# Cybersecurity Homelab Documentation

**Network Security and SOC Monitoring Platform**

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## 1. Executive Summary

### Project Overview

This project implements a complete enterprise-grade Security Operations Center environment distributed across three physical machines, a dedicated NAS appliance, a cloud VPS, and a Raspberry Pi 5. The lab simulates a realistic multi-site enterprise network with dual firewalls, multiple isolated network segments, multi-layer intrusion detection and prevention, centralized log management, endpoint detection, automated incident response, cyber threat intelligence management, and digital forensics capability.

The environment provides hands-on experience with the exact tools, workflows, and architectures used in professional SOC, threat intelligence, and incident response roles.

## Key Capabilities

- Edge IDS/IPS
  - Tool: Suricata on Raspberry Pi 5
  - Status: Running
- Internal IDS/IPS
  - Tool: Snort on pfSense-1 and pfSense-2
  - Status: Running
- Network Firewall
  - Tool: Dual pfSense CE with IPsec VPN
  - Status: Running
- Endpoint Detection
  - Tool: Wazuh XDR across 6+ agents
  - Status: Troubleshooting
- Primary SIEM
  - Tool: ELK Stack — 300,000+ events
  - Status: Running
- Secondary SIEM
  - Tool: Splunk — comparative enterprise SIEM
  - Status: In Progress
- SOAR
  - Tool: Shuffle + n8n automation
  - Status: In Progress
- Threat Intelligence
  - Tool: OpenCTI platform
  - Status: In Progress
- Honeypot
  - Tool: T-Pot on Linode — real attacker data
  - Status: In Progress
- DNS Security
  - Tool: Pi-hole with log forwarding
  - Status: Running
- Remote Access
  - Tool: Tailscale VPN
  - Status: Running
- Service Monitoring

    - Tool: Uptime Kuma
    - Status: Running
- Digital Forensics
    - Tool: SANS SIFT Workstation
    - Status: In Progress
- Malware Analysis
    - Tool: REMnux Workstation
    - Status: In Progress
- Cloud Identity
    - Tool: Microsoft Entra ID Connect
    - Status: In Progress
- Enterprise Storage
    - Tool: TerraMaster F4-425 iSCSI SAN
    - Status: In Progress

### Key Achievements

- Suricata detection rules: 65,796 — daily updated
- Snort rule sets: ET Open + Snort VRT
- Suricata events indexed: 300,000+
- Firewall logs indexed: 140,000+
- Wazuh enrolled agents: 6+ endpoints
- Kibana dashboards: 3 professional dashboards
- Attack types validated: 4 simulated and detected
- Physical machines: 3 + 1 NAS + 1 cloud VPS
- Network segments: 6 isolated segments
- IDS/IPS layers: 3 layers of detection
- SIEM platforms: 2 — ELK and Splunk
- CTI platform: OpenCTI
- DFIR workstations: 2 — SIFT and REMnux

## 2. Physical Infrastructure

### Hardware

- ThinkPad Laptop
    - Specs: 32GB RAM
    - Role: SOC controller, pfSense-1, Kali
- Desktop PC
    - Specs: 16GB RAM
    - Role: pfSense-2, Windows VMs via VirtualBox
- Dell Optiplex 7090
    - Specs: Dedicated
    - Role: Proxmox hypervisor — SIFT, REMnux, CTI VM
- TerraMaster F4-425
    - Specs: 4-bay, 10GbE
    - Role: iSCSI SAN, file storage

- Raspberry Pi 5
  - Specs: 8GB RAM
  - Role: Suricata edge sensor, Pi-hole, NAS, Tailscale
- Linode VPS
  - Specs: Cloud
  - Role: T-Pot honeypot — public internet exposure

## Network Hardware

- Core Switch
  - Model: Cisco Catalyst 3560CX
  - Role: Layer 3 routing, inter-VLAN
- Access Switch
  - Model: Cisco Catalyst 2960CX
  - Role: Layer 2 access, SPAN port
- Link
  - Model: LACP EtherChannel
  - Role: Aggregated uplink between switches
- SPAN Port
  - Model: Cisco hardware
  - Role: Mirrors all traffic to Raspberry Pi eth0

## Hypervisors

- ThinkPad Laptop
  - Hypervisor: VirtualBox
  - Hosts: Ubuntu NOC VM, pfSense-1, Kali Linux
- Desktop PC
  - Hypervisor: VirtualBox
  - Hosts: pfSense-2, Windows DC, PC-1, PC-2
- Dell Optiplex 7090
  - Hypervisor: Proxmox
  - Hosts: SANS SIFT VM, REMnux VM, Monitoring and CTI VM

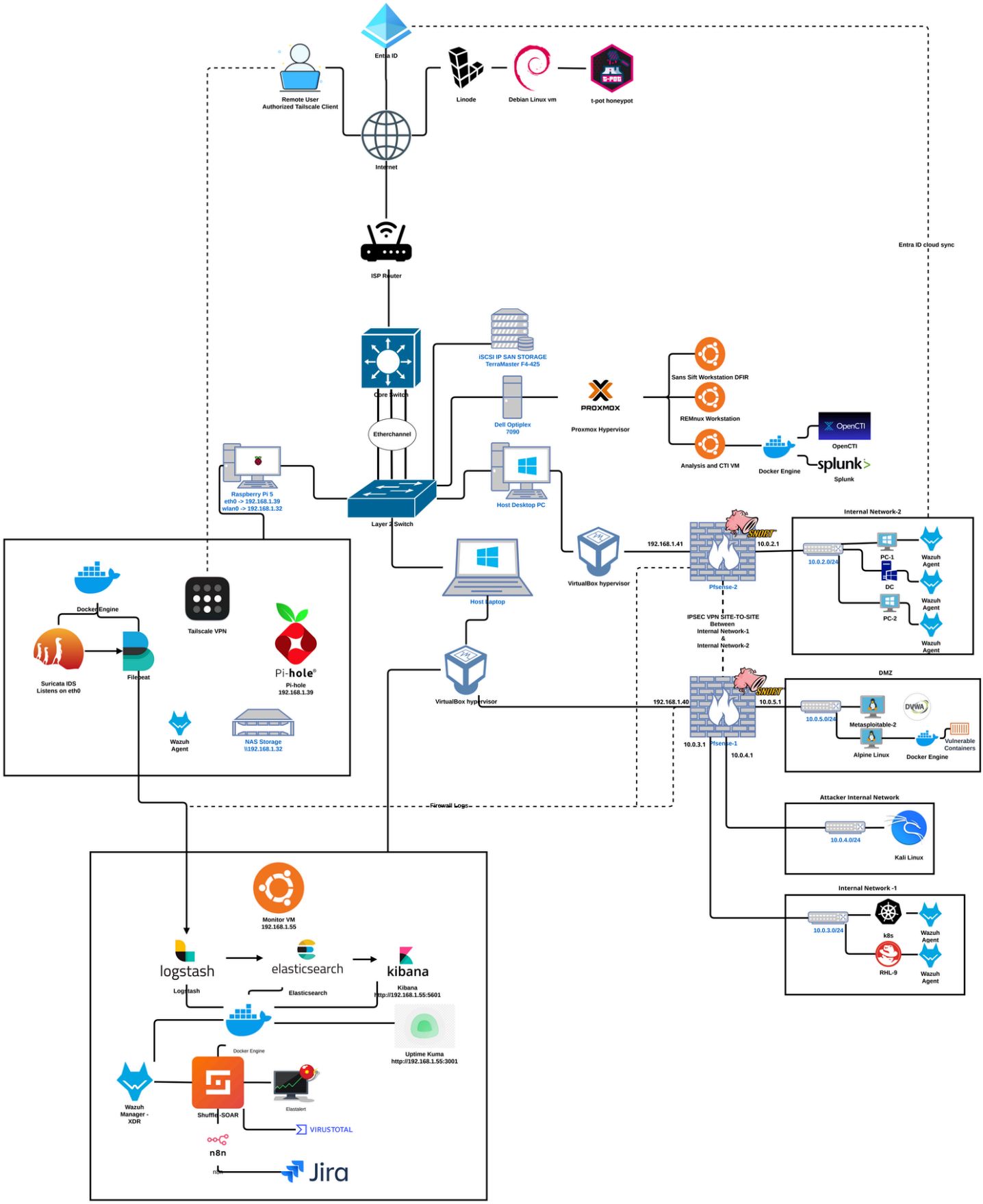
## Proxmox VM Allocation — Dell Optiplex 7090

- SANS SIFT Workstation
  - Purpose: Digital forensics and IR
  - Key Tools: Volatility, Autopsy, Plaso, RegRipper
- REMnux Workstation
  - Purpose: Malware analysis
  - Key Tools: Remnux tools, YARA, binary analysis
- Monitoring and CTI VM
  - Purpose: Threat intelligence and secondary SIEM
  - Key Tools: Splunk, OpenCTI via Docker

## Resource Allocation

- ThinkPad Laptop
  - Total RAM: 32GB
  - Allocated: ~28GB
  - Buffer: ~4GB
- Desktop PC
  - Total RAM: 16GB
  - Allocated: ~14GB
  - Buffer: ~2GB
- Dell Optiplex 7090
  - Total RAM: Dedicated
  - Allocated: Proxmox managed
  - Buffer: Per VM
- Raspberry Pi 5
  - Total RAM: 8GB
  - Allocated: ~3GB
  - Buffer: ~5GB

# 3. Network Architecture




Network Segments

| Network | Subnet | Gateway | Protected By | Purpose |
|---|---|---|---|---|
| Home LAN | 192.168.1.0/24 | 192.168.1.1 | Router | Management, SOC tools |
| Internal Network 1 | 10.0.3.0/24 | 10.0.3.1 | pfSense-1 + Snort | Linux workloads |
| Internal Network 2 | 10.0.2.0/24 | 10.0.2.1 | pfSense-2 + Snort | Windows workloads |
| DMZ | 10.0.5.0/24 | 10.0.5.1 | pfSense-1 + Snort | Vulnerable targets |
| Attacker Network | 10.0.4.0/24 | 10.0.4.1 | pfSense-1 + Snort | Isolated Kali Linux |
| Tailscale Mesh | 100.x.x.x/32 | Tailscale | WireGuard | Secure remote access |
| Storage VLAN | VLAN 88 | N/A | Isolated | iSCSI SAN fabric |
| Management VLAN | VLAN 99 | 192.168.1.1 | Router | Device management |

## Complete Device IP Reference

**Home LAN — 192.168.1.0/24**

| Device | IP | Role |
| --- | --- | --- |
| ISP Router | 192.168.1.1 | Default gateway |
| Raspberry Pi wlan0 | 192.168.1.32 | Wireless interface |
| Raspberry Pi eth0 | 192.168.1.39 | Wired — Suricata listens here |
| Ubuntu NOC VM | 192.168.1.55 | SOC controller |
| pfSense-1 WAN | 192.168.1.40 | Site A firewall external |
| pfSense-2 WAN | 192.168.1.41 | Site B firewall external |
| Kali Linux | 192.168.1.112 | Attack machine |

**Internal Network 1 — 10.0.3.0/24**

| Device | IP | Role |
| --- | --- | --- |
| pfSense-1 LAN | 10.0.3.1 | Gateway — Snort IPS inline |
| k8s Node | 10.0.3.17 | Kubernetes container host |
| Red Hat Linux | 10.0.3.13 | Linux production server |

**Internal Network 2 — 10.0.2.0/24**

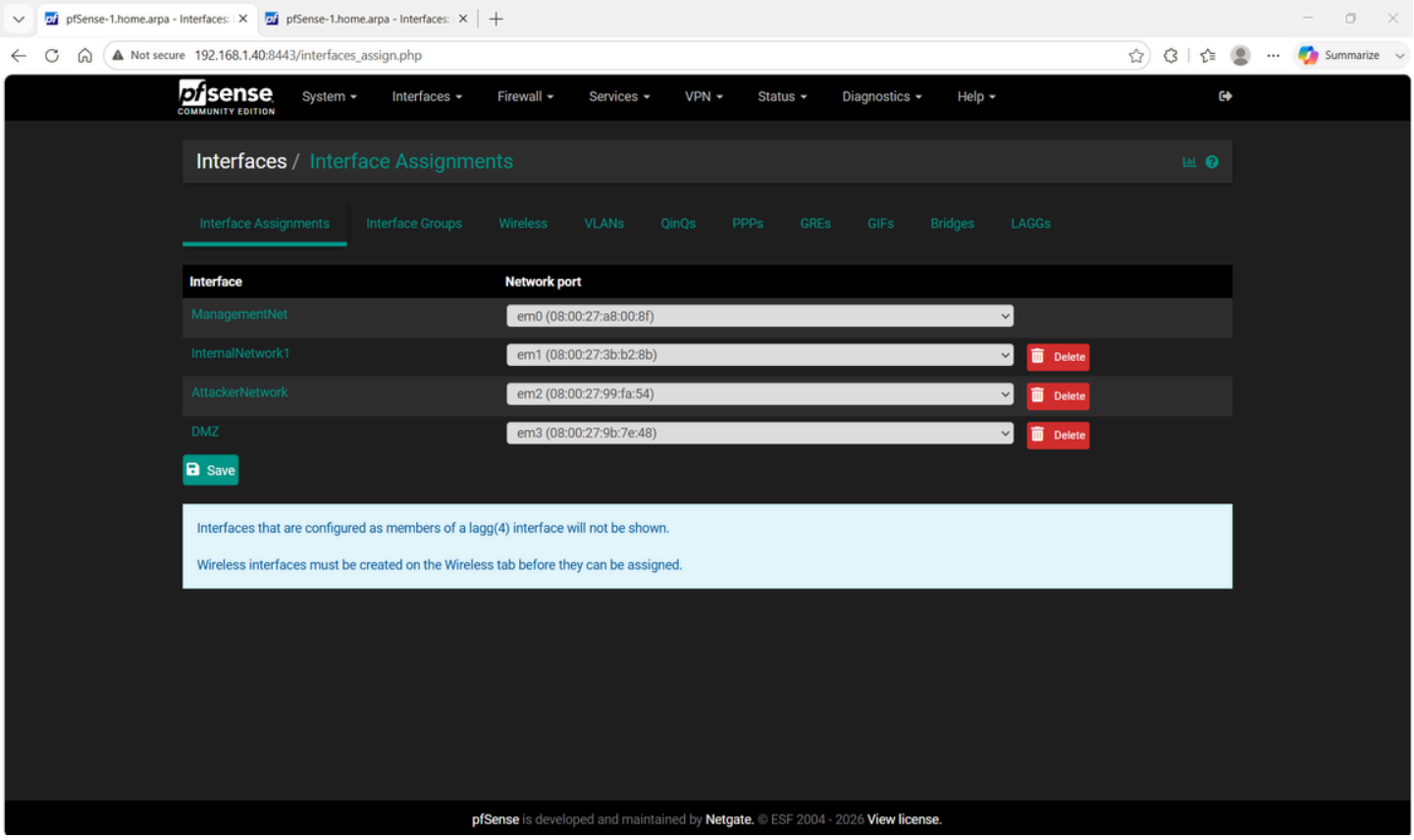
| Device | IP | Role |
| --- | --- | --- |
| pfSense-2 LAN | 10.0.2.1 | Gateway — Snort IPS inline |
| Domain Controller | 10.0.2.100 | Active Directory, DNS, DHCP |
| PC-1 | 10.0.2.5 | Windows 10 endpoint |
| PC-2 | 10.0.2.6 | Windows 10 endpoint |

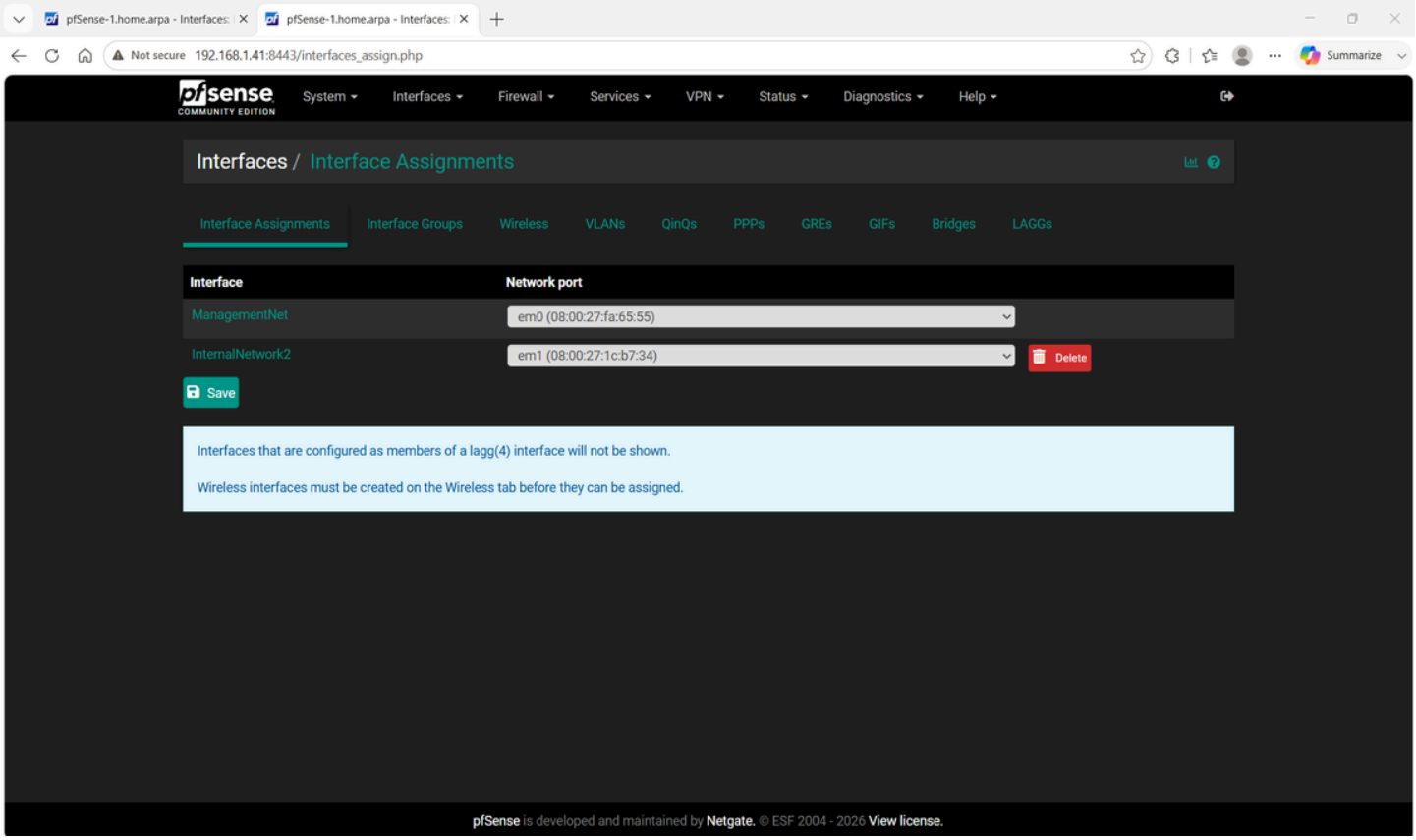
**DMZ — 10.0.5.0/24**

| Device | IP | Role |
| --- | --- | --- |
| pfSense-1 DMZ | 10.0.5.1 | DMZ gateway — Snort IPS inline |
| Metasploitable-2 | 10.0.5.x | Intentionally vulnerable Linux target |
| Alpine Linux | 10.0.5.x | Lightweight Linux target |
| DVWA | 10.0.5.x | Damn Vulnerable Web Application |

**Attacker Network — 10.0.4.0/24**

| Device | IP | Role |
| --- | --- | --- |
| pfSense-1 ATK | 10.0.4.1 | Attacker network gateway |
| Kali Linux | 10.0.4.4 | Isolated attack machine |




# 4. Security Zones and Segmentation

## Zone Architecture

The environment is organized into the following trust zones:

- Home LAN / Management (192.168.1.0/24): SOC tools, sensors, pfSense WAN interfaces. Suricata monitors all traffic on this segment.
- Internal Network 1 (10.0.3.0/24): Linux workloads behind pfSense-1 with Snort IPS inline
- Internal Network 2 (10.0.2.0/24): Windows workloads behind pfSense-2 with Snort IPS inline
- DMZ (10.0.5.0/24): Vulnerable targets — no access to internal networks
- Attacker Network (10.0.4.0/24): Isolated Kali Linux — DMZ access only

## Traffic Policy Matrix

| Source | Destination | Policy | Notes |
|---|---|---|---|
| Internal Net 1 | Internet | Allow web and DNS | Via NAT |
| Internal Net 1 | Internal Net 2 | Allow all | Via IPsec VPN |
| Internal Net 1 | SOC Server | Wazuh and syslog only | Ports 1514, 5140 |
| Internal Net 2 | Internet | Allow web and DNS | Via NAT |
| Internal Net 2 | Internal Net 1 | Allow all | Via IPsec VPN |
| Internal Net 2 | SOC Server | Wazuh and syslog only | Ports 1514, 5140 |
| DMZ | Internet | Web only | Restricted |
| DMZ | Internal networks | Deny | Hard block |
| DMZ | SOC Server | Wazuh and syslog only | Monitoring only |
| Attacker Net | DMZ | Allow all | Lab testing |
| Attacker Net | Internal networks | Deny | Hard block |
| Attacker Net | Home LAN | Deny | Hard block |
| Home LAN | pfSense GUIs | HTTPS and SSH | Management only |

# 5. Component Deep Dive

## Software Stack

- Firewall
  - Technology: pfSense CE
  - Version: 2.7.2
  - Host: Laptop + Desktop
- Edge IDS/IPS
  - Technology: Suricata
  - Version: 7.0.5
  - Host: Raspberry Pi
- Internal IDS/IPS
  - Technology: Snort
  - Version: Latest
  - Host: pfSense-1 and pfSense-2
- XDR
  - Technology: Wazuh
  - Version: 4.9.0
  - Host: Ubuntu NOC VM
- Log Storage
  - Technology: Elasticsearch
  - Version: 7.17.15
  - Host: Ubuntu NOC VM
- Log Processing
  - Technology: Logstash
  - Version: 7.17.15
  - Host: Ubuntu NOC VM
- Visualization
  - Technology: Kibana
  - Version: 7.17.15
  - Host: Ubuntu NOC VM
- Log Shipping
  - Technology: Filebeat
  - Version: 7.17.15
  - Host: Wazuh container
- SOAR
  - Technology: Shuffle
  - Version: Latest
  - Host: Ubuntu NOC VM
- Workflow Automation
  - Technology: n8n
  - Version: Latest
  - Host: Ubuntu NOC VM

- Ticketing
  - Technology: Jira
  - Version: Cloud free
  - Host: External
- Threat Intel API
  - Technology: VirusTotal
  - Version: v3
  - Host: Via Shuffle
- Threat Intelligence
  - Technology: OpenCTI
  - Version: Latest
  - Host: Monitoring and CTI VM
- Secondary SIEM
  - Technology: Splunk
  - Version: Latest
  - Host: Monitoring and CTI VM
- Honeypot
  - Technology: T-Pot
  - Version: Latest
  - Host: Linode VPS
- DNS Security
  - Technology: Pi-hole
  - Version: Latest
  - Host: Raspberry Pi
- Remote VPN
  - Technology: Tailscale
  - Version: Latest
  - Host: All machines
- Service Monitoring
  - Technology: Uptime Kuma
  - Version: 1.23.0
  - Host: Ubuntu NOC VM
- DFIR
  - Technology: SANS SIFT
  - Version: Latest
  - Host: Dell Optiplex Proxmox
- Malware Analysis
  - Technology: REMnux
  - Version: Latest
  - Host: Dell Optiplex Proxmox
- Cloud Identity
  - Technology: Microsoft Entra ID
  - Version: Free tier
  - Host: Cloud
- Storage
  - Technology: TerraMaster F4-425

    - Version: TOS
    - Host: Standalone NAS
- Attack Machine
    - Technology: Kali Linux
    - Version: Latest
    - Host: Laptop VM

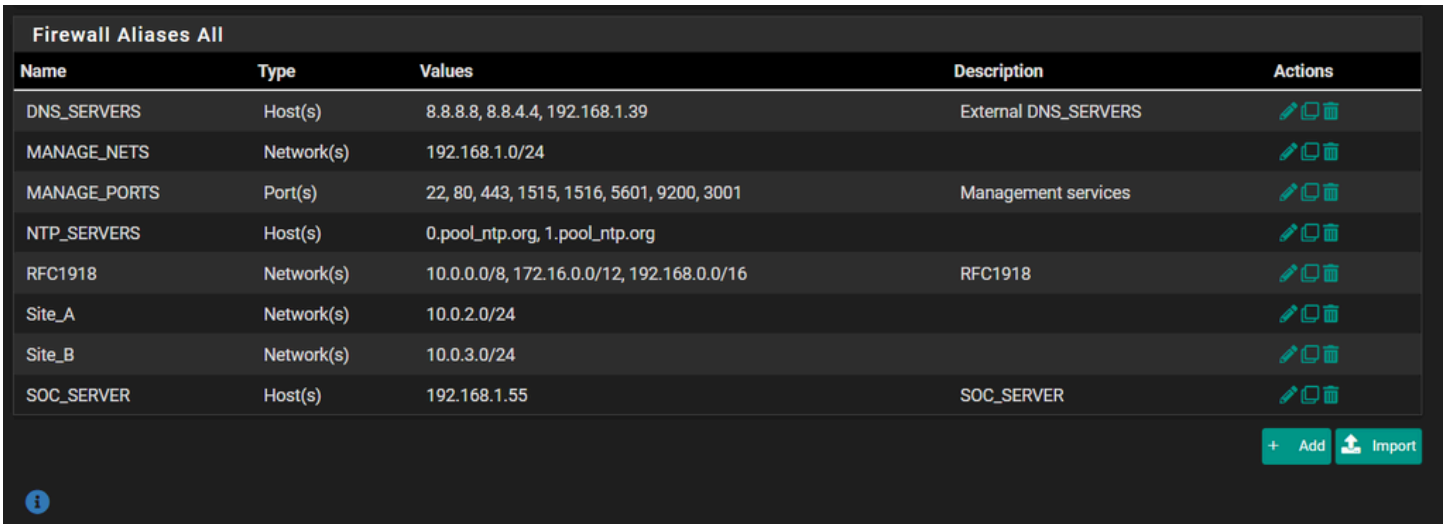
### Service Endpoints

| Service | URL | Purpose |
|---|---|---|
| Kibana | http://192.168.1.55:5601 | Primary security dashboards |
| Uptime Kuma | http://192.168.1.55:3001 | Service monitoring |
| Shuffle SOAR | http://192.168.1.55:3002 | Automated response |
| n8n | http://192.168.1.55:5678 | Workflow automation |
| Elasticsearch | http://192.168.1.55:9200 | Log queries and API |
| Wazuh API | http://192.168.1.55:55000 | XDR management |
| pfSense-1 GUI | https://192.168.1.40:8443 | Site A firewall |
| pfSense-2 GUI | https://192.168.1.41:8443 | Site B firewall |
| Pi-hole GUI | http://192.168.1.39:80 | DNS management |

## 6. Firewall Configuration — pfSense

### pfSense-1 — Site A

**Firewall Aliases:**

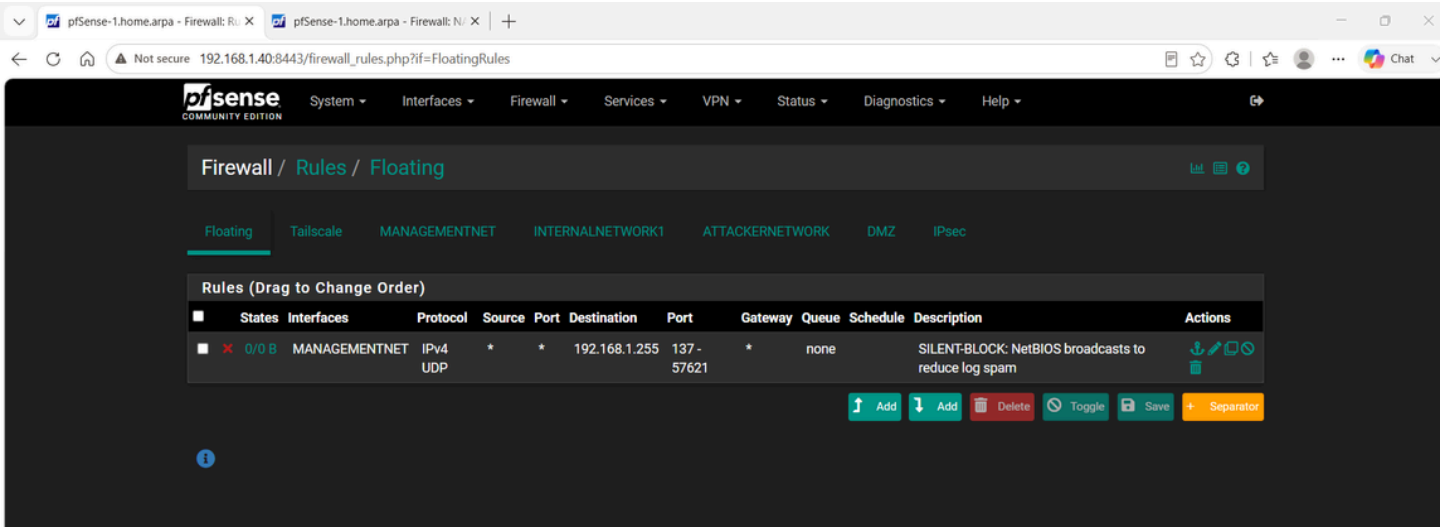


Firewall Aliases All

| Name | Type | Values | Description | Actions |
|---|---|---|---|---|
| DNS_SERVERS | Host(s) | 8.8.8.8, 8.8.4.4, 192.168.1.39 | External DNS_SERVERS | |
| MANAGE_NETS | Network(s) | 192.168.1.0/24 | | |
| MANAGE_PORTS | Port(s) | 22, 80, 443, 1515, 1516, 5601, 9200, 3001 | Management services | |
| NTP_SERVERS | Host(s) | 0.pool_ntp.org, 1.pool_ntp.org | | |
| RFC1918 | Network(s) | 10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16 | RFC1918 | |
| Site_A | Network(s) | 10.0.2.0/24 | | |
| Site_B | Network(s) | 10.0.3.0/24 | | |
| SOC_SERVER | Host(s) | 192.168.1.55 | SOC_SERVER | |

+ Add  Import

## Floating Rules:



pfSense-1.home.arpa - Firewall: Ru  pfSense-1.home.arpa - Firewall: Nu

Not secure 192.168.1.40:8443/firewall_rules.php?if=FloatingRules

pfsense COMMUNITY EDITION  System  Interfaces  Firewall  Services  VPN  Status  Diagnostics  Help

Firewall / Rules / Floating

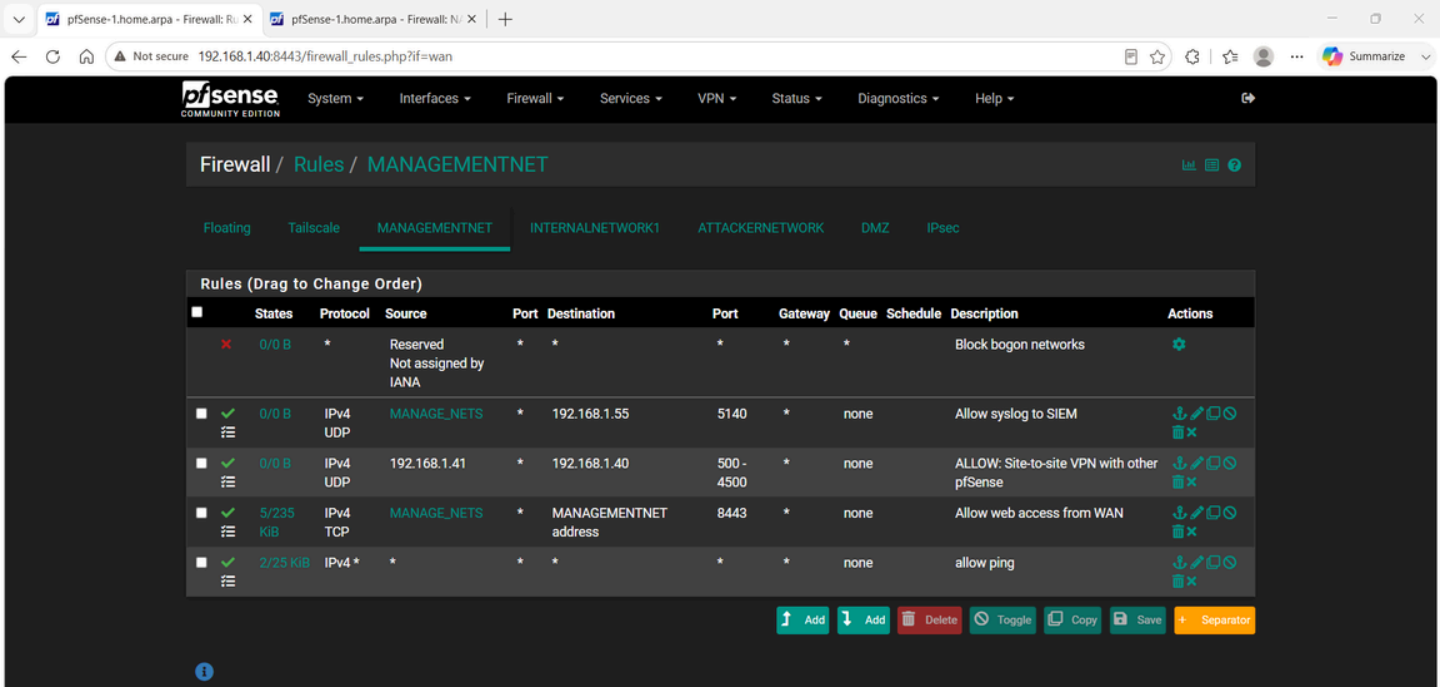
Floating  Tailscale  MANAGEMENTNET  INTERNALNETWORK1  ATTACKERNETWORK  DMZ  IPsec

Rules (Drag to Change Order)

| States | Interfaces | Protocol | Source | Port | Destination | Port | Gateway | Queue | Schedule | Description | Actions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0/0 B | MANAGEMENTNET | IPv4 UDP | * | * | 192.168.1.255 | 137 - 57621 | * | none | | SILENT-BLOCK: NetBIOS broadcasts to reduce log spam | |

Add  Add  Delete  Toggle  Save  + Separator

## Management Network Rules:



pfSense-1.home.arpa - Firewall: Ru  pfSense-1.home.arpa - Firewall: Nu

Not secure 192.168.1.40:8443/firewall_rules.php?if=wan

pfsense COMMUNITY EDITION  System  Interfaces  Firewall  Services  VPN  Status  Diagnostics  Help

Firewall / Rules / MANAGEMENTNET

Floating  Tailscale  MANAGEMENTNET  INTERNALNETWORK1  ATTACKERNETWORK  DMZ  IPsec

Rules (Drag to Change Order)

| States | Protocol | Source | Port | Destination | Port | Gateway | Queue | Schedule | Description | Actions |
|---|---|---|---|---|---|---|---|---|---|---|
| 0/0 B | * | Reserved Not assigned by IANA | * | * | * | * | * | | Block bogon networks | |
| 0/0 B | IPv4 UDP | MANAGE_NETS | * | 192.168.1.55 | 5140 | * | none | | Allow syslog to SIEM | |
| 0/0 B | IPv4 UDP | 192.168.1.41 | * | 192.168.1.40 | 500 - 4500 | * | none | | ALLOW: Site-to-site VPN with other pfSense | |
| 5/235 KiB | IPv4 TCP | MANAGE_NETS | * | MANAGEMENTNET address | 8443 | * | none | | Allow web access from WAN | |
| 2/25 KiB | IPv4 * | * | * | * | * | * | none | | allow ping | |

Add  Add  Delete  Toggle  Copy  Save  + Separator

## Internal Network 1 Rules:

Not secure 192.168.1.40:8443/firewall_rules.php?if=lan

Floating | Tailscale | MANAGEMENTNET | INTERNALNETWORK1 | ATTACKERNETWORK | DMZ | IPsec

Rules (Drag to Change Order)

| States | Protocol | Source | Port | Destination | Port | Gateway | Queue | Schedule | Description | Actions |
|---|---|---|---|---|---|---|---|---|---|---|
| 0/0 B | * | * | * | INTERNALNETWORK1 Address | 8443 | * | * | | Anti-Lockout Rule | |
| 0/0 B | IPv4 * | 10.0.3.0/24 | * | 10.0.3.0/24 | * | * | none | | Allow Full Internal Network Access | |
| 0/0 B | IPv4 TCP/UDP | 10.0.3.0/24 | * | DNS_SERVERS | 53 (DNS) | * | none | | ALLOW: DNS resolution | |
| 0/0 B | IPv4 TCP | 10.0.3.0/24 | * | * | 80 - 443 | * | none | | ALLOW: Web browsing | |
| 0/0 B | IPv4 TCP | * | * | * | 853 (DNS over TLS) | * | none | | Block DNS-over-TLS to prevent bypassing Pi-hole | |
| 0/0 B | IPv4 TCP/UDP | 192.168.1.39 | * | * | 53 (DNS) | * | none | | Bypass Pi-hole DNS Redirect to allow Pi-hole to work | |
| 0/0 B | IPv4 TCP | MANAGE_NETS | * | This Firewall (self) | 22 (SSH) | * | none | | ALLOW: SSH management | |
| 0/0 B | IPv4 TCP | 10.0.3.0/24 | * | SOC_SERVER | 1515 - 1516 | * | none | | ALLOW: Wazuh agent communication | |
| 0/0 B | IPv4 TCP/UDP | 10.0.3.0/24 | * | SOC_SERVER | 5140 | * | none | | ALLOW: pfSense syslog to SIEM | |
| 0/0 B | IPv4 * | 10.0.3.0/24 | * | ! RFC1918 | * | * | none | | ALLOW: General internet access | |
| 0/0 B | IPv4 * | 10.0.3.0/24 | * | 10.0.2.0/24 | * | * | none | | Allow to Internal 2 via VPN | |
| 0/0 B | IPv4 TCP/UDP | INTERNALNETWORK1 subnets | * | 192.168.1.55 | 1514 - 55000 | * | none | | wazuh agent to manager | |
| 0/0 B | IPv4 * | 10.0.3.0/24 | * | * | * | * | none | | Block Everything else | |
| 0/0 B | IPv4 * | INTERNALNETWORK1 subnets | * | * | * | * | none | | Default allow LAN to any rule | |
| 0/0 B | IPv6 * | INTERNALNETWORK1 subnets | * | * | * | * | none | | Default allow LAN IPv6 to any rule | |

## Attacker Network Rules:

Firewall / Rules / ATTACKERNETWORK

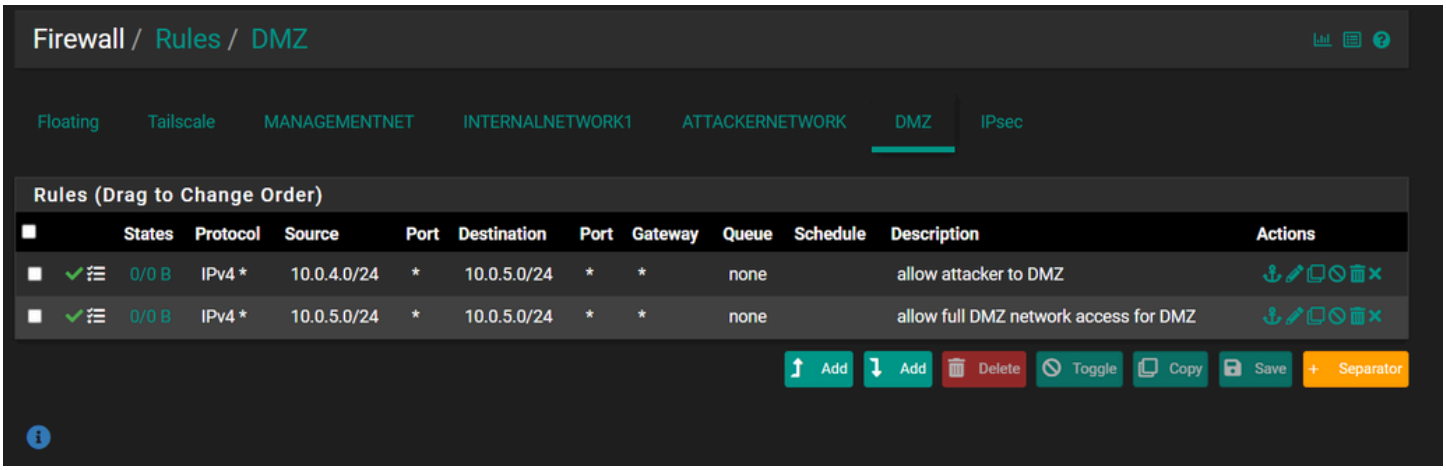
Floating | Tailscale | MANAGEMENTNET | INTERNALNETWORK1 | ATTACKERNETWORK | DMZ | IPsec

Rules (Drag to Change Order)

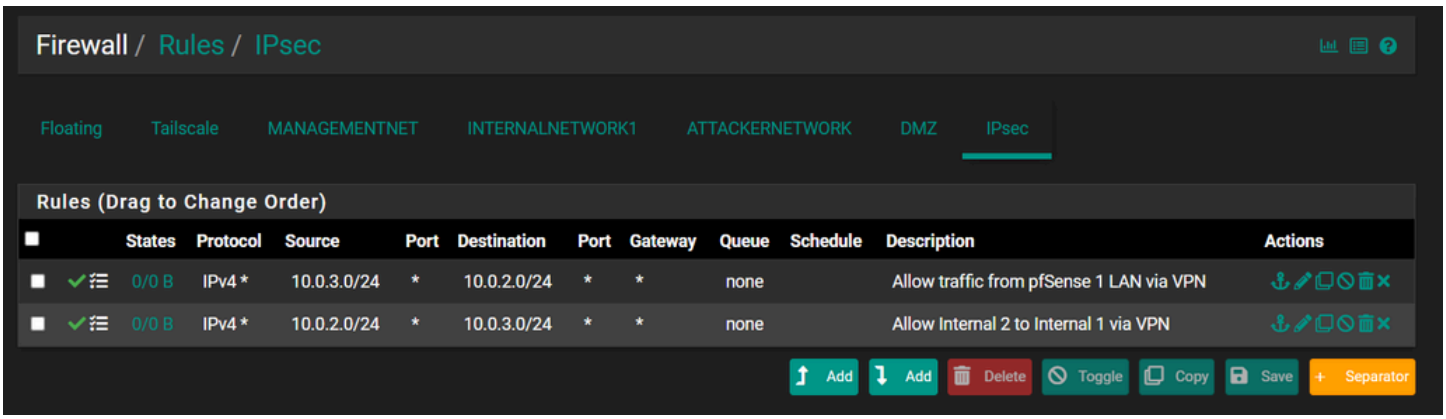
| States | Protocol | Source | Port | Destination | Port | Gateway | Queue | Schedule | Description | Actions |
|---|---|---|---|---|---|---|---|---|---|---|
| 0/0 B | IPv4 * | 10.0.4.0/24 | * | ! RFC1918 | * | * | none | | allow internet access for attacker | |
| 0/0 B | IPv4 * | 10.0.4.0/24 | * | 10.0.5.0/24 | * | * | none | | allow attacker to DMZ | |
| 0/0 B | IPv4 * | 10.0.4.0/24 | * | 10.0.4.0/24 | * | * | none | | allow full attacker network access for attacker | |
| 0/0 B | IPv4 * | 10.0.4.0/24 | * | * | * | * | none | | | |

Add | Add | Delete | Toggle | Copy | Save | + Separator

## DMZ Rules:

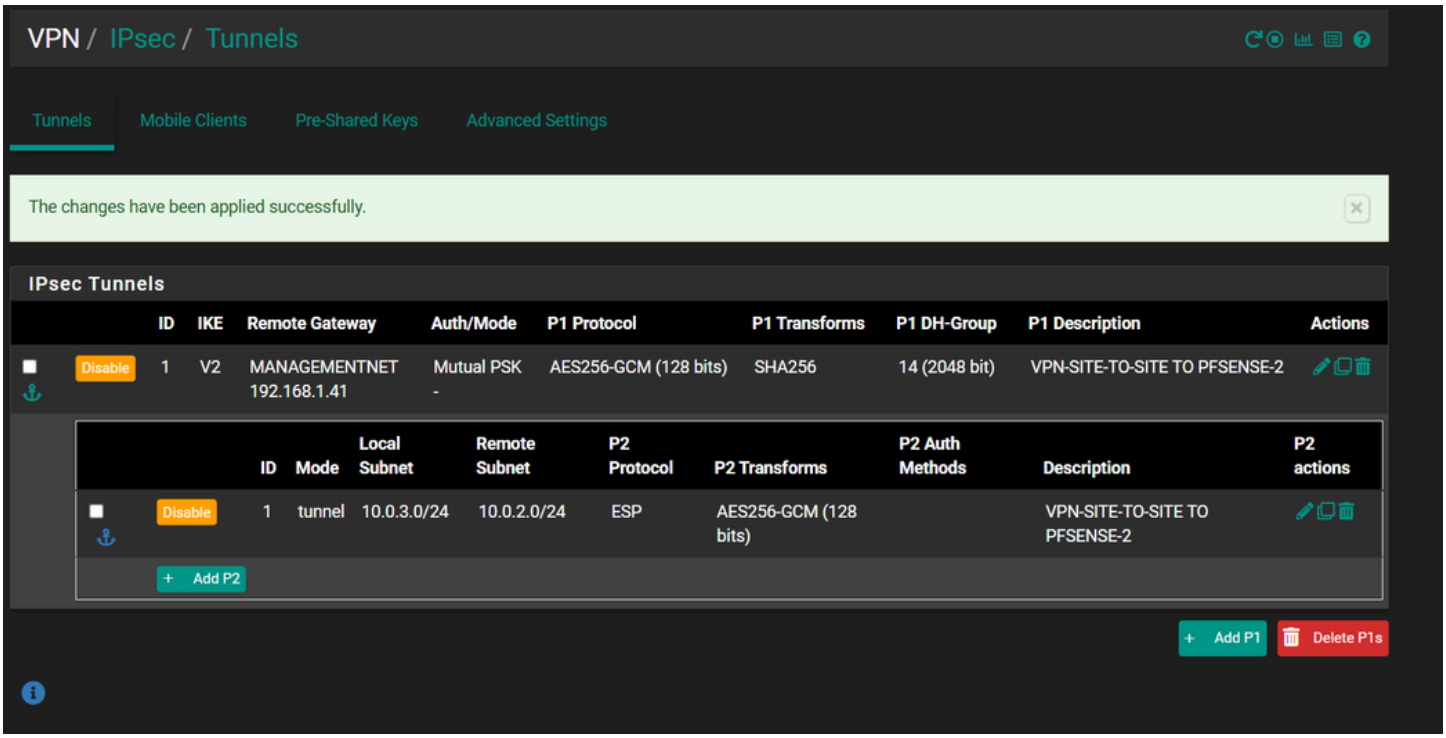



**IPSEC Rules:**

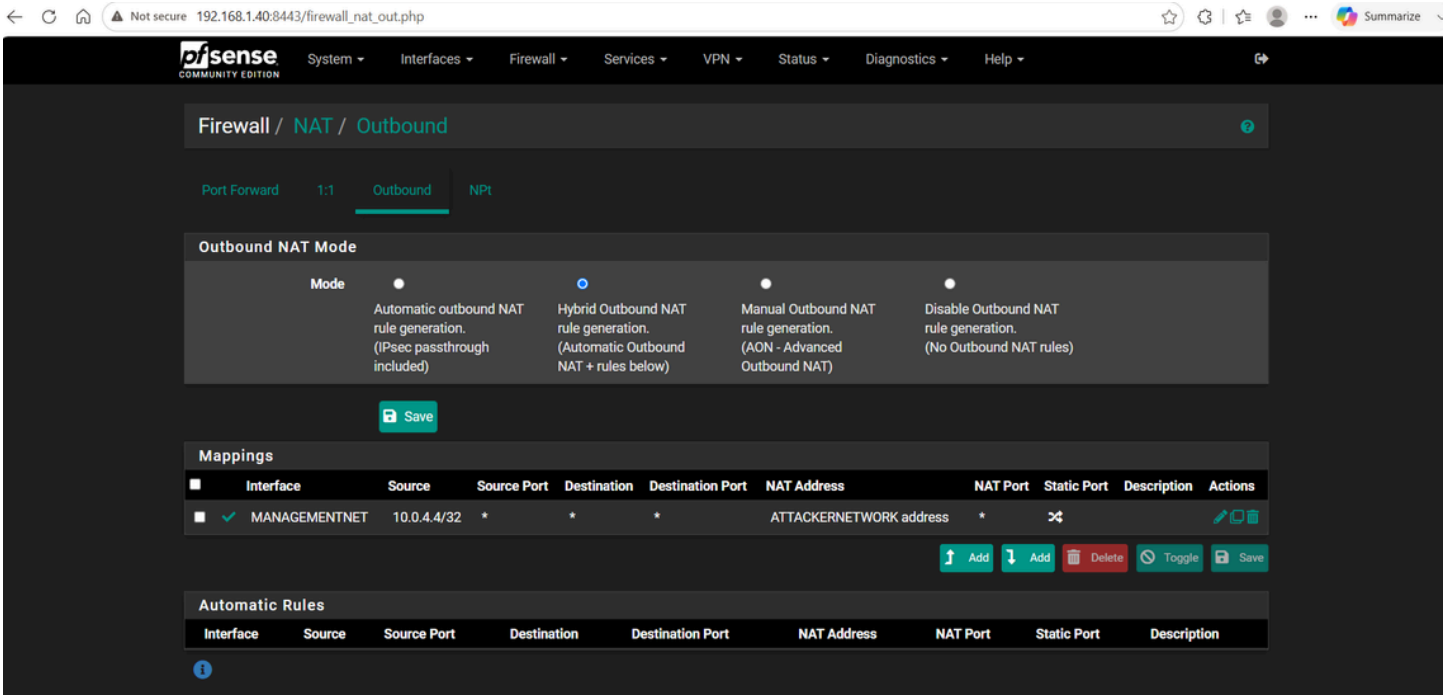



**IPsec VPN Configuration:**

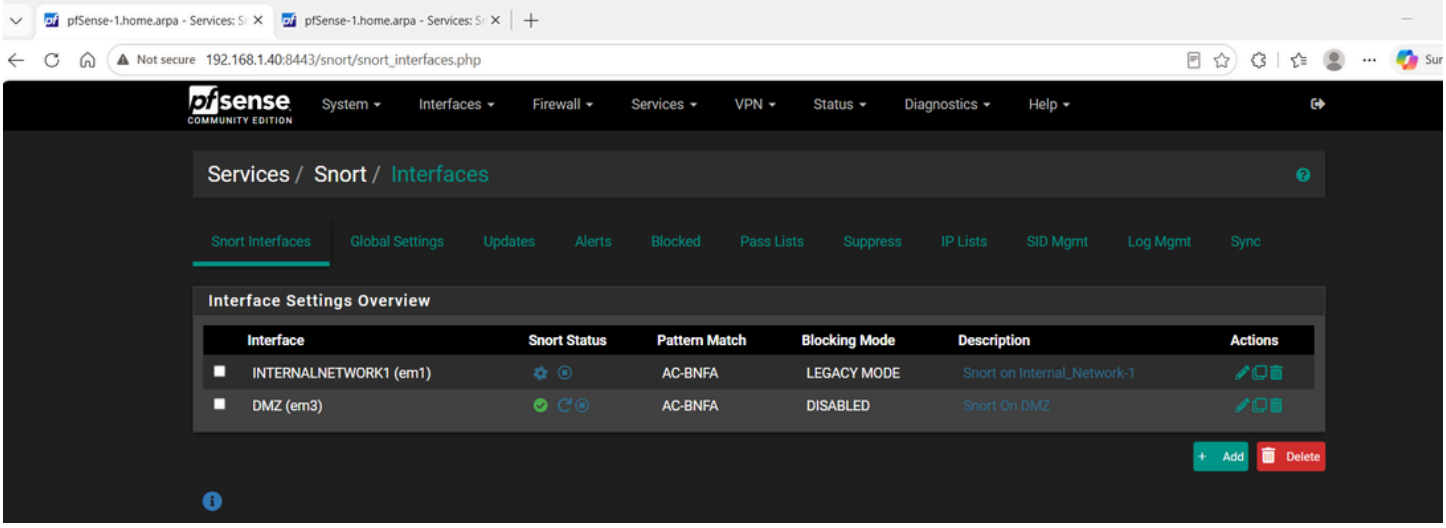
- Protocol: IKEv2
- Local subnet: 10.0.3.0/24
- Remote subnet: 10.0.2.0/24
- Remote gateway: 192.168.1.41
- Authentication: Pre-shared key
- Encryption: AES-256
- Hash: SHA-256
- DH Group: 14
- Phase 1 lifetime: 28800 seconds
- Phase 2 lifetime: 3600 seconds



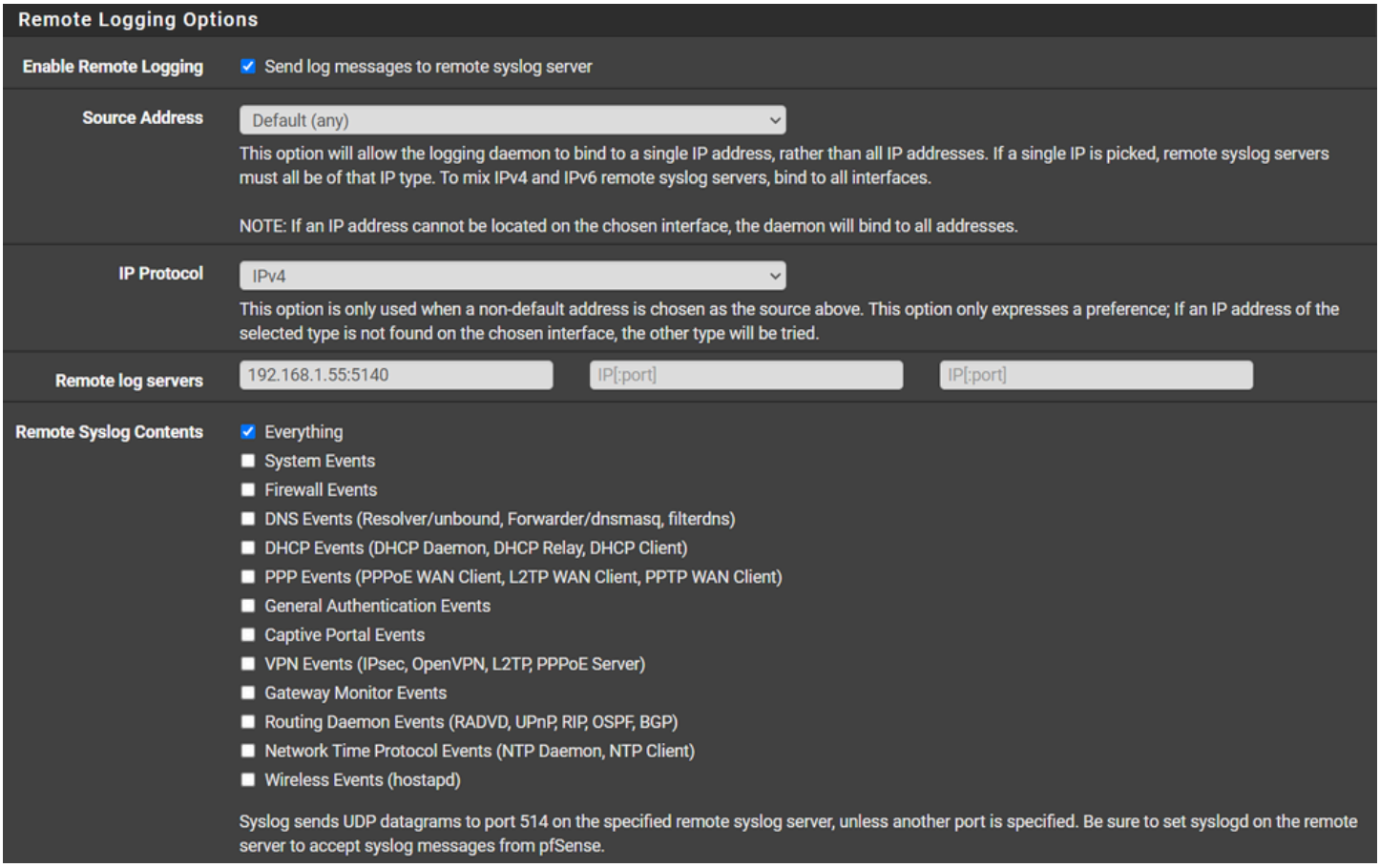

## NAT Outbound Rules:




## Snort:

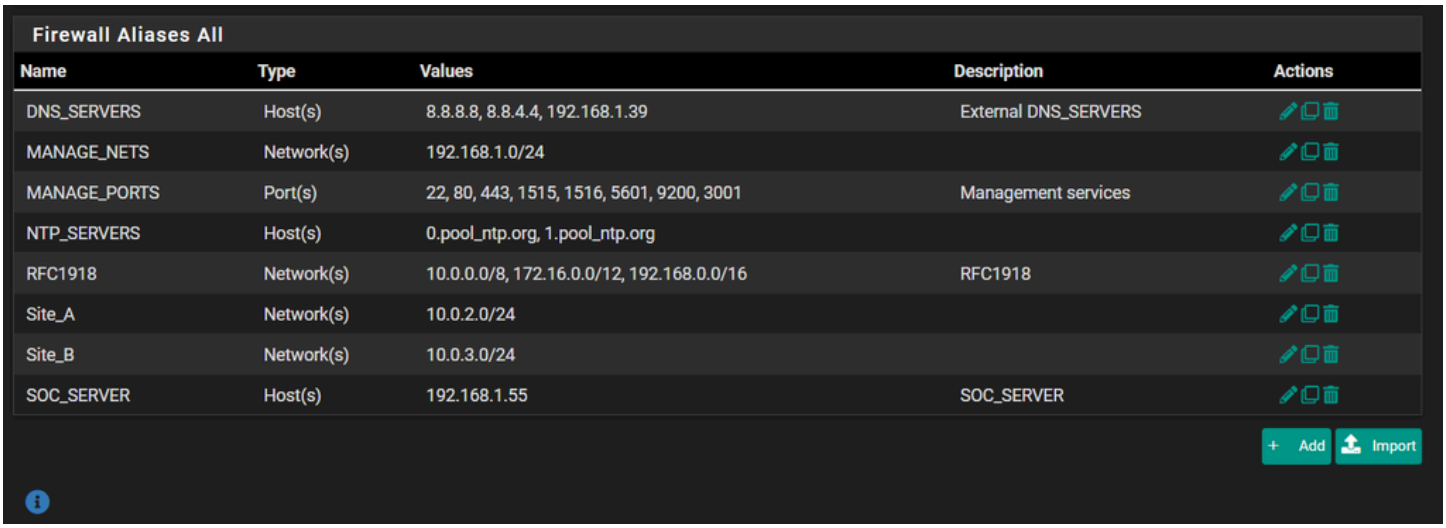



## Remote Syslog to Logstash:




# pfSense-2 — Site B

## Aliases:

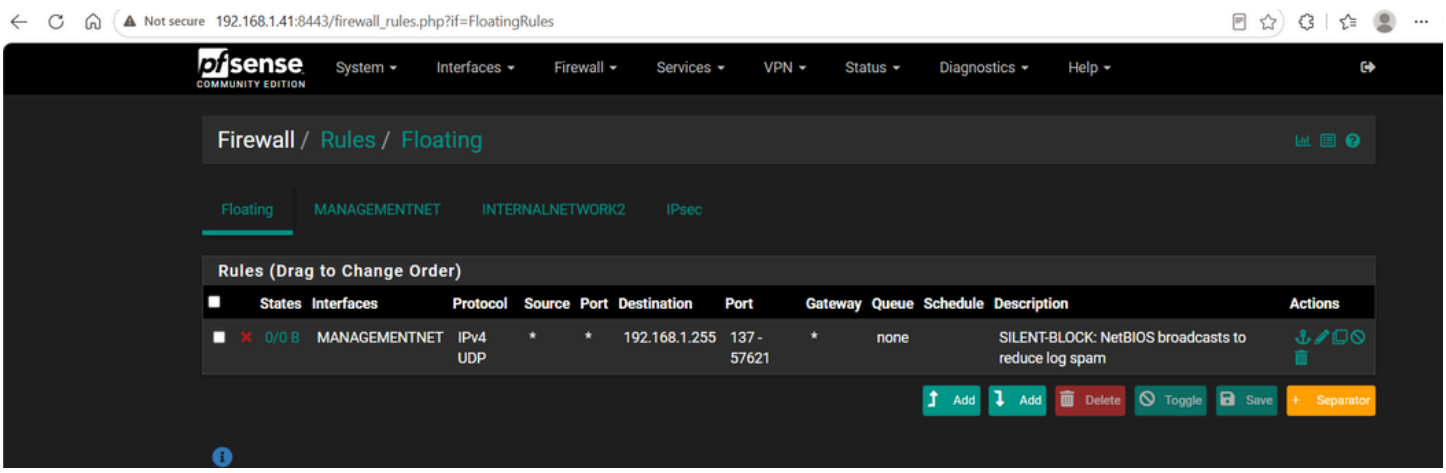


Firewall Aliases All

| Name | Type | Values | Description | Actions |
|---|---|---|---|---|
| DNS_SERVERS | Host(s) | 8.8.8.8, 8.8.4.4, 192.168.1.39 | External DNS_SERVERS | |
| MANAGE_NETS | Network(s) | 192.168.1.0/24 | | |
| MANAGE_PORTS | Port(s) | 22, 80, 443, 1515, 1516, 5601, 9200, 3001 | Management services | |
| NTP_SERVERS | Host(s) | 0.pool_ntp.org, 1.pool_ntp.org | | |
| RFC1918 | Network(s) | 10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16 | RFC1918 | |
| Site_A | Network(s) | 10.0.2.0/24 | | |
| Site_B | Network(s) | 10.0.3.0/24 | | |
| SOC_SERVER | Host(s) | 192.168.1.55 | SOC_SERVER | |

+ Add  Import

## Floating Rules:



Not secure 192.168.1.41:8443/firewall_rules.php?if=FloatingRules

pfsense COMMUNITY EDITION  System  Interfaces  Firewall  Services  VPN  Status  Diagnostics  Help

Firewall / Rules / Floating

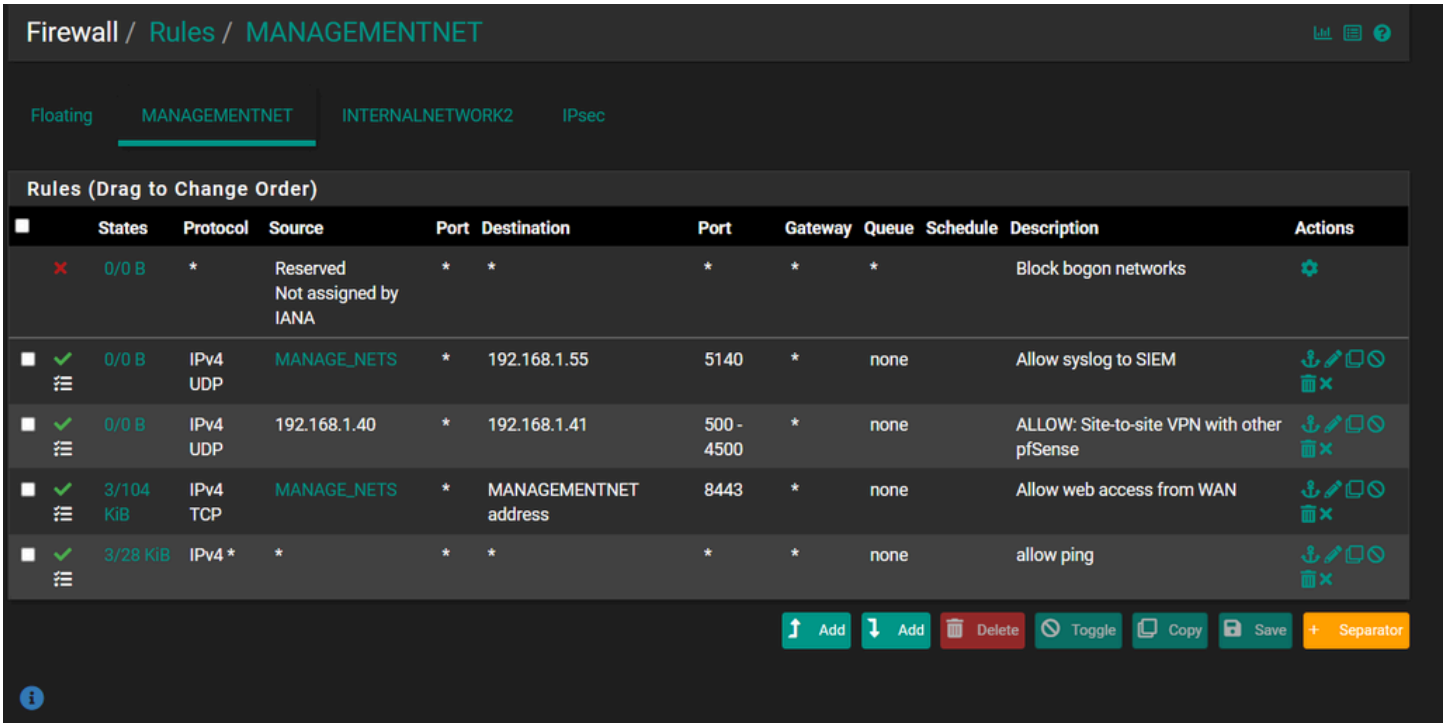
Floating  MANAGEMENTNET  INTERNALNETWORK2  IPsec

Rules (Drag to Change Order)

| States | Interfaces | Protocol | Source | Port | Destination | Port | Gateway | Queue | Schedule | Description | Actions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0/0 B | MANAGEMENTNET | IPv4 UDP | * | * | 192.168.1.255 | 137 - 57621 | * | none | | SILENT-BLOCK: NetBIOS broadcasts to reduce log spam | |

Add  Add  Delete  Toggle  Save  + Separator

## Mangement Network Rules:



Firewall / Rules / MANAGEMENTNET

Floating  MANAGEMENTNET  INTERNALNETWORK2  IPsec

Rules (Drag to Change Order)

| States | Protocol | Source | Port | Destination | Port | Gateway | Queue | Schedule | Description | Actions |
|---|---|---|---|---|---|---|---|---|---|---|
| 0/0 B | * | Reserved Not assigned by IANA | * | * | * | * | * | | Block bogon networks | |
| 0/0 B | IPv4 UDP | MANAGE_NETS | * | 192.168.1.55 | 5140 | * | none | | Allow syslog to SIEM | |
| 0/0 B | IPv4 UDP | 192.168.1.40 | * | 192.168.1.41 | 500 - 4500 | * | none | | ALLOW: Site-to-site VPN with other pfSense | |
| 3/104 KiB | IPv4 TCP | MANAGE_NETS | * | MANAGEMENTNET address | 8443 | * | none | | Allow web access from WAN | |
| 3/28 KiB | IPv4 * | * | * | * | * | * | none | | allow ping | |

Add  Add  Delete  Toggle  Copy  Save  + Separator

## Internal Network-2 Rules:

Not secure 192.168.1.41:8443/firewall_rules.php?if=lan

Floating | MANAGEMENTNET | INTERNALNETWORK2 | IPsec

Rules (Drag to Change Order)

| States | Protocol | Source | Port | Destination | Port | Gateway | Queue | Schedule | Description | Actions |
|---|---|---|---|---|---|---|---|---|---|---|
| 0/0 B | * | * | * | INTERNALNETWORK2 Address | 8443 | * | * | | Anti-Lockout Rule | |
| 0/0 B | IPv4 * | 10.0.2.0/24 | * | 10.0.2.0/24 | * | * | none | | Allow Full Internal Network Access | |
| 0/0 B | IPv4 TCP/UDP | 10.0.2.0/24 | * | DNS_SERVERS | 53 (DNS) | * | none | | ALLOW: DNS resolution | |
| 0/0 B | IPv4 TCP | 10.0.2.0/24 | * | ! RFC1918 | 80 - 443 | * | none | | ALLOW: Web browsing | |
| 0/0 B | IPv4 * | 10.0.2.0/24 | * | ! RFC1918 | * | * | none | | ALLOW: General internet access | |
| 0/0 B | IPv4 TCP | * | * | * | 853 (DNS over TLS) | * | none | | Block DNS-over-TLS to prevent bypassing Pi-hole | |
| 0/0 B | IPv4 TCP/UDP | 192.168.1.39 | * | * | 53 (DNS) | * | none | | Bypass Pi-hole DNS Redirect to allow Pi-hole to work | |
| 0/0 B | IPv4 TCP | MANAGE_NETS | * | This Firewall (self) | 22 (SSH) | * | none | | ALLOW: SSH management | |
| 0/0 B | IPv4 TCP | 10.0.2.0/24 | * | SOC_SERVER | 1515 - 1516 | * | none | | ALLOW: Wazuh agent communication | |
| 0/0 B | IPv4 TCP/UDP | 10.0.2.0/24 | * | SOC_SERVER | 5140 | * | none | | ALLOW: pfSense syslog to SIEM | |
| 0/0 B | IPv4 * | 10.0.2.0/24 | * | 10.0.3.0/24 | * | * | none | | Allow to Internal 2 via VPN | |
| 0/0 B | IPv4 TCP/UDP | INTERNALNETWORK2 subnets | * | 192.168.1.55 | 1514 - 55000 | * | none | | wazuh agent to manager | |
| 0/0 B | IPv4 * | 10.0.2.0/24 | * | * | * | * | none | | Block Everything else | |
| 0/0 B | IPv4 * | INTERNALNETWORK2 subnets | * | * | * | * | none | | Default allow LAN to any rule | |
| 0/0 B | IPv6 * | INTERNALNETWORK2 subnets | * | * | * | * | none | | Default allow LAN IPv6 to any rule | |

## IPsec Rules:

Firewall / Rules / IPsec

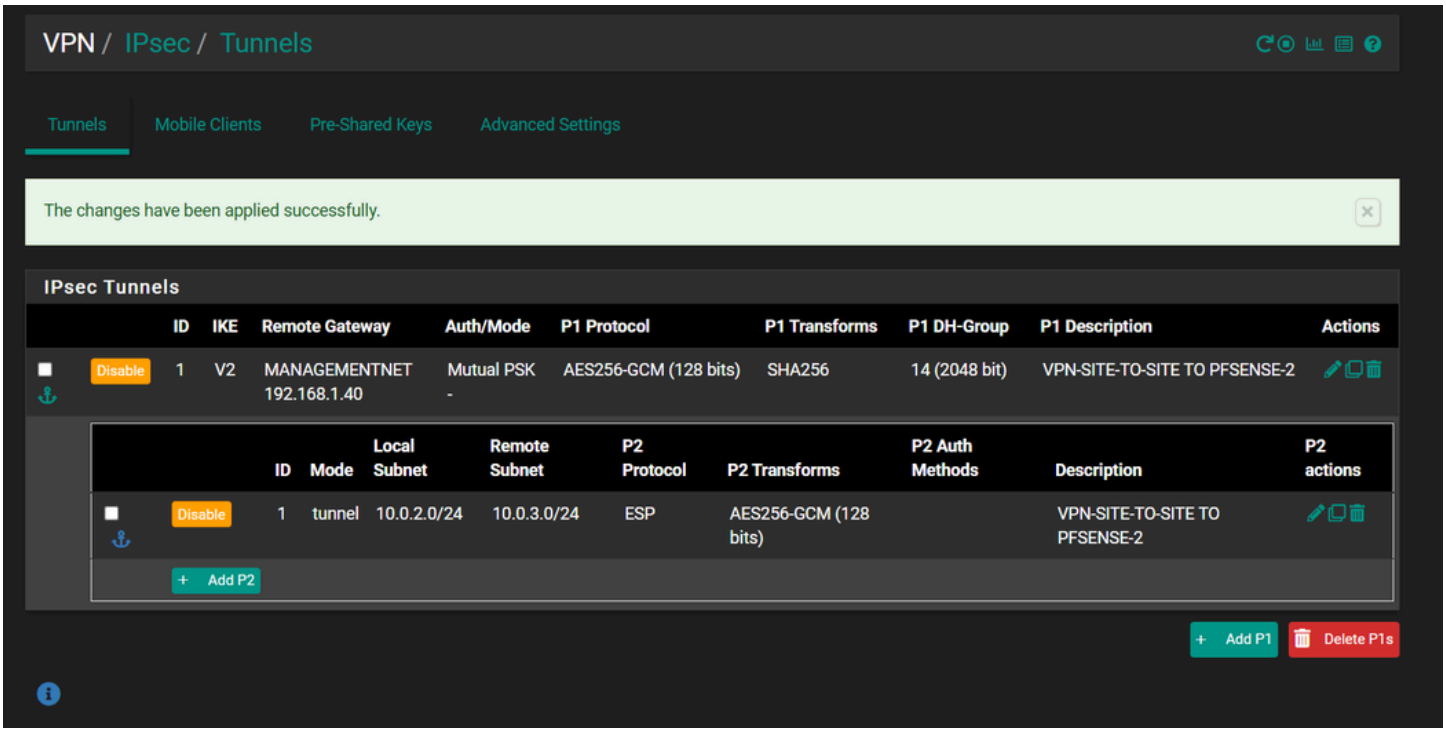
Floating | MANAGEMENTNET | INTERNALNETWORK2 | IPsec

Rules (Drag to Change Order)

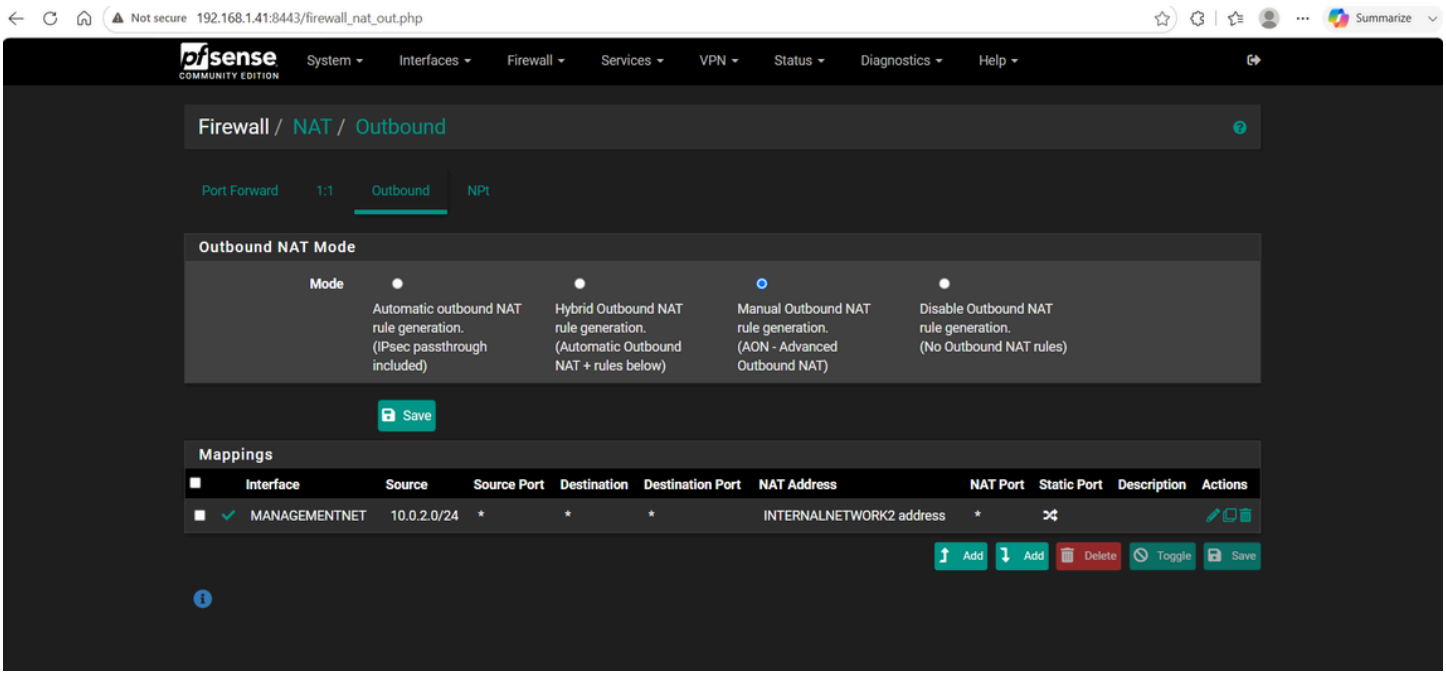
| States | Protocol | Source | Port | Destination | Port | Gateway | Queue | Schedule | Description | Actions |
|---|---|---|---|---|---|---|---|---|---|---|
| 0/0 B | IPv4 * | 10.0.2.0/24 | * | 10.0.3.0/24 | * | * | none | | Allow traffic from pfSense 1 LAN via VPN | |
| 0/0 B | IPv4 * | 10.0.3.0/24 | * | 10.0.2.0/24 | * | * | none | | Allow Internal 2 to Internal 1 via VPN | |

Add | Add | Delete | Toggle | Copy | Save | + Separator

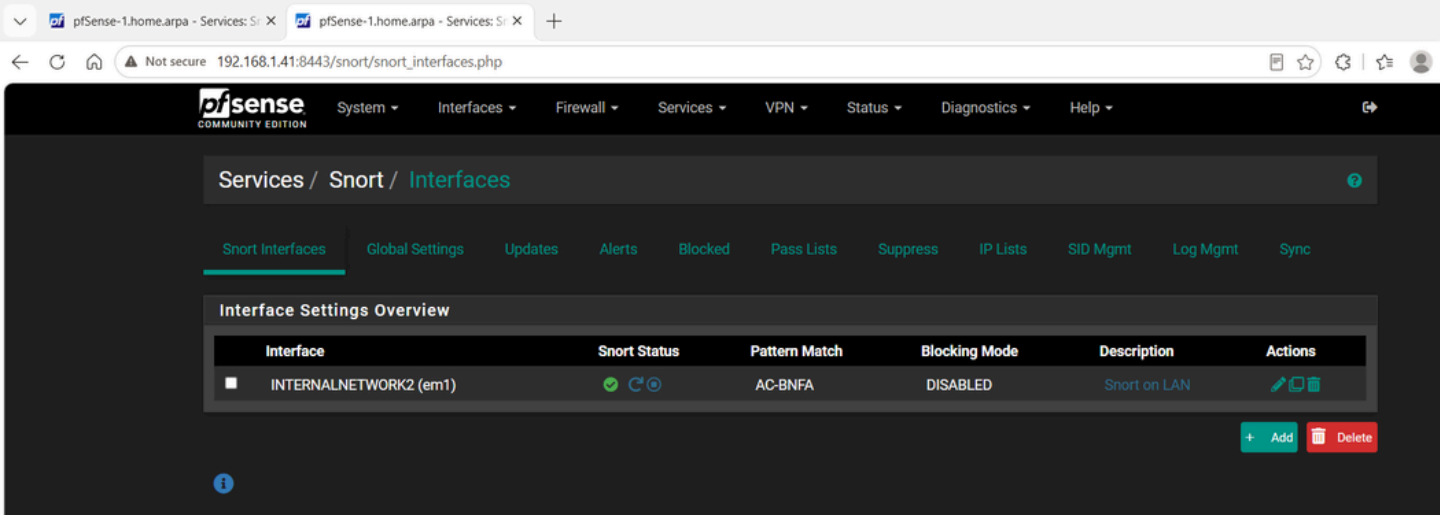
## IPsec Configs:



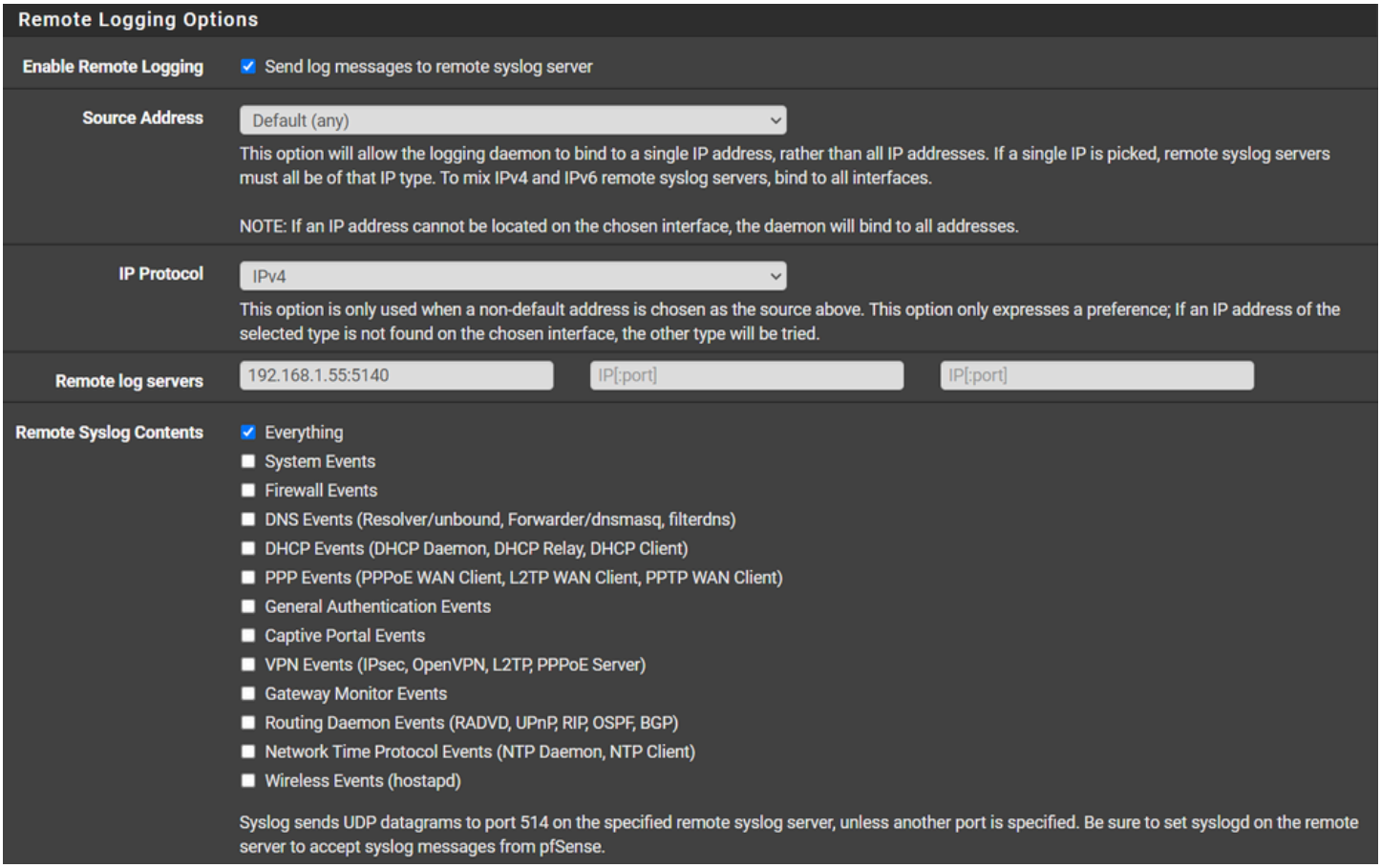

## NAT Outbound Rules:




## Snort:




**Remote Syslog to Logstash:**




# 7. IDS/IPS Architecture

## Overview — Three Layer Detection

- Layer 1: Suricata on Raspberry Pi 5 — edge IDS monitoring all home LAN traffic via hardware SPAN port — passive detection only
- Layer 2: Snort on pfSense-1 and pfSense-2 — internal IPS inline on all internal segments — active blocking, drops malicious packets
- Layer 3: T-Pot on Linode — cloud honeypot capturing real attacker traffic from the public internet

## Layer 1 — Suricata on Raspberry Pi 5

Role: Passive edge sensor monitoring all home LAN traffic captured directly from the Cisco switch SPAN port.

**Docker Deployment:**

```
docker run -d \
  --name suricata \
  --restart always \
  --network host \
  --cap-add=NET_ADMIN \
  --cap-add=NET_RAW \
  -v /var/log/suricata:/var/log/suricata \
  jasonish/suricata:latest \
  -i eth0
```

**Rule Statistics:**

- Total rules: 65,796
- Alert rules: 49,920
- Update frequency: Daily via suricata-update

**Key Detection Categories:**

- Port Scanning — ET SCAN Nmap
- Malware C2 — ET MALWARE C2 Channel
- Exploit Detection — ET EXPLOIT EternalBlue
- Suspicious Protocols — ET INFO Suspicious UserAgent
- Web Attacks — SQL injection, XSS
- DDoS — DOS Slowloris Attack
- DNS Anomalies — ET DNS suspicious queries

**Log Flow:**

```
Suricata -> /var/log/suricata/eve.json
    -> Filebeat -> Elasticsearch (suricata-*)
```

## Layer 2 — Snort on pfSense (Internal IPS)

Role: Inline IPS on both pfSense firewalls. Actively inspects and blocks malicious traffic within and between all internal segments.

**Installation:**

System -> Package Manager -> Available Packages -> Snort -> Install

**Interface Configuration — repeat for each internal interface:**

Services -> Snort -> Add Interface

Enable: yes

Block offenders: yes

Which IP to block: SRC

Kill states: yes

Log to syslog: yes

Alert log retention: 7 days

**HOME_NET per interface:**

- pfSense-1 LAN: 10.0.3.0/24
- pfSense-1 DMZ: 10.0.5.0/24
- pfSense-1 ATK: 10.0.4.0/24
- pfSense-2 LAN: 10.0.2.0/24

**Enabled Rule Categories:**

- emerging-attack_response
- emerging-exploit
- emerging-malware
- emerging-scan
- emerging-web_server
- snort_community

**Alert Severity Mapping:**

- Priority 1: Critical
- Priority 2: High
- Priority 3: Medium
- Priority 4+: Low

**Log Flow:**

Snort alert -> pfSense syslog -> Logstash:5140

-> Elasticsearch (snort-*)

## Layer 3 — T-Pot on Linode

Role: Internet-facing cloud honeypot capturing real attacker traffic from the public internet entirely separate from home infrastructure.

**Active Honeypot Services:**

- Cowrie — simulates SSH and Telnet server — captures credentials, commands, sessions
- Dionaea — simulates Windows SMB services — captures malware samples
- Elasticpot — simulates Elasticsearch instance — captures exploit attempts
- Honeytrap — simulates generic services — captures attack patterns
- Mailoney — simulates SMTP server — captures spam, phishing payloads

**Log Flow:**

T-Pot -> Filebeat -> TLS encrypted tunnel

-> Logstash on 192.168.1.55

-> Elasticsearch (tpot-*)

-> OpenCTI (IOC enrichment)

Value: T-Pot captures real attacker behavior from the internet — actual malware samples, real credential stuffing wordlists, and genuine exploitation techniques used against live infrastructure worldwide.

## IDS/IPS Complete Coverage Map

| Segment | Tool | Mode | Elasticsearch Index |
|---|---|---|---|
| Home LAN (192.168.1.x) | Suricata | IDS passive | suricata-* |
| Internal Network 1 | Snort | IPS inline | snort-* |
| DMZ | Snort | IPS inline | snort-* |
| Attacker Network | Snort | IPS inline | snort-* |
| Internal Network 2 | Snort | IPS inline | snort-* |
| Public Internet | T-Pot | IDS honeypot | tpot-* |

# 8. SIEM — ELK Stack

## Architecture

Data Sources -> Logstash (parsing) -> Elasticsearch (storage) -> Kibana (visualization)

## Log Ingestion Sources

| Source | Method | Port | Index |
|---|---|---|---|
| pfSense-1 | Syslog UDP/TCP | 5140 | pfsense-* |
| pfSense-2 | Syslog UDP/TCP | 5140 | pfsense-* |
| Suricata | Filebeat | Direct | suricata-* |
| Snort | Syslog via pfSense | 5140 | snort-* |
| Wazuh agents | TCP via Wazuh Manager | 1514 | wazuh-alerts-* |
| Pi-hole | Filebeat | Direct | pihole-* |
| T-Pot | Filebeat TLS | 5140 | tpot-* |

## Logstash Pipeline — pfSense and Snort

```
input {
  tcp { port => 5140 codec => line }
  udp { port => 5140 codec => line }
}


filter {
  if [message] =~ "filterlog" {
    mutate { add_tag => ["pfsense"] }
```

```
    csv {
      source => "message"
      separator => ","
      columns => ["full_message","col2","col3","if_name",
                  "reason","action","direction","ip_version",
                  "tos","ecn","ttl","length","id","offset",
                  "flags","protocol_id","protocol","src_port",
                  "src_ip","dest_ip","dest_port","data_len"]
    }
  }
  else if [message] =~ "snort" {
    mutate { add_tag => ["snort"] }
    grok {
      match => {
        "message" => "%{SYSLOGTIMESTAMP:timestamp} %{HOSTNAME:hostname}
        snort\[%{NUMBER:pid}\]: \[%{NUMBER:gid}:%{NUMBER:sid}:
        %{NUMBER:rev}\] %{DATA:alert_msg}
        \[Classification: %{DATA:classification}\]
        \[Priority: %{NUMBER:priority}\]
        \{%{WORD:protocol}\} %{IP:src_ip}:%{NUMBER:src_port}
        -> %{IP:dst_ip}:%{NUMBER:dst_port}"
      }
    }
  }
}
```

```
output {
  if "snort" in [tags] {
    elasticsearch {
      hosts => ["elasticsearch:9200"]
      index => "snort-%{+YYYY.MM.dd}"
    }
  } else {
    elasticsearch {
      hosts => ["elasticsearch:9200"]
      index => "pfsense-%{+YYYY.MM.dd}"
    }
  }
}
```

## Elasticsearch Indices

| Index Pattern | Documents | Retention | Purpose |
|---|---|---|---|
| suricata-* | 300,000+ | 30 days | Edge IDS alerts |
| snort-* | Active | 30 days | Internal IPS alerts |
| pfsense-* | 140,000+ | 30 days | Firewall logs |
| wazuh-alerts-* | 500+ | 90 days | Endpoint alerts |

## Wazuh Alert to Elasticsearch Flow

Wazuh Agent -> TCP 1514 -> Wazuh Manager (192.168.1.55)

-> /var/ossec/logs/alerts/alerts.json

-> Filebeat inside Wazuh container

-> http://192.168.1.55:9200

-> wazuh-alerts-YYYY.MM.dd

# 9. XDR — Wazuh

## Manager Deployment

```
services:
  wazuh.manager:
    image: wazuh/wazuh-manager:4.9.0
    ports:
      - "1514:1514"
      - "1515:1515"
      - "55000:55000"
    volumes:
      - wazuh-manager-data:/var/ossec
```

## Enrolled Agents

| Agent Name | OS | IP | Purpose |
|---|---|---|---|
| PC-1 | Windows 10 | 10.0.2.5 | Endpoint monitoring |
| PC-2 | Windows 10 | 10.0.2.6 | Endpoint monitoring |
| Domain Controller | Windows Server | 10.0.2.100 | Active Directory security |
| Red Hat Linux | RHEL 9 | 10.0.3.13 | Linux server monitoring |
| k8s Node | Linux | 10.0.3.17 | Container host monitoring |
| Raspberry Pi | Ubuntu | 192.168.1.39 | Sensor self-monitoring |

### Active Detection Capabilities

- Windows Event Channel monitoring — Event IDs 4624, 4625, 4688, 4720, 4672
- Linux auditd monitoring — privilege escalation and suspicious commands
- File Integrity Monitoring across all enrolled endpoints
- Malware detection signatures
- Rootkit detection
- MITRE ATT&CK automatic tactic and technique mapping
- Security Configuration Assessment
- Vulnerability detection

## 10. SOAR — Shuffle and n8n

### Shuffle SOAR

Purpose: Security-specific automated incident response triggered by Wazuh high-severity alerts.

**Primary Playbook — Automated Alert Triage:**

1. Trigger: Wazuh alert severity >= 10
2. Extract source IP from alert

3. Query VirusTotal API for IP reputation
4. If malicious score > 5: send enriched notification
5. Update Elasticsearch with verdict
6. Trigger n8n webhook for ticket creation
7. Feed IOC to OpenCTI

**Integrations:**

- Wazuh webhook — alert trigger source
- VirusTotal API — IP and hash enrichment
- n8n webhook — handoff to workflow automation
- Elasticsearch — update alert with enrichment verdict
- OpenCTI API — submit new IOCs from alerts

## n8n Workflow Automation

Purpose: Broader workflow automation — ticket creation, notifications, and reporting pipelines.

**Primary Workflow — Incident to Jira Ticket:**

1. Trigger: Shuffle webhook (high severity)
2. Format alert data into Jira structure
3. Create Jira ticket with alert description and severity, source IP with VirusTotal verdict, affected agent name and OS, MITRE ATT&CK tactic and technique
4. Send Discord notification with ticket link
5. Log incident to audit trail

## Complete Automation Pipeline

Wazuh alert fires

-> Shuffle receives via webhook

-> VirusTotal IP enrichment

-> IOC submitted to OpenCTI

-> n8n receives enriched payload

-> Jira ticket created automatically

-> Analyst notification sent

-> Analyst investigates in Kibana

-> Deep forensics in SIFT if needed

-> Malware samples to REMnux if needed

# 11. Threat Intelligence — OpenCTI

Host: Monitoring and CTI VM (192.168.1.115) Access: http://192.168.1.115:8080 Deployment: Docker container on Proxmox VM

## Purpose

OpenCTI is an enterprise-grade Cyber Threat Intelligence platform used by government agencies, MSSPs, and large enterprise SOC teams. It provides structured management of threat intelligence including IOCs, TTPs, threat actor profiles, and campaign tracking with native MITRE ATT&CK integration.

## Integrations

- T-Pot honeypot — attacker IPs, malware hashes — inbound
- VirusTotal via Shuffle — IP and hash reputation — inbound
- MITRE ATT&CK — TTP framework — inbound
- Wazuh via Shuffle — new IOCs from endpoint alerts — inbound
- Elasticsearch — enriched alert context — bidirectional
- REMnux findings — malware analysis IOCs — inbound

## Intelligence Workflow

T-Pot captures attacker IP

-> OpenCTI ingests as IOC

-> Correlated against MITRE ATT&CK

-> Wazuh rule created for that IP

-> Next appearance triggers alert automatically

-> Kibana dashboard updated

## Key Features Used

- IOC management — IPs, hashes, domains, URLs
- Threat actor tracking and attribution
- Campaign and intrusion set modeling
- MITRE ATT&CK matrix visualization
- Automated feed ingestion
- Connector framework for external integrations

# 12. Digital Forensics — SANS SIFT and REMnux

## SANS SIFT Workstation

Host: Dell Optiplex 7090 — Proxmox VM IP: 192.168.1.113 Purpose: Digital forensics and incident response analysis

**Forensic Workflow:**

Alert detected in Kibana

-> Analyst pivots to SIFT workstation

-> Mount disk image or memory dump

-> Timeline analysis with Plaso

-> Artifact extraction

-> Evidence stored on TerraMaster NAS

-> Forensic report documented

**Key Tools:**

- Volatility — memory forensics and analysis
- Autopsy — disk image forensics
- Plaso — super timeline creation
- NetworkMiner — PCAP file analysis
- YARA — malware pattern identification
- RegRipper — Windows registry analysis
- Log2timeline — timeline correlation

**Evidence Storage:** All forensic evidence, disk images, and investigation artifacts stored on TerraMaster NAS via Samba share for integrity, persistence, and access from other workstations.

## REMnux Workstation

Host: Dell Optiplex 7090 — Proxmox VM IP: 192.168.1.114 Purpose: Malware analysis and reverse engineering

**Malware Analysis Workflow:**

Malware sample identified by Wazuh FIM

or recovered from T-Pot honeypot

-> Sample staged in isolated REMnux VM

-> Static analysis — strings, hashes, headers

-> Dynamic behavioral analysis

-> Network traffic analysis

-> IOCs extracted — IPs, domains, hashes, mutexes

-> IOCs submitted to OpenCTI

-> Detection rules updated in Wazuh and Snort

**Key Tools:**

- YARA — malware signature identification
- Capa — malware capability detection
- PEiD — PE file analysis
- Strings — string extraction from binaries
- Wireshark — network capture analysis
- Ghidra — binary reverse engineering
- Floss — obfuscated string extraction
- Oledump — Office document analysis

**Integration with SOC Pipeline:** REMnux operates as the malware analysis stage in the post-incident pipeline. Artifacts recovered by Wazuh File Integrity Monitoring or captured by T-Pot are submitted to REMnux for analysis. Findings feed back into OpenCTI as structured IOCs and into Wazuh and Snort as new detection rules — closing the loop between detection and defense improvement.

# 13. Secondary SIEM — Splunk

Host: Monitoring and CTI VM (192.168.1.115) Access: http://192.168.1.115:8000 Deployment: Docker container on Proxmox VM

## Purpose

Splunk is deployed alongside the primary ELK Stack for two reasons. First, Splunk is the dominant enterprise SIEM in production SOC environments — the majority of enterprise SOC job postings list Splunk as a required skill. Second, running both platforms provides a direct comparison of query languages, dashboard capabilities, and data ingestion approaches.

## Log Sources

Logs are forwarded from Logstash to Splunk using the Splunk Universal Forwarder or HTTP Event Collector:

- pfSense logs — index: pfsense — firewall analysis
- Suricata alerts — index: suricata — IDS correlation
- Snort alerts — index: snort — internal IPS
- Wazuh alerts — index: wazuh — endpoint events

## Skills Practiced

- Splunk Processing Language (SPL) queries
- Splunk dashboard and visualization building
- Saved searches and alert configuration
- Splunk data model and CIM compliance
- Correlation searches across multiple data sources

# 14. Honeypot — T-Pot on Linode

Platform: Linode cloud VPS OS: Debian Linux VM WebUI: https://linode-ip:64295

## Active Honeypot Services

- Cowrie — simulates SSH and Telnet server — captures credentials, session commands
- Dionaea — simulates Windows SMB and FTP — captures malware binaries
- Elasticpot — simulates Elasticsearch — captures exploit payloads
- Honeytrap — simulates generic TCP services — captures raw attack patterns
- Mailoney — simulates SMTP server — captures phishing content

## Log Shipping to SIEM

T-Pot containers -> Filebeat

-> TLS encrypted connection

-> Logstash on 192.168.1.55

-> Elasticsearch (tpot-*)

-> Kibana honeypot dashboard

-> OpenCTI IOC enrichment

## Intelligence Value

T-Pot provides something no internal lab simulation can replicate — real attacker data from the public internet. Every credential attempt, every malware sample, every exploitation attempt comes from actual threat actors. This data feeds directly into OpenCTI to enrich the threat intelligence picture and back into Wazuh and Snort as detection rules based on observed real-world attack patterns.

# 15. Cloud Identity — Microsoft Entra ID

Status: In Progress

## Architecture

On-premises Active Directory (10.0.2.100)

-> Entra Connect Sync agent installed on DC

Microsoft Entra ID (cloud tenant — free tier)

-> Password Hash Synchronization

Hybrid identity — users exist in both locations

-> Remote user authentication via Tailscale + Entra ID

### Purpose

Simulates the hybrid identity environment used by the vast majority of enterprise organizations. Enables cloud-based authentication event monitoring, user identity context in firewall and SIEM logs, and conditional access policy practice — all skills directly relevant to enterprise SOC roles.

## 16. Remote Access — Tailscale

Tailscale VPN installed on: ThinkPad Laptop, Desktop PC, Raspberry Pi 5

When the laptop is taken to a workspace, Tailscale automatically maintains connectivity between all three physical machines. The pfSense site-to-site VPN, Wazuh agent communication, and Filebeat log shipping all continue operating as if the laptop never left the home network.

**Subnet routing configured:**

- Laptop — advertises 10.0.3.0/24 — enables access to Internal Network 1
- Desktop PC — advertises 10.0.2.0/24 — enables access to Internal Network 2
- Raspberry Pi — advertises 192.168.1.0/24 — enables access to Home LAN

## 17. DNS Security — Pi-hole

IP: 192.168.1.39 GUI: http://192.168.1.39:80

### Functions

- Network-wide DNS filtering blocking malware and C2 domains
- DNS query logging for threat correlation
- Ad blocking across all connected devices
- Upstream DNS forwarded to 8.8.8.8 and 8.8.4.4

### Integration with SIEM and CTI

Pi-hole query logs -> Filebeat -> Elasticsearch (pihole-*)

-> Kibana DNS dashboard

-> Correlate suspicious domains with Suricata alerts

-> Blocked domains submitted to OpenCTI as IOCs

### Security Layering with Suricata

Pi-hole and Suricata provide complementary coverage at the DNS layer. Pi-hole blocks the DNS lookup before any connection is established. Suricata alerts on the network connection attempt even if DNS was blocked. Two independent tools catching the same C2 communication at different points in the kill chain.

## 18. Storage — TerraMaster F4-425 NAS

Model: TerraMaster F4-425 GUI: https://192.168.88.10 Network: VLAN 88 — MTU 9000 (iSCSI) and Home LAN (Samba)

### Hardware Specifications

- Bays: 4
- Processor: Quad-core Intel
- Network: 10GbE capable
- OS: TOS — TerraMaster Operating System
- Protocol support: iSCSI, SMB, NFS, AFP

### Three-Tier Storage Design

- Tier 1 — Hot: iSCSI LUN, VLAN 88, MTU 9000 — Elasticsearch active data, optimized IOPS
- Tier 2 — Warm: Samba share, Home LAN, MTU 1500 — PCAP dumps, config backups, forensic evidence
- Tier 3 — Cold: External HDD via USB, local — VM disaster recovery, cold archive

### Storage Consumers

- Elasticsearch — iSCSI Tier 1 — all indexed log data
- SANS SIFT — Samba Tier 2 — forensic disk images, evidence
- REMnux — Samba Tier 2 — malware samples, analysis reports
- pfSense backup — Samba Tier 2 — configuration XML exports
- Kibana backup — Samba Tier 2 — saved objects and dashboard exports
- Suricata PCAP — Samba Tier 2 — packet capture archives

## 19. Service Monitoring — Uptime Kuma

URL: http://192.168.1.55:3001

### Monitored Services

- Kibana — HTTP 200 — alert on failure or timeout
- Elasticsearch — HTTP cluster health — alert when not green

- Wazuh Manager — TCP port 1514 — alert when port closed
- Shuffle SOAR — HTTP 200 — alert on failure
- n8n — HTTP 200 — alert on failure
- OpenCTI — HTTP 200 — alert on failure
- Splunk — HTTP 200 — alert on failure
- pfSense-1 — Ping — alert on no response
- pfSense-2 — Ping — alert on no response
- Pi-hole — HTTP 200 — alert on failure
- TerraMaster NAS — Ping — alert on no response

Alerting: Discord webhook notification when any service becomes unavailable.

# 20. Attack Simulations and Validation

## Simulation 1 — Port Scan

- Tool: Nmap stealth SYN scan
- Command: nmap -sS 192.168.1.40
- Source: Kali Linux 192.168.1.112
- Target: pfSense-1 WAN
- Detection: Suricata — ET SCAN Nmap
- Evidence: 4,180+ hits in suricata-* index
- Analyst conclusion: True positive — authorized internal scan

## Simulation 2 — SSH Brute Force

- Tool: Hydra with rockyou.txt wordlist
- Command: hydra -l root -P rockyou.txt ssh://192.168.1.41:2222
- Source: Kali Linux
- Target: pfSense-2 NAT SSH
- Detection: Wazuh — multiple failed login correlation
- Evidence: wazuh-alerts-* — authentication failure pattern
- Analyst conclusion: True positive — authorized brute force test

## Simulation 3 — Ping Flood DoS

- Tool: ping flood
- Command: sudo ping -f 192.168.1.40 -c 500
- Source: Kali Linux
- Target: pfSense-1 WAN
- Detection: pfSense rate-based ICMP detection
- Evidence: pfsense-* index — high ICMP volume confirmed
- Analyst conclusion: True positive — authorized DoS simulation

## Simulation 4 — SMB Enumeration

- Tool: enum4linux
- Command: enum4linux 192.168.1.39

- Source: Kali Linux
- Target: Raspberry Pi NAS — Samba
- Detection: Suricata flow alerts — 8-12 alerted flows
- Evidence: suricata-* — SMB reconnaissance confirmed
- Analyst conclusion: True positive — Samba service info exposed

# 21. Detection Capabilities and MITRE ATT&CK

## Detection Coverage by Layer

**Edge Layer — Suricata:**

- Port Scanning — threshold detection — ET SCAN Nmap scan
- Malware C2 — signature matching — ET MALWARE C2 Channel
- Exploit Attempts — vulnerability signatures — ET EXPLOIT EternalBlue
- DDoS Patterns — rate-based detection — DOS Slowloris Attack
- Suspicious Protocols — protocol anomaly — ET INFO Tor traffic

**Internal Layer — Snort:**

- Internal Scanning — threshold detection — scan rule triggers
- Lateral Movement — authentication anomaly — multiple auth failures
- Web Attacks — HTTP inspection — SQL injection pattern
- Exploit Attempts — vulnerability signatures — MS17-010 detection
- Malware Behavior — signature matching — known malware IOCs

**Endpoint Layer — Wazuh:**

- Malware Execution — FIM and signatures — malware detected
- Privilege Escalation — auditd monitoring — sudo abuse detected
- Persistence — registry monitoring — startup entry added
- Lateral Movement — auth log correlation — multiple failed logins
- Account Creation — Event ID 4720 — new user account created
- Admin Login — Event ID 4672 — privileged logon detected

**DNS Layer — Pi-hole:**

- Malware C2 Domains — blocklist matching — domain blocked
- DNS Tunneling — query frequency analysis — unusual DNS volume

**Cloud Honeypot — T-Pot:**

- SSH Brute Force — captures credentials, commands
- Malware Delivery — captures binary samples
- Exploitation — captures payload content
- Reconnaissance — captures scan patterns

## MITRE ATT&CK Mapping

| Detection | Tactic | Technique ID | Tool |
|---|---|---|---|
| Port scan detection | Reconnaissance | T1046 Network Service Scanning | Suricata |
| SSH brute force | Credential Access | T1110 Brute Force | Wazuh |
| SMB enumeration | Discovery | T1135 Network Share Discovery | Suricata |
| Malware C2 traffic | Command and Control | T1071 Application Layer Protocol | Suricata |
| New admin account | Privilege Escalation | T1078 Valid Accounts | Wazuh |
| Firewall rule bypass | Defense Evasion | T1562 Impair Defenses | pfSense |
| Public exploit attempt | Initial Access | T1190 Exploit Public-Facing App | Suricata |
| Registry modification | Persistence | T1547 Boot Autostart Execution | Wazuh |
| File modification | Impact | T1565 Data Manipulation | Wazuh FIM |
| Lateral movement | Lateral Movement | T1021 Remote Services | Wazuh |

## 22. Log Flow Architecture

Wazuh Manager -(webhook)-> Shuffle SOAR -(VirusTotal)-> Enriched Alert

-> OpenCTI (new IOC)

-> n8n Webhook

-> Jira Ticket + Notification

# 23. Kibana Dashboards

## Dashboard 1 — Main Security Dashboard

- Total Alerts count metric
- Blocked Connections count metric
- Unique Attacking IPs count metric
- Critical Alerts count metric
- Alerts over time — line chart by type
- Top attack sources — ranked table
- Protocol distribution — pie chart
- Most targeted ports — bar chart
- Recent security events — data table

## Dashboard 2 — Network Security Dashboard

- pfSense allowed vs blocked traffic — stacked bar chart
- Suricata alert severity distribution
- Snort alerts by interface and severity
- VPN tunnel health indicators
- Top Suricata signatures fired
- Top Snort signatures fired
- Geographic attack origin map

## Dashboard 3 — Endpoint Security Dashboard

- Wazuh active agent count and status
- Alerts by MITRE ATT&CK tactic — horizontal bar
- Top alert rules by frequency
- Recent endpoint alerts — data table
- FIM events timeline
- Agent health and last seen status

## Kibana Index Patterns

| Pattern | Time Field | Purpose |
|---|---|---|
| suricata-* | @timestamp | Edge IDS alerts |
| snort-* | @timestamp | Internal IPS alerts |
| pfsense-* | @timestamp | Firewall logs |
| wazuh-alerts-* | timestamp | Endpoint alerts |
| pihole-* | @timestamp | DNS queries |
| tpot-* | @timestamp | Honeypot data |

# 24. Maintenance and Troubleshooting

## Daily Health Checks

```
# Verify all containers running
docker ps

# Elasticsearch cluster health
curl -s "http://192.168.1.55:9200/_cluster/health" | jq .

# Recent Suricata alerts
docker exec suricata tail -5 /var/log/suricata/eve.json \
  | jq 'select(.event_type=="alert")'

# Recent Wazuh alerts timestamp
curl -s "http://192.168.1.55:9200/wazuh-alerts-*/_search\
?size=1&sort=timestamp:desc" | jq '.hits.hits[0]._source.timestamp'
```

# Check Kibana — Discover -> last 15 minutes -> data present

## Weekly Maintenance

- Update Suricata rules: docker exec suricata suricata-update
- Update Snort rules: pfSense -> Snort -> Updates -> Update Now
- Check disk space: df -h
- Clear old indices: curl -X DELETE http://192.168.1.55:9200/pfsense-YYYY.MM.*
- Backup pfSense-1 config: Diagnostics -> Backup/Restore -> Download
- Backup pfSense-2 config: Diagnostics -> Backup/Restore -> Download
- Backup Kibana dashboards: Stack Management -> Saved Objects -> Export
- Update T-Pot: SSH to Linode -> update containers

## Common Issues and Solutions

- No pfsense-* logs — empty index — check pfSense remote syslog settings
- No suricata-* data — no alerts in Kibana — check docker logs suricata
- No wazuh-alerts-* — stale timestamp — check filebeat.yml hosts field
- Wazuh agent offline — agent disconnected — systemctl restart wazuh-agent
- Kibana shows no data — no results found — check time range and index pattern
- High Elasticsearch memory — slow queries — increase ES_JAVA_OPTS heap
- VPN tunnel down — sites unreachable — pfSense -> VPN -> IPsec -> Status
- Snort blocking legitimate traffic — false positive — Services -> Snort -> Suppress
- Tailscale disconnected — remote access lost — tailscale up on affected machine
- OpenCTI not starting — container error — docker logs opencti check dependencies
- Splunk license warning — data limit — Splunk free tier limited to 500MB/day

## Log Retention Policy

| Index | Retention | Reason |
| --- | --- | --- |
| suricata-* | 30 days | High volume, short investigation window |
| snort-* | 30 days | High volume |
| pfsense-* | 30 days | High volume, operational value |
| wazuh-alerts-* | 90 days | Lower volume, longer investigation value |
| wazuh-archives-* | 7 days | Very high volume, raw data |
| pihole-* | 30 days | DNS reference |
| tpot-* | 30 days | Threat intelligence value |

## 25. Planned Improvements

- TerraMaster iSCSI activation — hot storage for Elasticsearch IOPS optimization — In Progress
- Entra ID Connect Sync — hybrid identity with on-prem AD — In Progress
- SANS SIFT full integration — DFIR pipeline with TerraMaster evidence storage — In Progress
- REMnux malware pipeline — automated sample staging from Wazuh and T-Pot — In Progress
- OpenCTI feed integration — T-Pot and VirusTotal IOC automation — In Progress
- Splunk log forwarding — forward from Logstash to Splunk via HEC — In Progress
- OpenCTI to ELK integration — bidirectional enrichment pipeline — Planned
- n8n + Jira ticketing — full SOC incident tracking automation — Planned
- Cisco SPAN port activation — hardware traffic mirroring to Raspberry Pi — Planned
- LACP EtherChannel activation — physical switch aggregation — Planned
- Custom Snort rules — lab-specific detection signatures — Planned
- PCAP long-term archive — Suricata captures to TerraMaster Tier 2 — Planned

## 26. Port Reference

| Port | Service | Protocol | Purpose |
| --- | --- | --- | --- |
| 22 | SSH | TCP | Remote management |
| 53 | DNS / Pi-hole | TCP/UDP | Name resolution |
| 80 | HTTP / Pi-hole GUI | TCP | Web services |
| 443 | HTTPS | TCP | Secure web |
| 500 | IKE | UDP | IPsec key exchange |
| 1514 | Wazuh | TCP | Agent communication |
| 1515 | Wazuh | TCP | Agent enrollment |
| 3001 | Uptime Kuma | HTTP | Service monitoring |
| 3002 | Shuffle SOAR | HTTP | SOAR platform |
| 4500 | IPsec NAT-T | UDP | VPN through NAT |
| 5140 | Logstash / Syslog | UDP/TCP | All firewall log collection |
| 5601 | Kibana | HTTP | Primary SIEM dashboards |
| 5678 | n8n | HTTP | Workflow automation |
| 8000 | Splunk | HTTP | Secondary SIEM |
| 8080 | OpenCTI | HTTP | Threat intelligence platform |
| 8443 | pfSense GUI | HTTPS | Firewall management |

| | | | |
|---|---|---|---|
| 9200 | Elasticsearch | HTTP | Log queries and API |
| 55000 | Wazuh API | HTTP | XDR management |
| 64295 | T-Pot WebUI | HTTPS | Honeypot dashboard |

# 27. Quick Reference Commands

## Docker Management

```
# List all running containers with status

docker ps


# View container logs

docker logs [container_name] --tail 50


# Restart a container

docker restart [container_name]


# Live resource usage per container

docker stats


# Open shell inside a container

docker exec -it [container_name] /bin/bash


# View all container resource usage snapshot

docker stats --no-stream
```

## Elasticsearch

```
# All indices with document counts and sizes
curl -s "http://192.168.1.55:9200/_cat/indices?v"

# Cluster health check
curl -s "http://192.168.1.55:9200/_cluster/health" | jq .

# Most recent Wazuh alert
curl -s "http://192.168.1.55:9200/wazuh-alerts-*/_search\
?size=1&sort=timestamp:desc" | jq \
'.hits.hits[0]._source | {timestamp, rule: .rule.description, agent: .agent.name}'

# Most recent Suricata alert
curl -s "http://192.168.1.55:9200/suricata-*/_search\
?size=1&sort=@timestamp:desc" | jq \
'.hits.hits[0]._source | {timestamp: ."@timestamp", alert: .alert.signature}'

# Delete old index
curl -X DELETE "http://192.168.1.55:9200/pfsense-2026.03.*"

# Index document count by pattern
curl -s "http://192.168.1.55:9200/_cat/indices/suricata-*?h=index,docs.count"
```

## Suricata

```
# View recent alerts only
docker exec suricata tail -20 /var/log/suricata/eve.json \
  | jq 'select(.event_type=="alert")'
```

```
# Update detection rules
docker exec suricata suricata-update

# Verify Suricata process is running
docker exec suricata ps aux | grep suricata

# Check loaded rule count
docker exec suricata suricata --list-runmodes
```

## Wazuh

```
# List all enrolled agents with status
docker exec wazuh-manager_wazuh.manager_1 \
  /var/ossec/bin/agent_control -lc

# Restart Wazuh agent on Windows endpoint
# Run in PowerShell as Administrator
Restart-Service WazuhSvc

# Check Wazuh agent logs on Windows
Get-Content "C:\Program Files (x86)\ossec-agent\ossec.log" -Tail 30

# Test agent connectivity from Windows
Test-NetConnection 192.168.1.55 -Port 1514
```

## Snort

```
# View Snort alerts
# Services -> Snort -> [interface] -> Alerts tab in pfSense GUI
```

# Check suppression list

# Services -> Snort -> [interface] -> Suppress tab

# Force rule update

# Services -> Snort -> Updates -> Update Rules Now

# Verify Snort running status per interface

# Services -> Snort -> Snort Interfaces tab

## Tailscale

# Check current connection status

tailscale status

# View all connected peers

tailscale peers

# Ping a peer by Tailscale hostname

tailscale ping [hostname]

# Re-authenticate or reconnect

tailscale up

# Check subnet routes being advertised

tailscale status --json | jq .Self.AllowedIPs

## Pi-hole

# Check Pi-hole container status

docker logs pihole --tail 20

# Update Pi-hole blocklists

# GUI -> Tools -> Update Gravity

# Check DNS query log

# GUI -> Query Log

# Flush DNS cache

docker exec pihole pihole restartdns

Documentation maintained as a living document — updated with each lab change.

Author: Ahmed Ashraf | github.com/CSCOD3X | May 2026

Active project — continuously updated as new components are implemented and validated.