Design, Implementation and Operation of NetBSD Base System Packaging

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Abstract

- OS built on fine granular small parts is preferable to one built on the large tarballs in order to ……
  - Speedy security update.
  - Easy replacement.
  - Rollback

- In Linux distributions, the system are already divided into many small packages.
Abstract

• BSD Unix are behind the curve on the base system packaging.

• We have developed a software “basepkg” to improve NetBSD base system granularity.

• This presentation shows replacement of a few OS granular parts is clearly faster and can provide extra useful functions for NetBSD users.
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2. Packages in BSD Unix
3. basepkg
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5. Conclusion
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Background (1/6)

• OS has been managed on one source tree set has been managed.

• In NetBSD, either of a large or small tarball or the combination is used.
  • `base.tgz` (Mandatory for the operating system)
  • `comp.tgz` (Compiler tools)
  • `man.tgz` (Manual)
Background (2/6)

• Third-party software are managed as a set of small archives called as “package”.

• Package consists of software, documentation, configuration files, and meta data.
Background (3/6)

- Meta data required to operate in installation and deinstallation.

- Meta data contains ……
  - Build environment
  - Comment
  - Description
  - Dependency
  - Install script

<table>
<thead>
<tr>
<th>OS</th>
<th>format</th>
<th>package manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>FreeBSD</td>
<td>.txz</td>
<td>pkg(7)</td>
</tr>
<tr>
<td>NetBSD</td>
<td>.tgz</td>
<td>pkg_install</td>
</tr>
</tbody>
</table>
Background (4/6)

• Historically, BSD Unix has been developed in its own source tree including kernel and userland program.

• Linux distribution needed to assemble a lot of system utilities.
• Major Linux distributions such as Debian and RHEL are already divided into many small packages.

• These OS’s can manage both its own base system and third-party software through its package manager.
• BSD Unix have each package framework
  • `ports(7)`
  • `pkgsrc(7)`
  ⋯ but they have been used only for third-party software management.

• However today, for uses, it’s better that OS can be assembled on a lot of small parts.
  • It’s suitable for security update, replacement and rollback of specific parts.
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Packages in BSD Unix (1/4)

- BSD Unix consists of the base system and optional third-party software not distributed within the base system.

- Third-party software provided by `ports(7)` or `pkgsrc(7)`.

<table>
<thead>
<tr>
<th></th>
<th>ports(7)</th>
<th>pkgsrc(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meta Data</td>
<td>+COMPACT_MANIFEST +MANIFEST</td>
<td>+BUILD_INFO +CONTENTS +DESC +...</td>
</tr>
<tr>
<td>Package Manager</td>
<td><code>pkg(7)</code></td>
<td><code>pkgtools/pkg_install</code></td>
</tr>
<tr>
<td>Platform</td>
<td>FreeBSD, OpenBSD</td>
<td>Multi Platform</td>
</tr>
</tbody>
</table>
Packages in BSD Unix (2/4)

• BSD Unix has some approach for base system packaging.

• FreeBSD 11 introduced a base system packaging mechanism called “PkgBase”.

• NetBSD has a framework called “syspkg” introduced at January 8, 2002.
  • It’s also merged into build.sh as a feature of the official building process.
  • build.sh syspkgs
Packages in BSD Unix (3/4)

• Especially, in syspkg, NetBSD wiki says “There has been a lot of work in this area already, but it has not yet been finalized.”

• syspkg has several problems for these years.
  1. The database under \texttt{usr/src/distrib/sets} has been incomplete.
  2. Package made by syspkg lacks several meta data the current pkgsrc package.
  3. It’s possible to overwrite existing \texttt{/etc} files because it has not install script.
Packages in BSD Unix (4/4)

• We focused on NetBSD’s `syspkg`.
  • Package is suitable for powerless architecture.
  • It look like there is room for advancement.

• It looks hard to directly fix `syspkg` framework which consists of a lot of makefiles, scripts, and undocumented data.

• We have developed another packaging mechanism as a third-party software by using only `syspkg` database and making the best use of `pkgsrc(7)` framework.
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We have developed a new framework “basepkg” that can packaging NetBSD base system instead of syspkg.

- It distributed under the 2-cause BSD License.
- It published on https://github.com/user340/basepkg

Oct 26, 2016: Published on GitHub.
May 19, 2017: Imported to pkgsrc-wip

The latest version is 1.4.
The feature comparison between **basepkg** and **syspkg** are shown at this table.

<table>
<thead>
<tr>
<th></th>
<th>syspkg</th>
<th>basepkg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>Makefile, Bourne shell</td>
<td>Bourne shell</td>
</tr>
<tr>
<td>Sum of Number of Lines</td>
<td>3,729 lines</td>
<td>1,190 lines</td>
</tr>
<tr>
<td>Execution Time</td>
<td>850.4 sec</td>
<td>1188.4 sec</td>
</tr>
<tr>
<td>Install Script</td>
<td>none</td>
<td>available</td>
</tr>
<tr>
<td>Kernel Package</td>
<td>none</td>
<td>available</td>
</tr>
<tr>
<td>Documentation, Report</td>
<td>none</td>
<td>ABC2017, 2018, ……</td>
</tr>
<tr>
<td>Develop Team</td>
<td>NetBSD Project</td>
<td>GitHub</td>
</tr>
</tbody>
</table>
To write a sustainable program, basepkg is written to be POSIX compliant and portable as could as possible.

- The latest code is POSIX compliant except …
  - hostname(1)
  - mktemp(1)
  - pkg_create(1)

We use ShellCheck to validate and gain code quality and make the code warning-less as could as possible.

- [https://github.com/koalaman/shellcheck](https://github.com/koalaman/shellcheck)
- [https://www.shcellcheck.net](https://www.shcellcheck.net)
basepkg (4/12)

$SRCDIR (/usr/src)

$SRCDIR/build.sh

$DESTDIR

basepkg.sh

generate under $category/$package/

+PERSIST
+BUILD_INFO
+ CONTENTS
+DESC
+COMMENTS
+INSTALL
+DEINSTALL

pkg_create ...

/usr/pkg/share/basepkg/packages/$VERSION/$ARCH-$MACHINE_ARCH/$package.tgz

syspkg meta-data

$SRCDIR/distrib/ssets/$ARCH
+ basepkg patches

basepkg.sh temporary meta-data

work/$category/FILES
work/$category/$package/PLIST
basepkg (5/12)

- basepkg reads list of a set of file name and package name from `mi` and `md.ARCH` under `sets/lists` directory.
- Then, basepkg generates temporary files.
• **basepkg** emulates the generation of pkgsrc meta data.

• We supporting these meta data.
basepkg runs `pkg_create(1)` for all packages.

In creating packages, `basepkg` gathers the package content under `$DESTDIR` directory made by `build.sh`.

`basepkg` creates the checksum files.

```
/usr/pkg/share/basepkg/packages/$VERSION/$ARCH-$MACHINE_ARCH/$package.tgz
```
basepkg (8/12)

- How to Install
  
  ```
  # cd /usr/pkgsrc/wip/basepkg
  # make install clean clean
  ```

- How to build packages
  
  ```
  # cd /usr/src
  # ./build.sh tools
  # ./build.sh distribution
  # cd /usr/pkg/share/basepkg
  # ./basepkg.sh pkg
  ```

- How to build kernel packages
  
  ```
  # cd /usr/src
  # ./build.sh kernel=GENERIC
  # cd /usr/pkg/share/basepkg
  # ./basepkg.sh kern
  ```
basepkg (9/12)

• It’s easy to add or delete the specific base package by using `pkg_*` tools since the package format is same as `pkgsrc(7)` one.
  
  • `pkg_add(1)` – Install the package
  • `pkg_delete(1)` – Remove the package

• To avoid confliction between `pkgsrc` and `basepkg` packages, we should specify the other database path such as
  
  # `pkg_add -K /var/db/basepkg base-sys-root`
Currently in using raw `pkg_*` tools to manipulate packages, we need to be very careful to handle `etc` package.

- E.g. `etc-sys-etc-7.1.tgz`
- Because it overwrites files under the `/etc` directory.

To avoid this disaster, once we extract the contents in another directory and running install script.

```bash
# pkg_add -K /var/db/basepkg -P /tmp/basepkg etc-sys-etc.7.1.tgz
```

We should prepare a wrapper for users not to handle raw `pkg_*` tools.
We have compared the installation time between tarball extraction and using package made by basepkg.

1. Fetch a tarball “games.tgz” from ftp.jp.netbsd.org, then extract it.
2. Install all packages beginning with “games” to system from basepkg.netbsd.fml.org
3. Install one “games-games-bin” package to system from basepkg.netbsd.fml.org

Where basepkg.netbsd.fml.org is an experimental base package distribution server we build and operate.
<table>
<thead>
<tr>
<th>Test</th>
<th>Real Time (s)</th>
<th>User Time (s)</th>
<th>System Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>tarball</td>
<td>7.2374</td>
<td>0.2267</td>
<td>0.8433</td>
</tr>
<tr>
<td>All packages</td>
<td>19.2955</td>
<td>0.9457</td>
<td>1.1725</td>
</tr>
<tr>
<td>One package</td>
<td>3.4656</td>
<td>0.0838</td>
<td>0.0924</td>
</tr>
</tbody>
</table>

- Only when we update a few packages in the system, the process is comparable to the tarball extracting.

- In almost cases under normal operation, we replace only a few small parts for rapid security update.
Demonstration

• wip/basepkg
  • make install clean clean-clean-depends

• cd /usr/pkg/basepkg

• Run basepkg.sh.

• pkg_add/pkg_delete some package.
Demonstration

• pkgtools/pkgin

• Create repository.

• Install package using pkgin.
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Discussion (1/8)

• We summarize changes and improvements from last year.
  • Import to pkgsrc-wip repository.
    • wip/basepkg
  • Update database (under sets/).
    • Fix PR#46937 by Lloyd Parkes at 2012.
  • Enhance meta data
    • +DEINSTALL, +INSTALL, +PRESERVE, +SIZE_PKG, +SIZE_ALL
  • Cross build support
  • Multi platform support
    • We have verified basepkg.sh can run on Ubuntu 17.04 amd64.
• There are a lot of technical issues to resolve as follows.

1. basepkg processing speed.
   • `basepkg.sh` slower than `build.sh syspkgs`.
   • We must need to try better shell coding technique.
   • We should not use `for` or `while` loop as could as possible, instead use internal loops such as `find(1)` and `grep(1)`.

2. basepkg database (under `sets/`) maintenance.
   • It looks `descrs` and `comments` has been incomplete.
Discussion (3/8)

• There are a lot of technical issues to resolve as follows.

3. A wrapper convenient for users.
   • Set database location.
   • Provide alias mapping for ambiguous package names.
     • `# wrapper install openssh --> # wrapper install base-secsh-bin`

4. Integrated system management support.
   • `pkg-vulnerabilities`
   • `pkgsrc/pkgtools/pkgin`
• How to use **pkgin(1)** for base package.

1. Install **pkgtools/pkgin**
2. Edit **/usr/pkg/etc/pkgin/repositories.conf**
   
   ```
   # echo "file:///path/to/basepkg/packages/7.1.1/amd64-x86_64/" ¥
   >> /usr/pkg/etc/pkgin/repositories.conf
   ```
3. # cd /path/to/basepkg/packages/7.1.1/amd64-x86_64
4. # pkg_info -X *.tgz > pkg_summary
5. # gzip pkg_summary
6. # pkgin in base-sys-root
Discussion (5/8)

• We estimated of base package distribution.

• In the case of building source and package by distribution server …….

• Current VPS Case
  • basepkg.netbsd.fml.org which runs on SAKURA VPS 2GB 3Core 200GB Disk.
  • We providing 30 architectures in NetBSD 7 stable.
    • One architecture requires 5GB Disk space. So, the upper limit of 30 architectures are restricted by this storage limit to run build.sh.
  • Building process costs about 1 hour per target.
  • If we can run processes parallelly per CPU core, we need 10 hour to prepare 30 architectures.
• Cloud Case (The evaluation is underway)
  • Cloud service is more suitable for intermittent work like this.
  • The updates for stable branches are rare, so we don’t need to build package daily.

• If we run this building process only when a NetBSD security advisory is released and the target can be restricted to stable branches, modern cloud service is more proper than the current VPS service.
In the case of cloud service, we assume the following usage:

- Normally the build process does not run. The low cost cloud archive holds the built data.
- On demand, we wake up the cloud service, extract the built data from the archive, build packages, update web service, re-archive the built data and make the cloud sleep again.
Discussion (8/8)

• In the case of building only package by distribution server ….

• Today it looks NetBSD daily build system can prepare daily binaries for some branches.

• Hence basepkg distribution server can fetch the tarballs and build base packages based on them.

• We hope to operate package distribution server at a low cost but only for latest branches.
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Conclusion (1/1)

• We have developed third-party framework “basepkg” to packaging NetBSD base system.

• It’s shown that this framework provides more granular and faster update of NetBSD base system and useful functions for users.

• However, we have a lot of issues to resolve for realistic system operations, so we need to continue dogfooding and development.