

Getting started with FreeBSD development

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What is an Operating System?



A set of lego blocks

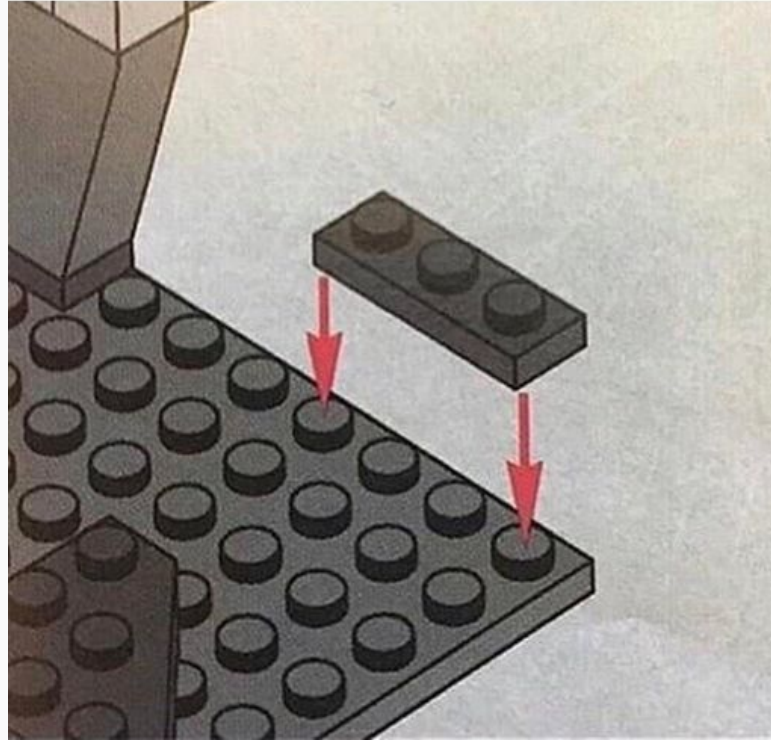
What do OS designers like to build?



Things they think are cool

Senior Developer: Just read the documentation!

The documentation:



This talk is trying to...

- Build a big picture of the FreeBSD development environment and process
- Help you avoid the stupid things which may waste your time
 - Save energy and the Earth

- BTW, our documents (man pages and handbooks) are not bad
 - We write codes and both documents, and commit them to the same repository
 - Let us know if there is any issue or unclear
 - https://www.freebsd.org/doc/zh_TW/

This talk is not...

- Going through the data structure, algorithm nor source code
- Instead, check these books or videos in reference

Environment

- Bare metal and virtual machine are both fine
- FreeBSD, latest release (12.0, 12.1 will be released in this Nov.)
 - <https://www.freebsd.org/where.html>
 - FreeBSD head **MUST** be able to be built on the latest RELEASE version
 - You don't have to install "src" component at this point
- With default install, you have everything you need for:
 - Getting latest source code (svnlite)
 - Editing text (vi)
 - Building toolchain (clang/gcc)



Customize Environment

- "latest" pkg branch, if you like to stay on the bleeding edge
 - `/etc/pkg/FreeBSD.conf`
 - `url: "pkg+http://pkg.FreeBSD.org/${ABI}/latest"`
 - quarterly (RELEASE default) -> latest
- `pkg update; pkg install <...>`
 - zsh, vim-console, git, subversion, sudo, ... # anything you like
- Setup your `~/.*` files and others, like `sudoers(5)`

Kernel and World

- Kernel -> **/boot/kernel**
 - Kernel and the dynamic loadable modules
 - Under **src/sys**
- World -> *any* other things except **/usr/local**
 - Under **src/bin, src/usr/sbin, src/lib** ...
 - 3rd party software goes to /usr/local/
- make kernel & make world
 - Too dangerous
- build* & install*
 - **make buildworld buildkernel installkernel installworld**
 - Don't rebuild things you don't have to build

SCM

- Yes... we're still using SVN in 2019...
 - We're working on evaluation migration and there are mirrors for other SCM
 - git-bata.freebsd.org
mirror -> <https://github.com/freebsd>
 - hg-beta.freebsd.org
- If it's a headache, it's committers', not yours (yet)

“We should not debate on what is the best SCM.

We should let everyone can contribute to FreeBSD with their favorite SCM”

svn.freebsd.org

- Repositories & branches (selected)
 - base (src)
 - head, stable
 - doc
 - head
 - ports
 - head, branches
- Focus on **head** first
 - `svn co svn://svn.freebsd.org/base/head freebsd-src`
- Web repository browser: <https://svnweb.freebsd.org>

Git

- <https://github.com/freebsd/>
 - freebsd (base) (src)
 - freebsd-doc (doc)
 - freebsd-ports (ports)
- We don't accept pull requests and issues on github currently
 - Problem report goes to <https://bugs.freebsd.org>
 - Patch goes to <https://reviews.freebsd.org>

Hack

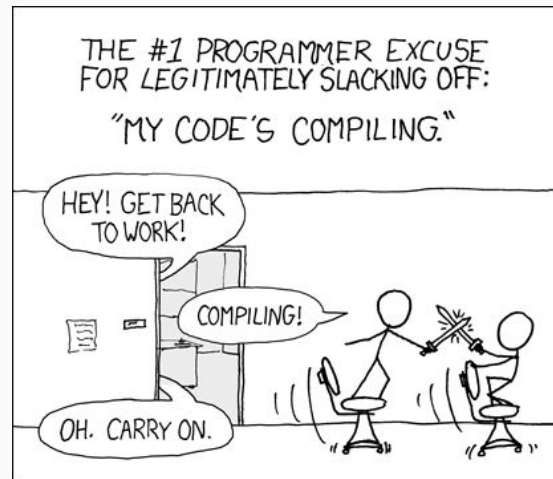
- You can checkout/clone the source to anywhere you like
- For beginning, `/usr/src` is safer
- (optional) use `mount_nullfs(8)`:
 - `sudo mount -t nullfs ~/freebsd-src /usr/src`

```
cd /usr/src; hack; hack; hack
```

Build

```
cd /usr/src make -DNO_CLEAN -j<N> buildworld buildkernel
```

- Object files go to `/usr/obj`
 - Set env `MAKEOBJDIRPREFIX` to change
- `/etc/make.conf`
 - `make.conf(5)`
 - Also affects ports building
 - `make __MAKE_CONF=~/.src/make.conf ...`
- `/etc/src.conf` & `/etc/src-env.conf`
 - `src.conf(5)`



Install & reboot & PRAY

- `cd /usr/src`
- `sudo make installkernel installworld`
- `sudo etcupdate`
- `sudo reboot`



If something goes wrong

- System boot menu -> “Escape to a loader prompt” ->

boot kernel.old

- **Before building the new kernel, backup the good one!**
- Handbook:
 - <https://www.freebsd.org/doc/en/books/handbook/kernelconfig-trouble.html>
 - https://www.freebsd.org/doc/zh_TW/books/handbook/kernelconfig-trouble.html

Package and create VM image

- Like how we build on <https://ci.freebsd.org>
 - Available at <https://artifact.ci.freebsd.org/snapshot/>
- **cd /usr/src/release**
- **sudo make clean; sudo make base.txz kernel.txz**
- **This is not the optimal method**
 - Can be done by **make DESTDIR=foo installkernel installworld distribution** and something small extra steps.
 - See these targets in **release/Makefile** and *.txz targets in **release/Makefile**
 - You should use those after you get familiar with the build system

Package and create VM image (c.)

- `mkdir -p ufs`
- `sudo tar Jxf base.txz -C ufs`
- `sudo tar Jxf base.txz -C ufs`
- `dd if=/dev/random of=ufs/boot/entropy bs=4k count=1`
- `sudo makefs -d 6144 -t ffs -f 200000 -s 8g -o version=2,bsize=32768,fsz=4096 -Z ufs.img ufs`
- `mking -s gpt -f raw \
-b ufs/boot/pmbr \
-p freebsd-boot/bootfs:=ufs/boot/gptboot \
-p freebsd-swap/swapfs::1G \
-p freebsd-ufs/rootfs:=ufs.img \
-o disk-test.img`
- Install 3rd party packages into image:
 - https://github.com/freebsd/freebsd-ci/blob/master/scripts/build/build-test_image.sh

Emulators

- Bhyve
 - Create disk image and run
 - `sh /usr/share/examples/bhyve/vmrun.sh -m 4096m -c 2 -d disk-test.img <test-vm-name>`
 - PXE with TFTP/HTTP
 - It is recommend to switch to this
- QEMU
 - <https://wiki.freebsd.org/QemuRecipes>
 - `src/.cirrus.yml`
- VirtualBox, VMWare, etc.

Tests

- ATF/Kyua by Julio Merino <jmmv@{NetBSD,FreeBSD}.org>
 - C/C++/sh unit test framework and test driver
 - <https://github.com/jmmv/atf> (framework, imported as contrib/atf)
 - <https://github.com/jmmv/kyua> (driver)
 - <https://github.com/jmmv/kyua/wiki/Quickstart>
 - Julio's talk & tutorial at AsiaBSDCon 2014
 - <https://drive.google.com/drive/folders/0B08g-X1kPkSYNmIEdTb5RjIFbkk>
 - Sample code: `src/tests/sys/netinet/socket_afinet.c`
 - **`cd /usr/tests; kyua test`**
- <https://ci.FreeBSD.org>
 - <https://github.com/freebsd/freebsd-ci>
- <https://cirrus-ci.com>

Userspace only changes

- `cd src/bin/cat (and src/bin/cat/tests)`
- `hack; hack; hack`
- `make depend`
- `make install`
- `cd /usr/tests/bin/cat`
- `kyua test`

Issue Tracking & Patch Review

- Issue tracker:
 - <https://bugs.freebsd.org>
 - Bug report, feature request, change request
 - Can link core review system with “URL” field
- Code review system:
 - <https://reviews.freebsd.org>
 - `pkg install arcanist-php73`
 - `arc install-certificate https://reviews.freebsd.org`
 - `arc diff --create path/to/file path/to/dir`
 - <https://wiki.freebsd.org/Phabricator>

Ask someone in the community to help you go through all the process!

There are still much, much more...

- More make command line options
 - Comments in the top of src/Makefile.inc1
- Non x86 system development
- Attach debugger
- Build with ccache
 - WITH_CCACHE_BUILD in src.conf
 - pkg install ccache; /usr/local/share/doc/ccache/ccache-howto-freebsd.txt
- External toolchain
 - pkg search xtoolchain -> aarch64-xtoolchain-gcc, xtoolchain-llvm-devel
 - make **CROSS_TOOLCHAIN=amd64-gcc** kernel
- Doc and ports
- ...etc, let's discuss in the community!

Ideas?

- We have good and experienced mentors, and eager good mentees
- <https://wiki.freebsd.org/IdeasPage>
- <https://wiki.freebsd.org/SummerOfCodeIdeas>

Questions?

- Local groups
 - <https://bsdtw.org>
- Wiki: <https://wiki.freebsd.org>
- Mailing list: <https://lists.freebsd.org>
 - freebsd-hackers
- IRC: <https://wiki.freebsd.org/IRC/>
 - Especially channels on EFnet and Freenode
- Worldwide user groups
 - Conferences
 - AsiaBSDCon, EuroBSDCon, BSDCan
 - <https://www.freebsd.foundation.org/what-we-do/grants/>

Reference

- FreeBSD Developers' Handbook
 - <https://www.freebsd.org/doc/en/books/developers-handbook/>
- FreeBSD Journal
 - <https://www.freebsdoundation.org/journal/browser-based-edition/>
- The Design and Implementation of the FreeBSD® Operating System, Second Edition
 - Addison-Wesley Professional ©2014 ISBN:0321968972 9780321968975
- FreeBSD Device Drivers
 - <https://nostarch.com/bsddrivers.htm>
- Designing BSD Rootkits
 - <https://nostarch.com/rootkits.htm>
- FreeBSD Kernel Internals: Data Structures and Algorithms
 - <https://www.mckusick.com/courses/introorderform.html>
- FreeBSD Kernel Internals: An Intensive Code Walkthrough
 - <https://www.mckusick.com/courses/advorderform.html>
- Others: <https://www.facebook.com/notes/freebsd-taiwan/912104518994533/>



Backup slides

Non-coding contribution?

- Documentation!
 - Doc modern project
 - Blog & tutorial articles, presentations
 - Data collection
 - <https://papers.freebsd.org>
 - <https://github.com/freebsd/freebsd-papers>

Debug

- ktrace/kdump
- <https://wiki.freebsd.org/Debugging>
- FreeBSD Journal November/December 2018, "Debugging the FreeBSD Kernel"
 - <https://www.freebsd.foundation.org/past-issues/freebsd-12/>