



Build a router?

Do you need a router?
Want to build your own router?
How about a budget router better
than a lot of off the shelf routers?





What does a router do?

A router is actually performing multiple functions

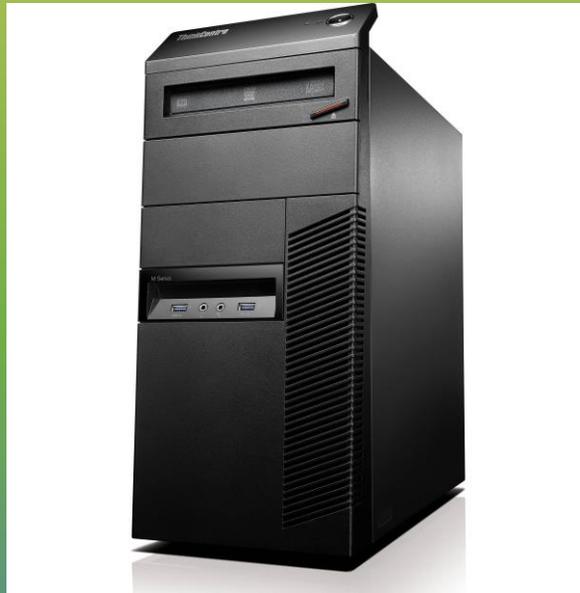
- Connects your devices to the internet
- Serves as a DHCP server
- Provides you with a Firewall
- Creates access for wireless devices





Build a router?

This project will outline building a router that is totally programmable and possibly better than a router you might purchase.





Build a router?

Things needed to complete this project

- An old desktop pc
- Additional ethernet card
- A gigabyte ethernet switch
- An old router
- pfSense OS





Build a router?

First thing to do is install the ethernet card. Once this is installed you'll have 2 ethernet ports on this pc. One will be the WAN port and one will be the LAN port.





Build a router?

Setup

Connect your incoming network to an ethernet port on the pc(WAN), connect a gigabyte switch to the other ethernet port (LAN) port on the rear of the pc.





Build a router?

Setup Wi-Fi

If you'd like your pfSense router to be Wi-Fi capable, follow the router manufacturers instructions and turn it in to an access point. Plug the WAN port of the router into the LAN switch and you'll be Wi-Fi ready





Build a router?

Install the pfSense OS

Once you have downloaded the ISO from pfSense, create a bootable medium, either a thumb drive or DVD.



Select Image To Download

Version: 2.5.0

Architecture: AMD64 (64-bit)

Installer: DVD Image (ISO) Installer

Mirror: Singapore

DOWNLOAD

Supported by





Build a router?

Install the pfSense OS

Booting up the software is pretty straight forward. Power up the pc and choose the device you'd like to boot from. Thumb drive, DVD, etc.





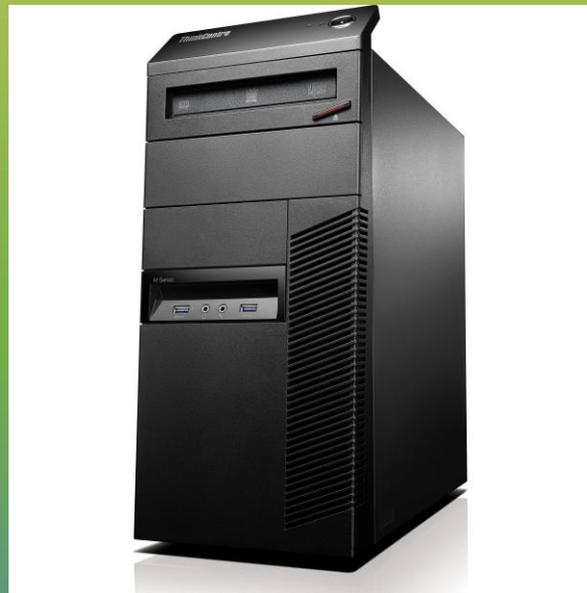
Build a router?

Install the pfSense OS part 3

Follow the steps provided by Netgate.
They are the creator of pfSense

Use this link

<https://docs.netgate.com/pfsense/en/latest/install/all/install-walkthrough.html>





Build a router?

Install the pfSense OS

Or if you prefer, There are some excellent Instructions on YouTube

Use this link for one example

<https://www.youtube.com/watch?v=IUzSsX4T4WQ&t=684s>





Build a router?

Setup

Once you've completed the install, you're ready to configure the system. Below is an example of the console screen. After the initial setup, pfSense can be configured using the web interface page

```
7) Ping host                16) Restart PHP-FPM
8) Shell

Enter an option:

FreeBSD/i386 (device-a.localdomain) (ttyv0)

*** Welcome to pfSense 2.2.2-RELEASE-pfSense (i386) on device-a ***

WAN (wan)      -> em0      -> v4: 192.168.1.32/24
LAN (lan)      -> em1      -> v4: 192.168.15.6/24
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) pfSense Developer Shell
4) Reset to factory defaults  13) Upgrade from console
5) Reboot system             14) Disable Secure Shell (sshd)
6) Halt system               15) Restore recent configuration
7) Ping host                 16) Restart PHP-FPM
8) Shell

Enter an option: |
```



Build a router?

Setup

This is where the fun and creativity begin. From the console screen you can start with choosing which interface device will be the WAN and which one will be the LAN.

```
7) Ping host                16) Restart PHP-FPM
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Enter an option:

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8) Shell

Enter an option: |
```



Build a router?

Setup

For this build I used the pc built-in ethernet port as the WAN listed below as em0.

Using the added network card for the LAN em1. Use option 1 to perform this.

```
7) Ping host
8) Shell
16) Restart PHP-FPM

Enter an option:

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6) Halt system
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8) Shell
9) pfTop
10) Filter Logs
11) Restart webConfigurator
12) pfSense Developer Shell
13) Upgrade from console
14) Disable Secure Shell (sshd)
15) Restore recent configuration
16) Restart PHP-FPM

Enter an option: |
```



Build a router?

Setup

After assigning interfaces, create you IP addresses and type of IP for each of these devices. When creating the LAN, leave some lower IPs for system devices. Use option 3.

```
7) Ping host                16) Restart PHP-FPM
8) Shell

Enter an option:

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8) Shell

Enter an option: |
```



Build a router?

Web interface screen

Once you've established your network, you should be able to reach the web interface screen through another pc connected to the switch plugged into the LAN port.

```
7) Ping host
8) Shell
16) Restart PHP-FPM

Enter an option:

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16) Restart PHP-FPM

Enter an option: █
```



Build a router?

Web interface screen

In this demonstration the web interface screen can be reached using Firefox and the IP address of 192.168.15.1 The IP addresses for use begin at 192.168.15.6

```
7) Ping host
8) Shell
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Enter an option:

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1) Assign Interfaces
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7) Ping host
8) Shell
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15) Restore recent configuration
16) Restart PHP-FPM

Enter an option: █
```



Build a router?

After these basic configuration steps, the pfSense firewall / router should now be functioning.

Default login info

Username: admin
Password: pfsense

pfSense

SIGN IN

Username

Password

SIGN IN



Build a router?

After these basic configuration steps, the pfSense firewall / router should now be functioning.

Default login info

Username: admin
Password: pfsense

The screenshot shows the pfSense web interface. At the top, there is a navigation menu with items: System, Interfaces, Firewall, Services, VPN, Status, Diagnostics, and Help. Below the menu, a breadcrumb trail reads: Wizard / pfSense Setup / Netgate@ Global Support is available 24/7. A progress indicator shows 'Step 1 of 9'. The main content area has a heading 'Netgate@ Global Support is available 24/7' and contains the following text:

Our 24/7 worldwide team of support engineers are the most qualified to diagnose your issue and resolve it quickly, from branch office to enterprise – on premises to cloud.

We offer several support subscription plans tailored to fit different environment sizes and requirements. Many companies around the world choose Netgate support because:

- Support is available 24 hours a day, seven days a week, including holidays.
- Support engineers are located around the world, ensuring that no support call is missed.
- Our support engineers hold many prestigious network engineer certificates and have years of hands-on experience with networking.

At the bottom of the content area, there are two buttons: 'Learn more' and 'Next'.

At the very bottom of the page, a footer states: pfSense is developed and maintained by Netgate. © ESF 2004 - 2020 View license.



Build a router?

Once logged in, the setup Wizard will start. The Wizard can always be run again at any time

The screenshot shows the pfSense web interface. At the top, there is a navigation menu with items: System, Interfaces, Firewall, Services, VPN, Status, Diagnostics, and Help. Below the menu, a breadcrumb trail reads: Wizard / pfSense Setup / Netgate® Global Support is available 24/7. A red bar indicates 'Step 1 of 9'. The main content area is titled 'Netgate® Global Support is available 24/7' and contains the following text:

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There are two buttons: 'Learn more' and '» Next'. At the bottom of the page, a footer states: 'pfSense is developed and maintained by Netgate. © ESF 2004 - 2020 View license.'

This screenshot shows a close-up of the 'System' menu in the pfSense web interface. The menu items are: Advanced, Cert. Manager, General Setup, High Avail. Sync, Logout (admin), Package Manager, Register, Routing, Setup Wizard (circled in red), Update, and User Manager. The background shows a 'System Info' table with columns for Name, User, System, BIOS, and Version. The Version field shows '21.02-RELEASE (amd64)'.



Build a router?

Follow the setup wizard to complete the initial setup

pfSense COMMUNITY EDITION

System ▾ Interfaces ▾ Firewall ▾ Services ▾ VPN ▾ Status ▾ Diagnostics ▾ Help ▾

Wizard / pfSense Setup / Netgate® Global Support is available 24/7

Step 1 of 9

Netgate® Global Support is available 24/7

Our 24/7 worldwide team of support engineers are the most qualified to diagnose your issue and resolve it quickly on premises to cloud.

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[Learn more](#)

[» Next](#)



Build a router?

Follow the setup wizard to complete the initial setup

Add in a primary and secondary DNS using these parameters to get started.

8.8.8.8

1.1.1.1

pfSense
COMMUNITY EDITION

System ▾ Interfaces ▾ Firewall ▾ Services ▾ VPN ▾ Status ▾ Diagnostics ▾ Help ▾

Wizard / pfSense Setup / General Information

Step 2 of 9

General Information

On this screen the general pfSense parameters will be set.

Hostname
EXAMPLE: myserver

Domain
EXAMPLE: mydomain.com

The default behavior of the DNS Resolver will ignore manually configured DNS servers for client queries and query root DNS servers directly. To manually configure DNS servers below for client queries, visit Services > DNS Resolver and enable DNS Query Forwarding after completion.

Primary DNS Server

Secondary DNS Server

Override DNS
Allow DNS servers to be overridden by DHCP/PPP on WAN



Build a router?

Follow the setup wizard to complete the initial setup

Change your time zone

pfSense
COMMUNITY EDITION

System ▾ Interfaces ▾ Firewall ▾ Services ▾ VPN ▾ Status ▾ Diagnostics ▾ Help ▾

Wizard / pfSense Setup / Time Server Information

Step 3 of 9

Time Server Information

Please enter the time, date and time zone.

Time server hostname
Enter the hostname (FQDN) of the time server.

Timezone

[Next](#)



Build a router?

Follow the setup wizard to complete the initial setup

This screen should be all set unless you need to make a change. This was configured on the initial install

The screenshot shows the pfSense web interface. At the top, there is a navigation menu with items: System, Interfaces, Firewall, Services, VPN, Status, Diagnostics, and Help. Below the menu, the breadcrumb trail reads "Wizard / pfSense Setup / Configure WAN Interface". A progress bar indicates "Step 4 of 9". The main heading is "Configure WAN Interface". Below this, a sub-heading states: "On this screen the Wide Area Network information will be configured." The "SelectedType" dropdown menu is set to "DHCP". Under the "General configuration" section, there are three input fields: "MAC Address" (with a tooltip: "This field can be used to modify ('spoof') the MAC address of the WAN interface (may be required with some cable connections). Enter a MAC address in the following format: xxx:xxx:xxx:xxx or leave blank."), "MTU" (with a tooltip: "Set the MTU of the WAN interface. If this field is left blank, an MTU of 1492 bytes for PPPoE and 1500 bytes for all other connection types will be assumed."), and "MSS" (with a tooltip: "If a value is entered in this field, then MSS clamping for TCP connections to the value entered above minus 40 (TCP/IP header size) will be in effect. If").



Build a router?

Follow the setup wizard to complete the initial setup

Use this screen to modify your LAN IP address. This also was configured on the initial setup.

The screenshot shows the pfSense Community Edition web interface. The top navigation bar includes links for System, Interfaces, Firewall, Services, VPN, Status, Diagnostics, and Help. The breadcrumb trail indicates the current location: Wizard / pfSense Setup / Configure LAN Interface. A progress bar shows 'Step 5 of 9'. The main heading is 'Configure LAN Interface'. Below this, a message states: 'On this screen the Local Area Network information will be configured.' There are two input fields: 'LAN IP Address' with the value '192.168.23.1' and a note 'Type dhcp if this interface uses DHCP to obtain its IP address.', and 'Subnet Mask' with the value '24'. A blue button labeled '>> Next' is at the bottom.



Build a router?

Follow the setup wizard to complete the initial setup

Change the default password to your choice of password

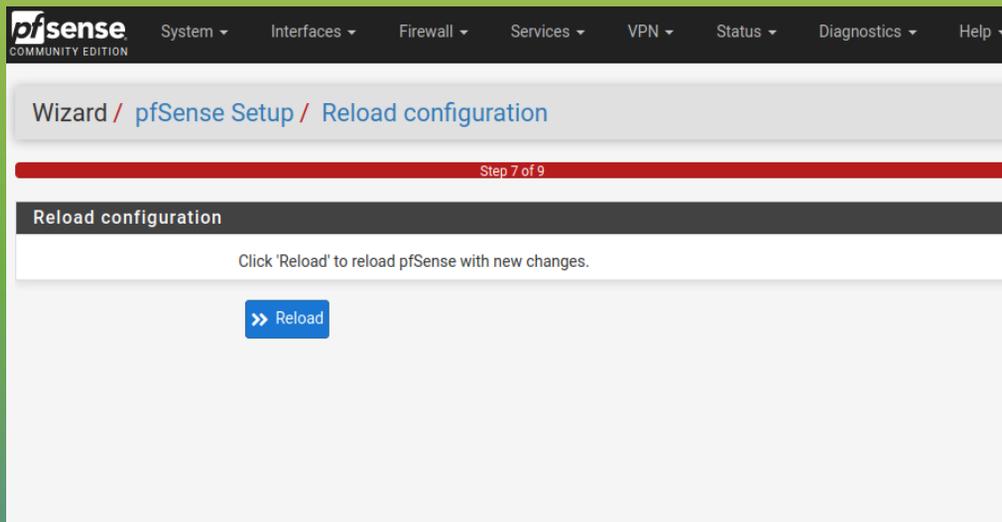
The screenshot shows the pfSense Community Edition web interface. The top navigation bar includes the pfSense logo and menu items: System, Interfaces, Firewall, Services, VPN, Status, Diagnostics, and Help. The breadcrumb trail reads: Wizard / pfSense Setup / Set Admin WebGUI Password. A progress bar indicates 'Step 6 of 9'. The main heading is 'Set Admin WebGUI Password'. Below this, a message states: 'On this screen the admin password will be set, which is used to access the WebGUI and also SSH services if enabled.' There are two input fields: 'Admin Password' and 'Admin Password AGAIN'. At the bottom, there is a blue button labeled '>> Next'.



Build a router?

Follow the setup wizard to complete the initial setup

At this point, click the reload button and you'll be ready to start running pfSense





Build a router?

Follow the setup wizard to complete the initial setup

This is an example of the dashboard.
This can be easily modified to your personal preference

WARNING: The 'admin' account password is set to the default value. [Change the password in the User Manager.](#)

Status / Dashboard 📄 + ?

System Information	
Name	pfSense.localdomain
User	admin@192.168.1.102 (Local Database)
System	PC Engines APU2 Netgate Device ID: d8366493da47db4ee1c4
BIOS	Vendor: coreboot Version: v4.9.0.7 Release Date: Tue Jul 9 2019
Version	2.4.4-RELEASE-p3 (amd64) built on Wed May 15 18:53:44 EDT 2019 FreeBSD 11.2-RELEASE-p10

Interfaces			
WAN	↑	1000baseT <full-duplex>	192.168.5.222
LAN	↑	1000baseT <full-duplex>	192.168.1.1
NORDVPN	↓		n/a

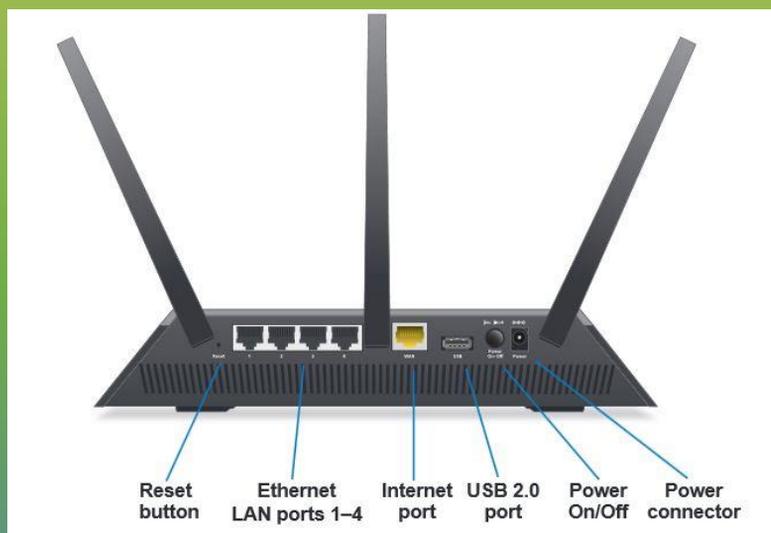
Gateways				
Name	RTT	RTTsd	Loss	Status
WAN_DHCP 192.168.5.1	0.6ms	0.1ms	0.0%	Online
NORDVPN_VPNV4 ~	0.0ms	0.0ms	100%	Offline



Build a router?

Follow the setup wizard to complete the initial setup

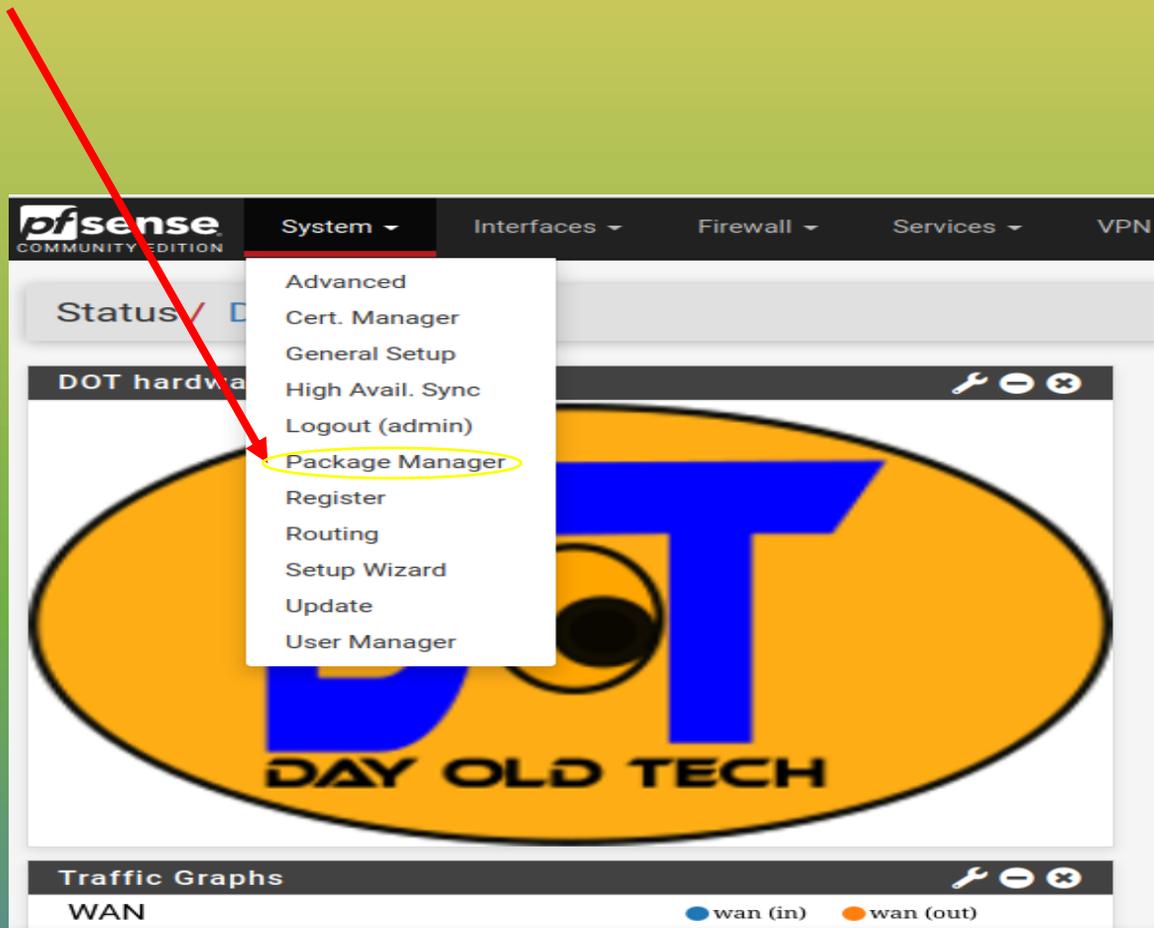
This is the end of the basic setup
If you'd like it to make this system accessible to wireless devices, add a wireless router configured as an access point.





Build a router?

The pfSense Package manager.
From the main dashboard, click system
in the upper tool bar and choose package
manager.





Build a router?

At this point there are various ways to modify the installation with a lot of different add-ons

Snort is a popular add-on. Scroll down and click install.

The screenshot shows the pfSense web interface for the Package Manager. The breadcrumb trail is "System / Package Manager / Available Packages". There are two tabs: "Installed Packages" and "Available Packages", with the latter being selected. A search bar is present with a search term field, a dropdown menu set to "Both", and "Search" and "Clear" buttons. Below the search bar is a table of available packages.

Name	Version	Description	Action
acme	0.7.3	Automated Certificate Management Environment, for automated use of LetsEncrypt certificates. Package Dependencies: pecl-ssh2-1.3.1 socat-1.7.4.2 php74-7.4.26 php74-ftp-7.4.26	+ Install
apcupsd	0.3.91_10	"apcupsd" can be used for controlling all APC UPS models It can monitor and log the current power and battery status, perform automatic shutdown, and can run in network mode in order to power down other hosts on a LAN Package Dependencies: apcupsd-3.14.14_4	+ Install



Build a router?

Summary

This project demonstrates how you can take some retired equipment, some open-source free software and a couple hours of time and create a router / Firewall that can be equal to or better than any off the shelf routers.





Build a router?

Summary

This project makes a great tool for hands on experience working with DHCP, VPN, DNS, Squid, pfBlockerNG, SquidGuard, Darkstat, Snort and many more applications.

