-upgrades/unattended-upgrades.log
2025-07-29 06:56:25,743 INFO Starting unattended upgrades script
2025-07-29 06:56:25,744 INFO Allowed origins are: o=Ubuntu,a=plucky, o=Ubuntu,a=plucky-security, o=UbuntuESMApps,a=pl
ucky-apps-security, o=UbuntuESM,a=plucky-infra-security
2025-07-29 06:56:25,745 INFO Initial blacklist:
2025-07-29 06:56:25,745 INFO Initial whitelist (not strict):
2025-07-29 06:56:27,182 INFO No packages found that can be upgraded unattended and no pending auto-removals
2025-07-29 07:03:18,859 INFO Starting unattended upgrades script
2025-07-29 07:03:18,860 INFO Allowed origins are: o=Ubuntu,a=plucky, o=Ubuntu,a=plucky-security, o=UbuntuESMApps,a=pl
ucky-apps-security, o=UbuntuESM,a=plucky-infra-security
2025-07-29 07:03:18,860 INFO Initial blacklist:
2025-07-29 07:03:18,860 INFO Initial whitelist (not strict):
2025-07-30 06:29:55,872 INFO Starting unattended upgrades script
2025-07-30 06:29:55,873 INFO Allowed origins are: o=Ubuntu,a=plucky, o=Ubuntu,a=plucky-security, o=UbuntuESMApps,a=pl
ucky-apps-security, o=UbuntuESM,a=plucky-infra-security
2025-07-30 06:29:55,873 INFO Initial blacklist:
2025-07-30 06:29:55,874 INFO Initial whitelist (not strict):
2025-07-30 06:29:57,483 INFO No packages found that can be upgraded unattended and no pending auto-removals
root@ZaidUbuntu:~#
```

## 5. Testing:

- Ran second scan: `sudo nmap -sS 192.168.10.10 (Placeholder Address)`




- Ports **22 (SSH)** and **80 (HTTP)** were open and reachable by Nmap in the Initial Scan. After configuring UFW to deny unnecessary ports, only the required **SSH port (22)** remained open, while **port 80** was successfully blocked, and **port 8080** is no longer detectable **— the firewall is working.**
- **Snort alerts confirm Nmap scan detected — IDS is working.**



## 6. Analysis:

### Strengths:

- Significantly reduced attack surface.
- Continuous monitoring via Snort IDS.
- Automatic patching minimizes manual oversight.

### Limitations:

- Does not protect against zero-day exploits.
- Requires regular review of logs and rule updates.

## 7. Conclusion:

The server was successfully hardened against common attacks by following CIS Benchmarks and best practices. The documented process can be used for securing similar deployments.

## 8. References:


- CIS 221 Lecture slides

- Installation and configuration of Snort:

  https://www.youtube.com/watch?v=cD-DoKLzq2s&t=201s

- Server deployed with DigitalOcean:

  https://www.digitalocean.com/community/tutorials/how-to-set-up-ssh-keys-on-ubuntu-22-04

- How to Set Up SSH Key-Based Authentication with Ubuntu

  Server: https://www.youtube.com/watch?v=Or3Sm_COFUY

- How to Install Homebrew on Mac OS:

  https://www.youtube.com/watch?v=Ml-j9qzb9xI

- How to install and use NMAP on UBUNTU

  https://www.youtube.com/watch?v=WPej0xUmmu4

- Helped make the data flow diagram

  https://online.visual-paradigm.com/app/diagrams/#diagram:proj=0&type=DataFlowDiagram&width=11&height=8.5&unit=inch