



**ALEPH
OBJECTS[®]**
INCORPORATED

FIREWALL

Aleph Objects Firewall

by Aleph Objects, Inc.

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Introduction

Firewall

Introduction

This document at present is a rough collection of notes of different hardware and software evaluated for Aleph Objects' network. The goal is to build a network out of routers and switches using as much Free Software as possible.

Firewall

Stop.

1.1 Overview

Aleph Objects has recently deployed pfSense firewalls, replacing OpenBSD. Most servers and workstations run GNU/Linux, which uses iptables.

1.2 iptables

iptables is part of the Netfilter project and has been included by default in the Linux kernel for many years.

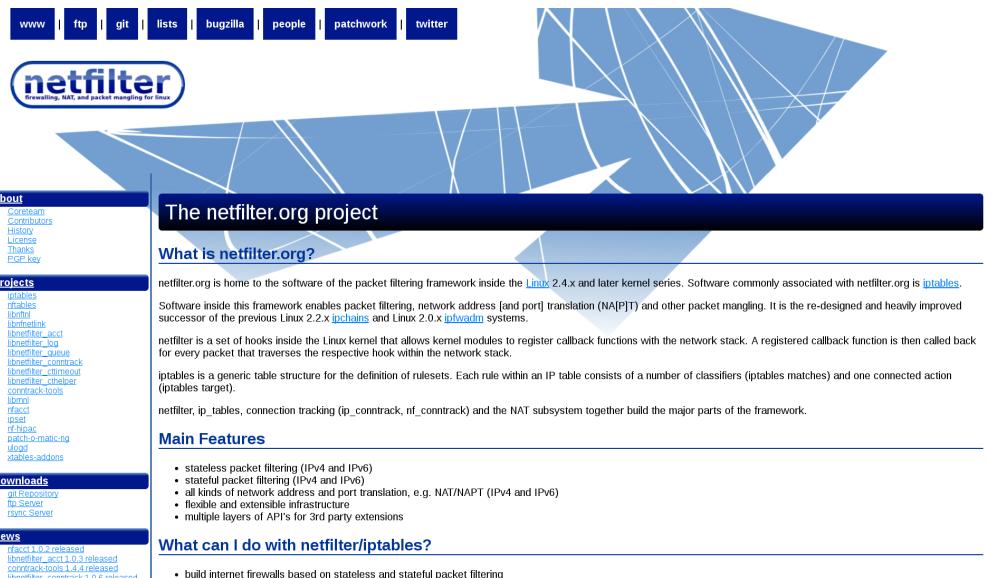


Figure 1.1: Netfilter Website

1.3 pfSense

pfSense — “Free, open source customized distribution of FreeBSD specifically tailored for use as a firewall and router that is entirely managed via web interface.”

pfSense was selected as Aleph Objects core router/firewall for backbone connections.

1.3. PFSENSE

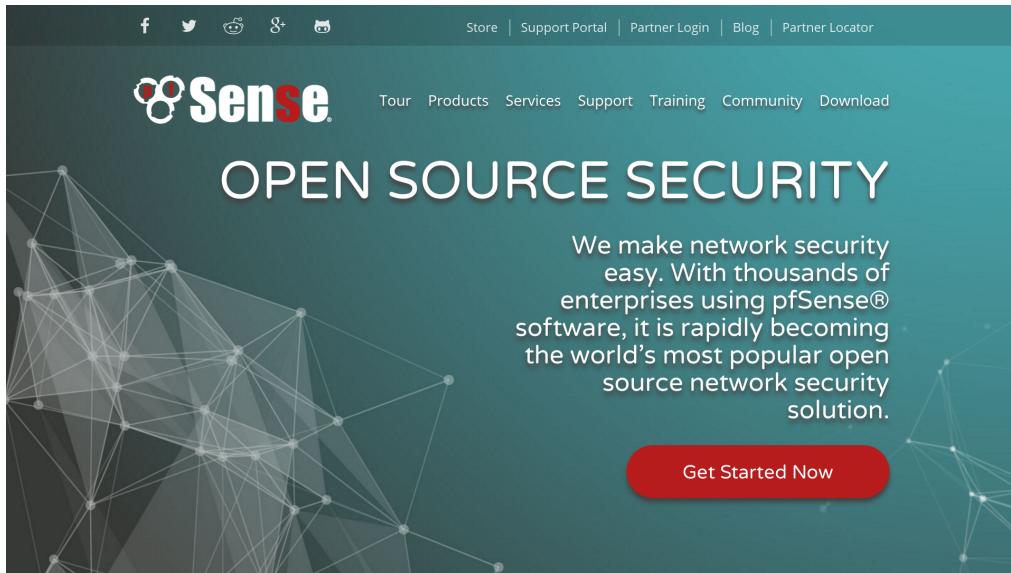


Figure 1.2: pfSense Website

NAT

Network Address Translation.

- VoIP using SIP is often a problem behind a NAT.
- Enable Keepalives in Grandstream phones to connect to the Asterisk server.
- Disable ALG (Application Level Gateway) in any consumer/home routers.

Traffic Shaping

- Prioritize admin ssh to firewalls/servers (in case of DoS, etc.)
- Prioritize VoIP
- De-prioritize SMTP, etc...

pfBlockerNG

- IP blocklists for botnets, etc.

Suricata

Suricata is being used as an Intrusion Detection System. It is preferred over Snort as Suricata is multithreaded and Snort isn't.

The screenshot shows the official Suricata website. At the top, there is a dark navigation bar with the word "Suricata" and "Open Source IDS / IPS / NSM engine" on the left, and links for "News", "Features", "Download", "Docs", "Participate", "Training", "Support", and "About" on the right. The "About" link is highlighted with a teal background. Below the navigation bar is a large, blurry image of two meerkats looking towards the camera. Underneath this image, the word "Suricata" is written in bold black text. A brief description follows: "Suricata is a high performance Network IDS, IPS and Network Security Monitoring engine. Open Source and owned by a community run non-profit foundation, the Open Information Security Foundation (OISF). Suricata is developed by the OISF and its supporting vendors." Below the description, a section titled "Top 3 Reasons You Should Try Suricata:" lists three points: "1. Highly Scalable", "2. Suricata is multi threaded. This means you can run one instance and it will balance the load of processing across every processor on a sensor. Suricata is configured to use. This allows", and "3. Emerging Threats Blacklists". To the right of the main content area, there is a sidebar with a section titled "SURICON 2.0" featuring a banner for "Suricon 2.0 Annual Suricata User Conference" in Washington, DC, November 9-11, 2016. Below this, there is a "TRAINING SESSIONS" section with "LIST" and "CALENDAR" buttons.

Figure 1.3: Suricata Website

- barnyard2
- Snort Blacklists
- Emerging Threats Blacklists
- GeoIP
- Alerts, Blocks, Suppress
- SID

DHCP

For DHCP services, pfSense uses Dnsmasq, which is also used for DNS forwarding.

- Disable IPv6.
- tftp netboot installs.
- Static mappings.

NTP

OpenVPN

Virtual Private Networks.

OpenVPN — “OpenVPN is a full-featured open source SSL VPN solution that accommodates a wide range of configurations, including remote access, site-to-site VPNs, Wi-Fi security, and enterprise-scale remote access solutions with load balancing, failover, and fine-grained access-controls.”



Figure 1.4: OpenVPN Website

Firewall

- Network design (e.g. many point to point, one central server, etc.).
- Main OpenVPN server.
- Other internal servers.
- External servers private connections.
- Laptops.
- Mobiles.
- SSL certificates.

Captive Portal

The Captive Portal for Aleph Mountain building wifi services.

SSL Certificates

pfSense makes it very easy to generate Certificate Signing Requests (CSRs), which can be send to Gandi.net to get issued a “properly” signed SSL certificate.

ssh

OpenSSH from OpenBSD is used. The BSD shell is a bit different from GNU.

DNS

DNS forwarding is provided by Dnsmasq.

Routing

- No BGP, OSPF, etc.
- Static backbone routes.
- WAN failover

Dnsmasq

Dnsmasq provides network infrastructure for small networks: DNS, DHCP, router advertisement and network boot. It is designed to be lightweight and have a small footprint, suitable for resource constrained routers and firewalls. It has also been widely used for tethering on smartphones and portable hotspots, and to support virtual networking in virtualisation frameworks. Supported platforms include Linux (with glibc and uclibc), Android, *BSD, and Mac OS X. Dnsmasq is included in most Linux distributions and the ports systems of FreeBSD, OpenBSD and NetBSD. Dnsmasq provides full IPv6 support.

The DNS subsystem provides a local DNS server for the network, with forwarding of all query types to upstream recursive DNS servers and cacheing of common record types (A, AAAA, CNAME and PTR, also DNSKEY and DS when DNSSEC is enabled).

- Local DNS names can be defined by reading /etc/hosts, by importing names from the DHCP subsystem, or by configuration of a wide range of useful record types.
- Upstream servers can be configured in a variety of convenient ways, including dynamic configuration as these change on moving upstream network.
- Authoritative DNS mode allows local DNS names may be exported to zone in the global DNS. Dnsmasq acts as authoritative server for this zone, and also provides zone transfer to secondaries for the zone, if required.
- DNSSEC validation may be performed on DNS replies from upstream nameservers, providing security against spoofing and cache poisoning.
- Specified sub-domains can be directed to their own upstream DNS servers. making VPN configuration easy.

Figure 1.5: Dnsmasq Website

Interfaces

- Gigabit ethernet.
- SPF+.
- Hardware offloading (e.g. checksums).

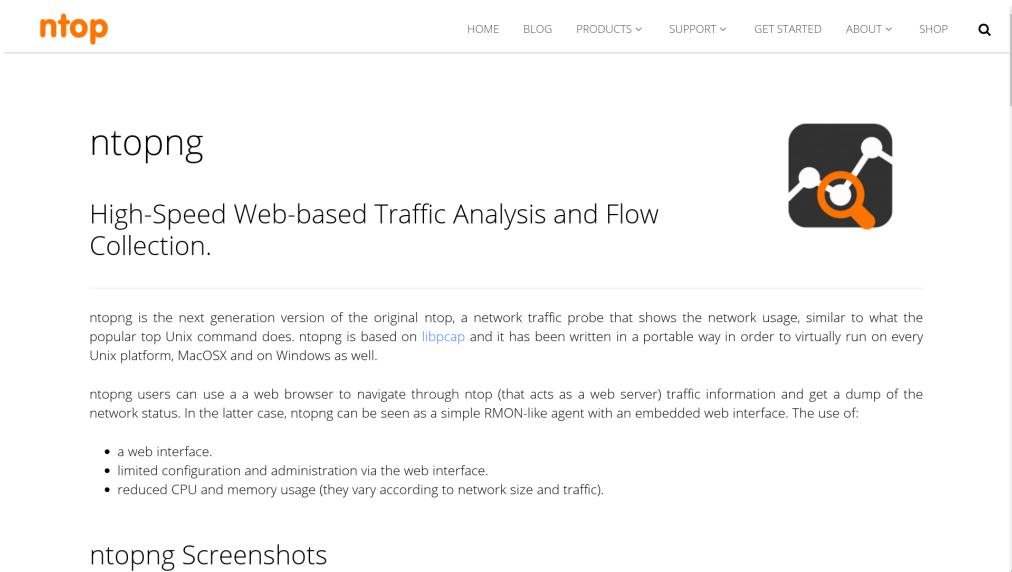
CARP and Synchronization

CARP can be used to have transparent failover to another firewall, if one firewall on the network should drop.

Synchronization between CARP firewalls allows easy configuration updates. For instance, if a configuration change is made to the DHCP server, it can “instantly” push to the backup firewall.

Reporting

- Dashboard.
- Darkstat.



The screenshot shows the ntopng website. At the top, there's a navigation bar with links for HOME, BLOG, PRODUCTS, SUPPORT, GET STARTED, ABOUT, and SHOP, along with a search icon. The main title "ntopng" is displayed in large orange letters. Below the title, the subtitle "High-Speed Web-based Traffic Analysis and Flow Collection." is shown. To the right of the subtitle is a black square icon featuring a magnifying glass and network nodes. The main content area contains a brief description of ntopng, its features, and screenshots.

Figure 1.6: ntopng Website

- ntopng (“Network Top Next Generation” ?).
- S.M.A.R.T.
- System Temperatures.
- MRTG
- RRD

Install notes

A few notes from the initial test install:

- Released May 18th, 2016.
- pfSense-CE-memstick-2.3.1-RELEASE-amd64.img
- FreeBSD 10.3 based.
- Installer feels like a step back in computing history.
- First boot goes to console with lots of useful options.

1.3. PFSENSE

- Web admin wizard mentions pfSense Gold Subscriptions. It doesn't appear to be for non-free software (e.g. isn't baitware).
- They sell very nice looking hardware with pfsense pre-installed. With failover systems (CARP).
- Load balancing, failover.
- Clean and very responsive web interface (based on Bootstrap).
- Web based updater to new minor version.
- x86 architecture only.
- Looks to have good security errata process, following FreeBSD.
- Snort threat lists are available. Paid for more recent ones, same as on other snort platforms.
- Installation of additional packages is clean, and doesn't appear to offer any non-free.
- ClamAV ...

Hardware

Purchase Order

2.1 Overview

Hardware.

- (8) 1 gig ethernet ports Connects to (1) 100M ethernet upstream fiber optic Connects to (1) 100M ethernet upstream wifi Various LAN
- (Hot swap?) Dual Power Supplies
- (How swap?) RAID (Linux md), with SSD storage.
- 2.5” drive bays
- Total 8GHz CPU
- 8-16 gigs RAM ? Depends on OS.
- Two servers total, for standby/failover

**Switches
Here.**

3.1 Overview

There are now many new free software solutions for network switches. Unfortunately, they are all high-end data center gear, the least expensive costing over \$3,000USD.

3.2 Open Compute Project

<http://www.opencompute.org/> <http://github.com/opencomputeproject>

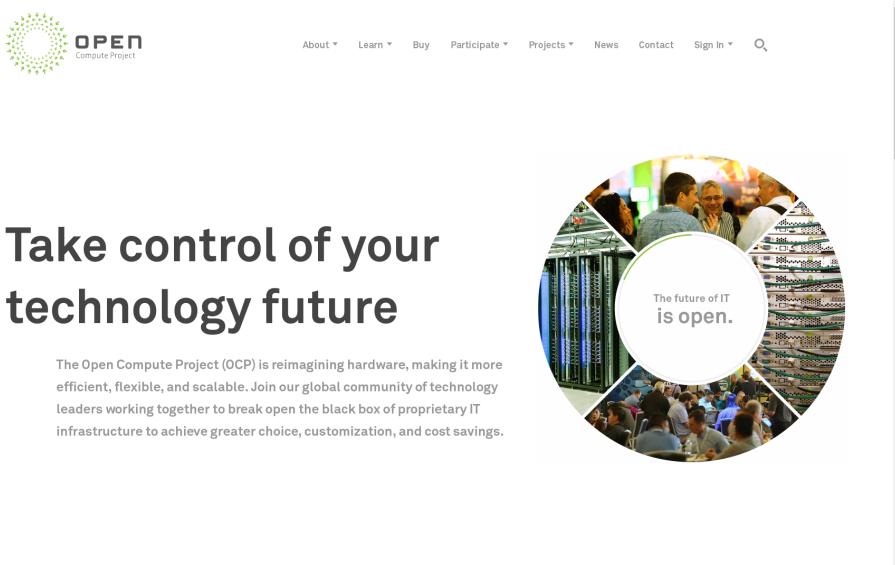


Figure 3.1: OpenCompute Website

Project so massive data centers can be more “open” and interoperate better between vendors, by using free software.

3.3 ONIE

“The Open Network Install Environment (ONIE) is an Open Compute Project open source initiative driven by a community to define an open “install environment” for bare metal network switches, such as existing ODM switches and the upcoming OCP Network Switch design. ONIE enables a

3.3. ONIE

bare metal network switch ecosystem where end users have a choice among different network operating systems.... ONIE was contributed to the Open Compute Project.... ONIE is an open source “install environment”, that acts as an enhanced boot loader utilizing facilities in a Linux/BusyBox environment. This small Linux operating system allows end-users and channel partners to install the target network OS as part of data center provisioning, in the fashion that servers are provisioned.”

Website: <http://onie.org>

Source code: <https://github.com/opencomputeproject/onie>

Wiki: <https://github.com/opencomputeproject/onie/wiki>

License: GPLv2

Hardware status: http://www.opencompute.org/wiki/Networking/ONIE/HW_Status

Operating System Support: http://www.opencompute.org/wiki/Networking/ONIE/NOS_Status

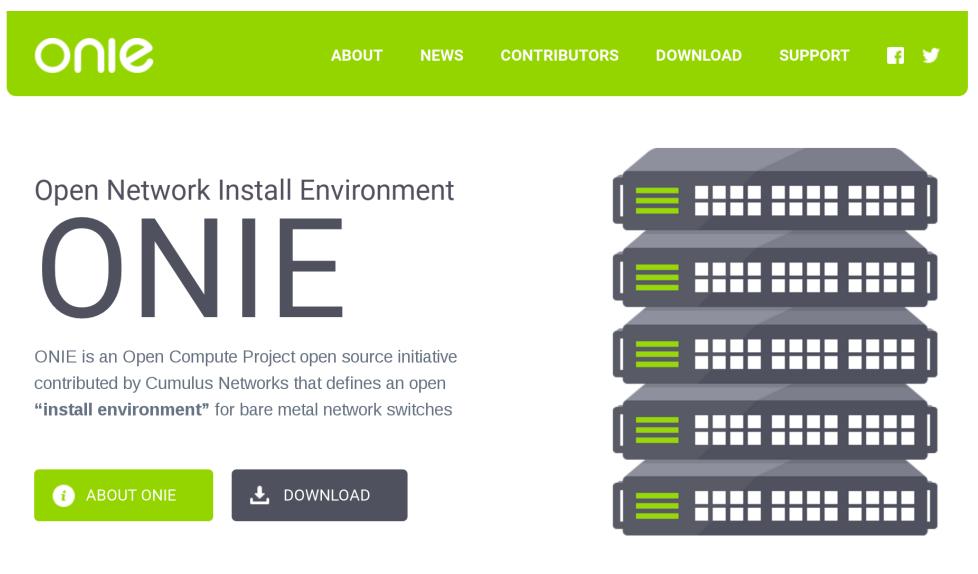


Figure 3.2: ONIE Website

3.4 Switch Operating Systems

Open Network Linux

opennetlinux.org Distro for bare metal switches.

<https://opennetlinux.org/>

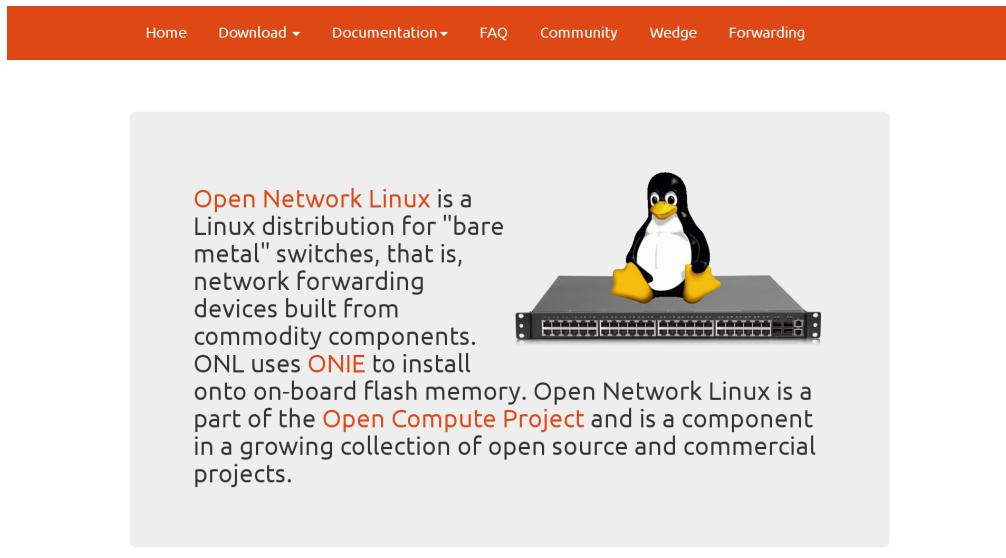


Figure 3.3: Open Network Linux Website

Snaproute

aka OpenSnaproute, FlexSwitch

<http://www.snaproute.com/>

<https://opensnaproute.github.io/docs/>

OpenSwitch

<http://www.openswitch.net/>

FBOSS

<https://github.com/facebook/fboss>

3.4. SWITCH OPERATING SYSTEMS

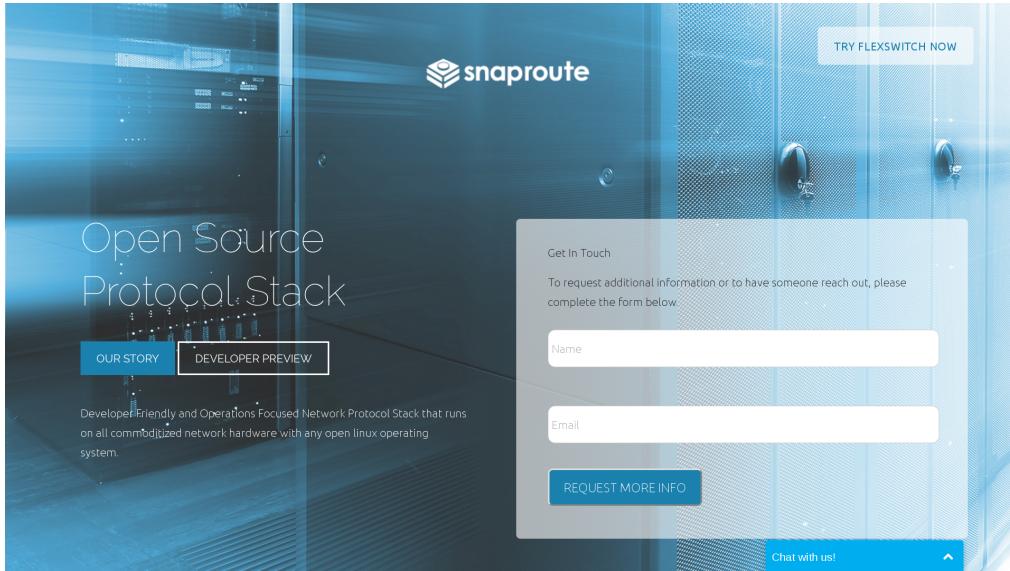


Figure 3.4: Snaproute Website



Figure 3.5: OpenSwitch Website

Big Switch

<http://www.bigswitch.com/community-edition>

Switches

The screenshot shows the GitHub repository page for 'facebook / fboss'. At the top, there are tabs for Personal, Open source, Business, Explore, Pricing, Blog, Support, and a search bar. Below the header, the repository name 'facebook / fboss' is displayed, along with statistics: 99 Watchers, 258 Stars, and 79 Forks. There are also links for Code, Issues (5), Pull requests (7), Pulse, and Graphs.

The main content area shows a summary of the repository's activity: 385 commits, 1 branch, 0 releases, and 24 contributors. A timeline of commits is listed, starting with a commit from Safi Hasan at 11 minutes ago. The commits include various updates to files like common, fboss, .gitignore, BUILD.md, CMakelists.txt, CONTRIBUTING.md, LICENSE, PATENTS, README.md, and getdeps.sh.

Below the commit history, there is a section titled 'Facebook Open Switching System (FBOSS)' which describes FBOSS as Facebook's software stack for controlling and managing network switches. A 'Components' section is also present.

Figure 3.6: FBOSS Website

Looks like baitware. Crippled version.



Figure 3.7: Big Switch Website

3.5 Misc

- OpenNSL – Broadcom chipsets. Accton. Github archive has proprietary license (LICENSE-Adv = non-free).
- OF-DPA – From Broadcom.
- SAI

Forwarding Agents

- Quagga – <http://www.quagga.net/>
- BIRD – <http://bird.network.cz/>
- Azure SONiC

3.6 Hardware

Edge-Core

Edge-Core – <http://www.edge-core.com/> – Owned by Accton.

Dell

Netberg

Quanta

3.7 Suppliers

White Box

White Box – <http://whiteboxswitch.com/> – Reseller of open switches.

Bare Metal Switches

Bare Metal Switches – <https://bm-switch.com/> – Reseller of open switches.

Switches

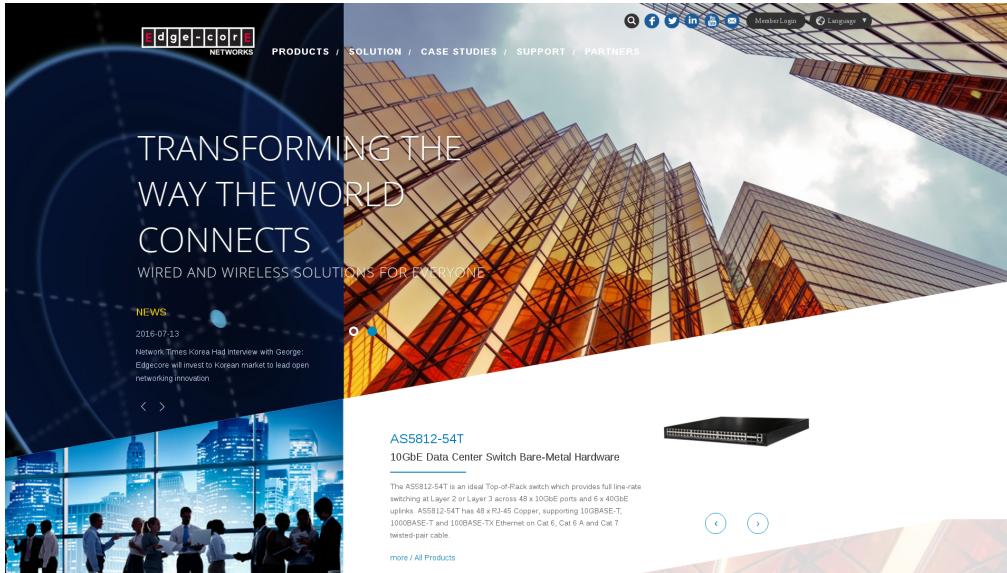


Figure 3.8: Edge-core Website

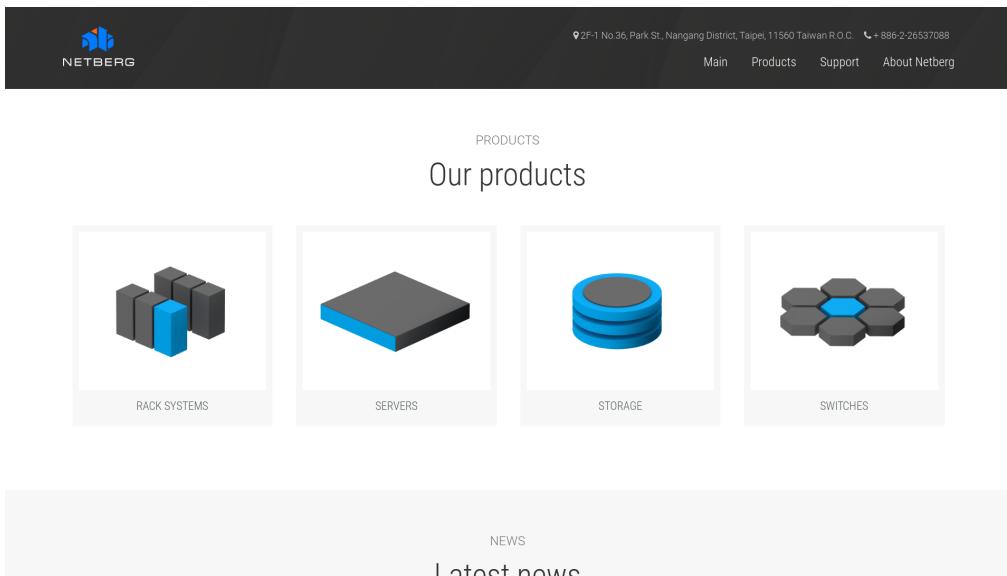


Figure 3.9: Netberg Website

Colfax Direct



FROM HYPERSCALE TO HYPER CONVERGED

Figure 3.10: Quanta Website

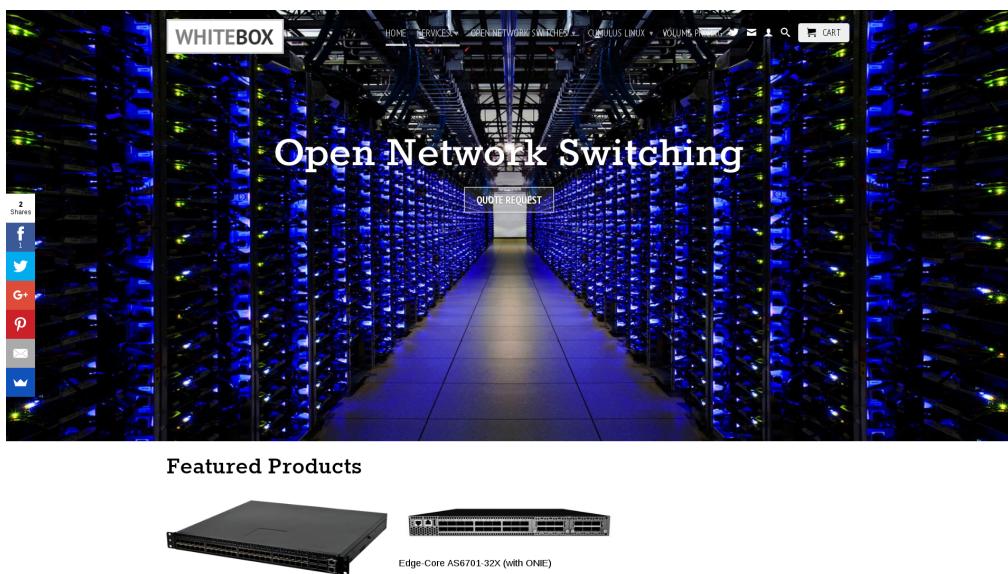


Figure 3.11: Whitebox Website

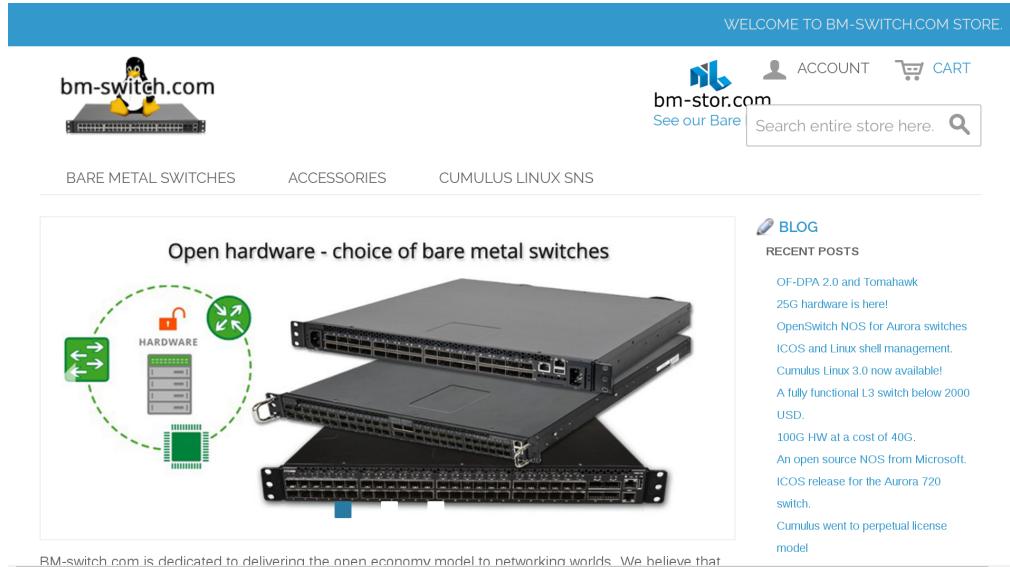


Figure 3.12: Bare Metal Switches Website

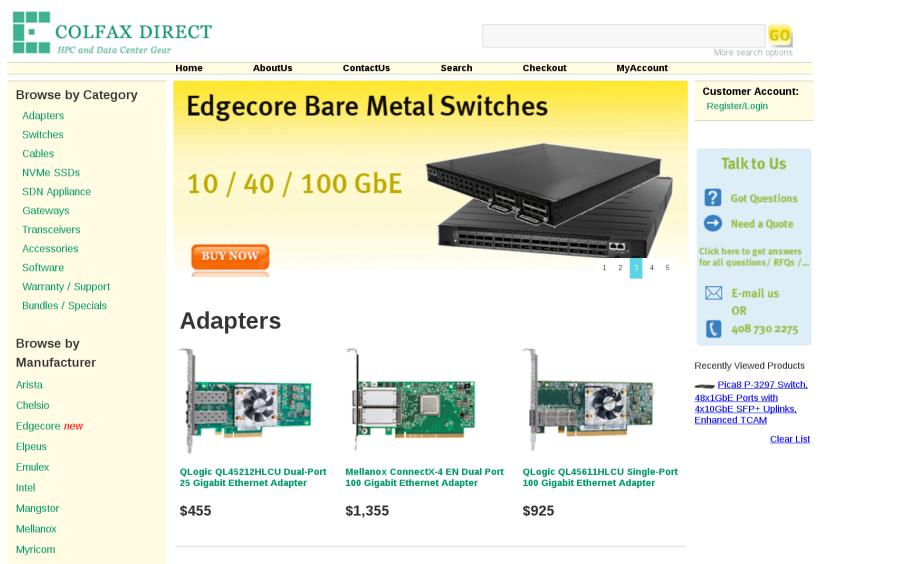


Figure 3.13: Colfax Direct Website

OS

Free Operating Systems

There are a lot of operating systems to consider to use as a firewall...

4.1 Requirements

Notes on some requirements in a firewall.

- Must be free software.
- The project must still be alive.
- Does it use a hardened kernel?
- How does it do security updates?
- Are there open security issues?
- Are there any CVEs?
- How are security issues handled?
- Is there a list of security issues?
- Does it have a wifi portal? (Should that be a separate box or in OpenWRT?)
- Does upstream https actually work?
- UTM - Unified Threat Management (e.g. snort, etc.)
- Load balancing between multiple upstreams (without BGP).
- Load balancing between dual local routers.
- Fail over to standby router (e.g. pfsync).
- “Anti-virus”, SMTP, POP scans? Meh? (e.g. OpenBSD has greylist/tarpit.)
- Packet cleansing (e.g. tcp header randomization).
- Do we want DNS, DHCP, etc? Probably not?
- OpenVPN (built into router, or thru it?).

4.2. FIREWALL OPERATING SYSTEMS IN USE

- Network graphing (MRTG, aguri, etc.)
- No broken “community” editions.
- Have mirrored server doing analysis?
- NAT options? cone, etc.
- Local system monitoring (e.g. system temp, hdd status, etc.)
- sshd
- GSM, pppd ?
- Two-factor authentication.
- snort, suricata

4.2 Firewall Operating Systems in Use

Debian

Debian

Aleph Objects uses Debian for nearly everything. It could easily be used as a router/firewall. There are better, more tuned options.

Linux's iptables is used on servers.

pfSense

pfSense

pfSense is used for the main firewalls. See pfSense chapter for more info.

FreeBSD

FreeBSD

FreeBSD is used as the base for pfSense.

Solid OS. Can use OpenBSD's PF (packet filtering). Same problem as with OpenBSD, few admins know it.

The screenshot shows the official Debian website. At the top, there's a navigation bar with links to "About Debian", "Getting Debian", "Support", and "Developers' Corner". Below this is a main banner featuring the Debian logo and the text "The universal operating system". To the right of the banner is a button labeled "Download Debian 8.5 (32/64-bit PC Network Installer)". The main content area contains text about Debian being a free operating system and provides links for installation and more information. A footer navigation bar at the bottom includes sections for "About", "Getting Debian", "News", "Support", and "Miscellaneous", along with links to "Social Contract", "Code of Conduct", "Free Software", "Partners", "Donations", "Contact Us", "Help Debian", "Documentation", "Installation manual", "Debian Books", "Debian Wiki", "Project News", "Events", "Release Info", "Bug reports", "Mailing Lists", "Mailing List Archives", "Ports/Architectures", "Debian International", "Security Information", "Search", "The Debian Blog", "IDENTI.ORA", and "PLANET".

Figure 4.1: Debian Website

The screenshot shows the official FreeBSD website. The header features the FreeBSD logo and the tagline "The Power To Serve". There are links for "Donate to FreeBSD", "Search", and "Search". Below the header is a navigation bar with links to "Home", "About", "Get FreeBSD", "Documentation", "Community", "Developers", "Support", and "Foundation". A language selection dropdown shows options like de, en, es, fr, hu, it, ja, nl, ru, zh_CN. A "IPv6 Armenia" dropdown with a "Go" button is also present. The main content area includes a section titled "The FreeBSD Project" with a paragraph about FreeBSD's history and features, and links to "Learn More" and "Get the FreeBSD Journal". To the right is a large cartoon character of a red devil-like creature holding a pitchfork. A yellow button says "Download FreeBSD". Below it is a "LATEST RELEASES" section with links to "Production: 10.3, 10.2, 10.1, 9.3" and "Upcoming: 11.0, Support Lifecycle". A "SHORTCUTS" section lists links to "Mailing Lists", "Reporting Problems", "FAQ", "Handbook", and "Ports". A "New to FreeBSD?" button is located in the bottom right corner.

Figure 4.2: FreeBSD Website

4.3 Firewalls Evaluated

The following firewalls were installed and tested for evaluation. pfSense was selected over these due to it being Free Software, its high security, the vast feature set, regular maintenance, and just being glorious overall.

Alpine Linux

Alpine — “Small. Simple. Secure. Alpine Linux is a security-oriented, lightweight Linux distribution based on musl libc and busybox.”

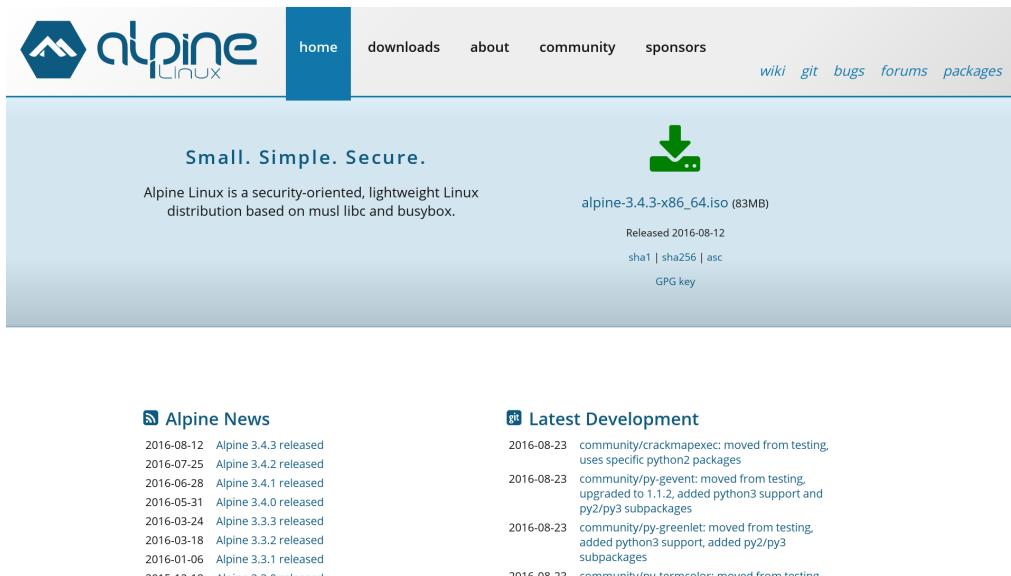


Figure 4.3: Alpine Linux Website

Download and install .iso to USB. Boot from USB, do text install onto HD. The installer looked very much like OpenBSD and was quite terse, but worked fine. The installed system is a basic lean GNU/Linux installation. Firewall configuration is text based. Looks nice, but not many features, except lightweight. Similar to OpenWRT in that way, except no web GUI, AFAICT.

clearOS

clearOS — “ClearOS is an operating system for your Server, Network, and Gateway systems. It is designed for homes, small to medium businesses, and distributed environments. ClearOS is commonly known as the Next Generation Small Business Server, while including indispensable Gateway and Networking functionality. It delivers a powerful IT solution with an elegant user interface that is completely web-based.”

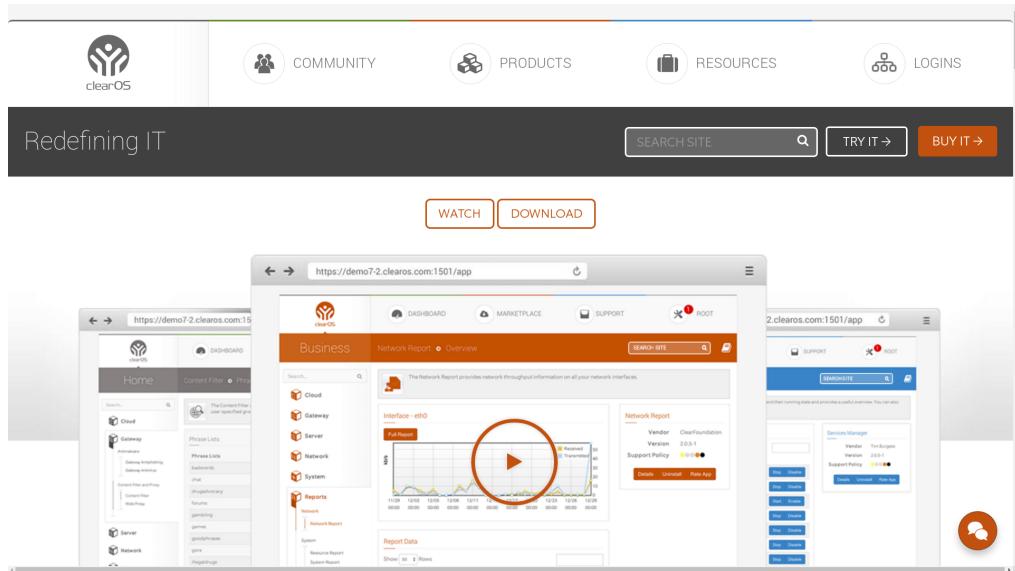


Figure 4.4: clearOS Website

- Overall, very very nice, very clean with many features.
- Baitware is the only thing holding this back.
- The web interface never crashed or caused issues.
- Usage is stable.
- Latest release: 7.2.0
- Release Date: March 7, 2015.
- Package Updater: yum

4.3. FIREWALLS EVALUATED

- Kernel: Linux 3.10.0-327.3.1.el17.x86_64
- Base OS: Fedora? CentOS?
- Easy GUI install
- Has enterprise (baitware?) version.
- Has enterprise hardware.
- Web based configuration system started on first boot
- Web wizard has option to select Community or non-free versions.
- Web wizard has system registration for a marketplace for apps. Have to register?
- Registering set “Software End-of-Life” to August 31, 2018.
- Lots of phone-home activity with marketplace and registration....
- Simple “Update All” button to update system (with yum, afaict).
- Very clean, overall.
- Wide variety of “Apps” in the Marketplace that are GPL.
- Non-free plugins are listed along free ones. The owncloud plugin is non-free.
- Most apps don’t have any ratings.
- The default “Exception Sites” whitelist had their clear*.com sites and a few *.microsoft.com.
- Has optionally transparent web proxy.
- Installed many Apps, and it was all very clean.
- clearOS gets pwned, we get pwnd? Yes.
- Need to create account to get to knowledge base ?
- Actual firewalling rules (e.g. block just these devices from everything but port 443) aren’t so strong.

- There doesn't appear to be a way to say "just allow port 22 from NNN"...
- A lot of great setup.
- MultiWAN — Nice, but simple load balancing between multiple upstreams.
- Failover to multiple upstreams.
- No fail over to another router (ala CARP).
- dhclient (?) overwrites DNS addresses, no place to set static (?!?)
- Some pretty graphs, but not the most useful.
- Overall kind of a toy compared to pfSense.

IPCop

IPCop — “The IPCop Firewall is a Linux firewall distribution. It is geared towards home and SOHO users. The IPCop web-interface is very user-friendly and makes usage easy.”

- Last release was 2015-02-23, well over a year ago.
- The i486 image doesn't boot all the way, gives video artifacts.
- All looks pretty old and crusty at this point.

IPFire

IPFire — “the professional and hardened Linux firewall distribution that is secure, easy to operate and coming with great functionality so that it is ready for enterprises, authorities, and anybody else.”

- Latest release: July 12th, 2016.
- http://downloads.ipfire.org/releases/ipfire-2.x/2.19-core103/ipfire-2.19.x86_64-full-core103.iso

4.3. FIREWALLS EVALUATED

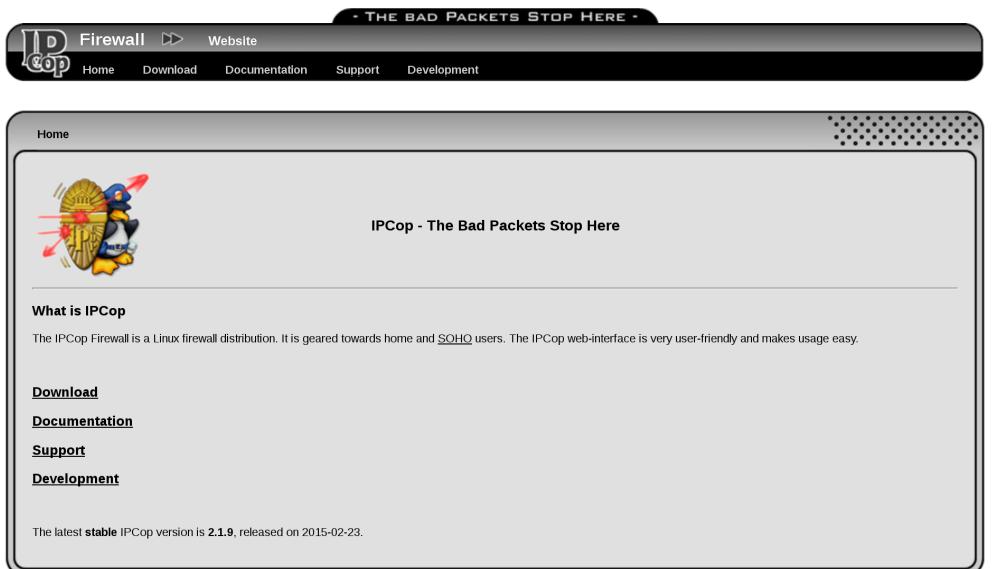


Figure 4.5: IPCop Website



Figure 4.6: IPFire Website

- Installer has a cool thing that flashes the light on the ethernet port to identify it.

- Kernel: Linux 3.14.65-ipfire
- Post install, apache httpd process is starting, but not listening on any ports. Still in “-k start”. So no web admin. Needed to modify listen.conf in Apache to 0.0.0.0:80 and 0.0.0.0:444. It appears it was hanging because of IPv6 (?).
- Nice MRTG-esque graphs of services and ports, including system temps, etc.
- Second set of non-MRTG network traffic graphs.
- Transparent web caching.
- Much more technical setup than clearOS. More SysAdmin oriented.
- OpenVPN.
- QoS.
- Load balancing? Fail over?
- IDS (snort).
- Uses its own pakfire package management tool.
- The wiki is under an NC license.
- Kernel uses grsec.
- No WAN failover (!).

OPNsense

OPNsense — “the Open Source Firewall that is easy-to-use and protects your network”

- Release is current.
- Making a dd of the .iso to a USB drive didn’t boot. OPNsense-16.7.r2-OpenSSL-cdrom-amd64.iso
- Based on FreeBSD.

4.4. PREVIOUS OPERATING SYSTEMS IN USE

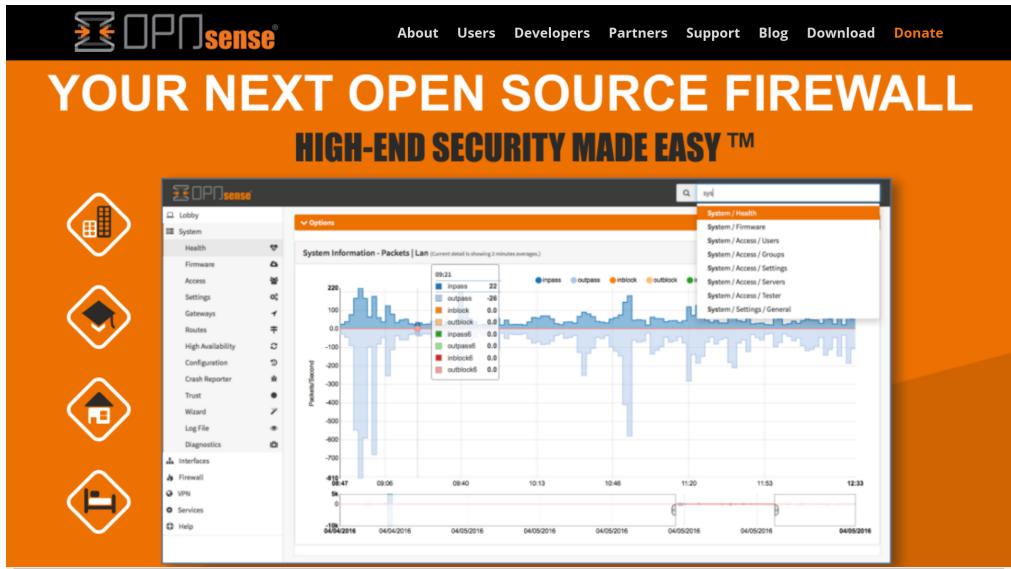


Figure 4.7: OPNsense Website

- Source in github.
- Looks decent, but wasn't tested.

4.4 Previous Operating Systems in Use

OpenBSD

OpenBSD

Aleph Objects has dropped OpenBSD in favor of pfSense.

OpenBSD with PF was previously used for our firewall for the first five years. It is very reliable and secure. Few people know how to administer it. It is all command line editing of firewall configuration files.

4.5 Other

Gentoo

Gentoo

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Figure 4.8: OpenBSD Website

Can be tuned in.

NetBSD

NetBSD

Solid OS. Can use OpenBSD's pf, iirc. Same problem as with OpenBSD, few admins know it.

Contact

Phone, Email, Web, Location

5.1 Support

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www.alephobjects.com

Colophon

Created with 100% Free Software

Debian GNU/Linux
LATEX Memoir
