

FreeBSD, The Other Unix-Like Operating System

And Why You Should Get Involved!

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LCA 2020

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freeBSD®

Goals

- Share FreeBSD's long history
- What is FreeBSD and Why People Use It
- Why you should use and/or contribute to FreeBSD
- FreeBSD Feature Highlights

The FreeBSD World

FreeBSD is an open source Unix-like **operating system** descended from the Unix developed at the University of California, Berkeley in the 1970s.



The FreeBSD Project is an active open source **community** since 1993 with hundreds of committers and thousands of contributors around the world.

The FreeBSD Foundation is a 501(c)3 **non-profit organization** registered in Colorado, USA in 2000 dedicated to supporting the FreeBSD Project, its development and its community.



What is FreeBSD?



It's not a Linux Distribution!

What is FreeBSD?

One of the oldest (1993), largest, and most successful open source projects in the world

Complete operating system including kernel, userland, documentation, and tools

Over 33,000 3rd Party Open Source Packages

What is FreeBSD?

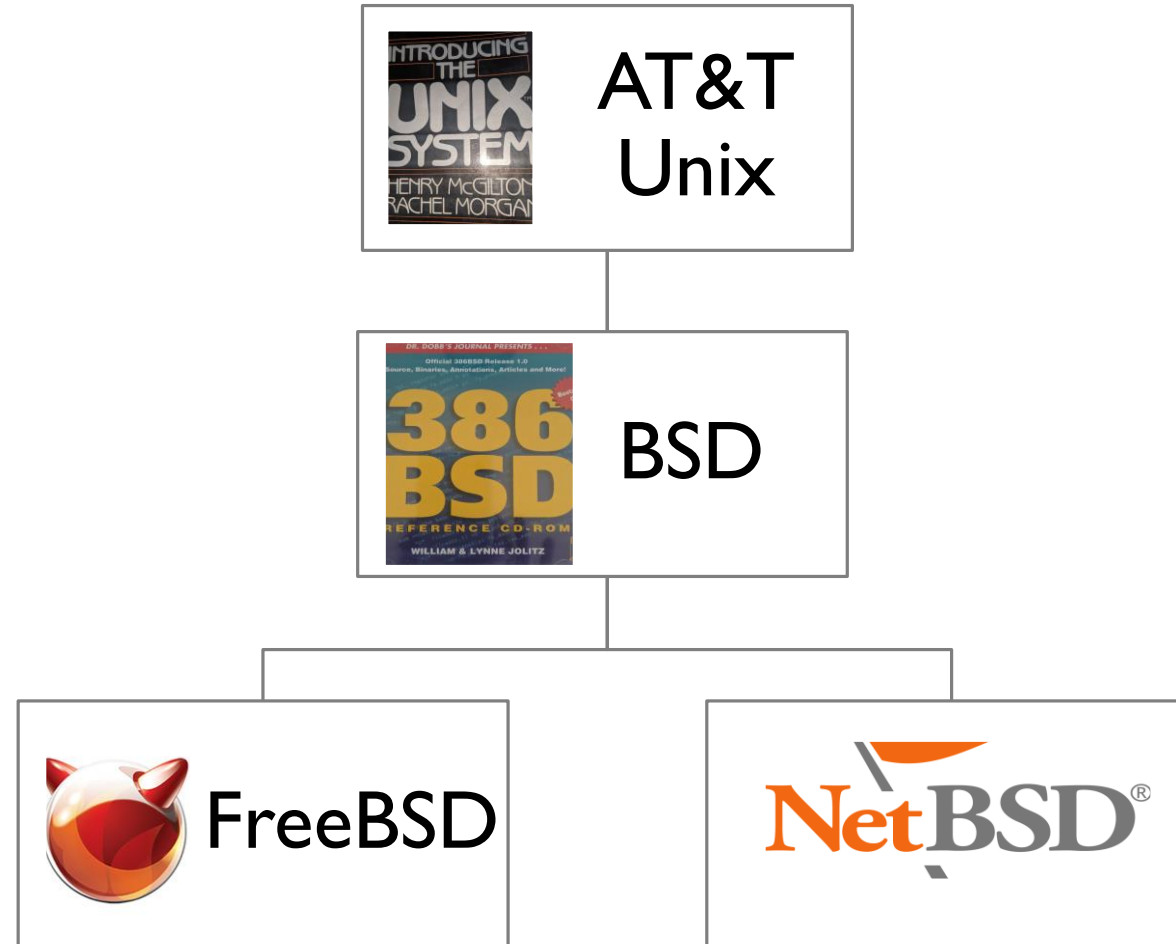
Created and distributed by a community of highly technical and committed contributors (Over 400 active developers and thousands of contributors)

Works on Intel / AMD x86 32 and 64-bit, 32 and 64 bit ARM, RISC-V, PowerPC, MIPS, AWS, Azure, GCP, ...

10s of millions of deployed systems



Abridged BSD Family Tree



The Evolution of FreeBSD

A Brief Look Back at the
History of FreeBSD



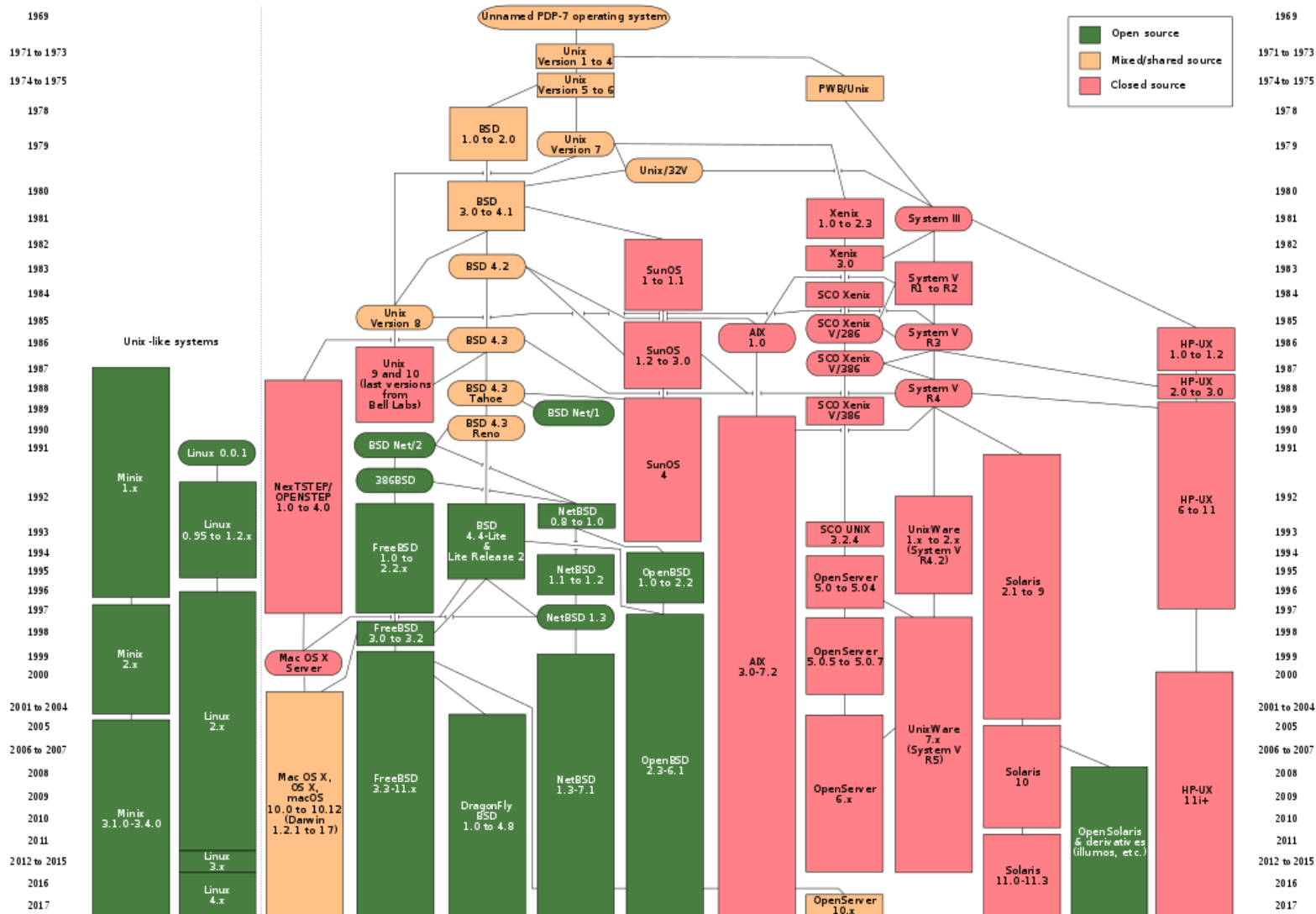
1969

UNIX

In 1969 Ken Thompson, Dennis Ritchie and others started working on a program

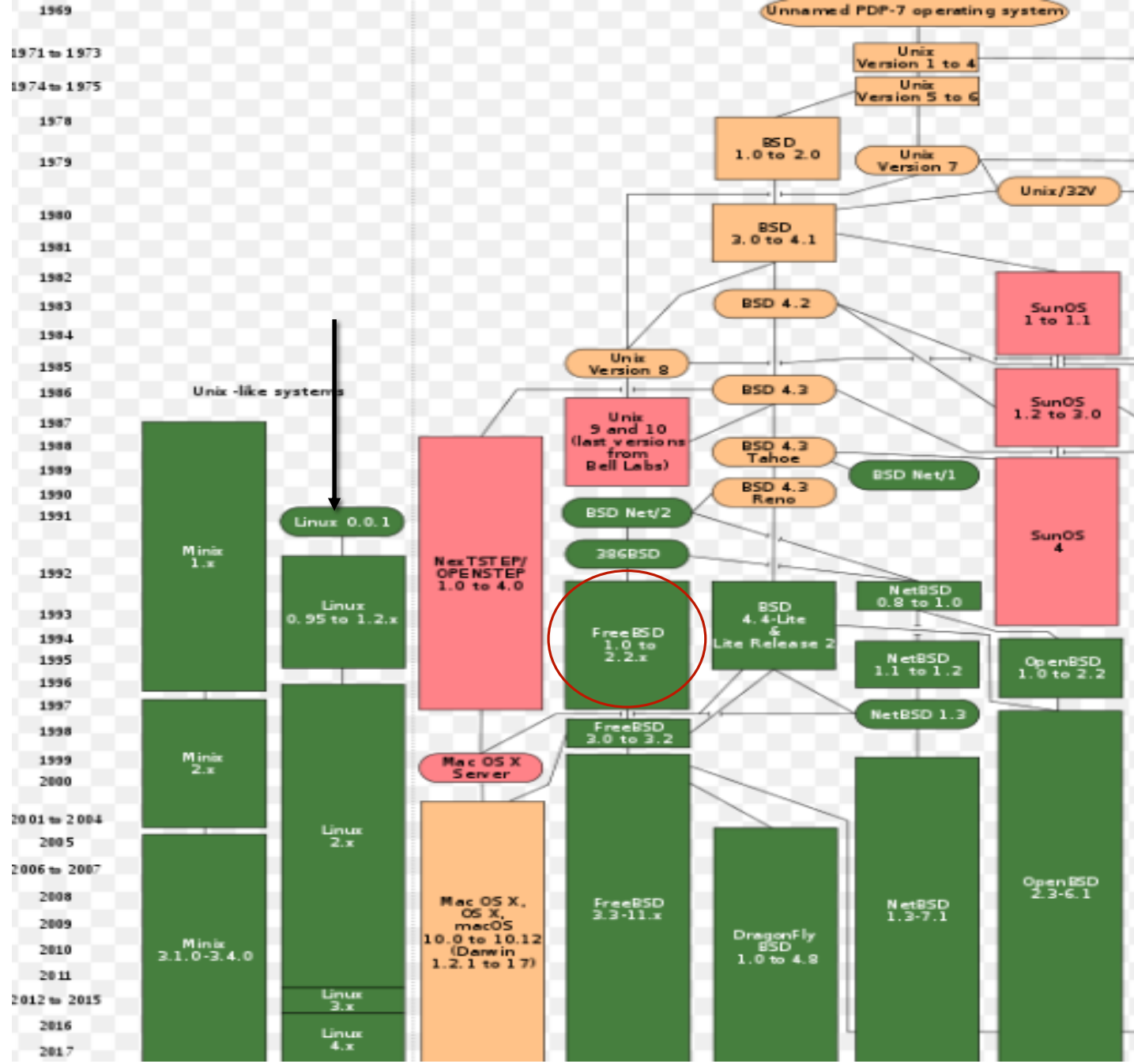


Evolution of Unix and Unix-like systems



By Eraserhead I, Infinity0, Sav_vas - Levenz Unix History Diagram, Information on the history of IBM's AIX on ibm.com, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=1801948>





Who Uses FreeBSD



NETFLIX



JUNIPER
NETWORKS

vmware®

arm



VERISIGN®



SONY
NGINX

trivago®

GROUPON®

FlightAware
Live Flight Tracking

Most Likely You Use FreeBSD!



iPhone or Apple computer

Streaming Netflix

NETFLIX



Messaging someone over Facebook's WhatsApp application

Sony PlayStation 4



trivago[®]

Planning your next vacation

Getting an awesome deal!

GROUPON[®]

Why Use FreeBSD?

- Friendly and Approachable Community
- Excellent Documentation
- Good Tooling and Modern Compilers
- Consistent Development and Release Processes
- Wide Variety of Architectures Supported
- 2-clause BSD license - Does not restrict what you can do with your own code!
- Secure



How the Project Works

Independent of the FreeBSD Foundation

Developer elected 9-person core team

Mentorship for Commit Bit

One community with different functional teams developing system as a whole (core, release engineering, security, ports, documentation,...)

Collaborative Development Environment



FreeBSD Project Org Chart

FreeBSD Foundation

FreeBSD Project

Core Team

Security Team

Document Team

Cluster Admin

Release Engineering

Ports Management

Other Teams include:

- Ports secteam
- Security Officer
- Bugmeisters
- Ports Security Team
- Continuous Integration Testing Admins
- Postmaster Team
- Webmaster Team
- Phabricator Code Review Administration

Core Team - 9

Committers - ~400

Contributors - Thousands

FreeBSD core team

9-member elected management body

- Elections held every two years
- Active committers vote for core members
- Non-voting core team secretary is selected by the core team

Responsibilities

- Administrative (commit bits, hats, team charters)
- Strategic (project direction, coordination, cajoling)
- Rules, conflict resolution, enforcement

We have no “benevolent” dictators for life!

Who are the FreeBSD committers

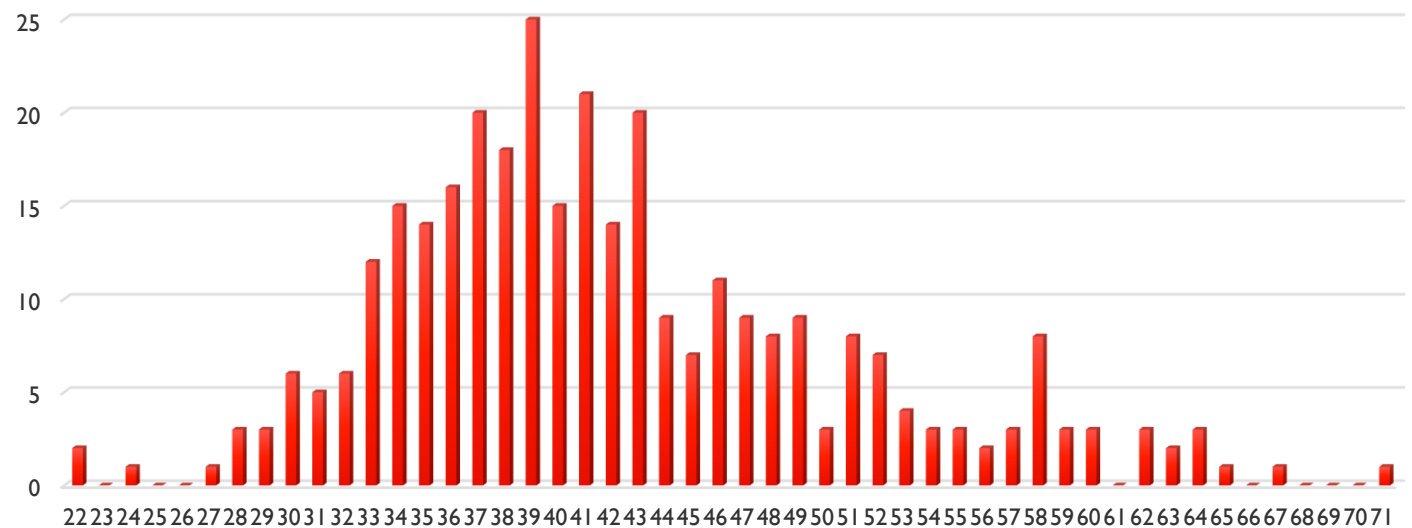
Locations

- 34 countries
- 6 continents

Ages

- Oldest (documented) committer born in 1948
- Youngest (documented) committer born in 1997
- Average age 42
- Data from circa June 2019

Committer Age Distribution



FreeBSD Releases

POLA: Principle Of Least Astonishment

Don't break things that work
Upgrades are generally painless
Even across major releases

Two types of releases:

Major Release

(Dot Release) –
12.0 - Around
every two years
(supported for 5
years)

Point Release –

11.3 Around every 9
months – ABI/API
compatibility

Two types of branches:

Current – Head – All changes to base system committed here. Dot releases built from here.

Stable – After testing, most changes in current moved here. Point releases built from stable.

Weekly snapshots available for current and stable branches

**Download
FreeBSD**

Supported Releases

- » Production: [12.0](#), [11.3](#), [11.2](#)
- » Upcoming: [12.1](#)
- » [Support Lifecycle](#)

How to Contribute to FreeBSD

Many ways to get involved with the project, including contributing code, writing documentation, maintaining ports, and advocacy.

The size of the project allows for a greater chance for anyone to make a notable impact.

Easy to get started contributing.

Start by translating or improving our documentation

Pick one of the many ports to maintain or add

Go through the PR list and fix some bugs

**New to
FreeBSD?**



Why Companies Use FreeBSD?

- History of innovation
- High performance
- Great tools
- ABI stability within major releases – Remember **POLA**
- Mature release model
- Excellent documentation
- Business Friendly License
- ZFS
- Open community
- Smaller footprint than most operating systems

“We choose FreeBSD for many of our internal services and product service offerings because we know we can rely on its consistent reliability and performance. Its portability not only allows us to run it on almost any commodity or enterprise server, but allows for the possibility to move a hard drive from one server to another, boot, and get back to normal operation with minimal fuss.”

The Power to Connect

Netflix Open Connect
Appliance
2RU 40Gb/s Storage
Appliance with 248TB
storage



Application

N Open Connect is the name of the global network that delivers Netflix TV shows and movies to members world-wide.

- The building blocks are purpose-built Open Connect Appliances (OCAs).
- FreeBSD was selected as the operating system for OCA because of its balance of stability and features, strong development community, and staff expertise.

Results

- **Delivers over 100 Tb/second at peak**
- FreeBSD is central to pushing this much content **cost-effectively**. By minimizing kernel to userspace copies, data stays in the kernel as long as possible
- [Async Sendfile](#), a Netflix and NGINX innovation, is available to all FreeBSD users
 - Web server tells kernel to send this chunk of this file out over this socket
 - Kernel returns to userspace so the web server can do other things
 - Kernel continues in background sending files to users

Where FreeBSD Stands Out

- Embedded Systems
- Video CDN/Streaming
- Security
- Research
- Storage
- Virtualization
- Networking
- High Performance
- Data Centers
- Servers
- ISPs



Kernel features

Multi-processing multi-threaded kernel

Support for many popular hardware architectures:

Intel/AMD x86/64, 32- and 64-bit ARM, RISC-V, PowerPC, MIPS

UNIX, POSIX, BSD programming interfaces

Multi-protocol network stack

- *IPv4, IPv6, IPX/SPX, AppleTalk, IPSEC, ATM, Bluetooth, IEEE 802.11, SCTP,...*
- Reference implementation for many protocols

Unified, coherent build-system across components

Extensive documentation

Userland features

Complete, integrated Unix system

- Expected tools are in the base installation – no extra packages needed
- Build-time knobs to trim the system down for appliances

Kernel and userland maintained together

- Userland is always in sync with the kernel
- New kernel features are immediately available in userland

Strong focus on consistency

Other Features

- **Robust file systems** including UFS and ZFS (Active work happening on ZFS)
- **DTrace** - an advanced event-based performance analysis and troubleshooting tool. DTrace can help you identify and quantify the root cause of virtually any performance issue, in both user-level and kernel code. It can be executed using custom and powerful one-liners and scripts.
- **Jails** – Lightweight virtualization added to FreeBSD in the early 2000s.
- **bhyve** – Full-blown hypervisor. This hypervisor supports a number of guests, including FreeBSD, OpenBSD, Microsoft Windows, and many Linux distributions.
- **TCP/IP** was originally developed on BSD and FreeBSD remains the reference implementation for several network protocols.
- **Capsicum** – Capsicum is a lightweight OS capability and sandbox framework developed at the [University of Cambridge Computer Laboratory](#). Capsicum extends the POSIX API, providing several new OS primitives **to support object-capability security** on UNIX-like operating systems

What is CHERI?



An early experimental FPGA-based CHERI tablet prototype running the CheriBSD operating system and applications, Cambridge, 2013

- CHERI is an **architectural protection model**
 - Composes the capability-system model with hardware and software
 - Adds new security primitives to Instruction-Set Architectures (ISAs)
 - Implemented by microarchitectural extensions to the CPU/SoC
 - Enables new security behavior in software
- CHERI mitigates vulnerabilities in **C/C++ Trusted Computing Bases**
 - Hypervisors, operating systems, language runtimes, browsers,
 - Fine-grained memory protection, scalable compartmentalization
 - Directly impedes common exploit-chain tools used by attackers
 - Mitigates many vulnerability classes .. even unknown future classes

The Morello Board

- An Industrial Demonstrator of a Capability architecture
- Uses a prototype capability extension to the Arm Architecture
 - Prototype is a “superset” of what could be adopted into the Arm architecture
- Use of a superset of the architecture is very unusual
 - Also unrealistic as a commercial product – there will be some frequency effects
 - However, there are tight timescales so architecture is nearly complete now
- The superset of the architecture will allow a lot of software experimentation
 - Various different mechanisms for compartmentalisation
 - Collection of features for which the justification is unclear
 - Techniques for holding the capability tag bit
- Architecture will have formally proved security properties (with UoC and UoE)
- **Morello Board will be the ONLY physical implementation of this prototype architecture**
 - Learnings from these experiments will be adopted into a mainstream extension to the Arm architecture
 - **NO COMMITMENT TO FULL BINARY COMPATIBILITY TO THE PROTOTYPE ARCHITECTURE**
 - But successful concepts are expected to be carried forward into the architecture and can be reused there



The FreeBSD Foundation

Founded in March 2000

501(c)3 (non-profit public charity)

Based in Boulder, Colorado

100% Funded by donations

Separate from the FreeBSD Project

Support critical needs of Project



Why We Should Work Together?

May work on multiple operating systems during your employment

Learn from each other. We both have successes and failures.

Different coding methodologies and philosophies –
Understanding the reasons for both.

FreeBSD's smaller code base makes it a great reference platform.

“Using and learning FreeBSD made me a better Linux admin and systems engineer.”



Why Contribute to FreeBSD

- Be part of an inclusive and welcoming community with a strong mentoring culture
- Great way to learn systems programming and study operating systems.
- The size of the project allows for a greater chance for anyone to make a notable impact.
- Some of the most notable BSD and FreeBSD Founders are still involved in the Project – And, they are approachable!
- Democratically run open source project allowing committers to commit their changes directly to the source tree without having to go through hierarchy of lieutenant model.



A screenshot of the FreeBSD website. The top navigation bar includes links for Home, About, Get FreeBSD, Documentation, Community, Developers, Support, and Foun. Below this is a sidebar with a list of links: » Documentation, » FAQ, » Handbook, » Manual Pages, » Books and Articles Online, » Publications, » Web Resources, » For Newbies, » Documentation Project, and » Archive. The main content area features sections for "Resources for Newbies", "Getting FreeBSD" (with a link to "here"), "Learning about FreeBSD" (with links to "FreeBSD Handbook" and "Frequently Asked Questions (FAQ)"), and "Questions and Support" (with a link to a mailing list form).

Get your hands dirty!

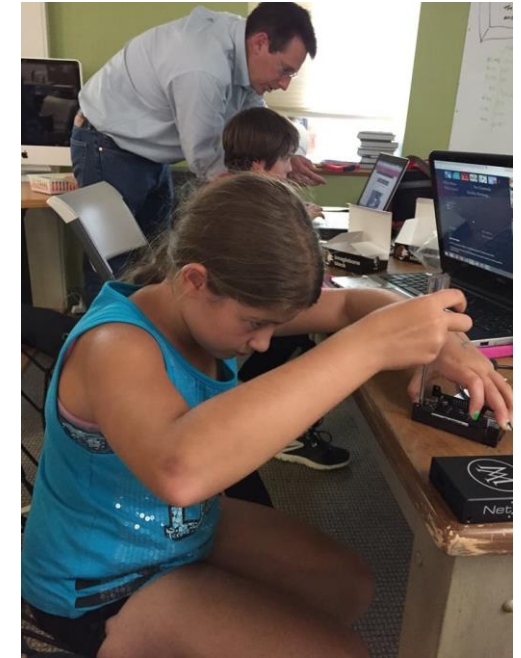
FreeBSD images available from all major cloud providers

- Amazon AWS
- Microsoft Azure
- Digital Ocean
- Gandi
- Vagrant
- Etc...

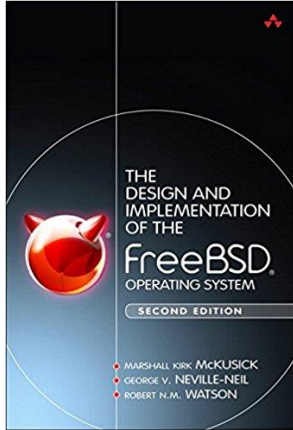
Or install in VMware / VirtualBox / ...

<https://www.FreeBSD.org/where.html>

**Download
FreeBSD**

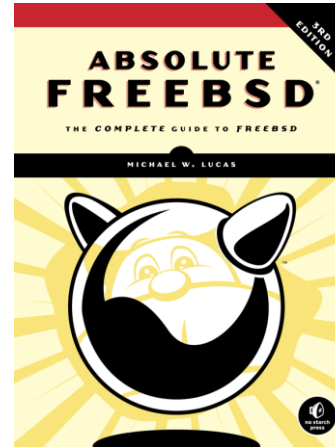


Resources



Mailing Lists

[Forums, Mailing Lists, IRC and Events](https://www.freebsd.org/community.html)
(<https://www.freebsd.org/community.html>)



Contributing to FreeBSD

(https://www.freebsd.org/doc/en_US.ISO8859-1/articles/contributing/)

FreeBSD Handbook

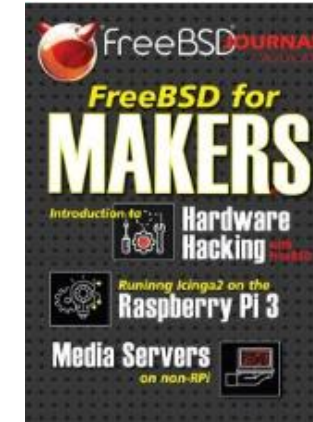
<https://www.freebsd.org/doc/handbook/book.html>

History

<https://www.mckusick.com/history/>

Forums:

<http://forums.freebsd.org/>



<https://www.freebsd.foundation.org/journal/>

The image is a screenshot of the FreeBSD Foundation website. At the top, there is a donation progress bar showing 'Amount Raised: \$1,332,398', 'Goal: \$1,250,000', and 'Donors: 979'. To the right of the bar is a 'DONATE' button. Below the bar is a navigation menu with links for 'ABOUT', 'WHAT WE DO', 'JOURNAL', 'GET INVOLVED', 'DONORS', 'NEWS & EVENTS', and 'FREE'. A large red banner with the text 'How-To Guides' is positioned below the navigation menu. Underneath the banner, there is a list of links including 'FREEBSD.ORG', 'WHO USES FREEBSD', 'PRODUCTS FROM FREEBSD', 'HOW-TO GUIDES', 'INSTALLFEST', 'OCTOBER 2018 FREEBSD DEVELOPER SUMMIT', 'FREEBSD DAY', and 'TIMELINE'. The 'HOW-TO GUIDES' link is highlighted.

Getting Started with FreeBSD

As part of the FreeBSD Foundation's education initiative, we've worked with community members and new recruits to develop guides that make getting started with FreeBSD a straight forward process. For an overview, see our [FreeBSD Quickstart Guide](#). Stay tuned for more how-tos as they become available.

FreeBSD Installation Guides:

- [Installing FreeBSD with VirtualBox \(Mac/Windows\)](#)
- [Installing a Desktop Environment on FreeBSD](#)
- [Installing FreeBSD for Raspberry Pi](#)
- [Installing PC-BSD as a Primary Operating System](#)

