INSTITUTE FOR ADVANCED COMPUTING
AND
SOFTWARE DEVELOPMENT
AKURDI, PUNE

DOCUMENTATION ON

“Securing Networks with PfSense: A Comprehensive Firewall Implementation ”

PG-DITISS SEPT-2023

SUBMITTED BY

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PROJECT GUIDE

ABSTRACT

This project aims to enhance the security and manageability of a network infrastructure through the implementation of various open-source technologies, namely pfSense, Captive Portal, Squid, SquidGuard, and DHCP service. The primary focus is to create a robust defense mechanism against unauthorized access, malicious activities, and content filtering within the network.The deployment of pfSense, an open-source firewall and router platform, forms the backbone of the security architecture. Through its intuitive interface and extensive feature set, pfSense offers granular control over network traffic, enabling administrators to define and enforce security policies effectively.The integration of Captive Portal functionality further fortifies the network by requiring users to authenticate before accessing the internet. This authentication mechanism enhances accountability and allows for the implementation of user-specific policies, ensuring compliance with organizational security standards.Squid, a caching proxy server, coupled with SquidGuard, a content filtering plugin, provides additional layers of security by inspecting and filtering web traffic based on predefined rulesets. This capability empowers administrators to mitigate threats posed by malicious websites, inappropriate content, and malware, thereby safeguarding the network integrity and protecting end-users from potential risks.Furthermore, the implementation of a DHCP service streamlines network management by automating the assignment of IP addresses and network configuration parameters to connected devices. This ensures seamless connectivity while facilitating efficient resource utilization and minimizing administrative overhead.Overall, this project demonstrates the efficacy of leveraging open-source technologies to establish a secure and well-managed network environment. By incorporating robust security measures and efficient network management practices, organizations can mitigate security risks, enhance productivity, and uphold the integrity of their network infrastructure effectively.

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1. INTRODUCTION

In today's interconnected world, web security is paramount for organizations to safeguard data and prevent cyber attacks. pfSense, an open-source firewall software, offers features like Snort, captive portal, DHCP service, Squid, and SquidGuard to detect and block threats, control user internet access, filter web content, and improve network performance. This project explores pfSense's practical implementation as a cost-effective and robust web traffic security solution, addressing challenges like budget constraints and evolving cyber threats. With Snort for intrusion detection, Captive Portal for authentication, DHCP for network management, and Squid/SquidGuard for content filtering, pfSense enhances defense, visibility, and control over web traffic. By creating a safer web environment, pfSense empowers organizations to protect data, maintain reputation, and ensure business continuity. This report delves into deployment steps, best practices, challenges, and impact on network performance and security posture, providing insights for organizationsseeking to bolster web security with pfSense.

1.1 PROBLEM STATEMENT

Many IT employees , and peoples don't know about which sites are authorized and which are not , some peoples opens harmful sites in companys pc , laptops due to only this reason it is possible the malware were enter into the systems , through download for harmful sites and unauthorised sites , this project will overcome those issues and prevent comapanys sensitive info and data , this is very helpful for companies as well as day to day life users who uses internet ,

This is will detect attack from unauthorised users , or attackers , it will detect it and provide

the attackers ip address and block attacks form that ip address.

ADVANTAGES :

1. Robust firewall protection for network security.
2. SquidGuard powerful content filtering to enforce policies.
3. Real-time intrusion detection and prevention.
4. Bandwidth Management Efficient allocation and prioritization.
5. Captive Portal using user authentication for controlled access.
6. Centralized Management & Simplified administration from one interface.
7. Logging and Reporting using valuable insights into network activity

2. LITERATURE SERVERY

A literature server employing pfSense, SquidGuard, Snort, and Captive Portal ensures robust network security. pfSense acts as a firewall, safeguarding against unauthorized access. SquidGuard enables content filtering, restricting access to inappropriate websites. Snort provides real-time intrusion detection and prevention, enhancing threat detection capabilities. Captive Portal enforces user authentication, allowing controlled access to resources. This setup offers centralized management, streamlined administration, and logging/reporting functionalities for network activity analysis. With customizable configurations and community support, it ensures high availability and reliability, crucial for maintaining a secure literature server environment.

Furthermore, bandwidth management features optimize resource allocation, ensuring smooth server operation even during peak usage. The integration of these tools not only fortifies network defenses but also enhances performance and user accountability. This comprehensive solution aligns with industry best practices, providing a solid foundation for protecting sensitive literary assets and maintaining a secure and efficient literature server infrastructure.

3. SURVEY OF TECHNOLEGY

1. SNORT

Securing web traffic at the WAN interface 192.168.80.128 is crucial for organizations to prevent cyber attacks and protect sensitive data. One way to achieve this is by configuring snort using pfSense, an open-source firewall software. Snort is an intrusion detection system that monitors network traffic for potential security threats and alerts system administrators in real-time. By configuring snort on the WAN interface, organizations can detect and block potential security threats at the network perimeter, enhancing their overall security posture. In this way, pfSense provides a powerful and effective solution for securing web traffic at the WAN interface and protecting organizations against cyber threats.

2. Squid

Squid is designed to improve the speed and efficiency of web browsing by caching frequently accessed web pages and serving them from memory instead of fetching them from the internet every time a user requests them.

3. Squid Guard

Squid-Guard is highly configurable, enabling administrators to define policies based on a wide range of criteria, including website URLs, domains, IP addresses, and keywords.In addition to content filtering, Squid-Guard can also be used to authenticate users and restrict access to certain parts of the internet based on their identity, location, or device. This makes it a powerful tool for protecting the organization's network from external threats and enforcing internal policies**.**

4. REQUIREMENT ANALYSIS

Hardware:

- Machine With Minimum Requirement:
  - Processor: Intel Core i3 or equivalent processor with at least 2 cores
  - Memory: At least 4GB RAM for small to medium-sized organizations, and 8GB or more for larger organizations.
  - Storage: At least 20GB of free disk space on the hard drive or SSD.
  - Network Interface Cards (NICs): At least two NICs, one for the WAN and one for the LAN.
  - Virtualization Platform: VMware vSphere or VMware Workstation, with the appropriate licenses for the number of virtual machines required**.**

Software :

- VM-ware Workstation
- pfSense OS
- Windows OS 10 or Latest
- 7-zip File Extractor

5. METHEDOLOGY

The methodology leveraging pfSense, SquidGuard, Snort, and Captive Portal involves a systematic approach to network security and access control. Initially, pfSense is deployed as the primary firewall solution, establishing perimeter defense and regulating traffic flow. SquidGuard is then integrated to enforce content filtering policies, restricting access to undesirable websites based on predefined rules.Subsequently, Snort is implemented to provide intrusion detection and prevention capabilities, monitoring network traffic for suspicious activity and blocking potential threats in real-time. Captive Portal is employed to enforce user authentication, requiring individuals to authenticate before accessing network resources, thereby ensuring controlled access and accountability.

This methodology emphasizes customization to align security measures with specific organizational requirements and risk profiles. Administrators configure rulesets within each component to address the unique security needs of the environment, such as blocking malicious URLs, detecting unauthorized access attempts, and enforcing user access policies.Continuous monitoring and analysis of network logs and reports generated by these integrated solutions facilitate proactive threat mitigation and performance optimization. Regular updates and community support ensure the ongoing effectiveness and resilience of the security infrastructure, ultimately safeguarding the network against evolving cyber threats while maintaining operational efficiency.

5.1 Proposed Systems

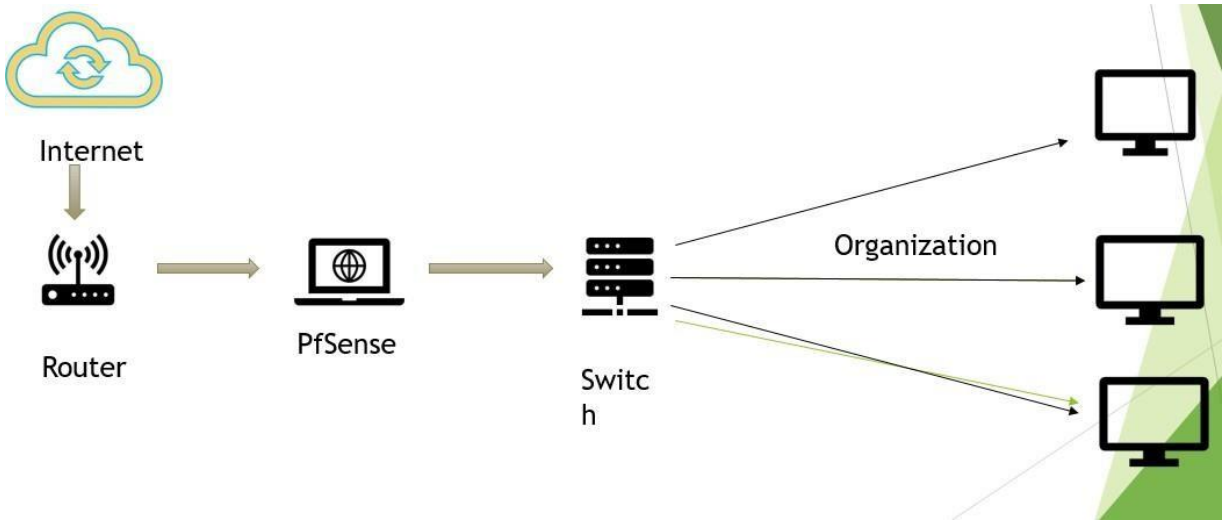
The proposed system integrates pfSense, SquidGuard, Snort, and Captive Portal to establish a robust and comprehensive network security infrastructure. pfSense serves as the core firewall solution, providing perimeter defense and traffic management capabilities. SquidGuard enhances security by implementing content filtering policies, restricting access to inappropriate or harmful websites.

Snort, an intrusion detection and prevention system, monitors network traffic for suspicious activity and blocks potential threats in real-time. Captive Portal ensures controlled access to network resources by enforcing user authentication, thereby enhancing accountability and preventing unauthorized access.

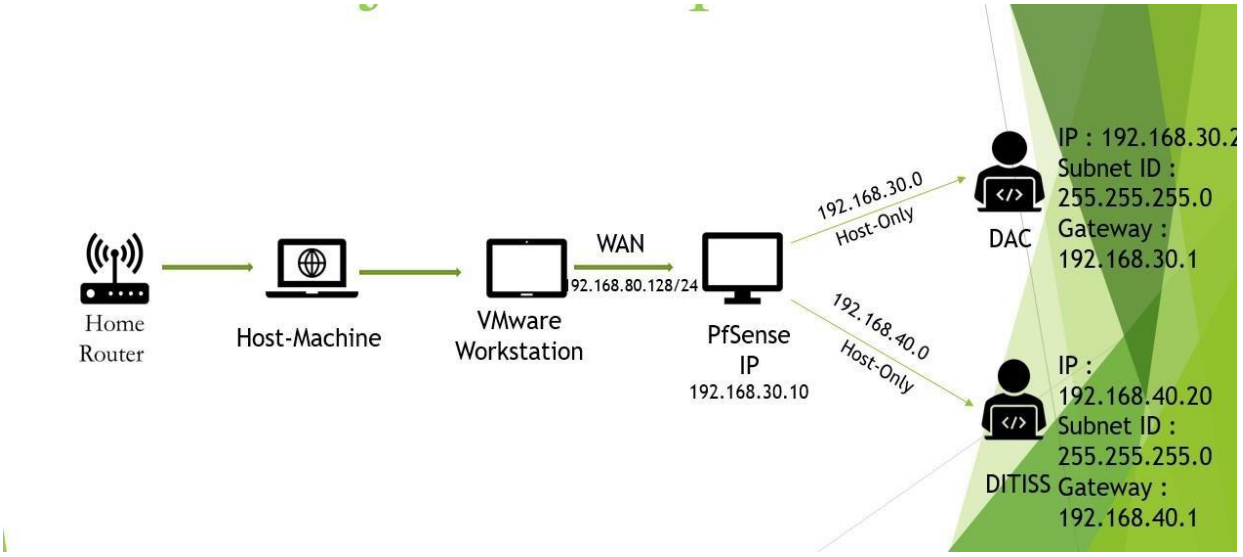
This system offers centralized management and configuration, simplifying administration tasks and providing a unified interface for monitoring and reporting network activities. Customization options allow organizations to tailor security measures to their specific needs, while continuous updates and community support ensure the ongoing effectiveness and adaptability of the security infrastructure. Overall, the proposed system provides comprehensive protection against a wide range of cyber threats while maintaining network performance and integrity.

6. SYSTEM DESIGN

1. BLOCK DIAGRAM



6.1 PROJECT SETUP



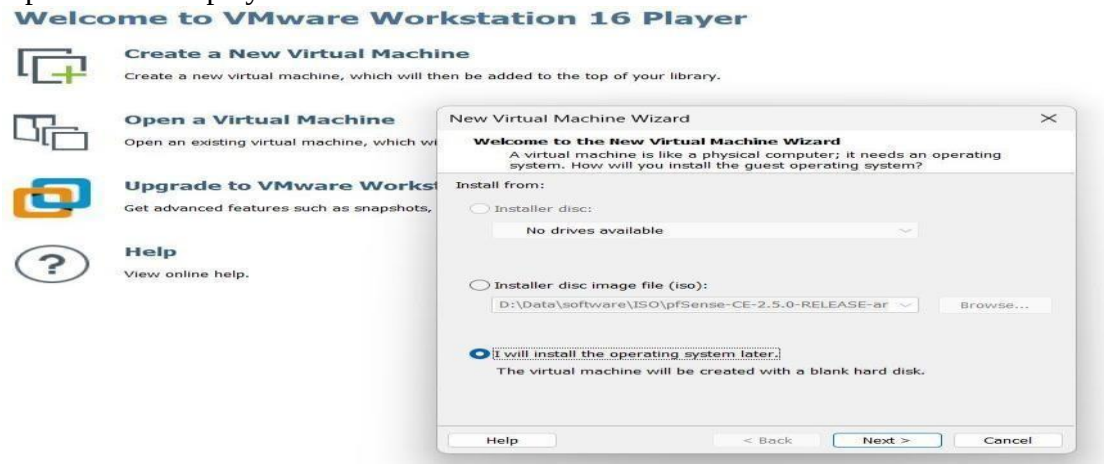
7. IMPLEMENTATION

pfSense Firewall Installation and Configuration

This lab demonstrates installation of pfSense firewall. Installing Squid proxy on it. Then configuring Squidguard on it for URL filtering. Configuring user based access tointernet.

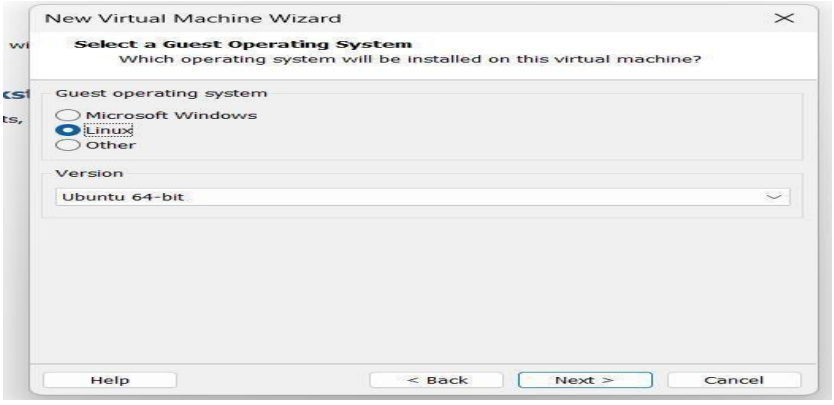
1. **Creating a virtual machine in VMWare player and install pfSense.**

Open VMWare player. Click Create a NEW Virtual Machine.

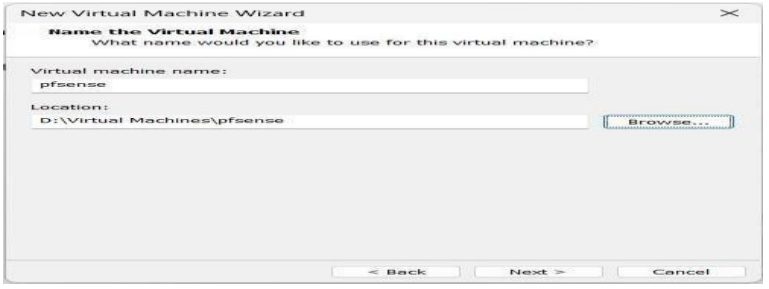


On the window that opens, select I will install the operating system later. Click Next.

On the following window that opens, select **Linux** in the Guest Operating System. Inthe version select **Ubuntu 64 bit**. Click Next.

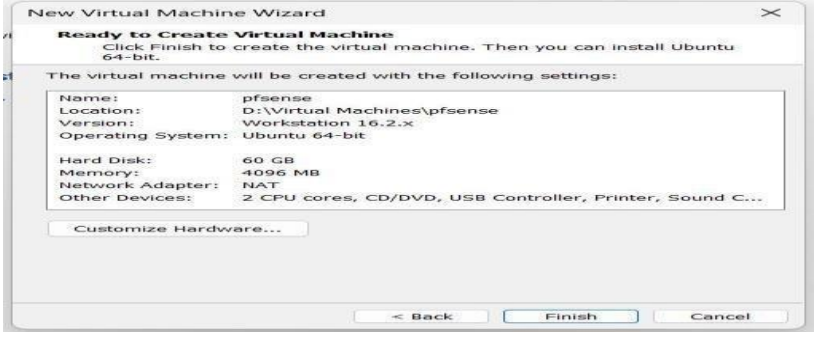


On the next window provide a name for the virtual machine. Also provide a path to store the virtual machine files.

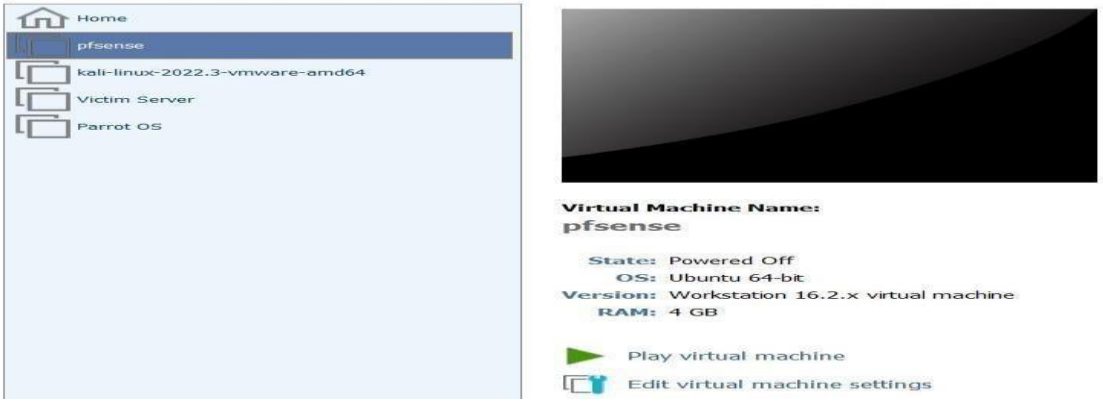

New Virtual Machine Wizard
Name the Virtual Machine
What name would you like to use for this virtual machine?
Virtual machine name:
pfsense
Location:
D:\Virtual Machines\pfsense
Browse...
< Back
Next >
Cancel

Click Next.
On the following window specify the hard disk size as 60 GB. Also click store virtualdisk as a single file. Click Next.

The next window displays the summary page. Check the configuration.



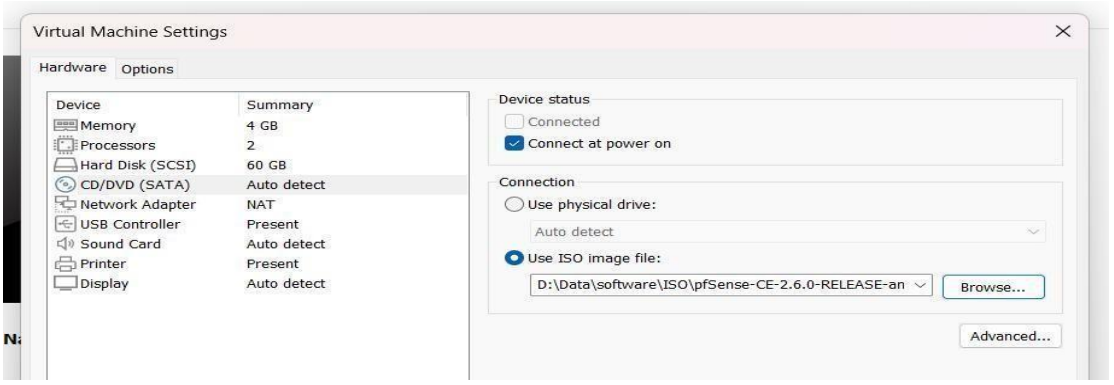
Click Finish to create the virtual machine. The virtual machine is shown as below.



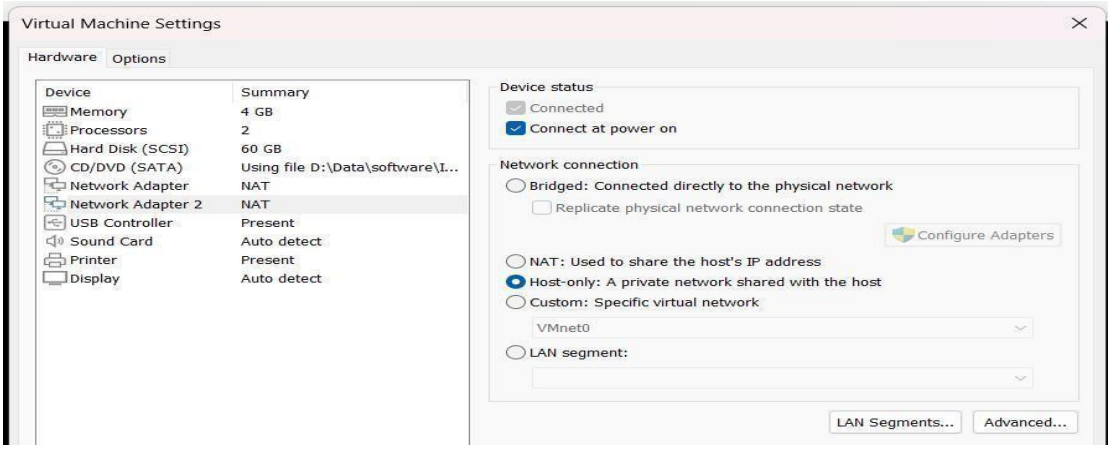
Select the machine and click **Edit virtual machine settings**. The option is displayed onthe right side.

On the settings window that opens, click CD/DVD. Click **use ISO image file** option. Click Browse button and select the pfSense iso image downloaded from the pfSense web site.

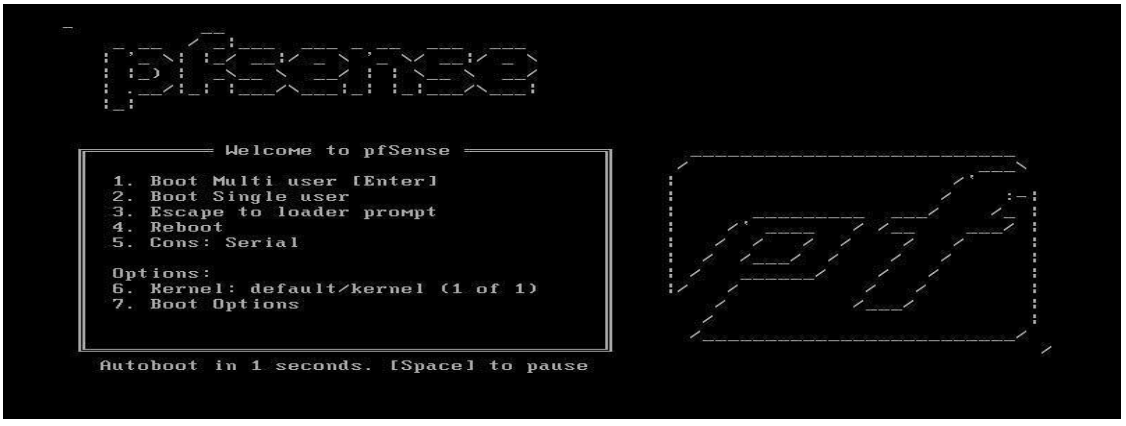
This is shown in the following image.



Then click Add button at the bottom. Select Network Adapter. This will add the second network adapter to the virtual machine.
pfSense requires 2 network cards. One is used as WAN adapter. This adapter is connected to the Internet. Second LAN adapter. It is connected to the internal network switch.
Thus keep the **first** network adapter in **NAT** mode. **Second** network adapter in **Host-only** mode. This is shown below.

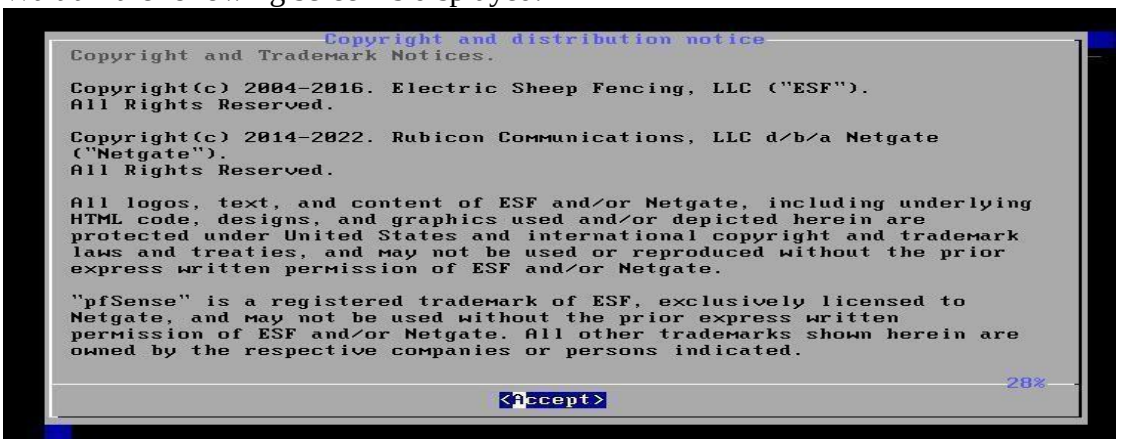


Click OK to close the settings window. Then Click the green arrow in the menu bar orclick Play virtual machine option.



The Virtual machine will start and the pfSense installation begins.

Wait till the following screen is displayed.



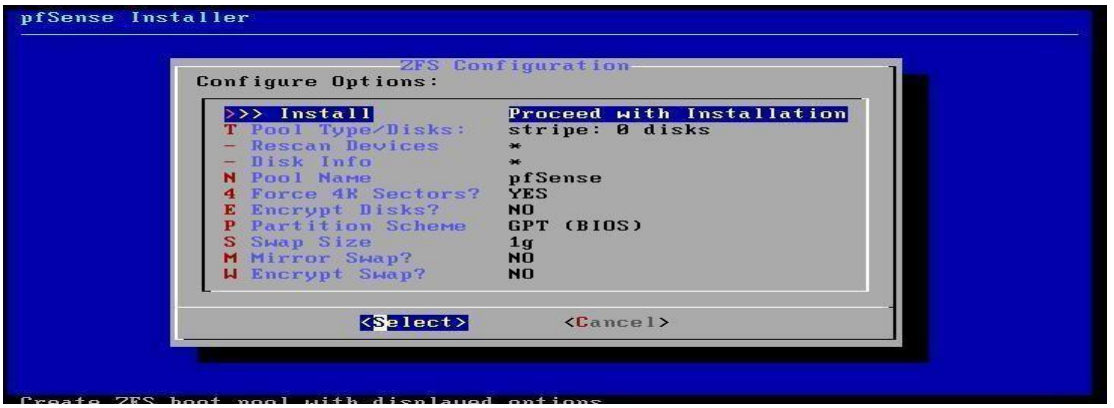
Press Enter to Accept to accept the Copyright and distribution notice.

Press Enter to select OK to install pfSense on the above screen.

When the above screen is displayed, press Enter to select the Default Keymap.

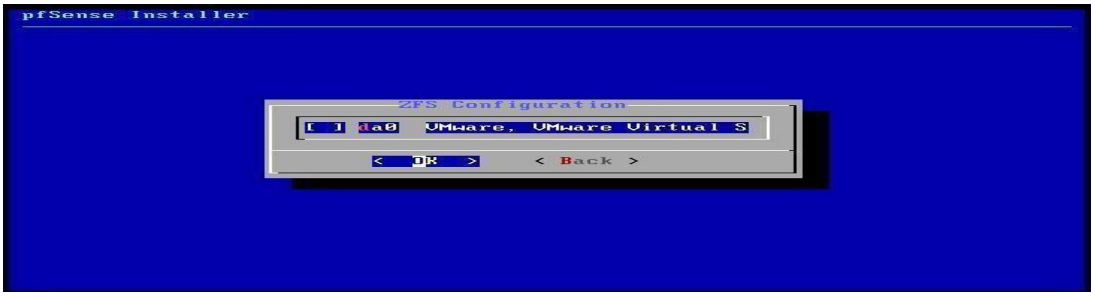
Press Enter to select OK to continue with the default option.

Press Enter on the following screen to proceed with the installation.

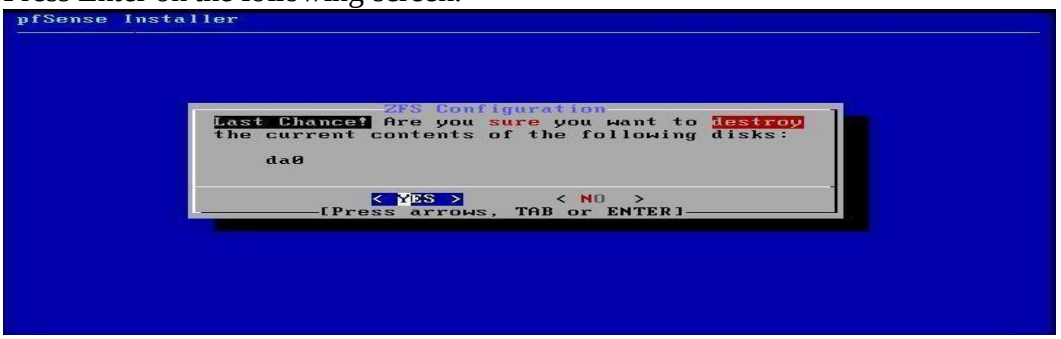


On the next screen again press Enter to continue with the default **stripe** option.

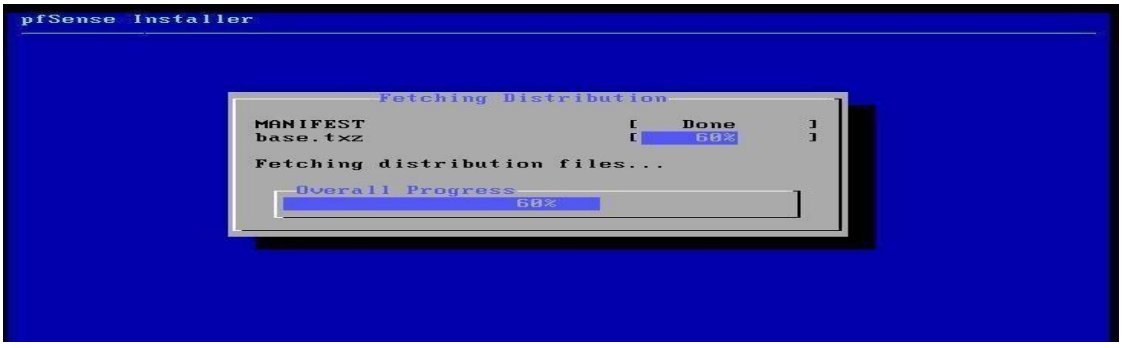
On the next screen displayed, press space bar to select the da0 square box. Then press Enter to continue.



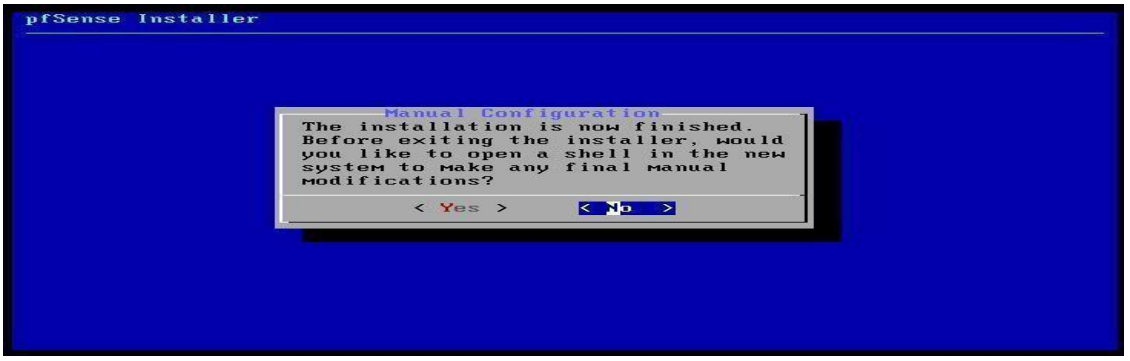
Press Enter on the following screen.



This will start the pfSense installation.



Once Installation is complete, following screen is displayed.



Press Enter to continue with the No option.

Press Enter to reboot the pfSense virtual machine. Once the pfSense starts following screen is displayed.

```
Enter an option: arprequest: cannot find matching address


FreeBSD/amd64 (pfSense.home.arpa) (ttyv0)

VMware Virtual Machine - Netgate Device ID: 609e95ab1164ad01e0fd

*** Welcome to pfSense 2.6.0-RELEASE (amd64) on pfSense ***

 WAN (wan)       -> em0         ->
 LAN (lan)       -> em1         -> v4: 192.168.1.1/24

 0) Logout (SSH only)                    9) pfTop
 1) Assign Interfaces                   10) Filter Logs
 2) Set interface(s) IP address         11) Restart webConfigurator
 3) Reset webConfigurator password      12) PHP shell + pfSense tools
 4) Reset to factory defaults           13) Update from console
 5) Reboot system                       14) Enable Secure Shell (sshd)
 6) Halt system                         15) Restore recent configuration
 7) Ping host                           16) Restart PHP-FPM
 8) Shell

Enter an option:
```

After installation pfSense by default assigns 192.168.1.1/24 IP address to the LAN interface. However we need to change it to match the vmnet1 adapter in our Windows.
First go to the main Windows. Open command prompt. Use ipconfig command and find out the IP address assigned to the VMnet1 adapter. This is as shown below.

```
Command Prompt

Ethernet adapter VMware Network Adapter VMnet1:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::5cef:595e:ffc4:c353%2
   IPv4 Address. . . . . . . . . . . : 192.168.148.1
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . :

Ethernet adapter VMware Network Adapter VMnet8:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::be77:8cee:4286:145f%18
   IPv4 Address. . . . . . . . . . . : 192.168.65.1
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . :
```

We will assign a new IP address to the pfSense LAN adapter which is in the range ofvMnet1 adapter.

```
 4) Reset to factory defaults          13) Update from console
 5) Reboot system                      14) Enable Secure Shell (sshd)
 6) Halt system                        15) Restore recent configuration
 7) Ping host                          16) Restart PHP-FPM
 8) Shell

Enter an option: 2

Available interfaces:

1 - WAN (em0 - dhcp, dhcp6)
2 - LAN (em1 - static)

Enter the number of the interface you wish to configure: 2

Enter the new LAN IPv4 address.  Press <ENTER> for none:
> 192.168.148.10

Subnet masks are entered as bit counts (as in CIDR notation) in pfSense.
e.g. 255.255.255.0 = 24
     255.255.0.0   = 16
     255.0.0.0     = 8

Enter the new LAN IPv4 subnet bit count (1 to 32):
> 24
```

On the pfSense console press 2 Set Interface(s) IP Address. As shown in the above image.
Select 2 again to change the LAN interface IP address.
Next Enter the IP address to be assigned to the LAN adapter. Make sure it is in the range of VMnet1 adapter. Here the IP address assigned is 192.168.148.10. But in your case the IP address may be different. Press Enter.

Next enter subnet mask as 24 and press enter.

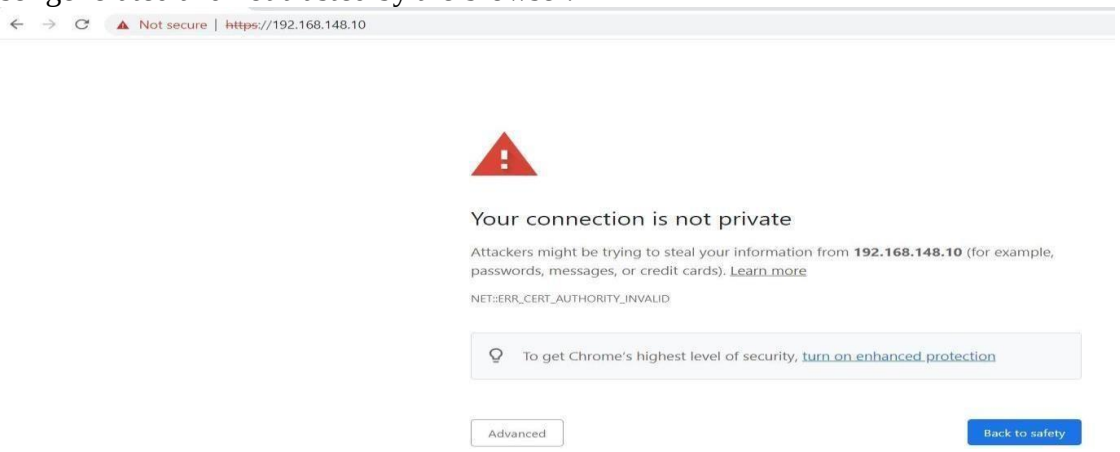
```
For a WAN, enter the new LAN IPv4 upstream gateway address.
For a LAN, press <ENTER> for none:
>

Enter the new LAN IPv6 address.  Press <ENTER> for none:
>

Do you want to enable the DHCP server on LAN? (y/n) n
Disabling IPv4 DHCPD...
Disabling IPv6 DHCPD...

Do you want to revert to HTTP as the webConfigurator protocol? (y/n) n
```

Then press Enter. Next type n as we do not want to start DHCP server on LAN network. However in production environment you may want to enable DHCP server.

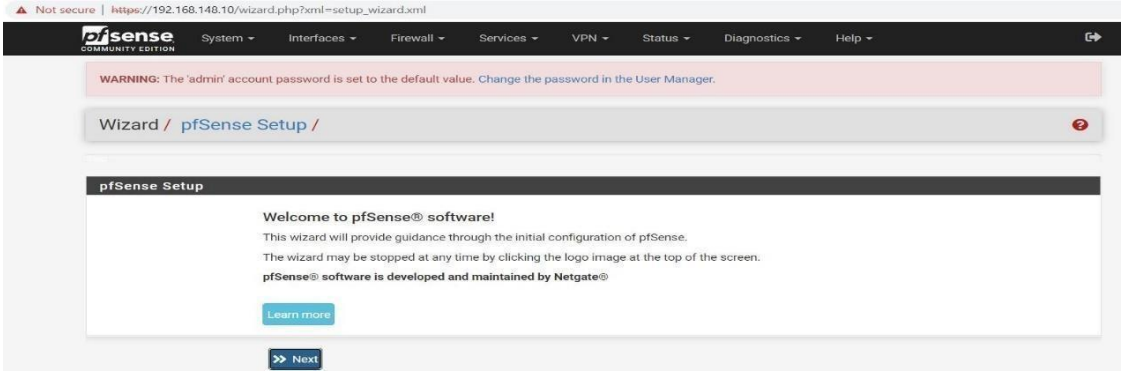
Type n on the next prompt. This will not revert the webConfigurator to HTTP.
Thuswe can access the pfSense web console using HTTPS.
Thus the LAN IP address is configured.

Now go to your second Virtual Machine (Either Windows or Linux) . Make sure thenetwork adapter of this VM is in **host-only** mode.

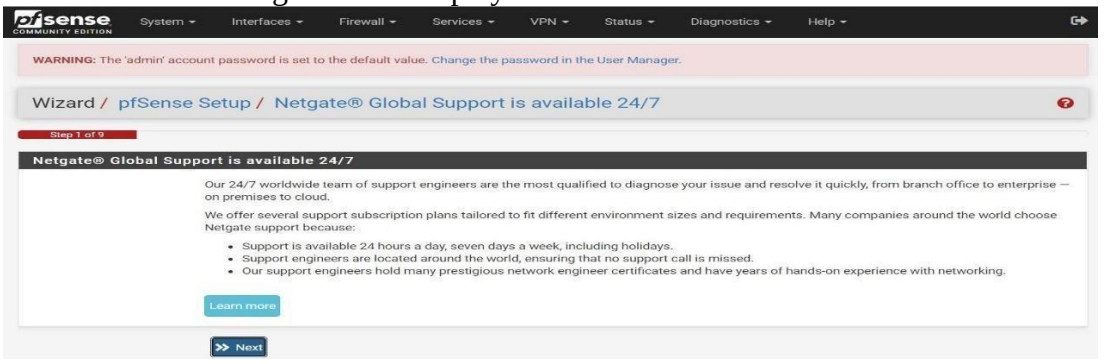
On this VM open the browser and type https://IP-of-pfSense-LAN . Following warning will be displayed. This is because the certificate issued by pfSense is selfgenerated and not trusted by the browser.



Click Advanced and proceed to the website. On the Login page login with username as **admin** and password as **pfsense**.
The pfSense initial setup will start as shown below.

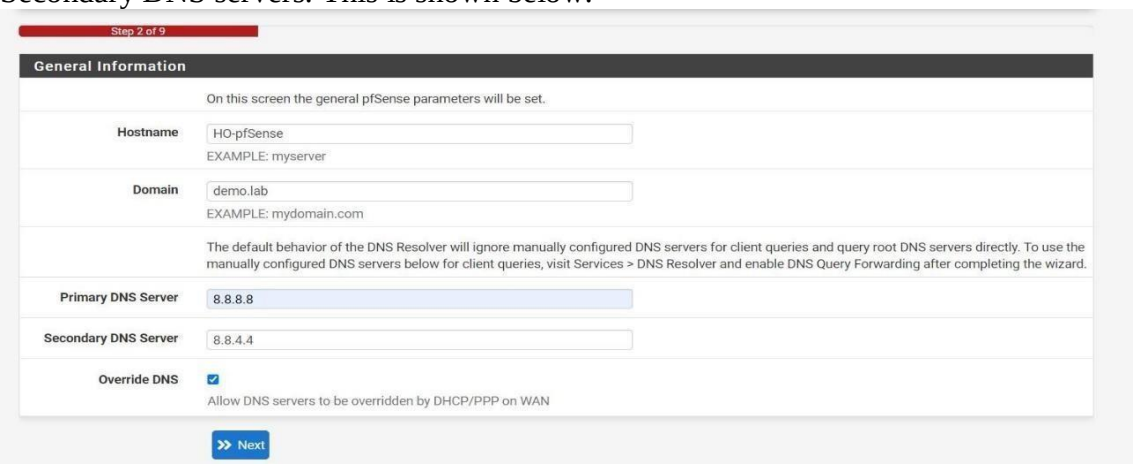


Click Next. Following screen is displayed.

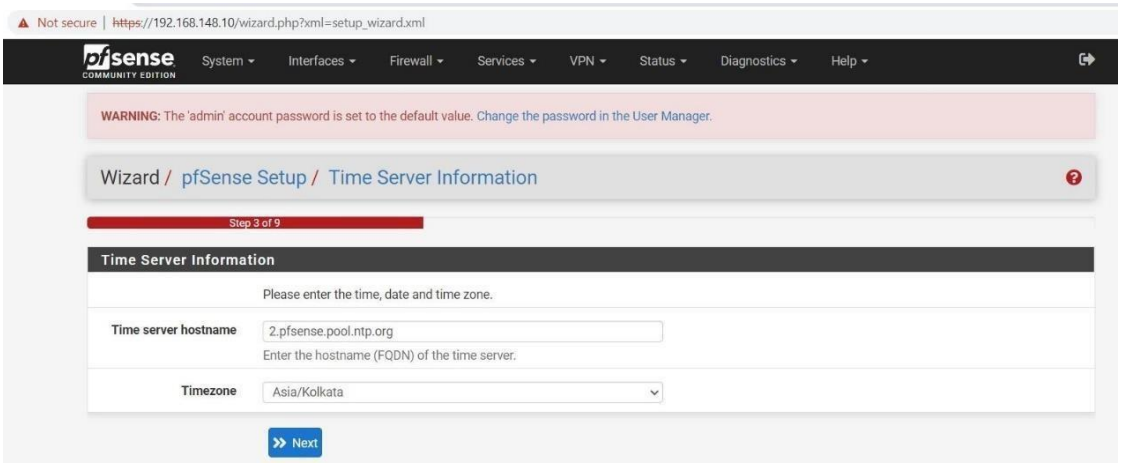


Click Next.

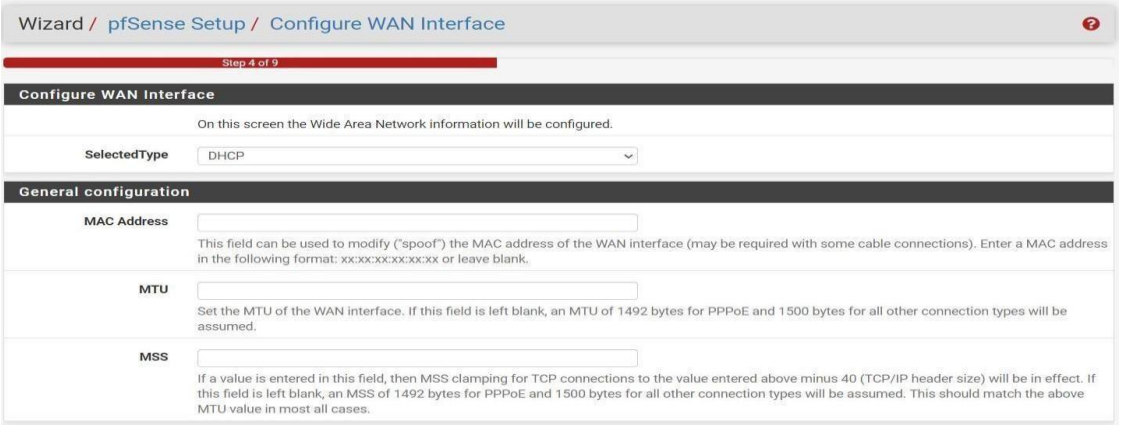
On the next screen enter a Hostname . Enter some domain name. Enter primary and Secondary DNS servers. This is shown below.



Click Next. The next Screen requires time server information. Keep it default.

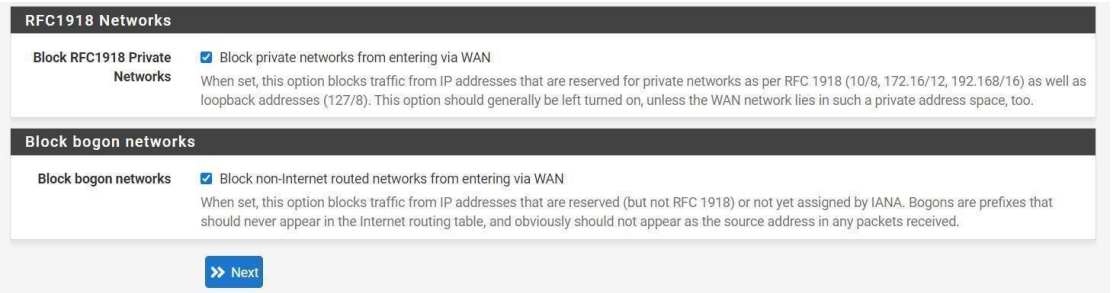


Click Next. The following screen requires setup for WAN interface. In production environment you may have to select PPPoE option as you may need to enter username and password provided by ISP to connect to Internet.
However for this LAB, we will keep the default option to DHCP.

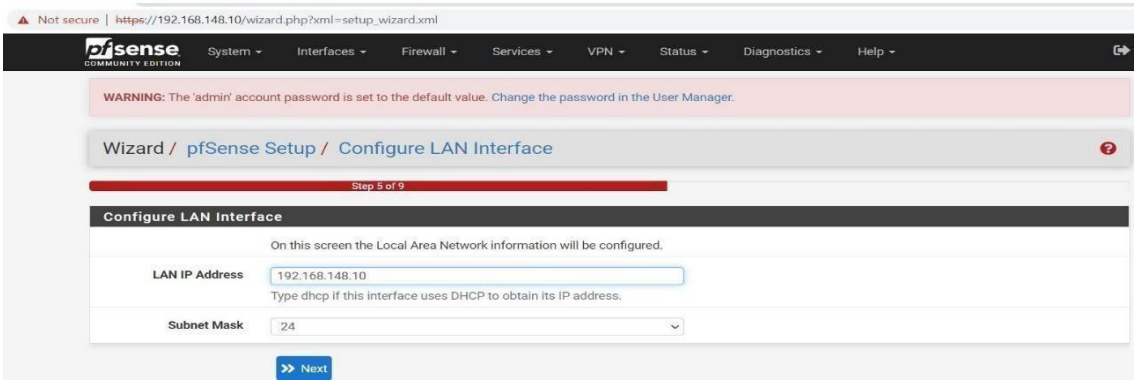


At the bottom of the page following 2 rules are present.

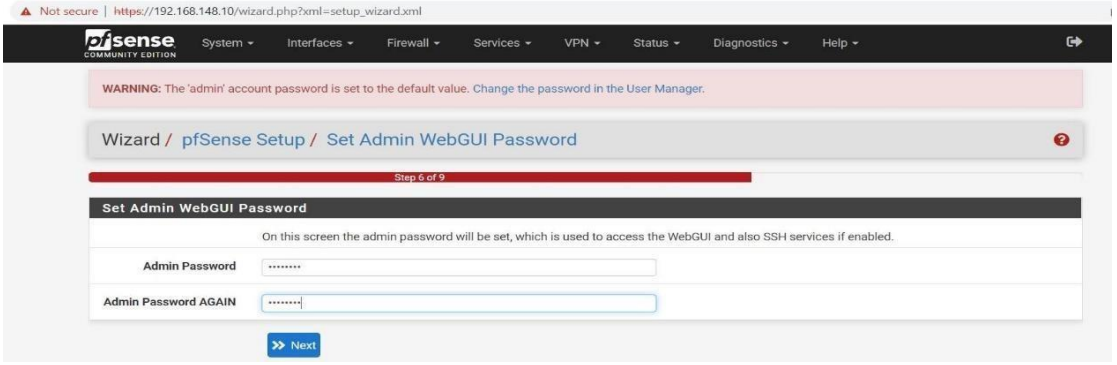
The first rule blocks any packet on WAN interface with the source IP from any IPv4private address range.
The second rule blocks the reserved IP range or addresses not assigned by IANA on the WAN interface.



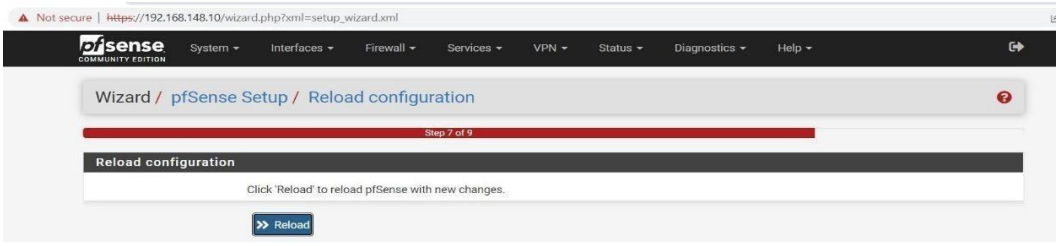
The rules are selected by default. Click Next. The next screen allows you to define the LAN IP address. However we have set the LAN IP already from the pfSense console.



Keep settings as it is. Click Next. The next screen will ask you to enter a newpassword for the Admin user.

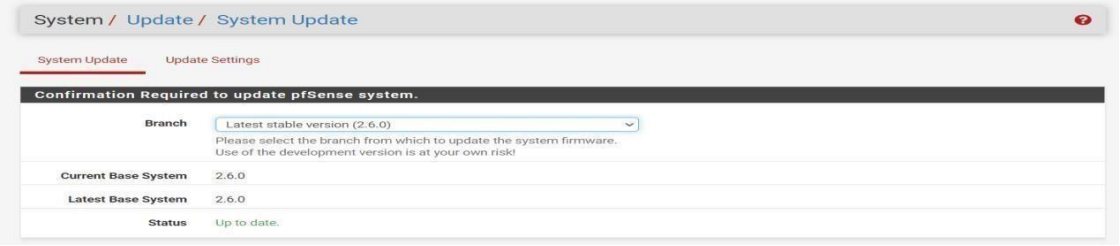


Enter a new password in both the fields and click Next. Click Reload on the nextscreen.



On the next screen click check for updates.

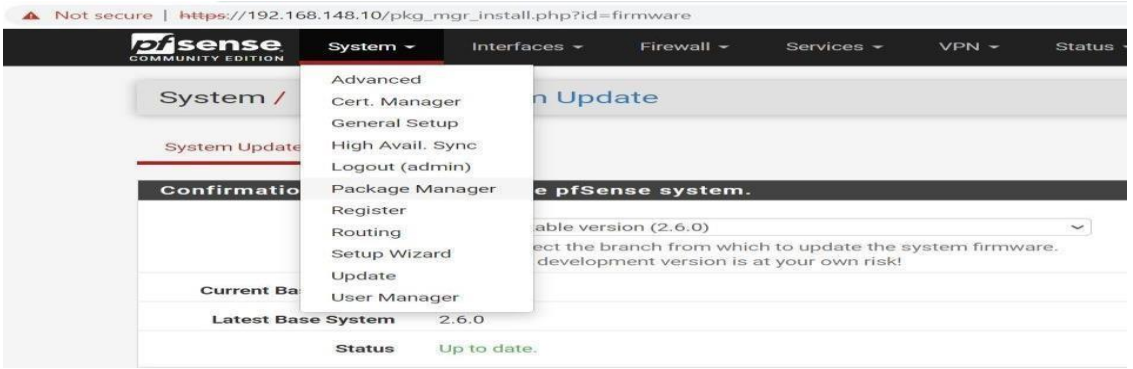
If any updates are present, then it will download the updates. It may take time based on update size and the internet speed.



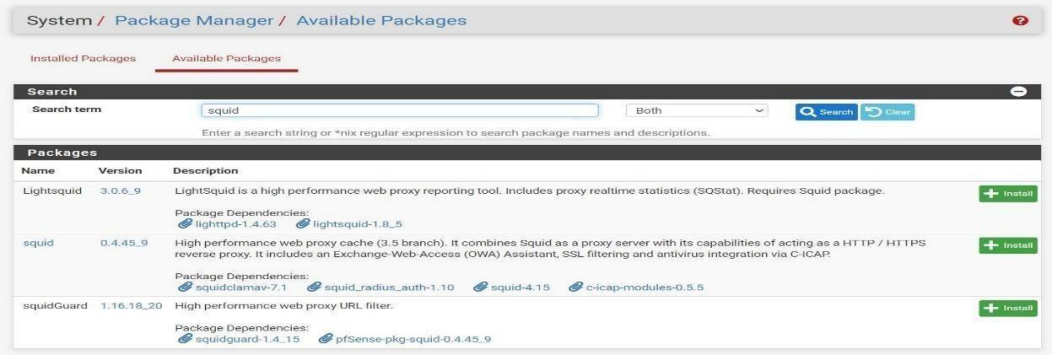
Finally once the update is over, above screen is displayed.

2. Install Squid on pfSense.

After initial setup, now we will install the Squid proxy on the pfSense. For this Clickthe **System** tab. In the list displayed click **Package Manager**.



In the screen that is displayed, click available packages. In the search box type squid and press enter. This will display 3 packages. Click Install button in front of Squid package.


System / Package Manager / Available Packages
Installed Packages
Available Packages
Search
Search term
squid
Both
Search
Clear
Enter a search string or *nix regular expression to search package names and descriptions.
Packages
Name
Version
Description
Lightsquid
3.0.6_9
LightSquid is a high performance web proxy reporting tool. Includes proxy realtime statistics (SQStat). Requires Squid package.
Package Dependencies:
lighttpd-1.4.63
lightsquid-1.8_5
Install
squid
0.4.45_9
High performance web proxy cache (3.5 branch). It combines Squid as a proxy server with its capabilities of acting as a HTTP / HTTPS reverse proxy. It includes an Exchange-Web-Access (OWA) Assistant, SSL filtering and antivirus integration via C-ICAP.
Package Dependencies:
squidclamav-7.1
squid_radius_auth-1.10
squid-4.15
c-icap-modules-0.5.5
Install
squidGuard
1.16.18_20
High performance web proxy URL filter.
Package Dependencies:
squidguard-1.4_15
pfSense-pkg-squid-0.4.45_9
Install

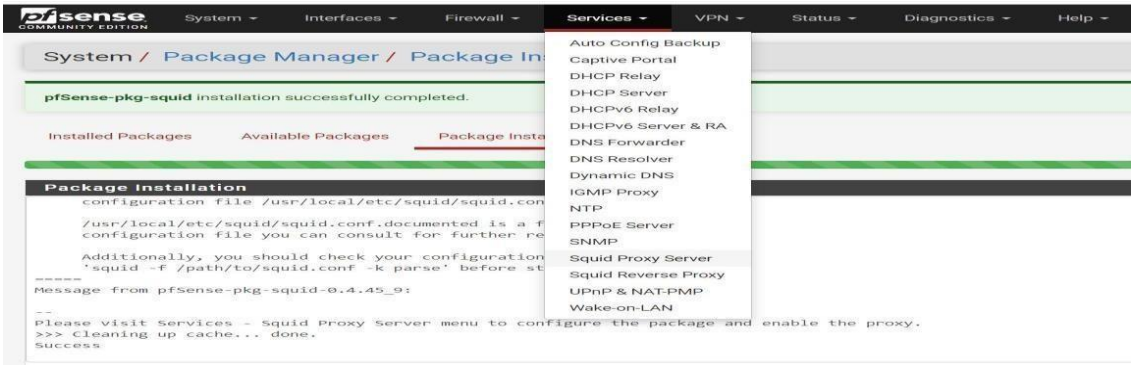
The following screen will appear asking confirmation to install the Squid package.

Click Confirm. The following screen will appear. It shows the Squid installationprogress.

The installation may take time depending on the Internet speed.

3. Configure Squid.

Now to configure squid proxy, Click Services tab. In the list displayed click SquidProxy Server.

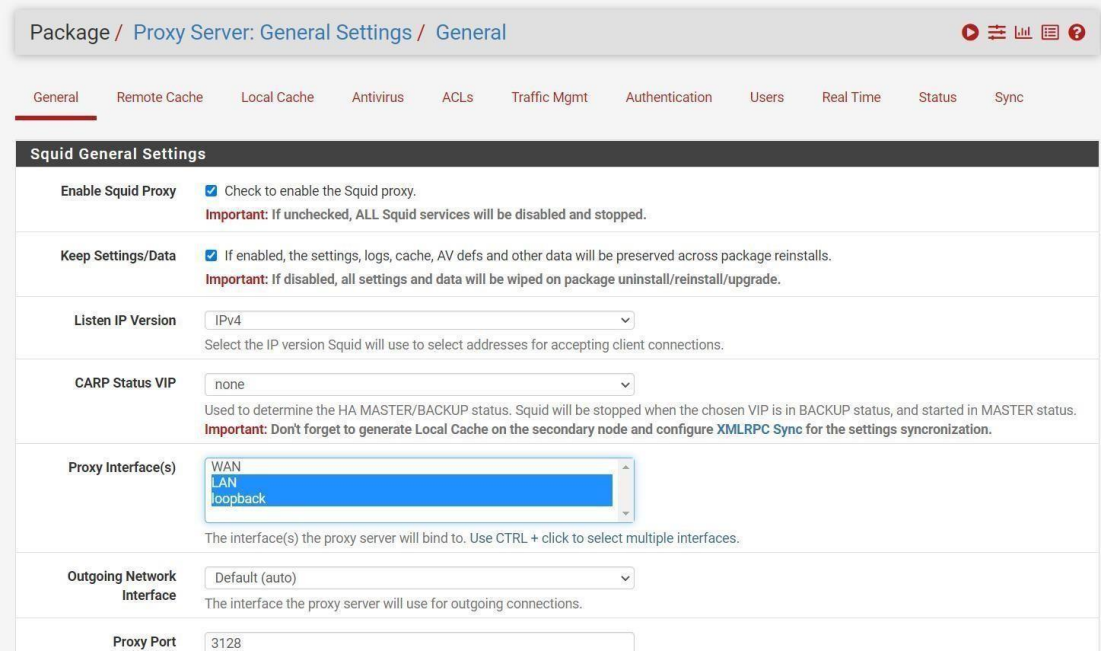


On the Squid proxy configuration page, first go to Local Cache tab as shown below.

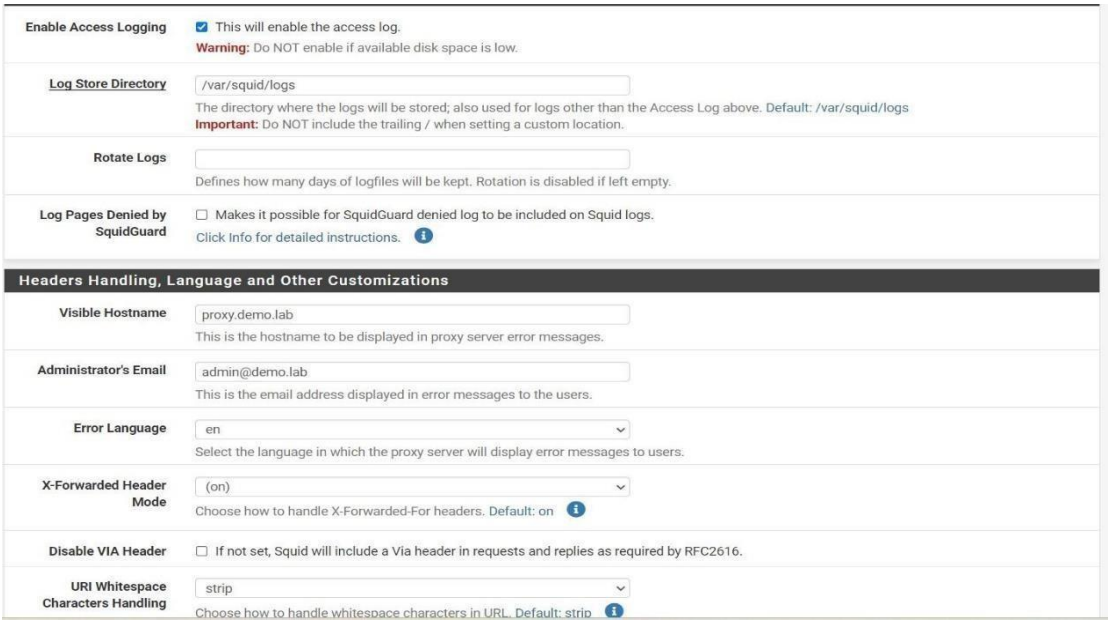

Package / Proxy Server: Cache Management / Local Cache
General
Remote Cache
Local Cache
Antivirus
ACLs
Traffic Mgmt
Authentication
Users
Real Time
Squid Cache General Settings
Disable Caching
Disable caching completely.
This may be required if Squid is only used as a proxy to audit website access.
Cache Replacement Policy
Heap LFUDA
The cache replacement policy decides which objects will remain in cache and which objects are replaced to create space
heap LFUDA
Low-Water Mark in %
90
The low-water mark for AUFS/UFS/diskd cache object eviction by the cache_replacement_policy algorithm.
High-Water Mark in %
95
The high-water mark for AUFS/UFS/diskd cache object eviction by the cache_replacement_policy algorithm.

On this page you can configure Hard Disk Cache size, Hard Disk Cache Location,Memory Cache size etc.
However for this lab purpose we keep all values to their default. **Click Save**.

Then go to the General tab as shown below.
On this page select the check box to Enable Squid Proxy. In the Proxy Interfaces Select LAN and Loopback both. The default port used by Squid is 3128.

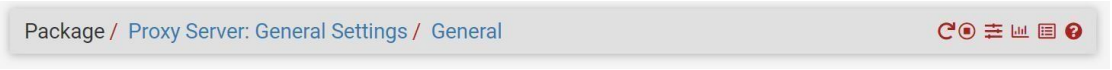


Scroll down. Click check box to Enable Access Logging. Set Visible Hostname. Set Administrator's Email.



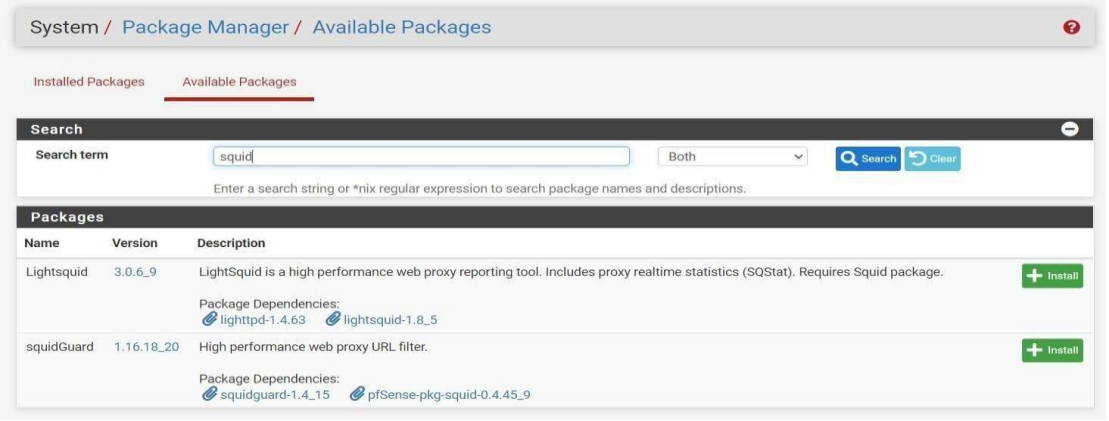
Scroll to the end. Click Save. This will start the squid proxy service.

At the top of Squid proxy server page buttons to restart, stop squid service will appear as shown below.

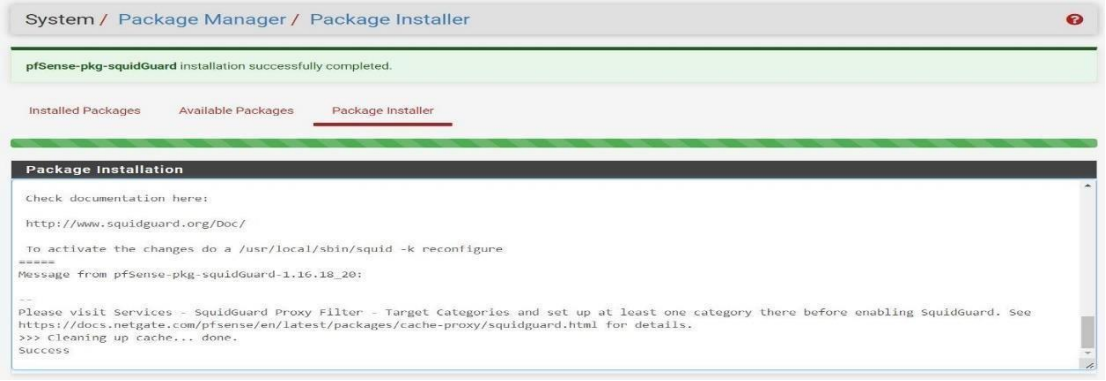


4. Install Squidguard

Again go to the Systems tab. Click Package Manager. Click Available Packages. In the search field type squid. Now 2 squid packages will be displayed.
Click Install button in front of Squidguard to install it.

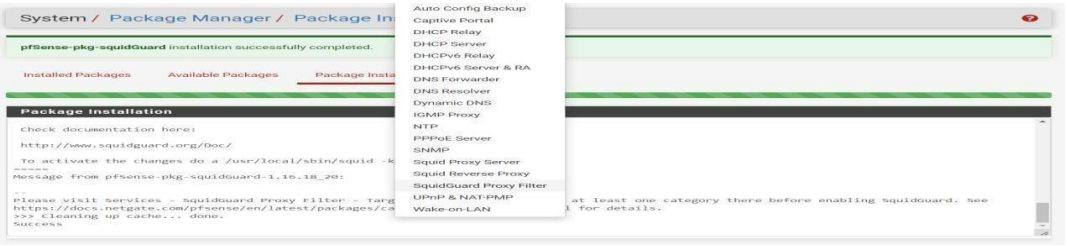


Click Confirm on the next screen . This will start Squidguard installation. Once theinstallation is complete following screen is displayed.

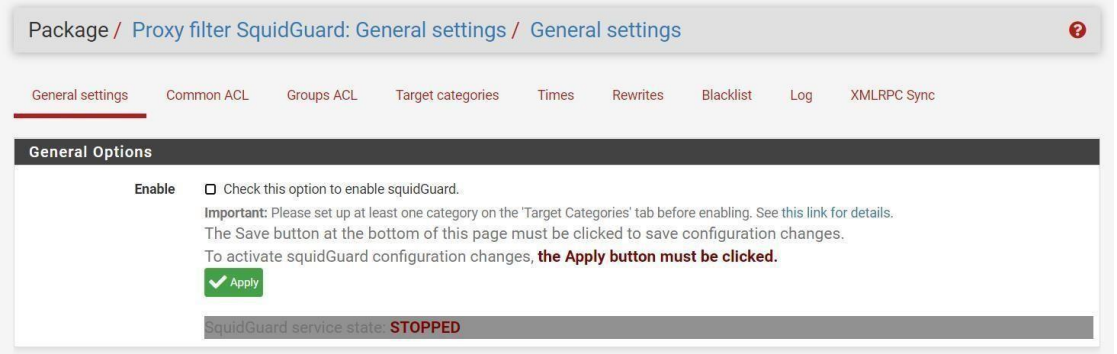


5. Configure Squidguard

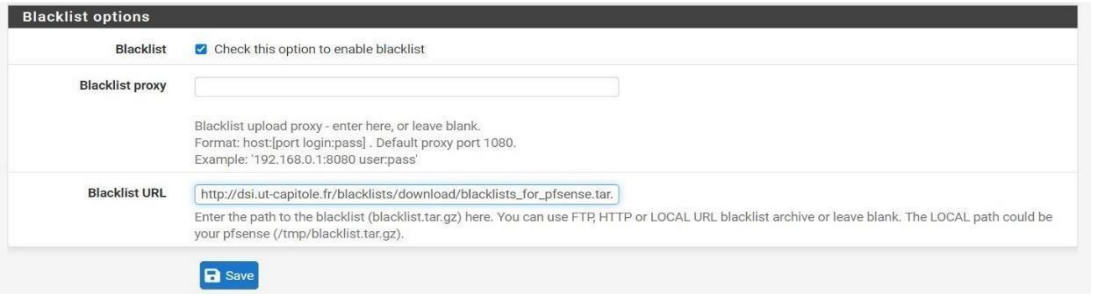
Go to Services tab. In the list displayed click Squidguard Proxy Filter option as shownbelow.


System / Package Manager / Package In
pfSense-pkg-squidGuard installation successfully completed.
Installed Packages
Available Packages
Package Insta
Package Installation
Check documentation here:
http://www.squidguard.org/Doc/
To activate the changes do a /usr/local/sbin/squid -k
Message from pfsense-pkg-squidguard-1.16.18_20:
Please visit Services - SquidGuard Proxy Filter - Targ
at least one category there before enabling SquidGuard. See
https://docs.netgate.com/pfsense/en/latest/packages/ca
for details.
>>> Cleaning up cache... done.
Success
Auto Config Backup
Captive Portal
DHCP Relay
DHCP Server
DHCPv6 Relay
DHCPv6 Server & RA
DNS Forwarder
DNS Resolver
Dynamic DNS
IGMP Proxy
NTP
PPPoE Server
SNMP
Squid Proxy Server
Squid Reverse Proxy
SquidGuard Proxy Filter
UPnP & NAT-PMP
Wake-on-LAN

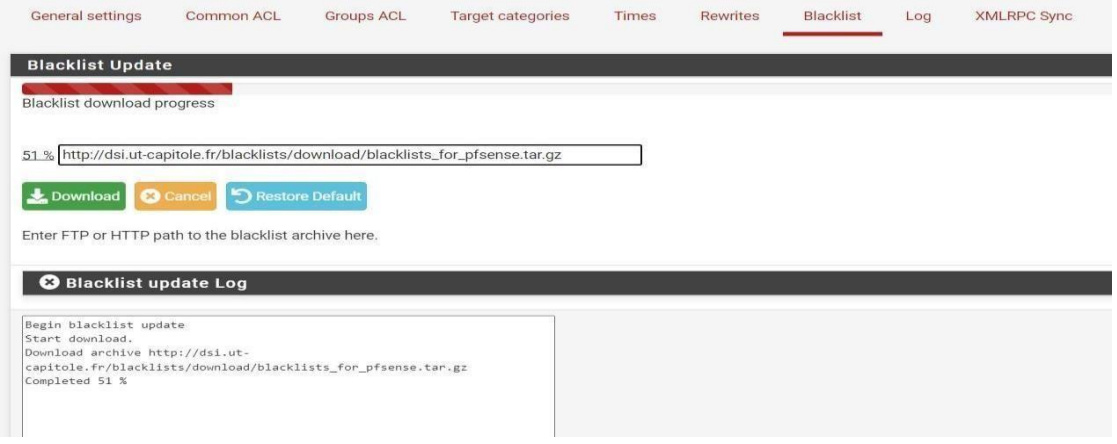
Click General Settings . Do not click the Check box to Enable Squidguard.



Scroll down to the Blacklist option. Click Blacklist checkbox. In the Blacklist URL typefollowing URL.
https://dsi.ut-capitole.fr/blacklists/download/blacklists_for_pfsense.tar.gz

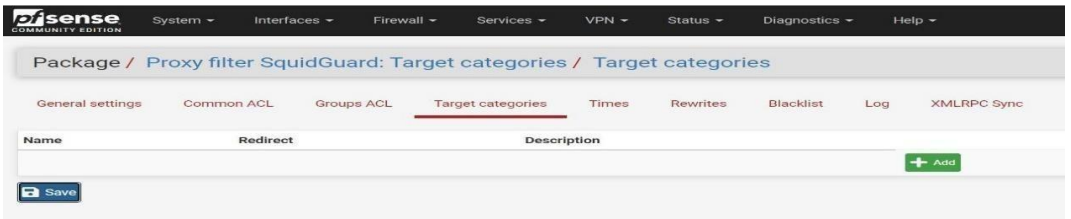


Click Save.
Then go to the Blacklist tab as shown below.

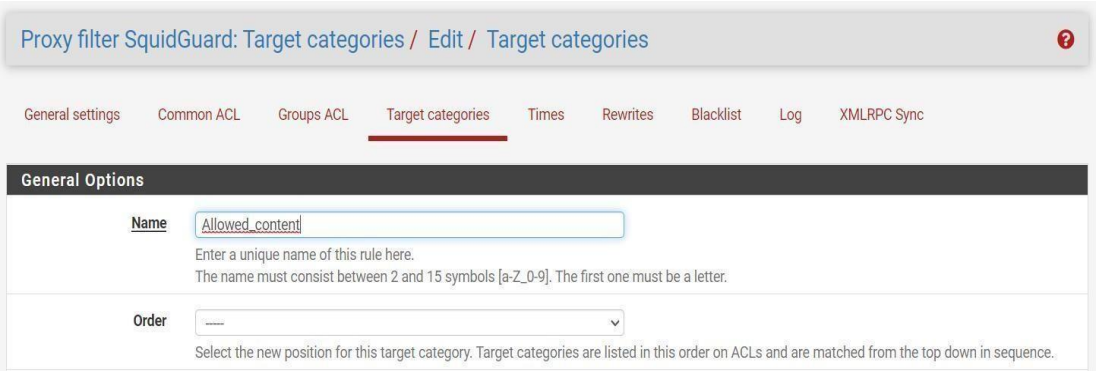


Make sure the URL is displayed. Click Download.This will download the blacklist for URL filter.

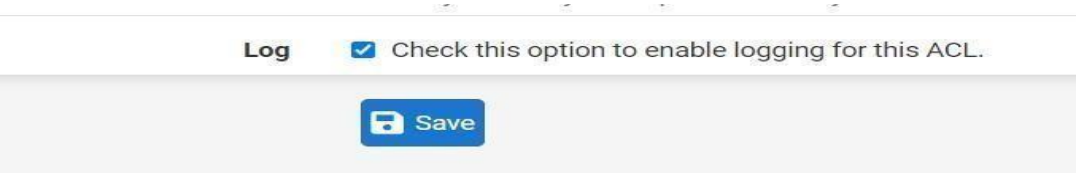
Next go to Target categories.


pfsense COMMUNITY EDITION
System
Interfaces
Firewall
Services
VPN
Status
Diagnostics
Help
Package / Proxy filter SquidGuard: Target categories / Target categories
General settings
Common ACL
Groups ACL
Target categories
Times
Rewrites
Blacklist
Log
XMLRPC Sync
Name
Redirect
Description
Add
Save

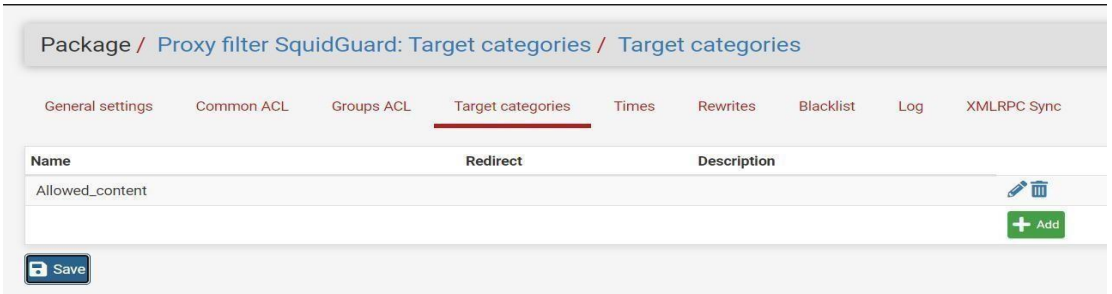
Click Add.
On the screen that is displayed, first provide a Name to the target category.



Click check box in front of Log.

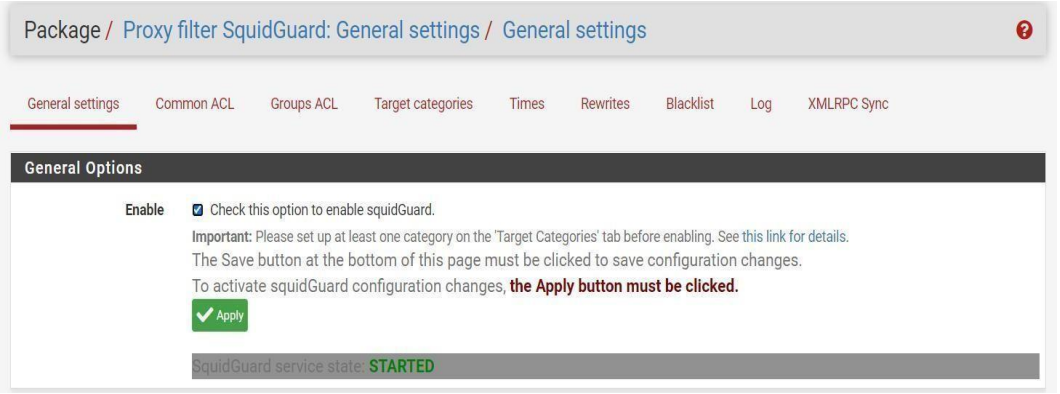


Click Save.
This will create the target category as shown below.



Click Save.

Then go to the General Settings. Click the check box to Enable Squidguard. ClickApply. Then the Squidguard service will start as shown below.

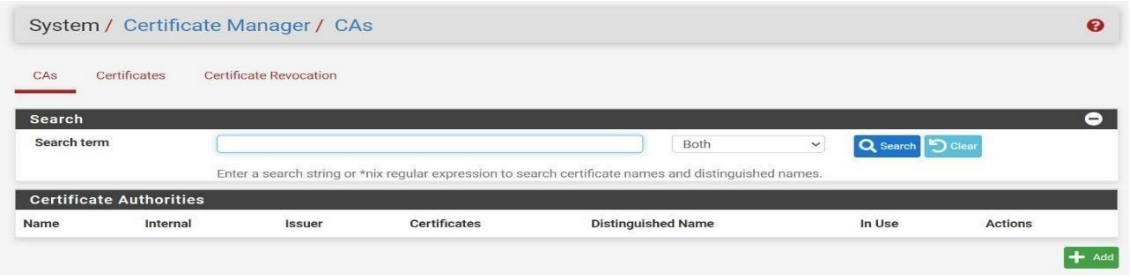

Package / Proxy filter SquidGuard: General settings / General settings
General settings
Common ACL
Groups ACL
Target categories
Times
Rewrites
Blacklist
Log
XMLRPC Sync
General Options
Enable
Check this option to enable squidGuard.
Important: Please set up at least one category on the 'Target Categories' tab before enabling. See this link for details.
The Save button at the bottom of this page must be clicked to save configuration changes.
To activate squidGuard configuration changes, the Apply button must be clicked.
Apply
SquidGuard service state: STARTED

6. Configure SSL Man in the Middle.

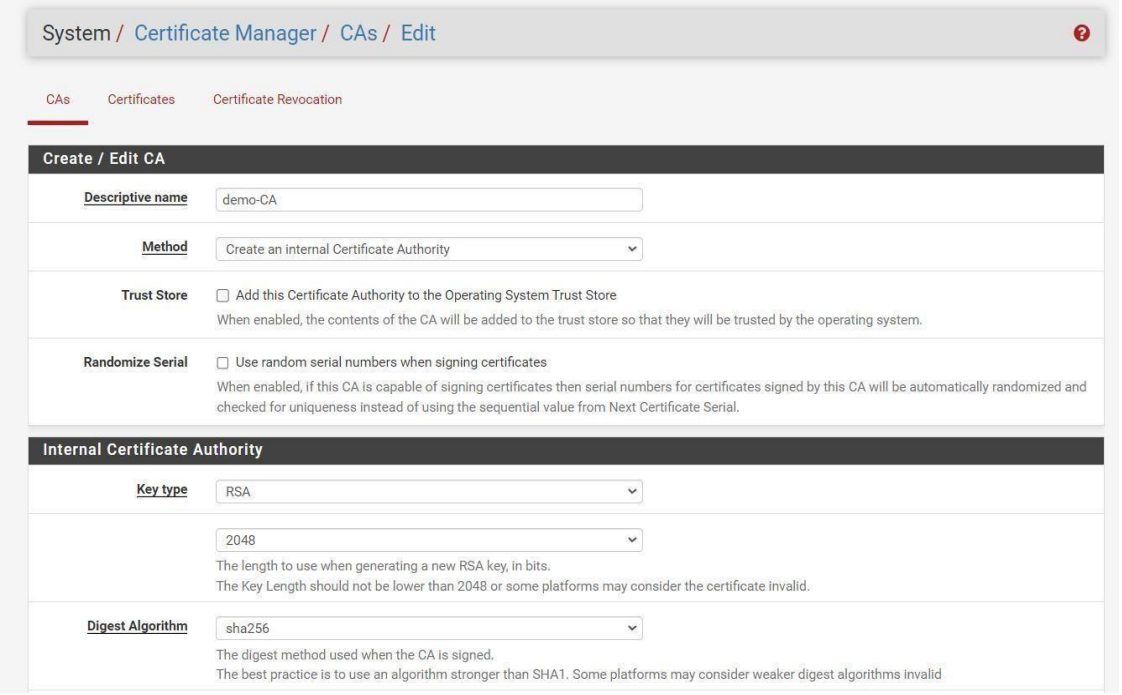
Now we will configure the SSL Man in the Middle for Squid proxy server. This willhelp Squid to perform more accurate filtering based on URL contents.

Click the System tab. In the list displayed click Cert. Manager.

Go to the CAs tab. By default there is no Certification Authority created.

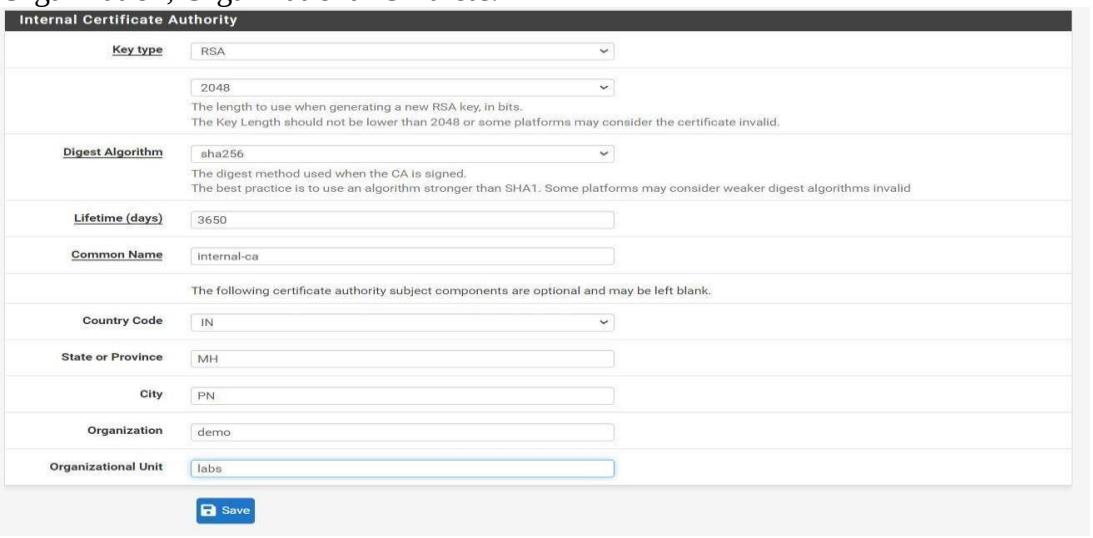


Click Add button. Following page will be displayed. This will create a new certificationauthority.
Provide a distinguished name. In method select Create an Internal Certificate Authority. Keep all other options to their default value.

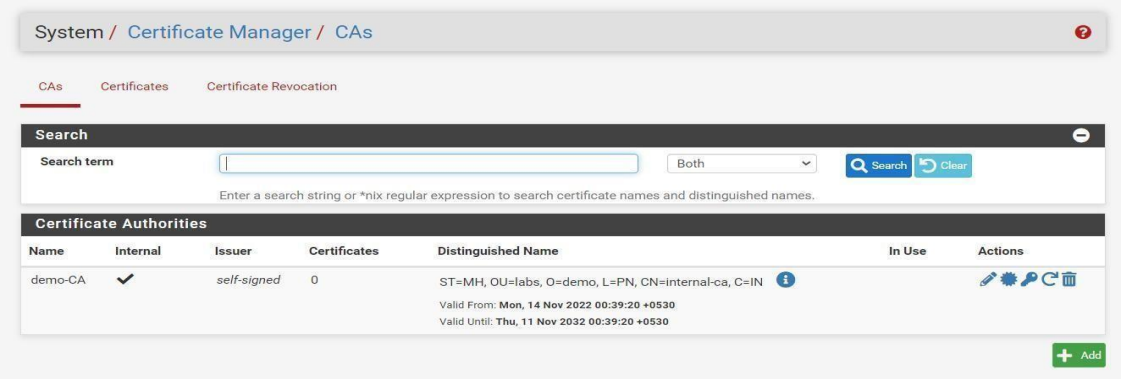


Scroll Down.

Provide a Common name. Enter details like Country Code, State or Province, City, Organization, Organizational Unit etc.



Click Save.



The above screen displays the new CA created.

Now configure the Squid proxy server to perform the SSL Man in the Middle. Click the Services tab. Select Squid Proxy Server. Click the general tab . Scroll down to the following section.

Click the check box in front of HTTPS/SSL

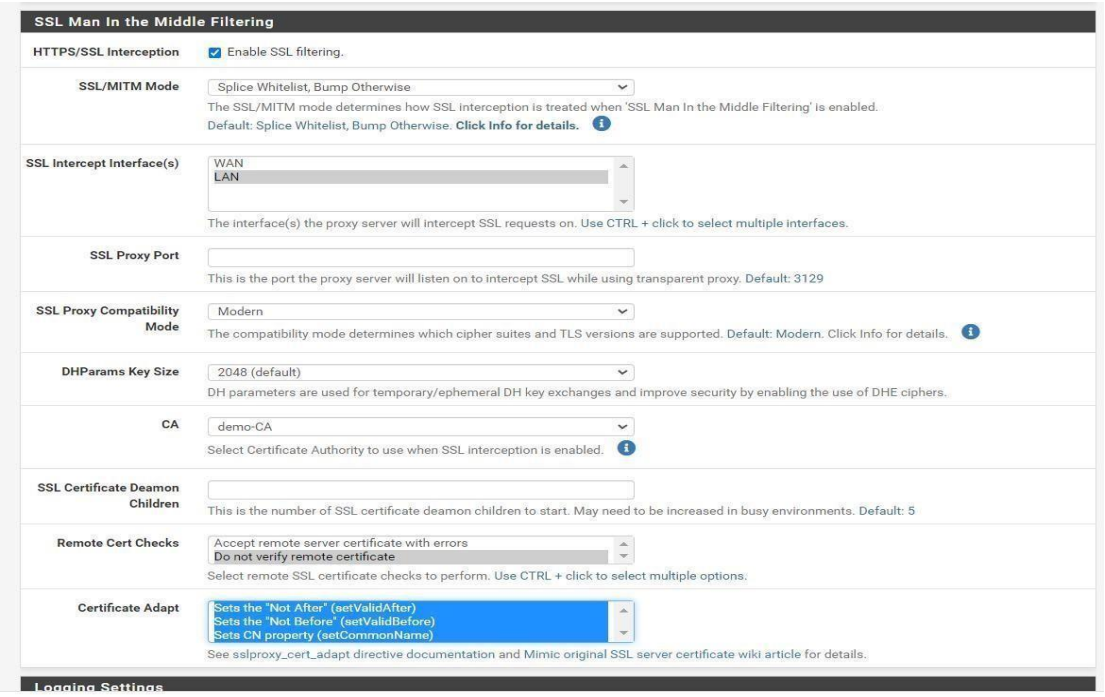
Interception.Select LAN in the SSL Intercept

Interface.

In the CA field click the drop down list to select the CA that we created above.

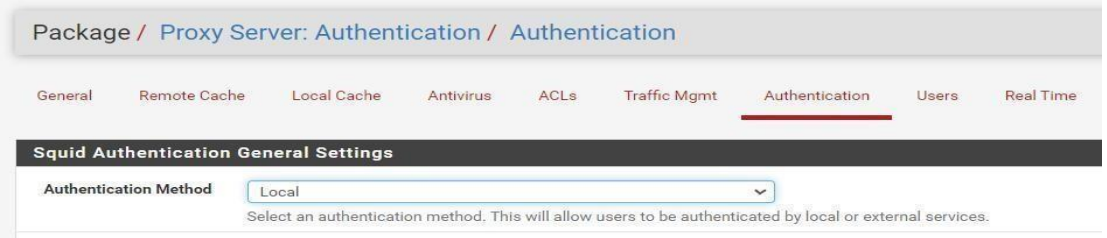
In the Remote cert. Checks, click Do not Verify remote Certificate option.

Select all options in the Certificate Adopt section.



Click Save.

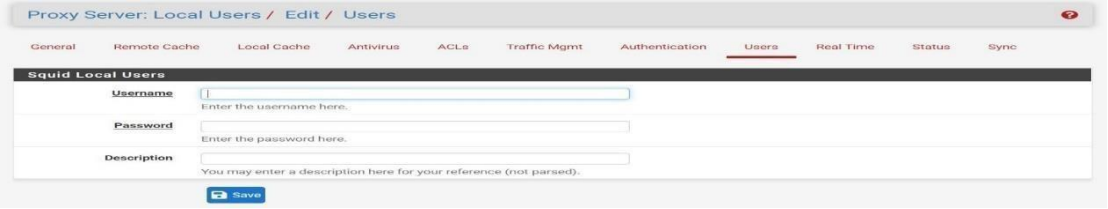
Now we enable user based access control. Go to the Authentication tab.In the Authentication Method use drop down and select Local .



Click Save.

To create Squid proxy users. Go to the Users tab.

Click Add to add a new user.



Provide Username , password , Description and Click Save

8. FUTURE SCOPE

The future scope of pfSense, SquidGuard, Snort, and Captive Portal lies in their continued evolution to address emerging cybersecurity challenges. Advancements in artificial intelligence and machine learning will enable these integrated solutions to enhance threat detection capabilities, enabling more proactive and adaptive responses to evolving cyber threats.Additionally, there will be a greater focus on integrating these tools with cloud-native architectures, enabling seamless deployment and management of security policies across distributed and hybrid cloud environments. This will facilitate scalability and agility in adapting to changing network infrastructures.Furthermore, with the increasing adoption of Internet of Things (IoT) devices and the proliferation of remote work, there will be a need for enhanced network visibility and control. Future developments may include features for IoT device management, advanced user behavior analytics, and seamless integration with identity and access management solutions.

Overall, the future of pfSense, SquidGuard, Snort, and Captive Portal holds promise for delivering robust, scalable, and adaptive cybersecurity solutions to meet the evolving needs of modern networks.

9. CONCLUSION

The integration of pfSense, SquidGuard, Snort, and Captive Portal offers a comprehensive approach to network security, content filtering, intrusion detection, and user authentication. With customizable configurations, centralized management, and future-ready adaptability, this unified solution ensures robust protection, optimal performance, and streamlined administration in modern network environments.

10. REFRENCES

- https://docs.netgate.com/pfsense/en/latest/
- https://www.snort.org/
- https://docs.netgate.com/pfsense/en/latest/packages/cache-proxy/squidguard.html
- https://docs.netgate.com/pfsense/en/latest/packages/snort/setup.html
- https://dsi.ut-capitole.fr/blacklists/download/blacklists_for_pfsense.tar.gz