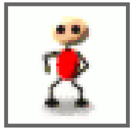
ZFS Boot Environments

Sławomir Wojciech Wojtczak



vermaden@interia.pl
vermaden.wordpress.com
twitter.com/vermaden

https://is.gd/BEADM

What is ZFS Boot Environment?

Its bootable **clone/snapshot** of the working system.

What is ZFS Boot Environment?

Its bootable **clone/snapshot** of the working system.

- In ZFS terminology its **clone** of the **snapshot**.

  ZFS dataset → ZFS dataset@snapshot → ZFS clone (origin=dataset@snapshot)

What is ZFS Boot Environment?

Its bootable **clone/snapshot** of the working system.

- In ZFS terminology its **clone** of the **snapshot**.

  ZFS dataset → ZFS dataset@snapshot → ZFS clone (origin=dataset@snapshot)

- In ZFS (as everywhere) **snapshot** is **read only**.

What is ZFS Boot Environment?

Its bootable **clone/snapshot** of the working system.

- In ZFS terminology its **clone** of the **snapshot**.

  ZFS dataset → ZFS dataset@snapshot → ZFS clone (origin=dataset@snapshot)

- In ZFS (as everywhere) **snapshot** is **read only**.

- In ZFS **clone** can be mounted **read write** (and you can *boot* from it).

What is ZFS Boot Environment?

Its bootable **clone/snapshot** of the working system.

- In ZFS terminology its **clone** of the **snapshot.**

  ZFS dataset → ZFS dataset@snapshot → ZFS clone (origin=dataset@snapshot)

- In ZFS (as everywhere) **snapshot** is **read only.**

- In ZFS **clone** can be mounted **read write** (and you can *boot* from it).

- The BEs are placed in the **pool/ROOT** ZFS dataset path.

  sys/ROOT/default

  sys/ROOT/pre-upgrade

  (...)

Use cases?

Allows **bulletproof** upgrades/changes to the system.

Use cases?

Allows **bulletproof** upgrades/changes to the system.

- Create **safe failback** ZFS Boot Environmnent before upgrade or major changes to system.

Use cases?

Allows **bulletproof** upgrades/changes to the system.

- Create **safe failback** ZFS Boot Environmnent before upgrade or major changes to system.

- Update system **inside** new ZFS Boot Environmnent without touching running system.

Use cases?

Allows **bulletproof** upgrades/changes to the system.

- Create **safe failback** ZFS Boot Environmnent before upgrade or major changes to system.
- Update system **inside** new ZFS Boot Environmnent without touching running system.
- Perform upgrade and test the results **inside FreeBSD Jail**.

Use cases?

Allows **bulletproof** upgrades/changes to the system.

- Create **safe failback** ZFS Boot Environmnent before upgrade or major changes to system.
- Update system **inside** new ZFS Boot Environmnent without touching running system.
- Perform upgrade and test the results **inside FreeBSD Jail**.
- **Copy/move** ZFS Boot Environment into another machine.

Use cases?

Allows **bulletproof** upgrades/changes to the system.

- Create **safe failback** ZFS Boot Environmnent before upgrade or major changes to system.
- Update system **inside** new ZFS Boot Environmnent without touching running system.
- Perform upgrade and test the results **inside FreeBSD Jail**.
- **Copy/move** ZFS Boot Environment into another machine.
- **Major reconfiguration** (Bareos/Postfix/...).

Can I test and break ZFS BEs without consequence?

Yes you **can! Over and over** again.

Groundhog Day (1993)

How it was before BEs?

Vendors used **split mirror** or **copying files** to the other/second disk.

IBM AIX

```
alt_disk_copy
alt_disk_install
nimadm
unmirrorvg
( … )
```

SUN Solaris *Live Upgrade*

```
lucreate
luactivate
luupgrade
ludelete
( … )
```

HP-UX

```
lvsplit
lvmerge
vgchange
vgcfgrestore
( … )
```

GNU/Linux

```
mdadm
mirrorlv
lvconvert
( … )
```

Mistyped command?

Felling **lucky**?

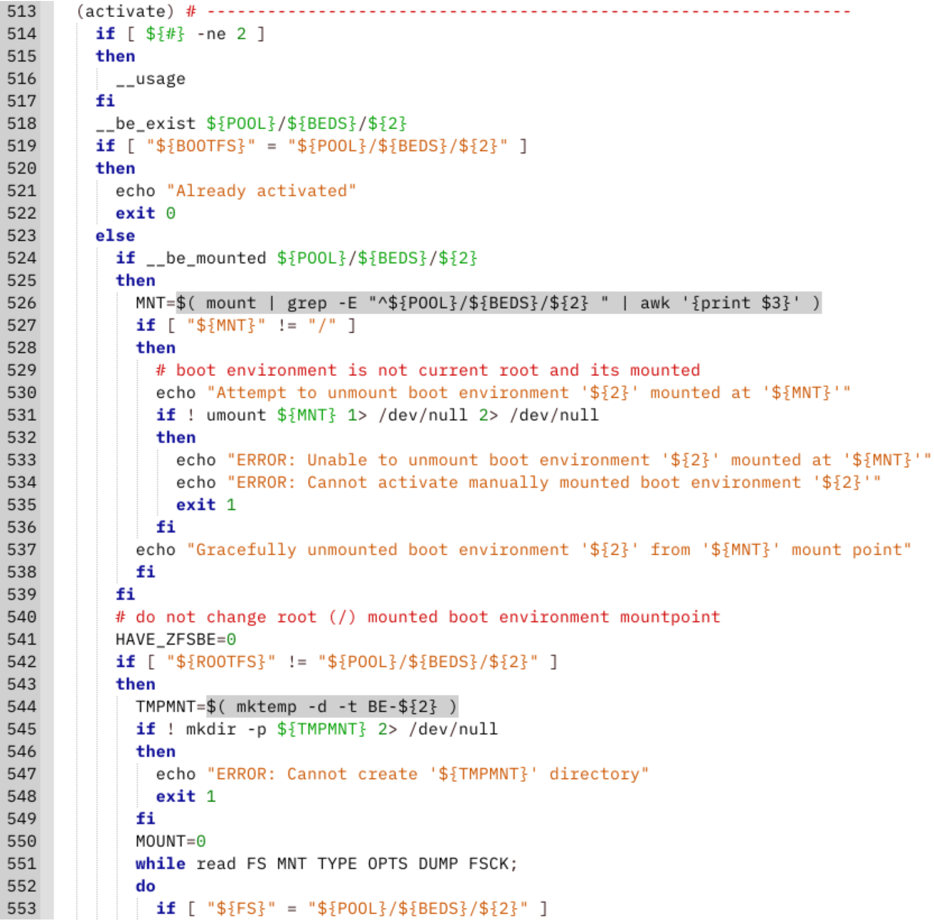
Raiders of the Lost Ark (1981)

The beadm command

One simple command – **beadm** – to create/activate/destroy ZFS Boot Environments.

```
# beadm
usage:
  beadm activate <beName>
  beadm create [-e nonActiveBe | -e beName@snapshot] <beName>
  beadm create <beName@snapshot>
  beadm destroy [-F] <beName | beName@snapshot>
  beadm list [-a] [-s] [-D] [-H]
  beadm rename <origBeName> <newBeName>
  beadm mount <beName> [mountpoint]
  beadm { umount | unmount } [-f] <beName>
  beadm version
```

The beadm is written in POSIX /bin/sh



```
(activate) # -----------------------------------------------------------------
  if [ ${#} -ne 2 ]
  then
    __usage
  fi
  __be_exist ${POOL}/${BEDS}/${2}
  if [ "${BOOTFS}" = "${POOL}/${BEDS}/${2}" ]
  then
    echo "Already activated"
    exit 0
  else
    if __be_mounted ${POOL}/${BEDS}/${2}
    then
      MNT=$( mount | grep -E "^${POOL}/${BEDS}/${2} " | awk '{print $3}' )
      if [ "${MNT}" != "/" ]
      then
        # boot environment is not current root and its mounted
        echo "Attempt to unmount boot environment '${2}' mounted at '${MNT}'"
        if ! umount ${MNT} 1> /dev/null 2> /dev/null
        then
          echo "ERROR: Unable to unmount boot environment '${2}' mounted at '${MNT}'"
          echo "ERROR: Cannot activate manually mounted boot environment '${2}'"
          exit 1
        fi
      echo "Gracefully unmounted boot environment '${2}' from '${MNT}' mount point"
      fi
    fi
    # do not change root (/) mounted boot environment mountpoint
    HAVE_ZFSBE=0
    if [ "${ROOTFS}" != "${POOL}/${BEDS}/${2}" ]
    then
      TMPMNT=$( mktemp -d -t BE-${2} )
      if ! mkdir -p ${TMPMNT} 2> /dev/null
      then
        echo "ERROR: Cannot create '${TMPMNT}' directory"
        exit 1
      fi
      MOUNT=0
      while read FS MNT TYPE OPTS DUMP FSCK;
      do
        if [ "${FS}" = "${POOL}/${BEDS}/${2}" ]
```

Example beadm **usage** (1/5)

List current BEs and create new one named **newbe**.

```
# beadm list
BE           Active Mountpoint  Space Created
11.2-RELEASE NR     /            6.3G 2018-05-21 16:01

# beadm create newbe
Created successfully

# beadm list
BE           Active Mountpoint  Space Created
11.2-RELEASE NR     /            6.3G 2018-05-21 16:01
newbe        -      -          296.0K 2018-07-18 10:04
```

Example beadm usage (2/5)

Verify which **snapshot** is used for this **clone** used as **newbe** BE.

```
# beadm list -s
BE/Dataset/Snapshot                         Active Mountpoint  Space Created

11.2-RELEASE
  sys/ROOT/11.2-RELEASE                     NR     /             6.3G 2018-05-21 16:01
  sys/ROOT/11.2-RELEASE@2018-07-18-10:04:22 -      -           288.0K 2018-07-18 10:04

newbe
  sys/ROOT/newbe                            -      -             8.0K 2018-07-18 10:04
    11.2-RELEASE@2018-07-18-10:04:22        -      -           288.0K 2018-07-18 10:04

# zfs get origin sys/ROOT/newbe
NAME            PROPERTY  VALUE                                      SOURCE
sys/ROOT/newbe  origin    sys/ROOT/11.2-RELEASE@2018-07-18-10:04:22  -
```

Example beadm **usage** (3/5)

Rename **snapshot** used for this **clone**.

```
# zfs rename sys/ROOT/11.2-RELEASE@2018-07-18-10:04:22 sys/ROOT/11.2-RELEASE@newbe

# zfs get origin sys/ROOT/newbe
NAME            PROPERTY  VALUE                        SOURCE
sys/ROOT/newbe  origin    sys/ROOT/11.2-RELEASE@newbe  -

# beadm list -s
BE/Dataset/Snapshot           Active Mountpoint  Space Created

11.2-RELEASE
  sys/ROOT/11.2-RELEASE       NR     /            6.3G 2018-05-21 16:01
  sys/ROOT/11.2-RELEASE@newbe -      -          516.0K 2018-07-18 10:04

newbe
  sys/ROOT/newbe              -      -            8.0K 2018-07-18 10:04
    11.2-RELEASE@newbe        -      -          516.0K 2018-07-18 10:04
```

Example beadm usage (4/5)

Activate the **newbe** BE to be booted after the restart.

```
# beadm list
BE           Active Mountpoint  Space Created
11.2-RELEASE NR     /            6.4G 2018-05-21 16:01
newbe        -      -           68.8M 2018-07-18 10:04

# beadm activate newbe
Activated successfully

# beadm list
BE           Active Mountpoint  Space Created
11.2-RELEASE N      /          187.5M 2018-05-21 16:01
newbe        R      -            6.3G 2018-07-18 10:04
```

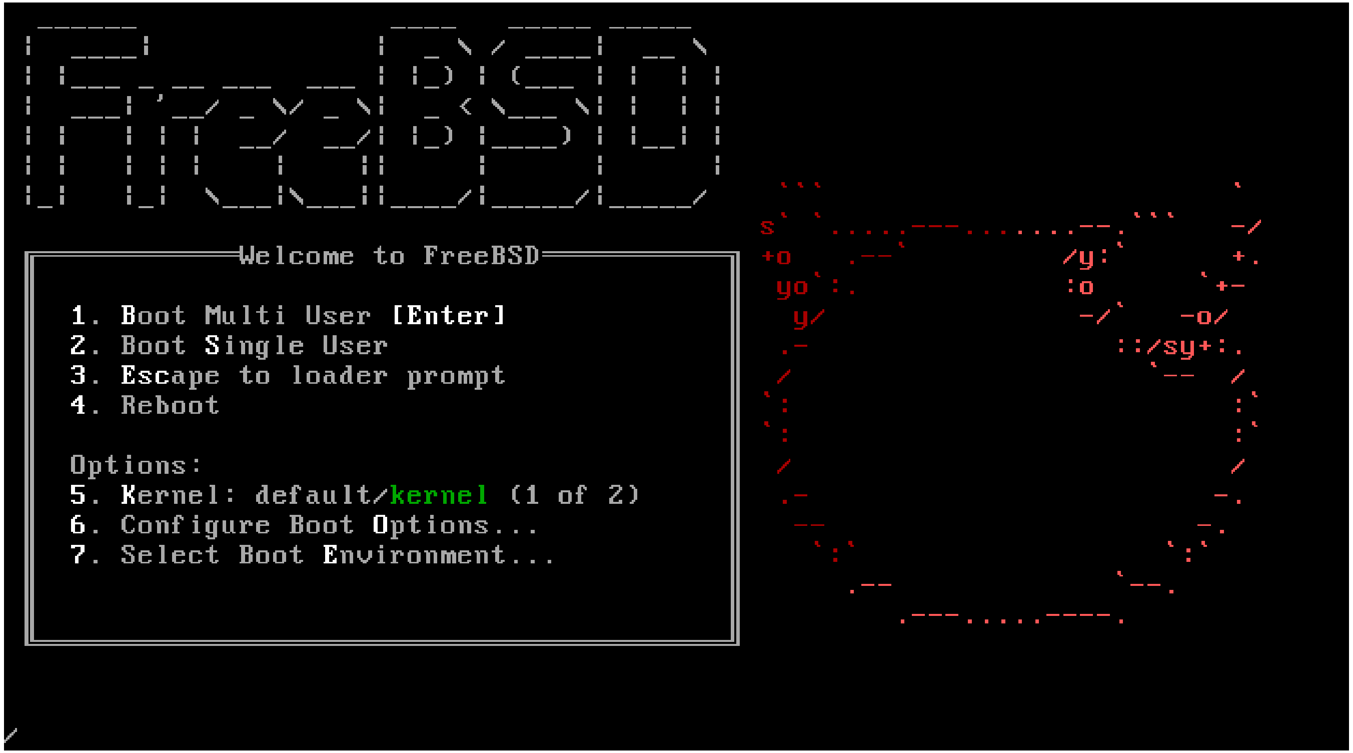
Example beadm usage (5/5)

Remove **newbe**. It will ask for additional confirmation as we renamed snapshot.

```
# beadm list
BE           Active Mountpoint  Space Created
11.2-RELEASE NR     /            6.4G 2018-05-21 16:01
newbe        -      -           68.8M 2018-07-18 10:04

# beadm destroy newbe
Are you sure you want to destroy 'newbe'?
This action cannot be undone (y/[n]): y
Boot environment 'newbe' was created from existing snapshot
Destroy '11.2-RELEASE@newbe' snapshot? (y/[n]): y
Destroyed successfully

# beadm list
BE           Active Mountpoint  Space Created
11.2-RELEASE NR     /            6.4G 2018-05-21 16:01
```

FreeBSD `loader` integration

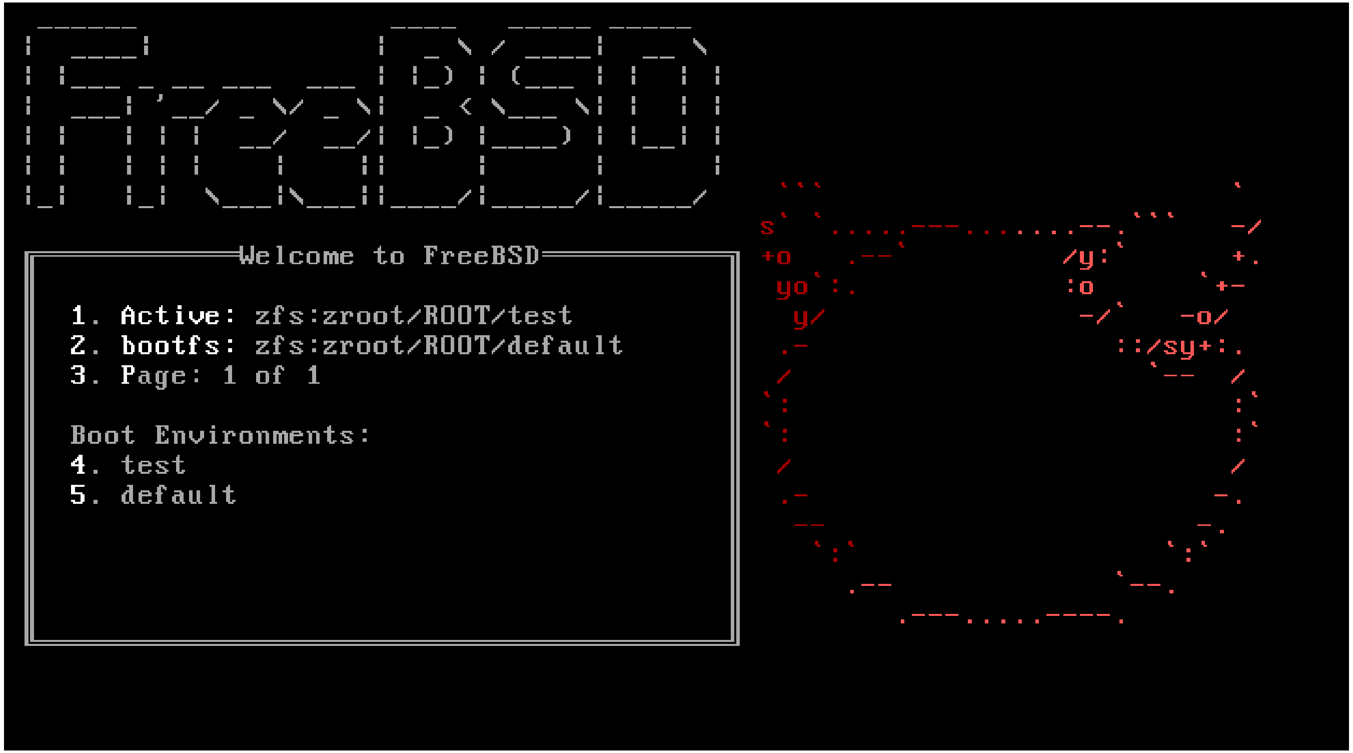
Selection of BE at boot is integrated into the FreeBSD **loader**.



```
Welcome to FreeBSD

1. Boot Multi User [Enter]
2. Boot Single User
3. Escape to loader prompt
4. Reboot

Options:
5. Kernel: default/kernel (1 of 2)
6. Configure Boot Options...
7. Select Boot Environment...
```

FreeBSD `loader` integration

The **`test`** BE is selected to boot instead of the **`default`** one.

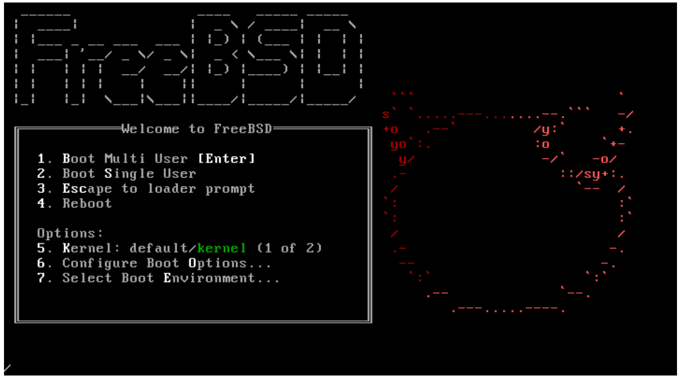


```
Welcome to FreeBSD

1. Active: zfs:zroot/ROOT/test
2. bootfs: zfs:zroot/ROOT/default
3. Page: 1 of 1

Boot Environments:
4. test
5. default
```

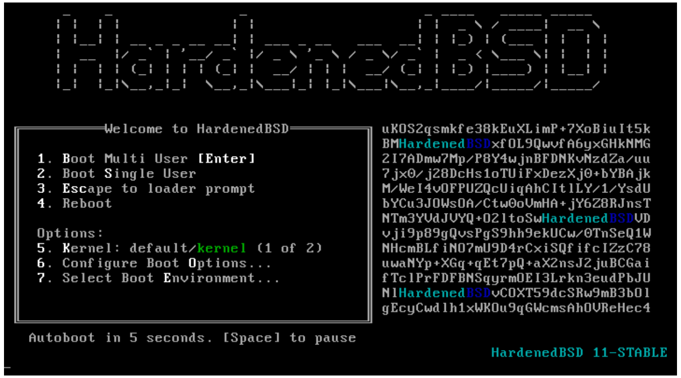
Not just FreeBSD `loader` ...

Its integrated into **other operating systems** as well.

- **BSDs**
  - FreeBSD
  - HardenedBSD
    (rolling FreeBSD fork)
- **Illumos**
  - OpenIndiana
  - OmniOS



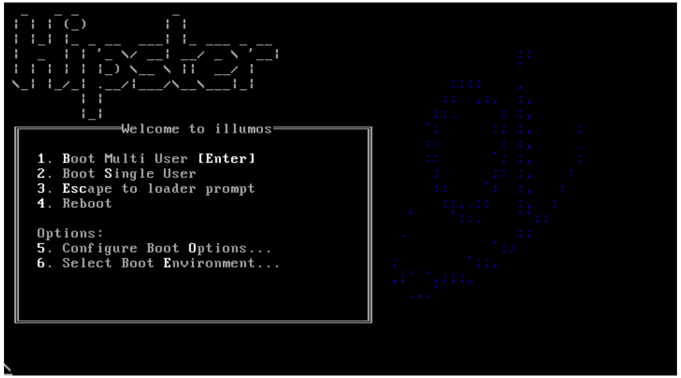
```
Welcome to FreeBSD

 1. Boot Multi User [Enter]
 2. Boot Single User
 3. Escape to loader prompt
 4. Reboot

 Options:
 5. Kernel: default/kernel (1 of 2)
 6. Configure Boot Options...
 7. Select Boot Environment...
```



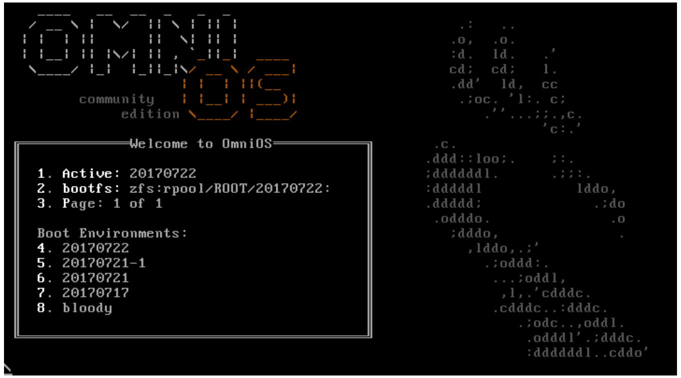
```
Welcome to HardenedBSD

 1. Boot Multi User [Enter]
 2. Boot Single User
 3. Escape to loader prompt
 4. Reboot

 Options:
 5. Kernel: default/kernel (1 of 2)
 6. Configure Boot Options...
 7. Select Boot Environment...

Autoboot in 5 seconds. [Space] to pause
```

```
uKOS2qsmkfe38kEuXLimP+7XoBiuIt5k
BMHardenedBSDxfOL9QwvfA6yxGHkNMG
2I7ADmw7Mp/P8Y4wjnBFDNKvNzdZa/uu
7jx0/jZ8DcHs1oTUiFxDezXj0+bYBAjk
M/WeI4vOFPUZQcUiqAhCItlLY/1/YsdU
bYCu3JOWsOA/Ctw0oVmHA+jY6Z8RJnsT
NTm3YVdJVYQ+O2ltoSwHardenedBSDVD
vji9p89gQvsPgS9hh9ekUCw/0TnSeQ1W
NHcmBLfiNO7mU9D4rCxiSQfifcIZzC78
uwaNYp+XGq+qEt7pQ+aX2nsJ2juBCGai
fTclPrFDFBNSqyrmOEI3Lrkn3eudPbJU
NlHardenedBSDvCOXT59dcSRw9mB3bOl
gEcyCwdlh1xWKOu9qGWcmsAhOVReHec4
```

HardenedBSD 11-STABLE



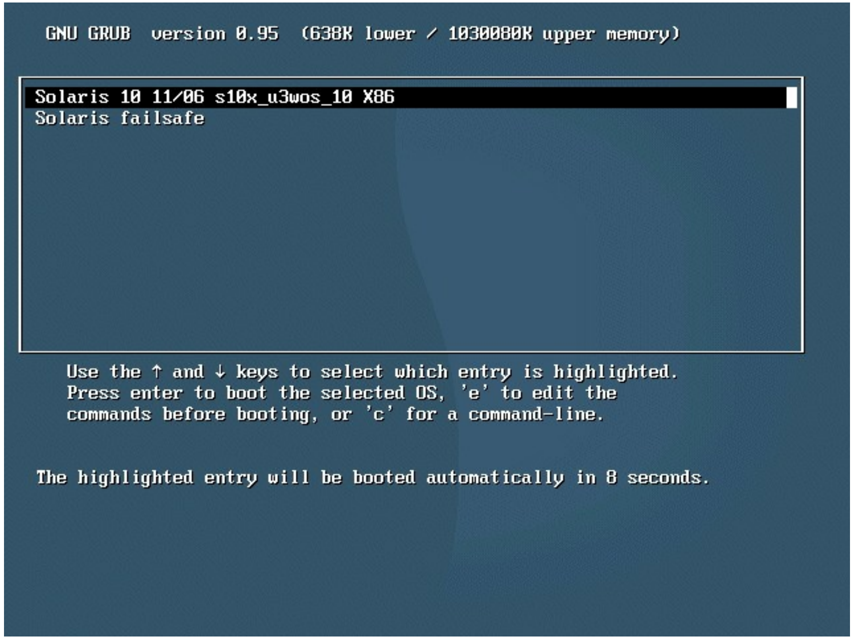
```
Welcome to illumos

 1. Boot Multi User [Enter]
 2. Boot Single User
 3. Escape to loader prompt
 4. Reboot

 Options:
 5. Configure Boot Options...
 6. Select Boot Environment...
```



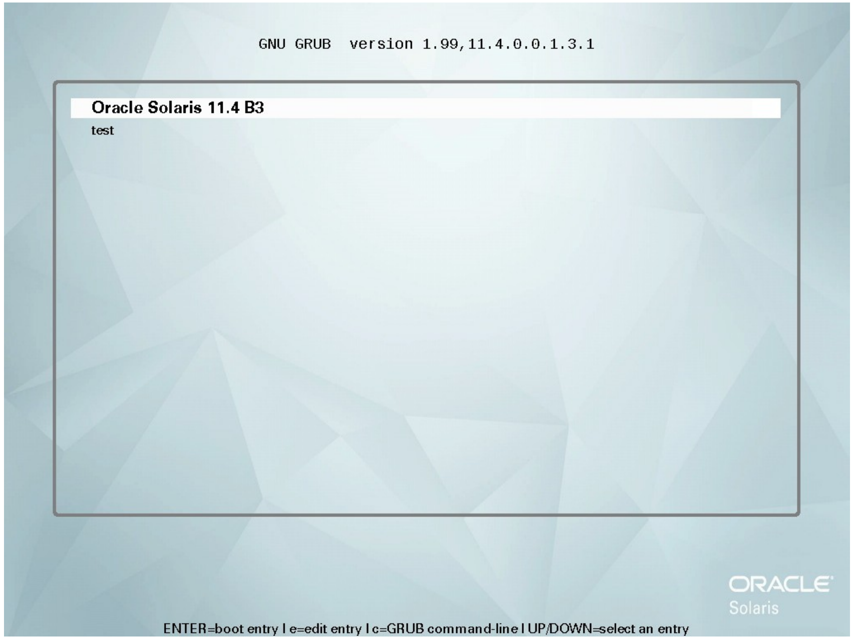
```
Welcome to OmniOS

 1. Active: 20170722
 2. bootfs: zfs:rpool/ROOT/20170722:
 3. Page: 1 of 1

 Boot Environments:
 4. 20170722
 5. 20170721-1
 6. 20170721
 7. 20170717
 8. bloody
```

Original not so original ...

SUN Solaris and **Oracle Solaris** use **GNU GRUB** for the BE selection at boot.



```
  GNU GRUB  version 0.95  (638K lower / 1030080K upper memory)

 Solaris 10 11/06 s10x_u3wos_10 X86
 Solaris failsafe

    Use the ↑ and ↓ keys to select which entry is highlighted.
    Press enter to boot the selected OS, 'e' to edit the
    commands before booting, or 'c' for a command-line.

 The highlighted entry will be booted automatically in 8 seconds.
```



```
GNU GRUB  version 1.99,11.4.0.0.1.3.1

Oracle Solaris 11.4 B3
test

ENTER=boot entry | e=edit entry | c=GRUB command-line | UP/DOWN=select an entry
```

What about Linux?

Instructions are **fragmented and complicated**.

What about Linux?

Instructions are **fragmented and complicated**.

- Only ONE distribution allows root on ZFS install.

  Antergos has ZFS option in installer.

  Ubuntu comes with ZFS support but not for root.

What about Linux?

Instructions are **fragmented and complicated**.

- Only ONE distribution allows root on ZFS install.

  Antergos has ZFS option in installer.

  Ubuntu comes with ZFS support but not for root.

- Howtos do not use **`beadm`** command integration.

What about Linux?

Instructions are **fragmented and complicated**.

- Only ONE distribution allows root on ZFS install.

  Antergos has ZFS option in installer.

  Ubuntu comes with ZFS support but not for root.

- Howtos do not use **`beadm`** command integration.

- Howtos are complicated and **VERY** long.

What about Linux?

Instructions are **fragmented and complicated.**

- Only ONE distribution allows root on ZFS install.

  Antergos has ZFS option in installer.

  Ubuntu comes with ZFS support but not for root.

- Howtos do not use **`beadm`** command integration.

- Howtos are complicated and **VERY** long.

- BTRFS alternative with **`snapper`** on openSUSE/SUSE.

  Red Hat depracated BTRFS recently.

  Red Hat does not have BTRFS developers.

  Red Hat has lots of XFS developers.

  Fedora and CentOS will follow Red Hat.

What about Linux?

Instructions are **fragmented and complicated**.

- Only ONE distribution allows root on ZFS install.

  Antergos has ZFS option in installer.

  Ubuntu comes with ZFS support but not for root.

- Howtos do not use **beadm** command integration.

- Howtos are complicated and **VERY** long.

- BTRFS alternative with **snapper** on openSUSE/SUSE.

  Red Hat depracated BTRFS recently.

  Red Hat does not have BTRFS developers.

  Red Hat has lots of XFS developers.

  Fedora and CentOS will follow Red Hat.

What about BTRFS?

Can **BTRFS Snapshots** provide same functionality as **ZFS Boot Environments**?

What about BTRFS?

Can **BTRFS Snapshots** provide same functionality as **ZFS Boot Environments**?

Nope.

What about BTRFS?

Can **BTRFS Snapshots** provide same functionality as **ZFS Boot Environments**?

Nope.

Cite from **System Recovery and Snapshot Management with Snapper** for **openSUSE Leap 15** Linux.

- Limitations

  A **complete system rollback**, restoring the complete system to the identical state as it was in when a snapshot was taken, **is not possible**.

What about Linux?

Too busy rewriting **`ip`** for **`ifconfig`** or **`ss`** for **`netstat`**?

What about Linux?

Too busy rewriting **`ip`** for **`ifconfig`** or **`ss`** for **`netstat`**? … or **`systemd`** for **`init`**?

What about Linux?

Too busy rewriting **`ip`** for **`ifconfig`** or **`ss`** for **`netstat`**? ... or **`systemd`** for **`init`**?

Default FreeBSD layout supports ZFS BEs

Default Auto (ZFS) **bsdinstall** option supports ZFS BEs.

```
# zfs list
NAME                    USED  AVAIL  REFER  MOUNTPOINT
zroot                   339M  8.87G    88K  /zroot
zroot/ROOT              337M  8.87G    88K  none
zroot/ROOT/default      337M  8.87G   337M  /
zroot/tmp                88K  8.87G    88K  /tmp
zroot/usr               352K  8.87G    88K  /usr
zroot/usr/home           88K  8.87G    88K  /usr/home
zroot/usr/ports          88K  8.87G    88K  /usr/ports
zroot/usr/src            88K  8.87G    88K  /usr/src
zroot/var               596K  8.87G    88K  /var
zroot/var/audit          88K  8.87G    88K  /var/audit
zroot/var/crash          88K  8.87G    88K  /var/crash
zroot/var/log           152K  8.87G   152K  /var/log
zroot/var/mail           92K  8.87G    92K  /var/mail
zroot/var/tmp            88K  8.87G    88K  /var/tmp
```

Default FreeBSD layout supports ZFS BEs

The **/usr** and **/var** filesystems have **canmount** property set to **off**.

```
# zfs get -r canmount zroot
NAME                PROPERTY  VALUE     SOURCE
zroot               canmount  on        default
zroot/ROOT          canmount  on        default
zroot/ROOT/default  canmount  noauto    local
zroot/tmp           canmount  on        default
zroot/usr           canmount  off       local
zroot/usr/home      canmount  on        default
zroot/usr/ports     canmount  on        default
zroot/usr/src       canmount  on        default
zroot/var           canmount  off       local
zroot/var/audit     canmount  on        default
zroot/var/crash     canmount  on        default
zroot/var/log       canmount  on        default
zroot/var/mail      canmount  on        default
zroot/var/tmp       canmount  on        default
```

Default FreeBSD layout supports ZFS BEs

This way **/usr** and **/var** are placed on the **/** dataset the **zroot/ROOT/default** BE.

```
# df -g
Filesystem           1G-blocks Used Avail Capacity  Mounted on
zroot/ROOT/default           9    0     8     4%    /            ⟸ /usr & /var
devfs                        0    0     0   100%    /dev
zroot/tmp                    8    0     8     0%    /tmp
zroot/usr/home               8    0     8     0%    /usr/home
zroot/usr/ports              8    0     8     0%    /usr/ports
zroot/usr/src                8    0     8     0%    /usr/src
zroot/var/audit              8    0     8     0%    /var/audit
zroot/var/crash              8    0     8     0%    /var/crash
zroot/var/log                8    0     8     0%    /var/log
zroot/var/mail               8    0     8     0%    /var/mail
zroot/var/tmp                8    0     8     0%    /var/tmp
zroot                        8    0     8     0%    /zroot
```

Add beadm to FreeBSD

Just add **beadm** package or install **sysutils/beadm** port ... or download it.

- Package.

```
# pkg install -y beadm
```

- Port.

```
# make -C /usr/ports/sysutils/beadm install clean
```

- Manual.

```
# fetch https://raw.githubusercontent.com/vermaden/beadm/master/beadm
# chmod +x beadm
# ./beadm list
BE           Active Mountpoint  Space Created
11.2-RELEASE NR     /            6.4G 2018-05-21 16:01
newbe        -      -           80.2M 2018-07-18 10:04
```

Using update/upgrade tools with BEs

These tools on **FreeBSD** are **`freebsd-update(8)`** and **`pkg(8)`**.

Using update/upgrade tools with BEs

These tools on **FreeBSD** are **`freebsd-update(8)`** and **`pkg(8)`**.

- On **FreeBSD** by default these tools **operate on running system.**

Using update/upgrade tools with BEs

These tools on **FreeBSD** are **`freebsd-update(8)`** and **`pkg(8)`**.

- On **FreeBSD** by default these tools **operate on running system.**
- By contrast on **Solaris/Illumos** by default they operate on newly created BE and require reboot into that BE.

Using update/upgrade tools with BEs

These tools on **FreeBSD** are **freebsd-update(8)** and **pkg(8)**.

- On **FreeBSD** by default these tools **operate on running system.**
- By contrast on **Solaris/Illumos** by default they operate on newly created BE and require reboot into that BE.

PKG(8) - https://man.freebsd.org/pkg

```
    -c ⟨chroot path⟩, --chroot ⟨chroot path⟩
            pkg will chroot in the ⟨chroot path⟩ environment.

    -r ⟨root directory⟩, --rootdir ⟨root directory⟩
            pkg will install all packages within the specified ⟨root directory⟩.
```

FREEBSD-UPDATE(8) - https://man.freebsd.org/freebsd-update

```
    -b basedir     Operate on a system mounted at basedir. (default: /)

    -d workdir     Store working files in workdir. (default: /var/db/freebsd-update)
```

Emulate Solaris/Illumos behaviour on FreeBSD

Example **upgrade of packages** in the newly created BE for that purpose.

```
# beadm create safe
Created successfully

# beadm mount safe
Mounted successfully on '/tmp/BE-safe.ostSai22'

# pkg -r /tmp/BE-safe.ostSai22 update -f
(…)

# pkg -r /tmp/BE-safe.ostSai22 upgrade
(…)

# pkg -r /tmp/BE-safe.ostSai22 info -s feh
feh-2.27.1                     438KiB

# pkg -r / info -s feh
feh-2.27                       438KiB

# pkg info -s feh
feh-2.27                       438KiB
```

Emulate Solaris/Illumos behaviour on FreeBSD

Example **fetch security updates** in the newly created BE for that purpose.

```
# beadm create safe
Created successfully

# beadm mount safe /tmp/safe
Mounted successfully on '/tmp/safe'

# rm -rf /var/db/freebsd-update

# freebsd-update -b /tmp/safe fetch
freebsd-update: Directory does not exist or is not writable: /var/db/freebsd-update

# freebsd-update -b /tmp/safe -d /tmp/safe/var/db/freebsd-update fetch
Looking up update.FreeBSD.org mirrors... 3 mirrors found.
Fetching metadata signature for 11.2-RELEASE from update4.freebsd.org... done.
Fetching metadata index... done.
Inspecting system... done.
Preparing to download files... done.

No updates needed to update system to 11.2-RELEASE-p0.
```

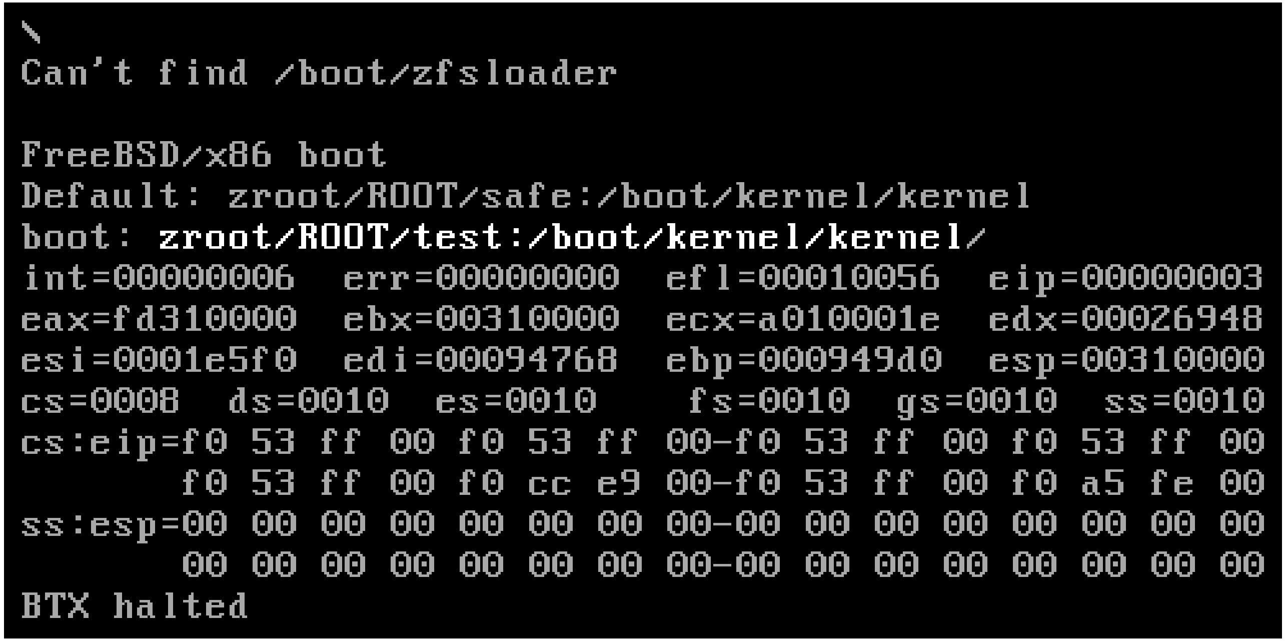
Case where FreeBSD ISO or MEMSTICK boot is required

Deleting **/boot** directory from the BE that is currently set as **bootfs** in your zpool.

```
# beadm create test
Created successfully

# beadm list
BE   Active Mountpoint  Space Created
safe NR     /             6.2G 2018-05-21 16:01
test -      -           220.0K 2018-07-22 01:17

# rm -rf /boot

# reboot
```

Case where FreeBSD ISO or MEMSTICK boot is required

Now **`loader(8)`** does not even show us *Boot Menu* but only following error message.



```
\
Can't find /boot/zfsloader

FreeBSD/x86 boot
Default: zroot/ROOT/safe:/boot/kernel/kernel
boot: zroot/ROOT/test:/boot/kernel/kernel/
int=00000006  err=00000000  efl=00010056  eip=00000003
eax=fd310000  ebx=00310000  ecx=a010001e  edx=00026948
esi=0001e5f0  edi=00094768  ebp=000949d0  esp=00310000
cs=0008  ds=0010  es=0010    fs=0010  gs=0010  ss=0010
cs:eip=f0 53 ff 00 f0 53 ff 00-f0 53 ff 00 f0 53 ff 00
       f0 53 ff 00 f0 cc e9 00-f0 53 ff 00 f0 a5 fe 00
ss:esp=00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00
       00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00
BTX halted
```

- Bug already submitted - https://bugs.freebsd.org/bugzilla/show_bug.cgi?id=229926

Case where FreeBSD ISO or MEMSTICK boot is required

Workaround that brings system back to normal functional state.

- Boot broken system from FreeBSD ISO or MEMSTICK image and select **<Live CD>** option.

```
login: root
( ... )
root@:~ #
```

- Forcefully import the ZFS pool.

```
root@:~ # zpool import -f zroot
```

- Set **bootfs** manurally for the ZFS pool to created backup BE - **zroot/ROOT/test** in our case.

```
root@:~ # zpool set bootfs=zroot/ROOT/test zroot
```

- Reboot system without FreeBSD ISO or MEMSTICK image and it will boot as usual with *Boot Menu*.

```
root@:~ # reboot
```

History/Mods/Forks/Alternatives

First one was **manageBE** script which had some problems and complicated syntax.

- Create new BE.

```
# manageBE create -n 9_20120321 -s 9_20120317 -p zroot
manageBE: cannot create /zroot/ROOT/9_20120321/boot/loader.conf: No such file or directory
manageBE: cannot create /zroot/ROOT/9_20120321/etc/fstab: No such file or directory
The  new Boot-Environment is ready to be updated and/or activated.
```

- Listing existing BEs.

```
# manageBE list
Poolname: zroot
BE                        Active Active Mountpoint                      Space
Name                      Now    Reboot -                               Used
----                      ------ ------ ----------                      -----
9_20120321                no     no     /ROOT/9_20120321                 145M
9_20120317                yes    yes    /                               1.59G

Used by BE snapshots: 1.99G
```

History/Mods/Forks/Alternatives

Current upstream **`beadm`** source and alternatives/forks.

History/Mods/Forks/Alternatives

Current upstream **beadm** source and alternatives/forks.

- The **manageBE** source - https://outpost.h3q.com/patches/manageBE/manageBE

History/Mods/Forks/Alternatives

Current upstream **beadm** source and alternatives/forks.

- The **manageBE** source - https://outpost.h3q.com/patches/manageBE/manageBE

- Current **beadm** implementation - https://github.com/vermaden/beadm ==> source for **beadm** package
  - Fork with separate boot pool support - https://bitbucket.org/aasoft/beadm ==> fork of vermaden/beadm
  - Fork with support for Linux system - https://github.com/b333z/beadm ==> fork of vermaden/beadm
  - Original **HOWTO: FreeBSD ZFS Madness** thread - https://forums.freebsd.org/threads/31662/

History/Mods/Forks/Alternatives

Current upstream **beadm** source and alternatives/forks.

- The **manageBE** source - https://outpost.h3q.com/patches/manageBE/manageBE
- Current **beadm** implementation - https://github.com/vermaden/beadm ==> source for **beadm** package
  - Fork with separate boot pool support - https://bitbucket.org/aasoft/beadm ==> fork of vermaden/beadm
  - Fork with support for Linux system - https://github.com/b333z/beadm ==> fork of vermaden/beadm
  - Original **HOWTO: FreeBSD ZFS Madness** thread - https://forums.freebsd.org/threads/31662/
- The **zedenv** in Python 3.6 with support for FreeBSD and Linux - https://github.com/johnramsden/zedenv
  - Currently at alpha stage of development (experimental) - not production ready.
  - Needs **python36** and **py36-setuptools** packages to work.
  - Supports plugins but currently comparable with **beadm** features or its forks.

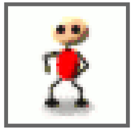
History/Mods/Forks/Alternatives

Current upstream **beadm** source and alternatives/forks.

- The **manageBE** source - https://outpost.h3q.com/patches/manageBE/manageBE
- Current **beadm** implementation - https://github.com/vermaden/beadm ==> source for **beadm** package
  - Fork with separate boot pool support - https://bitbucket.org/aasoft/beadm ==> fork of vermaden/beadm
  - Fork with support for Linux system - https://github.com/b333z/beadm ==> fork of vermaden/beadm
  - Original **HOWTO: FreeBSD ZFS Madness** thread - https://forums.freebsd.org/threads/31662/
- The **zedenv** in Python 3.6 with support for FreeBSD and Linux - https://github.com/johnramsden/zedenv
  - Currently at alpha stage of development (experimental) - not production ready.
  - Needs **python36** and **py36-setuptools** packages to work.
  - Supports plugins but currently comparable with **beadm** features or its forks.
- Ansible **beadm** module - https://docs.ansible.com/ansible/latest/modules/beadm_module.html

Questions?

Sławomir Wojciech Wojtczak

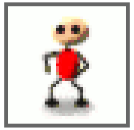


vermaden@interia.pl
vermaden.wordpress.com
twitter.com/vermaden

https://is.gd/BEADM

Thank You!

Sławomir Wojciech Wojtczak



vermaden@interia.pl
vermaden.wordpress.com
twitter.com/vermaden

https://is.gd/BEADM