“The Package Man Always Builds Twice” -- From SysV Packaging To The Image Packaging System

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Terms and Definitions

The Old World: SysV

The New World: IPS

How to Build an IPS Package

Advice to Packagers

Links and Resources
Mailing List Alphabet Soup:

SVR4 pkgadd IPS SS12 DC ON pkg(1) .py BE JET zvol SFW SXCE pkgbuild OSOL CBE SS11 SNV ZFS SFWNV SPEC WOS RFE ...
Software Life Cycle

• Develop Source
• Build Binary
• Release
• **Package**
• Deploy / Install
• Run / Patch
Package Creation Steps

- Create Metadata
- Install Package Content in Staging Area
- Compile Package

Some other systems combine these steps with the binary production processes.
Example: NetBSD pkgsrc, Fink for MacOSX
Package Creation Steps

- Create Metadata
- Install Package Content in Staging Area
- Compile Package

Both the System V Packaging tools and the Image Packaging System perform only these steps; no binaries are built.
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Package Management
pkginfo(1M) -- list packages
pkgadd(1M) -- add a package
pkgrm(1M) -- remove a package
(plus some 20 more commands)

patchadd(1M) -- add a patch
patchrm(1M) -- remove a patch
(A patch is one or more packages!)
Package Format: Directory

```
<shelob:tree/bbc/sparc/5.8,19051> ls -goLF BBCssh2
  total 24
  drwxr-xr-x  2       5 Apr   9  2001 install/
  -rw-r--r--  1     546 Apr   9  2001 pkginfo
  -rw-r--r--  1    5220 Apr   9  2001 pkgmap
  drwxr-xr-x  3       3 Apr   9  2001 reloc/
  drwxr-xr-x  3       3 Apr   9  2001 root/
```

Note the `reloc` and `root` directories -- there is an implicit semantic difference!
The `pkginfo` file contains metadata about the package:

```
PKG=BBCssh2
ARCH=sparc
BASEDIR=/opt
BBC_BUILD=2
BBC_OS=5.8/sparc
BBC_VERSION=0.0
CATEGORY=application,bbc
CLASSES=none
...
OWNER=bin
...```
The `pkgmap` file contains metadata about objects within the package:

```
: 1 8436
1 d none $PKG 0755 $OWNER $GROUP
1 d none $PKG/bin 0755 $OWNER $GROUP
1 s none $PKG/bin/scp=scp2
1 f none $PKG/bin/scp2 0555 $OWNER $GROUP 298048 15043 967227952
1 s none $PKG/bin/sftp=sftp2
...
1 f none $PKG/sbin/sshd2 0555 $OWNER $GROUP 644096 63972 967227952
1 d none /etc ? ? ?
...
1 i copyright 215 19511 967223316
1 i pkginfo 546 44021 967230548
1 i postinstall 132 10132 967224620
1 i preremove 318 26161 967224872
```
Problems

- scripts like `postinstall` run as root and can do anything
- no protection for `pkginfo` and `pkgmap`
- parameter substitution difficult to trace
- every object is an object in the file system
Package Format: Stream

Stream consists of a signature header and a concatenation of ASCII and cpio format files:

# file BBCbase-2.0.4.pkg
BBCbase-2.0.4.pkg:    package datastream

# strings BBCbase-2.0.4.pkg
# PaCkAgE DaTaStReAm
BBCbase 1 1989
# end of header
07070123a4153b000081a400000...
Problems

• package datastream needs to be unpacked
• confusion about package-internal and datastream compression
• `cpio` compatibility problems
• size limit of 2 Gigabytes
• not really feasible to implement network-centric installation environments
Management of Installed Packages

<shelob:/var/sadm,19068> ls -golF
...
dr-xr-xr-x  4        9 Jun 18 01:30 install/
drwxr-xr-x  2        4 Dec 21 2007 install_data/
drwxr-xr-x  84       85 Jun 10 00:22 patch/
dr-xr-xr-x 1336    1336 Jun 18 01:30 pkg/
...
<shelob:/var/sadm,19069> ls -l install/contents
-rw-r--r--  1 27041389 Jun 18 01:30 install/contents
<shelob:/var/sadm,19070> wc -l install/contents
  242049 install/contents
<shelob:/var/sadm,19072> ls -ld pkg/*|wc -l
    1334
Management Problems:
- package tools do not scale well; a database doesn't help
- dependency is only package-to-package, statically recorded in ASCII files
- dependencies are not resolved automatically
- there are no metapackages or package bundles except what Sun provides for the special case of Solaris installation
- a package decides about allowed number of instances
- it is difficult to re-root a package, or to manage more than one package trees on a given system, including install servers
Things SysV packages do well:

- powerful: anything root can do a package can do
- an old and true AT&T standard, well documented
- easy to compile/edit/modify
- very flexible: there is a high degree of dynamic adaptation to the Solaris installation target possible
- installed base: thousands of packages are available
From SysV Packages to the IPS

Agenda

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Oh My God!
They've thrown everything away! They're rewriting everything from scratch! I'm ruined!
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They've thrown everything away! They're rewriting everything from scratch!
I'm ruined!

Fortunately it's not *that* bad!
Image Packaging System

- project (pkg) within the *Installation and Packaging Community* within OpenSolaris
- other projects in that community are the Caiman installer, the original SysV packaging tools, and Live Media
- IPS is development in progress, a moving target!
IPS Mission Statement: Design Goals

- software delivery must become more flexible
- operating system patching is too complicated; updating a system must be radically simpler than it is now
- software delivery focus has changed from tape and CD-ROM to a network-centric approach
- separate BEs need to be managed on one system
- the packaging system must provide the building blocks to construct new OS distributions
- old packages should be automatically converted if possible
- dependencies should be explicit; when dependencies exist during package deployment; they should be resolved automatically
IPS Mission Statement: More Goals

- be bandwidth efficient, transmit everything only once
- allow more than one package source, provide for package mirrors
- make package transmission secure and auditable
- provide an (optional) GUI for image management
- be aware of OS features (ZFS, zones)
- support virtualization, multiple install scenarios, developer deployment through partial images, nested images, per-user images
What's all this about images???

• an *image* is a collection of installed packages that can be managed as one entity
• a *user image* is an image that contains only *relocatable packages* (the image is not dependent on any specific location within the file system)
• a non-user image is sometimes referred to as an *entire image*

This implies that we can have many trees of installed packages in one file system, and we can manage them all using IPS.
IPS: Workflow

`pkgsend(1)` -- run by package creator

`pkg.depotd(1M)` -- daemon running on the repository server

`pkg(1)` -- run on client to retrieve packages or metadata from repository
IPS: Package Naming Scheme

The IPS package are Fault Management Resource Identifiers (FMRI)s:

pkg://[authority]/[pkg_name]
    @[version][,build]-[branch]:[timestamp]

Examples:

pkg://bbc/SUNWbinutils@2.15,5.11-0.86:20080426T173002Z
pkg://SUNWcar@0.5.11,5.11-0.86:20080426T182143Z

Authorities:

# pkg authority
AUTHORITY          URL
bbc (preferred)    http://caiman.bb-c.de:10000/
opensolaris.org    http://pkg.opensolaris.org:80/
IPS: The `pkg(1)` Client

One command covers all usage aspects on the client to manage images and packages. It can:

- install, verify, and uninstall packages
- list packages, their contents, and metadata
- create and update images
- download and refresh package catalogs from repository servers
- add, list, and delete authorities

For more information, please consult the man page...
IPS: The Configuration Database

```bash
<caiman:/var/pkg,752>  ls -goLF
total 56
drwxr-xr-x  4 4  May 28 15:48 catalog/
-rw-r--r--  1 368 May 28 15:48 cfg_cache
drwx------  2 2  May 28 17:52 download/
drwxr-xr-x  2 2  Apr 27 03:42 file/
drwxr-xr-x  2 2  Apr 27 03:42 index/
drwxr-xr-x 649 649 May 28 17:34 pkg/
drwxr-xr-x  7 9  May 28 14:55 repo/
```
IPS: The link to SysV Packages

The old `pkginfo(1)` sees the new packages deployed through IPS, because IPS creates “shim” directories under the `/var/sadm/pkg` directory hierarchy. This makes it possible to have a SysV package depend on an IPS package (traditionally, many packages look for `SUNWcsr` and friends as a sanity check).

However, `pkginfo(1)` does not create any entries for individual package objects in the `/var/sadm/install/contents` file, so all the other SysV package commands do not really work.
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First, we need to enable the repository server:

```
svccfg -s pkg/server "setprop pkg/port=10000"
svccfg -s pkg/server "setprop pkg/inst_root=/var/repo"
svcadm refresh pkg/server
svcadm enable pkg/server
svcadm restart pkg/server
```

Check for correct configuration using the `svcprop(1)` and `svcs(1)` commands.
Then create some content and a description file:

```bash
# cat /tmp/mypkg.manifest
set name="pkg.name" value="hello -- a hello world script"
set name="pkg.description" value="This script prints a nice
greeting message."
set name="maintainer" value="Volker A. Brandt <vab@bb-c.de>"
set name="upstream" value="support@bb-c.de"

dir mode=0755 owner=root group=bin path=/opt

dir mode=0755 owner=root group=bin path=/opt/local

dir mode=0755 owner=root group=bin path=/opt/local/bin

file hello.sh mode=0555 owner=bin group=bin path=/opt/local/bin/hello
```

The entries in this file are called actions. Every atomic operation on an IPS package object is an action. For complete details, see the `pkg(5)` man page.
Next, send the package to the repository:

```bash
> pkgsend open BBChello@1.0
export PKG_TRANS_ID=1214255862_pkg%3A%2FBBChello%401.0...
> setenv PKG_TRANS_ID 1214255862_pkg%3A%2FBBChello%401.0...
> pkgsend include mypkg.manifest
> pkgsend close
```

PUBLISHED

pkg:/BBChello@1.0,5.11:20080623T231742Z

Verify the existence of the package in the repository:

```bash
> pkg info -r pkg:/BBChello
    Name: BBChello
    Summary:
    State: Not installed
    Authority: bbc (preferred)
    Version: 1.0
    Build Release: 5.11
    Branch: None
    Packaging Date: Mon Jun 23 23:17:42 2008
    Size: 32 B
    FMRI: pkg:/BBChello@1.0,5.11:20080623T231742Z
```
Finally, install the package in a new image for testing:

```
# pkg install -v BBChello
Before evaluation:
UNEVALUATED:
+pkg:/BBChello@1.0,5.11:20080623T231742Z

After evaluation:
None -> pkg:/BBChello@1.0,5.11:20080623T231742Z
None
```

```
DOWNLOAD        PKGS       FILES
XFER (MB)        1/1         1/1
Completed        0.00/0.00

PHASE            ACTIONS
Install Phase    7/7
```

```
# ls -goLF /opt/local/bin
total 2
-r-xr-xr-x 1 32 Jun 24 00:07 hello*
```
As an alternative, import a SysV package:

```
> pkgsend open BBCcert@1.0.0
export PKG_TRANS_ID=1214263101_pkg%3A%2FBBCcert%401.0.0%2C5...
> setenv PKG_TRANS_ID 1214263101_pkg%3A%2FBBCcert%401.0.0%2C5...
> pkgsend import BBCcert-1.0.0-any-20070605132603.pkg
> pkgsend close
PUBLISHED
pkg:/BBCcert@1.0.0,5.11:20080624T011821Z
# pkg refresh --full
```

Again, verify the operation:

```
# pkg info -r pkg:/BBCcert
Name: BBCcert
  Summary: 
    State: Not installed
  Authority: bbc (preferred)
    Version: 1.0.0
  Build Release: 5.11
  Branch: None
Packaging Date: Tue Jun 24 01:18:21 2008
  Size: 11 kB
  FMRI: pkg:/BBCcert@1.0.0,5.11:20080624T011821Z
```
What's missing?

- there is no good way to replicate a repository; for example, if we want a mirror of pkg.opensolaris.org
- many of the SysV packages features are silently ignored when importing an existing package into an IPS repository
- there is no way to run a script; thus, many many things cannot be done that used to be very easy
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Advice #1: Use manifest files and scripts

Don't type in anything directly, IPS is too complex for that. Always use scripts and manifest files that can be version-controlled and rolled back. A small typo can make a big difference.
Advice #2: Learn some Python basics

In their infinite wisdom, our Sun friends implemented IPS in Python instead of a real scripting language like Perl. Knowing some Python helps a lot when facing error messages like:

```python
Creating Plan -pkg: install failed: ['Duplicate actions',
    [('set', 'value'),
     set([<pkg.actions.attribute.AttributeAction object at 0x898d36c>,
          <pkg.actions.attribute.AttributeAction object at 0x898d6ac>,
          <pkg.actions.attribute.AttributeAction object at 0x898d02c>,
          <pkg.actions.attribute.AttributeAction object at 0x898d42c>,
          <pkg.actions.attribute.AttributeAction object at 0x898d10c>,
          <pkg.actions.attribute.AttributeAction object at 0x898d1ec>])])
```
Advice #3: Remember, it's Work in Progress

Don't trust older presentations about IPS. Some commands are not implemented yet, argument names have changed and probably will change more. When in doubt about a specific functionality, check the source.
Advice #4: Don't try to build a package that works in both worlds

It is currently impossible to reproduce SysV package functionality in IPS. We could isolate all script-like functionality in one place and hope that it would be easy to port to IPS, but that is just a wish for the future.

So: The package man always builds twice.
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OpenSolaris Installation and Packaging community:

http://opensolaris.org/os/community/install/

OpenSolaris Image Packaging System Project:

http://opensolaris.org/os/project/pkg/

Source Code (Mercurial Repository):

hg clone ssh://anon@opensolaris.org/hg/pkg/gate

The Author's Link List for this Presentation:

http://www.bb-c.de/osdevcon2008/
Questions and Discussion

Thank you!

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