OpenZFS Everywhere

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We ❤ OpenZFS

Jörgen's Development

2013

OpenZFS on Mac OS X

2017

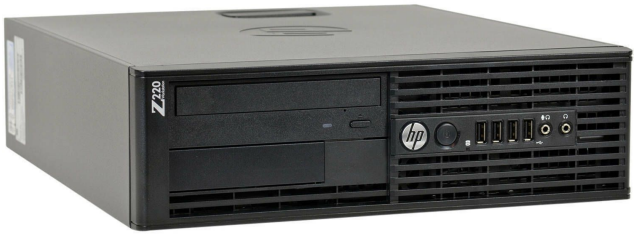
OpenZFS on Windows

Michael's Lab

10 X HP Z220 Xeon E3's

8 X HP Z420 Xeon E5's

2 X Dell R720 Xeon E5's



A Very Brief History

2005 OpenSolaris
2006 Linux/FUSE
2007 Apple/MacZFS
2008 FreeBSD
2009 NetBSD
2010 OpenSolaris
2012 Zevo Mac OS X
2013 ZFS on Linux
2013 Mac OS X/macOS
2017 Windows
2017 NetBSD (FreeBSD Rebase)

OpenZFS Today

Illumos – Production, Upstream: Self
Linux – Production, Upstream: Self
FreeBSD – Production, Illumos/ZoL
macOS – Production, Upstream: Illumos
NetBSD – Experimental, Upstream: FreeBSD
Windows, Upstream: macOS

The Feature Flag Gap: Everyone Has...

```
feature@async_destroy
feature@empty_bpobj
feature@lz4_compress
feature@multi_vdev_crash_dump
feature@spacemap_histogram
feature@_txg
feature@hole_birth
feature@extensible_dataset
feature@embedded_data
feature@bookmarks
feature@filesystem_limits
feature@large_blocks
```

Feature Flag Gap: FreeBSD 11.2 Lacks...

`feature@large_dnode`

`feature@edonr`

`feature@spacemap_v2`

Feature Flag Gap: OmniOSCE Lacks…

`feature@encryption`

`feature@allocation_classes`

`feature@resilver_defer`

`feature@bookmark_v2`

Feature Flag Gap: Windows & macOS Lack…

`feature@userobj_accounting`

`feature@project_quota`

Feature Flag Gap: ZoL on FreeBSD Exclusives!

```
feature@redaction_bookmarks

feature@redacted_datasets

feature@bookmark_written

feature@log_spacemap
```

Feature Flags For The Win!

Root on ZFS

Illumos and Solaris: Definitive

FreeBSD and Derivatives: Mature

GNU/Linux: Fledgling

NetBSD: Not Supported

macOS/Windows: In a minute...

Installation type

This computer currently has Ubuntu 19.04 on it. What would you like to do?

- ○ Erase Ubuntu 19.04 and reinstall
  Warning: This will delete all your Ubuntu 19.04 programs, documents, photos, music, and any other files.
- ○ Install Ubuntu alongside Ubuntu 19.04
  Documents, music, and other personal files will be kept. You can choose which operating system you want each time the computer starts up.
- ○ Erase disk and install Ubuntu
  Warning: This will delete all your programs, documents, photos, music, and any other files in all operating systems.
  - ☐ Encrypt the new Ubuntu installation for security
    You will choose a security key in the next step.
  - ☐ Use LVM with the new Ubuntu installation
    This will set up Logical Volume Management. It allows taking snapshots and easier partition resizing.
- ◉ EXPERIMENTAL: Erase disk and use ZFS
  Warning: This will delete all your files on all operating systems. This is experimental and may cause data loss. Do not use on production systems.
- ○ Something else
  You can create or resize partitions yourself, or choose multiple partitions for Ubuntu.

Quit Back Continue

Root on ZFS

Ubuntu 19.10: Integrated!

```
root@ubuntu:~# zpool list
NAME      SIZE      ALLOC  FREE   CKPOINT  EXPANDSZ   FRAG  CAP DEDUP HEALTH  ALTROOT
bpool     1.88G     130M   1.75G        -         -    -    6%  1.00x ONLINE  -
rpool     107G      3.00G  104G         -         -    0%   2%  1.00x ONLINE  -

Device       Start       End   Sectors   Size Type
/dev/sda1     2048   1050623   1048576   512M EFI System
/dev/sda2  1050624   1153023    102400   50M Linux filesystem
/dev/sda3  1153024   5347327   4194304   2G Linux swap
/dev/sda4  5347328   9541631   4194304   2G Solaris boot
/dev/sda5  9541632 234441614 224899983   107.2G Solaris root

Device         Start       End   Sectors   Size Type
/dev/sdb1       2048 234424319 234422272   111.8G Solaris /usr & Apple ZFS
/dev/sdb9  234424320 234440703     16384   8M Solaris reserved 1
```

Root on ZFS

Ubuntu 19.10: Integrated!

```
libzfs2linux/eoan,now 0.8.1-1ubuntu14 amd64 [installed]
zfs-initramfs/eoan,now 0.8.1-1ubuntu14 amd64 [installed]
zfs-zed/eoan,now 0.8.1-1ubuntu14 amd64 [installed]
zfsutils-linux/eoan,now 0.8.1-1ubuntu14 amd64 [installed]

bpool  feature@async_destroy          disabled                       local
bpool  feature@empty_bpobj            disabled                       local
bpool  feature@lz4_compress           disabled                       local
bpool  feature@multi_vdev_crash_dump  disabled                       local
bpool  feature@spacemap_histogram     disabled                       local
bpool  feature@enabled_txg            disabled                       local
bpool  feature@hole_birth             disabled                       local
bpool  feature@extensible_dataset     disabled                       local
bpool  feature@embedded_data          disabled                       local
bpool  feature@bookmarks              disabled                       local
...
```

Root on ZFS

Proxmox 5: Integrated!

```
root@proxmox:~# zpool list
NAME      SIZE ALLOC   FREE  CKPOINT  EXPANDSZ   FRAG  CAP  DEDUP     HEALTH  ALTROOT
rpool     928G 1.10G   927G        -         -    0%   0%   1.00x     ONLINE  -

Device       Start        End    Sectors  Size Type
/dev/sda1       34       2047       2014 1007K BIOS boot
/dev/sda2     2048    1050623    1048576  512M EFI System
/dev/sda3  1050624 1953525134 1952474511  931G Solaris /usr & Apple ZFS

libzfs2linux/now 0.8.1-pve1 amd64 [installed,local]
zfs-initramfs/now 0.8.1-pve1 all [installed,local]
zfsutils-linux/now 0.8.1-pve1 amd64 [installed,local]
```

One Pool!

Proxmox 5

```
rpool  feature@async_destroy          enabled                    local
rpool  feature@empty_bpobj            active                     local
rpool  feature@lz4_compress           active                     local
rpool  feature@multi_vdev_crash_dump  enabled                    local
rpool  feature@spacemap_histogram     active                     local
rpool  feature@enabled_txg            active                     local
rpool  feature@hole_birth             active                     local
rpool  feature@extensible_dataset     active                     local
rpool  feature@embedded_data          active                     local
rpool  feature@bookmarks              enabled                    local
rpool  feature@filesystem_limits      enabled                    local
rpool  feature@large_blocks           enabled                    local
rpool  feature@large_dnode            enabled                    local
rpool  feature@sha512                 enabled                    local
rpool  feature@skein                  enabled                    local
rpool  feature@edonr                  enabled                    local
rpool  feature@userobj_accounting     active                     local
rpool  feature@encryption             enabled                    local
...
```

The send/receive Baton Pass

```
root@freenas[~]# md5 /tank/baton/baton.img
MD5 (/tank/baton/baton.img)
=329e6a75bae28cf5ab709f92b47f2972
```

FreeNAS to ZoLoF • ZoLoF to FreeBSD ARM64 • FreeBSD ARM64 to OmniOSCE

OmniOSCE to Ubuntu 19.10 • Ubuntu 19.10 to Debian 10

Debian 10 to NetBSD • NetBSD to macOS

Windows 10 *pull from* NetBSD • NetBSD to Solaris 11.2

```
root@solaris:~# md5sum /tank/baton/baton.img
329e6a75bae28cf5ab709f92b47f2972  /tank/baton/baton.img
```

The Oracle ZFS Question

Success! v28 send from ZoLoF to Solaris 11.2

Success! FreeBSD 11.2/12.1 to Solaris 11.2

Success! Debian 10 to Solaris 11.2

Solaris 11.2 or 11.4 to Anywhere:

`cannot receive: stream has unsupported feature, feature flags = 24` or `4a`

Anywhere to 11.4:

```
cannot receive: '' is not resumable:
cannot find resumable dataset for guid=0.
```

A Few Numbers

“All benchmarks are wrong”

`fio(1)` versions differ

`fio(1)` is not available on Solaris

`sync=always compression=off`

`--bs=128k --size=1G --readwrite=randrw --sync=1`

Hardware: Crucial BX500 120GB

A Few Numbers

macOS ZFS
READ: bw=111MiB/s (116MB/s)
WRITE: bw=114MiB/s (119MB/s)

macOS APFS
READ: bw=284MiB/s (298MB/s)
WRITE: bw=290MiB/s (304MB/s)

A Few Numbers

Windows ZFS
READ: bw=87.4MiB/s (91.6MB/s)
WRITE: bw=89.3MiB/s (93.7MB/s)

Windows NTFS
READ: bw=67.6MiB/s (70.9MB/s)
WRITE: bw=69.1MiB/s (72.5MB/s)

A Few Numbers

Windows ZFS
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Windows NTFS
READ: bw=67.6MiB/s (70.9MB/s)
WRITE: bw=69.1MiB/s (72.5MB/s)

A Few Numbers

NetBSD ZFS
READ: bw=100MiB/s (105MB/s)
WRITE: bw=101MiB/s (106MB/s)

NetBSD UFS
READ: bw=61.8MiB/s (64.8MB/s)
WRITE: bw=61.1MiB/s (64.1MB/s)

A Few Numbers

OmniOSCE ZFS
READ: bw=59.2MiB/s (62.1MB/s)
WRITE: bw=60.5MiB/s (63.5MB/s)

Ubuntu ZFS
READ: bw=39.3MiB/s (41.2MB/s)
WRITE: bw=40.2MiB/s (42.2MB/s)

A Few Numbers

Debian ZFS
READ: bw=95.9MiB/s (101MB/s)
WRITE: bw=98.1MiB/s (103MB/s)

Debian Native
READ: bw=70.8MiB/s (74.2MB/s)
WRITE: bw=72.4MiB/s (75.9MB/s)

A Few Numbers

FreeNAS 11.2
READ: bw=130MiB/s (137MB/s)
WRITE: bw=133MiB/s (140MB/s)

ZoLoF
READ: bw=67.1MiB/s (70.3MB/s)
WRITE: bw=68.6MiB/s (71.9MB/s)

A Few Numbers

FreeBSD 12.0 ARM64
READ: bw=104MiB/s (110MB/s)
WRITE: bw=107MiB/s (112MB/s)

Mail me your favorite tests.

Eyes on the Prize

```
Select Boot Environment:

       [ X ] illumos

       [   ] FreeBSD

       [   ] Windows
```

I’m not worried about OpenZFS…

Michael Dexter
@michaeldexter

Follow

SAS Multipathing on GNU/Linux...

16% All the time!

26% Yeh, tried it a few times

58% What's that?

19 votes • Final results

9:59 PM - 24 Oct 2019

2 Retweets **2** Likes

2 2

Obtaining a disk label...

FreeBSD: `glabel status`

GNU/Linux:

```
blkid -s LABEL
lsblk -o label
e2label /dev/sda
udevadm info /dev/sda
tune2fs -l /dev/sda
mount -l
```

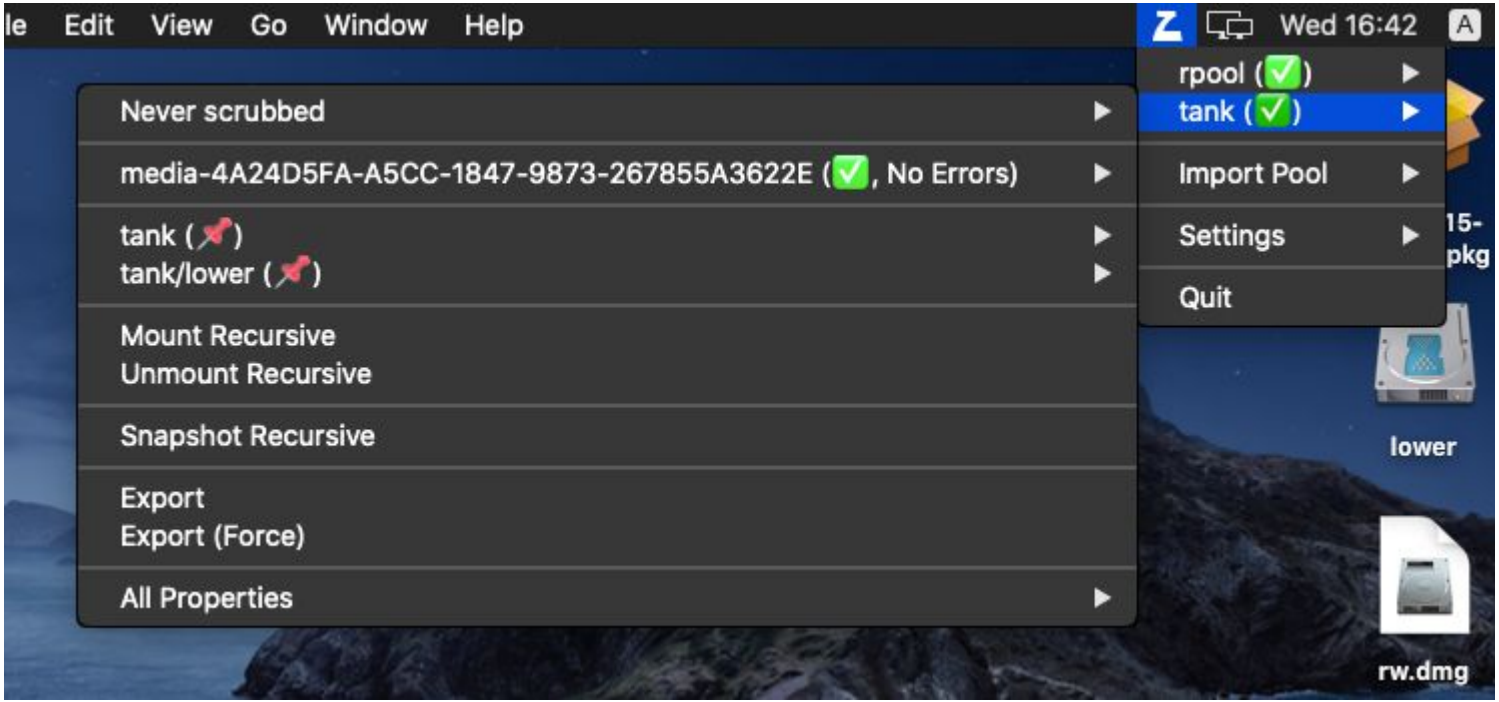
It Takes A Village...

GRUB/Loader Challenges
Partitioning Differences
SAS Multipath/SED Differences
ACL/Metadata Differences
No `zed(8)` in Proxmox 5 and others
Different or Missing Perf/Observability Tools
Machine Parsability of Utility Output
ARM64 Builds... PowerShell hates `'zfs send'`...
GPT is a standard without a standard implementation...

OpenZFS on OS X
(macOS ?)

- Version: 1.9.3 (Catalina)
- macOS 10.11-10.15
- ZFS boot with fonts (?!)
- ZOL upstream prep

Zeta Watch


le Edit View Go Window Help
Wed 16:42
A
rpool (✅)
tank (✅)
Import Pool
Settings
Quit
Never scrubbed
media-4A24D5FA-A5CC-1847-9873-267855A3622E (✅, No Errors)
tank (📌)
tank/lower (📌)
Mount Recursive
Unmount Recursive
Snapshot Recursive
Export
Export (Force)
All Properties
15-
pkg
lower
rw.dmg

Open ZFS on Windows

- Version: 0.20
- Signed Installer
- No boot, yet
- Lx/Ubuntu

Have a help wanted slide?

Thank You!

@MichaelDexter

@JorgenLundman