Rapid Recovery Techniques: Exploring the Solaris™ Software Registry

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System recovery time, also described as mean time to recover (MTTR), is an important part of availability calculations. Reducing recovery time directly and positively impacts the overall availability of systems.

This is the first article in a series that will discuss rapid recovery techniques for the Solaris operating environment. The focus of this series is to show ways in which recovery time for repairing or restoring systems can be decreased thus increasing overall availability. This series will also deal with recovery techniques for problems specifically not related to failed hardware. Computer industry analysts observe failures of three main types: product, people, and process. In particular, this series will discuss how to use processes to recover from errors caused by people.

The Software Registry

The Solaris operating environment maintains a software registry for maintaining information on software packages and files installed on the system. This registry plays a critical role in software installation, upgrades, and patches. The registry is the primary location for software installation information.
The software and patch installation information is kept under the system administration directory, `/var/sadm`. The layout of the `/var/sadm` directory structure changed in Solaris 7 operating environment. Table 1 shows the `/var/sadm` directory contents.

**Table 1: `/var/sadm` Directory Contents.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Pre-Solaris 7 Location</th>
<th>Solaris 7 Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log files from installation and system configuration software</td>
<td>.</td>
<td><code>system/logs/</code></td>
</tr>
<tr>
<td>Data files generated by system installation and configuration utilities containing system-relevant configuration data</td>
<td>.</td>
<td><code>system/data/</code></td>
</tr>
<tr>
<td>Database of installed files</td>
<td><code>install/contents</code></td>
<td><code>install/contents</code></td>
</tr>
<tr>
<td>Directories for storing patched files and patch information</td>
<td><code>patch/</code></td>
<td><code>patch/</code></td>
</tr>
<tr>
<td>Directories for storing software package information</td>
<td><code>pkg/</code></td>
<td><code>pkg/</code></td>
</tr>
<tr>
<td>Log of Solaris operating environment installation including file system creation, Solaris operating environment package installations, and file system information</td>
<td><code>install_data/install_log</code></td>
<td><code>system/logs/install_log</code></td>
</tr>
<tr>
<td>Log of Solaris operating environment upgrade messages</td>
<td><code>install_data/upgrade_log</code></td>
<td><code>system/logs/upgrade_log</code></td>
</tr>
<tr>
<td>Log of Solaris operating environment post upgrade cleanup messages</td>
<td><code>install_data/upgrade_cleanup</code></td>
<td><code>system/data/upgrade_cleanup</code></td>
</tr>
<tr>
<td>File system size information from upgrade</td>
<td><code>install_data/upgrade_space_report</code></td>
<td><code>system/data/upgrade_space_report</code></td>
</tr>
<tr>
<td>Begin script output, usually empty unless customized for AutoInstall</td>
<td><code>begin.log</code></td>
<td><code>system/logs/begin.log</code></td>
</tr>
</tbody>
</table>
The software registry is a key component of the Solaris operating environment because it contains information on what software is installed and where. This information is vital for recovering from errors that involve changes in the software or files on the system. The registry is also invaluable for auditing the system to determine what software has been installed, removed, or patched.

The software registry is located in the /var file system. /var may vary widely in its disk space consumption because it contains the /var/tmp directory where users can place temporary files, as well as /var/adm and /var/log, which collect accounting and logging information. The software registry requires space to grow as software is installed. Any patches that are installed without explicitly using the “do not backup the files” option will store the files needed for back out in the /var/sadm/pkg directory. Enough space should be available in the /var directory to hold user temporary files plus software installation requirements and patch management. For a large server, the software registry may require 50MB or more and will grow over time as patches are added.

Software for Solaris operating systems is typically installed as packages. A package contains files, installation scripts, copyright information, and removal scripts. Refer to the Solaris Application Packaging Developer’s Guide for a complete description of packages, package construction, and management. This guide is available in the Software Developer Collection in the Answerbook™ documentation and on the internet at http://docs.sun.com

Occasionally packages that are related in some way are collected into clusters. Clusters aid in systems management as it is easier to install a single cluster than the dozens of individual packages. Solaris clusters are named SUNWChame.

Solaris patches are distributed as sparse packages. A patch usually contains fewer files than a complete package. A patch will not normally include pre installation scripts.

Patches are not required to update packages. A complete package may be built that includes a few updated files. At installation time, only the files that have been changed are installed. Files which remain the same are not reinstalled. The software registry is used to manage the changes needed. The ability to update files by installing a later version of a package is a very useful feature that will be explored in detail in articles later in this series.

<table>
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<th>Description</th>
<th>Pre-Solaris 7 Location</th>
<th>Solaris 7 Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish script output, usually empty unless customized for AutoInstall</td>
<td>finish.log</td>
<td>system/logs/finish.log</td>
</tr>
</tbody>
</table>

Table 1: /var/sadm Directory Contents.
Tools for Administering the Software Registry

Starting with the Solaris 2.0 release, the Solaris operating environment has included tools for manipulating the software registry. These are: installf, removef, pkgadd, pkgrm, pkginfo, and pkgchk. These commands are intended for system administrators and software developers.

The Solaris 2.3 release added the software management tool, swmtool. swmtool has an X-window GUI that can be used to add and remove packages. The back end to swmtool is the normal pkgadd, pkgrm, and pkginfo. All interaction with the pkg commands is done in a text window. This function was later added to the admintool under the browse software menu.

The Solaris 2.6 release added the patchadd and patchrm command. Until the Solaris 2.6 release, each patch was bundled with a script, installpatch, to install the patch and manage the registry. A back out script, backoutpatch, included with each patch is now replaced by patchrm. However, since the scripts were built on the shell pkg commands, the process of adding patches was slow. For a large server with lots of software installed, the patch process was painfully slow. The patchadd program is a binary executable and manages the registry through a C API. The result is a more efficient patch process.

The Solaris 2.6 release added a new software installation procedure based on technology from InstallShield. InstallShield is the most popular interface for installing software in the Microsoft Windows environments. While the InstallShield front end looks very Windows-like, the back end is still the familiar pkgadd command. Hence, the registry remains the same.

The Solaris 75/99 release added a new Java™ technology-based application, prodreg. prodreg is a GUI interface for manipulating packages and clusters of packages. prodreg is an updated version of admintool using Java Abstract Windowing Toolkit (AWT) or SWING GUI interface instead of Motif.

The Database of Installed Files

Every file installed on a Solaris operating system using the pkgadd command has an entry in the database of installed files, /var/sadm/install/contents. The contents is a text file that contains one line per installed file. Information about each file includes:
- full pathname where the file is installed
- type of file: normal file, editable, volatile, directory, link, raw, cooked, etc.
- a secondary descriptor field, as needed
- file permissions (mode) in octal (see chmod(1))
- owner id
- group id
- 16-bit checksum from the sum command
- size in bytes
- package name(s) which installed the file

Using pkgchk to Provide Information about Specific Files

The pkgchk command can provide a verbose description of the information in the contents file. For example:

```bash
$ pkgchk -l -p /usr/bin/ls
Pathname: /usr/bin/ls
Type: regular file
Expected mode: 0555
Expected owner: bin
Expected group: bin
Expected file size (bytes): 18120
Expected sum(1) of contents: 53113
Expected last modification: Oct 06 00:43:05 1998
Referenced by the following packages:
    SUNWcsu
Current status: installed
```
The equivalent information can be retrieved in raw form using grep. For example:

```
$ grep /usr/bin/ls /var/sadm/install/contents
/usr/bin/ls f none 0555 bin bin 18120 53113 907657985 SUNWcsu
```

All updates to the contents file must be carefully controlled to avoid corruption of the database. The Solaris operating environment commands installf and removef are used to help ensure controlled updating of the contents file and proper format of the database entries. Commands that read the database, such as pkgchk, properly follow the locking semantics enforced by installf and removef. The contents file is a text file, so Solaris operating environment commands that process text files will work as expected. However, they do not recognize the locking mechanism used to avoid corruption of the database. There is no mechanism to repair a corrupted contents file other than to restore from a backup. Use only the Solaris pkg commands to interface with the contents file.

grep can be useful for locating the locations of installed files. For example, if there is a file called “pkgchk” installed somewhere on the system, it can be located easily without using find:

```
$ grep pkgchk /var/sadm/install/contents
/usr/sbin/pkgchk f none 0555 root sys 157836 25516 907660189 SUNWcsu
/usr/share/man/sman1m/pkgchk.1m f none 0444 bin bin 12016 56338 904250063 SUNWman
```

A more readable example may be:

```
$ grep pkgchk /var/sadm/install/contents | awk '{print $1}'
/usr/sbin/pkgchk
/usr/share/man/sman1m/pkgchk.1m
```
In these examples, the entire pathname for the installed file and the manual page are found.

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**Using `pkginfo` to Provide Information about Specific Packages**

The `pkginfo` command can provide information about specific packages. This information is useful for discovering the packages that are installed and detailed information about them. For example:

```
$ pkginfo
systemSUNWcsrCore Solaris, (Root)
systemSUNWcsuCore Solaris, (Usr)
...

$ pkginfo -l SUNWcsr
PKGINST: SUNWcsr
   NAME: Core Solaris, (Root)
   CATEGORY: system
   ARCH: sparc
   VERSION: 11.7.0,REV=1998.09.01.04.16
   BASEDIR: /
   VENDOR: Sun Microsystems, Inc.
   DESC: core software for a specific instruction-set architecture
   PStamp: on998-patch19981105094318
   INSTDATE: Jul 08 1999 17:36
   HOTLINE: Please contact your local service provider
   STATUS: completely installed
   FILES: 511 installed pathnames
          38 shared pathnames
          64 linked files
          79 directories
          168 executables
          23482 blocks used (approx)
```
Using prodreg to Manage Packages

Figure 1 shows the prodreg main screen. prodreg allows easy exploration of the installed clusters and packages.

In this example, software clusters are shown in the software registry window with triangle icons. Individual packages are shown with square icons. Cluster and package details are immediately visible on the right side when selected.

Using admintool to Manage Packages

Figure 2 shows the admintool browsing screen. admintool allows easy exploration of the installed clusters and packages.
FIGURE 2 admintool Sample Display

However, clusters are not as obvious in admintool as they are in prodreg. Individual packages are the right most indented items. It is difficult in admintool to determine at a glance whether an item is a cluster or a package. You must select an item and press the Show Details... button to see any significant detail about the cluster or package.

Conclusion

This article describes the Solaris Operating Environment software registry. The registry contains records and logs of all software packages installed and patched on a Solaris operating system. This information is important for maintaining the software configuration of a Solaris operating system. Techniques for using the registry to rapidly recover a system will be discussed in a future Sun BluePrints™ OnLine article.
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