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ZFS Snapshot and Rollback with Local Zones

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Introduction

This paper provides instructions and best practices on how to create and manage Oracle Solaris ZFS snapshot and rollback within the local zone, a method to revert the original system status of a local zone after any change on the system. You can use the `zfs rollback` command to discard all changes made to a file system since a specific snapshot was created. The file system reverts to its state at the time the snapshot was taken. This process is tested on Oracle Solaris 10 and 11. In addition ZFS snapshot and rollback is the best way to return to a stable setting of deployments, applications, productions and QA systems after any modifications on the system.

Snapshot

A *snapshot* is a read-only copy of a file system or volume at a given point in time. Snapshots can be created extremely quickly, and they initially consume no additional disk space within the pool. However, as data within the active dataset changes, the snapshot consumes disk space by continuing to reference the old data, thus preventing the disk space from being freed. File system snapshots can be accessed under the `.zfs/snapshot` directory in the root of the file system.

ZFS snapshots include the following features:

- They persist across system reboots.
- The theoretical maximum number of snapshots is 2^{64}.
- Snapshots use no separate backing store. Snapshots consume disk space directly from the same storage pool as the file system or volume from which they were created.
- Recursive snapshots are created quickly as one atomic operation. The snapshots are created together (all at once) or not created at all. The benefit of atomic snapshot operations is that the snapshot data is always taken at one consistent time, even across descendent file systems.

Creating a ZFS Snapshot

Snapshots are created by using the `zfs snapshot` command, which takes as its only argument the name of the snapshot to create. The snapshot name is specified as follows:

```
# zfs snapshot [-r][-o property=value]… filesystem@snapname
```

This command creates a snapshot with the given name. All previous modifications to the file system are part of the snapshot.

`-r`	Recursively create snapshots of all descendent datasets. Snapshots are taken atomically, so that all recursive snapshots correspond to the same moment in time.
`-o property=value`	Sets the specified property.

The snapshot name must satisfy the naming requirements listed in “ZFS Component Naming Requirements”: http://docs.oracle.com/cd/E19253-01/819-5461/gbcpt/index.html.

In the following example, an Oracle Solaris 11 local zone `zoneA` was created in the path `/export/home/zoneA`. The `zfs snapshot` command is used to create a snapshot of `/rpool/export/home/zoneA` that is named `initial`. You can create snapshots for all descendent file systems by using the `-r` option.

```
# root@mkblade:~# cat /etc/release
                            Oracle Solaris 11.1 X86
  Copyright (c) 1983, 2012, Oracle and/or its affiliates.  All rights reserved.
                          Assembled 19 September 2012
# root@mkblade:~# zfs snapshot -r rpool/export/home/zoneA@initial
# root@mkblade:~# zfs list -r -t all

NAME                                                 USED  AVAIL  REFER  MOUNTPOINT
rpool                                               31,7G   234G  4,58M  /rpool
rpool/ROOT                                          2,39G   234G    31K  legacy
rpool/ROOT/solaris                                  2,39G   234G  1,98G  /
rpool/ROOT/solaris@install                          6,21M      -  1,92G  -
rpool/ROOT/solaris/var                               410M   234G   408M  /var
rpool/ROOT/solaris/var@install                      1,69M      -  97,3M  -
rpool/VARSHARE                                       302K   234G   302K  /var/share
rpool/dump                                          24,8G   235G  24,0G  -
rpool/export                                         445M   234G    32K  /export
rpool/export/home                                    445M   234G    33K  /export/home
rpool/export/home/sun                               35,5K   234G  35,5K  /export/home/sun
rpool/export/home/zoneA                              445M   234G    33K  /export/home/zoneA
rpool/export/home/zoneA@initial                         0      -    33K  -
rpool/export/home/zoneA/rpool                        445M   234G    31K  /export/home/zoneA/root/rpool
rpool/export/home/zoneA/rpool@initial                   0      -    31K  -
rpool/export/home/zoneA/rpool/ROOT                   444M   234G    31K  legacy
rpool/export/home/zoneA/rpool/ROOT@initial              0      -    31K  -
rpool/export/home/zoneA/rpool/ROOT/solaris           444M   234G   416M  /export/home/zoneA/root
rpool/export/home/zoneA/rpool/ROOT/solaris@install   370K      -   390M  -
rpool/export/home/zoneA/rpool/ROOT/solaris@initial      0      -   416M  -
rpool/export/home/zoneA/rpool/ROOT/solaris/var      28,0M   234G  27,4M  /export/home/zoneA/root/var
rpool/export/home/zoneA/rpool/ROOT/solaris/var@install  669K      -  27,2M  -
rpool/export/home/zoneA/rpool/ROOT/solaris/var@initial    0      -  27,4M  -
rpool/export/home/zoneA/rpool/VARSHARE               39K   234G    39K  /export/home/zoneA/root/var/share
rpool/export/home/zoneA/rpool/VARSHARE@initial          0      -    39K  -
rpool/export/home/zoneA/rpool/export                 98K   234G    32K  /export/home/zoneA/root/export
rpool/export/home/zoneA/rpool/export@initial            0      -    32K  -
rpool/export/home/zoneA/rpool/export/home            66K   234G    32K  /export/home/zoneA/root/export/home
rpool/export/home/zoneA/rpool/export/home@initial       0      -    32K  -
rpool/export/home/zoneA/rpool/export/home/sun        34K   234G    34K  /export/home/zoneA/root/export/home/sun
rpool/export/home/zoneA/rpool/export/home/sun@initial   0      -    34K  -
rpool/swap                                          4,13G   234G  4,00G  -

# root@mkblade:~# zoneadm list -cv
  ID NAME             STATUS     PATH                           BRAND    IP
   0 global           running    /                              solaris  shared
   1 zoneA            running    /export/home/zoneA             solaris  excl
```

The following example uses the `zfs list` command on Oracle Solaris 10. You can compare `zfs list` paths between Oracle Solaris 10 in this example and Oracle Solaris 11 in the previous example.

```
# uxi310:/# cat /etc/release
                     Oracle Solaris 10 8/11 s10x_u10wos_17b X86
  Copyright (c) 1983, 2011, Oracle and/or its affiliates. All rights reserved.
                          Assembled 23 August 2011
# uxi310:/# zfs list -t all
NAME                          USED  AVAIL  REFER  MOUNTPOINT
rpool                        49,3G   216G  42,5K  /rpool
rpool/ROOT                   6,82G   216G    31K  legacy
rpool/ROOT/s10u10            6,82G   216G  6,82G  /
rpool/cam                    1,16G   216G  1,16G  /CAM
rpool/dump                   1,50G   216G  1,50G  -
rpool/export                   63K   216G    32K  /export
```

```
rpool/export/home                31K   216G    31K  /export/home
rpool/swap                      128M   217G  1,12M  -
rpool/zones                    39,7G   216G    38K  /zones
rpool/zones/ux10z2             19,5G   216G  25,7G  /zones/ux10z2
rpool/zones/ux10z2@initial     37,5K      -  25,7G  -
rpool/zones/ux10z3             13,9G   216G  20,0G  /zones/ux10z3

# uxi310:/# zoneadm list -cv
  ID NAME             STATUS     PATH                           BRAND    IP
   0 global           running    /                              native   shared
   1 ux10z2           running    /zones/ux10z2                  native   shared
   8 ux10z3           running    /zones/ux10z3                  native   shared
```

After creating the ZFS snapshot, you can change any data on the local zone `zoneA`. By performing the rollback you are able to revert to the original system status before any change on the system. In this example after creating the ZFS snapshot, the data `file1` is generated under directory `/export/home` on `zoneA` as follows:

```
# root@zoneA:/export/home# touch file1
# root@zoneA:/export/home# ls -la
total 10
drwxr-xr-x   3 root     root           4 Aug  4 15:10 .
drwxr-xr-x   3 root     root           4 Jul  2 11:10 ..
-rw-r--r--   1 root     root           0 Aug  4 15:10 file1
drwxr-xr-x   2 sun      staff          5 Jul 21 20:11 sun
```

Rolling Back a ZFS Snapshot

You can use the `zfs rollback` command to discard all changes made to a file system since a specific snapshot was created. The file system reverts to its state at the time the snapshot was taken.

```
# zfs rollback [-rRf] snapshot
```

This command rolls back the given dataset to a previous snapshot. When a dataset is rolled back, all data that has changed since the snapshot is discarded, and the dataset reverts to the state at the time of the snapshot was taken. By default, the command refuses to roll back to a snapshot other than the most recent one. In order to do so, all intermediate snapshots must be destroyed be specifying the `-r` option.

`-r` Recursively destroys any snapshots more recent than the one specified.

`-R` Recursively destroys any more recent snapshots, as well as any clones of those snapshots.

`-f` Used with the `-R` option to force an unmount of any clone file systems that are to be destroyed.

The `-rR` options do not recursively roll back the child snapshots of a recursive snapshot. Only the top-level recursive snapshot is rolled back by either of these options. To completely roll back a recursive snapshot, you must roll back the individual child snapshots. In the following example, the `/rpool/export/home/zoneA` and child snapshots file systems are rolled back to the initial snapshot.

```
# root@mkblade:~# zfs rollback rpool/export/home/zoneA@initial
# root@mkblade:~# zfs rollback rpool/export/home/zoneA/rpool@initial
# root@mkblade:~# zfs rollback rpool/export/home/zoneA/rpool/ROOT@initial
# root@mkblade:~# zfs rollback rpool/export/home/zoneA/rpool/ROOT/solaris@initial
# root@mkblade:~# zfs rollback rpool/export/home/zoneA/rpool/ROOT/solaris/var@initial
```

```
# root@mkblade:~# zfs rollback rpool/export/home/zoneA/rpool/VARSHARE@initial
# root@mkblade:~# zfs rollback rpool/export/home/zoneA/rpool/export@initial
# root@mkblade:~# zfs rollback rpool/export/home/zoneA/rpool/export/home@initial
# root@mkblade:~# zfs rollback rpool/export/home/zoneA/rpool/export/home/sun@initial
```

Back to the example: After performing the `zfs rollback` command on `zoneA`, you can see that the created data `file1` doesn't exist under the directory `/export/home`.

```
# root@zoneA:/export/home# ls -la
total 9
drwxr-xr-x   3 root     root           3 Aug  4 15:17 .
drwxr-xr-x   3 root     root           4 Jul  2 11:10 ..
drwxr-xr-x   2 sun      staff          5 Jul 21 20:11 sun
```

Destroying a ZFS Snapshot

Snapshots are destroyed by using the `zfs destroy` command. For example:

```
# zfs destroy [-rRd] snapshot
# zfs destroy -r rpool/export/home/zoneA@initial
```

The given snapshot is destroyed immediately if and only if the `zfs destroy` command within the `-d` option would have destroyed it.

`-d` Defer snapshot.

`-r` Destroy (or mark for deferred deletion) all snapshots with this name in descendent file systems.

`-R` Recursively destroy all dependents.

```
# root@mkblade:~# zfs destroy -r rpool/export/home/zoneA@intial
# root@mkblade:~# zfs list -t all
NAME                                                  USED  AVAIL  REFER  MOUNTPOINT
rpool                                                31,7G   234G  4,58M  /rpool
rpool/ROOT                                           2,39G   234G    31K  legacy
rpool/ROOT/solaris                                   2,39G   234G  1,98G  /
rpool/ROOT/solaris@install                           6,21M      -  1,92G  -
rpool/ROOT/solaris/var                                409M   234G   407M  /var
rpool/ROOT/solaris/var@install                       1,69M      -  97,3M  -
rpool/VARSHARE                                        301K   234G   301K  /var/share
rpool/dump                                           24,8G   235G  24,0G  -
rpool/export                                          445M   234G    32K  /export
rpool/export/home                                     445M   234G    33K  /export/home
rpool/export/home/sun                                  35K   234G    35K  /export/home/sun
rpool/export/home/zoneA                               445M   234G    33K  /export/home/zoneA
rpool/export/home/zoneA/rpool                         445M   234G    31K
/export/home/zoneA/root/rpool
rpool/export/home/zoneA/rpool/ROOT                    444M   234G    31K  legacy
rpool/export/home/zoneA/rpool/ROOT/solaris            444M   234G   416M  /export/home/zoneA/root
rpool/export/home/zoneA/rpool/ROOT/solaris@install    362K      -   390M  -
rpool/export/home/zoneA/rpool/ROOT/solaris/var       28,0M   234G  27,4M  /export/home/zoneA/root/var
rpool/export/home/zoneA/rpool/ROOT/solaris/var@install  669K      -  27,2M  -
rpool/export/home/zoneA/rpool/VARSHARE                 39K   234G    39K  /export/home/zoneA/root/var/share
rpool/export/home/zoneA/rpool/export                   98K   234G    32K  /export/home/zoneA/root/export
rpool/export/home/zoneA/rpool/export/home              66K   234G    32K
/export/home/zoneA/root/export/home
rpool/export/home/zoneA/rpool/export/home/sun          34K   234G    34K  /export/home/zoneA/root/export/home
rpool/swap                                           4,13G   234G  4,00G  -
```

A dataset cannot be destroyed if snapshots of the dataset exist. For example:

```
# root@mkblade:~# zfs destroy rpool/export/home/zoneA
cannot destroy 'rpool/export/home/zoneA': filesystem has children
use '-r' to destroy the following datasets:
rpool/export/home/zoneA/rpool/ROOT/solaris/var@install
rpool/export/home/zoneA/rpool/ROOT/solaris/var@initial
rpool/export/home/zoneA/rpool/ROOT/solaris/var
rpool/export/home/zoneA/rpool/ROOT/solaris@install
rpool/export/home/zoneA/rpool/ROOT/solaris@initial
rpool/export/home/zoneA/rpool/ROOT/solaris
rpool/export/home/zoneA/rpool/ROOT@initial
rpool/export/home/zoneA/rpool/ROOT
rpool/export/home/zoneA/rpool/export/home/sun@initial
rpool/export/home/zoneA/rpool/export/home/sun
rpool/export/home/zoneA/rpool/export/home@initial
rpool/export/home/zoneA/rpool/export/home
rpool/export/home/zoneA/rpool/export@initial
rpool/export/home/zoneA/rpool/export
rpool/export/home/zoneA/rpool/VARSHARE@initial
rpool/export/home/zoneA/rpool/VARSHARE
rpool/export/home/zoneA/rpool@initial
rpool/export/home/zoneA/rpool
rpool/export/home/zoneA@initial
```

About the Author

This document is based on Motahareh Kardeh's experience with ZFS snapshot and rollback on Oracle Solaris. Motahareh Kardeh is a Software Developer in Oracle's ISV-Engineering teams for SAP and Security.

References

For more information about Oracle Solaris and ZFS snapshot and rollback, see the following documents:

- Oracle Solaris ZFS Administration Guide.
  docs.oracle.com/cd/E19253-01/819-5461/gbcya/index.html
- Man pages section 1M: System Administration Commands.
  docs.oracle.com/cd/E19253-01/816-5166/6mbb1kqo8/index.html
- Oracle Solaris Administration: ZFS File Systems.
  docs.oracle.com/cd/E23824_01/html/821-1448/gbciq.html#gbcxk

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