FreeBSD Release Engineering

Abstract

This article describes the release engineering process of the FreeBSD Project.

This document has not yet been updated to describe the current release procedures of the FreeBSD Release Engineering team following the transition from Subversion to Git.

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1. Introduction to the FreeBSD Release Engineering Process

Development of FreeBSD has a very specific workflow. In general, all changes to the FreeBSD base system are committed to the head/ branch, which reflects the top of the source tree.

After a reasonable testing period, changes can then be merged to the stable/ branches. The default minimum timeframe before merging to stable/ branches is three (3) days.

Although a general rule to wait a minimum of three days before merging from head/, there are a few special circumstances where an immediate merge may be necessary, such as a critical security fix, or a bug fix that directly inhibits the release build process.

After several months, and the number of changes in the stable/ branch have grown significantly, it is time to release the next version of FreeBSD. These releases have been historically referred to as "point" releases.

In between releases from the stable/ branches, approximately every two (2) years, a release will be
cut directly from head/. These releases have been historically referred to as "dot-zero" releases.

This article will highlight the workflow and responsibilities of the FreeBSD Release Engineering Team for both "dot-zero" and "point" releases.

The following sections of this article describe:

General Information and Preparation
   General information and preparation before starting the release cycle.

Website Changes During the Release Cycle
   Website Changes During the Release Cycle

Release Engineering Terminology
   Terminology and general information, such as the "code slush" and "code freeze", used throughout this document.

Release from head/
   The Release Engineering process for a "dot-zero" release.

Release from stable/
   The Release Engineering process for a "point" release.

Building FreeBSD Installation Media
   Information related to the specific procedures to build installation medium.

Publishing FreeBSD Installation Media to Project Mirrors
   Procedures to publish installation medium.

Wrapping up the Release Cycle
   Wrapping up the release cycle.

2. General Information and Preparation

Approximately two months before the start of the release cycle, the FreeBSD Release Engineering Team decides on a schedule for the release. The schedule includes the various milestone points of the release cycle, such as freeze dates, branch dates, and build dates. For example:

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Anticipated Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>head/ slush:</td>
<td>May 27, 2016</td>
</tr>
<tr>
<td>head/ freeze:</td>
<td>June 10, 2016</td>
</tr>
<tr>
<td>head/ KBI freeze:</td>
<td>June 24, 2016</td>
</tr>
<tr>
<td>doc/ tree slush [1]:</td>
<td>June 24, 2016</td>
</tr>
<tr>
<td>Ports quarterly branch [2]:</td>
<td>July 1, 2016</td>
</tr>
<tr>
<td>stable/12/ branch:</td>
<td>July 8, 2016</td>
</tr>
<tr>
<td>Milestone</td>
<td>Anticipated Date</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>doc/ tree tag [3]:</td>
<td>July 8, 2016</td>
</tr>
<tr>
<td>BETA1 build starts:</td>
<td>July 8, 2016</td>
</tr>
<tr>
<td>head/ thaw:</td>
<td>July 9, 2016</td>
</tr>
<tr>
<td>BETA2 build starts:</td>
<td>July 15, 2016</td>
</tr>
<tr>
<td>BETA3 build starts [*]:</td>
<td>July 22, 2016</td>
</tr>
<tr>
<td>releng/12.0/ branch:</td>
<td>July 29, 2016</td>
</tr>
<tr>
<td>RC1 build starts:</td>
<td>July 29, 2016</td>
</tr>
<tr>
<td>stable/12/ thaw:</td>
<td>July 30, 2016</td>
</tr>
<tr>
<td>RC2 build starts:</td>
<td>August 5, 2016</td>
</tr>
<tr>
<td>Final Ports package builds [4]:</td>
<td>August 6, 2016</td>
</tr>
<tr>
<td>Ports release tag:</td>
<td>August 12, 2016</td>
</tr>
<tr>
<td>RC3 build starts [*]:</td>
<td>August 12, 2016</td>
</tr>
<tr>
<td>RELEASE build starts:</td>
<td>August 19, 2016</td>
</tr>
<tr>
<td>RELEASE announcement:</td>
<td>September 2, 2016</td>
</tr>
</tbody>
</table>

Items marked with "[*]" are "as needed".

1. The doc/ tree slush is coordinated by the FreeBSD Documentation Engineering Team.

2. The Ports quarterly branch used is determined by when the final RC build is planned. A new quarterly branch is created on the first day of the quarter, so this metric should be used when taking the release cycle milestones into account. The quarterly branch is created by the FreeBSD Ports Management Team.

3. The doc/ tree is tagged by the FreeBSD Documentation Engineering Team.

4. The final Ports package build is done by the FreeBSD Ports Management Team after the final (or what is expected to be final) RC build.

If the release is being created from an existing stable/ branch, the KBI freeze date can be excluded, since the KBI is already considered frozen on established stable/ branches.

When writing the release cycle schedule, a number of things need to be taken into consideration, in particular milestones where the target date depends on predefined milestones upon which there is a dependency. For example, the Ports Collection release tag originates from the active quarterly branch at the time of the last RC. This in part defines which quarterly branch is used, when the release tag can happen, and what revision of the ports tree is used for the final RELEASE build.

After general agreement on the schedule, the FreeBSD Release Engineering Team emails the schedule to the FreeBSD Developers.

It is somewhat typical that many developers will inform the FreeBSD Release Engineering Team
about various works-in-progress. In some cases, an extension for the in-progress work will be requested, and in other cases, a request for "blanket approval" to a particular subset of the tree will be made.

When such requests are made, it is important to make sure timelines (even if estimated) are discussed. For blanket approvals, the length of time for the blanket approval should be made clear. For example, a FreeBSD developer may request blanket approvals from the start of the code slush until the start of the RC builds.

To keep track of blanket approvals, the FreeBSD Release Engineering Team uses an internal repository to keep a running log of such requests, which defines the area upon which a blanket approval was granted, the author(s), when the blanket approval expires, and the reason the approval was granted. One example of this is granting blanket approval to release/doc/ to all FreeBSD Release Engineering Team members until the final RC to update the release notes and other release-related documentation.

The FreeBSD Release Engineering Team also uses this repository to track pending approval requests that are received just prior to starting various builds during the release cycle, which the Release Engineer specifies the cutoff period with an email to the FreeBSD developers.

Depending on the underlying set of code in question, and the overall impact the set of code has on FreeBSD as a whole, such requests may be approved or denied by the FreeBSD Release Engineering Team.

The same applies to work-in-progress extensions. For example, in-progress work for a new device driver that is otherwise isolated from the rest of the tree may be granted an extension. A new scheduler, however, may not be feasible, especially if such dramatic changes do not exist in another branch.

The schedule is also added to the Project website, in the doc/ repository, in ~/website/content/en/releases/12.0R/schedule.adoc. This file is continuously updated as the release cycle progresses.

In most cases, the schedule.adoc can be copied from a prior release and updated accordingly.

In addition to adding schedule.adoc to the website, ~/shared/releases.adoc is also updated to add the link to the schedule to various subpages, as well as enabling the link to the schedule on the Project website index page.

The schedule is also linked from ~/website/content/en/releng/_index.adoc.

Approximately one month prior to the scheduled "code slush", the FreeBSD Release Engineering Team sends a reminder email to the FreeBSD Developers.
3. Release Engineering Terminology

This section describes some of the terminology used throughout the rest of this document.

3.1. The Code Slush

Although the code slush is not a hard freeze on the tree, the FreeBSD Release Engineering Team requests that bugs in the existing code base take priority over new features.

The code slush does not enforce commit approvals to the branch.

3.2. The Code Freeze

The code freeze marks the point in time where all commits to the branch require explicit approval from the FreeBSD Release Engineering Team.

The FreeBSD Subversion repository contains several hooks to perform sanity checks before any commit is actually committed to the tree. One of these hooks will evaluate if committing to a particular branch requires specific approval.

To enforce commit approvals by the FreeBSD Release Engineering Team, the Release Engineer updates `base/svnadmin/conf/approvers`, and commits the change back to the repository. Once this is done, any change to the branch must include an "Approved by:" line in the commit message.

The "Approved by:" line must match the second column in `base/svnadmin/conf/approvers`, otherwise the commit will be rejected by the repository hooks.

During the code freeze, FreeBSD committers are urged to follow the Change Request Guidelines.

3.3. The KBI/KPI Freeze

KBI/KPI stability implies that the caller of a function across two different releases of software that implement the function results in the same end state. The caller, whether it is a process, thread, or function, expects the function to operate in a certain way, otherwise the KBI/KPI stability on the branch is broken.

4. Website Changes During the Release Cycle

This section describes the changes to the website that should occur as the release cycle progresses.

The files specified throughout this section are relative to the `head/` branch of the `doc` repository in Subversion.
4.1. Website Changes Before the Release Cycle Begins

When the release cycle schedule is available, these files need to be updated to enable various different functionalities on the FreeBSD Project website:

<table>
<thead>
<tr>
<th>File to Edit</th>
<th>What to Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>~/shared/releases.adoc</td>
<td>Change beta-upcoming from IGNORE to INCLUDE</td>
</tr>
<tr>
<td>~/shared/releases.adoc</td>
<td>Change beta-testing from IGNORE to INCLUDE</td>
</tr>
</tbody>
</table>

4.2. Website Changes During BETA or RC

When transitioning from PRERELEASE to BETA, these files need to be updated to enable the "Help Test" block on the download page. All files are relative to head/ in the doc repository:

<table>
<thead>
<tr>
<th>File to Edit</th>
<th>What to Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>share/releases.adoc</td>
<td>Update betarel-vers to BETA1</td>
</tr>
<tr>
<td>~/website/data/en/news/news.toml</td>
<td>Add an entry announcing the BETA</td>
</tr>
<tr>
<td>~/website/static/security/advisory-template.txt</td>
<td>Add the new BETA, RC, or final RELEASE to the template</td>
</tr>
<tr>
<td>~/website/static/security/errata-template.txt</td>
<td>Add the new BETA, RC, or final RELEASE to the template</td>
</tr>
</tbody>
</table>

Once the releng/12.0/ branch is created, the various release-related documents need to be generated and manually added to the doc repository.

Within release/doc, invoke to generate errata.html, hardware.html, readme.html, and relnotes.html pages, which are then added to doc/head/en_US.ISO8859-1/htdocs/releases/X.YR/, where X.Y represents the major and minor version number of the release.

The fbsd:nokeywords property must be set to on on the newly-added files before the pre-commit hooks will allow them to be added to the repository.

The relevant release-related documents exist in the doc repository for FreeBSD 12.x and later.

4.3. Ports Changes During BETA, RC, and the Final RELEASE

For each build during the release cycle, the MANIFEST files containing the SHA256 of the various distribution sets, such as base.txz, kernel.txz, and so on, are added to the misc/freebsd-release-manifests port. This allows utilities other than, such as ports-mgmt/poudriere, to safely use these distribution sets by providing a mechanism through which the checksums can be verified.
5. Release from head/

This section describes the general procedures of the FreeBSD release cycle from the head/ branch.

5.1. FreeBSD “ALPHA” Builds

Starting with the FreeBSD 10.0-RELEASE cycle, the notion of “ALPHA” builds was introduced. Unlike the BETA and RC builds, ALPHA builds are not included in the FreeBSD Release schedule.

The idea behind ALPHA builds is to provide regular FreeBSD-provided builds before the creation of the stable/ branch.

FreeBSD ALPHA snapshots should be built approximately once a week.

For the first ALPHA build, the BRANCH value in sys/conf/newvers.sh needs to be changed from CURRENT to ALPHA1. For subsequent ALPHA builds, increment each ALPHAN value by one.

See Building FreeBSD Installation Media for information on building the ALPHA images.

5.2. Creating the stable/12/ Branch

When creating the stable/ branch, several changes are required in both the new stable/ branch and the head/ branch. The files listed are relative to the repository root. To create the new stable/12/ branch in Subversion:

```
%svn cp ^/head stable/12/
```

Once the stable/12/ branch has been committed, make the following edits:

<table>
<thead>
<tr>
<th>File to Edit</th>
<th>What to Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>stable/12/UPDATING</td>
<td>Update the FreeBSD version, and remove the notice about WITNESS</td>
</tr>
<tr>
<td>stable/12/contrib/jemalloc/include/jemalloc/jemalloc_FreeBSD.h</td>
<td></td>
</tr>
<tr>
<td></td>
<td>#ifndef MALLOC_PRODUCTION</td>
</tr>
<tr>
<td></td>
<td>#define MALLOC_PRODUCTION</td>
</tr>
<tr>
<td></td>
<td>#endif</td>
</tr>
<tr>
<td>stable/12/lib/clang/llvm.build.mk</td>
<td>Uncomment -DNDEBUG</td>
</tr>
<tr>
<td>stable/12/sys/<em>/conf GENERIC</em></td>
<td>Remove debugging support</td>
</tr>
<tr>
<td>stable/12/sys/*/conf MINIMAL</td>
<td>Remove debugging support</td>
</tr>
<tr>
<td>stable/12/release/release.conf.sample</td>
<td>Update SRCBRANCH</td>
</tr>
<tr>
<td>stable/12/sys/*/conf GENERIC-NODEBUG</td>
<td>Remove these kernel configurations</td>
</tr>
<tr>
<td>stable/12/sys/arm/conf/std.arm*</td>
<td>Remove debugging options</td>
</tr>
<tr>
<td>stable/12/sys/conf/newvers.sh</td>
<td>Update the BRANCH value to reflect BETA1</td>
</tr>
</tbody>
</table>
### 6. Release from stable/

This section describes the general procedures of the FreeBSD release cycle from an established stable/ branch.

#### 6.1. FreeBSD stable Branch Code Slush

In preparation for the code freeze on a stable branch, several files need to be updated to reflect the release cycle is officially in progress. These files are all relative to the top-most level of the stable branch:

<table>
<thead>
<tr>
<th>File to Edit</th>
<th>What to Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>sys/conf/newvers.sh</td>
<td>Update the BRANCH value to reflect PRERELEASE</td>
</tr>
<tr>
<td>Makefile.inc1</td>
<td>Update TARGET_TRIPLE</td>
</tr>
<tr>
<td>lib/clang/llvm.build.mk</td>
<td>Update OS_VERSION</td>
</tr>
<tr>
<td>lib/clang/freebsd_cc_version.h</td>
<td>Update FREEBSD_CC_VERSION</td>
</tr>
<tr>
<td>lib/clang/include/lld/Common/Version.inc</td>
<td>Update LLD_REVISION_STRING</td>
</tr>
<tr>
<td>head/Makefile.libcompat</td>
<td>Update LIB32CPUFLAGS</td>
</tr>
</tbody>
</table>

---

**File to Edit**

| stable/12/share/mk/src.opts.mk | Move REPRODUCIBLE_BUILD from __DEFAULT_NO_OPTIONS to __DEFAULT_YES_OPTIONS |
| stable/12/share/mk/src.opts.mk | Move LLVM_ASSERTIONS from __DEFAULT_YES_OPTIONS to __DEFAULT_NO_OPTIONS (FreeBSD 13.x and later only) |
| stable/12/libexec/rc/rc.conf | Set dumpdev from AUTO to NO (it is configurable via for those that want it enabled by default) |
| stable/12/release/Makefile | Remove the debug.witness.trace entries |

Then in the head/ branch, which will now become a new major version:

<table>
<thead>
<tr>
<th>File to Edit</th>
<th>What to Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>head/UPDATING</td>
<td>Update the FreeBSD version</td>
</tr>
<tr>
<td>head/sys/conf/newvers.sh</td>
<td>Update the BRANCH value to reflect CURRENT, and increment REVISION</td>
</tr>
<tr>
<td>head/Makefile.inc1</td>
<td>Update TARGET_TRIPLE and MACHINE_TRIPLE</td>
</tr>
<tr>
<td>head/sys/sys/param.h</td>
<td>Update __FreeBSD_version</td>
</tr>
<tr>
<td>head-gnu/usr.bin/cc/cc_tools/freebsd-native.h</td>
<td>Update FBSD_MAJOR and FBSD_CC_VER</td>
</tr>
<tr>
<td>head/contrib/gcc/config.gcc</td>
<td>Append the freebsdversion.h section</td>
</tr>
<tr>
<td>head/lib/clang/llvm.build.mk</td>
<td>Update the value of OS_VERSION</td>
</tr>
<tr>
<td>head/lib/clang/freebsd_cc_version.h</td>
<td>Update FREEBSD_CC_VERSION</td>
</tr>
<tr>
<td>head/lib/clang/include/lld/Common/Version.inc</td>
<td>Update LLD_REVISION_STRING</td>
</tr>
<tr>
<td>head/Makefile.libcompat</td>
<td>Update LIB32CPUFLAGS</td>
</tr>
</tbody>
</table>
6.2. FreeBSD BETA Builds

Following the code slush, the next phase of the release cycle is the code freeze. This is the point at which all commits to the stable branch require explicit approval from the FreeBSD Release Engineering Team. This is enforced by pre-commit hooks in the Subversion repository by editing base/svnadmin/conf/approvers to include a regular expression matching the stable/12/ branch for the release:

```
^/stable/12/ re
^/releng/12.0/ re
```

There are two general exceptions to requiring commit approval during the release cycle. The first is any change that needs to be committed by the Release Engineer to proceed with the day-to-day workflow of the release cycle, the other is security fixes that may occur during the release cycle.

Once the code freeze is in effect, the next build from the branch is labeled BETA. This is done by updating the BRANCH value in sys/conf/newvers.sh from PRERELEASE to BETA1.

Once this is done, the first set of BETA builds are started. Subsequent BETA builds do not require updates to any files other than sys/conf/newvers.sh, incrementing the BETA build number.

6.3. Creating the releng/12.0/ Branch

When the first RC (Release Candidate) build is ready to begin, the releng/ branch is created. This is a multi-step process that must be done in a specific order, to avoid anomalies such as overlaps with __FreeBSD_version values, for example. The order of commits and what to change are:

```
% svn cp ^/stable/12/ releng/12.0/
```

<table>
<thead>
<tr>
<th>File to Edit</th>
<th>What to Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>releng/12.0/sys/conf/newvers.sh</td>
<td>Change BETAX to RC1</td>
</tr>
<tr>
<td>releng/12.0/sys/sys/param.h</td>
<td>Update __FreeBSD_version</td>
</tr>
<tr>
<td>[.filename]#releng/12.0/sys/conf/kern.opts.mk</td>
<td>Move REPRODUCIBLE_BUILD from DEFAULT_NO_OPTIONS to DEFAULT_YES_OPTIONS</td>
</tr>
<tr>
<td>releng/12.0/etc/pkg/FreeBSD.conf</td>
<td>Replace latest with quarterly as the default package repository location</td>
</tr>
<tr>
<td>File to Edit</td>
<td>What to Change</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>releng/12.0/release/pkg_repos/release-dvd.conf</td>
<td>Replace <code>latest</code> with <code>quarterly</code> as the default package repository location</td>
</tr>
<tr>
<td>stable/12/sys/conf/newvers.sh</td>
<td>Update <code>BETA</code> with <code>PRERELEASE</code></td>
</tr>
<tr>
<td>stable/12/sys/sys/param.h</td>
<td>Update <code>__FreeBSD_version</code></td>
</tr>
<tr>
<td>svnadmin/conf/approvers</td>
<td>Add a new approvers line for the releng branch as was done for the stable branch</td>
</tr>
</tbody>
</table>

```bash
% svn propdel -R svn:mergeinfo releng/12.0/
% svn commit releng/12.0/
% svn commit stable/12/
```

Now that two new `__FreeBSD_version` values exist, also update `/documentation/content/en/books/porters-handbook/versions/chapter.adoc` in the Documentation Project repository.

After the first RC build has completed and tested, the stable/ branch can be "thawed" by removing (or commenting) the `^/stable/12/` entry in `svnadmin/conf/approvers`.

Following the availability of the first RC, FreeBSD Bugmeister Team should be emailed to add the new FreeBSD `-RELEASE` to the `versions` available in the drop-down menu shown in the bug tracker.

## 7. Building FreeBSD Installation Media

This section describes the general procedures producing FreeBSD development snapshots and releases.

### 7.1. Release Build Scripts

This section describes the build scripts used by FreeBSD Release Engineering Team to produce development snapshots and releases.

#### 7.1.1. The `release.sh` Script

Prior to FreeBSD 9.0-RELEASE, `src/release/Makefile` was updated to support , and the `src/release/generate-release.sh` script was introduced as a wrapper to automate invoking the targets.

Prior to FreeBSD 9.2-RELEASE, `src/release/release.sh` was introduced, which heavily based on `src/release/generate-release.sh` included support to specify configuration files to override various options and environment variables. Support for configuration files provided support for cross building each architecture for a release by specifying a separate configuration file for each invocation.

As a brief example of using `src/release/release.sh` to build a single release in `/scratch`: 
As a brief example of using `src/release/release.sh` to build a single, cross-built release using a different target directory, create a custom `release.conf` containing:

```
# release.sh configuration for powerpc/powerpc64
CHROOTDIR="/scratch-powerpc64"
TARGET="powerpc"
TARGET_ARCH="powerpc64"
KERNEL="GENERIC64"
```

Then invoke `src/release/release.sh` as:

```
# /bin/sh /usr/src/release/release.sh -c $HOME/release.conf
```

See and `src/release/release.conf.sample` for more details and example usage.

### 7.1.2. The thermite.sh Wrapper Script

To make cross building the full set of architectures supported on a given branch faster, easier, and reduce human error factors, a wrapper script around `src/release/release.sh` was written to iterate through the various combinations of architectures and invoke `src/release/release.sh` using a configuration file specific to that architecture.

The wrapper script is called `thermite.sh`, which is available in the FreeBSD Subversion repository at `svn://svn.freebsd.org/base/user/gjb/thermite/`, in addition to configuration files used to build `head/` and stable/12/ development snapshots.

Using `thermite.sh` is covered in [Building FreeBSD Development Snapshots](#) and [Building FreeBSD Releases](#).

Each architecture and individual kernel have their own configuration file used by `release.sh`. Each branch has its own defaults-X.conf configuration which contains entries common throughout each architecture, where overrides or special variables are set and/or overridden in the per-build files.

The per-build configuration file naming scheme is in the form of `${revision}-${TARGET_ARCH}-${KERNCONF}-${type}.conf`, where the uppercase variables are equivalent to what uses in the build system, and lowercase variables are set within the configuration files, mapping to the major version of the respective branch.

Each branch also has its own builds-X.conf configuration, which is used by `thermite.sh`. The `thermite.sh` script iterates through each `${revision}`, `${TARGET_ARCH}`, `${KERNCONF}`, and `${type}` value, creating a master list of what to build. However, a given combination from the list will only be built if the respective configuration file exists, which is where the naming scheme above is relevant.

There are two paths of file sourcing:
• builds-12.conf - main.conf
  This controls thermite.sh behavior

• 12-amd64 GENERIC-snap.conf - defaults-12.conf - main.conf
  This controls release/release.sh behavior within the build

The builds-12.conf, defaults-12.conf, and main.conf configuration files exist to reduce repetition between the various per-build files.

7.2. Building FreeBSD Development Snapshots

The official release build machines have a specific filesystem layout, which using ZFS, thermite.sh takes heavy advantage of with clones and snapshots, ensuring a pristine build environment.

The build scripts reside in /releng/scripts-snapshot/scripts or /releng/scripts-release/scripts respectively, to avoid collisions between an RC build from a releng branch versus a STABLE snapshot from the respective stable branch.

A separate dataset exists for the final build images, /snap/ftp. This directory contains both snapshots and releases directories. They are only used if the EVERYTHINGISFINE variable is defined in main.conf.

The EVERYTHINGISFINE variable name was chosen to avoid colliding with a variable that might be possibly set in the user environment, accidentally enabling the behavior that depends on it being defined.

As thermite.sh iterates through the master list of combinations and locates the per-build configuration file, a ZFS dataset is created under /releng, such as /releng/12-amd64 GENERIC-snap. The src/, ports/, and doc/ trees are checked out to separate ZFS datasets, such as /releng/12-src-snap, which are then cloned and mounted into the respective build datasets. This is done to avoid checking out a given tree more than once.

Assuming these filesystem paths, thermite.sh would be invoked as:

```
# cd /releng/scripts-snapshot/scripts
# ./setrev.sh -b stable/12/
# ./zfs-cleanup.sh -c ./builds-12.conf
# ./thermite.sh -c ./builds-12.conf
```

Once the builds have completed, additional helper scripts are available to generate development snapshot emails which are sent to the freebsd snapshots@freebsd.org mailing list:

```
# cd /releng/scripts-snapshot/scripts
# ./get-checksums.sh -c ./builds-12.conf | ./generate-email.pl > snapshot-12-mail
```
7.3. Building FreeBSD Releases

Similar to building FreeBSD development snapshots, thermite.sh would be invoked the same way. The difference between development snapshots and release builds, BETA and RC included, is that the configuration files must be named with release instead of snap as the type, as mentioned above.

In addition, the BUILDTYPE and types must be changed from snap to release in defaults-12.conf and builds-12.conf, respectively.

When building BETA, RC, and the final RELEASE, also statically set BUILDSVNREV to the revision on the branch reflecting the name change, BUILDDATE to the date the builds are started in YYYYMMDD format. If the doc/ and ports/ trees have been tagged, also set PORTBRANCH and DOCBRANCH to the relevant tag path in the Subversion repository, replacing HEAD with the last changed revision. Also set releasesrc in builds-12.conf to the relevant branch, such as stable/12/ or releng/12.0/.

During the release cycle, a copy of CHECKSUM.SHA512 and CHECKSUM.SHA256 for each architecture are stored in the FreeBSD Release Engineering Team internal repository in addition to being included in the various announcement emails. Each MANIFEST containing the hashes of base.txz, kernel.txz, etc. are added to misc/freebsd-release-manifests in the Ports Collection, as well.

In preparation for the release build, several files need to be updated:

<table>
<thead>
<tr>
<th>File to Edit</th>
<th>What to Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>sys/conf/newvers.sh</td>
<td>Update the BRANCH value to RELEASE</td>
</tr>
<tr>
<td>UPDATING</td>
<td>Add the anticipated announcement date</td>
</tr>
<tr>
<td>lib/csu/common/crtbrand.S</td>
<td>Replace __FreeBSD_version with the value in sys/sys/param.h</td>
</tr>
</tbody>
</table>

After building the final RELEASE, the releng/12.0/ branch is tagged as release/12.0.0/ using the revision from which the RELEASE was built. Similar to creating the stable/12/ and releng/12.0/ branches, this is done with svn cp. From the repository root:

```bash
% svn cp ^/releng/12.0/@r306420 release/12.0.0/
% svn commit release/12.0.0/
```
8. Publishing FreeBSD Installation Media to Project Mirrors

This section describes the procedure to publish FreeBSD development snapshots and releases to the Project mirrors.

8.1. Staging FreeBSD Installation Media Images

Staging FreeBSD snapshots and releases is a two part process:

- Creating the directory structure to match the hierarchy on `ftp-master`

  If `EVERYTHINGISFINE` is defined in the build configuration files, `main.conf` in the case of the build scripts referenced above, this happens automatically in the after the build is complete, creating the directory structure in `${DESTDIR}/R/ftp-stage` with a path structure matching what is expected on `ftp-master`. This is equivalent to running the following in the directly:

  ```
  # make -C /usr/src/release -f Makefile.mirrors EVERYTHINGISFINE=1 ftp-stage
  ```

  After each architecture is built, `thermite.sh` will rsync the `${DESTDIR}/R/ftp-stage` from the build to `/snap/ftp/snapshots` or `/snap/ftp/releases` on the build host, respectively.

- Copying the files to a staging directory on `ftp-master` before moving the files into `pub/` to begin propagation to the Project mirrors

  Once all builds have finished, `/snap/ftp/snapshots`, or `/snap/ftp/releases` for a release, is polled by `ftp-master` using rsync to `/archive/tmp/snapshots` or `/archive/tmp/releases`, respectively.

  On `ftp-master` in the FreeBSD Project infrastructure, this step requires `root` level access, as this step must be executed as the `archive` user.

8.2. Publishing FreeBSD Installation Media

Once the images are staged in `/archive/tmp/`, they are ready to be made public by putting them in `/archive/pub/FreeBSD`. To reduce propagation time, `rsync` is used to create hard links from `/archive/tmp` to `/archive/pub/FreeBSD`.

  For this to be effective, both `/archive/tmp` and `/archive/pub` must reside on the same logical filesystem.

There is a caveat, however, where rsync must be used after to correct the symbolic links in `pub/FreeBSD/snapshots/ISO-IMAGES` which will replace with a hard link, increasing the propagation time.

  As with the staging steps, this requires `root` level access, as this step must be
As the `archive` user:

```bash
% cd /archive/tmp/snapshots
% pax -r -w -l . /archive/pub/FreeBSD/snapshots
% /usr/local/bin/rsync -avH /archive/tmp/snapshots/* /archive/pub/FreeBSD/snapshots/
```

Replace `snapshots` with `releases` as appropriate.

9. Wrapping up the Release Cycle

This section describes general post-release tasks.

9.1. Post-Release Errata Notices

As the release cycle approaches conclusion, it is common to have several EN (Errata Notice) candidates to address issues that were discovered late in the cycle. Following the release, the FreeBSD Release Engineering Team and the FreeBSD Security Team revisit changes that were not approved prior to the final release, and depending on the scope of the change in question, may issue an EN.

The actual process of issuing ENs is handled by the FreeBSD Security Team.

To request an Errata Notice after a release cycle has completed, a developer should fill out the Errata Notice template, in particular the Background, Problem Description, Impact, and if applicable, Workaround sections.

The completed Errata Notice template should be emailed together with either a patch against the releng/ branch or a list of revisions from the stable/ branch.

For Errata Notice requests immediately following the release, the request should be emailed to both the FreeBSD Release Engineering Team and the FreeBSD Security Team. Once the releng/ branch has been handed over to the FreeBSD Security Team as described in Handoff to the FreeBSD Security Team, Errata Notice requests should be sent to the FreeBSD Security Team.

9.2. Handoff to the FreeBSD Security Team

Roughly two weeks following the release, the Release Engineer updates svnadmin/conf/approvers changing the approver column from `re` to `(so|security-officer)` for the releng/12.0/ branch.

10. Release End-of-Life

This section describes the website-related files to update when a release reaches EoL (End-of-Life).
# 10.1. Website Updates for End-of-Life

When a release reaches End-of-Life, references to that release should be removed and/or updated on the website:

<table>
<thead>
<tr>
<th>File</th>
<th>What to Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>~/website/themes/beastie/layouts/index.html</td>
<td>Remove <em>u-relXXX-announce</em> and <em>u-relXXX-announce</em> references.</td>
</tr>
<tr>
<td>~/website/content/en/releases/_index.adoc</td>
<td>Move the <em>u-relXXX-</em> variables from the supported release list to the Legacy Releases list.</td>
</tr>
<tr>
<td>~/website/content/en/releng/_index.adoc</td>
<td>Update the appropriate releng branch to reflect the branch is no longer supported.</td>
</tr>
<tr>
<td>~/website/content/en/security/_index.adoc</td>
<td>Remove the branch from the supported branch list.</td>
</tr>
<tr>
<td>~/website/content/en/where.adoc</td>
<td>Remove the URLs for the release.</td>
</tr>
<tr>
<td>~/website/themes/beastie/layouts/partials/sidenav.html</td>
<td>Remove <em>u-relXXX-announce</em> and <em>u-relXXX-announce</em> references.</td>
</tr>
<tr>
<td>~/website/static/security/advisory-template.txt</td>
<td>Remove references to the release and releng branch.</td>
</tr>
<tr>
<td>~/website/static/security/errata-template.txt</td>
<td>Remove references to the release and releng branch.</td>
</tr>
</tbody>
</table>