System Administration

Week 09, Segment 3

Time Travel and Snapshots

Department of Computer Science
Stevens Institute of Technology

Jan Schaumann
jschauma@stevens.edu
https://stevens.netmeister.org/615/

Image Credit: JMortonPhoto.com & OtoGodfrey.com
https://is.gd/xlsYR8
server-to-back-up# echo yay
yay
server-to-back-up# df
Filesystem  1K-blocks Used Avail %Cap Mounted on
/dev/xbd0a 10318062 1232044  8570116  12% /
ptysfs 1 1 0 100% /dev/pts
/dev/fss0 10318062 1226792 8575368  12% /mnt
server-to-back-up# umount /mnt
server-to-back-up# fssconfig -u fss0
server-to-back-up# ls -l /backup
-rw------ 1 root wheel 10736370152 Apr 4 03:40 /backup
server-to-back-up# rm /backup
override rw------ root:wheel for '/backup'? y
server-to-back-up#
Filesystem Snapshots

In contrast to other backup mechanisms we’ve seen:

• snapshot creation is near-instantaneous
• snapshot takes up (virtually) no additional space
• snapshot can be mounted and traversed like any other filesystem
• snapshots are immutable
• since all permissions and protections remain, you effectively get “self-restore” capabilities
• snapshots are bound to the system they were taken on
Filesystem Backup

Example: Mac OS X “Time Machine”

• automatically creates a full backup (equivalent of a ”level0 dump”) to separate device or NAS, recording (specifically) last-modified date of all directories

• every hour, creates a full copy via hardlinks (hence no additional disk space consumed) for files that have not changed, new copy of files that have changed

• changed files are determined by inspecting last-modified date of directories (cheaper than doing comparison of all files’ last-modified date or data)

• saves hourly backups for 24 hours, daily backups for the past month, and weekly backups for everything older than a month
Filesystem Backup

Example: WAFL (Write Anywhere File Layout)

• used by NetApp’s “Data ONTAP” OS

• uses regular snapshots (“consistency points”, every 10 seconds) to allow for speedy recovery from crashes

• a snapshot is a read-only copy of a file system (cheap and near instantaneous, due to Redirect-on-Write (RoW))
Example: WAFL (Write Anywhere File Layout)
Example: WAFL (Write Anywhere File Layout)

```
root inode

Data Block A  Data Block B  Data Block C  Data Block D

snapshot
```

- Data Block A
- Data Block B
- Data Block C
- Data Block D

- Snapshot

Example: WAFL (Write Anywhere File Layout)

Copy-on-Write

root inode

Data Block A

Data Block B

Data Block C'

Data Block D'

Data Block C

Data Block D

snapshot
Example: WAFL (Write Anywhere File Layout)

Redirect-on-Write

```
root inode
```

```
Data Block A — Data Block B — Data Block C — Data Block D
```

```
snapshot
```
Example: WAFL (Write Anywhere File Layout)

Redirect-on-Write faster
than Copy-on-Write
Example: WAFL (Write Anywhere File Layout)

Only in /root/:: date-of-last-incident
Only in /zfs/snapshot/20210406172012/root/.ssh: authorized_keys

root@ip-10-10-0-30:~# cp /zfs/snapshot/20210406172012/root/.ssh/authorized_keys /root/.ssh

root@ip-10-10-0-30:~# date > /root/last-recovered
root@ip-10-10-0-30:~# rm /root/.ssh/authorized_keys
root@ip-10-10-0-30:~# date >> /root/date-of-last-incident
root@ip-10-10-0-30:~# ls /root

date-of-last-incident last-recovered

root@ip-10-10-0-30:~# zfs list -t snapshot

<table>
<thead>
<tr>
<th>NAME</th>
<th>USED</th>
<th>AVAIL</th>
<th>REFER</th>
<th>MOUNTPOINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>rpool/ROOT/omnios-r151034m@kayak</td>
<td>48.3M</td>
<td>-</td>
<td>745M</td>
<td>-</td>
</tr>
<tr>
<td>rpool/ROOT/omnios-r151034m@20210406172012</td>
<td>224K</td>
<td>-</td>
<td>860M</td>
<td>-</td>
</tr>
</tbody>
</table>

root@ip-10-10-0-30:~# zfs rollback rpool/ROOT/omnios-r151034m@20210406172012

root@ip-10-10-0-30:~# ls /root

authorized_keys

root@ip-10-10-0-30:~# zfs destroy rpool/ROOT/omnios-r151034m@20210406172012

root@ip-10-10-0-30:~# zfs list -t snapshot

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Summary

• Snapshots are fast and (comparatively) cheap — use ‘em!
• Snapshots allow for trivial self-restore within the Recovery Point Objective and minimal Recovery Time Objective.
• Snapshots allow for
  • consumer backup solutions (e.g., macOS Time Machine)
  • enterprise scale safety and redundancy (e.g., NetApp OnTAP WAFL)
  • end-user data recovery (e.g., ZFS, BTRFS, FFS)
• Combine with other backup strategies for a comprehensive disaster recovery plan.

Remember: your backups need to be regular, frequent, automated, and regularly verified!
Links

• https://wiki.netbsd.org/tutorials/the_netbsd_system_manager__39__s_manual/#index34h2
• https://wiki.netbsd.org/tutorials/how_to_use_snapshots/
• https://e17i.github.io/articles-netbsd-backup/
• https://en.wikipedia.org/wiki/Time_Machine_(macOS)
• https://en.wikipedia.org/wiki/Write_Anywhere_File_Layout
• https://is.gd/AbHmzQ
• https://docs.oracle.com/cd/E19253-01/819-5461/gbcya/index.html