Application Packaging Developer's Guide

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Contents

Preface

The *Application Packaging Developer's Guide* provides step-by-step instructions and relevant background information for designing, building, and verifying packages. This guide also includes advanced techniques that you might find helpful during the package creation process.

Who Should Use This Book

This book is intended for application developers whose responsibilities include designing and building packages.

Though much of the book is directed towards novice package developers, it also contains information useful to more experienced package developers.

Note – The Solaris™ operating system (Solaris OS) runs on two platforms, SPARC® and IA. The Solaris OS runs on both 64–bit and 32–bit address spaces. The information in this document pertains to both platforms and address spaces unless called out in a special chapter, section, note, bulleted item, figure, table, or example.

How This Book Is Organized

The following table describes the chapters in this book.

Chapter Name	Chapter Description
Chapter 1	Describes package components and package design criteria. Also describes related commands, files, and scripts.
Chapter 2	Describes the process and required tasks for building a package. Also provides step-by-step instructions for each task.
Chapter 3	Provides step-by-step instructions for adding optional features to a package.
Chapter 4	Describes how to verify the integrity of a package and how to transfer a package to a distribution medium.
Chapter 5	Provides case studies for creating packages.
Chapter 6	Describes advanced techniques for creating packages.
Glossary	Defines terms used in this book.

Related Books

The following documentation, available through retail booksellers, can provide additional background information on building System V packages.

- *System V Application Binary Interface*
- *System V Application Binary Interface - SPARC Processor Supplement*
- *System V Application Binary Interface - Intel386 Processor Supplement*

Accessing Sun Documentation Online

The docs.sun.com^{SM} Web site enables you to access Sun technical documentation online. You can browse the docs.sun.com archive or search for a specific book title or subject. The URL is `http://docs.sun.com`.

Ordering Sun Documentation

Sun Microsystems offers select product documentation in print. For a list of documents and how to order them, see "Buy printed documentation" at `http://docs.sun.com`.

Typographic Conventions

The following table describes the typographic changes that are used in this book.

TABLE P–1 Typographic Conventions

Typeface or Symbol	Meaning	Example
`AaBbCc123`	The names of commands, files, and directories, and onscreen computer output	Edit your `.login` file. Use `ls -a to list all files.` `machine_name% you have mail.`

`AaBbCc123`	What you type, contrasted with onscreen computer output	`machine_name%` **`su`**
		`Password:`

AaBbCc123	Command-line placeholder: replace with a real name or value	The command to remove a file is `rm` *filename*.
AaBbCc123	Book titles, new terms, and terms to be emphasized	Read Chapter 6 in the *User's Guide*. Perform a *patch analysis*. Do *not* save the file. [Note that some emphasized items appear bold online.]

Shell Prompts in Command Examples

The following table shows the default system prompt and superuser prompt for the C shell, Bourne shell, and Korn shell.

TABLE P–2 Shell Prompts

Shell	Prompt
C shell prompt	`machine_name%`
C shell superuser prompt	`machine_name#`
Bourne shell and Korn shell prompt	`$`
Bourne shell and Korn shell superuser prompt	`#`

CHAPTER 1

Designing a Package

Before you build a package, you need to know which files you need to create and the commands you need to execute. You also need to consider your application software's requirements and the needs of your customers. Your customers are the administrators who will be installing your package. This chapter discusses the files, commands, and criteria you should know and consider before building a package.

This is a list of the information in this chapter.

- "Where to Find Packaging Tasks" on page 13
- "What Are Packages?" on page 14
- "Package Components" on page 14
- "Considerations Before Building a Package" on page 17
- "Packaging Commands, Files, and Scripts" on page 19

Where to Find Packaging Tasks

Use these task maps to find step-by-step instructions for building and verifying packages.

- "The Process of Building a Package (Task Map)" on page 23
- "Creating Information Files and Installation Scripts (Task Map)" on page 51
- "Verifying and Transferring a Package (Task Map)" on page 85

What Are Packages?

Application software is delivered in units called *packages*. A package is a collection of files and directories that are required for a software product. A package is usually designed and built by the application developer after completing the development of the application code. A software product needs to be built into one or more packages so that it can easily be transferred to a distribution medium. Then, the software product can be mass produced and installed by administrators.

A package is a collection of files and directories in a defined format. This format conforms to the application binary interface (ABI), which is a supplement to the System V Interface Definition.

Package Components

The components of a package fall into two categories.

- *package objects* are the application files to be installed.
- *control files* control how, where, and if the package is installed.

The control files are also divided into two categories: *information files* and *installation scripts*. Some control files are required. Some control files are optional.

To package your applications, you must first create the required components, and any optional components, that make up your package. You can then build the package by using the `pkgmk` command.

To build a package, you must provide the following:

- Package objects (the application software's files and directories)
- Two required information files (the `pkginfo` and `prototype` files)
- Optional information files
- Optional installation scripts

The following figure describes the contents of a package.

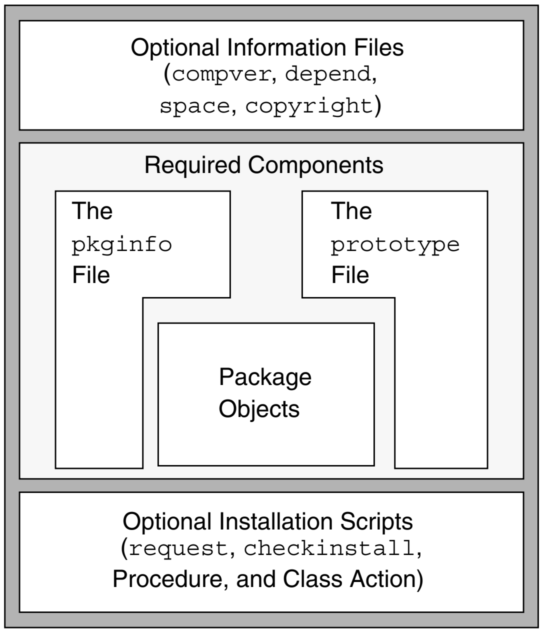


FIGURE 1–1 The Contents of a Package

Required Package Components

You must create the following components before you build your package:

- Package objects

  These components make up the application. They can consist of the following items:

  - Files (executable files or data files)
  - Directories
  - Named pipes
  - Links
  - Devices
- The `pkginfo` file

  The `pkginfo` file is a required package information file that defines parameter values. Parameter values include the package abbreviation, the full package name, and the package architecture. For more information, see "Creating a `pkginfo` File" on page 26 and the `pkginfo`(4) man page.

Note – There are two `pkginfo`(1) man pages. The first man page describes a section 1 command that displays information about installed packages. The second man page describes a section 4 file that describes the characteristics of a package. When accessing the man pages, be sure to specify the applicable man page section. For example: `man -s 4 pkginfo`.

- The `prototype` file

  The `prototype` file is a required package information file that lists the components of the package. One entry exists for each package object, information file, and installation script. An entry consists of several fields of information that describe each component, including its location, attributes, and file type. For more information, see "Creating a `prototype` File" on page 31 and the `prototype`(4) man page.

Optional Package Components

Package Information Files

You can include four optional package information files in your package:

- The `compver` file

  Defines previous versions of the package that are compatible with this version of your package.
- The `depend` file

  Indicates other packages that have a special relationship with your package.
- The `space` file

  Defines disk space requirements for the target environment, beyond what is required by the objects defined in the `prototype` file. For example, additional space might be needed for files that are dynamically created at installation time.
- The `copyright` file

  Defines the text for a copyright message that displays at the time of package installation.

Each package information file should have an entry in the `prototype` file. See "Creating Information Files" on page 53 for more information on creating these files.

Package Installation Scripts

Installation scripts are not required. However, you can provide scripts that perform customized actions during the installation of your package. An installation script has the following characteristics:

- The script is composed of Bourne shell commands.
- The script's file permissions should be set to 0644.
- The script does not need to contain the shell identifier (`#! /bin/sh`).

The four script types are as follows:

- The `request` script

  The `request` script requests input from the administrator who is installing the package.
- The `checkinstall` script

  The `checkinstall` script performs special file system verification.

  Note – The `checkinstall` script is only available with the Solaris™ 2.5 release and compatible releases.

- Procedure scripts

  Procedure scripts define actions that occur at particular points during package installation and removal. You can create four procedure scripts with these predefined names: `preinstall`, `postinstall`, `preremove`, and `postremove`.
- Class action scripts

  Class action scripts define a set of actions to be performed on a group of objects.

See "Creating Installation Scripts" on page 58 for a more information on installation scripts.

Considerations Before Building a Package

Before building a package, you need to decide whether your product will consist of one or more packages. Note that many small packages take longer to install than one big package. Although creating a single package is a good idea, doing so is not always possible. If you decide to build more than one package, you need to determine how to segment the application code. This section provides a list of criteria to use when planning to build a package.

Many of the packaging criteria present trade-offs among themselves. Satisfying all requirements equally is often difficult. These criteria are presented in order of importance. However, this sequence is meant to serve as a flexible guide depending on the circumstances. Although each criterion is important, it is up to you to optimize these requirements to produce a good set of packages.

For more design ideas, see Chapter 6.

Make Packages Remotely Installable

All packages must be *remotely installable*. Being remotely installable means that the administrator installing your package might be trying to install it on a client system, not necessarily to the root (/) file system where the `pkgadd` command is being executed.

Optimize for Client-Server Configurations

Consider the various types of system software configurations (for example, standalone system and server) when laying out packages. Good packaging design divides the affected files to optimize installation of each configuration type. For example, the contents of the root (/) and `/usr` file systems should be segmented so that server configurations can easily be supported.

Package by Functional Boundaries

Packages should be self-contained and distinctly identified with a set of functionality. For example, a package that contains UFS should contain all UFS utilities and be limited to only UFS binaries.

Packages should be organized from a customer's point of view into functional units.

Package Along Royalty Boundaries

Put code that requires royalty payments due to contractual agreements in a dedicated package or group of packages. Do not disperse the code into more packages than necessary.

Package by System Dependencies

Keep system-dependent binaries in dedicated packages. For example, the kernel code should be in a dedicated package, with each implementation architecture consisting of a distinct package instance. This rule also applies to binaries for different architectures. For example, binaries for a SPARC system would be in one package and binaries for an x86 system would be in another package.

Eliminate Overlap in Packages

When constructing packages, eliminate duplicate files whenever possible. Unnecessary duplication of files results in support and version difficulties. If your product has multiple packages, repeatedly compare the contents of these packages for duplicated files.

Package Along Localization Boundaries

Localization-specific items should be in their own package. An ideal packaging model would have a product's localizations delivered as one package per locale. Unfortunately, in some cases organizational boundaries conflict with the functional and product boundaries criteria.

International defaults can also be delivered in a package. This design isolates the files that are necessary for localization changes and standardizes the delivery format of localization packages.

Packaging Commands, Files, and Scripts

This section describes the commands, files, and scripts that you might use when manipulating packages. They are described in man pages and in detail throughout this book, in relation to the specific task they perform.

The following table shows the commands to help you build, verify, install, and obtain information about a package.

TABLE 1–1 Packaging Commands

Task	Command/ man Page	Description	For More Information
Create packages	`pkgproto`(1)	Generates a `prototype` file for input to the `pkgmk` command	"Example—Creating a `prototype` File With the `pkgproto` Command" on page 37
`pkgmk`(1)	Creates an installable package	"Building a Package" on page 45	
Install, remove, and transfer packages	`pkgadd`(1M)	Installs a software package onto a system	"Installing Software Packages" on page 86

TABLE 1–1 Packaging Commands *(Continued)*

Task	Command/ man Page	Description	For More Information
pkgask(1M)	Stores answers to a request script	"Design Rules for request Scripts" on page 64	
pkgtrans(1)	Copies packages onto a distribution medium	"Transferring a Package to a Distribution Medium" on page 96	
pkgrm(1M)	Removes a package from a system	"Removing a Package" on page 95	
Obtain information about packages	pkgchk(1M)	Verifies the integrity of a software package	"Verifying the Integrity of a Package" on page 88
pkginfo(1)	Displays software package information	"The pkginfo Command" on page 92	
pkgparam(1)	Displays package parameter values	"The pkgparam Command" on page 90	
Modify installed packages	installf(1M)	Incorporates a new package object into an already installed package	"Design Rules for Procedure Scripts" on page 68 and Chapter 5
removef(1M)	Removes a package object from an already installed package	"Design Rules for Procedure Scripts" on page 68	

The following table shows the information files that help you build a package.

TABLE 1–2 Package Information Files

File	Description	For More Information
admin(4)	Package installation defaults file	"The Administrative Defaults File" on page 128
compver(4)	Package compatibility file	"Defining Package Dependencies" on page 53
copyright(4)	Package copyright information file	"Writing a Copyright Message" on page 55
depend(4)	Package dependencies file	"Defining Package Dependencies" on page 53
pkginfo(4)	Package characteristics file	"Creating a pkginfo File" on page 26
pkgmap(4)	Package contents description file	"The pkgmap File" on page 45

TABLE 1–2 Package Information Files *(Continued)*

File	Description	For More Information
`prototype`(4)	Package information file	"Creating a `prototype` File" on page 31
`space`(4)	Package disk space requirements file	"Reserving Additional Space on a Target System" on page 57

The following table describes optional installation scripts that you can write that affect if and how a package is installed.

TABLE 1–3 Package Installation Scripts

Script	Description	For More Information
`request`	Solicits information from the installer	"Writing a `request` Script" on page 63
`checkinstall`	Gathers file system data	"Gathering File System Data With the `checkinstall` Script" on page 65
`preinstall`	Performs any custom installation requirements before class installation	"Writing Procedure Scripts" on page 68
`postinstall`	Performs any custom installation requirements after all volumes are installed	"Writing Procedure Scripts" on page 68
`preremove`	Performs any custom removal requirements before class removal	"Writing Procedure Scripts" on page 68
`postremove`	Performs any custom removal requirements after all classes have been removed	"Writing Procedure Scripts" on page 68
Class action	Performs a series of actions on a specific group of objects	"Writing Class Action Scripts" on page 70

CHAPTER 2

Building a Package

This chapter describes the process and the tasks involved in building a package. Some of these tasks are required. Some of these tasks are optional. The required tasks are discussed in detail in this chapter. For information on the optional tasks, which enable you to add more features to your package, see Chapter 3 and Chapter 6.

This is a list of the information in this chapter.

The Process of Building a Package (Task Map)

Table 2–1 describes a process for you to follow when building packages, especially if you are inexperienced at building them. Although it is not mandatory for you to complete the first four tasks in the exact order listed, your package building experience will be easier if you do. Once you are an experienced package designer, you can shuffle the sequence of these tasks to your preference.

As an experienced package designer, you can automate the package building process by using the `make` command and makefiles. For more information, see the `make`(1S) man page.

TABLE 2–1 The Process of Building a Package Task Map

Task	Description	For Instructions
1. Create a `pkginfo` file	Create the `pkginfo` file to describe the characteristics of the package.	"How to Create a `pkginfo` File" on page 29
2. Organize package contents	Arrange the package components into a hierarchical directory structure.	"Organizing a Package's Contents" on page 30
3. (optional) Create information files	Define package dependencies, include a copyright message, and reserve additional space on the target system.	Chapter 3
4. (optional) Create installation scripts	Customize the installation and removal processes of the package.	Chapter 3
5. Create a `prototype` file	Describe the object in your package in a `prototype` file.	"Creating a `prototype` File" on page 31
6. Build the package	Build the package by using the `pkgmk` command.	"Building a Package" on page 45
7. Verify and transfer the package	Verify the integrity of the package before copying it to a distribution medium.	Chapter 4

Package Environment Variables

You can use variables in the required information files, `pkginfo` and `prototype`. You can also use an option to the `pkgmk` command, which is used to build a package. As these files and commands are discussed in this chapter, more context-sensitive information on variables is provided. However, before you begin building your package, you should understand the different types of variables and how they can affect the successful creation of a package.

There are two types of variables:

- Build variables

  Build variables begin with a lowercase letter and are evaluated at *build time*, as the package is being built with the `pkgmk` command.

- Install variables

  Install variables begin with an uppercase letter and are evaluated at *install time*, as the package is being installed with the `pkgadd` command.

General Rules on Using Environment Variables

In the `pkginfo` file, a variable definition takes the form *PARAM=value*, where the first letter of *PARAM* is an uppercase letter. These variables are evaluated only at install time. If any of these variables cannot be evaluated, the `pkgadd` command aborts with an error.

In the `prototype` file, a variable definition can take the form `!`*PARAM=value* or `$`*variable*. Both *PARAM* and *variable* can begin with either an uppercase or a lowercase letter. Only variables whose values are known at build time are evaluated. If *PARAM* or *variable* is a build or install variable whose value is not known at build time, the `pkgmk` command aborts with an error.

You can also include the option *PARAM=value* as an option to the `pkgmk` command. This option works the same as in the `prototype` file, except that its scope is global to the entire package. The `!`*PARAM=value* definition in a `prototype` file is local to that file and the part of the package it defines.

If *PARAM* is an install variable, and *variable* is an install variable or build variable with a known value, the `pkgmk` command inserts the definition into the `pkginfo` file so that the definition will be available at install time. However, the `pkgmk` command does not evaluate *PARAM* that are in any path names that are specified in the `prototype` file.

Package Environment Variables Summary

The following table summarizes variable specification formats, location, and scope.

TABLE 2–2 Package Environment Variables Summary

Where Variable Is Defined	Variable Definition Format	Variable Type Being Defined	When the Variable is Evaluated	Where the Variable is Evaluated	Items the VariableMay Substitute For
`pkginfo` file	*PARAM=value*	Build	Ignored at build time	N/A	None
Install	Install time	In the `pkgmap` file	*owner*, *group*, *path*, or link target		
`prototype` file	`!`*PARAM=value*	Build	Build time	In the `prototype` file and any included files	*mode*, *owner*, *group*, or *path*

TABLE 2–2 Package Environment Variables Summary *(Continued)*

Where Variable Is Defined	Variable Definition Format	Variable Type Being Defined	When the Variable is Evaluated	Where the Variable is Evaluated	Items the VariableMay Substitute For
Install	Build time	In the `prototype` file and any included files	`!search` and `!command` commands only		
`pkgmk` command line	*PARAM=value*	Build	Build time	In the `prototype` file	*mode*, *owner*, *group*, or *path*
Install	Build time	In the `prototype` file	`!search` command only		
Install time	In the `pkgmap` file	*owner*, *group*, *path*, or link target			

Creating a `pkginfo` File

The `pkginfo` file is an ASCII file that describes the characteristics of a package along with information that helps control the flow of installation.

Each entry in the `pkginfo` file is a line that establishes the value of a parameter using the format *PARAM=value*. *PARAM* can be any of the standard parameters described in the `pkginfo`(4) man page. There is no required order in which the parameters must be specified.

Note – Each *value* can be enclosed with single or double quotation marks (for example, '*value*' or "*value*"). If *value* contains any characters that are considered special to a shell environment, you should use quotation marks. The examples and case studies in this book do not use quotation marks. See the `pkginfo`(4) man page for an example that uses double quotation marks.

You can also create your own package parameters by assigning a value to them in the `pkginfo` file. Your parameters must begin with a capital letter followed by either uppercase or lowercase letters. An uppercase letter indicates that the parameter (variable) will be evaluated at install time (as opposed to build time). For information on the difference between install variables and build variables, see "Package Environment Variables" on page 24.

Note – Trailing whitespace after any parameter value is ignored.

You must define these five parameters in a `pkginfo` file: `PKG`, `NAME`, `ARCH`, `VERSION`, and `CATEGORY`. The `PATH`, `PKGINST`, and `INSTDATE` parameters are inserted automatically by the software when the package is built. Do not modify these eight parameters. For information on the remaining parameters, see the `pkginfo`(4) man page.

Defining a Package Instance

The same package can have different versions, be compatible with different architectures, or both. Each variation of a package is known as a *package instance*. A package instance is determined by combining the definitions of the `PKG`, `ARCH`, and `VERSION` parameters in the `pkginfo` file.

The `pkgadd` command assigns a *package identifier* to each package instance at installation time. The package identifier is the package abbreviation with a numerical suffix, for example `SUNWadm.2`. This identifier distinguishes a package instance from any other package, including instances of the same package.

Defining a Package Abbreviation (`PKG`)

A *package abbreviation* is a short name for a package that is defined by the `PKG` parameter in the `pkginfo` file. A package abbreviation must have these characteristics:

- The abbreviation must consist of alphanumeric characters. The first character cannot be a number.
- The abbreviation cannot exceed 32 characters in length.
- The abbreviation cannot be one of the reserved abbreviations: `install`, `new`, or `all`.

Note – The first four characters should be unique to your company, such as your company's stock symbol. For example, packages built by Sun Microsystems™ all have "SUNW" as the first four characters of their package abbreviation.

This is an example package abbreviation entry in a `pkginfo` file:

```
PKG=SUNWcadap
```

Specifying a Package Architecture (`ARCH`)

The `ARCH` parameter in the `pkginfo` file identifies which architectures are associated with the package. The architecture name has a maximum length of 16 alphanumeric characters. If a package is associated with more than one architecture, specify the architectures in a comma-separated list.

This is an example of a package architecture specification in a `pkginfo` file:

```
ARCH=sparc
```

Specifying a Package Instruction Set Architecture (`SUNW_ISA`)

The `SUNW_ISA` parameter in the `pkginfo` file identifies which instruction set architecture is associated with a Sun Microsystems package. The values are as follows:

- `sparcv9`, for a package that contains 64–bit objects
- `sparc`, for a package that contains 32–bit objects

For example, the `SUNW_ISA` value in a `pkginfo` file for a package containing 64–bit objects would be:

```
SUNW_ISA=sparcv9
```

If `SUNW_ISA` is not set, the default instruction set architecture of the package is set to the value of the `ARCH` parameter.

Specifying a Package Version (`VERSION`)

The `VERSION` parameter in the `pkginfo` file identifies the version of the package. The version has a maximum length of 256 ASCII characters, and cannot begin with a left parenthesis.

This is an example version of a specification in a `pkginfo` file:

```
VERSION=release 1.0
```

Defining a Package Name (`NAME`)

A *package name* is the full name of the package, which is defined by the `NAME` parameter in the `pkginfo` file.

Because system administrators often use package names to determine whether a package needs to be installed, writing clear, concise, and complete package names is important. Package names must meet the following criteria:

- State when a package is needed (for example, to provide certain commands or functionality, or state if the package is needed for specific hardware).
- State what the package is used for (for example, the development of device drivers).
- Include a description of the package abbreviation mnemonic, using key words that indicate the abbreviation is a short form of the description. For example, the package name for the package abbreviation `SUNWbnuu` is "Basic Networking UUCP Utilities, (Usr)" .
- Name the partition into which the package is installed.
- Use terms consistently with their industry meaning.
- Take advantage of the 256–character limit.

Here is an example package name defined in a `pkginfo` file:

```
NAME=Chip designers need CAD application software to design
abc chips.  Runs only on xyz hardware and is installed in the
usr partition.
```

Defining a Package Category (`CATEGORY`)

The `CATEGORY` parameter in the `pkginfo` file specifies in which categories a package belongs. At a minimum, a package must belong to either the `system` or `application` category. Category names consist of alphanumeric characters. Category names have a maximum length of 16 characters and are case insensitive.

If a package belongs to more than one category, specify the categories in a comma-separated list.

Here is an example `CATEGORY` specification in a `pkginfo` file:

```
CATEGORY=system
```

▼ How to Create a `pkginfo` File

Steps

1. **Using your favorite text editor, create a file named `pkginfo`.**

   You can create this file anywhere on your system.

2. **Edit the file and define the five required parameters.**

   The five required parameters are: `PKG`, `NAME`, `ARCH`, `VERSION`, and `CATEGORY`. For more information on these parameters, see "Creating a `pkginfo` File" on page 26.

3. **Add any optional parameters to the file.**

   Create your own parameters or see the `pkginfo`(4) man page for information on the standard parameters.

4. **Save your changes and quit the editor.**

Example 2–1 Creating a `pkginfo` File

This example shows the contents of a valid `pkginfo` file, with the five required parameters defined, as well as the `BASEDIR` parameter. The `BASEDIR` parameter is discussed in more detail in "The *path* Field" on page 33.

```
PKG=SUNWcadap
NAME=Chip designers need CAD application software to design abc chips.
Runs only on xyz hardware and is installed in the usr partition.
ARCH=sparc
VERSION=release 1.0
CATEGORY=system
BASEDIR=/opt
```

See Also See "How to Organize a Package's Contents" on page 30.

Organizing a Package's Contents

Organize your package objects in a hierarchical directory structure that mimics the structure that the package objects will have on the target system after installation. If you do this step before you create a `prototype` file, you can save yourself some time and effort when creating that file.

▼ How to Organize a Package's Contents

Steps

1. **Determine how many packages you need to create and which package objects shall be located in each package.**

   For help in completing this step, see "Considerations Before Building a Package" on page 17.

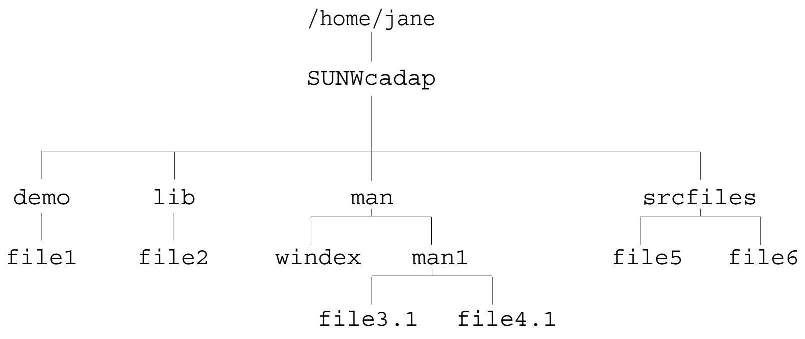
2. **Create a directory for each package you need to build.**

   You can create this directory anywhere on your system and name it anything you like. The examples in this chapter assume that a package directory has the same name as the package abbreviation.

   ```
   $ cd /home/jane
   $ mkdir SUNWcadap
   ```

3. **Organize the package objects in each package into a directory structure beneath their corresponding package directory. The directory structure must mimic the structure that the package objects will have on the target system.**

For example, the CAD application package, `SUNWcadap`, requires the following directory structure.



4. **Decide where you will keep your information files. If appropriate, create a directory to keep the files in one location.**

   This example assumes that the example `pkginfo` file from "How to Create a `pkginfo` File" on page 29 was created in Jane's home directory.

   ```
   $ cd /home/jane
   $ mkdir InfoFiles
   $ mv pkginfo InfoFiles
   ```

See Also See "How to Create a `prototype` File by Using the `pkgproto` Command" on page 43.

Creating a `prototype` File

The `prototype` file is an ASCII file used to specify information about the objects in a package. Each entry in the `prototype` file describes a single object, such as a data file, directory, source file, or executable object. Entries in a `prototype` file consist of several fields of information separated by white space. Note that the fields *must* appear in a specific order. Comment lines begin with a pound sign (#) and are ignored.

You can create a `prototype` file with a text editor or by using the `pkgproto` command. When you first create this file, it is probably easier to do so with the `pkgproto` command, because it creates the file based on the directory hierarchy you created previously. If you have not organized your files as described in "Organizing a Package's Contents" on page 30, you have the cumbersome task of creating the `prototype` file from scratch with your favorite text editor.

Format of the `prototype` File

Here is the format for each line in the `prototype` file:

partftypeclasspathmajorminormodeownergroup

part	Is an optional, numeric field that enables you to group package objects into parts. The default value is part 1.
ftype	Is a one-character field that specifies the object's type. See "The ftype Field" on page 32.
class	Is the installation class to which the object belongs. See "The *class* Field" on page 33.
path	Is the absolute or relative path name indicating where the package object will reside on the target system. See "The *path* Field" on page 33.
major	Is the major device number for block or character special devices.
minor	Is the minor device number for block or character special devices.
mode	Is the octal mode of the object (for example, 0644). See "The *mode* Field" on page 36.
owner	Is the owner of the object (for example, `bin` or `root`). See "The *owner* Field" on page 36.
group	Is the group to which the object belongs (for example, `bin` or `sys`). See "The *group* Field" on page 37.

Usually, only the *ftype*, *class*, *path*, *mode*, *owner*, and *group* fields are defined. These fields are described in the following sections. See the `prototype`(4) man page for additional information on these fields.

The ftype Field

The *ftype*, or file type, field is a one-character field that specifies a package object's file type. Valid file types are described in the following table

TABLE 2–3 Valid File Types in the `prototype` File

File type field value	File Type Description
`f`	Standard executable file or data file

TABLE 2–3 Valid File Types in the `prototype` File *(Continued)*

File type field value	File Type Description
`e`	File to be edited upon installation or removal (may be shared by several packages)
`v`	Volatile file (whose contents are expected to change, such as a log file)
`d`	Directory
`x`	Exclusive directory accessible only by this package (may contain unregistered logs or database information)
`l`	Linked file
`p`	Named pipe
`c`	Character special device
`b`	Block special device
`i`	Information file or installation script
`s`	Symbolic link

The *class* Field

The *class* field names the class to which an object belongs. Using classes is an optional package design feature. This feature is discussed in detail in "Writing Class Action Scripts" on page 70.

If you do not use classes, an object belongs to the `none` class. When you execute the `pkgmk` command to build your package, the command inserts the `CLASSES=none` parameter in the `pkginfo` file. Files with file type `i` must have a blank *class* field.

The *path* Field

The *path* field is used to define where the package object will reside on the target system. You may indicate the location with either an absolute path name (for example, `/usr/bin/mail`) or a relative path name (for example, `bin/mail`). Using an absolute path name means that the object's location on the target system is defined by the package and cannot be changed. Package objects with relative path names indicate that the object is *relocatable*.

A *relocatable object* does not need an absolute path location on the target system. Instead, the object's location is determined during the installation process.

All or some of a package's objects can be defined as relocatable. Before writing any installation scripts or creating the `prototype` file, decide if package objects will have fixed locations (such as start-up scripts in `/etc`) or be relocatable .

There are two kinds of relocatable objects, *collectively relocatable* and *individually relocatable*.

Collectively Relocatable Objects

Collectively relocatable objects are located relative to a common installation base called the *base directory*. A base directory is defined in the `pkginfo` file, using the `BASEDIR` parameter. For example, a relocatable object in the `prototype` file named `tests/generic` requires that the `pkginfo` file define the default `BASEDIR` parameter. For example:

```
BASEDIR=/opt
```

This example means that when the object is installed, it will be located in the `/opt/tests/generic` directory.

Note – The `/opt` directory is the only directory to which software that is not part of the base Solaris software may be delivered.

Use collectively relocatable objects whenever possible. In general, the major part of a package can be relocatable with a few files (such as files in `/etc` or `/var`) specified as absolute. However, if a package contains many different relocations, consider dividing the package into multiple packages with distinct `BASEDIR` values in their `pkginfo` files.

Individually Relocatable Objects

Individually relocatable objects are not restricted to the same directory location as collectively relocatable objects. To define an individually relocatable object, you need to specify an install variable in the *path* field in the `prototype` file. After specifying the install variable, create a `request` script to prompt the installer for the relocatable base directory, or a `checkinstall` script to determine the path name from file system data. For more information on `request` scripts, see "Writing a `request` Script" on page 63 and for information on `checkinstall` scripts, see "How to Gather File System Data" on page 67.

Caution – Individually relocatable objects are difficult to manage. Use of individually relocatable objects might result in widely scattered package components that are difficult to isolate when installing multiple versions or architectures of the package. Use collectively relocatable objects whenever possible.

Parametric Path Names

A *parametric path name* is a path name that includes a variable specification. For example, `/opt/$PKGINST/`*filename* is a parametric path name because of the `$PKGINST` variable specification. A default value for the variable specification *must* be defined in the `pkginfo` file. The value may then be changed by a `request` script or a `checkinstall` script.

A variable specification in a path must begin or end the path name, or be bounded by slashes (/). Valid parametric path names take the following form:

```
$PARAM/tests
tests/$PARAM/generic
/tests/$PARAM
```

The variable specification, once defined, may cause the path to be evaluated as absolute or relocatable. In the following example, the `prototype` file contains this entry:

```
f none $DIRLOC/tests/generic
```

The `pkginfo` file contains this entry:

```
DIRLOC=/myopt
```

The path name `$DIRLOC/tests/generic` evaluates to the absolute path name `/myopt/tests/generic`, regardless of whether the `BASEDIR` parameter is set in the `pkginfo` file.

In this example, the `prototype` file is identical to the one in the previous example and the `pkginfo` file contains the following entries:

```
DIRLOC=firstcut
BASEDIR=/opt
```

The path name `$DIRLOC/tests/generic` will evaluate to the relocatable path name `/opt/firstcut/tests/generic`.

For more information on parametric path names, see "Using Parametric Base Directories" on page 130.

A Brief Word on an Object's Source and Destination Locations

The *path* field in the `prototype` file defines where the object will be located on the target system. Specify the present location of the package's objects in the `prototype` file if their directory structure does not mimic the intended structure on the target system. See "Organizing a Package's Contents" on page 30 for more information on structuring objects in a package.

If your development area is not structured in the same way that you want your package structured, you can use the *path1=path2* format in the *path* field. In this format, *path1* is the location the object should have on the target system, and *path2* is the location the object has on your system.

You can also use the *path1*=*path2* path name format with *path1* as a relocatable object name and *path2* as a full path name to that object on your system.

Note – *path1* may not contain undefined build variables, but may contain undefined install variables. *path2* may not contain any undefined variables, although both build variables and install variables may be used. For information on the difference between install variables and build variables, see "Package Environment Variables" on page 24.

Links must use the *path1*= *path2* format because they are created by the `pkgadd` command. As a general rule, *path2* of a link should never be absolute, but should instead be relative to the directory portion of *path1*.

An option to using the *path1*=*path2* format is to use the `!search` command. For more information, see "Providing a Search Path for the `pkgmk` Command" on page 42.

The *mode* Field

The *mode* field may contain an octal number, a question mark (`?`), or a variable specification. An octal number specifies the mode of the object when it is installed on the target system. A `?` means that the mode will be unchanged as the object is installed, implying that the object of the same name already exists on the target system.

A variable specification of the form `$`*mode*, where the first letter of the variable must be a lowercase letter, means that this field will be set as the package is built. Note that this variable must be defined at build time in either the `prototype` file or as an option to the `pkgmk` command. For information on the difference between install variables and build variables, see "Package Environment Variables" on page 24.

Files with file type `i` (information file), `l` (hard link), and `s` (symbolic link) should leave this field blank.

The *owner* Field

The *owner* field may contain a user name, a question mark (`?`), or a variable specification. A user name has a maximum of 14 characters and should be a name that already exists on the target system (such as `bin` or `root`). A `?` means that the owner will be unchanged as the object is installed, implying that the object of the same name already exists on the target system.

A variable specification can be of the form `$`*Owner* or `$`*owner*, where the first letter of the variable is either an uppercase letter or a lowercase letter. If the variable begins with a lowercase letter, it must be defined as the package is built, either in the `prototype` file or as an option to the `pkgmk` command. If the variable begins with an uppercase letter, the variable specification will be inserted into the `pkginfo` file as a default value, and may be redefined at install time by a `request` script. For information on the difference between install variables and build variables, see "Package Environment Variables" on page 24.

Files with file type `i` (information file) and `lb` (hard link) should leave this field blank.

The *group* Field

The *group* field may contain a group name, a question mark (`?`), or a variable specification. A group name has a maximum of 14 characters and should be a name that already exists on the target system (such as, `bin` or `sys`). A `?` means that the group will be unchanged as the object is installed, implying that the object of the same name already exists on the target system.

A variable specification can be of the form `$`*Group* or `$`*group*, where the first letter of the variable is either an uppercase letter or a lowercase letter. If the variable begins with a lowercase letter, it must be defined as the package is built, either in the `prototype` file or as an option to the `pkgmk` command. If the variable begins with an uppercase letter, the variable specification will be inserted into the `pkginfo` file as a default value, and may be redefined at install time by a `request` script. For information on the difference between install variables and build variables, see "Package Environment Variables" on page 24.

Files with file type `i` (information file) and `l` (hard link) should leave this field blank.

Creating a `prototype` File From Scratch

If you want to create a `prototype` file from scratch, you can do so with your favorite text editor, adding one entry per package object. See "Format of the `prototype` File" on page 32 and the `prototype`(4) man page for more information on the format of this file. However, after you have defined each package object, you might want to include some of the features described in "Adding Functionality to a `prototype` File" on page 40.

Example—Creating a `prototype` File With the `pkgproto` Command

You can use the `pkgproto` command to build a basic `prototype` file, as long as you have organized your package directory structure as described in "Organizing a Package's Contents" on page 30. For example, using the sample directory structure and `pkginfo` file described in previous sections, the commands for creating the `prototype` file are as follows:

```
$ cd /home/jane
$ pkgproto ./SUNWcadap > InfoFiles/prototype
```

The `prototype` file looks like the following:

```
d none SUNWcadap 0755 jane staff
d none SUNWcadap/demo 0755 jane staff
f none SUNWcadap/demo/file1 0555 jane staff
d none SUNWcadap/srcfiles 0755 jane staff
f none SUNWcadap/srcfiles/file5 0555 jane staff
f none SUNWcadap/srcfiles/file6 0555 jane staff
d none SUNWcadap/lib 0755 jane staff
f none SUNWcadap/lib/file2 0644 jane staff
d none SUNWcadap/man 0755 jane staff
f none SUNWcadap/man/windex 0644 jane staff
d none SUNWcadap/man/man1 0755 jane staff
f none SUNWcadap/man/man1/file4.1 0444 jane staff
f none SUNWcadap/man/man1/file3.1 0444 jane staff
```

Note – The actual owner and group of the person building the package is recorded by the `pkgproto` command. A good technique is to use the `chown -R` and the `chgrp -R` commands, setting the owner and group as intended *before* running the `pkgproto` command.

This example `prototype` file is not complete. See the following section for information on completing this file.

Fine-Tuning a `prototype` File Created With the `pkgproto` Command

Although the `pkgproto` command is useful in creating an initial `prototype` file, it does not create entries for every package object that needs to be defined. This command does not make complete entries. The `pkgproto` command does not do any of the following:

- Create complete entries for objects with file types `v` (volatile files), `e` (editable files), `x` (exclusive directories), or `i` (information files or installation scripts)
- Support multiple classes with a single invocation

Creating Object Entries With File Types `v`, `e`, `x`, and `i`

At the very least, you need to modify the `prototype` file to add objects with file type `i`. If you stored your information files and installation scripts in the first level of your package directory (for example, `/home/jane/SUNWcadap/pkginfo`), then an entry in the `prototype` file would look like the following:

```
i pkginfo
```

If you did not store your information files and installation scripts in the first level of your package directory, then you need to specify their source location. For example:

```
i pkginfo=/home/jane/InfoFiles/pkginfo
```

Or, you can use the `!search` command to specify the location for the `pkgmk` command to look when building the package. See "Providing a Search Path for the `pkgmk` Command" on page 42 for more information.

To add entries for objects with file types `v`, `e`, and `x`, follow the format described in "Format of the `prototype` File" on page 32, or refer to the `prototype`(4) man page.

Note – Remember to always assign a class to files with a file type of `e` (editable) and have an associated class action script for that class. Otherwise, the files will be removed during package removal, even if the path name is shared with other packages.

Using Multiple Class Definitions

If you use the `pkgproto` command to create your basic `prototype` file, you can assign all the package objects to the `none` class or to one, specific class. As shown in "Example—Creating a `prototype` File With the `pkgproto` Command" on page 37, the basic `pkgproto` command assigns all objects to the `none` class. To assign all objects to a specific class, you can use the `-c` option. For example:

```
$ pkgproto -c classname /home/jane/SUNWcadap > /home/jane/InfoFiles/prototype
```

If you use multiple classes, you might need to manually edit the `prototype` file and modify the *class* field for each object. If you use classes, you also need to define the `CLASSES` parameter in the `pkginfo` file and write class action scripts. Using classes is an optional feature and is discussed in detail in "Writing Class Action Scripts" on page 70.

Example—Fine-Tuning a `prototype` File Created Using the `pkgproto` Command

Given the `prototype` file created by the `pkgproto` command in "Example—Creating a `prototype` File With the `pkgproto` Command" on page 37, several modifications need to be made.

- There needs to be an entry for the `pkginfo` file.
- The *path* fields need to be changed to the *path1*=*path2* format because the package source is in `/home/jane`. Since the package source is a hierarchical directory, and the `!search` command does not search recursively, it might be easier to use the *path1*=*path2* format.

- The *owner* and *group* fields should contain the names of existing users and groups on the target system. That is, the owner `jane` will result in an error because this owner is not part of the SunOS™ operating system.

  The modified `prototype` file looks like the following:

```
i pkginfo=/home/jane/InfoFiles/pkginfo
d none SUNWcadap=/home/jane/SUNWcadap 0755 root sys
d none SUNWcadap/demo=/home/jane/SUNWcadap/demo 0755 root bin
f none SUNWcadap/demo/file1=/home/jane/SUNWcadap/demo/file1 0555 root bin
d none SUNWcadap/srcfiles=/home/jane/SUNWcadap/srcfiles 0755 root bin
f none SUNWcadap/srcfiles/file5=/home/jane/SUNWcadap/srcfiles/file5 0555 root bin
f none SUNWcadap/srcfiles/file6=/home/jane/SUNWcadap/srcfiles/file6 0555 root bin
d none SUNWcadap/lib=/home/jane/SUNWcadap/lib 0755 root bin
f none SUNWcadap/lib/file2=/home/jane/SUNWcadap/lib/file2 0644 root bin
d none SUNWcadap/man=/home/jane/SUNWcadap/man 0755 bin bin
f none SUNWcadap/man/windex=/home/jane/SUNWcadap/man/windex 0644 root other
d none SUNWcadap/man/man1=/home/jane/SUNWcadap/man/man1 0755 bin bin
f none SUNWcadap/man/man1/file4.1=/home/jane/SUNWcadap/man/man1/file4.1 0444 bin bin
f none SUNWcadap/man/man1/file3.1=/home/jane/SUNWcadap/man/man1/file3.1 0444 bin bin
```

Adding Functionality to a `prototype` File

Besides defining every package object in the `prototype` file, you can also do the following:

- Define additional objects to be created at install time.
- Create links at install time.
- Distribute packages over multiple volumes.
- Nest `prototype` files.
- Set a default value for the *mode*, *owner*, and *group* fields.
- Provide a search path for the `pkgmk` command.
- Set environment variables.

See the following sections for information on making these changes.

Defining Additional Objects to Be Created at Install Time

You can use the `prototype` file to define objects that are not actually delivered on the installation medium. During installation, using the `pkgadd` command, these objects are created with the required file types, if they do not already exist at the time of installation.

To specify that an object be created on the target system, add an entry for it in the `prototype` file with the appropriate file type.

For example, if you want a directory created on the target system, but do not want to deliver it on the installation medium, add the following entry for the directory in the `prototype` file:

```
d none /directory 0644 root other
```

If you want to create an empty file on the target system, an entry for the file in the `prototype` file might look like the following:

```
f none filename=/dev/null 0644 bin bin
```

The only objects that *must* be delivered on the installation medium are regular files and edit scripts (file types `e`, `v`, `f`) and the directories required to contain them. Any additional objects are created without reference to the delivered objects, directories, named pipes, devices, hard links, and symbolic links.

Creating Links at Install Time

To create links during package installation, define the following in the `prototype` file entry for the linked object:

- Its file type as `l` (a link) or `s` (a symbolic link).
- The linked object's path name with the format *path1=path2* where *path1* is the destination and *path2* is the source file. As a general rule, *path2* of a link should never be absolute, but should instead be relative to the directory portion of *path1*. For example, a `prototype` file entry that defines a symbolic link could be as follows:

  ```
  s none etc/mount=../usr/etc/mount
  ```

Relative links would be specified in this manner whether the package is installed as absolute or relocatable.

Distributing Packages Over Multiple Volumes

When you build your package with the `pkgmk` command, the command performs the calculations and actions necessary to organize a multiple volume package. A multiple volume package is called a *segmented package*.

However, you can use the optional *part* field in the `prototype` file to define which part you want an object to be located. A number in this field overrides the `pkgmk` command and forces the placement of the component into the part given in the field. Note that a one-to-one correspondence exists between parts and volumes for removable media formatted as file systems. If the volumes are preassigned by the developer, the `pkgmk` command issues an error if there is insufficient space on any volume.

Nesting `prototype` Files

You can create multiple `prototype` files and then include them by using the `!include` command in the `prototype` file. You might want to nest files for easier maintenance.

In the following example there are three `prototype` files. The main file (`prototype`) is being edited. The other two files (`proto2` and `proto3`) are being included.

```
!include /source-dir/proto2
!include /source-dir/proto3
```

Setting Default Values for the *mode*, *owner*, and *group* Fields

To set default values for the *mode*, *owner*, and *group* fields for specific package objects, you can insert the `!default` command into the `prototype` file. For example:

```
!default 0644 root other
```

Note – The `!default` command's range starts from where it is inserted and extends to the end of the file. The command's range does not span to included files.

However, for directories (file type `d`) and editable files (file type `e`) that you know exist on target systems (like `/usr` or `/etc/vfstab`), make sure that the *mode*, *owner*, and *group* fields in the `prototype` file are set to question marks (`?`). That way you will not destroy existing settings that a site administrator may have modified.

Providing a Search Path for the `pkgmk` Command

If the source location for package objects is different than their destination location, and you do not want to use the *path1*=*path2* format as described in "A Brief Word on an Object's Source and Destination Locations" on page 35, then you can use the `!search` command in the `prototype` file.

For example, if you created a directory, `pkgfiles`, in your home directory, and it contains all of your information files and installation scripts, you can specify that this directory be searched when the package is built with the `pkgmk` command.

The command in the prototype file would look like the following:

```
!search /home-dir/pkgfiles
```

Note – Search requests do not span to included files. In addition, a search is limited to the specific directories listed and does not search recursively.

Setting Environment Variables

You can also add commands to the `prototype` file of the form `!`*PARAM=value*. Commands of this form define variables in the current environment. If you have multiple `prototype` files, the scope of this command is local to the `prototype` file where it is defined.

The variable *PARAM* can begin with either a lowercase letter or an uppercase letter. If the value of the *PARAM* variable is not known at build time, the `pkgmk` command aborts with an error. For more information on the difference between build variables and install variables, see "Package Environment Variables" on page 24.

▼ How to Create a `prototype` File by Using the `pkgproto` Command

Note – It is easier to create information files and installation scripts before you create a `prototype` file. However, this order is not required. You can always edit the `prototype` file after changing your package contents. For more information on information files and installation scripts, see Chapter 3.

Steps

1. **Determine which package objects will be absolute and which package objects will be relocatable, if not done already.**

   For information that will help you complete this step, see "The *path* Field" on page 33.

2. **Organize your package's objects to mimic their location on the target system.**

   If you already organized your packages as described in "Organizing a Package's Contents" on page 30, note that you might need to make some changes based on your decisions in Step 1. If you have not organized your package yet, you should do so now. If you do not organize your package, you cannot use the `pkgproto` command to create a basic `prototype` file.

3. **If your package has collectively relocatable objects, edit the `pkginfo` file to set the `BASEDIR` parameter to the appropriate value.**

   For example:

   ```
   BASEDIR=/opt
   ```

   For information on collectively relocatable objects, see "Collectively Relocatable Objects" on page 34.

4. **If your package has individually relocatable objects, create a `request` script to prompt the installer for the appropriate path name. Alternatively, create a `checkinstall` script to determine the appropriate path from file system data.**

The following list gives page numbers for your reference regarding common tasks:

- To create a `request` script, see "How to Write a `request` Script" on page 64.
- To create a `checkinstall` script, see "How to Gather File System Data" on page 67.
- For more information on individually relocatable objects, see "Individually Relocatable Objects" on page 34.

5. **Change the owner and group on all of your package components to be the intended owner and group on the target systems.**

   Use the `chown -R` and the `chgrp -R` commands on your package directory and information files directory.

6. **Execute the `pkgproto` command to create a basic `prototype` file.**

   The `pkgproto` command scans your directories to create a basic file. For example:

   ```
   $ cd package-directory
   $ pkgproto ./package-directory > prototype
   ```

   The `prototype` file can be located anywhere on your system. Keeping your information files and installation scripts in one place simplifies access and maintenance. For additional information on the `pkgproto` command, see the `pkgproto`(1) man page.

7. **Edit the `prototype` file by using your favorite text editor, and add entries for files of type `v`, `e`, `x`, and `i`.**

   For information on the specific changes you might need to make, see "Fine-Tuning a `prototype` File Created With the `pkgproto` Command" on page 38.

8. **(Optional) If you are using multiple classes, edit the `prototype` and `pkginfo` files. Use your favorite text editor to make the necessary changes, and create corresponding class action scripts.**

   For information on the specific changes you might need to make, see "Fine-Tuning a `prototype` File Created With the `pkgproto` Command" on page 38 and "Writing Class Action Scripts" on page 70.

9. **Edit the `prototype` file by using your favorite text editor to redefine path names and change other field settings.**

   For more information, see "Fine-Tuning a `prototype` File Created With the `pkgproto` Command" on page 38.

10. **(Optional) Edit the `prototype` file by using your favorite text editor to add functionality to your `prototype` file.**

    For more information, see "Adding Functionality to a `prototype` File" on page 40.

11. **Save your changes and quit the editor.**

See Also If you are ready for the next task, see "How to Build a Package" on page 46.

Building a Package

Use the `pkgmk` command to build your package. The `pkgmk` command performs the following tasks:

- Puts all the objectes defined in the `prototype` file into directory format.
- Creates the `pkgmap` file, which replaces the `prototype` file.
- Produces an installable package that is used as input to the `pkgadd` command.

Using the Simplest `pkgmk` Command

The simplest form of this command is the `pkgmk` command without any options. Before using the `pkgmk` command without options, make sure that your current working directory contains the package's `prototype` file. The output of the command, files and directories, are written to the `/var/spool/pkg` directory.

The `pkgmap` File

When you build a package with the `pkgmk` command, it creates a `pkgmap` file that replaces the `prototype` file. The `pkgmap` file from the previous example has the following contents:

```
$ more pkgmap
: 1 3170
1 d none SUNWcadap 0755 root sys
1 d none SUNWcadap/demo 0755 root bin
1 f none SUNWcadap/demo/file1 0555 root bin 14868 45617 837527496
1 d none SUNWcadap/lib 0755 root bin
1 f none SUNWcadap/lib/file2 0644 root bin 1551792 62372 837527499
1 d none SUNWcadap/man 0755 bin bin
1 d none SUNWcadap/man/man1 0755 bin bin
1 f none SUNWcadap/man/man1/file3.1 0444 bin bin 3700 42989 837527500
1 f none SUNWcadap/man/man1/file4.1 0444 bin bin 1338 44010 837527499
1 f none SUNWcadap/man/windex 0644 root other 157 13275 837527499
1 d none SUNWcadap/srcfiles 0755 root bin
1 f none SUNWcadap/srcfiles/file5 0555 root bin 12208 20280 837527497
1 f none SUNWcadap/srcfiles/file6 0555 root bin 12256 63236 837527497
1 i pkginfo 140 10941 837531104
$
```

The format of this file is very similar to the format of the `prototype` file. However, the `pkgmap` file includes the following information:

- The first line indicates the number of volumes that the package spans, and the approximate size the package will be when it is installed.

For example, `: 1 3170` indicates that the package spans one volume and will use approximately 3170 512-byte blocks when it is installed.

- There are three additional fields that define the size, checksum, and modification time for each package object.
- The package objects are listed in alphabetical order by class and by path name to reduce the time it takes to install the package.

▼ How to Build a Package

Steps

1. **Create a `pkginfo` file, if not done already.**

   For step-by-step instructions, see "How to Create a `pkginfo` File" on page 29.

2. **Create a `prototype` file, if not done already.**

   For step-by-step instructions, see "How to Create a `prototype` File by Using the `pkgproto` Command" on page 43.

3. **Make your current working directory the same directory that contains your package's `prototype` file.**

4. **Build the package.**

```
$ pkgmk [-o] [-a arch] [-b base-src-dir] [-d device]
    [-f filename] [-l limit] [-p pstamp] [-r rootpath]
    [-v version] [PARAM=value] [pkginst]
```

`-o`	Overwrites the existing version of the package.
`-a` *arch*	Overrides the architecture information in the `pkginfo` file.
`-b` *base-src-dir*	Requests that *base-src-dir* be added to the beginning of relocatable path names when the `pkgmk` command is searching for objects on the development system.
`-d` *device*	Specifies that the package should be copied onto *device*, which may be a an absolute directory path name, diskette, or removable disk.
`-f` *filename*	Names a file, *filename*, that is used as your `prototype` file. The default names are `prototype` or `Prototype`.
`-l` *limit*	Specifies the maximum size, in 512-byte blocks, of the output device.
`-p` *pstamp*	Overrides the production stamp definition in the `pkginfo` file.
`-r` *rootpath*	Requests that the root directory *rootpath* be used to locate objects on the development system.
`-v` *version*	Overrides the version information in the `pkginfo` file.
PARAM=value	Sets global environment variables. Variables beginning with lowercase letters are resolved at build time. Those beginning

with uppercase letters are placed into the `pkginfo` file for use at install time.

pkginst	Specifies a package by its package abbreviation or a specific instance (for example, `SUNWcadap.4`).

For more information, see the `pkgmk`(1) man page.

5. **Verify the contents of the package.**

```
$ pkgchk -d device-name pkg-abbrev
Checking uninstalled directory format package pkg-abbrev
from device-name
## Checking control scripts.
## Checking package objects.
## Checking is complete.
$
```

`-d` *device-name*	Specifies the location of the package. Note that *device-name* can be a full directory path name or the identifiers for a tape or removable disk.
pkg-abbrev	Is the name of one or more packages (separated by spaces) to be checked. If omitted, the `pkgchk` command checks all available packages.

The `pkgchk` command prints what aspects of the package are being checked and displays warnings or errors, as appropriate. For more information on the `pkgchk` command, see "Verifying the Integrity of a Package" on page 88.

Caution – Errors should be considered very seriously. An error could mean that a script needs fixing. Check all errors and move on if you disagree with the output from the `pkgchk` command.

Example 2–2 Building a Package

This example uses the `prototype` file created in "Fine-Tuning a `prototype` File Created With the `pkgproto` Command" on page 38.

```
$ cd /home/jane/InfoFiles
$ pkgmk
## Building pkgmap from package prototype file.
## Processing pkginfo file.
WARNING: parameter  set to "system990708093144"
WARNING: parameter  set to "none"
## Attempting to volumize 13 entries in pkgmap.
part  1 -- 3170 blocks, 17 entries
## Packaging one part.
/var/spool/pkg/SUNWcadap/pkgmap
/var/spool/pkg/SUNWcadap/pkginfo
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/demo/file1
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/lib/file2
```

```
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/man/man1/file3.1
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/man/man1/file4.1
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/man/windex
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/srcfiles/file5
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/srcfiles/file6
## Validating control scripts.
## Packaging complete.
$
```

Example 2–3 Specifying a Source Directory for Relocatable Files

If your package contains relocatable files, you can use the `-b` *base-src-dir* option to the `pkgmk` command to specify a path name to be added to the beginning of the relocatable path names while the package is being created. This option is useful if you haven't used the *path1=path2* format for relocatable files or specified a search path with the `!search` command in the `prototype` file.

The following command builds a package with the following characteristics:

- The package is built by using the sample `prototype` file that is created by the `pkgproto` command. See "Example—Creating a `prototype` File With the `pkgproto` Command" on page 37 for more information.
- The package is built without modifying the *path* fields.
- The package adds an entry for the `pkginfo` file

```
$ cd /home/jane/InfoFiles
$ pkgmk -o -b /home/jane
## Building pkgmap from package prototype file.
## Processing pkginfo file.
WARNING: parameter  set to "system960716102636"
WARNING: parameter  set to "none"
## Attempting to volumize 13 entries in pkgmap.
part  1 -- 3170 blocks, 17 entries
## Packaging one part.
/var/spool/pkg/SUNWcadap/pkgmap
/var/spool/pkg/SUNWcadap/pkginfo
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/demo/file1
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/lib/file2
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/man/man1/file3.1
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/man/man1/file4.1
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/man/windex
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/srcfiles/file5
/var/spool/pkg/SUNWcadap/reloc/SUNWcadap/srcfiles/file6
## Validating control scripts.
## Packaging complete.
```

In this example, the package is built in the default directory, `/var/spool/pkg`, by specifying the `-o` option. This option overwrites the package that was created in Example 2–2.

Example 2–4 Specifying Different Source Directories for Information Files and Package Objects

If you put package information files (such as `pkginfo` and `prototype`) and the package objects in two different directories, you can create your package by using the `-b` *base-src-dir* and `-r` *rootpath* options to the `pkgmk` command. If you have your package objects in a directory called `/product/pkgbin` and the other package information files in a directory called `/product/pkgsrc`, you could use the following command to place the package in the `/var/spool/pkg` directory:

```
$ pkgmk -b /product/pkgbin -r /product/pkgsrc -f /product/pkgsrc/prototype
```

Optionally, you could use these commands to achieve the same result:

```
$ cd /product/pkgsrc
$ pkgmk -o -b /product/pkgbin
```

In this example, the `pkgmk` command uses the current working directory to find the remaining parts of the package (such as the `prototype` and `pkginfo` information files).

See Also If you want to add any optional information files and installation scripts to your package, see Chapter 3. Otherwise, after you build the package, you should verify its integrity. Chapter 4 explains how to do so, and provides step-by-step instructions on how to transfer your verified package to a distribution medium.

CHAPTER 3

Enhancing the Functionality of a Package (Tasks)

This chapter describes how to create optional information files and installation scripts for a package. While Chapter 2 discussed the minimum requirements for making a package, this chapter discusses additional functionality that you can build into a package. This additional functionality is based on the criteria you considered when planning how to design your package. For more information, see "Considerations Before Building a Package" on page 17.

This is a list of the overview information in this chapter.

- "Creating Information Files and Installation Scripts (Task Map)" on page 51
- "Creating Information Files" on page 53
- "Creating Installation Scripts" on page 58
- "Creating Signed Packages" on page 77

Creating Information Files and Installation Scripts (Task Map)

The following task map describes the optional features you can build into a package.

TABLE 3–1 Creating Information Files and Installation Scripts (Task Map)

Task	Description	For Instructions
1. Create information files	*Define package dependencies* A definition of package dependencies allows you to specify whether your package is compatible with previous versions, dependent on other packages, or whether other packages are dependent on yours.	"How to Define Package Dependencies" on page 54
	Write a copyright message A `copyright` file provides legal protection for your software application.	"How to Write a Copyright Message" on page 56
	Reserve additional space on the target system. A `space` file sets aside blocks on the target system, which enables you to create files during installation that are not defined in the `pkgmap` file.	"How to Reserve Additional Space on a Target System" on page 57
2. Create installation scripts	*Obtain information from the installer* A `request` script enables you to obtain information from the person installing your package.	"How to Write a `request` Script" on page 64
	Gather file system data needed for installation A `checkinstall` script enables you to perform an analysis of the target system and set up the correct environment for, or cleanly halt, the installation.	"How to Gather File System Data" on page 67
	Write procedure scripts Procedure scripts enable you to provide customized installation instructions during specific phases of the installation or removal process.	"How to Write Procedure Scripts" on page 69
	Write class action scripts Class action scripts enable you to specify a set of instructions to be executed during package installation and removal on specific groups of package objects.	"How to Write Class Action Scripts" on page 76

Creating Information Files

This section discusses optional package information files. With these files you can define package dependencies, provide a copyright message, and reserve additional space on a target system.

Defining Package Dependencies

You need to determine whether your package has dependencies on other packages and if any other packages depend on yours. Package dependencies and incompatibilities can be defined with two of the optional package information files, `compver` and `depend`.

Delivering a `compver` file lets you name previous versions of your package that are compatible with the package being installed.

Delivering a `depend` file lets you define three types of dependencies associated with your package. These dependency types are as follows:

- A *prerequisite package* – Your package depends on the existence of another package
- A *reverse dependency* – Another package depends on the existence of your package

> **Note –** Use the reverse dependency type only when a package that cannot deliver a `depend` file relies on your package.

- An *incompatible package* – Your package is incompatible with the named package

The `depend` file resolves only very basic dependencies. If your package depends upon a specific file, its contents, or its behavior, the `depend` file does not supply adequate precision. In this case, a `request` script or the `checkinstall` script should be used for detailed dependency checking. The `checkinstall` script is also the only script capable of cleanly halting the package installation process.

> **Note –** Be certain that your `depend` and `compver` files have entries in the `prototype` file. The file type should be `i` (for package information file).

Refer to the `depend`(4) and `compver`(4) man pages for more information.

▼ How to Define Package Dependencies

Steps

1. **Make the directory that contains your information files the current working directory.**

2. **If previous versions of your package exist and you need to specify that your new package is compatible with them, create a file named `compver` with your favorite text editor.**

   List the versions with which your package is compatible. Use this format:

   string string . . .

   The value of *string* is identical to the value assigned to the `VERSION` parameter in the `pkginfo` file, for each compatible package.

3. **Save your changes and quit the editor.**

4. **If your package depends on the existence of other packages, other packages depend on the existence of your package, or your package is incompatible with another package, create a file named `depend` with your favorite text editor.**

   Add an entry for each dependency. Use this format:

   ```
   type pkg-abbrev pkg-name
       (arch) version
       (arch) version . . .
   ```

type	Defines the dependency type. Must be one of the following characters: `P` (prerequisite package), `I` (incompatible package), or `R` (reverse dependency).
pkg-abbrev	Specifies the package abbreviation, such as `SUNWcadap`.
pkg-name	Specifies the full package name, such as `Chip designers need CAD application software to design abc chips. Runs only on xyz hardware and is installed in the usr partition.`
(*arch*)	Optional. Specifies the type of hardware on which the package runs. For example, `sparc` or `x86`. If you specify an architecture, you must use the parentheses as delimiters.
version	Optional. Specifies the value assigned to the `VERSION` parameter in the `pkginfo` file.

   For more information, see `depend`(4).

5. **Save your changes and quit the editor.**

6. **Complete *one* of the following tasks:**

   ■ If you want to create additional information files and installation scripts, skip to the next task, "How to Write a Copyright Message" on page 56.

- If you have not created your prototype file, complete the procedure "How to Create a prototype File by Using the pkgproto Command" on page 43. Skip to Step 7.
- If you have already created your prototype file, edit it and add an entry for each file you just created.

7. **Build your package.**

   See "How to Build a Package" on page 46, if needed.

Example 3–1 compver File

In this example, there are four versions of a package: 1.0, 1.1, 2.0, and the new package, 3.0. The new package is compatible with all the three previous versions. The compver file for the newest version might look like the following:

```
release 3.0
release 2.0
version 1.1
1.0
```

The entries do not have to be in sequential order. However, they should exactly match the definition of the VERSION parameter in each package's pkginfo file. In this example, the package designers used different formats in the first three versions.

Example 3–2 depend File

This example assumes that the sample package, SUNWcadap, requires that the SUNWcsr and SUNWcsu packages already be installed on a target system. The depend file for SUNWcadap looks like the following:

```
P SUNWcsr Core Solaris, (Root)
P SUNWcsu Core Solaris, (Usr)
```

See Also After you build the package, install it to confirm that it installs correctly and verify its integrity. Chapter 4 explains these tasks and provides step-by-step instructions on how to transfer your verified package to a distribution medium.

Writing a Copyright Message

You need to decide whether your package should display a copyright message while it is being installed. If so, create the copyright file.

Note – You should include a `copyright` file to provide legal protection for your software application. Check with the legal department of your company for the exact wording of the message.

To deliver a copyright message, you must create a file named `copyright`. During installation, the message is displayed exactly as it appears in the file (with no formatting). See the `copyright`(4) man page for more information.

Note – Be certain that your `copyright` file has an entry in the `prototype` file. The file type should be `i` (for package information file).

▼ How to Write a Copyright Message

Steps

1. **Make the directory that contains your information files the current working directory.**
2. **Create a file named `copyright` with your favorite text editor.**

   Type the text of the copyright message exactly as you want it to appear as your package is installed.
3. **Save your changes and quit the editor.**
4. **Complete *one* of the following tasks.**
   - If you want to create additional information files and installation scripts, skip to the next task, "How to Reserve Additional Space on a Target System" on page 57.
   - If you have *not* created your `prototype` file, complete the procedure "How to Create a `prototype` File by Using the `pkgproto` Command" on page 43. Skip to Step 5.
   - If you have already created your `prototype` file, edit it and add an entry for the information file you just created.
5. **Build your package.**

   See "How to Build a Package" on page 46, if needed.

Example 3–3 `copyright` File

For example, a partial copyright message might look like the following:

```
Copyright (c) 2003 Company Name
All Rights Reserved

This product is protected by copyright and distributed under
licenses restricting copying, distribution, and decompilation.
```

See Also After you build the package, install it to confirm that it installs correctly and verify its integrity. Chapter 4 explains these tasks and provides step-by-step instructions on how to transfer your verified package to a distribution medium.

Reserving Additional Space on a Target System

You need to determine whether your package needs additional disk space on the target system. This space is in addition to the space required by the package objects. If so, create the `space` information file. This task is different than creating empty files and directories at installation time, as discussed in "Defining Additional Objects to Be Created at Install Time" on page 40.

The `pkgadd` command ensures that there is enough disk space to install your package based on the object definitions in the `pkgmap` file. However, a package may require additional disk space beyond that needed by the objects defined in the `pkgmap` file. For example, your package might create a file after installation, which may contain a database, log files, or some other growing file that consumes disk space. To be sure that there is space reserved for it, you should include a `space` file that specifies the disk space requirements. The `pkgadd` command checks for the additional space specified in a `space` file. Refer to the `space`(4) man page for more information.

Note – Be certain that your `space` file has an entry in the `prototype` file. The file type should be `i` (for package information file).

▼ How to Reserve Additional Space on a Target System

Steps

1. **Make the directory that contains your information files the current working directory.**
2. **Create a file named `space` with your favorite text editor.**

   Specify any additional disk space requirements needed by your package. Use this format:

   pathname blocks inodes

pathname	Specifies a directory name, which may or may not be the mount point for a file system.
blocks	Specifies the number of 512-byte blocks that you want reserved.
inodes	Specifies the number of required inodes.

For more information, see the `space`(4) man page.

3. **Save your changes and quit the editor.**
4. **Complete one of the following tasks.**
   - If you want to create installation scripts, skip to the next task, "How to Write a `request` Script" on page 64.
   - If you have not created your `prototype` file, complete the procedure in "How to Create a `prototype` File by Using the `pkgproto` Command" on page 43. Skip to Step 5.
   - If you have already created your `prototype` file, edit it and add an entry for the information file you just created.
5. **Build your package.**

   See "How to Build a Package" on page 46, if needed.

Example 3–4 `space` File

This example `space` file specifies that 1000 512-byte blocks and 1 inode be reserved in the `/opt` directory on the target system.

```
/opt   1000   1
```

See Also After you build the package, install it to confirm that it installs correctly and verify its integrity. Chapter 4 explains these tasks and provides step-by-step instructions on how to transfer your verified package to a distribution medium.

Creating Installation Scripts

This section discusses optional package installation scripts. The `pkgadd` command automatically performs all the actions necessary to install a package using the package information files as input. You do *not* have to supply any package installation scripts. However, if you want to create customized installation procedures for your package, you can do so with installation scripts. Installation scripts:

- Must be executable by the Bourne shell (`sh`)
- Must contain Bourne shell commands and text

- Do not need to contain the `#!/bin/sh` shell identifier
- Need not be an executable file

There are four types of installation scripts with which you can perform customized actions:

- The `request` script

  The `request` script solicits data from the administrator who is installing a package for assigning or redefining environment variables.
- The `checkinstall` script

  The `checkinstall` script examines the target system for needed data, can set or modify package environment variables, and determines whether the installation proceeds.

  Note – The `checkinstall` script is available starting with the Solaris 2.5 and compatible releases.

- Procedure scripts

  Procedure scripts identify a procedure to be invoked before or after the installation or removal of a package. The four procedure scripts are `preinstall`, `postinstall`, `preremove`, and `postremove`.
- Class action scripts

  Class action scripts define an action or set of actions that should be applied to a class of files during installation or removal. You can define your own classes. Alternatively, you can use one of the four standard classes (`sed`, `awk`, `build`, and `preserve`).

Script Processing During Package Installation

The type of scripts you use depends on when the action of the script is needed during the installation process. As a package is installed, the `pkgadd` command performs the following steps:

1. Executes the `request` script

   This step is the only point at which your package can solicit input from the administrator who is installing the package.
2. Executes the `checkinstall` script

   The `checkinstall` script gathers file system data and can create or alter environment variable definitions to control the subsequent installation. For more information on package environment variables, see "Package Environment Variables" on page 24.

3. Executes the `preinstall` script
4. Installs package objects, for each class to be installed

   Installation of these files occurs class by class, and class action scripts are executed accordingly. The list of classes operated on and the order in which they should be installed is initially defined with the `CLASSES` parameter in your `pkginfo` file. However, your `request` script or `checkinstall` script can change the value of the `CLASSES` parameter. For more information on how classes are processed during installation, see "How Classes Are Processed During Package Installation" on page 70.

   a. Creates symbolic links, devices, named pipes, and required directories
   b. Installs the regular files (file types `e`, `v`, `f`), based on their class

      The class action script is passed only regular files to install. All other package objects are created automatically from information in the `pkgmap` file.
   c. Creates all hard links
5. Executes the `postinstall` script

Script Processing During Package Removal

When a package is being removed, the `pkgrm` command performs these steps:

1. Executes the `preremove` script
2. Removes the package objects, for each class

   Removal also occurs class by class. Removal scripts are processed in the reverse order of installation, based on the sequence defined in the `CLASSES` parameter. For more information on how classes are processed during installation, see "How Classes Are Processed During Package Installation" on page 70.

   a. Removes hard links
   b. Removes regular files
   c. Removes symbolic links, devices, and named pipes
3. Executes the `postremove` script

The `request` script is not processed at the time of package removal. However, the script's output is retained in the installed package and made available to removal scripts. The `request` script's output is a list of environment variables.

Package Environment Variables Available to Scripts

The following groups of environment variables are available to all installation scripts. Some of the environment variables can be modified by a `request` script or a `checkinstall` script.

- The `request` script or the `checkinstall` script can set or modify any of the standard parameters in the `pkginfo` file, except for the required parameters. The standard installation parameters are described in detail in the `pkginfo`(4) man page.

Note – The `BASEDIR` parameter can only be modified starting with the Solaris 2.5 release and compatible releases.

- You can define your own installation environment variables by assigning values to them in the `pkginfo` file. Such environment variables must be alphanumeric with initial capital letters. Any of these environment variables can be changed by a `request` script or a `checkinstall` script.
- Both a `request` script and a `checkinstall` script can define new environment variables by assigning values to them and putting them in the installation environment.
- The following table lists environment variables that are available to all installation scripts through the environment. None of these environment variables can be modified by a script.

Environment Variable	Description
`CLIENT_BASEDIR`	The base directory with respect to the target system. While `BASEDIR` is the variable to use if you are referring to a specific package object from the install system (most likely a server), `CLIENT_BASEDIR` is the path to include in files placed on the client system. `CLIENT_BASEDIR` exists if `BASEDIR` exists and is identical to `BASEDIR` if there is no `PKG_INSTALL_ROOT`.
`INST_DATADIR`	The directory where the package now being read is located. If the package is being read from a tape, this variable will be the location of a temporary directory where the package has been transferred into directory format. In other words, assuming there is no extension to the package name (for example, `SUNWstuff.d`), the `request` script for the current package would be found at `$INST_DATADIR/$PKG/install`.
`PATH`	The search list used by `sh` to find commands on script invocation. `PATH` is usually set to `/sbin:/usr/sbin:/usr/bin:/usr/sadm/install/bin`.
`PKGINST`	The instance identifier of the package being installed. If another instance of the package is not already installed, the value is the package abbreviation (for example, `SUNWcadap`). Otherwise, the value is the package abbreviation followed by a suffix, such as `SUNWcadap.4`.
`PKGSAV`	The directory where files can be saved for use by removal scripts or where previously saved files can be found. Available only in the Solaris 2.5 release and compatible releases.

Environment Variable	Description
`PKG_INSTALL_ROOT`	The root file system on the target system where the package is being installed. This variable exists only if the `pkgadd` and `pkgrm` commands were invoked with the `-R` option. This conditional existence facilitates its use in procedure scripts in the form `${PKG_INSTALL_ROOT}`/*somepath*.
`PKG_NO_UNIFIED`	An environment variable that gets set if the `pkgadd` and `pkgrm` commands were invoked with the `-M` and `-R` options. This environment variable is passed to any package installation script or package command that is part of the package environment.
`UPDATE`	This environment variable does not exist under most installation environments. If this variable does exist (with the value `yes`), it means one of two things. Either a package with the same name, version, and architecture is already installed on the system. Or this package is overwriting an installed package of the same name at the direction of the administrator. In these events, the original base directory is always used.

Obtaining Package Information for a Script

Two commands can be used from scripts to solicit information about a package:

- The `pkginfo` command returns information about software packages, such as the instance identifier and package name.
- The `pkgparam` command returns values for requested environment variables.

  See the `pkginfo`(1) man page, the `pkgparam`(1) man page, and Chapter 4 for more information.

Exit Codes for Scripts

Each script must exit with one of the exit codes shown in the following table.

TABLE 3–2 Installation Script Exit Codes

Code	Meaning
0	Successful completion of script.
1	Fatal error. Installation process is terminated at this point.
2	Warning or possible error condition. Installation continues. A warning message is displayed at the time of completion.

TABLE 3–2 Installation Script Exit Codes *(Continued)*

Code	Meaning
3	The `pkgadd` command is cleanly halted. Only the `checkinstall` script returns this code.
10	System should be rebooted when installation of all selected packages is completed. (This value should be added to one of the single-digit exit codes.)
20	System should be rebooted immediately upon completing installation of the current package. (This value should be added to one of the single-digit exit codes.)

See Chapter 5 for examples of exit codes that are returned by installation scripts.

Note – All installation scripts delivered with your package should have an entry in the `prototype` file. The file type should be `i` (for package installation script).

Writing a `request` Script

The `request` script is the only way your package can interact directly with the administrator who is installing it. This script can be used, for example, to ask the administrator if optional pieces of a package should be installed.

The output of a `request` script must be a list of environment variables and their values. This list can include any of the parameters that you created in the `pkginfo` file, and the `CLASSES` and `BASEDIR` parameters. The list can also introduce environment variables that have not been defined elsewhere. However, the `pkginfo` file should always provide default values when practical. For more information on package environment variables, see "Package Environment Variables" on page 24.

When your `request` script assigns values to an environment variable, it must then make those values available to the `pkgadd` command and other package scripts.

`request` Script Behaviors

- The `request` script cannot modify any files. This script only interacts with administrators who are installing the package and creates a list of environment variable assignments based upon that interaction. To enforce this restriction, the `request` script is executed as the non privileged user `install` if that user exists. Otherwise, the script is executed as the non privileged user `nobody`. The `request` script does not have superuser authority.
- The `pkgadd` command calls the `request` script with one argument that names the script's response file. The response file stores the administrator's responses.
- The `request` script is not executed during package removal. However, the environment variables assigned by the script are saved and are available during package removal.

Design Rules for `request` Scripts

- There can be only one `request` script per package. The script must be named `request`.
- The environment variable assignments should be added to the installation environment for use by the `pkgadd` command and other packaging scripts by writing them to the response file (known to the script as `$1`).
- System environment variables and standard installation environment variables, except for the `CLASSES` and `BASEDIR` parameters, cannot be modified by a `request` script. Any of the other environment variables that you created can be changed.

Note – A `request` script can only modify the `BASEDIR` parameter starting with the Solaris 2.5 and compatible releases.

- Every environment variable that the `request` script may manipulate should be assigned a default value in the `pkginfo` file.
- The format of the output list should be *PARAM=value*. For example:

  ```
  CLASSES=none class1
  ```
- The administrator's terminal is defined as standard input to the `request` script.
- Do not perform any special analysis of the target system in a `request` script. It is risky to test the system for the presence of certain binaries or behaviors, and to set environment variables based upon that analysis. There is no guarantee that the `request` script will actually be executed at install time. The administrator who is installing the package may provide a response file that will insert the environment variables without ever calling the `request` script. If the `request` script is also evaluating the target file system, that evaluation may not happen. An analysis of the target system for special treatment is best left to the `checkinstall` script.

Note – If the administrators who will be installing your package might use the JumpStart™ product., then the installation of your package must not be interactive. Either you should not provide a `request` script with your package, or you need to communicate to the administrators that they should use the `pkgask` command prior to installation. The `pkgask` command stores their responses to the `request` script. For more information on the `pkgask` command, see the `pkgask`(1M) man page.

▼ How to Write a `request` Script

Steps 1. **Make the directory that contains your information files the current working directory.**

2. **Create a file named `request` with your favorite text editor.**

3. **Save your changes and quit the editor when you are done.**

4. **Complete one of the following tasks.**

   - If you want to create additional installation scripts, skip to the next task, "How to Gather File System Data" on page 67.
   - If you have not created your `prototype` file, complete the procedure "How to Create a `prototype` File by Using the `pkgproto` Command" on page 43. Skip to Step 5.
   - If you have already created your `prototype` file, edit it and add an entry for the installation script you just created.

5. **Build your package.**

   See "How to Build a Package" on page 46, if needed.

Example 3–5 Writing a `request` Script

When a `request` script assigns values to environment variables, it must make those values available to the `pkgadd` command. This example shows a `request` script segment that performs this task for the four environment variables: `CLASSES`, `NCMPBIN`, `EMACS`, and `NCMPMAN`. Assume that these variables were defined in an interactive session with the administrator earlier in the script.

```
# make environment variables available to installation
# service and any other packaging script we might have

cat >$1 <<!
CLASSES=$CLASSES
NCMPBIN=$NCMPBIN
EMACS=$EMACS
NCMPMAN=$NCMPMAN
!
```

See Also After you build the package, install it to confirm that it installs correctly and verify its integrity. Chapter 4 explains these tasks and provides step-by-step instructions on how to transfer your verified package to a distribution medium.

Gathering File System Data With the `checkinstall` Script

The `checkinstall` script is executed shortly after the optional `request` script. The `checkinstall` script runs as the user `install`, if such a user exists, or as the user `nobody`. The `checkinstall` script does not have the authority to change file system data. However, based on the information the script gathers, it can create or modify environment variables in order to control the course of the resulting installation. The script is also capable of cleanly halting the installation process.

The `checkinstall` script is intended to perform basic checks on a file system that would not be normal for the `pkgadd` command. For example, this script can be used to check ahead to determine if any files from the current package are going to overwrite existing files, or manage general software dependencies. The `depend` file only manages package-level dependencies.

Unlike the `request` script, the `checkinstall` script is executed whether or not a response file is provided. The script's presence does not brand the package as interactive. The `checkinstall` script can be used in situations where a `request` script is forbidden or administrative interaction is not practical.

Note – The `checkinstall` script is available starting with the Solaris 2.5 and compatible releases.

`checkinstall` Script Behaviors

- The `checkinstall` script cannot modify any files. This script only analyzes the state of the system and creates a list of environment variable assignments based upon that interaction. To enforce this restriction, the `checkinstall` script is executed as the non privileged user `install` if that user exists. Otherwise, this script is executed as the non privileged user `nobody`. The `checkinstall` script does not have superuser authority.
- The `pkgadd` command calls the `checkinstall` script with one argument that names the script's response file. The script's response file is the file that stores the administrator's responses.
- The `checkinstall` script is not executed during package removal. However, the environment variables assigned by the script are saved and are available during package removal.

Design Rules for `checkinstall` Scripts

- There can be only one `checkinstall` script per package. The script must be named `checkinstall`.
- The environment variable assignments should be added to the installation environment for use by the `pkgadd` command and other packaging scripts by writing them to the response file (known to the script as `$1`).
- System environment variables and standard installation environment variables, except for the `CLASSES` and `BASEDIR` parameters, cannot be modified by a `checkinstall` script. Any of the other environment variables that you created can be changed.
- Every environment variable that the `checkinstall` script may manipulate should be assigned a default value in the `pkginfo` file.

- The format of the output list should be *PARAM=value*. For example:

  ```
  CLASSES=none class1
  ```

- Administrator interaction is not permitted during execution of a `checkinstall` script. All administrator interaction is restricted to the `request` script.

▼ How to Gather File System Data

Steps

1. **Make the directory that contains your information files the current working directory.**
2. **Create a file named `checkinstall` with your favorite text editor.**
3. **Save your changes and quit the editor when you are done.**
4. **Complete one of the following tasks.**
   - If you want to create additional installation scripts, skip to the next task, "How to Write Procedure Scripts" on page 69.
   - If you have not created your `prototype` file, complete the procedure "How to Create a `prototype` File by Using the `pkgproto` Command" on page 43. Skip to Step 5.
   - If you have already created your `prototype` file, edit it and add an entry for the installation script you just created.
5. **Build your package.**

   See "How to Build a Package" on page 46, if needed.

Example 3–6 Writing a `checkinstall` Script

This example `checkinstall` script checks to see if database software needed by the `SUNWcadap` package is installed.

```
# checkinstall script for SUNWcadap
#
# This confirms the existence of the required specU database

# First find which database package has been installed.
pkginfo -q SUNWspcdA    # try the older one

if [ $? -ne 0 ]; then
   pkginfo -q SUNWspcdB    # now the latest

      if [ $? -ne 0 ]; then    # oops
            echo "No database package can be found. Please install the"
            echo "SpecU database package and try this installation again."
            exit 3        # Suspend
```

```
      else
            DBBASE="`pkgparam SUNWsbcdB BASEDIR`/db"    # new DB software
      fi
else
      DBBASE="`pkgparam SUNWspcdA BASEDIR`/db"    # old DB software
fi

# Now look for the database file we will need for this installation
if [ $DBBASE/specUlatte ]; then
      exit 0        # all OK
else
      echo "No database file can be found. Please create the database"
      echo "using your installed specU software and try this"
      echo "installation again."
      exit 3        # Suspend
fi
```

See Also After you build the package, install it to confirm that it installs correctly and verify its integrity. Chapter 4 explains these tasks and provides step-by-step instructions on how to transfer your verified package to a distribution medium.

Writing Procedure Scripts

The procedure scripts provide a set of instructions to be performed at particular points in package installation or removal. The four procedure scripts must be named one of the predefined names, depending on when the instructions are to be executed. The scripts are executed without arguments.

- The `preinstall` script

  Runs before class installation begins. No files should be installed by this script.
- The `postinstall` script

  Runs after all volumes have been installed.
- The `preremove` script

  Runs before class removal begins. No files should be removed by this script.
- The `postremove` script

  Runs after all classes have been removed.

Procedure Script Behaviors

Procedure scripts are executed as `uid=root` and `gid=other`.

Design Rules for Procedure Scripts

- Each script should be able to be executed more than once because it is executed once for each volume in a package. This means that executing a script any number of times with the same input produces the same results as executing the script only once.

- Each procedure script that installs a package object not in the `pkgmap` file must use the `installf` command to notify the package database that it is adding or modifying a path name. After all additions or modifications are complete, this command should be invoked with the `-f` option. Only the `postinstall` and `postremove` scripts may install package objects in this way. See the `installf`(1M) man page and Chapter 5 for more information.
- Administrator interaction is not permitted during execution of a procedure script. All administrator interaction is restricted to the `request` script.
- Each procedure script that removes files not installed from the `pkgmap` file must use the `removef` command to notify the package database that it is removing a path name. After removal is complete, this command should be invoked with the `-f` option. See the `removef`(1M) man page and Chapter 5 for details and examples.

Note – The `installf` and `removef` commands must be used because procedure scripts are not automatically associated with any path names listed in the `pkgmap` file.

▼ How to Write Procedure Scripts

Steps

1. **Make the directory that contains your information files the current working directory.**
2. **Create one or more procedure scripts with your favorite text editor.**

   A procedure script must be named one of the predefined names: `preinstall`, `postinstall`, `preremove`, or `postremove`.
3. **Save your changes and quit the editor.**
4. **Complete one of the following tasks.**
   - If you want to create class action scripts, skip to the next task, "How to Write Class Action Scripts" on page 76.
   - If you have not created your `prototype` file, complete the procedure "How to Create a `prototype` File by Using the `pkgproto` Command" on page 43. Skip to Step 5.
   - If you have already created your `prototype` file, edit it and add an entry for each installation script you just created.
5. **Build your package.**

   See "How to Build a Package" on page 46, if needed.

See Also After you build the package, install it to confirm that it installs correctly and verify its integrity. Chapter 4 explains these tasks and provides step-by-step instructions on how to transfer your verified package to a distribution medium.

Writing Class Action Scripts

Defining Object Classes

Object classes allow a series of actions to be performed on a group of package objects at installation or removal. You assign objects to a class in the `prototype` file. All package objects must be given a class, although the class of `none` is used by default for objects that require no special action.

The installation parameter `CLASSES`, defined in the `pkginfo` file, is a list of classes to be installed (including the `none` class).

Note – Objects defined in the `pkgmap` file that belong to a class not listed in this parameter in the `pkginfo` file will *not* be installed.

The `CLASSES` list determines the order of installation. Class `none` is always installed first, if present, and removed last. Since directories are the fundamental support structure for all other file system objects, they should all be assigned to the `none` class. Exceptions can be made, but as a general rule, the `none` class is safest. This strategy ensures that the directories are created before the objects they will contain. In addition, no attempt is made to delete a directory before it has been emptied.

How Classes Are Processed During Package Installation

The following describes the system actions that occur when a class is installed. The actions are repeated once for each volume of a package, as that volume is being installed.

1. The `pkgadd` command creates a path name list.

   The `pkgadd` command creates a list of path names upon which the action script operates. Each line of this list contains source and destination path names, separated by a space. The source path name indicates where the object to be installed resides on the installation volume. The destination path name indicates the location on the target system where the object should be installed. The contents of the list are restricted by the following criteria:

   - The list contains only path names that belong to the associated class.
   - If the attempt to create the package object fails, then directories, named pipes, character devices, block devices, and symbolic links are included in the list with the source path name set to `/dev/null`. Normally, these items are

automatically created by the pkgadd command (if not already in existence) and given proper attributes (mode, owner, group) as defined in the pkgmap file.

- Linked files where the file type is l are not included in the list under any circumstances. Hard links in the given class are created in item 4.

2. If no class action script is provided for installation of a particular class, the path names in the generated list are copied from the volume to the appropriate target location.
3. A class action script is executed if one exists.

   The class action script is invoked with standard input that contains the list generated in item 1. If this volume is the last volume of the package, or no more objects exist in this class, the script is executed with the single argument of ENDOFCLASS.

   Note – Even if no regular files of this class exist in the package, the class action script is called at least once with an empty list and the ENDOFCLASS argument.

   ---

4. The pkgadd command performs a content and attribute audit, and creates hard links.

   After successfully executing items 2 or 3, the pkgadd command audits both content and attribute information for the list of path names. The pkgadd command creates the links associated with the class automatically. Detected attribute inconsistencies are corrected for all path names in the generated list.

How Classes Are Processed During Package Removal

Objects are removed class by class. Classes that exist for a package but are not listed in the CLASSES parameter are removed first (for example, an object installed with the installf command). Classes listed in the CLASSES parameter are removed in reverse order. The none class is always removed last. The following describes the system actions that occur when a class is removed:

1. The pkgrm command creates a path name list.

   The pkgrm command creates a list of installed path names that belong to the indicated class. Path names referenced by another package are excluded from the list unless their file type is e. A file type of e means the file should be edited upon installation or removal.

   If the package being removed had modified any files of type e during installation, it should remove just the lines it added. Do not delete a non-empty editable file. Remove the lines that the package added.

2. If no class action script exists, the path names are deleted.

   If your package has no removal class action script for the class, all the path names in the list generated by the pkgrm command are deleted.

Note – Files with a file type of `e` (editable) are not assigned to a class and an associated class action script. These files are removed at this point, even if the path name is shared with other packages.

---

3. If a class action script exists, the script is executed.

   The `pkgrm` command invokes the class action script with standard input for the script that contains the list generated in item 1.
4. The `pkgrm` command performs an audit.

   After successfully executing the class action script, the `pkgrm` command removes references to the path names from the package database unless a path name is referenced by another package.

The Class Action Script

The class action script defines a set of actions to be executed during installation or removal of a package. The actions are performed on a group of path names based on their class definition. See Chapter 5 for examples of class action scripts.

The name of a class action script is based on the class on which it should operate and whether those operations should occur during package installation or package removal. The two name formats are shown in the following table:

Name Format	Description
`i.`*class*	Operates on path names in the indicated class during package installation
`r.`*class*	Operates on path names in the indicated class during package removal

For example, the name of the installation script for a class named `manpage` would be `i.manpage`. The removal script would be named `r.manpage`.

Note – This file name format is not used for files that belong to the `sed`, `awk`, or `build` system classes. For more information on these special classes, see "The Special System Classes" on page 73.

Class Action Script Behaviors

- Class action scripts are executed as `uid=root` and `gid=other`.
- A script is executed for all files in the given class on the current volume.

- The `pkgadd` and `pkgrm` commands create a list of all objects listed in the `pkgmap` file that belong to the class. As a result, a class action script can act only upon path names defined in the `pkgmap` that belong to a particular class.
- When a class action script is executed for the last time (that is, no more files belong to that class), the class action script is executed once with the keyword argument `ENDOFCLASS`.
- Administrator interaction is not permitted during execution of a class action script.

Design Rules for Class Action Scripts

- If a package spans more than one volume, the class action script is executed once for each volume that contains at least one file that belongs to a class. Consequently, each script must be able to be executed more than once. This means that executing a script any number of times with the same input must produce the same results as executing the script only once.
- When a file is part of a class that has a class action script, the script must install the file. The `pkgadd` command does not install files for which a class action script exists, although it does verify the installation.
- A class action script should never add, remove, or modify a path name or system attribute that does not appear in the list generated by the `pkgadd` command. For more information on this list, see item 1 in "How Classes Are Processed During Package Installation" on page 70.
- When your script sees the `ENDOFCLASS` argument, put post-processing actions such as clean up into your script.
- All administrator interaction is restricted to the `request` script. Do not try to obtain information from the administrator by using a class action script.

The Special System Classes

The system provides four special classes:

- The `sed` class

  Provides a method for using `sed` instructions to edit files upon package installation and removal
- The `awk` class

  Provides a method for using `awk` instructions to edit files upon package installation and removal
- The `build` class

  Provides a method to dynamically construct or modify a file by using Bourne shell commands
- The `preserve` class

  Provides a method to preserve files that should not be overwritten by future package installations

If several files in a package require special processing that can be fully defined through sed, awk, or sh commands, installation is faster by using the system classes rather than multiple classes and their corresponding class action scripts.

The sed *Class Script*

The sed class provides a method to modify an existing object on the target system. The sed class action script executes automatically at installation if a file that belongs to class sed exists. The name of the sed class action script should be the same as the name of the file on which the instructions are executed.

A sed class action script delivers sed instructions in the following format:

Two commands indicate when instructions should be executed. The sed instructions that follow the !install command are executed during package installation. The sed instructions that follow the !remove command are executed during package removal. The order in which these commands are used in the file does not matter.

For more information on sed instructions, see the sed(1) man page. For examples of sed class action scripts, see Chapter 5.

The awk *Class Script*

The awk class provides a method to modify an existing object on the target system. Modifications are delivered as awk instructions in an awk class action script.

The awk class action script is executed automatically at installation if a file that belongs to class awk exists. Such a file contains instructions for the awk class script in the following format:

Two commands indicate when instructions should be executed. The awk instructions that follow the !install command are executed during package installation. The instructions that follow the !remove command are executed during package removal. These commands may be used in any order.

The name of the awk class action script should be the same as the name of the file on which the instructions are executed.

The file to be modified is used as input to the awk command and the output of the script ultimately replaces the original object. Environment variables may not be passed to the awk command with this syntax.

For more information on awk instructions, see the awk(1) man page.

The build *Class Script*

The build class creates or modifies a package object file by executing Bourne shell instructions. These instructions are delivered as the package object. The instructions run automatically at installation if the package object belongs to the build class.

The name of the build class action script should be the same as the name of the file on which the instructions are executed. The name must also be executable by the sh command. The script's output becomes the new version of the file as it is built or modified. If the script produces no output, the file is not created or modified. Therefore, the script can modify or create the file itself.

For example, if a package delivers a default file, /etc/randomtable, and if the file does not already exist on the target system, the prototype file entry might be as follows:

```
e build /etc/randomtable ? ? ?
```

The package object, /etc/randomtable, might look like the following:

```
!install
# randomtable builder
if [ -f $PKG_INSTALL_ROOT/etc/randomtable ]; then
        echo "/etc/randomtable is already in place.";
        else
        echo "# /etc/randomtable" > $PKG_INSTALL_ROOT/etc/randomtable
        echo "1121554    # first random number" >> $PKG_INSTALL_ROOT/etc/randomtable
fi

!remove
# randomtable deconstructor
if [ -f $PKG_INSTALL_ROOT/etc/randomtable ]; then
        # the file can be removed if it's unchanged
        if [ egrep "first random number" $PKG_INSTALL_ROOT/etc/randomtable ]; then
            rm $PKG_INSTALL_ROOT/etc/randomtable;
        fi
fi
```

See Chapter 5 for another example using the build class.

The preserve Class Script

The preserve class preserves a package object file by determining whether or not an existing file should be overwritten when the package is installed. Two possible scenarios when using a preserve class script are:

- If the file to be installed does not already exist in the target directory, the file will be installed normally.
- If the file to be installed exists in the target directory, a message describing that the file exists is displayed, and the file is not installed.

Both scenario outcomes are considered successful by the preserve script. A failure occurs only in the second scenario when the file is unable to be copied to the target directory.

Starting with the Solaris 7 release, the i.preserve script and a copy of this script, i.CONFIG.prsv, can be found in the /usr/sadm/install/scripts directory with the other class action scripts.

Modify the script to include the filename or filenames you would like to preserve.

▼ How to Write Class Action Scripts

Steps

1. **Make the directory that contains your information files the current working directory.**
2. **Assign the package objects in the `prototype` file the desired class names.**

   For example, assigning objects to an `application` and `manpage` class would look like the following:

   ```
   f manpage /usr/share/man/manl/myappl.1l
   f application /usr/bin/myappl
   ```

3. **Modify the `CLASSES` parameter in the `pkginfo` file to contain the class names you want to use in your package.**

   For example, entries for the `application` and `manpage` classes would look like the following:

   ```
   CLASSES=manpage application none
   ```

   Note – The `none` class is always installed first and removed last, regardless of where it appears in the definition of the `CLASSES` parameter.

   ---

4. **If you are a creating a class action script for a file that belongs to the `sed`, `awk`, or `build` class, make the directory that contains the package object your current working directory.**
5. **Create the class action scripts or package objects (for files that belong to the `sed`, `awk`, or `build` class).**

   For example, an installation script for a class named `application` would be named `i.application` and a removal script would be named `r.application`.

   Remember, when a file is part of a class that has a class action script, the script must install the file. The `pkgadd` command does not install files for which a class action script exists, although it does verify the installation. And, if you define a class but do not deliver a class action script, the only action taken for that class is to copy components from the installation medium to the target system (the default `pkgadd` behavior).

6. **Complete *one* of the following tasks.**
   - If you have *not* created your `prototype` file, complete the procedure "How to Create a `prototype` File by Using the `pkgproto` Command" on page 43, and skip to Step 7.

- If you have already created your `prototype` file, edit it and add an entry for each installation script you just created.

7. **Build your package.**

   See "How to Build a Package" on page 46, if needed.

More Information

Where to Go Next

After you build the package, install it to confirm that it installs correctly and verify its integrity. Chapter 4 explains how to do this and provides step-by-step instructions on how to transfer your verified package to a distribution medium.

Creating Signed Packages

The process of creating signed packages involves a number of steps and requires some comprehension of new concepts and terminology. This section provides information about signed packages, its terminology, and information about certificate management. This section also provides step-by-step procedures about how to create a signed package.

Signed Packages

A signed package is a normal stream-format package that has a digital signature (PEM-encoded PKCS7 digital signature which is defined below) that verifies the following:

- The package came from the entity who signed it
- The entity indeed signed it
- The package has not been modified since the entity signed it
- The entity who signed it is a trusted entity

A signed package is identical to an unsigned package, except for the signature. A signed package is binary-compatible with an unsigned package. Therefore, a signed package can be used with older versions of the packaging tools. However, the signature is ignored in this case.

The signed packaging technology introduces some new terminology and abbreviations, which are described in the following table.

Term	Definition
ASN.1	Abstract Syntax Notation 1 - A way of expressing abstract objects. For example, ASN.1 defines a public key certificate, all of the objects that make up the certificate, and the order in which the objects are collected. However, ASN.1 does not specify how the objects are serialized for storage or transmission.
X.509	ITU-T Recommendation X.509 - Specifies the widely-adopted X.509 public key certificate syntax.
DER	Distinguished Encoding Rules - A binary representation of an ASN.1 object and defines how an ASN.1 object is serialized for storage or transmission in computing environments.
PEM	Privacy Enhanced Message - A way to encode a file (in DER or another binary format) using base 64 encoding and some optional headers. PEM was initially used for encoding MIME-type email messages. PEM is also used extensively for encoding certificates and private keys into a file that exists on a file system or in an email message.
PKCS7	Public Key Cryptography Standard #7 - This standard describes a general syntax for data that may have cryptography applied to it, such as digital signatures and digital envelopes. A signed package contains an embedded PKCS7 signature. This signature contains at a minimum the encrypted digest of the package, along with the signer's X.509 public key certificate. The signed package can also contain chain certificates. Chain certificates can be used when forming a chain of trust from the signer's certificate to a locally-stored trusted certificate.
PKCS12	Public Key Cryptography Standard #12 - This standard describes a syntax for storing cryptographic objects on disk. The package keystore is maintained in this format.
Package keystore	A repository of certificates and keys that can be queried by the package tools.

Certificate Management

Before creating a signed package, you must have a package keystore. This package keystore contains certificates in the form of objects. Two types of objects exist in a package keystore:

Trusted certificate	A trusted certificate contains a single public key certificate that belongs to another entity. The trusted certificate is named as such because the keystore owner trusts that the public key in the certificate indeed belongs to the identity indicated by the

	"subject" (owner) of the certificate. The issuer of the certificate vouches for this trust by signing the certificate. Trusted certificates are used when verifying signatures and when initiating a connection to a secure (SSL) server.
User key	A user key holds sensitive cryptographic key information. This information is stored in a protected format to prevent unauthorized access. A user key consists of both the user's private key and the public key certificate that corresponds to the private key. User keys are used when creating a signed package.

By default, the package keystore is stored in the `/var/sadm/security` directory. Individual users can also have their own keystore stored by default in the `$HOME/.pkg/security` directory.

On disk, a package keystore can be in two formats: a multiple-file format and a single-file format. A multiple-file format stores its objects in multiple files. Each type of object is stored in a separate file. All of these files must be encrypted using the same passphrase. A single-file keystore stores all of its objects in a single file on the file system.

The primary utility used to manage the certificates and the package keystore is the `pkgadm` command. The following subsections describe the more common tasks used for managing the package keystore.

Adding Trusted Certificates to the Package Keystore

A trusted certificate can be added to the package keystore using the `pkgadm` command. The certificate can be in PEM or DER format. For example:

```
$ pkgadm addcert -t /tmp/mytrustedcert.pem
```

In this example, the PEM format certificate called `mytrustedcert.pem` is added to the package keystore.

Adding a User Certificate and Private Key to the Package Keystore

The `pkgadm` command does not generate user certificates or private keys. User certificates and private keys are normally obtained from a Certificate Authority, such as Verisign. Or, they are generated locally as a self-signed certificate. Once the key and certificate are obtained, they can be imported into the package keystore using the `pkgadm` command. For example:

```
pkgadm addcert -n myname -e /tmp/myprivkey.pem /tmp/mypubcert.pem
```

In this example, the following options are used:

`-n` *myname*	Identifies the entity (*myname*) in the package keystore on which you wish to operate. The *myname* entity becomes the alias under which the objects are stored.
`-e /tmp/`*myprivkey.pem*	Specifies the file that contains the private key. In this case, the file is *myprivkey.pem*, which is located in the `/tmp` directory.
`/tmp/`*mypubcert.pem*	Specifies the PEM format certificate file called *mypubcert.pem*.

Verifying the Contents in the Package Keystore

The `pkgadm` command is also used to view the contents of the package keystore. For example:

```
$ pkgadm listcert
```

This command displays the trusted certificates and private keys in the package keystore.

Deleting Trusted Certificates and Private Keys From the Package Keystore

The `pkgadm` command can be used to delete trusted certificates and private keys from the package keystore.

When you delete user certificates, the alias of the certificate/key pair must be specified. For example:

```
$ pkgadm removecert -n myname
```

The alias of the certificate is the common name of the certificate, which can be identified using the `pkgadm listcert` command. For example, this command deletes a trusted certificate entitled Trusted CA Cert 1:

```
$ pkgadm removecert -n "Trusted CA Cert 1"
```

Note – If you have both a trusted certificate and a user certificate stored using the same alias, they are both deleted when you specify the `-n` option.

Signed Packages Creation

The process of creating signed packages involves three basic steps:

1. Creating an unsigned, directory-format package.
2. Importing the signing certificate, CA certificates, and private key into the package keystore.
3. Signing the package from Step 1 with the certificates from Step 2.

Note – The packaging tools do not create certificates. These certificates must be obtained from a Certificate Authority, such as Verisign or Thawte.

Each step for creating signed packages is described in the following procedures.

▼ How to Create an Unsigned, Directory-Format Package

The procedure for creating an unsigned, directory-format package is the same as the procedure for creating a normal package, as previously described in this manual. The following procedure describes the process of creating this unsigned, directory-format package. If you need more information, refer to the previous sections about building packages.

Steps

1. **Create the `pkginfo` file.**

   The `pkginfo` file should have the following basic content:

   ```
   PKG=SUNWfoo
   BASEDIR=/
   NAME=My Test Package
   ARCH=sparc
   VERSION=1.0.0
   CATEGORY=application
   ```

2. **Create the `prototype` file.**

   The `prototye` file should have the following basic content:

   ```
   $cat prototype
   i pkginfo
   d none usr 0755 root sys
   d none usr/bin 0755 root bin
   f none usr/bin/myapp=/tmp/myroot/usr/bin/myapp 0644 root bin
   ```

3. **List the contents of the object source directory.**

   For example:

$ ls -lR /tmp/myroot

The output would appear similar to the following:

```
/tmp/myroot:
total 16
drwxr-xr-x   3 abc      other        177 Jun  2 16:19 usr

/tmp/myroot/usr:
total 16
drwxr-xr-x   2 abc      other        179 Jun  2 16:19 bin

/tmp/myroot/usr/bin:
total 16
-rw-------   1 abc      other       1024 Jun  2 16:19 myapp
```

4. **Create the unsigned package.**

   pkgmk -d ‘pwd‘

   The output would appear similar to the following:

```
## Building pkgmap from package prototype file.
## Processing pkginfo file.
WARNING: parameter <PSTAMP> set to "syrinx20030605115507"
WARNING: parameter <CLASSES> set to "none"
## Attempting to volumize 3 entries in pkgmap.
part  1 -- 84 blocks, 7 entries
## Packaging one part.
/tmp/SUNWfoo/pkgmap
/tmp/SUNWfoo/pkginfo
/tmp/SUNWfoo/reloc/usr/bin/myapp
## Validating control scripts.
## Packaging complete.
```

   The package now exists in the current directory.

▼ How to Import the Certificates Into the Package Keystore

The certificate and private key to be imported must exist as a PEM- or DER-encoded X.509 certificate and private key. In addition, any intermediate or “chain” certificates linking your signing certificate to the Certificate Authority certificate must be imported into the package keystore before a package can be signed.

Note – Each Certificate Authority can issue certificates in various formats. To extract the certificates and private key out of the PKCS12 file and into a PEM-encoded X.509 file (suitable for importing into the package keystore), use a freeware conversion utility such as OpenSSL.

If your private key is encrypted (which should usually be the case), you are prompted for the passphrase. Also, you are prompted for a password to protect the resulting package keystore. You can optionally not supply any password, but doing so results in an unencrypted package keystore.

The following procedure describes how to import the certificates using the `pkgadm` command once the certificate is in the proper format.

Steps

1. **Import all the Certificate Authority certificates found in your PEM- or DER-encoded X.509 certificate file.**

   For example, to import all the Certificate Authority certificates found in the file `ca.pem`, you would type the following:

   ```
   $ pkgadm addcert -k ~/mykeystore -ty ca.pem
   ```

   The output would appear similar to the following:

   ```
   Trusting certificate <VeriSign Class 1 CA Individual \
   Subscriber-Persona Not Validated>
   Trusting certificate </C=US/O=VeriSign, Inc./OU=Class 1 Public \
   Primary Certification Authority
   Type a Keystore protection Password.
   Press ENTER for no protection password (not recommended):
   For Verification: Type a Keystore protection Password.
   Press ENTER for no protection password (not recommended):
   Certificate(s) from <ca.pem> are now trusted
   ```

   In order to import your signing key into the package keystore, you must supply an alias that is used later when signing the package. This alias can also be used if you want to delete the key from the package keystore.

   For example, to import your signing key from the file `sign.pem`, you would type the following:

   ```
   $ pkgadm addcert -k ~/mykeystore -n mycert sign.pem
   ```

   The output would appear similar to the following:

   ```
   Enter PEM passphrase:
   Enter Keystore Password:
   Successfully added Certificate <sign.pem> with alias <mycert>
   ```

2. **Verify that the certificates are in the package keystore.**

   For example, to view the certificates in the keystore created in the previous step, you would type the following:

   ```
   $ pkgadm listcert -k ~/mykeystore
   ```

▼ How to Sign the Package

Once the certificates are imported into the package keystore, you can now sign the package. The actual signing of the package is done using the `pkgtrans` command.

Step ● **Sign the package using the `pkgtrans` command. Supply the location of the unsigned package and the alias of the key to sign the package.**

For example, using the examples from the previous procedures, you would type the following to create a signed package called `SUNWfoo.signed`:

```
$ pkgtrans -g -k ~/mykeystore -n mycert . ./SUNWfoo.signed SUNWfoo
```

The output of this command would appear similar to the following:

```
Retrieving signing certificates from keystore </home/user/mykeystore>
Enter keystore password:
Generating digital signature for signer <Test User>
Transferring <SUNWfoot> package instance
```

The signed package is created in the file `SUNWfoo.signed` and is in the package-stream format. This signed package is suitable for copying to a web site and being installed using the `pkgadd` command and a URL.

CHAPTER 4

Verifying and Transferring a Package

This chapter describes how to verify your package's integrity and transfer it to a distribution medium, such as floppy disk or a CD-ROM.

This is a list of the overview information in this chapter:

Verifying and Transferring a Package (Task Map)

The table below describes the steps you should follow in order to verify your package's integrity and transfer it to a distribution medium.

TABLE 4–1 Verifying and Transferring a Package Task Map

Task	Description	For Instructions, Go To ...
1. Build Your Package	Build your package on disk.	Chapter 2
2. Install Your Package	Test your package by installing it and making sure that it installs without errors.	"How to Install a Package on a Standalone System or Server" on page 87

TABLE 4–1 Verifying and Transferring a Package Task Map *(Continued)*

Task	Description	For Instructions, Go To ...
3. Verify Your Package's Integrity	Use the pkgchk command to verify the integrity of your package.	"How to Verify the Integrity of a Package" on page 89
4. Obtain Other Package Information	*Optional*. Use the `pkginfo` and `pkgparam` commands to perform package-specific verification.	"Displaying Additional Information About Installed Packages" on page 90
5. Remove the Installed Package	Use the `pkgrm` command to remove your installed package from the system.	"How to Remove a Package" on page 95
6. Transfer Your Package to a Distribution Medium	Use the `pkgtrans` command to transfer your package (in package format) to a distribution medium.	"How to Transfer a Package to a Distribution Medium" on page 96

Installing Software Packages

Software packages are installed using the `pkgadd` command. This command transfers the contents of a software package from the distribution medium or directory and installs it onto a system.

This section provides basic installation instructions for installing your package in order to verify that it installs correctly.

The Installation Software Database

Information for all packages installed on a system is kept in the installation software database. There is an entry for every object in a package, with information such as the component name, where it resides, and its type. An entry contains a record of the package to which a component belongs; other packages that might reference the component; and information such as path name, where the component resides and the component type. Entries are added and removed automatically by the `pkgadd` and `pkgrm` commands. You can view the information in the database by using the `pkgchk` and the `pkginfo` commands.

Two types of information are associated with each package component. The attribute information describes the component itself. For example, the component's access permissions, owner ID, and group ID are attribute information. The content information describes the contents of the component, such as file size and time of last modification.

The installation software database keeps track of the package status. A package can be either fully installed (it has successfully completed the installation process), or partially installed (it did not successfully complete the installation process).

When a package is partially installed, portions of a package may have been installed before installation was terminated; thus, part of the package is installed, and recorded in the database, and part is not. When you reinstall the package, you are prompted to start at the point where installation stopped because the `pkgadd` command can access the database and detect which portions have already been installed. You can also remove the portions that have been installed, based on the information in the installation software database using the `pkgrm` command.

Interacting With the `pkgadd` Command

If the `pkgadd` command encounters a problem, it first checks the installation administration file for instructions. (See `admin`(4) for more information.) If no instructions exist, or if the relevant parameter in the administration file is set to `ask`, the `pkgadd` displays a message describing the problem and prompts for a reply. The prompt is usually `Do you want to continue with this installation?`. You should respond with `yes`, `no`, or `quit`.

If you have specified more than one package, `no` stops installation of the package being installed but `pkgadd` continues with installation of the other packages. `quit` indicates that `pkgadd` should stop installation of all packages.

Installing Packages on Standalone Systems or Servers in a Homogeneous Environment

This section describes how to install packages on a standalone or a server system in a homogeneous environment.

▼ How to Install a Package on a Standalone System or Server

Steps

1. **Build your package.**

   See "Building a Package" on page 45, if needed.

2. **Log in to the system as superuser.**

3. **Add the software package to the system.**

   ```
   # pkgadd -d device-name [pkg-abbrev...]
   ```

`-d` *device-name*	Specifies the location of the package. Note that *device-name* can be a full directory path name or the identifiers for a tape, floppy disk, or removable disk.
pkg-abbrev	Is the name of one or more packages (separated by spaces) to be added. If omitted, `pkgadd` installs all available packages.

Example 4–1 Installing Packages on Standalones and Servers

To install a software package named `pkgA` from a tape device named `/dev/rmt/0`, you would enter the following command:

```
# pkgadd -d /dev/rmt/0 pkgA
```

You can also install multiple packages at the same time, as long as you separate package names with a space, as follows:

```
# pkgadd -d /dev/rmt/0 pkgA pkgB pkgC
```

If you do not name the device on which the package resides, the command checks the default spool directory (`/var/spool/pkg`). If the package is not there, the installation fails.

See Also If you are ready to go to the next task, see "How to Verify the Integrity of a Package" on page 89.

Verifying the Integrity of a Package

The `pkgchk` command enables you to check the integrity of packages, whether they are installed on a system or in package format (ready to be installed with the `pkgadd` command). It confirms package structure or the installed files and directories, or displays information about package objects. The `pkgchk` command can list or check the following:

- The package installation scripts.
- The contents or attributes, or both, of objects currently installed on the system.
- The contents of a spooled, uninstalled package.
- The contents or attributes, or both, of objects described in the specified `pkgmap` file.

For more information about this command, refer to `pkgchk`(1M).

The `pkgchk` command performs two kinds of checks. It checks file attributes (the permissions and ownership of a file and major/minor numbers for block or character special devices) and the file contents (the size, checksum, and modification date). By default, the command checks both the file attributes and the file contents.

The `pkgchk` command also compares the file attributes and contents of the installed package against the installation software database. The entries concerning a package may have been changed since the time of installation; for example, another package may have changed a package component. The database reflects that change.

▼ How to Verify the Integrity of a Package

Steps

1. **Install your package.**

   See "How to Install a Package on a Standalone System or Server" on page 87, if needed.

2. **Verify the integrity of your package.**

   ```
   # pkgchk  [-v] [-R root-path] [pkg-abbrev...]
   ```

`-v`	Lists files as they are processed.
`-R` *root-path*	Specifies the location of the client system's root file system.
pkg-abbrev	Is the name of one or more packages (separated by spaces) to be checked. If omitted, `pkgchk` checks all available packages.

Example 4–2 Verifying the Integrity of a Package

This example shows the command you should use to verify the integrity of an installed package.

```
$ pkgchk pkg-abbrev
$
```

If there are errors, the `pkgchk` command prints them. Otherwise, it does not print anything and returns an exit code of 0. If you do not supply a package abbreviation, then it will check all of the packages on the system.

Alternately, you could use the `-v` option, which will print a list of files in the package if there are no errors. For example:

```
$ pkgchk -v SUNWcadap
/opt/SUNWcadap
/opt/SUNWcadap/demo
/opt/SUNWcadap/demo/file1
/opt/SUNWcadap/lib
/opt/SUNWcadap/lib/file2
/opt/SUNWcadap/man
/opt/SUNWcadap/man/man1
/opt/SUNWcadap/man/man1/file3.1
/opt/SUNWcadap/man/man1/file4.1
```

```
/opt/SUNWcadap/man/windex
/opt/SUNWcadap/srcfiles
/opt/SUNWcadap/srcfiles/file5
/opt/SUNWcadap/srcfiles/file6
$
```

If you need to verify a package that is installed on a client system's root file system, use this command:

```
$ pkgchk -v -R root-path  pkg-abbrev
```

See Also If you are ready to go to the next task, see "How to Obtain Information With the `pkginfo` Command" on page 95.

Displaying Additional Information About Installed Packages

You can use two other commands to display information about installed packages:

- The `pkgparam` command displays parameter values.
- The `pkginfo` command displays information from the installation software database.

The `pkgparam` Command

The `pkgparam` command enables you to display the values associated with the parameters you specified on the command line. The values are retrieved from either the `pkginfo` file for a specific package, or from the file you name. One parameter value is shown per line. You can display the values only or the parameters and their values.

▼ How to Obtain Information With the `pkgparam` Command

Steps

1. **Install your package.**

   See "How to Install a Package on a Standalone System or Server" on page 87, if needed.

2. **Display additional information about your package.**

```
# pkgparam [-v] pkg-abbrev [param...]
```

`-v`	Displays the name of the parameter and its value.
pkg-abbrev	Is the name of a specific package.
param	Specifies one or more parameters whose value is displayed.

Example 4–3 Obtaining Information With the `pkgparam` Command

For example, to display values only, use this command.

```
$ pkgparam SUNWcadap
none
/opt
US/Mountain
/sbin:/usr/sbin:/usr/bin:/usr/sadm/install/bin
/usr/sadm/sysadm
SUNWcadap
Chip designers need CAD application software to design abc
chips.  Runs only on xyz hardware and is installed in the usr
partition.
system
release 1.0
SPARC
venus990706083849
SUNWcadap
/var/sadm/pkg/SUNWcadap/save
Jul 7 1999 09:58
$
```

To display parameters and their values, use the following command.

```
$ pkgparam -v SUNWcadap
pkgparam -v SUNWcadap
CLASSES='none'
BASEDIR='/opt'
TZ='US/Mountain'
PATH='/sbin:/usr/sbin:/usr/bin:/usr/sadm/install/bin'
OAMBASE='/usr/sadm/sysadm'
PKG='SUNWcadap'
NAME='Chip designers need CAD application software to design abc chips.
Runs only on xyz hardware and is installed in the usr partition.'
CATEGORY='system'
VERSION='release 1.0'
ARCH='SPARC'
PSTAMP='venus990706083849'
PKGINST='SUNWcadap'
PKGSAV='/var/sadm/pkg/SUNWcadap/save'
INSTDATE='Jul 7 1999 09:58'
$
```

Or, if you want to display the value of a specific parameter, use this format:

```
$ pkgparam SUNWcadap BASEDIR
/opt
$
```

For more information, refer to pkgparam(1).

See Also If you are ready to go to the next task, see "How to Remove a Package" on page 95.

The pkginfo Command

You can display information about installed packages with the pkginfo command. This command has several options that enable you to customize both the format and the contents of the display.

You can request information about any number of package instances.

The Default pkginfo Display

When the pkginfo command is executed without options, it displays the category, package instance, and package name of all packages that have been completely installed on your system. The display is organized by categories as shown in the following example.

```
$ pkginfo
.
.
.
system      SUNWinst       Install Software
system      SUNWipc        Interprocess Communications
system      SUNWisolc      XSH4 conversion for ISO Latin character sets
application SUNWkcspf      KCMS Optional Profiles
application SUNWkcspg      KCMS Programmers Environment
application SUNWkcsrt      KCMS Runtime Environment
.
.
.
$
```

Customizing the Format of the pkginfo Display

You can get a pkginfo display in any of three formats: short, extracted, and long.

The short format is the default. It shows only the category, package abbreviation, and full package name, as shown in "The Default pkginfo Display" on page 92.

The extracted format shows the package abbreviation, package name, package architecture (if available), and package version (if available). Use the -x option to request the extracted format as shown in the next example.

```
$ pkginfo -x
.
.
.
SUNWipc         Interprocess Communications
                (sparc) 11.8.0,REV=1999.08.20.12.37
SUNWisolc       XSH4 conversion for ISO Latin character sets
                (sparc) 1.0,REV=1999.07.10.10.10
SUNWkcspf       KCMS Optional Profiles
                (sparc) 1.1.2,REV=1.5
SUNWkcspg       KCMS Programmers Environment
                (sparc) 1.1.2,REV=1.5
.
.
.
$
```

Using the `-l` option produces a display in the long format showing all of the available information about a package, as in the following example.

```
$ pkginfo -l SUNWcadap
   PKGINST:  SUNWcadap
      NAME:  Chip designers need CAD application software to
design abc chips.  Runs only on xyz hardware and is installed
in the usr partition.
  CATEGORY:  system
      ARCH:  SPARC
   VERSION:  release 1.0
   BASEDIR:  /opt
    PSTAMP:  system980706083849
  INSTDATE:  Jul 7 1999 09:58
    STATUS:  completely installed
     FILES:     13 installed pathnames
                 6 directories
                 3 executables
              3121 blocks used (approx)
$
```

Parameter Descriptions for the `pkginfo` Long Format

The table below describes the package parameters that can be displayed for each package. A parameter and its value are displayed only when the parameter has a value assigned to it.

TABLE 4–2 Package Parameters

Parameter	Description
`ARCH`	The architecture supported by this package.

TABLE 4–2 Package Parameters *(Continued)*

Parameter	Description
`BASEDIR`	The base directory in which the software package resides (shown if the package is relocatable).
`CATEGORY`	The software category, or categories, of which this package is a member (for example, `system` or `application`).
`CLASSES`	A list of classes defined for a package. The order of the list determines the order in which the classes are installed. Classes listed first will be installed first (on a media by media basis). This parameter may be modified by the request script.
`DESC`	Text that describes the package.
`EMAIL`	The electronic mail address for user inquiries.
`HOTLINE`	Information on how to receive hotline help about this package.
`INTONLY`	Indicates that the package should only be installed interactively when set to any non-NULL value.
`ISTATES`	A list of allowable run states for package installation (for example, `S s 1`).
`MAXINST`	The maximum number of package instances that should be allowed on a machine at the same time. By default, only one instance of a package is allowed.
`NAME`	The package name, generally text describing the package abbreviation.
`ORDER`	A list of classes defining the order in which they should be put on the medium. Used by the `pkgmk` command in creating the package. Classes not defined in this parameter are placed on the medium using the standard ordering procedures.
`PKGINST`	Abbreviation for the package being installed.
`PSTAMP`	The production stamp for this package.
`RSTATES`	A list of allowable run states for package removal (for example, `S s 1`).
`ULIMIT`	If set, this parameter is passed as an argument to the `ulimit` command, which establishes the maximum size of a file during installation. This applies only to files created by procedure scripts.
`VENDOR`	The name of the vendor who supplied the software package.
`VERSION`	The version of this package.
`VSTOCK`	The vendor-supplied stock number.

For detailed information about the `pkginfo` command, refer to the `pkginfo`(1) man page.

▼ How to Obtain Information With the `pkginfo` Command

Steps

1. **Install your package.**

   See "How to Install a Package on a Standalone System or Server" on page 87, if needed.

2. **Display additional information about your package.**

   ```
   # pkginfo [-x | -l] [pkg-abbrev]
   ```

`-x`	Displays package information in extracted format.
`-l`	Displays package information in long format.
pkg-abbrev	Is the name of a specific package. If omitted, the `pkginfo` command displays information about all installed packages, in the default format.

More Information

Where to Go Next

If you are ready to go to the next task, see "How to Remove a Package" on page 95.

Removing a Package

Because the `pkgrm` command updates information in the software products database, it is important when you remove a package to use the `pkgrm` command—even though you might be tempted to use the `rm` command instead. For example, you could use the `rm` command to remove a binary executable file, but that is not the same as using `pkgrm` to remove the software package that includes that binary executable. Using the `rm` command to remove a package's files will corrupt the software products database. (If you really only want to remove one file, you can use the `removef` command, which will update the software product database correctly.

▼ How to Remove a Package

Steps

1. **Log in to the system as superuser.**

2. **Remove an installed package.**

   ```
   # pkgrm pkg-abbrev ...
   ```

pkg-abbrev	Is the name of one or more packages (separated by spaces). If omitted, `pkgrm` removes all available packages.

3. **Verify that the package has successfully been removed, use the `pkginfo` command.**

   ```
   $ pkginfo | egrep pkg-abbrev
   ```

   If *pkg-abbrev* is installed, the `pkginfo` command returns a line of information about it. Otherwise, `pkginfo` returns the system prompt.

Transferring a Package to a Distribution Medium

The `pkgtrans` command moves packages and performs package format translations. You can use the `pkgtrans` command to perform the following translations for an installable package:

- File system format to datastream format
- Datastream format to file system format
- One file system format to another file system format

▼ How to Transfer a Package to a Distribution Medium

Steps

1. **Build your package, creating a directory format package, if you have not already done so.**

   For more information, see "How to Build a Package" on page 46.

2. **Install your package to verify that it installs correctly.**

   See "How to Install a Package on a Standalone System or Server" on page 87, if needed.

3. **Verify your package's integrity.**

   See "How to Verify the Integrity of a Package" on page 89, "How to Obtain Information With the `pkginfo` Command" on page 95, and "How to Obtain Information With the `pkgparam` Command" on page 90, if needed.

4. **Remove the installed package from the system.**

   See "How to Remove a Package" on page 95, if needed.

5. **Transfer the package (in package format) to a distribution medium.**

   To perform a basic translation, execute the following command:

   ```
   $ pkgtrans device1 device2 [pkg-abbrev...]
   ```

device1	Is the name of the device where the package currently resides.
device2	Is the name of the device onto which the translated package will be written.
[*pkg-abbrev*]	Is one or more package abbreviations.

If no package names are given, all packages residing in *device1* are translated and written to *device2*.

Note – If more than one instance of a package resides on *device1*, you must use an instance identifier for the package. For a description of a package identifier, see "Defining a Package Instance" on page 27. When an instance of the package being translated already exists on *device2*, the `pkgtrans` command does not perform the translation. You can use the `-o` option to tell the `pkgtrans` command to overwrite any existing instances on the destination device and the `-n` option to tell it to create a new instance if one already exists. Note that this check does not apply when *device2* supports a datastream format.

More Information

Where to Go Next

At this point you have completed the steps necessary to design, build, verify, and transfer your package. If you are interested in looking at some case studies, see Chapter 5. If you are interested in advanced package design ideas, see Chapter 6.

CHAPTER 5

Case Studies of Package Creation

This chapter provides case studies to show packaging scenarios such as installing objects conditionally, determining at run time how many files to create, and modifying an existing data file during package installation and removal.

Each case study begins with a description, followed by a list of the packaging techniques used, a narrative description of the approach taken when using those techniques, and sample files and scripts associated with the case study.

This is a list of the case studies in this chapter:

Soliciting Input From the Administrator

The package in this case study has three types of objects. The administrator may choose which of the three types to install and where to locate the objects on the installation machine.

Techniques

This case study demonstrates the following techniques:

- Using parametric path names (variables in object path names) that are used to establish multiple base directories

  For information on parametric path names, see "Parametric Path Names" on page 35.
- Using a `request` script to solicit input from the administrator

  For information on `request` scripts, see "Writing a `request` Script" on page 63.
- Setting conditional values for an installation parameter

Approach

To set up the selective installation in this case study, you must complete the following tasks:

- Define a class for each type of object that can be installed.

  In this case study, the three object types are the package executables, the man pages, and the `emacs` executables. Each type has its own class: `bin`, `man`, and `emacs`, respectively. Notice that in the `prototype` file all the object files belong to one of these three classes.
- Initialize the `CLASSES` parameter in the `pkginfo` file to null.

  Normally when you define a class, you should list that class in the `CLASSES` parameter in the `pkginfo` file. Otherwise, no objects in that class are installed. For this case study, the parameter is initially set to null, which means no objects will get installed. The `CLASSES` parameter will be changed by the `request` script, based on the choices of the administrator. This way, the `CLASSES` parameter is set to only those object types that the administrator wants installed.

  Note – Usually it is a good idea to set parameters to a default value. If this package had components common to all three object types, you could assign them to the `none` class, and then set the `CLASSES` parameter equal to `none`.

- Insert parametric path names into the `prototype` file.

  The `request` script sets these environment variables to the value that the administrator provides. Then, the `pkgadd` command resolves these environment variables at installation time and knows where to install the package.

  The three environment variables used in this example are set to their default in the `pkginfo` file and serve the following purposes:

  - `$NCMPBIN` defines the location for object executables
  - `$NCMPMAN` defines the location for man pages
  - `$EMACS` defines the location for `emacs` executables

  The example `prototype` file shows how to define the object path names with variables.

- Create a `request` script to ask the administrator which parts of the package should be installed and where they should be placed.

  The `request` script for this package asks the administrator two questions:

  - Should this part of the package be installed?

    When the answer is yes, the appropriate class name is added to the `CLASSES` parameter. For example, when the administrator chooses to install the man pages associated with this package, the class `man` is added to the `CLASSES` parameter.
  - If so, where should this part of the package be placed?

    The appropriate environment variable is set to the response to this question. In the man page example, the variable `$NCMPMAN` is set to the response value.

  These two questions are repeated for each of the three object types.

  At the end of the `request` script, the parameters are made available to the installation environment for the `pkgadd` command and any other packaging scripts. The `request` script does this by writing these definitions to the file provided by the calling utility. For this case study, no other scripts are provided.

  When looking at the `request` script for this case study, notice that the questions are generated by the data validation tools `ckyorn` and `ckpath`. For more information on these tools, see `ckyorn`(1) and `ckpath`(1).

Case Study Files

The `pkginfo` File

```
PKG=ncmp
NAME=NCMP Utilities
CATEGORY=application, tools
BASEDIR=/
ARCH=SPARC
VERSION=RELEASE 1.0, Issue 1.0
CLASSES=""
NCMPBIN=/bin
NCMPMAN=/usr/man
EMACS=/usr/emacs
```

The `prototype` File

```
i pkginfo
i request
x bin $NCMPBIN 0755 root other
```

```
f bin $NCMPBIN/dired=/usr/ncmp/bin/dired 0755 root other
f bin $NCMPBIN/less=/usr/ncmp/bin/less 0755 root other
f bin $NCMPBIN/ttype=/usr/ncmp/bin/ttype 0755 root other
f emacs $NCMPBIN/emacs=/usr/ncmp/bin/emacs 0755 root other
x emacs $EMACS 0755 root other
f emacs $EMACS/ansii=/usr/ncmp/lib/emacs/macros/ansii 0644 root other
f emacs $EMACS/box=/usr/ncmp/lib/emacs/macros/box 0644 root other
f emacs $EMACS/crypt=/usr/ncmp/lib/emacs/macros/crypt 0644 root other
f emacs $EMACS/draw=/usr/ncmp/lib/emacs/macros/draw 0644 root other
f emacs $EMACS/mail=/usr/ncmp/lib/emacs/macros/mail 0644 root other
f emacs $NCMPMAN/man1/emacs.1=/usr/ncmp/man/man1/emacs.1 0644 root other
d man $NCMPMAN 0755 root other
d man $NCMPMAN/man1 0755 root other
f man $NCMPMAN/man1/dired.1=/usr/ncmp/man/man1/dired.1 0644 root other
f man $NCMPMAN/man1/ttype.1=/usr/ncmp/man/man1/ttype.1 0644 root other
f man $NCMPMAN/man1/less.1=/usr/ncmp/man/man1/less.1 0644 inixmr other
```

The `request` Script

```
trap 'exit 3' 15
# determine if and where general executables should be placed
ans=`ckyorn -d y \
-p "Should executables included in this package be installed"
` || exit $?
if [ "$ans" = y ]
then
   CLASSES="$CLASSES bin"
   NCMPBIN=`ckpath -d /usr/ncmp/bin -aoy \
   -p "Where should executables be installed"
   ` || exit $?
fi
# determine if emacs editor should be installed, and if it should
# where should the associated macros be placed
ans=`ckyorn -d y \
-p "Should emacs editor included in this package be installed"
` || exit $?
if [ "$ans" = y ]
then
   CLASSES="$CLASSES emacs"
   EMACS=`ckpath -d /usr/ncmp/lib/emacs -aoy \
   -p "Where should emacs macros be installed"
   ` || exit $?
fi
```

Note that a `request` script can exit without leaving any files on the file system. For installations on Solaris versions prior to 2.5 and compatible versions (where no `checkinstall` script may be used) the `request` script is the correct place to test the file system in any manner necessary to ensure that the installation will succeed. When the `request` script exits with code 1, the installation will quit cleanly.

These example files show the use of parametric paths to establish multiple base directories. However, the preferred method involves use of the `BASEDIR` parameter which is managed and validated by the `pkgadd` command. Whenever multiple base directories are used, take special care to provide for installation of multiple versions and architectures on the same platform.

Creating a File at Installation and Saving It During Removal

This case study creates a database file at installation time and saves a copy of the database when the package is removed.

Techniques

This case study demonstrates the following techniques:

- Using classes and class action scripts to perform special actions on different sets of objects

  For more information, see "Writing Class Action Scripts" on page 70.
- Using the `space` file to inform the `pkgadd` command that extra space is required to install this package properly

  For more information on the `space` file, see "Reserving Additional Space on a Target System" on page 57.
- Using the `installf` command to install a file not defined in the `prototype` and `pkgmap` files

Approach

To create a database file at installation and save a copy on removal for this case study, you must complete the following tasks:

- Define three classes.

  The package in this case study requires the following three classes be defined in the `CLASSES` parameter:

  - The standard class of `none`, which contains a set of processes belonging in the subdirectory `bin`.
  - The `admin` class, which contains an executable file `config` and a directory containing data files.

    - The `cfgdata` class, which contains a directory.
- Make the package collectively relocatable.

  Notice in the `prototype` file that none of the path names begins with a slash or an environment variable. This indicates that they are collectively relocatable.
- Calculate the amount of space the database file requires and create a `space` file to deliver with the package. This file notifies the `pkgadd` command that the package requires extra space and specifies how much.
- Create a class action script for the `admin` class (`i.admin`).

  The sample script initializes a database using the data files belonging to the `admin` class. To perform this task, it does the following:

    - Copies the source data file to its proper destination
    - Creates an empty file named `config.data` and assigns it to a class of `cfgdata`
    - Executes the `bin/config` command (delivered with the package and already installed) to populate the database file `config.data` using the data files belonging to the `admin` class
    - Executes the `installf -f` command to finalize installation of `config.data`

  No special action is required for the `admin` class at removal time so no removal class action script is created. This means that all files and directories in the `admin` class are removed from the system.
- Create a removal class action script for the `cfgdata` class (`r.cfgdata`).

  The removal script makes a copy of the database file before it is deleted. No special action is required for this class at installation time, so no installation class action script is needed.

  Remember that the input to a removal script is a list of path names to remove. Path names always appear in reverse alphabetical order. This removal script copies files to the directory named `$PKGSAV`. When all the path names have been processed, the script then goes back and removes all directories and files associated with the `cfgdata` class.

  The outcome of this removal script is to copy `config.data` to `$PKGSAV` and then remove the `config.data` file and the data directory.

Case Study Files

The `pkginfo` File

```
PKG=krazy
NAME=KrAzY Applications
CATEGORY=applications
```

```
BASEDIR=/opt
ARCH=SPARC
VERSION=Version 1
CLASSES=none cfgdata admin
```

The `prototype` File

```
i pkginfo
i request
i i.admin
i r.cfgdata
d none bin 555 root sys
f none bin/process1 555 root other
f none bin/process2 555 root other
f none bin/process3 555 root other
f admin bin/config 500 root sys
d admin cfg 555 root sys
f admin cfg/datafile1 444 root sys
f admin cfg/datafile2 444 root sys
f admin cfg/datafile3 444 root sys
f admin cfg/datafile4 444 root sys
d cfgdata data 555 root sys
```

The `space` File

```
# extra space required by config data which is
# dynamically loaded onto the system
data 500 1
```

The `i.admin` Class Action Script

```
# PKGINST parameter provided by installation service
# BASEDIR parameter provided by installation service
while read src dest
do
   cp $src $dest || exit 2
done
# if this is the last time this script will be executed
# during the installation, do additional processing here.
if [ "$1" = ENDOFCLASS ]
then
# our config process will create a data file based on any changes
# made by installing files in this class; make sure the data file
# is in class 'cfgdata' so special rules can apply to it during
# package removal.
   installf -c cfgdata $PKGINST $BASEDIR/data/config.data f 444 root
   sys || exit 2
   $BASEDIR/bin/config > $BASEDIR/data/config.data || exit 2
   installf -f -c cfgdata $PKGINST || exit 2
```

```
fi
exit 0
```

This illustrates a rare instance in which `installf` is appropriate in a class action script. Because a `space` file has been used to reserve room on a specific file system, this new file may be safely added even though it is not included in the `pkgmap` file.

The `r.cfgdata` Removal Script

```
# the product manager for this package has suggested that
# the configuration data is so valuable that it should be
# backed up to $PKGSAV before it is removed!
while read path
do
# path names appear in reverse lexical order.
   mv $path $PKGSAV || exit 2
   rm -f $path || exit 2
done
exit 0
```

Defining Package Compatibilities and Dependencies

The package in this case study uses optional information files to define package compatibilities and dependencies, and to present a copyright message during installation.

Techniques

This case study demonstrates the following techniques:

- Using the `copyright` file
- Using the `compver` file
- Using the `depend` file

For more information on these files, see "Creating Information Files" on page 53.

Approach

To meet the requirements in the description, you must:

- Create a `copyright` file.

A `copyright` file contains the ASCII text of a copyright message. The message shown in the sample file is displayed on the screen during package installation.

- Create a `compver` file.

  The `pkginfo` file shown in the next figure defines this package version as version 3.0. The `compver` file defines version 3.0 as being compatible with versions 2.3, 2.2, 2.1, 2.1.1, 2.1.3 and 1.7.

- Create a `depend` file.

  Files listed in a `depend` file must already be installed on the system when a package is installed. The example file has 11 packages which must already be on the system at installation time.

Case Study Files

The `pkginfo` File

```
PKG=case3
NAME=Case Study #3
CATEGORY=application
BASEDIR=/opt
ARCH=SPARC
VERSION=Version 3.0
CLASSES=none
```

The `copyright` File

```
Copyright (c) 1999 company_name
All Rights Reserved.
THIS PACKAGE CONTAINS UNPUBLISHED PROPRIETARY SOURCE CODE OF
company_name.
The copyright notice above does not evidence any
actual or intended publication of such source code
```

The `compver` File

```
Version 3.0
Version 2.3
Version 2.2
Version 2.1
Version 2.1.1
Version 2.1.3
Version 1.7
```

The `depend` File

```
P acu Advanced C Utilities
Issue 4 Version 1
```

```
P cc C Programming Language
Issue 4 Version 1
P dfm Directory and File Management Utilities
P ed Editing Utilities
P esg Extended Software Generation Utilities
Issue 4 Version 1
P graph Graphics Utilities
P rfs Remote File Sharing Utilities
Issue 1 Version 1
P rx Remote Execution Utilities
P sgs Software Generation Utilities
Issue 4 Version 1
P shell Shell Programming Utilities
P sys System Header Files
Release 3.1
```

Modifying a File by Using Standard Classes and Class Action Scripts

This case study modifies an existing file during package installation using standard classes and class action scripts. It uses one of three modification methods. The other two methods are described in "Modifying a File by Using the `sed` Class and a `postinstall` Script" on page 111 and "Modifying a File by Using The `build` Class" on page 113. The file modified is `/etc/inittab`.

Techniques

This case study demonstrates how to use installation and removal class action scripts. For more information, see "Writing Class Action Scripts" on page 70.

Approach

To modify `/etc/inittab` during installation, using classes and class action scripts, you must complete the following tasks:

- Create a class.

  Create a class called `inittab`. You must provide an installation and a removal class action script for this class. Define the `inittab` class in the `CLASSES` parameter in the `pkginfo` file.
- Create an `inittab` file.

This file contains the information for the entry that you will add to /etc/inittab. Notice in the prototype file figure that inittab is a member of the inittab class and has a file type of e for editable.

- Create an installation class action script (i.inittab).

  Remember that class action scripts must produce the same results each time they are executed. The class action script performs the following procedures:

  - Checks if this entry has been added before
  - If it has, removes any previous versions of the entry
  - Edits the inittab file and adds the comment lines so you know where the entry is from
  - Moves the temporary file back into /etc/inittab
  - Executes the init q command when it receives the ENDOFCLASS indicator

  Note that the init q command can be performed by this installation script. A one-line postinstall script is not needed by this approach.

- Create a removal class action script (r.inittab).

  The removal script is very similar to the installation script. The information added by the installation script is removed and the init q command is executed.

This case study is more complicated than the next one; see "Modifying a File by Using the sed Class and a postinstall Script" on page 111. Instead of providing two files, three are needed and the delivered /etc/inittab file is actually just a place holder containing a fragment of the entry to be inserted. This could have been placed into the i.inittab file except that the pkgadd command must have a file to pass to the i.inittab file. Also, the removal procedure must be placed into a separate file (r.inittab). While this method works fine, it is best reserved for cases involving very complicated installations of multiple files. See "Modifying crontab Files During Installation" on page 115.

The sed program used in "Modifying a File by Using the sed Class and a postinstall Script" on page 111 supports multiple package instances since the comment at the end of the inittab entry is based on package instance. The case study in "Modifying a File by Using The build Class" on page 113 shows a more streamlined approach to editing /etc/inittab during installation.

Case Study Files

The pkginfo File

```
PKG=case5
NAME=Case Study #5
CATEGORY=applications
```

```
BASEDIR=/opt
ARCH=SPARC
VERSION=Version 1d05
CLASSES=inittab
```

The prototype File

```
i pkginfo
i i.inittab
i r.inittab
e inittab /etc/inittab ? ? ?
```

The i.inittab Installation Class Action Script

```
# PKGINST parameter provided by installation service
while read src dest
do
# remove all entries from the table that
# associated with this PKGINST
sed -e "/^[^:]*:[^:]*:[^:]*:[^#]*#$PKGINST$/d" $dest >
/tmp/$$itab ||
exit 2
sed -e "s/$/#$PKGINST" $src >> /tmp/$$itab ||
exit 2
mv /tmp/$$itab $dest ||
exit 2
done
if [ "$1" = ENDOFCLASS ]
then
/sbin/init q ||
exit 2
fi
exit 0
```

The r.inittab Removal Class Action Script

```
# PKGINST parameter provided by installation service
while read src dest
do
# remove all entries from the table that
# are associated with this PKGINST
sed -e "/^[^:]*:[^:]*:[^:]*:[^#]*#$PKGINST$/d" $dest >
/tmp/$$itab ||
exit 2
mv /tmp/$$itab $dest ||
exit 2
done
/sbin/init q ||
exit 2
exit 0
```

The `inittab` File

```
rb:023456:wait:/usr/robot/bin/setup
```

Modifying a File by Using the `sed` Class and a `postinstall` Script

This case study modifies a file which exists on the installation machine during package installation. It uses one of three modification methods. The other two methods are described in "Modifying a File by Using Standard Classes and Class Action Scripts" on page 108 and "Modifying a File by Using The `build` Class" on page 113. The file modified is `/etc/inittab`.

Techniques

This case study demonstrates the following techniques:

- Using the `sed` class

  For more information on the `sed` class, see "The `sed` Class Script" on page 74.
- Using a `postinstall` script

  For more information on this script, see "Writing Procedure Scripts" on page 68.

Approach

To modify `/etc/inittab` at the time of installation, using the `sed` class, you must complete the following tasks:

- Add the `sed` class script to the `prototype` file.

  The name of a script must be the name of the file that will be edited. In this case, the file to be edited is `/etc/inittab` and so the `sed` script is named `/etc/inittab`. There are no requirements for the mode, owner, and group of a `sed` script (represented in the sample `prototype` by question marks). The file type of the `sed` script must be `e` (indicating that it is editable).
- Set the `CLASSES` parameter to include the `sed` class.

  As shown in the example file, `sed` is the only class being installed. However, it could be one of any number of classes.

- Create a `sed` class action script.

  Your package cannot deliver a copy of `/etc/inittab` that looks the way you need it to, since `/etc/inittab` is a dynamic file and you have no way of knowing how it will look at the time of package installation. However, using a `sed` script allows you to modify the `/etc/inittab` file during package installation.
- Create a `postinstall` script.

  You need to execute the `init q` command to inform the system that `/etc/inittab` has been modified. The only place you can perform that action in this example is in a `postinstall` script. Looking at the example `postinstall` script, you will see that its only purpose is to execute the `init q` command.

This approach to editing `/etc/inittab` during installation has one drawback; you have to deliver a full script (the `postinstall` script) simply to perform the `init q` command.

Case Study Files

The `pkginfo` File

```
PKG=case4
NAME=Case Study #4
CATEGORY=applications
BASEDIR=/opt
ARCH=SPARC
VERSION=Version 1d05
CLASSES=sed
```

The `prototype` File

```
i pkginfo
i postinstall
e sed /etc/inittab ? ? ?
```

The `sed` Class Action Script (`/etc/inittab`)

```
!remove
# remove all entries from the table that are associated
# with this package, though not necessarily just
# with this package instance
/^[^:]*:[^:]*:[^:]*:[^#]*#ROBOT$/d
!install
# remove any previous entry added to the table
# for this particular change
```

```
/^[^:]*:[^:]*:[^:]*:[^#]*#ROBOT$/d
# add the needed entry at the end of the table;
# sed(1) does not properly interpret the '$a'
# construct if you previously deleted the last
# line, so the command
# $a\
# rb:023456:wait:/usr/robot/bin/setup #ROBOT
# will not work here if the file already contained
# the modification. Instead, you will settle for
# inserting the entry before the last line!
$i\
rb:023456:wait:/usr/robot/bin/setup #ROBOT
```

The `postinstall` Script

```
# make init re-read inittab
/sbin/init q ||
exit 2
exit 0
```

Modifying a File by Using The `build` Class

This case study modifies a file which exists on the installation machine during package installation. It uses one of three modification methods. The other two methods are described in "Modifying a File by Using Standard Classes and Class Action Scripts" on page 108 and "Modifying a File by Using the `sed` Class and a `postinstall` Script" on page 111. The file modified is `/etc/inittab`.

Techniques

This case study demonstrates how to use the `build` class. For more information on the `build` class, see "The `build` Class Script" on page 74.

Approach

This approach to modifying `/etc/inittab` uses the `build` class. A `build` class script is executed as a shell script and its output becomes the new version of the file being executed. In other words, the data file `/etc/inittab` that is delivered with this package will be executed and the output of that execution will become `/etc/inittab`.

The `build` class script is executed during package installation and package removal. The argument `install` is passed to the file if it is being executed at installation time. Notice in the sample `build` class script that installation actions are defined by testing for this argument.

To edit `/etc/inittab` using the `build` class, you must complete the following tasks:

- Define the build file in the `prototype` file.

  The entry for the build file in the `prototype` file should place it in the `build` class and define its file type as `e`. Be certain that the `CLASSES` parameter in the `pkginfo` file is defined as `build`.
- Create the `build` class script.

  The sample `build` class script performs the following procedures:

  - Edits the `/etc/inittab` file to remove any existing changes for this package. Notice that the file name `/etc/inittab` is hardcoded into the `sed` command.
  - If the package is being installed, adds the new line to the end of `/etc/inittab`. A comment tag is included in this new entry to describe where that entry came from.
  - Executes the `init q` command.

This solution addresses the drawbacks described in the case studies in "Modifying a File by Using Standard Classes and Class Action Scripts" on page 108 and "Modifying a File by Using the `sed` Class and a `postinstall` Script" on page 111. Only one short file is needed (beyond the `pkginfo` and `prototype` files). The file works with multiple instances of a package since the `PKGINST` parameter is used, and no `postinstall` script is required since the `init q` command can be executed from the `build` class script.

Case Study Files

The `pkginfo` File

```
PKG=case6
NAME=Case Study #6
CATEGORY=applications
BASEDIR=/opt
ARCH=SPARC
VERSION=Version 1d05
CLASSES=build
```

The `prototype` File

```
i pkginfo
e build /etc/inittab ? ? ?
```

The Build File

```
# PKGINST parameter provided by installation service
# remove all entries from the existing table that
# are associated with this PKGINST
sed -e "/^[^:]*:[^:]*:[^:]*:[^#]*#$PKGINST$/d" /etc/inittab ||
exit 2
if [ "$1" = install ]
then
# add the following entry to the table
echo "rb:023456:wait:/usr/robot/bin/setup #$PKGINST" ||
exit 2
fi
/sbin/init q ||
exit 2
exit 0
```

Modifying `crontab` Files During Installation

This case study modifies `crontab` files during package installation.

Techniques

This case study demonstrates the following techniques:

- Using classes and class action scripts

  For more information, see "Writing Class Action Scripts" on page 70.
- Using the `crontab` command within a class action script

Approach

The most efficient way to edit more than one file during installation is to define a class and provide a class action script. If you used the `build` class approach, you would need to deliver one `build` class script for each `crontab` file edited. Defining a `cron` class provides a more general approach. To edit `crontab` files with this approach, you must:

- Define the `crontab` files that are to be edited in the `prototype` file.

  Create an entry in the `prototype` file for each `crontab` file that will be edited. Define the class as `cron` and the file type as `e` for each file. Use the actual name of the file to be edited.

- Create the `crontab` files for the package.

  These files contain the information you want added to the existing `crontab` files of the same name.
- Create an installation class action script for the `cron` class.

  The sample `i.cron` script performs the following procedures:
  - Determines the user ID (UID).

    The `i.cron` script sets the variable *user* to the base name of the `cron` class script being processed. That name is the UID. For example, the base name of `/var/spool/cron/crontabs/root` is root, which is also the UID.
  - Executes `crontab` using the UID and the `-l` option.

    Using the `-l` option tells `crontab` to send the contents of the `crontab` file for the defined user to the standard output.
  - Pipes the output of the `crontab` command to a `sed` script that removes any previous entries added with this installation technique.
  - Puts the edited output into a temporary file.
  - Adds the data file for the root UID (that was delivered with the package) to the temporary file and adds a tag so you will know where these entries came from.
  - Executes `crontab` with the same UID and gives it the temporary file as input.
- Create a removal class action script for the `cron` class.

  The `r.cron` script is the same as the installation script except there is no procedure to add information to the `crontab` file.

  These procedures are performed for every file in the `cron` class.

Case Study Files

The `i.cron` and `r.cron` scripts described below are executed by superuser. Editing another user's `crontab` file as superuser may have unpredictable results. If necessary, change the following entry in each script:

```
crontab $user < /tmp/$$crontab ||
```

to

```
su $user -c "crontab /tmp/$$crontab" ||
```

The `pkginfo` Command

```
PKG=case7
NAME=Case Study #7
CATEGORY=application
BASEDIR=/opt
```

```
ARCH=SPARC
VERSION=Version 1.0
CLASSES=cron
```

The `prototype` File

```
i pkginfo
i i.cron
i r.cron
e cron /var/spool/cron/crontabs/root ? ? ?
e cron /var/spool/cron/crontabs/sys ? ? ?
```

The `i.cron` Installation Class Action Script

```
# PKGINST parameter provided by installation service
while read src dest
do
user=‘basename $dest‘ ||
exit 2
(crontab -l $user |
sed -e "/#$PKGINST$/d" > /tmp/$$crontab) ||
exit 2
sed -e "s/$/#$PKGINST/" $src >> /tmp/$$crontab ||
exit 2
crontab $user < /tmp/$$crontab ||
exit 2
rm -f /tmp/$$crontab
done
exit 0
```

The `r.cron` Removal Class Action Script

```
# PKGINST parameter provided by installation service
while read path
do
user=‘basename $path‘ ||
exit 2
(crontab -l $user |
sed -e "/#$PKGINST$/d" > /tmp/$$crontab) ||
exit 2
crontab $user < /tmp/$$crontab ||
exit 2
rm -f /tmp/$$crontab
done
exit
```

`crontab` File #1

```
41,1,21 * * * * /usr/lib/uucp/uudemon.hour > /dev/null
45 23 * * * ulimit 5000; /usr/bin/su uucp -c
"/usr/lib/uucp/uudemon.cleanup" >
```

```
/dev/null 2>&1
11,31,51 * * * * /usr/lib/uucp/uudemon.poll > /dev/null
```

`crontab` File #2

```
0 * * * 0-6 /usr/lib/sa/sa1
20,40 8-17 * * 1-5 /usr/lib/sa/sa1
5 18 * * 1-5 /usr/lib/sa/sa2 -s 8:00 -e 18:01 -i 1200 -A
```

Note – If editing of a group of files will increase total file size by more than 10K, supply a `space` file so the `pkgadd` command can allow for this increase. For more information on the `space` file, see "Reserving Additional Space on a Target System" on page 57.

Installing and Removing a Driver With Procedure Scripts

This package installs a driver.

Techniques

This case study demonstrates the following techniques:

- Installing and loading a driver with a `postinstall` script
- Unloading a driver with a `preremove` script

For more information on these scripts, see "Writing Procedure Scripts" on page 68.

Approach

- Create a `request` script.

  The `request` script determines where the administrator wants the driver objects to be installed, by questioning the administrator and assigning the answer to the `$KERNDIR` parameter.

  The script ends with a routine to make the two parameters `CLASSES` and `KERNDIR` available to the installation environment and the `postinstall` script.

- Create a `postinstall` script.

  The `postinstall` script actually performs the driver installation. It is executed after the two files `buffer` and `buffer.conf` have been installed. The `postinstall` file shown for this example performs the following actions:

  - Uses the `add_drv` command to load the driver into the system.
  - Creates a link for the device using the `installf` command.
  - Finalizes the installation using the `installf -f` command.
  - Creates a `preremove` script.

    The `preremove` script uses the `rem_drv` command to unload the driver from the system, and then removes the link `/dev/buffer0`.

Case Study Files

The `pkginfo` File

```
PKG=bufdev
NAME=Buffer Device
CATEGORY=system
BASEDIR=/
ARCH=INTEL
VERSION=Software Issue #19
CLASSES=none
```

The `prototype` File

To install a driver at the time of installation, you must include the object and configuration files for the driver in the `prototype` file.

In this example, the executable module for the driver is named `buffer`; the `add_drv` command operates on this file. The kernel uses the configuration file, `buffer.conf`, to help configure the driver.

```
i pkginfo
i request
i postinstall
i preremove
f none $KERNDIR/buffer 444 root root
f none $KERNDIR/buffer.conf 444 root root
```

Looking at the `prototype` file for this example, notice the following:

- Since no special treatment is required for the package objects, you can put them into the standard `none` class. The `CLASSES` parameter is set to `none` in the `pkginfo` file.

- The path names for buffer and buffer.conf begin with the variable $KERNDIR. This variable is set in the request script and allows the administrator to decide where the driver files should be installed. The default directory is /kernel/drv.
- There is an entry for the postinstall script (the script that will perform the driver installation).

The request Script

```
trap 'exit 3' 15
# determine where driver object should be placed; location
# must be an absolute path name that is an existing directory
KERNDIR=`ckpath -aoy -d /kernel/drv -p \
"Where do you want the driver object installed"` || exit $?

# make parameters available to installation service, and
# so to any other packaging scripts
cat >$1 <<!

CLASSES='$CLASSES'
KERNDIR='$KERNDIR'
!
exit 0
```

The postinstall Script

```
# KERNDIR parameter provided by 'request' script
err_code=1                    # an error is considered fatal
# Load the module into the system
cd $KERNDIR
add_drv -m '* 0666 root sys' buffer || exit $err_code
# Create a /dev entry for the character node
installf $PKGINST /dev/buffer0=/devices/eisa/buffer*:0 s
installf -f $PKGINST
```

The preremove Script

```
err_code=1                    # an error is considered fatal
# Unload the driver
rem_drv buffer || exit $err_code
# remove /dev file
removef $PKGINST /dev/buffer0 ; rm /dev/buffer0
removef -f $PKGINST
```

Installing a Driver by Using the `sed` Class and Procedure Scripts

This case study describes how to install a driver using the `sed` class and procedure scripts. It is also different from the previous case study (see "Installing and Removing a Driver With Procedure Scripts" on page 118) because this package is made up of both absolute and relocatable objects.

Techniques

This case study demonstrates the following techniques:

- Building a `prototype` file with both absolute and relocatable objects.

  For more information on building a `prototype` file, see "Creating a `prototype` File" on page 31.
- Using a `postinstall` script

  For more information on this script, see "Writing Procedure Scripts" on page 68.
- Using a `preremove` script

  For more information on this script, see "Writing Procedure Scripts" on page 68.
- Using a `copyright` file

  For more information on this file, see "Writing a Copyright Message" on page 55.

Approach

- Create a `prototype` file containing both absolute and relocatable package objects.

  This is discussed in detail in "The `prototype` File" on page 122.
- Add the `sed` class script to the `prototype` file.

  The name of a script must be the name of the file that will be edited. In this case, the file to be edited is `/etc/devlink.tab` and so the `sed` script is named `/etc/devlink.tab`. There are no requirements for the mode, owner, and group of a `sed` script (represented in the sample `prototype` by question marks). The file type of the `sed` script must be `e` (indicating that it is editable).
- Set the `CLASSES` parameter to include the `sed` class.
- Create a `sed` class action script (`/etc/devlink.tab`).
- Create a `postinstall` script.

  The `postinstall` script needs to execute the `add_drv` command to add the device driver to the system.

- Create a `preremove` script.

  The `preremove` script needs to execute the `rem_drv` command to remove the device driver from the system, prior to the package being removed.
- Create a `copyright` file.

  A `copyright` file contains the ASCII text of a copyright message. The message shown in the sample file is displayed on the screen during package installation.

Case Study Files

The `pkginfo` File

```
PKG=SUNWsst
NAME=Simple SCSI Target Driver
VERSION=1
CATEGORY=system
ARCH=sparc
VENDOR=Sun Microsystems
BASEDIR=/opt
CLASSES=sed
```

The `prototype` File

For example, this case study uses the hierarchical layout of the package objects shown in the figure below.

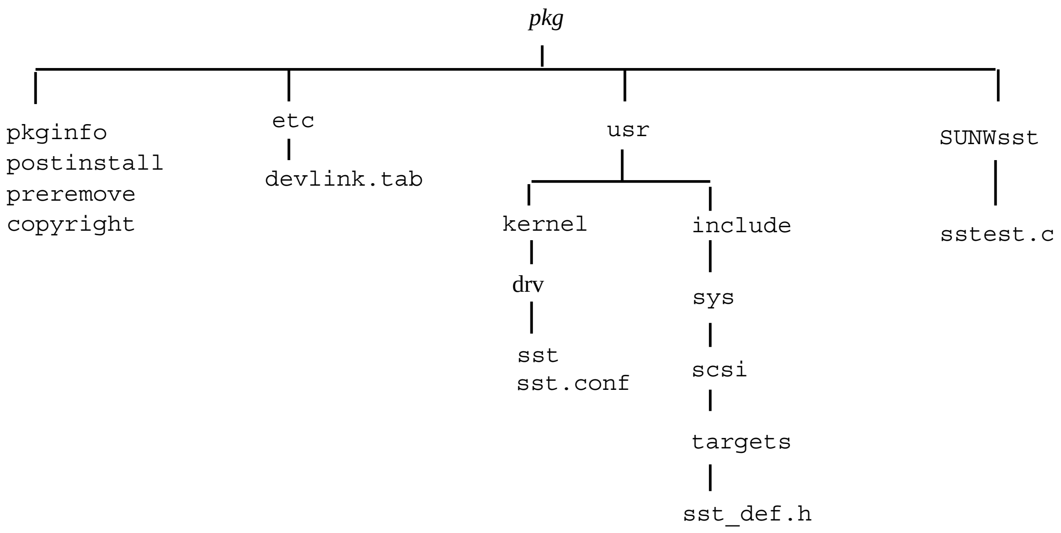


FIGURE 5–1 Hierarchical Package Directory Structure

The package objects are installed in the same places as they are in the `pkg` directory above. The driver modules (`sst` and `sst.conf`) are installed into `/usr/kernel/drv` and the include file is installed into `/usr/include/sys/scsi/targets`. The `sst`, `sst.conf`, and `sst_def.h` files are absolute objects. The test program, `sstest.c`, and its directory `SUNWsst` are relocatable; their installation location is set by the `BASEDIR` parameter.

The remaining components of the package (all the control files) go in the top directory of the package on the development machine, except the `sed` class script. This is called `devlink.tab` after the file it modifies, and goes into `etc`, the directory containing the real `devlink.tab` file.

From the `pkg` directory, run the `pkgproto` command as follows:

```
find usr SUNWsst -print | pkgproto > prototype
```

The output from the above command looks like this:

```
d none usr 0775 pms mts
d none usr/include 0775 pms mts
d none usr/include/sys 0775 pms mts
d none usr/include/sys/scsi 0775 pms mts
d none usr/include/sys/scsi/targets 0775 pms mts
f none usr/include/sys/scsi/targets/sst_def.h 0444 pms mts
d none usr/kernel 0775 pms mts
d none usr/kernel/drv 0775 pms mts
f none usr/kernel/drv/sst 0664 pms mts
f none usr/kernel/drv/sst.conf 0444 pms mts
d none SUNWsst 0775 pms mts
f none SUNWsst/sstest.c 0664 pms mts
```

This `prototype` file is not yet complete. To complete this file, you need to make the following modifications:

- Insert the entries for the control files (file type `i`), because they have a different format than the other package objects.
- Remove entries for directories that already exist on the target system.
- Change the access permission and ownership for each entry.
- Prepend a slash to the absolute package objects.

This is the final `prototype` file:

```
i pkginfo
i postinstall
i preremove
i copyright
e sed /etc/devlink.tab ? ? ?
f none /usr/include/sys/scsi/targets/sst_def.h 0644 bin bin
f none /usr/kernel/drv/sst 0755 root sys
f none /usr/kernel/drv/sst.conf 0644 root sys
d none SUNWsst 0775 root sys
f none SUNWsst/sstest.c 0664 root sys
```

The questions marks in the entry for the `sed` script indicate that the access permissions and ownership of the existing file on the installation machine should not be changed.

The `sed` Class Action Script (`/etc/devlink.tab`)

In the driver example, a `sed` class script is used to add an entry for the driver to the file `/etc/devlink.tab`. This file is used by the `devlinks` command to create symbolic links from `/dev` into `/devices`. This is the `sed` script:

```
# sed class script to modify /etc/devlink.tab
!install
/name=sst;/d
$i\
type=ddi_pseudo;name=sst;minor=character    rsst\\A1

!remove
/name=sst;/d
```

The `pkgrm` command does not run the removal part of the script. You may need to add a line to the `preremove` script to run `sed` directly to remove the entry from the `/etc/devlink.tab` file.

The `postinstall` Installation Script

In this example, all the script needs to do is run the `add_drv` command.

```
# Postinstallation script for SUNWsst
# This does not apply to a client.
if [$PKG_INSTALL_ROOT = "/" -o -z $PKG_INSTALL_ROOT]; then
```

```
   SAVEBASE=$BASEDIR
   BASEDIR=””; export BASEDIR
   /usr/sbin/add_drv sst
   STATUS=$?
   BASEDIR=$SAVEBASE; export BASEDIR
   if [ $STATUS -eq 0 ]
   then
         exit 20
   else
         exit 2
   fi
else
   echo "This cannot be installed onto a client."
   exit 2
fi
```

The `add_drv` command uses the `BASEDIR` parameter, so the script has to unset `BASEDIR` before running the command, and restore it afterwards.

One of the actions of the `add_drv` command is to run `devlinks`, which uses the entry placed in `/etc/devlink.tab` by the `sed` class script to create the `/dev` entries for the driver.

The exit code from the `postinstall` script is significant. The exit code `20` tells the `pkgadd` command to tell the user to reboot the system (necessary after installing a driver), and the exit code `2` tells the `pkgadd` command to tell the user that the installation partially failed.

The `preremove` Removal Script

In the case of this driver example, it removes the links in `/dev` and runs the `rem_drv` command on the driver.

```
# Pre removal script for the sst driver
echo “Removing /dev entries”
/usr/bin/rm -f /dev/rsst*

echo “Deinstalling driver from the kernel”
SAVEBASE=$BASEDIR
BASEDIR=””; export BASEDIR
/usr/sbin/rem_drv sst
BASEDIR=$SAVEBASE; export BASEDIR

exit
```

The script removes the `/dev` entries itself; the `/devices` entries are removed by the `rem_drv` command.

The `copyright` File

This is a simple ASCII file containing the text of a copyright notice. The notice is displayed at the beginning of package installation exactly as it appears in the file.

```
    Copyright (c) 1999 Drivers-R-Us, Inc.
    10 Device Drive, Thebus, IO 80586

All rights reserved. This product and related documentation is
protected by copyright and distributed under licenses
restricting its use, copying, distribution and decompilation.
No part of this product or related documentation may be
reproduced in any form by any means without prior written
authorization of Drivers-R-Us and its licensors, if any.
```

CHAPTER 6

Advanced Techniques for Creating Packages

The full capabilities of System V packaging as implemented in the Solaris operating environment provide a powerful tool for the installation of software products. As a package designer, you can take advantage of these capabilities. Packages that are not part of the Solaris operating environment (unbundled packages) may use the class mechanism to customize server/client installations. Relocatable packages can be designed to accommodate the desires of the administrator. A complex product can be delivered as a set of composite packages that automatically resolve package dependencies. Upgrading and patching may be customized by the package designer. Patched packages can be delivered in the same way as unpatched packages, and the backout archives can also be included in the product.

This is a list of the overview information in this chapter.

Specifying the Base Directory

You can use several methods to specify where a package will be installed, and it is important to be able to change the installation base dynamically at install time. If this is accomplished correctly, an administrator can install multiple versions and multiple architectures without complications.

This section discusses common methods first, followed by approaches that enhance installations to heterogeneous systems.

The Administrative Defaults File

Administrators responsible for installing packages can use administration files to control package installation. However, as a package designer, you need to know about administration files and how an administrator can alter your intended package installation.

An administration file tells the `pkgadd` command whether to perform any of the checks or prompts that it normally does. Consequently, administrators should fully understand a package's installation process and the scripts involved before using administration files.

A basic administrative defaults file is shipped with the SunOS operating system in `/var/sadm/install/admin/default`. This is the file that establishes the most basic level of administrative policy as regards the installation of software products. The file looks like this as shipped:

```
#ident "@(#)default
1.4 92/12/23 SMI"    /* SVr4.0 1.5.2.1    */
mail=
instance=unique
partial=ask
runlevel=ask
idepend=ask
rdepend=ask
space=ask
setuid=ask
conflict=ask
action=ask
basedir=default
```

The administrator may edit this file to establish new default behaviors, or create a different administration file and specify its existence by using the `-a` option to the `pkgadd` command.

Eleven parameters can be defined in an administration file, but not all need to be defined. For more information, see `admin`(4).

The `basedir` parameter specifies how the base directory will be derived when a package is installed. Most administrators leave this as `default`, but `basedir` can be set to one of the following:

- `ask`, which means always ask the administrator for a base directory
- An absolute path name
- An absolute path name containing the `$PKGINST` construction, which means always install to a base directory derived from the package instance

Note – If the `pkgadd` command is called with the argument `-a none`, it always asks the administrator for a base directory. Unfortunately, this also sets *all* parameters in the file to the default value of `quit`, which can result in additional problems.

Becoming Comfortable With Uncertainty

An administrator has control over all packages being installed on a system by using an administration file. Unfortunately, an alternate administrative defaults file is often provided by the *package designer*, bypassing the wishes of the administrator.

Package designers sometimes include an alternate administration file so that they, not the administrator, control a package's installation. Because the `basedir` entry in the administrative defaults file overrides all other base directories, it provides a simple method for selecting the appropriate base directory at install time. In all versions of the Solaris operating environment prior to the Solaris 2.5 release, this was considered the simplest method for controlling the base directory.

However, it is necessary for you to accept the administrator's desires regarding the installation of the product. Providing a temporary administrative defaults file for the purpose of controlling the installation leads to mistrust on the part of administrators. You should use a `request` script and `checkinstall` script to control these installations under the supervision of the administrator. If the `request` script faithfully involves the administrator in the process, System V packaging will serve both administrators and package designers.

Using the `BASEDIR` Parameter

The `pkginfo` file for any relocatable package must include a default base directory in the form of an entry like this:

```
BASEDIR=absolute_path
```

This is only the default base directory; it can be changed by the administrator during installation.

While some packages require more than one base directory, the advantage to using this parameter to position the package is because the base directory is guaranteed to be in place and writable as a valid directory by the time installation begins. The correct path to the base directory for the server and client is available to all procedure scripts in the form of reserved environment variables, and the `pkginfo -r SUNWstuf` command displays the current installation base for the package.

In the `checkinstall` script, `BASEDIR` is the parameter exactly as defined in the `pkginfo` file (it has not been conditioned yet). In order to inspect the target base directory, the `${PKG_INSTALL_ROOT}$BASEDIR` construction is required. This means that the `request` or `checkinstall` script can change the value of `BASEDIR` in the installation environment with predictable results. By the time the `preinstall` script is called, the `BASEDIR` parameter is the fully conditioned pointer to the actual base directory on the target system, even if the system is a client.

Note – The `request` script utilizes the `BASEDIR` parameter differently for different releases of the SunOS operating system. In order to test a `BASEDIR` parameter in a `request` script, the following code should be used to determine the actual base directory in use.

```
# request script
constructs base directory
if [ ${CLIENT_BASEDIR} ]; then
      LOCAL_BASE=$BASEDIR
else
      LOCAL_BASE=${PKG_INSTALL_ROOT}$BASEDIR
fi
```

Using Parametric Base Directories

If a package requires multiple base directories, you can establish them with parametric path names. This method has become quite popular, although it has the following drawbacks.

- A package with parametric path names usually behaves like an absolute package but is treated by the `pkgadd` command like a relocatable package. The `BASEDIR` parameter must be defined even if it is not used.
- The administrator cannot ascertain the installation base for the package using the System V utilities (the `pkginfo -r` command will not work).
- The administrator cannot use the established method to relocate the package (it is called relocatable but it acts absolute).
- Multiple architecture or multiple version installations require contingency planning for each of the target base directories which often means multiple complex class action scripts.

While the parameters that determine the base directories are defined in the `pkginfo` file, they may be modified by the `request` script. That is one of the primary reasons for the popularity of this approach. The drawbacks, however are chronic and you should consider this configuration a last resort.

Examples—Using Parametric Base Directories

The `pkginfo` File

```
# pkginfo file
PKG=SUNWstuf
```

```
NAME=software stuff
ARCH=sparc
VERSION=1.0.0,REV=1.0.5
CATEGORY=application
DESC=a set of utilities that do stuff
BASEDIR=/
EZDIR=/usr/stuf/EZstuf
HRDDIR=/opt/SUNWstuf/HRDstuf
VENDOR=Sun Microsystems, Inc.
HOTLINE=Please contact your local service provider
EMAIL=
MAXINST=1000
CLASSES=none
PSTAMP=hubert980707141632
```

The `pkgmap` File

```
: 1 1758
1 d none $EZDIR 0775 root bin
1 f none $EZDIR/dirdel 0555 bin bin 40 773 751310229
1 f none $EZDIR/usrdel 0555 bin bin 40 773 751310229
1 f none $EZDIR/filedel 0555 bin bin 40 773 751310229
1 d none $HRDDIR 0775 root bin
1 f none $HRDDIR/mksmart 0555 bin bin 40 773 751310229
1 f none $HRDDIR/mktall 0555 bin bin 40 773 751310229
1 f none $HRDDIR/mkcute 0555 bin bin 40 773 751310229
1 f none $HRDDIR/mkeasy 0555 bin bin 40 773 751310229
1 d none /etc    ? ? ?
1 d none /etc/rc2.d ? ? ?
1 f none /etc/rc2.d/S70dostuf 0744 root sys 450 223443
1 i pkginfo 348 28411 760740163
1 i postinstall 323 26475 751309908
1 i postremove 402 33179 751309945
1 i preinstall 321 26254 751310019
1 i preremove 320 26114 751309865
```

Managing the Base Directory

Any package that is available in multiple versions or for multiple architectures should be designed to *walk* the base directory, if needed. Walking a base directory means that if a previous version or a different architecture of the package being installed already exists in the base directory, the package being installed resolves this issue, perhaps by creating a new base directory with a slightly different name. The `request` and `checkinstall` scripts in the Solaris 2.5 and compatible releases have the ability to modify the `BASEDIR` environment variable. This is not true for any prior version of the Solaris operating environment.

Even in older versions of the Solaris operating environment, the `request` script had the authority to redefine directories within the installation base. The `request` script can do this in a way that still supports most administrative preferences.

Accommodating Relocation

While you can select base directories for various packages that are guaranteed unique to an architecture and version, this leads to unnecessary levels of directory hierarchy. For example, for a product designed for SPARC and x86 based processors, you could organize the base directories by processor and version as shown below.

Base Directory	Version and Processor
`/opt/SUNWstuf/sparc/1.0`	Version 1.0, SPARC
`/opt/SUNWstuf/sparc/1.2`	Version 1.2, SPARC
`/opt/SUNWstuf/x86/1.0`	Version 1.0, x86

This is okay and it does work, but you are treating names and numbers as though they mean something to the administrator. A better approach is to do this automatically *after* explaining it to the administrator and obtaining permission.

This means that you can do the whole job in the package without requiring the administrator to do it manually. You can assign the base directory arbitrarily and then transparently establish the appropriate client links in a `postinstall` script. You can also use the `pkgadd` command to install all or part of the package to the clients in the `postinstall` script. You can even ask the administrator which users or clients need to know about this package and automatically update `PATH` environment variables and `/etc` files. This is completely acceptable as long as whatever the package does upon installation, it undoes upon removal.

Walking Base Directories

You can take advantage of two methods for controlling the base directory at install time. The first is best for new packages that will install only to Solaris 2.5 and compatible releases; it provides very useful data for the administrator and supports multiple installed versions and architectures and requires minimal special work. The second method can be used by any package and makes use of the `request` script's inherent control over build parameters to ensure successful installations.

Using the BASEDIR Parameter

The checkinstall script can select the appropriate base directory at install time, which means that the base directory can be placed very low in the directory tree. This example increments the base directory sequentially, leading to directories of the form /opt/SUNWstuf, /opt/SUNWstuf.1, and /opt/SUNWstuf.2. The administrator can use the pkginfo command to determine which architecture and version are installed in each base directory.

If the SUNWstuf package (containing a set of utilities that do stuff) uses this method, its pkginfo and pkgmap files would look like this.

The pkginfo File

```
# pkginfo file
PKG=SUNWstuf
NAME=software stuff
ARCH=sparc
VERSION=1.0.0,REV=1.0.5
CATEGORY=application
DESC=a set of utilities that do stuff
BASEDIR=/opt/SUNWstuf
VENDOR=Sun Microsystems, Inc.
HOTLINE=Please contact your local service provider
EMAIL=
MAXINST=1000
CLASSES=none daemon
PSTAMP=hubert990707141632
```

The pkgmap File

```
: 1 1758
1 d none EZstuf 0775 root bin
1 f none EZstuf/dirdel 0555 bin bin 40 773 751310229
1 f none EZstuf/usrdel 0555 bin bin 40 773 751310229
1 f none EZstuf/filedel 0555 bin bin 40 773 751310229
1 d none HRDstuf 0775 root bin
1 f none HRDstuf/mksmart 0555 bin bin 40 773 751310229
1 f none HRDstuf/mktall 0555 bin bin 40 773 751310229
1 f none HRDstuf/mkcute 0555 bin bin 40 773 751310229
1 f none HRDstuf/mkeasy 0555 bin bin 40 773 751310229
1 d none /etc    ? ? ?
1 d none /etc/rc2.d ? ? ?
1 f daemon /etc/rc2.d/S70dostuf 0744 root sys 450 223443
1 i pkginfo 348 28411 760740163
1 i postinstall 323 26475 751309908
1 i postremove 402 33179 751309945
1 i preinstall 321 26254 751310019
1 i preremove 320 26114 751309865
1 i i.daemon 509 39560 752978103
1 i r.daemon 320 24573 742152591
```

Example—Analysis Scripts That Walk a BASEDIR

Assume that the x86 version of SUNWstuf is already installed on the server in /opt/SUNWstuf. When the administrator uses the pkgadd command to install the SPARC version, the request script needs to detect the existence of the x86 version and interact with the administrator regarding the installation.

Note – The base directory could be walked without administrator interaction in a checkinstall script, but if arbitrary operations like this happen too often, administrators lose confidence in the process.

The request script and checkinstall script for a package that handle this situation might look like this.

The request Script

```
# request script
for SUNWstuf to walk the BASEDIR parameter.

PATH=/usr/sadm/bin:${PATH}    # use admin utilities

GENMSG="The base directory $LOCAL_BASE already contains a \
different architecture or version of $PKG."

OLDMSG="If the option \"-a none\" was used, press the  \
key and enter an unused base directory when it is requested."

OLDPROMPT="Do you want to overwrite this version? "

OLDHELP="\"y\" will replace the installed package, \"n\" will \
stop the installation."

SUSPEND="Suspending installation at user request using error \
code 1."

MSG="This package could be installed at the unused base directory $WRKNG_BASE."

PROMPT="Do you want to use to the proposed base directory? "

HELP="A response of \"y\" will install to the proposed directory and continue,
\"n\" will request a different directory. If the option \"-a none\" was used,
press the  key and enter an unused base directory when it is requested."

DIRPROMPT="Select a preferred base directory ($WRKNG_BASE) "

DIRHELP="The package $PKG will be installed at the location entered."

NUBD_MSG="The base directory has changed. Be sure to update \
any applicable search paths with the actual location of the \
binaries which are at $WRKNG_BASE/EZstuf and $WRKNG_BASE/HRDstuf."

OldSolaris=""
Changed=""
Suffix="0"

#
# Determine if this product is actually installed in the working
# base directory.
#
Product_is_present () {
      if [ -d $WRKNG_BASE/EZstuf -o -d $WRKNG_BASE/HRDstuf ]; then
            return 1
      else
            return 0
      fi
}

if [ ${BASEDIR} ]; then
      # This may be an old version of Solaris. In the latest Solaris
      # CLIENT_BASEDIR won't be defined yet. In older version it is.
      if [ ${CLIENT_BASEDIR} ]; then
            LOCAL_BASE=$BASEDIR
            OldSolaris="true"
      else    # The base directory hasn't been processed yet
            LOCAL_BASE=${PKG_INSTALL_ROOT}$BASEDIR
fi

WRKNG_BASE=$LOCAL_BASE

    # See if the base directory is already in place and walk it if
    # possible
while [ -d ${WRKNG_BASE} -a Product_is_present ]; do
         # There is a conflict
         # Is this an update of the same arch & version?
         if [ ${UPDATE} ]; then
               exit 0    # It's out of our hands.
         else
               # So this is a different architecture or
               # version than what is already there.
               # Walk the base directory
               Suffix=`expr $Suffix + 1`
               WRKNG_BASE=$LOCAL_BASE.$Suffix
               Changed="true"
         fi
done

    # So now we can propose a base directory that isn't claimed by
    # any of our other versions.
if [ $Changed ]; then
         puttext "$GENMSG"
         if [ $OldSolaris ]; then
               puttext "$OLDMSG"
               result=`ckyorn -Q -d "a" -h "$OLDHELP" -p "$OLDPROMPT"`
               if [ $result="n" ]; then
```

```
                    puttext "$SUSPEND"
                    exit 1    # suspend installation
              else
                    exit 0
              fi
        else    # The latest functionality is available
              puttext "$MSG"
              result=‘ckyorn -Q -d "a" -h "$HELP" -p "$PROMPT"‘
              if [ $? -eq 3]; then
                    echo quitinstall >> $1
                    exit 0
              fi

              if [ $result="n" ]; then
                    WRKNG_BASE=‘ckpath -ayw -d "$WRKNG_BASE" \
                    -h "$DIRHELP" -p "$DIRPROMPT"‘
              else if [ $result="a" ]
                    exit 0
              fi
           fi
           echo "BASEDIR=$WRKNG_BASE" >> $1
           puttext "$NUBD_MSG"
      fi
fi
exit 0
```

The `checkinstall` Script

```
# checkinstall
script for SUNWstuf to politely suspend

grep quitinstall $1
if [ $? -eq 0 ]; then
    exit 3        # politely suspend installation
fi

exit 0
```

This approach would not work very well if the base directory was simply `/opt`. This package has to call out the `BASEDIR` more precisely since `/opt` would be difficult to walk. In fact, depending on the mount scheme, it may not be possible. The example walks the base directory by creating a new directory under `/opt`, which does not introduce any problems.

This example uses a `request` script and a `checkinstall` script even though versions of Solaris prior to the 2.5 release cannot run a `checkinstall` script. The `checkinstall` script in this example is used for the purpose of politely halting the installation in response to a private message in the form of the string “quitinstall.” If this script executes under the Solaris 2.3 release, the `checkinstall` script is ignored and the `request` script halts the installation with an error message.

Remember that prior to the Solaris 2.5 and compatible releases, the `BASEDIR` parameter is a read-only parameter and cannot be changed by the `request` script. For this reason, if an old version of the SunOS operating system is detected (by testing for a conditioned `CLIENT_BASEDIR` environment variable), the `request` script has only two options—continue or quit.

Using Relative Parametric Paths

If your software product might be installed on older versions of the SunOS operating system, the `request` script needs to do all the necessary work. This approach can also be used to manipulate multiple directories. If additional directories are required, they still need to be included under a single base directory in order to provide an easily administrable product. While the `BASEDIR` parameter does not provide the level of granularity available in the latest Solaris release, your package can still walk the base directory by using the `request` script to manipulate parametric paths. This is how the `pkginfo` and `pkgmap` files might look.

The `pkginfo` File

```
# pkginfo file
PKG=SUNWstuf
NAME=software stuff
ARCH=sparc
VERSION=1.0.0,REV=1.0.5
CATEGORY=application
DESC=a set of utilities that do stuff
BASEDIR=/opt
SUBBASE=SUNWstuf
VENDOR=Sun Microsystems, Inc.
HOTLINE=Please contact your local service provider
EMAIL=
MAXINST=1000
CLASSES=none daemon
PSTAMP=hubert990707141632
```

The `pkgmap` File

```
: 1 1758
1 d none $SUBBASE/EZstuf 0775 root bin
1 f none $SUBBASE/EZstuf/dirdel 0555 bin bin 40 773 751310229
1 f none $SUBBASE/EZstuf/usrdel 0555 bin bin 40 773 751310229
1 f none $SUBBASE/EZstuf/filedel 0555 bin bin 40 773 751310229
1 d none $SUBBASE/HRDstuf 0775 root bin
1 f none $SUBBASE/HRDstuf/mksmart 0555 bin bin 40 773 751310229
1 f none $SUBBASE/HRDstuf/mktall 0555 bin bin 40 773 751310229
1 f none $SUBBASE/HRDstuf/mkcute 0555 bin bin 40 773 751310229
1 f none $SUBBASE/HRDstuf/mkeasy 0555 bin bin 40 773 751310229
1 d none /etc    ? ? ?
```

```
1 d none /etc/rc2.d ? ? ?
1 f daemon /etc/rc2.d/S70dostuf 0744 root sys 450 223443
1 i pkginfo 348 28411 760740163
1 i postinstall 323 26475 751309908
1 i postremove 402 33179 751309945
1 i preinstall 321 26254 751310019
1 i preremove 320 26114 751309865
1 i i.daemon 509 39560 752978103
1 i r.daemon 320 24573 742152591
```

This example is not perfect. A `pkginfo -r` command returns `/opt` for the installation base, which is pretty ambiguous. Many packages are in `/opt`, but at least it is a meaningful directory. Just like the previous example, this next example fully supports multiple architectures and versions. The `request` script can be tailored to the needs of the specific package and resolve whatever dependencies are applicable.

Example—A `request` Script That Walks a Relative Parametric Path

```
# request script
for SUNWstuf to walk a parametric path

PATH=/usr/sadm/bin:${PATH}    # use admin utilities

MSG="The target directory $LOCAL_BASE already contains \
different architecture or version of $PKG. This package \
could be installed at the unused target directory $WRKNG_BASE."

PROMPT="Do you want to use to the proposed directory? "

HELP="A response of \"y\" will install to the proposed directory \
and continue, \"n\" will request a different directory. If \
the option \"-a none\" was used, press the <RETURN> key and \
enter an unused base directory when it is requested."

DIRPROMPT="Select a relative target directory under $BASEDIR/"

DIRHELP="The package $PKG will be installed at the location entered."

SUSPEND="Suspending installation at user request using error \
code 1."

NUBD_MSG="The location of this package is not the default. Be \
sure to update any applicable search paths with the actual \
location of the binaries which are at $WRKNG_BASE/EZstuf \
and $WRKNG_BASE/HRDstuf."

Changed=""
Suffix="0"

#
# Determine if this product is actually installed in the working
# base directory.
#
Product_is_present () {
      if [ -d $WRKNG_BASE/EZstuf -o -d $WRKNG_BASE/HRDstuf ]; then
            return 1
      else
            return 0

      fi
}

if [ ${BASEDIR} ]; then
      # This may be an old version of Solaris. In the latest Solaris
      # CLIENT_BASEDIR won't be defined yet. In older versions it is.
      if [ ${CLIENT_BASEDIR} ]; then
            LOCAL_BASE=$BASEDIR/$SUBBASE
      else    # The base directory hasn't been processed yet
            LOCAL_BASE=${PKG_INSTALL_ROOT}$BASEDIR/$SUBBASE
      fi

WRKNG_BASE=$LOCAL_BASE

# See if the base directory is already in place and walk it if
# possible
while [ -d ${WRKNG_BASE} -a Product_is_present ]; do
         # There is a conflict
         # Is this an update of the same arch & version?
         if [ ${UPDATE} ]; then
               exit 0    # It's out of our hands.
         else
               # So this is a different architecture or
               # version than what is already there.
               # Walk the base directory
               Suffix=`expr $Suffix + 1`
               WRKNG_BASE=$LOCAL_BASE.$Suffix
               Changed="true"
         fi
done

# So now we can propose a base directory that isn't claimed by
# any of our other versions.
if [ $Changed ]; then
         puttext "$MSG"
         result=`ckyorn -Q -d "a" -h "$HELP" -p "$PROMPT"`
         if [ $? -eq 3 ]; then
               puttext "$SUSPEND"
               exit 1
         fi

         if [ $result="n" ]; then
               WRKNG_BASE=`ckpath -lyw -d "$WRKNG_BASE" -h "$DIRHELP" \
               -p "$DIRPROMPT"`

            elif [ $result="a" ]; then
                   exit 0
            else
                  exit 1
            fi
            echo SUBBASE=$SUBBASE.$Suffix >> $1
            puttext "$NUBD_MSG"
      fi
fi
exit 0
```

Supporting Relocation in a Heterogeneous Environment

The original concept behind System V packaging assumed one architecture per system. The concept of a server did not play a role in the design. Now, of course, a single server may provide support for several architectures, which means there may be several copies of the same software on a server, each for a different architecture. While Solaris packages are sequestered within recommended file system boundaries (for example, / and `/usr`), with product databases on the server as well as each client, not all installations necessarily support this division. Certain implementations support an entirely different structure and imply a common product database. While pointing the clients to different versions is straightforward, actually installing System V packages to different base directories can introduce complications for the administrator.

When you design your package, you should also consider the common methods administrators use for introducing new software versions. Administrators often seek to install and test the latest version side-by-side with the currently installed version. The procedure involves installing the new version to a different base directory than the current version and directing a handful of non-critical clients to the new version as a test. As confidence builds, the administrator redirects more and more clients to the new version. Eventually, the administrator retains the old version only for emergencies and then finally deletes it.

What this means is that packages destined for modern heterogeneous systems must support true relocation in the sense that the administrator may put them any reasonable place on the file system and still see full functionality. The Solaris 2.5 and compatible releases provide a number of useful tools which allow multiple architectures and versions to install cleanly to the same system. Solaris 2.4 and compatible versions also support true relocation but accomplishing the task is not quite as obvious.

Traditional Approach

Relocatable Packages

The System V ABI implies that the original intention behind the relocatable package was to make installing the package more convenient for the administrator. Now the need for relocatable packages goes much further. Convenience is not the only issue, rather it is quite possible that during the installation an active software product is already installed in the default directory. A package that is not designed to deal with this situation either overwrites the existing product or fails to install. However, a package designed handle multiple architectures and multiple versions can install smoothly and offer the administrator a wide range of options that are fully compatible with existing administrative traditions.

In some ways the problem of multiple architectures and the problem of multiple versions is the same. It must be possible to install a variant of the existing package side by side with other variants, and direct clients or standalone consumers of exported file systems to any one of those variants, without degraded functionality. While Sun has established methods for dealing with multiple architectures on a server, the administrator may not adhere to those recommendations. All packages need to be capable of complying with the administrators' reasonable wishes regarding installation.

Example-A Traditional Relocatable Package

This example shows what a traditional relocatable package may look like. The package is to be located in `/opt/SUNWstuf`, and its `pkginfo` file and `pkgmap` file might look like this.

The `pkginfo` File

```
# pkginfo file
PKG=SUNWstuf
NAME=software stuff
ARCH=sparc
VERSION=1.0.0,REV=1.0.5
CATEGORY=application
DESC=a set of utilities that do stuff
BASEDIR=/opt
VENDOR=Sun Microsystems, Inc.
HOTLINE=Please contact your local service provider
EMAIL=
MAXINST=1000
CLASSES=none
PSTAMP=hubert990707141632
```

The pkgmap File

```
: 1 1758
1 d none SUNWstuf 0775 root bin
1 d none SUNWstuf/EZstuf 0775 root bin
1 f none SUNWstuf/EZstuf/dirdel 0555 bin bin 40 773 751310229
1 f none SUNWstuf/EZstuf/usrdel 0555 bin bin 40 773 751310229
1 f none SUNWstuf/EZstuf/filedel 0555 bin bin 40 773 751310229
1 d none SUNWstuf/HRDstuf 0775 root bin
1 f none SUNWstuf/HRDstuf/mksmart 0555 bin bin 40 773 751310229
1 f none SUNWstuf/HRDstuf/mktall 0555 bin bin 40 773 751310229
1 f none SUNWstuf/HRDstuf/mkcute 0555 bin bin 40 773 751310229
1 f none SUNWstuf/HRDstuf/mkeasy 0555 bin bin 40 773 751310229
1 i pkginfo 348 28411 760740163
1 i postinstall 323 26475 751309908
1 i postremove 402 33179 751309945
1 i preinstall 321 26254 751310019
1 i preremove 320 26114 751309865
```

This is referred to as the traditional method because every package object is installed to the base directory defined by the `BASEDIR` parameter from the `pkginfo` file. For example, the first object in the `pkgmap` file is installed as the directory `/opt/SUNWstuf`.

Absolute Packages

An absolute package is one that installs to a particular root (/) file system. These packages are difficult to deal with from the standpoint of multiple versions and architectures. As a general rule, all packages should be relocatable. There are, however very good reasons to include absolute elements in a relocatable package.

Example-A Traditional Absolute Package

If the `SUNWstuf` package was an absolute package, the `BASEDIR` parameter should not be defined in the `pkginfo` file, and the `pkgmap` file would look like this.

The pkgmap File

```
: 1 1758
1 d none /opt ? ? ?
1 d none /opt/SUNWstuf 0775 root bin
1 d none /opt/SUNWstuf/EZstuf 0775 root bin
1 f none /opt/SUNWstuf/EZstuf/dirdel 0555 bin bin 40 773 751310229
1 f none /opt/SUNWstuf/EZstuf/usrdel 0555 bin bin 40 773 751310229
1 f none /opt/SUNWstuf/EZstuf/filedel 0555 bin bin 40 773 751310229
1 d none /opt/SUNWstuf/HRDstuf 0775 root bin
1 f none /opt/SUNWstuf/HRDstuf/mksmart 0555 bin bin 40 773 751310229
1 f none /opt/SUNWstuf/HRDstuf/mktall 0555 bin bin 40 773 751310229
```

```
1 f none /opt/SUNWstuf/HRDstuf/mkcute 0555 bin bin 40 773 751310229
1 f none /opt/SUNWstuf/HRDstuf/mkeasy 0555 bin bin 40 773 751310229
1 i pkginfo 348 28411 760740163
1 i postinstall 323 26475 751309908
1 i postremove 402 33179 751309945
1 i preinstall 321 26254 751310019
1 i preremove 320 26114 751309865
```

In this example, if the administrator specified an alternate base directory during installation, it would be ignored by the `pkgadd` command. This package always installs to `/opt/SUNWstuf` of the target system.

The `-R` argument to the `pkgadd` command works as expected. For example,

```
pkgadd -d . -R /export/opt/client3 SUNWstuf
```

installs the objects in `/export/opt/client3/opt/SUNWstuf`; but that is the closest this package comes to being relocatable.

Notice the use of the question mark (`?`) for the `/opt` directory in the `pkgmap` file. This indicates that the existing attributes should not be changed. It does not mean "create the directory with default attributes," although under certain circumstances that may happen. Any directory that is specific to the new package must specify all attributes explicitly.

Composite Packages

Any package containing relocatable objects is referred to as a relocatable package. This can be misleading because a relocatable package may contain absolute paths in its `pkgmap` file. Using a root (`/`) entry in a `pkgmap` file can enhance the relocatable aspects of the package. Packages that have both relocatable and root entries are called *composite* packages.

Example-A Traditional Solution

Assume that one object in the `SUNWstuf` package is a startup script executed at run level 2. The file `/etc/rc2.d/S70dostuf` needs to be installed as a part of the package, but it cannot be placed into the base directory. Assuming that a relocatable package is the only solution, the `pkginfo` and a `pkgmap` might look like this.

The `pkginfo` File

```
# pkginfo file
PKG=SUNWstuf
NAME=software stuff
ARCH=sparc
VERSION=1.0.0,REV=1.0.5
```

```
CATEGORY=application
DESC=a set of utilities that do stuff
BASEDIR=/
VENDOR=Sun Microsystems, Inc.
HOTLINE=Please contact your local service provider
EMAIL=
MAXINST=1000
CLASSES=none
PSTAMP=hubert990707141632
```

The `pkgmap` *File*

```
: 1 1758
1 d none opt/SUNWstuf/EZstuf 0775 root bin
1 f none opt/SUNWstuf/EZstuf/dirdel 0555 bin bin 40 773 751310229
1 f none opt/SUNWstuf/EZstuf/usrdel 0555 bin bin 40 773 751310229
1 f none opt/SUNWstuf/EZstuf/filedel 0555 bin bin 40 773 751310229
1 d none opt/SUNWstuf/HRDstuf 0775 root bin
1 f none opt/SUNWstuf/HRDstuf/mksmart 0555 bin bin 40 773 751310229
1 f none opt/SUNWstuf/HRDstuf/mktall 0555 bin bin 40 773 751310229
1 f none opt/SUNWstuf/HRDstuf/mkcute 0555 bin bin 40 773 751310229
1 f none opt/SUNWstuf/HRDstuf/mkeasy 0555 bin bin 40 773 751310229
1 d none etc    ? ? ?
1 d none etc/rc2.d ? ? ?
1 f none etc/rc2.d/S70dostuf 0744 root sys 450 223443
1 i pkginfo 348 28411 760740163
1 i postinstall 323 26475 751309908
1 i postremove 402 33179 751309945
1 i preinstall 321 26254 751310019
1 i preremove 320 26114 751309865
```

There is not much difference between this approach and that of the absolute package. In fact, this would be better off as an absolute package—if the administrator provided an alternate base directory for this package, it would not work!

In fact, only one file in this package needs to be root-relative, the rest could be moved anywhere. How to solve this problem through the use of a composite package is discussed throughout the remainder of this section.

Beyond Tradition

The approach described in this section does not apply to all packages, but it does result in improved performance during installation to an heterogeneous environment. Very little of this applies to packages that are delivered as part of the Solaris operating environment (bundled packages); however, unbundled packages can practice non-traditional packaging.

The reason behind encouraging relocatable packages is to support this requirement:

When a package is added or removed, the existing desirable behaviors of installed software products will be unchanged.

Unbundled packages should reside under /opt so as to assure that the new package does not interfere with existing products.

Another Look at Composite Packages

There are two rules to follow when constructing a functional composite package:

- Establish the base directory based upon where the vast majority of the package objects go.
- If a package object goes into a common directory that is not the base directory (for example, /etc), specify it as an absolute path name in the prototype file.

In other words, since "relocatable" means the object can be installed anywhere and still work, no startup script run by init at boot time can be considered relocatable! While there is nothing wrong with specifying /etc/passwd as a relative path in the delivered package, there is only one place it can go.

Making Absolute Path Names Look Relocatable

If you are going to construct a composite package, the absolute paths must operate in a manner which does not interfere with existing installed software. A package that can be entirely contained in /opt gets around this problem since there are no existing files in the way. When a file in /etc is included in the package, you must ensure that the absolute path names behave in the same way that is expected from relative path names. Consider the following two examples.

Example—Modifying a File

Description

An entry is being added to a table, or the object is a new table which is likely to be modified by other programs or packages.

Implementation

Define the object as file type e and belonging to the build, awk, or sed class. The script that performs this task must remove itself as effectively as it adds itself.

Example

An entry needs to be added to /etc/vfstab in support of the new solid state hard disk.

The entry in the pkgmap file might be

```
1 e sed /etc/vfstab ? ? ?
```

The `request` script asks the operator if `/etc/vfstab` should be modified by the package. If the operator answers “no” then the request script will print instructions on how to do the job manually and will execute

```
echo "CLASSES=none" >> $1
```

If the operator answers “yes” then it executes

```
echo "CLASSES=none sed" >> $1
```

which activates the class action script that will make the necessary modifications. The `sed` class means that the package file `/etc/vfstab` is a `sed` program which contains both the install and remove operations for the same-named file on the target system.

Example—Creating a New File

Description

The object is an entirely new file that is unlikely to be edited at a later time or, it is replacing a file owned by another package.

Implementation

Define the package object as file type `f` and install it using a class action script capable of undoing the change.

Example

A brand new file is required in `/etc` to provide the necessary information to support the solid state hard disk, named `/etc/shdisk.conf`. The entry in the `pkgmap` file might look like this:

```
.
.
.
1 f newetc /etc/shdisk.conf
.
.
.
```

The class action script `i.newetc` is responsible for installing this and any other files that need to go into `/etc`. It checks to make sure there is not another file there. If there is not, it will simply copy the new file into place. If there is already a file in place, it will back it up before installing the new file. The script `r.newetc` removes these files and restores the originals, if required. Here is the key fragment of the install script.

```
# i.newetc
while read src dst; do
      if [ -f $dst ]; then
        dstfile=`basename $dst`
        cp $dst $PKGSAV/$dstfile
      fi
      cp $src $dst
done

if [ "${1}" = "ENDOFCLASS" ]; then
      cd $PKGSAV
      tar cf SAVE.newetc .
      $INST_DATADIR/$PKG/install/squish SAVE.newetc
fi
```

Notice that this script uses the PKGSAV environment variable to store a backup of the file to be replaced. When the argument ENDOFCLASS is passed to the script, that is the pkgadd command informing the script that these are the last entries in this class, at which point the script archives and compresses the files that were saved using a private compression program stored in the install directory of the package.

While the use of the PKGSAV environment variable is not reliable during a package update; if the package is not updated (through a patch, for instance) the backup file is secure. The following remove script includes code to deal with the other issue—the fact that older versions of the pkgrm command do not pass the scripts the correct path to the PKGSAV environment variable.

The removal script might look like this.

```
# r.newetc

# make sure we have the correct PKGSAV
if [ -d $PKG_INSTALL_ROOT$PKGSAV ]; then
      PKGSAV="$PKG_INSTALL_ROOT$PKGSAV"
fi

# find the unsquish program
UNSQUISH_CMD=`dirname $0`/unsquish

while read file; do
      rm $file
done

if [ "${1}" = ENDOFCLASS ]; then
      if [ -f $PKGSAV/SAVE.newetc.sq ]; then
         $UNSQUISH_CMD $PKGSAV/SAVE.newetc
      fi

      if [ -f $PKGSAV/SAVE.newetc ]; then
         targetdir=dirname $file    # get the right directory
         cd $targetdir
            tar xf $PKGSAV/SAVE.newetc
            rm $PKGSAV/SAVE.newetc
      fi
```

```
fi
```

This script uses a private uninstalled algorithm (`unsquish`) which is in the install directory of the package database. This is done automatically by the `pkgadd` command at install time. All scripts not specifically recognized as install-only by the `pkgadd` command are left in this directory for use by the `pkgrm` command. You cannot count on where that directory is, but you can depend on the directory being flat and containing all appropriate information files and installation scripts for the package. This script finds the directory by virtue of the fact that the class action script is guaranteed to be executing from the directory that contains the `unsquish` program.

Notice, also, that this script does not just assume the target directory is `/etc`. It may actually be `/export/root/client2/etc`. The correct directory could be constructed in one of two ways.

- Use the `${PKG_INSTALL_ROOT}/etc` construction, or
- Take the directory name of a file passed by the `pkgadd` command (which is what this script does).

By using this approach for each absolute object in the package, you can be sure that the current desirable behavior is unchanged or at least recoverable.

Example—A Composite Package

This is an example of the `pkginfo` and `pkgmap` files for a composite package.

The `pkginfo` File

```
PKG=SUNWstuf
NAME=software stuff
ARCH=sparc
VERSION=1.0.0,REV=1.0.5
CATEGORY=application
DESC=a set of utilities that do stuff
BASEDIR=/opt
VENDOR=Sun Microsystems, Inc.
HOTLINE=Please contact your local service provider
EMAIL=
MAXINST=1000
CLASSES=none daemon
PSTAMP=hubert990707141632
```

The `pkgmap` File

```
: 1 1758
1 d none SUNWstuf/EZstuf 0775 root bin
1 f none SUNWstuf/EZstuf/dirdel 0555 bin bin 40 773 751310229
1 f none SUNWstuf/EZstuf/usrdel 0555 bin bin 40 773 751310229
```

```
1 f none SUNWstuf/EZstuf/filedel 0555 bin bin 40 773 751310229
1 d none SUNWstuf/HRDstuf 0775 root bin
1 f none SUNWstuf/HRDstuf/mksmart 0555 bin bin 40 773 751310229
1 f none SUNWstuf/HRDstuf/mktall 0555 bin bin 40 773 751310229
1 f none SUNWstuf/HRDstuf/mkcute 0555 bin bin 40 773 751310229
1 f none SUNWstuf/HRDstuf/mkeasy 0555 bin bin 40 773 751310229
1 d none /etc    ? ? ?
1 d none /etc/rc2.d ? ? ?
1 e daemon /etc/rc2.d/S70dostuf 0744 root sys 450 223443
1 i i.daemon 509 39560 752978103
1 i pkginfo 348 28411 760740163
1 i postinstall 323 26475 751309908
1 i postremove 402 33179 751309945
1 i preinstall 321 26254 751310019
1 i preremove 320 26114 751309865
1 i r.daemon 320 24573 742152591
```

While S70dostuf belongs to the daemon class, the directories that lead up to it (which are already in place at install time) belong to the none class. Even if the directories were unique to this package, you should leave them in the none class. The reason for this is that the directories need to be created first and deleted last, and this is always true for the none class. The pkgadd command creates directories; they are not copied from the package and they are not passed to a class action script to be created. Instead, they are created by the pkgadd command before it calls the install class action script, and the pkgrm command deletes directories after completion of the removal class action script.

This means that if a directory in a special class contains objects in the class none, when the pkgrm command attempts to remove the directory, it fails because the directory will not be empty in time. If an object of class none is to be inserted into a directory of some special class, that directory will not exist in time to accept the object. The pkgadd command will create the directory on-the-fly during installation of the object and may not be able to synchronize the attributes of that directory when it finally sees the pkgmap definition.

Note – When assigning a directory to a class, always remember the order of creation and deletion.

Making Packages Remotely Installable

All packages *must* be installable remotely. Installable remotely means you do not assume the administrator installing your package is installing to the root (/) file system of the system running the pkgadd command. If, in one of your procedure scripts, you need to get to the /etc/vfstab file of the target system, you need to use the PKG_INSTALL_ROOT environment variable. In other words, the path name /etc/vfstab will get you to the /etc/vfstab file of the system running the pkgadd command, but the administrator may be installing to a client at /export/root/client3. The path ${PKG_INSTALL_ROOT}/etc/vfstab is guaranteed to get you to the target file system.

Example – Installing to a Client System

In this example, the SUNWstuf package is installed to client3, which is configured with /opt in its root (/) file system. One other version of this package is already installed on client3, and the base directory is set to basedir=/opt/$PKGINST from an administration file, thisadmin. (For more information on administration files, see "The Administrative Defaults File" on page 128.) The pkgadd command executed on the server is:

```
# pkgadd -a thisadmin -R /export/root/client3 SUNWstuf
```

The table below lists the environment variables and their values that are passed to the procedure scripts.

TABLE 6–1 Values Passed to Procedure Scripts

Environment Variable	Value
PKGINST	SUNWstuf.2
PKG_INSTALL_ROOT	/export/root/client3
CLIENT_BASEDIR	/opt/SUNWstuf.2
BASEDIR	/export/root/client3/opt/SUNWstuf.2

Example – Installing to a Server or Standalone System

To install to the server or a standalone system under the same circumstances as the previous example, the command is:

```
# pkgadd -a thisadmin SUNWstuf
```

The table below lists the environment variables and their values that are passed to the procedure scripts.

TABLE 6–2 Values Passed to Procedure Scripts

Environment Variable	Value
PKGINST	SUNWstuf.2
PKG_INSTALL_ROOT	Not defined.
CLIENT_BASEDIR	/opt/SUNWstuf.2
BASEDIR	/opt/SUNWstuf.2

Example – Mounting Shared File Systems

Assume that the `SUNWstuf` package creates and shares a file system on the server at `/export/SUNWstuf/share`. When the package is installed to the client systems, their `/etc/vfstab` files need to be updated to mount this shared file system. This is a situation where you can use the `CLIENT_BASEDIR` variable.

The entry on the client needs to present the mount point with reference to the client's file system. This line should be constructed correctly whether the installation is from the server or from the client. Assume that the server's system name is `$SERVER`. You can go to `$PKG_INSTALL_ROOT/etc/vfstab` and, using the `sed` or `awk` commands, construct the following line for the client's `/etc/vfstab` file.

```
$SERVER:/export/SUNWstuf/share - $CLIENT_BASEDIR/usr nfs - yes ro
```

For example, for the server `universe` and the client system `client9`, the line in the client system's `/etc/vfstab` file would look like:

```
universe:/export/SUNWstuf/share - /opt/SUNWstuf.2/usr nfs - yes ro
```

Using these parameters correctly, the entry always mounts the client's file system, whether it is being constructed locally or from the server.

Patching Packages

A patch to a package is just a sparse package designed to overwrite certain files in the original. There is no real reason for shipping a sparse package except to save space on the delivery medium. You could also ship the entire original package with a few files changed, or provide access to the modified package over a network. As long as only those new files are actually different (the other files were not recompiled), the `pkgadd` command installs the differences. Review the following guidelines regarding patching packages.

- A patch must not change the intended delivered behavior of the package—it is *not* a mechanism for installing new features. A patch is used to repair objects installed on the system.
- If the system is complex enough, it is wise to establish a patch identification system which assures that no two patches replace the same file in an attempt to correct different aberrant behaviors. For instance, Sun patch base numbers are assigned mutually exclusive sets of files for which they are responsible.
- It is necessary to be able to back out a patch.

It is crucial that the version number of the patch package be the same as that of the original package. This is true because a patch *must not* add functionality. You should keep track of the patch status of the package using a separate `pkginfo` file entry of the form

`PATCH=`*patch_number*

If the package version is changed for a patch, you create another instance of the package and it becomes extremely difficult to manage the patched product. This method of progressive instance patching carried certain advantages in the early releases of the Solaris operating environment, but makes management of more complicated systems tedious.

As far as the packages that make up the Solaris operating environment are concerned, there should be only one copy of the package in the package database, although there may be multiple patched instances. In order to remove an object from an installed package (using the `removef` command) you need to figure out what instances own that file.

However, if your package (that is not part of the Solaris operating environment) needs to determine the patch level of a particular package that *is* part of the Solaris operating environment, this becomes a problem to be resolved here. The installation scripts can be quite large without significant impact since they are not stored on the target file system. Using class action scripts and various other procedure scripts, you can save changed files using the `PKGSAV` environment variable (or to some other, more permanent directory) in order to allow backing out installed patches. You can also monitor patch history by setting appropriate environment variables through the `request` scripts. The scripts in the next sections assume that there may be multiple patches whose numbering scheme carries some meaning when applied to a single package. In this case, individual patch numbers represent a subset of functionally related files within the package. Two different patch numbers cannot change the same file.

In order to make a regular sparse package into a patch package, the scripts described in the following sections can simply be folded into the package. All of them are recognizable as standard package components with the exception of the last two which are named `patch_checkinstall` and `patch_postinstall`. Those two scripts can be incorporated into the backout package, if you want to include the ability to back out the patch. The scripts are fairly simple and their various tasks are straightforward.

Note – This method of patching can be used to patch client systems, but client root directories on the server must have the correct permissions to allow reading by the user `install` or `nobody`.

The `checkinstall` Script

The `checkinstall` script verifies that the patch is appropriate for this particular package. Once that is confirmed, it constructs the *patch list* and the *patch info* list, and then inserts them into the response file for incorporation into the package database.

A patch list is the list of patches that have affected the current package. This list of patches is recorded in the installed package in the `pkginfo` file with a line that might look like this:

`PATCHLIST=`*patch_id patch_id* `...`

A patch info list is the list of patches on which the current patch is dependent. This list of patches is also recorded in the `pkginfo` file with a line that might look like this.

```
PATCH_INFO_103203-01=Installed... Obsoletes:103201-01 Requires: \ Incompatibles: 120134-01
```

Note – These lines (and their format) are declared as a public interface. Any company that ships patches for Solaris packages should update this list appropriately. When a patch is delivered, each package within the patch contains a `checkinstall` script that performs this task. That same `checkinstall` script also updates some other patch-specific parameters. This is the new patch architecture, which is called Direct Instance Patching.

In this example, both the original packages and their patches exist in the same directory. The two original packages are named `SUNWstuf.v1` and `SUNWstuf.v2`, and their patches are named `SUNWstuf.p1` and `SUNWstuf.p2`. What this means is that it could be very difficult for a procedure script to figure out what directory these files came from, since everything in the package name after the dot (".") is stripped for the `PKG` parameter, and the `PKGINST` environment variable refers to the installed instance not the source instance. So the procedure scripts can find the source directory, the `checkinstall` script (which is always executed from the source directory) makes the inquiry and passes the location on as the variable `SCRIPTS_DIR`. If there had been only one package in the source directory called `SUNWstuf`, then the procedure scripts could have found it using `$INSTDIR/$PKG`.

```
# checkinstall script to control a patch installation.
# directory format options.
#
#       @(#)checkinstall 1.6 96/09/27 SMI
```

```
#
# Copyright (c) 1995 by Sun Microsystems, Inc.
# All rights reserved
#

PATH=/usr/sadm/bin:$PATH

INFO_DIR=`dirname $0`
INFO_DIR=`dirname $INFO_DIR`    # one level up

NOVERS_MSG="PaTcH_MsG 8 Version $VERSION of $PKG is not installed on this system."
ALRDY_MSG="PaTcH_MsG 2 Patch number $Patch_label is already applied."
TEMP_MSG="PaTcH_MsG 23 Patch number $Patch_label cannot be applied until all \
restricted patches are backed out."

# Read the provided environment from what may have been a request script
. $1

# Old systems can't deal with checkinstall scripts anyway
if [ "$PATCH_PROGRESSIVE" = "true" ]; then
        exit 0
fi

#
# Confirm that the intended version is installed on the system.
#
if [ "${UPDATE}" != "yes" ]; then
        echo "$NOVERS_MSG"
        exit 3
fi

#
# Confirm that this patch hasn't already been applied and
# that no other mix-ups have occurred involving patch versions and
# the like.
#
Skip=0
active_base=`echo $Patch_label | nawk '
        { print substr($0, 1, match($0, "Patchvers_pfx")-1) } '`
active_inst=`echo $Patch_label | nawk '
        { print substr($0, match($0, "Patchvers_pfx")+Patchvers_pfx_lnth) } '`

# Is this a restricted patch?
if echo $active_base | egrep -s "Patchstrict_str"; then
        is_restricted="true"
        # All restricted patches are backoutable
        echo "PATCH_NO_UNDO=" >> $1
else
        is_restricted="false"
fi

for patchappl in ${PATCHLIST}; do
        # Is this an ordinary patch applying over a restricted patch?
        if [ $is_restricted = "false" ]; then
                if echo $patchappl | egrep -s "Patchstrict_str"; then
```

```
                        echo "$TEMP_MSG"
                        exit 3;
                fi
        fi

        # Is there a newer version of this patch?
        appl_base=‘echo $patchappl | nawk ’
                { print substr($0, 1, match($0, "Patchvers_pfx")-1) } ’‘
        if [ $appl_base = $active_base ]; then
                appl_inst=‘echo $patchappl | nawk ’
                        { print substr($0, match($0, "Patchvers_pfx")\
+Patchvers_pfx_lnth) } ’‘
                result=‘expr $appl_inst \> $active_inst‘
                if [ $result -eq 1 ]; then
                        echo "PaTcH_MsG 1 Patch number $Patch_label is \
superceded by the already applied $patchappl."
                        exit 3
                elif [ $appl_inst = $active_inst ]; then
                        # Not newer, it’s the same
                        if [ "$PATCH_UNCONDITIONAL" = "true" ]; then
                                if [ -d $PKGSAV/$Patch_label ]; then
                                        echo "PATCH_NO_UNDO=true" >> $1
                                fi
                        else
                                echo "$ALRDY_MSG"
                                exit 3;
                        fi
                fi
        fi
done

# Construct a list of applied patches in order
echo "PATCHLIST=${PATCHLIST} $Patch_label" >> $1

#
# Construct the complete list of patches this one obsoletes
#
ACTIVE_OBSOLETES=$Obsoletes_label

if [ -n "$Obsoletes_label" ]; then
        # Merge the two lists
        echo $Obsoletes_label | sed ’y/\ /\n/’ | \
        nawk -v PatchObsList="$PATCH_OBSOLETES" ’
        BEGIN {
                printf("PATCH_OBSOLETES=");
                PatchCount=split(PatchObsList, PatchObsComp, " ");

                for(PatchIndex in PatchObsComp) {
                        Atisat=match(PatchObsComp[PatchIndex], "@");
                        PatchObs[PatchIndex]=substr(PatchObsComp[PatchIndex], \
0, Atisat-1);
                        PatchObsCnt[PatchIndex]=substr(PatchObsComp\
[PatchIndex], Atisat+1);
                }
        }
        {
                Inserted=0;
                for(PatchIndex in PatchObs) {
                        if (PatchObs[PatchIndex] == $0) {
                                if (Inserted == 0) {
                                        PatchObsCnt[PatchIndex]=PatchObsCnt\
[PatchIndex]+1;
                                        Inserted=1;
                                } else {
                                        PatchObsCnt[PatchIndex]=0;
                                }
                        }
                }
                if (Inserted == 0) {
                        printf ("%s@1 ", $0);
                }
                next;
        }
        END {
                for(PatchIndex in PatchObs) {
                        if ( PatchObsCnt[PatchIndex] != 0) {
                                printf("%s@%d ", PatchObs[PatchIndex], \
PatchObsCnt[PatchIndex]);
                        }
                }
                printf("\n");
        } ' >> $1
        # Clear the parameter since it has already been used.
        echo "Obsoletes_label=" >> $1

        # Pass it's value on to the preinstall under another name
        echo "ACTIVE_OBSOLETES=$ACTIVE_OBSOLETES" >> $1
fi

#
# Construct PATCH_INFO line for this package.
#

tmpRequire=`nawk -F= ' $1 ~ /REQUIR/ { print $2 } ' $INFO_DIR/pkginfo `
tmpIncompat=`nawk -F= ' $1 ~ /INCOMPAT/ { print $2 } ' $INFO_DIR/pkginfo `

if [ -n "$tmpRequire" ] && [ -n "$tmpIncompat" ]
then
        echo "PATCH_INFO_$Patch_label=Installed: `date` From: `uname -n` \
          Obsoletes: $ACTIVE_OBSOLETES Requires: $tmpRequire \
          Incompatibles: $tmpIncompat" >> $1
elif [ -n "$tmpRequire" ]
then
        echo "PATCH_INFO_$Patch_label=Installed: `date` From: `uname -n` \
          Obsoletes: $ACTIVE_OBSOLETES Requires: $tmpRequire \
Incompatibles: " >> $1
elif [ -n "$tmpIncompat" ]
then
        echo "PATCH_INFO_$Patch_label=Installed: `date` From: `uname -n` \
          Obsoletes: $ACTIVE_OBSOLETES Requires: Incompatibles: \
$tmpIncompat" >> $1
else
        echo "PATCH_INFO_$Patch_label=Installed: `date` From: `uname -n` \
          Obsoletes: $ACTIVE_OBSOLETES Requires: Incompatibles: " >> $1
fi

#
# Since this script is called from the delivery medium and we may be using
# dot extensions to distinguish the different patch packages, this is the
# only place we can, with certainty, trace that source for our backout
# scripts. (Usually $INST_DATADIR would get us there).
#
echo "SCRIPTS_DIR=`dirname $0`" >> $1

# If additional operations are required for this package, place
# those package-specific commands here.

#XXXSpecial_CommandsXXX#

exit 0
```

The `preinstall` Script

The `preinstall` script initializes the `prototype` file, information files, and installation scripts for the backout package to be constructed. This script is very simple and the remaining scripts in this example only allow a backout package to describe regular files.

If you wanted to restore symbolic links, hard links, devices, and named pipes in a backout package, you could modify the `preinstall` script to use the `pkgproto` command to compare the delivered `pkgmap` file with the installed files, and then create a `prototype` file entry for each non-file to be changed in the backout package. The method you should use is similar to the method in the class action script.

The scripts `patch_checkinstall` and `patch_postinstall` are inserted into the package source tree from the `preinstall` script. These two scripts undo what the patch does.

```
# This script initializes the backout data for a patch package
# directory format options.
#
#       @(#)preinstall 1.5 96/05/10 SMI
#
# Copyright (c) 1995 by Sun Microsystems, Inc.
# All rights reserved
#

PATH=/usr/sadm/bin:$PATH
recovery="no"

if [ "$PKG_INSTALL_ROOT" = "/" ]; then
```

```
        PKG_INSTALL_ROOT=""
fi

# Check to see if this is a patch installation retry.
if [ "$INTERRUPTION" = "yes" ]; then
    if [ -d "$PKG_INSTALL_ROOT/var/tmp/$Patch_label.$PKGINST" ] || [ -d \
"$PATCH_BUILD_DIR/$Patch_label.$PKGINST" ]; then
        recovery="yes"
    fi
fi

if [ -n "$PATCH_BUILD_DIR" -a -d "$PATCH_BUILD_DIR" ]; then
        BUILD_DIR="$PATCH_BUILD_DIR/$Patch_label.$PKGINST"
else
        BUILD_DIR="$PKG_INSTALL_ROOT/var/tmp/$Patch_label.$PKGINST"
fi

FILE_DIR=$BUILD_DIR/files
RELOC_DIR=$BUILD_DIR/files/reloc
ROOT_DIR=$BUILD_DIR/files/root
PROTO_FILE=$BUILD_DIR/prototype
PKGINFO_FILE=$BUILD_DIR/pkginfo
THIS_DIR=`dirname $0`

if [ "$PATCH_PROGRESSIVE" = "true" ]; then
        # If this is being used in an old-style patch, insert
        # the old-style script commands here.

        #XXXOld_CommandsXXX#

        exit 0
fi

#
# Unless specifically denied, initialize the backout patch data by
# creating the build directory and copying over the original pkginfo
# which pkgadd saved in case it had to be restored.
#
if [ "$PATCH_NO_UNDO" != "true" ] && [ "$recovery" = "no" ]; then
        if [ -d $BUILD_DIR ]; then
                rm -r $BUILD_DIR
        fi

        # If this is a retry of the same patch then recovery is set to
        # yes. Which means there is a build directory already in
        # place with the correct backout data.

        if [ "$recovery" = "no" ]; then
                mkdir $BUILD_DIR
                mkdir -p $RELOC_DIR
                mkdir $ROOT_DIR
        fi

        #
        # Here we initialize the backout pkginfo file by first
        # copying over the old pkginfo file and themn adding the
        # ACTIVE_PATCH parameter so the backout will know what patch
        # it's backing out.
        #
        # NOTE : Within the installation, pkgparam returns the
        # original data.
        #
        pkgparam -v $PKGINST | nawk '
                $1 ~ /PATCHLIST/        { next; }
                $1 ~ /PATCH_OBSOLETES/  { next; }
                $1 ~ /ACTIVE_OBSOLETES/ { next; }
                $1 ~ /Obsoletes_label/  { next; }
                $1 ~ /ACTIVE_PATCH/     { next; }
                $1 ~ /Patch_label/      { next; }
                $1 ~ /UPDATE/   { next; }
                $1 ~ /SCRIPTS_DIR/      { next; }
                $1 ~ /PATCH_NO_UNDO/    { next; }
                $1 ~ /INSTDATE/ { next; }
                $1 ~ /PKGINST/  { next; }
                $1 ~ /OAMBASE/  { next; }
                $1 ~ /PATH/     { next; }
                { print; } ' > $PKGINFO_FILE
        echo "ACTIVE_PATCH=$Patch_label" >> $PKGINFO_FILE
        echo "ACTIVE_OBSOLETES=$ACTIVE_OBSOLETES" >> $PKGINFO_FILE

        # And now initialize the backout prototype file with the
        # pkginfo file just formulated.
        echo "i pkginfo" > $PROTO_FILE

        # Copy over the backout scripts including the undo class
        # action scripts
        for script in $SCRIPTS_DIR/*; do
                srcscript=`basename $script`
                targscript=`echo $srcscript | nawk '
                        { script=$0; }
                        /u\./ {
                                sub("u.", "i.", script);
                                print script;
                                next;
                        }
                        /patch_/ {
                                sub("patch_", "", script);
                                print script;
                                next;
                        }
                        { print "dont_use" } '`
                if [ "$targscript" = "dont_use" ]; then
                        continue
                fi

                echo "i $targscript=$FILE_DIR/$targscript" >> $PROTO_FILE
                cp $SCRIPTS_DIR/$srcscript $FILE_DIR/$targscript
        done
         #
        # Now add entries to the prototype file that won't be passed to
```

```
        # class action scripts. If the entry is brand new, add it to the
        # deletes file for the backout package.
        #
        Our_Pkgmap=`dirname $SCRIPTS_DIR`/pkgmap
        BO_Deletes=$FILE_DIR/deletes

        nawk -v basedir=${BASEDIR:-/} '
                BEGIN { count=0; }
                {
                        token = $2;
                        ftype = $1;
                }
                $1 ~ /[#\!:]/ { next; }
                $1 ~ /[0123456789]/ {
                        if ( NF >= 3) {
                                token = $3;
                                ftype = $2;
                        } else {
                                next;
                        }
                }
                { if (ftype == "i" || ftype == "e" || ftype == "f" || ftype == \
"v" || ftype == "d") { next; } }
                {
                        equals=match($4, "=")-1;
                        if ( equals == -1 ) { print $3, $4; }
                        else { print $3, substr($4, 0, equals); }
                }
                ' < $Our_Pkgmap | while read class path; do
                        #
                        # NOTE: If pkgproto is passed a file that is
                        # actually a hard link to another file, it
                        # will return ftype "f" because the first link
                        # in the list (consisting of only one file) is
                        # viewed by pkgproto as the source and always
                        # gets ftype "f".
                        #
                        # If this isn't replacing something, then it
                        # just goes to the deletes list.
                        #
                        if valpath -l $path; then
                                Chk_Path="$BASEDIR/$path"
                                Build_Path="$RELOC_DIR/$path"
                                Proto_From="$BASEDIR"
                        else    # It's an absolute path
                                Chk_Path="$PKG_INSTALL_ROOT$path"
                                Build_Path="$ROOT_DIR$path"
                                Proto_From="$PKG_INSTALL_ROOT"
                        fi
                         #
                        # Hard links have to be restored as regular files.
                        # Unlike the others in this group, an actual
                        # object will be required for the pkgmk.
                        #
                        if [ -f "$Chk_Path" ]; then
```

```
                                mkdir -p `dirname $Build_Path`
                                cp $Chk_Path $Build_Path
                                cd $Proto_From
                                pkgproto -c $class "$Build_Path=$path" 1>> \
$PROTO_FILE 2> /dev/null
                                cd $THIS_DIR
                        elif [ -h "$Chk_Path" -o \
                             -c "$Chk_Path" -o \
                             -b "$Chk_Path" -o \
                             -p "$Chk_Path" ]; then
                                pkgproto -c $class "$Chk_Path=$path" 1>> \
$PROTO_FILE 2> /dev/null
                        else
                                echo $path >> $BO_Deletes
                        fi
                done
fi

# If additional operations are required for this package, place
# those package-specific commands here.

#XXXSpecial_CommandsXXX#

exit 0
```

The Class Action Script

The class action script creates a copy of each file that replaces an existing file and adds a corresponding line to the `prototype` file for the backout package. This is all done with fairly simple `nawk` scripts. The class action script receives a list of source/destination pairs consisting of ordinary files that do not match the corresponding installed files. Symbolic links and other non-files must be dealt with in the `preinstall` script.

```
# This class action script copies the files being replaced
# into a package being constructed in $BUILD_DIR. This class
# action script is only appropriate for regular files that
# are installed by simply copying them into place.
#
# For special package objects such as editable files, the patch
# producer must supply appropriate class action scripts.
#
# directory format options.
#
#       @(#)i.script 1.6 96/05/10 SMI
#
# Copyright (c) 1995 by Sun Microsystems, Inc.
# All rights reserved
#

PATH=/usr/sadm/bin:$PATH
```

```
ECHO="/usr/bin/echo"
SED="/usr/bin/sed"
PKGPROTO="/usr/bin/pkgproto"
EXPR="/usr/bin/expr"    # used by dirname
MKDIR="/usr/bin/mkdir"
CP="/usr/bin/cp"
RM="/usr/bin/rm"
MV="/usr/bin/mv"

recovery="no"
Pn=$$
procIdCtr=0

CMDS_USED="$ECHO $SED $PKGPROTO $EXPR $MKDIR $CP $RM $MV"
LIBS_USED=""

if [ "$PKG_INSTALL_ROOT" = "/" ]; then
        PKG_INSTALL_ROOT=""
fi

# Check to see if this is a patch installation retry.
if [ "$INTERRUPTION" = "yes" ]; then
        if [ -d "$PKG_INSTALL_ROOT/var/tmp/$Patch_label.$PKGINST" ] ||
\
[ -d "$PATCH_BUILD_DIR/$Patch_label.$PKGINST" ]; then
                recovery="yes"
        fi
fi

if [ -n "$PATCH_BUILD_DIR" -a -d "$PATCH_BUILD_DIR" ]; then
        BUILD_DIR="$PATCH_BUILD_DIR/$Patch_label.$PKGINST"
else
        BUILD_DIR="$PKG_INSTALL_ROOT/var/tmp/$Patch_label.$PKGINST"
fi

FILE_DIR=$BUILD_DIR/files
RELOC_DIR=$FILE_DIR/reloc
ROOT_DIR=$FILE_DIR/root
BO_Deletes=$FILE_DIR/deletes
PROGNAME=`basename $0`

if [ "$PATCH_PROGRESSIVE" = "true" ]; then
        PATCH_NO_UNDO="true"
fi

# Since this is generic, figure out the class.
Class=`echo $PROGNAME | nawk ' { print substr($0, 3)  }'`

# Since this is an update, $BASEDIR is guaranteed to be correct
BD=${BASEDIR:-/}

cd $BD

#
# First, figure out the dynamic libraries that can trip us up.
```

```
#
if [ -z "$PKG_INSTALL_ROOT" ]; then
        if [ -x /usr/bin/ldd ]; then
                LIB_LIST=`/usr/bin/ldd $CMDS_USED | sort -u | nawk '
                        $1 ~ /\// { continue; }
                        { printf "%s ", $3 } '`
        else
                LIB_LIST="/usr/lib/libc.so.1 /usr/lib/libdl.so.1
\
/usr/lib/libw.so.1 /usr/lib/libintl.so.1 /usr/lib/libadm.so.1 \
/usr/lib/libelf.so.1"
        fi
fi

#
# Now read the list of files in this class to be replaced. If the file
# is already in place, then this is a change and we need to copy it
# over to the build directory if undo is allowed. If it's a new entry
# (No $dst), then it goes in the deletes file for the backout package.
#
procIdCtr=0
while read src dst; do
        if [ -z "$PKG_INSTALL_ROOT" ]; then
                Chk_Path=$dst
                for library in $LIB_LIST; do
                        if [ $Chk_Path = $library ]; then
                                $CP $dst $dst.$Pn
                                LIBS_USED="$LIBS_USED $dst.$Pn"
                                LD_PRELOAD="$LIBS_USED"
                                export LD_PRELOAD
                        fi
                done
        fi

        if [ "$PATCH_PROGRESSIVE" = "true" ]; then
                # If this is being used in an old-style patch, insert
                # the old-style script commands here.

                #XXXOld_CommandsXXX#
                echo >/dev/null # dummy
        fi

        if [ "${PATCH_NO_UNDO}" != "true" ]; then
                #
                # Here we construct the path to the appropriate source
                # tree for the build. First we try to strip BASEDIR. If
                # there's no BASEDIR in the path, we presume that it is
                # absolute and construct the target as an absolute path
                # by stripping PKG_INSTALL_ROOT. FS_Path is the path to
                # the file on the file system (for deletion purposes).
                # Build_Path is the path to the object in the build
                # environment.
                #
                if [ "$BD" = "/" ]; then
                        FS_Path=`$ECHO $dst | $SED s@"$BD"@@`
                else
                        FS_Path=`$ECHO $dst | $SED s@"$BD/"@@`
                fi

                # If it's an absolute path the attempt to strip the
                # BASEDIR will have failed.
                if [ $dst = $FS_Path ]; then
                        if [ -z "$PKG_INSTALL_ROOT" ]; then
                                FS_Path=$dst
                                Build_Path="$ROOT_DIR$dst"
                        else
                                Build_Path="$ROOT_DIR`echo $dst | \
                                    sed s@"$PKG_INSTALL_ROOT"@@`"
                                FS_Path=`echo $dst | \
                                    sed s@"$PKG_INSTALL_ROOT"@@`
                        fi
                else
                        Build_Path="$RELOC_DIR/$FS_Path"
                fi

                if [ -f $dst ]; then    # If this is replacing something
                        cd $FILE_DIR
                        #
                        # Construct the prototype file entry. We replace
                        # the pointer to the filesystem object with the
                        # build directory object.
                        #
                        $PKGPROTO -c $Class $dst=$FS_Path | \
                            $SED -e s@=$dst@=$Build_Path@ >> \
                            $BUILD_DIR/prototype

                        # Now copy over the file
                        if [ "$recovery" = "no" ]; then
                                DirName=`dirname $Build_Path`
                                $MKDIR -p $DirName
                                $CP -p $dst $Build_Path
                        else
                                # If this file is already in the build area skip it
                                if [ -f "$Build_Path" ]; then
                                        cd $BD
                                        continue
                                else
                                        DirName=`dirname $Build_Path`
                                        if [ ! -d "$DirName" ]; then
                                                $MKDIR -p $DirName
                                        fi
                                        $CP -p $dst $Build_Path
                                fi
                        fi

                        cd $BD
                else    # It's brand new
                        $ECHO $FS_Path >> $BO_Deletes
                fi
        fi
```

```
        # If special processing is required for each src/dst pair,
        # add that here.
        #
        #XXXSpecial_CommandsXXX#
        #

        $CP $src $dst.$$$procIdCtr
        if [ $? -ne 0 ]; then
                $RM $dst.$$$procIdCtr 1>/dev/null 2>&1
        else
                $MV -f $dst.$$$procIdCtr $dst
                for library in $LIB_LIST; do
                        if [ "$library" = "$dst" ]; then
                                LD_PRELOAD="$dst"
                                export LD_PRELOAD
                        fi
                done
        fi
        procIdCtr=`expr $procIdCtr + 1`
done

# If additional operations are required for this package, place
# those package-specific commands here.

#XXXSpecial_CommandsXXX#

#
# Release the dynamic libraries
#
for library in $LIBS_USED; do
        $RM -f $library
done

exit 0
```

The `postinstall` Script

The `postinstall` script creates the backout package using the information provided by the other scripts. Since the `pkgmk` and `pkgtrans` commands do not require the package database, they can be executed within a package installation.

In the example, undoing the patch is permitted by constructing a stream format package in the save directory (using the `PKGSAV` environment variable). It is not obvious, but this package must be in stream format, because the save directory gets moved around during a `pkgadd` operation. If the `pkgadd` command is applied to a package in its own save directory, assumptions about where the package source is at any given time become very unreliable. A stream format package is unpacked into a temporary directory and installed from there. (A directory format package would begin installing from the save directory and find itself suddenly relocated during a `pkgadd` fail-safe operation.)

To determine which patches are applied to a package, use this command:

```
$ pkgparam SUNWstuf PATCHLIST
```

With the exception of `PATCHLIST`, which is a Sun public interface, there is nothing significant in the parameter names in this example. Instead of `PATCH` you could use the traditional `SUNW_PATCHID` and the various other lists such as `PATCH_EXCL` and `PATCH_REQD` could be renamed accordingly.

If certain patch packages depend upon other patch packages which are available from the same medium, the `checkinstall` script could determine this and create a script to be executed by the `postinstall` script in the same way that the upgrade example (see "Upgrading Packages" on page 173) does.

```
# This script creates the backout package for a patch package
#
# directory format options.
#
# @(#) postinstall 1.6 96/01/29 SMI
#
# Copyright (c) 1995 by Sun Microsystems, Inc.
# All rights reserved
#

# Description:
#       Set the TYPE parameter for the remote file
#
# Parameters:
#       none
#
# Globals set:
#       TYPE

set_TYPE_parameter () {
        if [ ${PATCH_UNDO_ARCHIVE:?????} = "/dev" ]; then
                # handle device specific stuff
                TYPE="removable"
        else
                TYPE="filesystem"
        fi
}

#
# Description:
#       Build the remote file that points to the backout data
#
# Parameters:
#       $1:     the un/compressed undo archive
#
# Globals set:
#       UNDO, STATE

build_remote_file () {
        remote_path=$PKGSAV/$Patch_label/remote
        set_TYPE_parameter
        STATE="active"

        if [ $1 = "undo" ]; then
                UNDO="undo"
        else
                UNDO="undo.Z"
        fi

        cat > $remote_path << EOF
# Backout data stored remotely
TYPE=$TYPE
FIND_AT=$ARCHIVE_DIR/$UNDO
STATE=$STATE
EOF
}

PATH=/usr/sadm/bin:$PATH

if [ "$PKG_INSTALL_ROOT" = "/" ]; then
        PKG_INSTALL_ROOT=""
fi

if [ -n "$PATCH_BUILD_DIR" -a -d "$PATCH_BUILD_DIR" ]; then
        BUILD_DIR="$PATCH_BUILD_DIR/$Patch_label.$PKGINST"
else
        BUILD_DIR="$PKG_INSTALL_ROOT/var/tmp/$Patch_label.$PKGINST"
fi

if [ ! -n "$PATCH_UNDO_ARCHIVE" ]; then
        PATCH_UNDO_ARCHIVE="none"
fi

FILE_DIR=$BUILD_DIR/files
RELOC_DIR=$FILE_DIR/reloc
ROOT_DIR=$FILE_DIR/root
BO_Deletes=$FILE_DIR/deletes
THIS_DIR=`dirname $0`
PROTO_FILE=$BUILD_DIR/prototype
TEMP_REMOTE=$PKGSAV/$Patch_label/temp

if [ "$PATCH_PROGRESSIVE" = "true" ]; then
        # remove the scripts that are left behind
        install_scripts=`dirname $0`
        rm $install_scripts/checkinstall \
$install_scripts/patch_checkinstall $install_scripts/patch_postinstall

        # If this is being used in an old-style patch, insert
        # the old-style script commands here.

        #XXXOld_CommandsXXX#

        exit 0
fi
#
```

```
# At this point we either have a deletes file or we don't. If we do,
# we create a prototype entry.
#
if [ -f $BO_Deletes ]; then
        echo "i deletes=$BO_Deletes" >> $BUILD_DIR/prototype
fi

#
# Now delete everything in the deletes list after transferring
# the file to the backout package and the entry to the prototype
# file. Remember that the pkgmap will get the CLIENT_BASEDIR path
# but we have to actually get at it using the BASEDIR path. Also
# remember that removef will import our PKG_INSTALL_ROOT
#
Our_Deletes=$THIS_DIR/deletes
if [ -f $Our_Deletes ]; then
        cd $BASEDIR

        cat $Our_Deletes | while read path; do
                Reg_File=0

                if valpath -l $path; then
                        Client_Path="$CLIENT_BASEDIR/$path"
                        Build_Path="$RELOC_DIR/$path"
                        Proto_Path=$BASEDIR/$path
                else    # It's an absolute path
                        Client_Path=$path
                        Build_Path="$ROOT_DIR$path"
                        Proto_Path=$PKG_INSTALL_ROOT$path
                fi

                # Note: If the file isn't really there, pkgproto
                # doesn't write anything.
                LINE=`pkgproto $Proto_Path=$path`
                ftype=`echo $LINE | nawk '{ print $1 }'`
                if [ $ftype = "f" ]; then
                        Reg_File=1
                fi

                if [ $Reg_File = 1 ]; then
                        # Add source file to the prototype entry
                        if [ "$Proto_Path" = "$path" ]; then
                                LINE=`echo $LINE | sed -e s@$Proto_Path@$Build_Path@2`
                        else
                                LINE=`echo $LINE | sed -e s@$Proto_Path@$Build_Path@`
                        fi

                        DirName=`dirname $Build_Path`
                        # make room in the build tree
                        mkdir -p $DirName
                        cp -p $Proto_Path $Build_Path
                fi

                # Insert it into the prototype file
                echo $LINE 1>>$PROTO_FILE 2>/dev/null
                # Remove the file only if it’s OK’d by removef
                rm ‘removef $PKGINST $Client_Path‘ 1>/dev/null 2>&1
        done
        removef -f $PKGINST

        rm $Our_Deletes
fi

#
# Unless specifically denied, make the backout package.
#
if [ "$PATCH_NO_UNDO" != "true" ]; then
        cd $BUILD_DIR   # We have to build from here.

        if [ "$PATCH_UNDO_ARCHIVE" != "none" ]; then
                STAGE_DIR="$PATCH_UNDO_ARCHIVE"
                ARCHIVE_DIR="$PATCH_UNDO_ARCHIVE/$Patch_label/$PKGINST"
                mkdir -p $ARCHIVE_DIR
                mkdir -p $PKGSAV/$Patch_label
        else
                if [ -d $PKGSAV/$Patch_label ]; then
                        rm -r $PKGSAV/$Patch_label
                fi
                STAGE_DIR=$PKGSAV
                ARCHIVE_DIR=$PKGSAV/$Patch_label
                mkdir $ARCHIVE_DIR
        fi

        pkgmk -o -d $STAGE_DIR 1>/dev/null 2>&1
        pkgtrans -s $STAGE_DIR $ARCHIVE_DIR/undo $PKG 1>/dev/null 2>&1
        compress $ARCHIVE_DIR/undo
        retcode=$?
        if [ "$PATCH_UNDO_ARCHIVE" != "none" ]; then
                if [ $retcode != 0 ]; then
                        build_remote_file "undo"
                else
                        build_remote_file "undo.Z"
                fi
        fi
        rm -r $STAGE_DIR/$PKG

        cd ..
        rm -r $BUILD_DIR
        # remove the scripts that are left behind
        install_scripts=‘dirname $0‘
        rm $install_scripts/checkinstall $install_scripts/patch_\
checkinstall $install_scripts/patch_postinstall
fi

#
# Since this apparently worked, we’ll mark as obsoleted the prior
# versions of this patch - installpatch deals with explicit obsoletions.
#
cd ${PKG_INSTALL_ROOT:-/}
cd var/sadm/pkg

active_base=`echo $Patch_label | nawk '
        { print substr($0, 1, match($0, "Patchvers_pfx")-1) } '`

List=`ls -d $PKGINST/save/${active_base}*`
if [ $? -ne 0 ]; then
        List=""
fi

for savedir in $List; do
        patch=`basename $savedir`
        if [ $patch = $Patch_label ]; then
                break
        fi

        # If we get here then the previous patch gets deleted
        if [ -f $savedir/undo ]; then
                mv $savedir/undo $savedir/obsolete
                echo $Patch_label >> $savedir/obsoleted_by
        elif [ -f $savedir/undo.Z ]; then
                mv $savedir/undo.Z $savedir/obsolete.Z
                echo $Patch_label >> $savedir/obsoleted_by
        elif  [ -f $savedir/remote ]; then
                `grep . $PKGSAV/$patch/remote | sed 's/STATE=.*/STATE=obsolete/
' > $TEMP_REMOTE`
                rm -f $PKGSAV/$patch/remote
                mv $TEMP_REMOTE $PKGSAV/$patch/remote
                rm -f $TEMP_REMOTE
                echo $Patch_label >> $savedir/obsoleted_by
        elif  [ -f $savedir/obsolete -o -f $savedir/obsolete.Z ]; then
                echo $Patch_label >> $savedir/obsoleted_by
        fi
done

# If additional operations are required for this package, place
# those package-specific commands here.

#XXXSpecial_CommandsXXX#

exit 0
```

The `patch_checkinstall` Script

```
# checkinstall script to validate backing out a patch.
# directory format option.
#
#       @(#)patch_checkinstall 1.2 95/10/10 SMI
#
# Copyright (c) 1995 by Sun Microsystems, Inc.
# All rights reserved
#
```

```
PATH=/usr/sadm/bin:$PATH

LATER_MSG="PaTcH_MsG 6 ERROR: A later version of this patch is applied."
NOPATCH_MSG="PaTcH_MsG 2 ERROR: Patch number $ACTIVE_PATCH is not installed"
NEW_LIST=""

# Get OLDLIST
. $1

#
# Confirm that the patch that got us here is the latest one installed on
# the system and remove it from PATCHLIST.
#
Is_Inst=0
Skip=0
active_base=‘echo $ACTIVE_PATCH | nawk ’
        { print substr($0, 1, match($0, "Patchvers_pfx")-1) } ’‘
active_inst=‘echo $ACTIVE_PATCH | nawk ’
        { print substr($0, match($0, "Patchvers_pfx")+1) } ’‘
for patchappl in ${OLDLIST}; do
        appl_base=‘echo $patchappl | nawk ’
                { print substr($0, 1, match($0, "Patchvers_pfx")-1) } ’‘
        if [ $appl_base = $active_base ]; then
                appl_inst=‘echo $patchappl | nawk ’
                        { print substr($0, match($0, "Patchvers_pfx")+1) } ’‘
                result=‘expr $appl_inst \> $active_inst‘
                if [ $result -eq 1 ]; then
                        puttext "$LATER_MSG"
                        exit 3
                elif [ $appl_inst = $active_inst ]; then
                        Is_Inst=1
                        Skip=1
                fi
        fi
        if [ $Skip = 1 ]; then
                Skip=0
        else
                NEW_LIST="${NEW_LIST} $patchappl"
        fi
done

if [ $Is_Inst = 0 ]; then
        puttext "$NOPATCH_MSG"
        exit 3
fi

#
# OK, all’s well. Now condition the key variables.
#
echo "PATCHLIST=${NEW_LIST}" >> $1
echo "Patch_label=" >> $1
echo "PATCH_INFO_$ACTIVE_PATCH=backed out" >> $1

# Get the current PATCH_OBSOLETES and condition it
```

```
Old_Obsoletes=$PATCH_OBSOLETES

echo $ACTIVE_OBSOLETES | sed 'y/\ /\n/' | \
nawk -v PatchObsList="$Old_Obsoletes" '
        BEGIN {
                printf("PATCH_OBSOLETES=");
                PatchCount=split(PatchObsList, PatchObsComp, " ");

                for(PatchIndex in PatchObsComp) {
                        Atisat=match(PatchObsComp[PatchIndex], "@");
                        PatchObs[PatchIndex]=substr(PatchObsComp[PatchIndex], \
0, Atisat-1);
                        PatchObsCnt[PatchIndex]=substr(PatchObsComp\
[PatchIndex], Atisat+1);
                }
        }
        {
                for(PatchIndex in PatchObs) {
                        if (PatchObs[PatchIndex] == $0) {
                                PatchObsCnt[PatchIndex]=PatchObsCnt[PatchIndex]-1;
                        }
                }
                next;
        }
        END {
                for(PatchIndex in PatchObs) {
                        if ( PatchObsCnt[PatchIndex] > 0 ) {
                                printf("%s@%d ", PatchObs[PatchIndex], PatchObsCnt\
[PatchIndex]);
                        }
                }
                printf("\n");
        } ' >> $1

        # remove the used parameters
        echo "ACTIVE_OBSOLETES=" >> $1
        echo "Obsoletes_label=" >> $1

exit 0
```

The `patch_postinstall` Script

```
# This script deletes the used backout data for a patch package
# and removes the deletes file entries.
#
# directory format options.
#
#       @(#)patch_postinstall 1.2 96/01/29 SMI
#
# Copyright (c) 1995 by Sun Microsystems, Inc.
# All rights reserved
#
```

```
PATH=/usr/sadm/bin:$PATH
THIS_DIR=`dirname $0`

Our_Deletes=$THIS_DIR/deletes

#
# Delete the used backout data
#
if [ -f $Our_Deletes ]; then
        cat $Our_Deletes | while read path; do
                if valpath -l $path; then
                        Client_Path=`echo "$CLIENT_BASEDIR/$path" | sed s@//@/@`
                else    # It's an absolute path
                        Client_Path=$path
                fi
                rm `removef $PKGINST $Client_Path`
        done
        removef -f $PKGINST

        rm $Our_Deletes
fi

#
# Remove the deletes file, checkinstall and the postinstall
#
rm -r $PKGSAV/$ACTIVE_PATCH
rm -f $THIS_DIR/checkinstall $THIS_DIR/postinstall

exit 0
```

Upgrading Packages

The process of upgrading a package is very different from that of overwriting a package. While there are special tools to support the upgrade of standard packages delivered as part of the Solaris operating environment, an unbundled package can be designed to support its own upgrade—several previous examples described packages that look ahead and control the precise method of installation under the direction of the administrator. You can design the `request` script to support direct upgrade of a package as well. If the administrator chooses to have one package install so as to completely replace another, leaving no residual obsolete files, the package scripts can do this.

The `request` script and `postinstall` script in this example provide a simple upgradable package. The `request` script communicates with the administrator and then sets up a simple file in the `/tmp` directory to remove the old package instance. (Although the `request` script creates a file (which is forbidden), it is okay because everyone has access to `/tmp`).

The `postinstall` script then executes the shell script in `/tmp`, which executes the necessary `pkgrm` command against the old package and then deletes itself.

This example illustrates a basic upgrade. It is less than fifty lines of code including some fairly long messages. It could be expanded to backout the upgrade or make other major transformations to the package as required by the designer.

The design of the user interface for an upgrade option must be absolutely sure that the administrator is fully aware of the process and has actively requested upgrade rather than parallel installation. There is nothing wrong with performing a well understood complex operation like upgrade as long as the user interface makes the operation clear.

The `request` Script

```
# request script
control an upgrade installation

PATH=/usr/sadm/bin:$PATH
UPGR_SCRIPT=/tmp/upgr.$PKGINST

UPGRADE_MSG="Do you want to upgrade the installed version ?"

UPGRADE_HLP="If upgrade is desired, the existing version of the \
    package will be replaced by this version. If it is not \
    desired, this new version will be installed into a different \
    base directory and both versions will be usable."

UPGRADE_NOTICE="Conflict approval questions may be displayed. The \
    listed files are the ones that will be upgraded. Please \
    answer \"y\" to these questions if they are presented."

pkginfo -v 1.0 -q SUNWstuf.\*

if [ $? -eq 0 ]; then
      # See if upgrade is desired here
      response=`ckyorn -p "$UPGRADE_MSG" -h "$UPGRADE_HLP"`
      if [ $response = "y" ]; then
            OldPkg=`pkginfo -v 1.0 -x SUNWstuf.\* | nawk ' \
            /SUNW/{print $1} '`
            # Initiate upgrade
            echo "PATH=/usr/sadm/bin:$PATH" > $UPGR_SCRIPT
            echo "sleep 3" >> $UPGR_SCRIPT
            echo "echo Now removing old instance of $PKG" >> \
            $UPGR_SCRIPT
            if [ ${PKG_INSTALL_ROOT} ]; then
                  echo "pkgrm -n -R $PKG_INSTALL_ROOT $OldPkg" >> \
                  $UPGR_SCRIPT
            else
                  echo "pkgrm -n $OldPkg" >> $UPGR_SCRIPT
            fi
            echo "rm $UPGR_SCRIPT" >> $UPGR_SCRIPT
            echo "exit $?" >> $UPGR_SCRIPT

            # Get the original package's base directory
            OldBD=`pkgparam $OldPkg BASEDIR`
            echo "BASEDIR=$OldBD" > $1
            puttext -l 5 "$UPGRADE_NOTICE"
       else
             if [ -f $UPGR_SCRIPT ]; then
                   rm -r $UPGR_SCRIPT
             fi
       fi
fi

exit 0
```

The `postinstall` Script

```
# postinstall
to execute a simple upgrade

PATH=/usr/sadm/bin:$PATH
UPGR_SCRIPT=/tmp/upgr.$PKGINST

if [ -f $UPGR_SCRIPT ]; then
      sh $UPGR_SCRIPT &
fi

exit 0
```

Creating Class Archive Packages

A class archive package, which is an enhancement to the Application Binary Interface (ABI), is one in which certain sets of files have been combined into single files, or archives, and optionally compressed or encrypted. Class archive formats increase initial install speed by up to 30% and improves reliability during installation of packages and patches onto potentially active file systems.

The following sections provide information about the archive package directory structure, keywords, and `faspac` utility.

Structure of the Archive Package Directory

The package entry shown in the figure below represents the directory containing the package files. This directory must be the same name as the package.

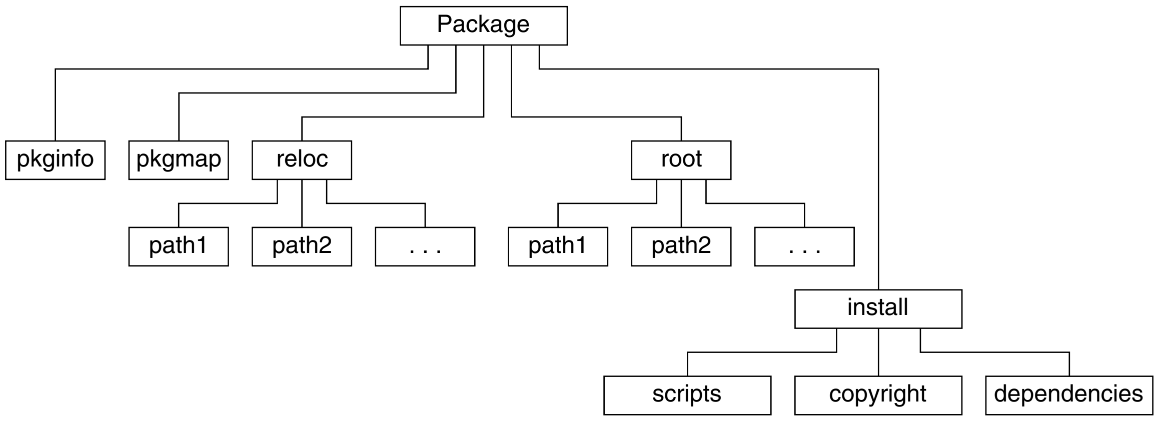


FIGURE 6–1 Package Directory Structure

The following lists the functions of the files and directories contained within the package directory.

Item	Description
`pkginfo`	File describing the package as a whole including special environment variables and installation directives
`pkgmap`	File describing each object (file, directory, pipe, etc.) to be installed
`reloc`	Optional directory containing the files to be installed relative to the base directory (the relocatable objects)
`root`	Optional directory containing the files to be installed relative to the `root` directory (the root objects)
`install`	Optional directory containing scripts and other auxiliary files (except for `pkginfo` and `pkgmap`, all `ftype i` files to here)

The class archive format allows the package builder to combine files from the `reloc` and `root` directories into archives which can be compressed, encrypted, or otherwise processed in any desired way in order to increase install speed, reduce package size, or increase package security.

The ABI allows any file within a package to be assigned to a class. All files within a specific class may be installed to the disk using a custom method defined by a class action script. This custom method may make use of programs available on the target system or programs delivered with the package. The resulting format looks much like the standard ABI format. As shown in the following illustration, another directory is added. Any class of files intended for archive is simply combined into a single file and placed into the `archive` directory. All archived files are removed from the `reloc` and `root` directories and an install class action script is placed into the `install` directory.

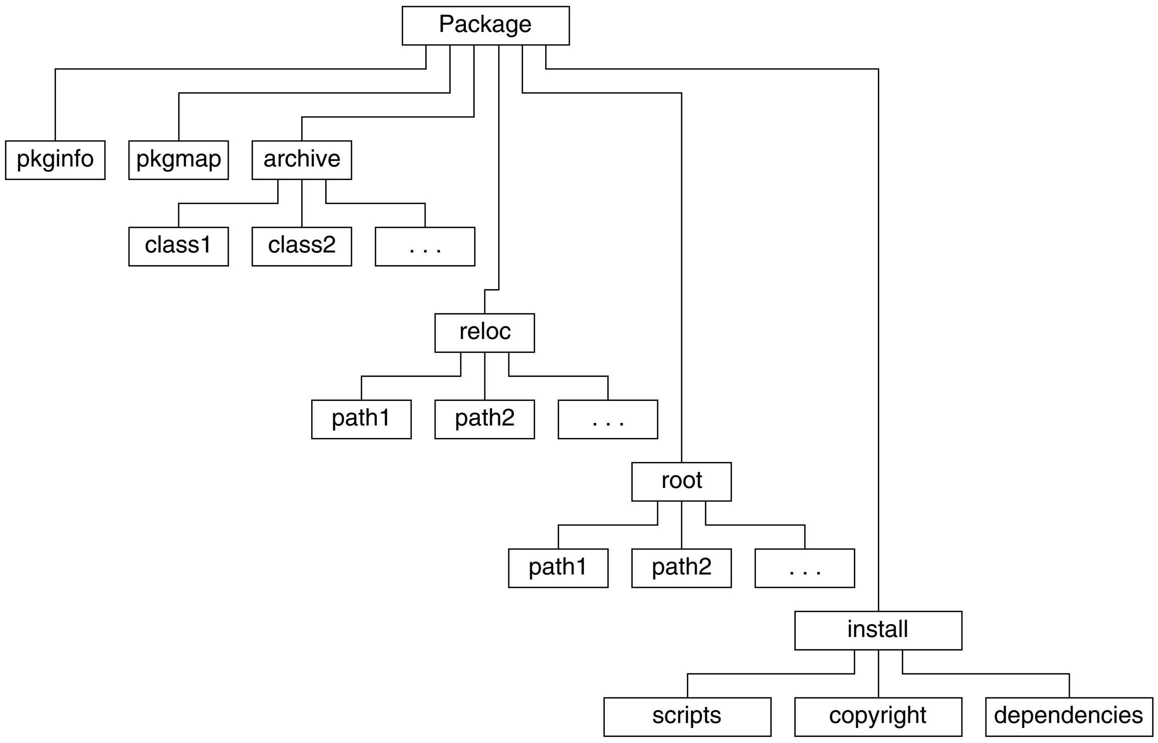


FIGURE 6–2 Archive Package Directory Structure

Keywords to Support Class Archive Packages

In order to support this new class archive format, three new interfaces in the form of keywords have special meaning within the `pkginfo` file. These keywords are used to designate classes requiring special treatment. The format of each keyword statement is: `keyword=class1[class2 class3 ...]`. Each keyword values are defined in the following table.

Keyword	Description
PKG_SRC_NOVERIFY	This tells pkgadd not to verify the existence and properties of the files in the delivered package's reloc or root directories if they belong to the named class. This is required for all archived classes, because those files are no longer in a reloc or root directory. They are a private format file in the archive directory.
PKG_DST_QKVERIFY	The files in these classes are verified after installation using a quick algorithm with little to no text output. The quick verify first sets each file's attributes correctly and then checks to see if the operation succeeded. There is then a test of the file size and modification time against the pkgmap. No checksum verification is performed and there is poorer error recovery than that provided by the standard verification mechanism. In the event of a power outage or disk failure during installation, the contents file may be inconsistent with the installed files. This inconsistency can always be resolved with a pkgrm.
PKG_CAS_PASSRELATIVE	Normally the install class action script receives from stdin a list of source and destination pairs telling it which files to install. The classes assigned to PKG_CAS_PASSRELATIVE do not get the source and destination pairs. Instead they receive a single list, the first entry of which is the location of the source package and the rest of which are the destination paths. This is specifically for the purpose of simplifying extraction from an archive. From the location of the source package, you can find the archive in the archive directory. The destination paths are then passed to the function responsible for extracting the contents of the archive. Each destination path provided is either absolute or relative to the base directory depending on whether the path was located in root or reloc originally. If this option is chosen, it may be difficult to combine both relative and absolute paths into a single class.

For each archived class a class action script is required. This is a file containing Bourne shell commands which is executed by pkgadd to actually install the files from the archive. If a class action script is found in the install directory of the package, pkgadd turns all responsibility for installation over to that script. The class action script is run with root permissions and can place its files just about anywhere on the target system.

Note – The only keyword that is absolutely necessary in order to implement a class archive package is PKG_SRC_NOVERIFY. The others may be used to increase installation speed or conserve code.

The `faspac` Utility

The `faspac` utility converts a standard ABI package into a class archive format used for bundled packages. This utility archives using cpio and compresses using compress. The resulting package has an additional directory in the top directory called `archive`. In this directory will be all of the archives named by class. The `install` directory will contain the class action scripts necessary to unpack each archive. Absolute paths are not archived.

The `faspac` utility has the following format:

```
faspac [-m Archive Method] -a -s -q [-d Base Directory] /
[-x Exclude List] [List of Packages]
```

Each `faspac` command option is described in the following table.

Option	Description
`-m` *Archive Method*	Indicates a method for archive or compression. `bzip2` is the default compression utilities used. To switch to zip or unzip method use `-m zip` or for cpio or compress use `-m cpio`.
`-a`	Fixes attributes (must be root to do this).
`-s`	Indicates standard ABI-type package translation. This option takes a cpio or compresssed packaged and makes it a standard ABI-compliant package format.
`-q`	Indicates quiet mode.
`-d` *Base Directory*	Indicates the directory in which all packages present will be acted upon as required by the command line. This is mutually exclusive with the *List of Packages* entry.
`-x` *Exclude List*	Indicates a comma-separated or quoted, space-separated list of packages to exclude from processing.
List of Packages	Indicates the list of packages to be processed.

Glossary

ABI	See application binary interface (ABI).
abstract syntax notation 1	A way of expressing abstract objects. For example, ASN.1 defines a public key certificate, all of the objects that make up the certificate, and the order in which the objects are collected. However, ASN.1 does not specify how the objects are serialized for storage or transmission.
application binary interface	Definition of the binary system interface between compiled applications and the operating system on which they run.
ASN.1	See abstract syntax notation 1 (ASN.1)
base directory	The location where relocatable objects will be installed. It is defined in the `pkginfo` file, using the `BASEDIR` parameter.
build time	The time during which a package is being built with the `pkgmk` command.
build variable	A variable that begins with a lowercase letter and is evaluated at build time.
certificate authority	An agency, such as Verisign, that issues certificates used in the signing of packages.
class	A name that is used to group package objects. See also class action script.
class action script	A file that defines a set of actions to be performed on a group of package objects.
collectively relocatable object	A package object that is located relative to a common installation base. See also base directory.
common name	An alias name listed in the package keystore for signed packages.
composite package	A package that contains both relocatable and absolute path names.
`compver` file	A method of specifying package backward-compatibility.

control file	File that controls how, where, and if a package is to be installed. See information file and installation script.
copyright	The right to own and sell intellectual property, such as software, source code, or documentation. Ownership must be stated on the CD-ROM and insert text, whether the copyright is owned by SunSoft, or by another party. Copyright ownership is also acknowledged in SunSoft documentation.
`depend` file	A method of resolving basic package dependencies. See also `compver` file.
DER	See distinguished encoding rules.
distinguished encoding rules	A binary representation of an ASN.1 object and defines how an ASN.1 object is serialized for storage or transmission in computing environments. Used with signed packages.
digital signature	An encoded message used to verify the integrity and security of a package.
incompatible package	A package that is incompatible with the named package. See also `depend` file.
individually relocatable object	A package object that is not restricted to the same directory location as a collectively relocatable object. It is defined using an install variable in the *path* field in the `prototype` file, and the installation location is determined via a `request` script or a `checkinstall` script.
information file	A file that can define package dependencies, provide a copyright message, or reserve space on a target system.
installation script	A script that enables you to provide customized installation procedures for a package.
install time	The time during which a package is being installed with the `pkgadd` command.
install variable	A variable that begins with an uppercase letter and is evaluated at install time.
ITU-T Recommendation X.509	A protocol that Specifies the widely-adopted X.509 public key certificate syntax.
package	A collection of files and directories required for a software application.
package abbreviation	A short name for a package that is defined via the `PKG` parameter in the `pkginfo` file.
package identifier	A numerical suffix added to a package abbreviation by the `pkgadd` command.
package instance	A variation of a package, which is determined by combining the definitions of the `PKG`, `ARCH`, and `VERSION` parameters in the `pkginfo` file for the package.

package object	Another name for an application file that is contained in a package to be installed on a target system.
package keystore	A repository of certificates and keys that can be queried by the package tools.
parametric path name	A path name that includes a variable specification.
patch list	A list of patches that affect the current package. This list of patches is recorded in the installed package in the `pkginfo` file.
PEM	See privacy enhanced message.
PKCS7	See public key cryptography standard #7.
PKCS12	See public key cryptography standard #12.
prerequisite package	A package that depends on the existence of another package. See also `depend` file.
privacy enhanced message	A way to encode a file using base 64 encoding and some optional headers. Used extensively for encoding certificates and private keys into a file that exists on a file system or in an email message.
private key	An encryption/decryption key known only to the party or parties that exchange secret messages. This private key is used in conjunction with public keys to create signed packages.
procedure script	A script that defines actions that occur at a particular point during package installation and package removal.
public key	A value generated as an encryption key that, combined with the private key derived from the public key, can be used to effectively encrypt messages and digital signatures.
public key cryptography standard #7	A standard that describes a general syntax for data that may have cryptography applied to it, such as digital signatures and digital envelopes. A signed package contains an embedded PKCS7 signature.
public key cryptography standard #12	A standard that describes a syntax for storing cryptographic objects on disk. The package keystore is maintained in this format.
relocatable	A package object defined in a `prototype` file with a relative path name.
relocatable object	A package object that does not need an absolute path location on a target system. Instead, its location is determined during the installation process. See also collectively relocatable object and individually relocatable object.
reverse dependency	A condition when another package depends on the existence of your package. See also `depend` file.
segmented	A package that does not fit on a single volume, such as a floppy disk.

signed packages	A normal stream-format package with a digital signature that verifies the following: that the package came from the entity that signed it, the entity indeed signed it, the package has not been modified since the entity signed it, and the entity that signed it is a trusted entity.
`tar`	Tape archive retrieval. Solaris command for adding or extracting files from a media.
trusted certificate	A certificate that contains a single public key certificate that belongs to another entity. Trusted certificates are used when verifying digital signatures and when initiating a connection to a secure (SSL) server.
unsigned package	A normal, ABI package without any encryption or digital signatures.
user key	A key that holds sensitive cryptographic key information. This information is stored in a protected format to prevent unauthorized use. User keys are used when a signed package is created.
X.509	See ITU-T Recommendation X.509.

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