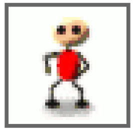
ZFS Boot Environments Reloaded

Sławomir Wojciech Wojtczak



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

  sys/ROOT/default
  sys/ROOT/safe
  sys/ROOT/pre-upgrade
  (...)

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- Bare metal **backup** solution.

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Groundhog Day (1993)

How the World 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**?

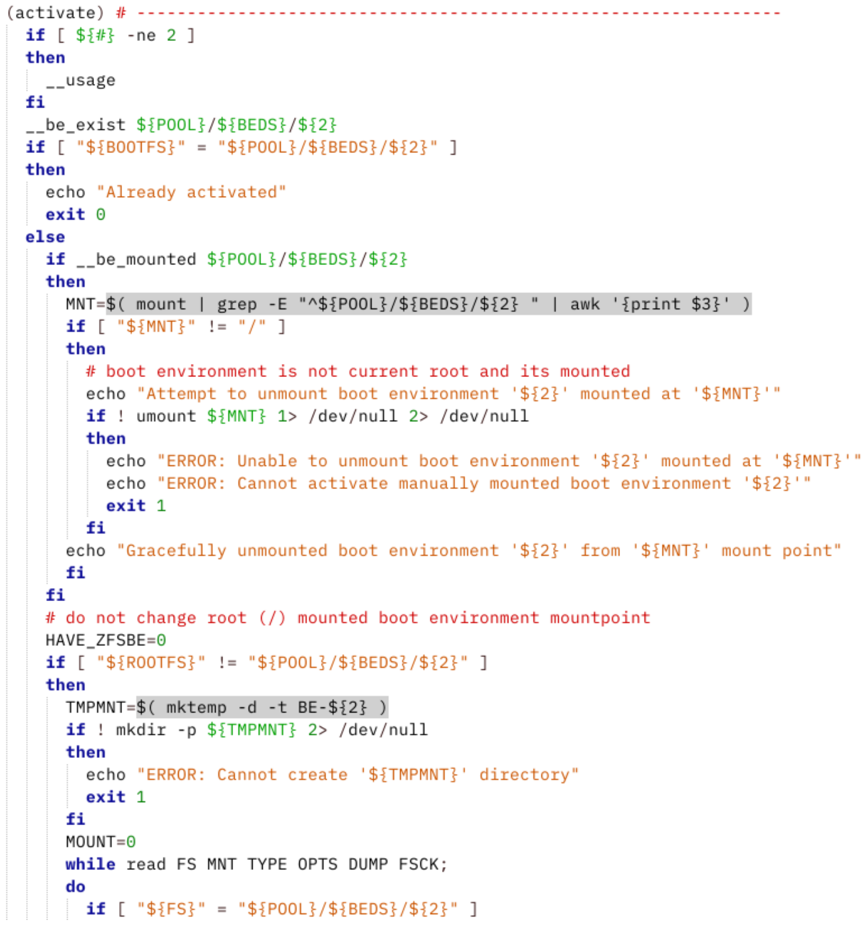
Raiders of the Lost Ark (1981)

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 2018-11-15 16:01

# beadm create newbe
Created successfully

# beadm list
BE             Active Mountpoint  Space Created
11.2-RELEASE NR     /              6.3G 2018-11-15 16:01
newbe        -      -            296.0K 2018-11-15 17:04
```

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 2018-11-15 16:01
  sys/ROOT/11.2-RELEASE@2018-11-15-17:04:22 -      -                 288.0K 2018-11-15 10:04

newbe
  sys/ROOT/newbe                                   -      -            8.0K 2018-11-15 10:04
    11.2-RELEASE@2018-11-15-17:04:22               -      -          288.0K 2018-11-15 10:04

# zfs get origin sys/ROOT/newbe
NAME            PROPERTY  VALUE                                      SOURCE
sys/ROOT/newbe  origin    sys/ROOT/11.2-RELEASE@2018-11-15-17:04:22  -
```

Example beadm usage (3/5)

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

```
# zfs rename sys/ROOT/11.2-RELEASE@2018-11-15-17:04:22 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 2018-11-15 16:01
  sys/ROOT/11.2-RELEASE@newbe      -      -          516.0K 2018-11-15 17:04

newbe
  sys/ROOT/newbe                   -      -            8.0K 2018-11-15 17:04
    11.2-RELEASE@newbe             -      -          516.0K 2018-11-15 17:04
```

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 2018-11-15 16:01
newbe         -      -           68.8M 2018-11-15 17:04

# beadm activate newbe
Activated successfully

# beadm list
BE            Active Mountpoint  Space Created
11.2-RELEASE  N      /          187.5M 2018-11-15 16:01
newbe         R      -            6.3G 2018-11-15 17:04
```

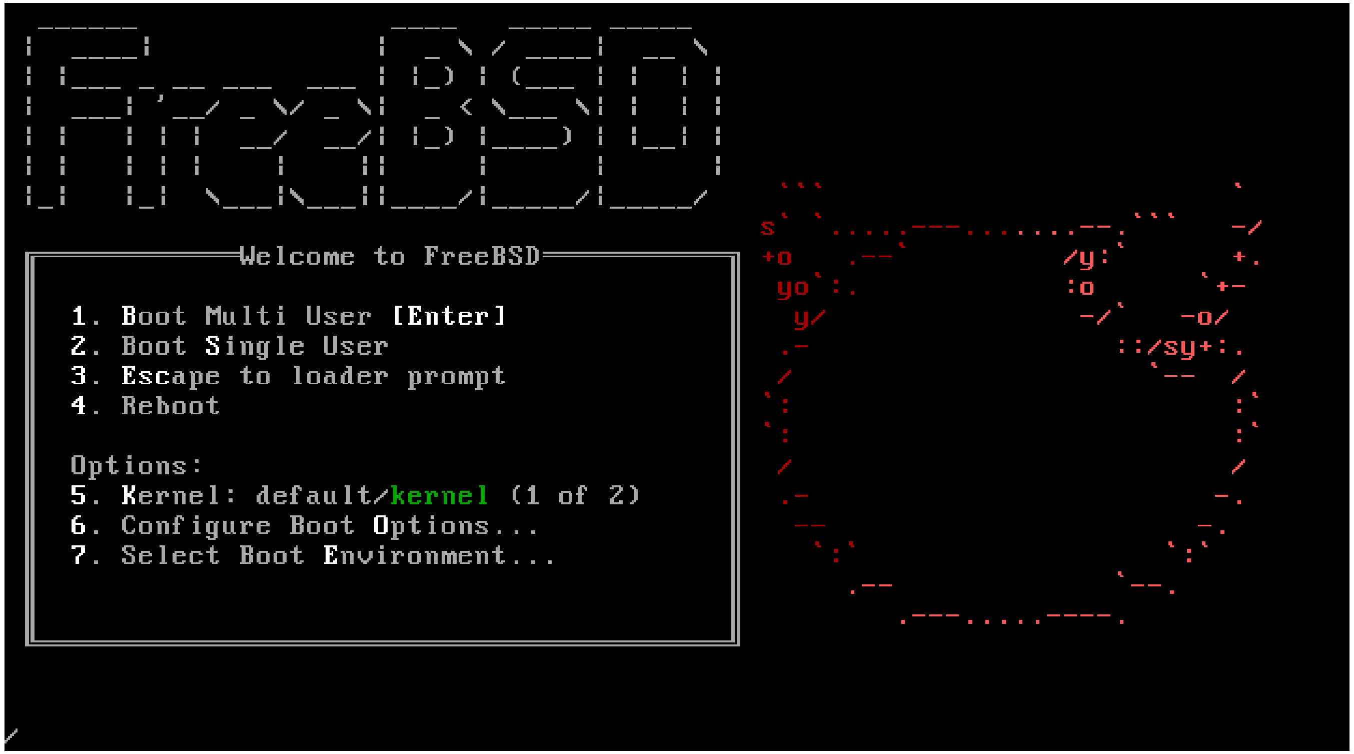
Example beadm usage (5/5)

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 2018-11-15 16:01
newbe        -      -           68.8M 2018-11-15 17:04

# 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 2018-11-15 16:01
```

FreeBSD `loader` integration

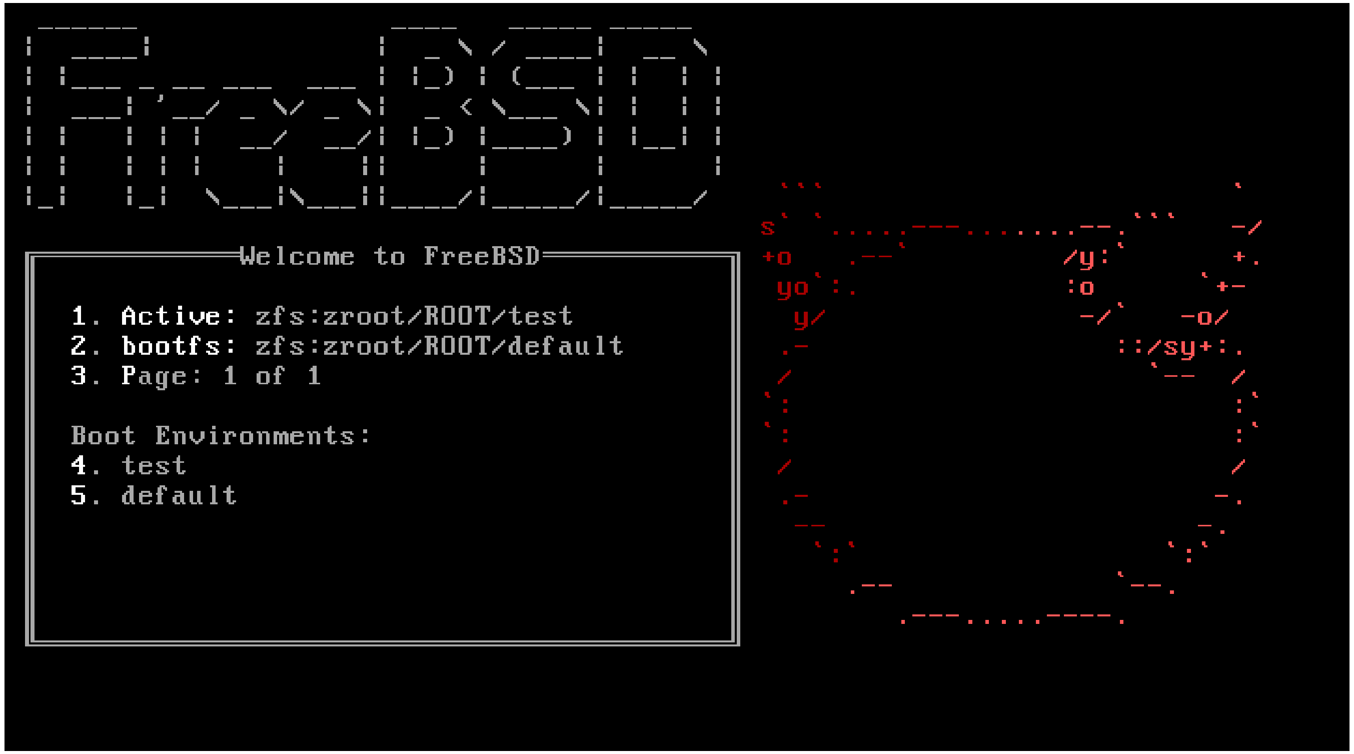
Selection of BE at boot is integrated into the FreeBSD **`loader`**.



```
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.

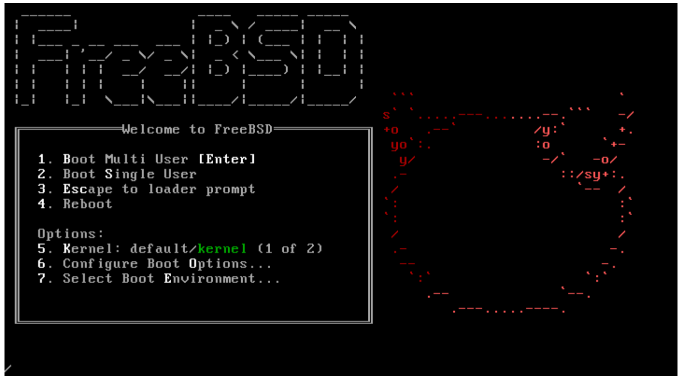


```
Welcome to FreeBSD

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

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

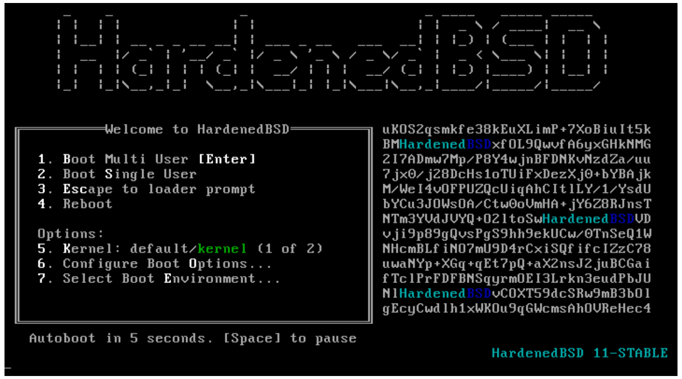
Not just FreeBSD `loader` ...

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

- **BSDs**
  - FreeBSD
  - HardenedBSD
    (rolling FreeBSD fork)

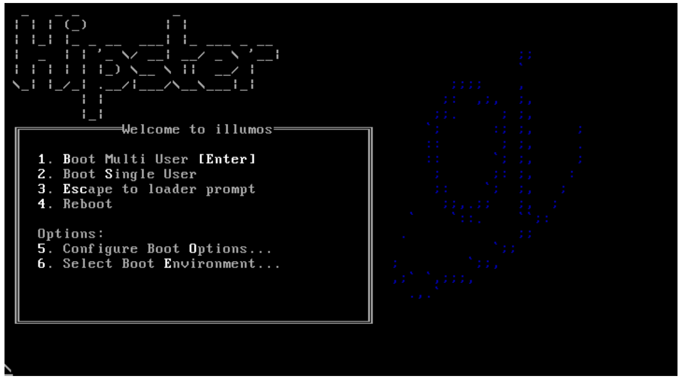


```
Welcome to FreeBSD

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...
```

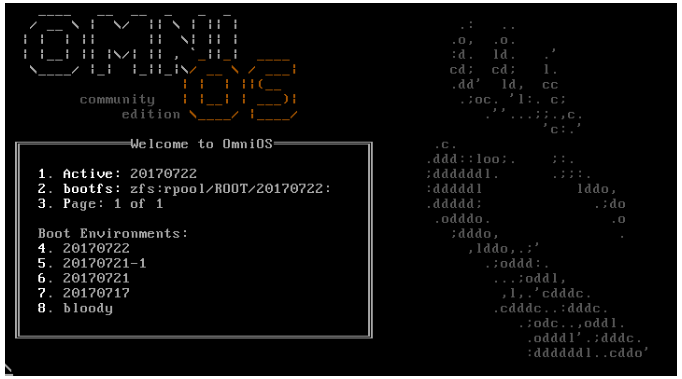


```
Welcome to HardenedBSD                 uKOS2qsmkfe38kEuXLimP+7XoBiuIt5k
                                       BMHardenedBSDxfOL9QwvfA6yxGHkNMG
1. Boot Multi User [Enter]             2I7ADmw7Mp/P8Y4wjnBFDNKvNzdZa/uu
2. Boot Single User                    7jx0/j28DcHs1oTUiFxDezXj0+bYBAjk
3. Escape to loader prompt             M/WeI4vOFPUZQcUiqAhCItlLY/1/YsdU
4. Reboot                              bYCu3JOWsOA/Ctw0oVmHA+jY6Z8RJnsT
                                       NTm3YVdJVYQ+O2ltoSwHardenedBSDVD
Options:                               vji9p89gQvsPgS9hh9ekUCw/0TnSeQ1W
5. Kernel: default/kernel (1 of 2)     NHcmBLfiNO7mU9D4rCxiSQfifcIZzC78
6. Configure Boot Options...           uwaNYp+XGq+qEt7pQ+aX2nsJ2juBCGai
7. Select Boot Environment...          fTclPrFDFBNSqyrmOEI3Lrkn3eudPbJU
                                       NlHardenedBSDvCOXT59dcSRw9mB3bOl
                                       gEcyCwdlh1xWKOu9qGWcmsAhOVReHec4

Autoboot in 5 seconds. [Space] to pause

                                                HardenedBSD 11-STABLE
```

- **Illumos**
  - OpenIndiana
  - OmniOS



```
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...
```



```
community
  edition

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
```

Not just FreeBSD `loader` ...

Its ~~integrated~~ idea implemented into **other operating systems** as well.

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

EuroBSDcon 2018 | Building Boot Environment Manager for DragonFly BSD

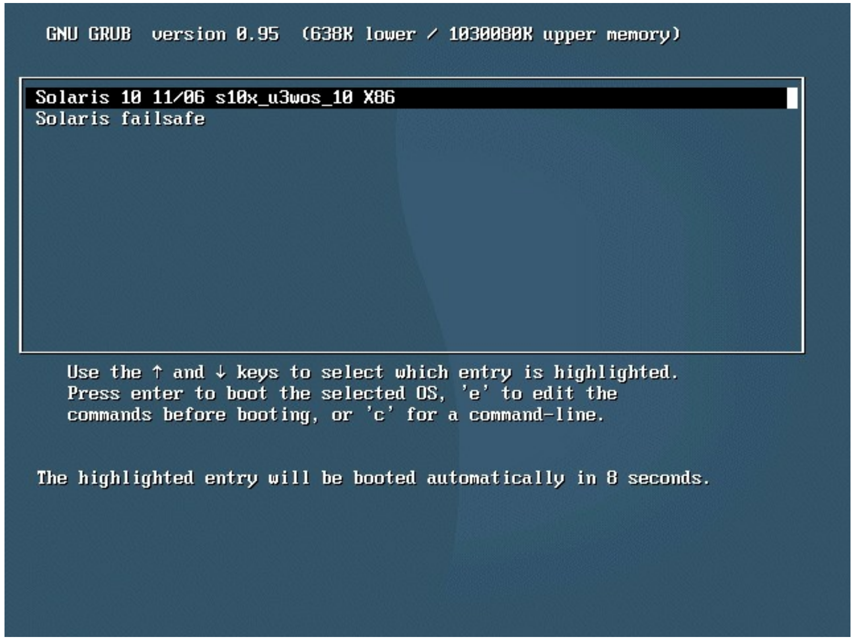
As many users may be aware, DragonFly BSD's recently declared the HAMMER2 filesystem to be stable and suitable for use. Since this is a CoW filesystem, and allows mounting of arbitrary snapshots of any PFS (analagous to ZFS datasets), we can define a custom scheme of creating and managing snapshots of any mounted HAMMER2 PFSes and updating the fstab accordingly.

Turns out beadm(1) is a shell script.

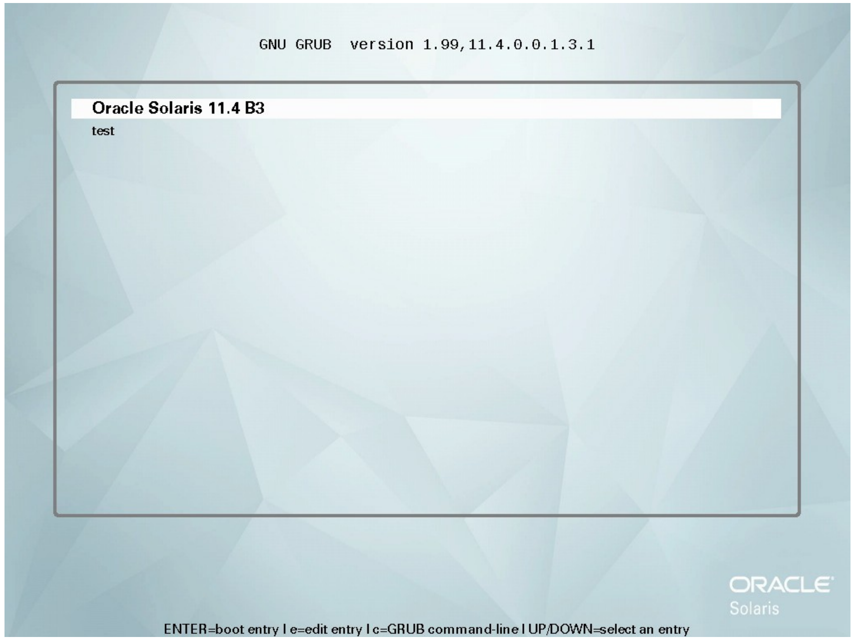
While investigating how **beadm** actually gets ZFS dataset information, I discovered it's actually a very clever mix of **sh** and **awk**, which is not what I expected. Since I'm using C, things are a bit more complex. So I've had to get into the VFS layer of DragonFly BSD to query which filesystems are mounted, and then get and manipulate their names internally, which has quickly turned into a much more complex task than initially expected.

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 I e=edit entry I c=GRUB command-line I UP/DOWN=select an entry
```

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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 BTRFS?

The **BTRFS Snapshots** limitations/excludes are as follows.

Also from **System Recovery and Snapshot Management with Snapper** for **OpenSUSE Leap 15** Linux.

```
/boot/grub2/*             /var/cache
/home                     /var/crash
/opt                      /var/lib/libvirt/images
/var/opt                  /var/lib/mailman
/srv                      /var/spool
/usr/local                /var/lib/named
/tmp                      /var/lib/mariadb
/var/tmp                  /var/lib/mysql
/var/log                  /var/lib/pgqsl
```

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 2018-11-15 16:01
newbe        -      -           80.2M 2018-11-15 17:04
```

Using update/upgrade tools with BEs

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- 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.
```

History/Mods/Forks/Alternatives

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

- Create a 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.
```

- List 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.

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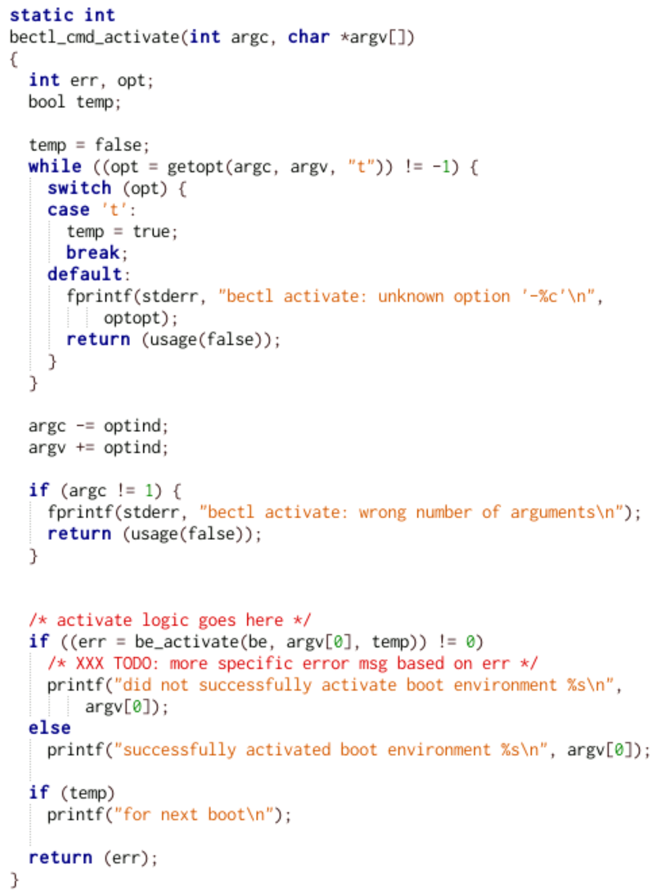
- Ansible **beadm** module - https://docs.ansible.com/ansible/latest/modules/beadm_module.html
- New **bectl** FreeBSD 12.x base system utility compatible with **beadm** command.

The bectl command

New FreeBSD 12.x base system command - **bectl** - to manage ZFS Boot Environments.

```
# bectl
usage:  bectl {-h | -? | subcommand [args...]}
        bectl activate [-t] beName
        bectl create [-e {nonActiveBe | -e beName@snapshot}] beName
        bectl create beName@snapshot
        bectl destroy [-F] {beName | beName@snapshot}
        bectl export sourceBe
        bectl import targetBe
        bectl jail [{-b | -U}] [{-o key=value | -u key}]... bootenv [utility [argument ...]]
        bectl list [-a] [-D] [-H] [-s]
        bectl mount beName [mountpoint]
        bectl rename origBeName newBeName
        bectl {ujail | unjail} ⟨jailID | jailName | bootenv)
        bectl {umount | unmount} [-f] beName
```

The `bectl` is written in C language



```c
static int
bectl_cmd_activate(int argc, char *argv[])
{
	int err, opt;
	bool temp;

	temp = false;
	while ((opt = getopt(argc, argv, "t")) != -1) {
		switch (opt) {
		case 't':
			temp = true;
			break;
		default:
			fprintf(stderr, "bectl activate: unknown option '-%c'\n",
			    optopt);
			return (usage(false));
		}
	}

	argc -= optind;
	argv += optind;

	if (argc != 1) {
		fprintf(stderr, "bectl activate: wrong number of arguments\n");
		return (usage(false));
	}


	/* activate logic goes here */
	if ((err = be_activate(be, argv[0], temp)) != 0)
		/* XXX TODO: more specific error msg based on err */
		printf("did not successfully activate boot environment %s\n",
		    argv[0]);
	else
		printf("successfully activated boot environment %s\n", argv[0]);

	if (temp)
		printf("for next boot\n");

	return (err);
}
```

Difference between beadm and bectl usage

All commands that work with **beadm** will work with **bectl** tool without modifications.

```
# beadm create ASD
Created successfully
#
```

```
# beadm activate ASD
Activated successfully
#
```

```
# beadm list
BE   Active Mountpoint  Space Created
11.2 N      /            7.0G 2018-11-15 16:01
ASD  R      -            6.9M 2018-11-15 17:29
```

```
# beadm destroy ASD
Are you sure you want to destroy 'ASD'?
This action cannot be undone (y/[n]): y
Destroyed successfully
#
```

```
# beadm rename ASD NEW
Renamed successfully
#
```

```
# bectl create ASD
# (silent creation)
```

```
# bectl activate ASD
successfully activated boot environment ASD
#
```

```
# bectl list
BE   Active Mountpoint Space Created
12.0 N      /          471M  2018-11-15 13:15
ASD  R      -          448K  2018-11-15 14:03
```

```
# bectl destroy ASD
# (no confirmation for destroy)
```

```
# bectl rename ASD NEW
# (silent rename)
```

New features/commands in `bectl` tool

New **`jail`**/**`unjail`** command to start FreeBSD Jail within ZFS Boot Environment.

```
freebsd12 # hostname
freebsd12.local
freebsd12 # sysctl security.jail.jailed
security.jail.jailed: 0
freebsd12 # bectl jail ASD
# hostname
ASD
# sysctl security.jail.jailed
security.jail.jailed: 1
# (you are directly in newly created FreeBSD Jail within ‘ASD’ ZFS Boot Environment)
```

Meanwhile on the FreeBSD Host …

```
freebsd12 # mount | grep ASD
zroot/ROOT/ASD on /tmp/be_mount.WR1F (zfs, local, noatime, nfsv4acls)
freebsd12 # jls -a
   JID  IP Address      Hostname                      Path
     1                  ASD                           /tmp/be_mount.WR1F
```

New features/commands in `bectl` tool

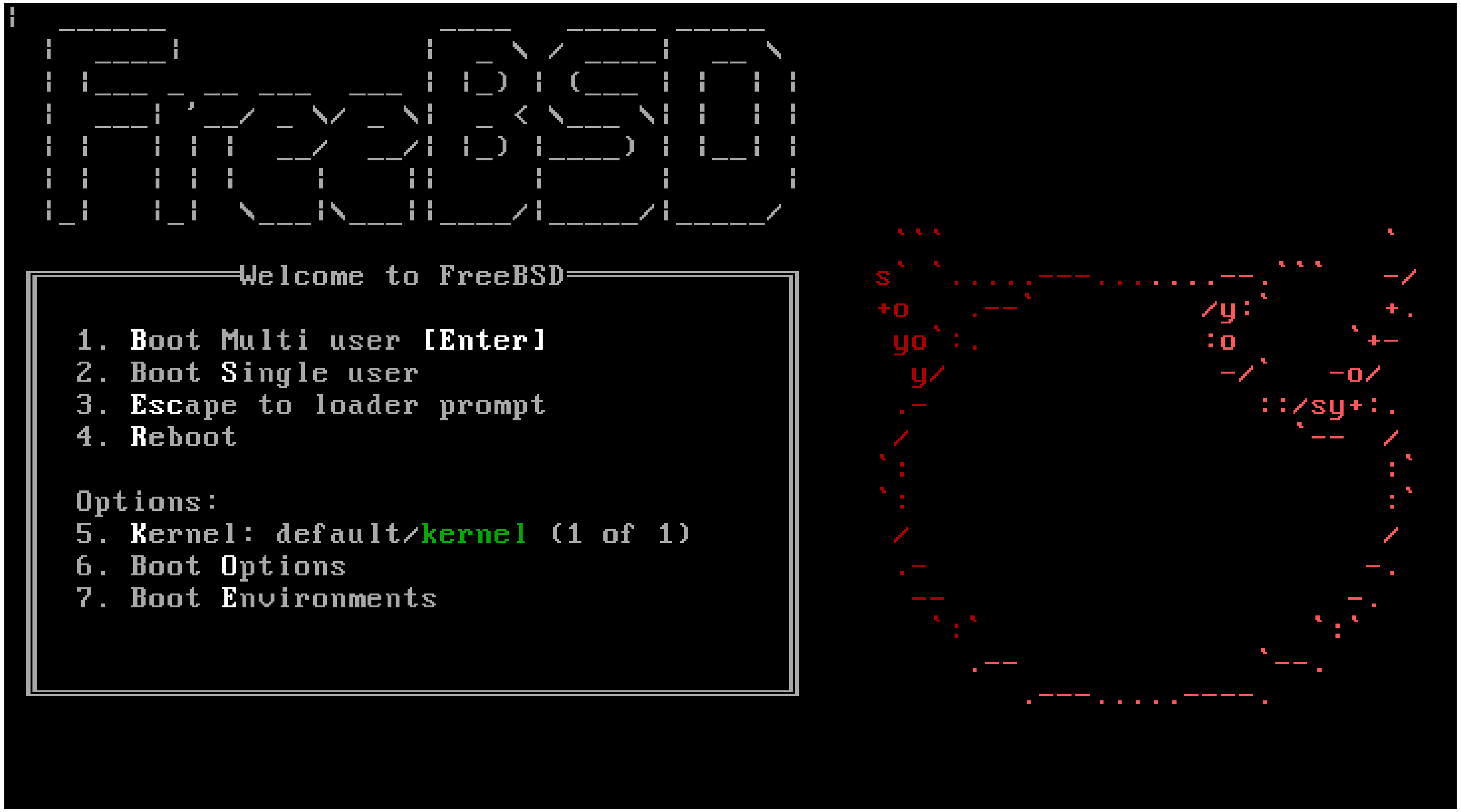
New **`export`**/**`import`** command that sends ZFS Boot Environment into/from plain file.

```
# bectl export ASD
bectl export: must redirect output
# bectl export ASD > ASD.raw
# file ASD.raw | tr ',' '\n'
ASD.raw: ZFS shapshot (little-endian machine)
 version 17
 type: ZFS
 destination GUID: D9 72 9E 43 9C CF F9 A2
 name: 'zroot/ROOT/NEW@2018-11-15-15:39:25'

# bectl import NEW.raw
bectl import: input can not be from terminal
# bectl import NEW < NEW.raw
# bectl list
BE   Active Mountpoint Space Created
12.0 NR     /          905M  2018-11-15 13:24
ASD  -      -          448K  2018-11-15 15:39
NEW  -      -          471M  2018-11-15 16:44
```

New LUA based `loader` in FreeBSD 12.x

New LUA based **`loader`** that deprecates the old Forth based **`loader`**.



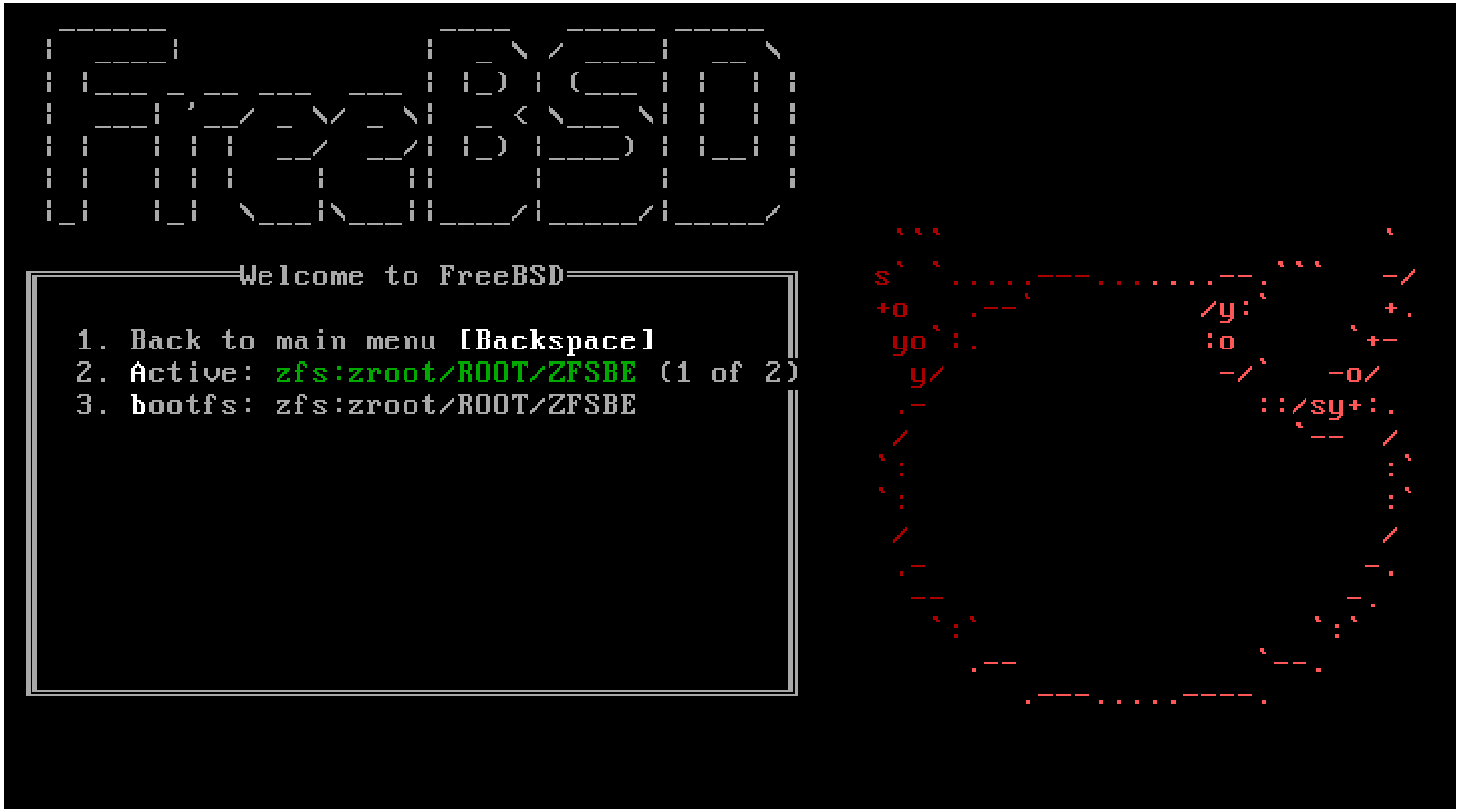
```
Welcome to FreeBSD

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

 Options:
 5. Kernel: default/kernel (1 of 1)
 6. Boot Options
 7. Boot Environments
```

New LUA based `loader` in FreeBSD 12.x

New **`loader`** menu is not perfect - longer (5!) BE names ovelap on the menu border.

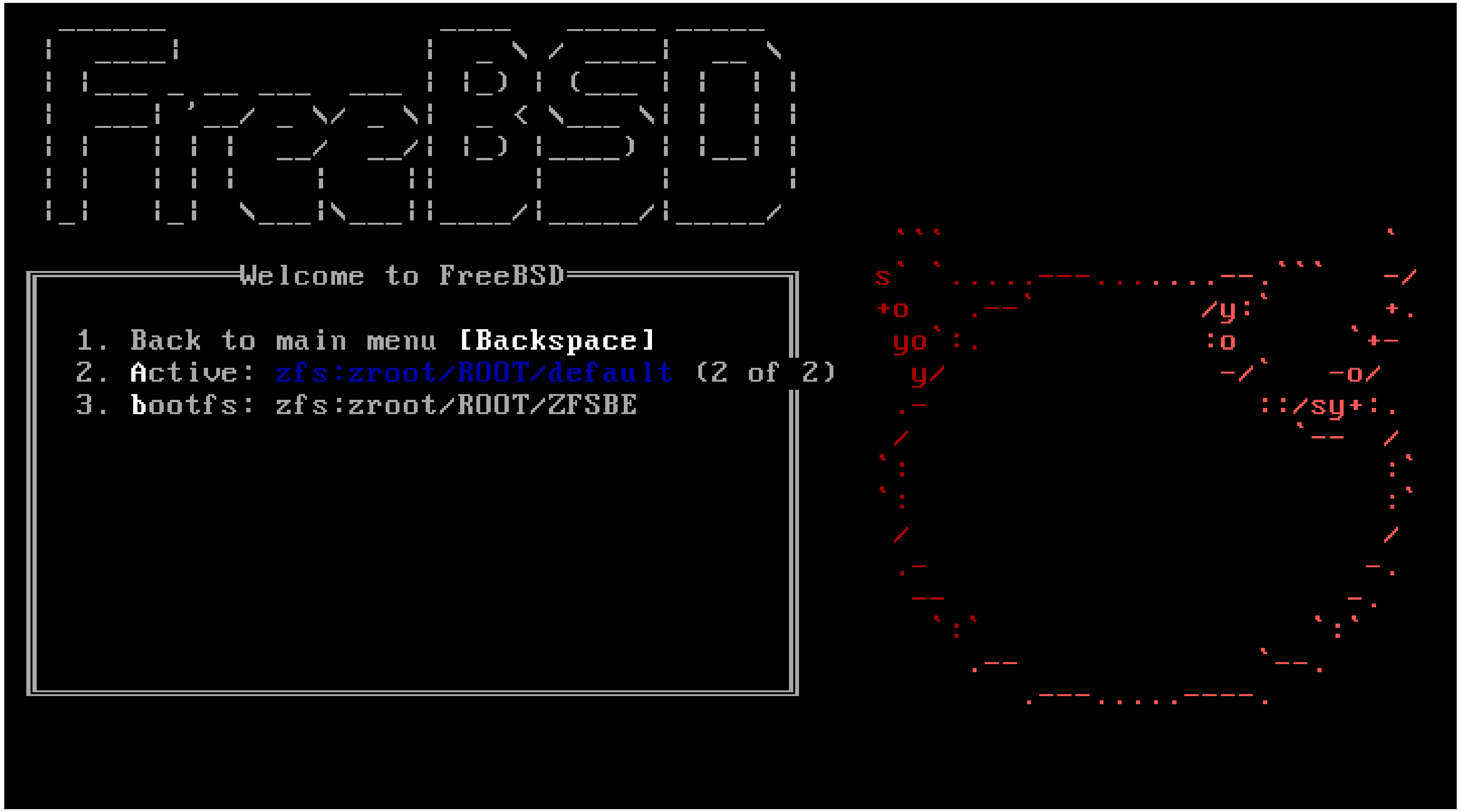


```
Welcome to FreeBSD

 1. Back to main menu [Backspace]
 2. Active: zfs:zroot/ROOT/ZFSBE (1 of 2)
 3. bootfs: zfs:zroot/ROOT/ZFSBE
```

New LUA based `loader` in FreeBSD 12.x

There is no list of BEs - you can only switch between existing BEs in sequence.



```
Welcome to FreeBSD

 1. Back to main menu [Backspace]
 2. Active: zfs:zroot/ROOT/default (2 of 2)
 3. bootfs: zfs:zroot/ROOT/ZFSBE
```

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With new **`loader`** you do not need ZFS boot pool to have GELI encrypted ZFS root!

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- Works both on UEFI and BIOS (Legacy/CSM/...) boot type.

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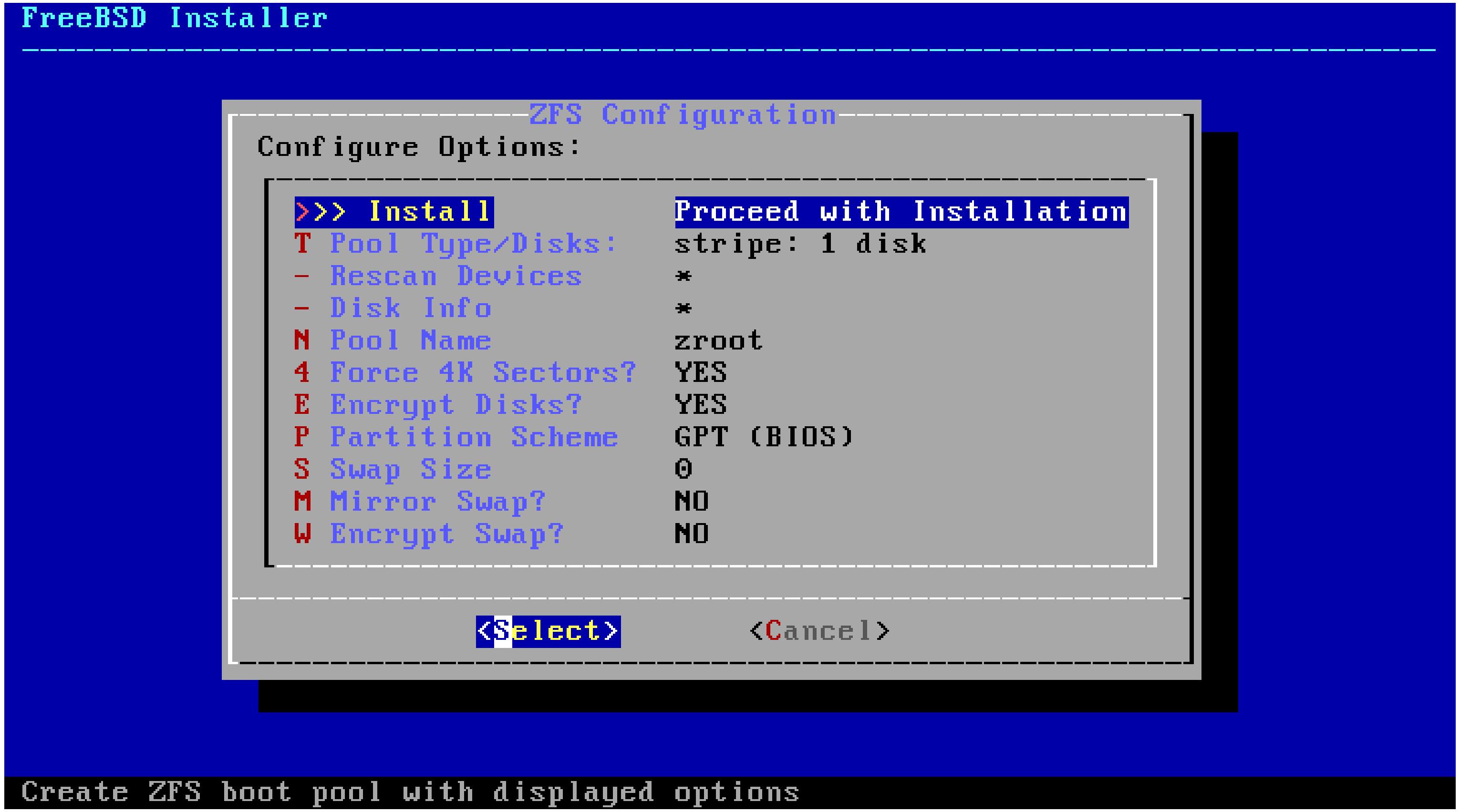
- Works both on UEFI and BIOS (Legacy/CSM/...) boot type.

```
# gpart show
⇒       40  16777136  ada0  GPT  (8.0G)
        40      1024     1  freebsd-boot  (512K)
      1064       984        - free -  (492K)
      2048  16773120     2  freebsd-zfs  (8.0G)
  16775168      2008        - free -  (1.0M)

# geli status
      Name  Status  Components
ada0p2.eli  ACTIVE  ada0p2
```

New LUA based `loader` in FreeBSD 12.x

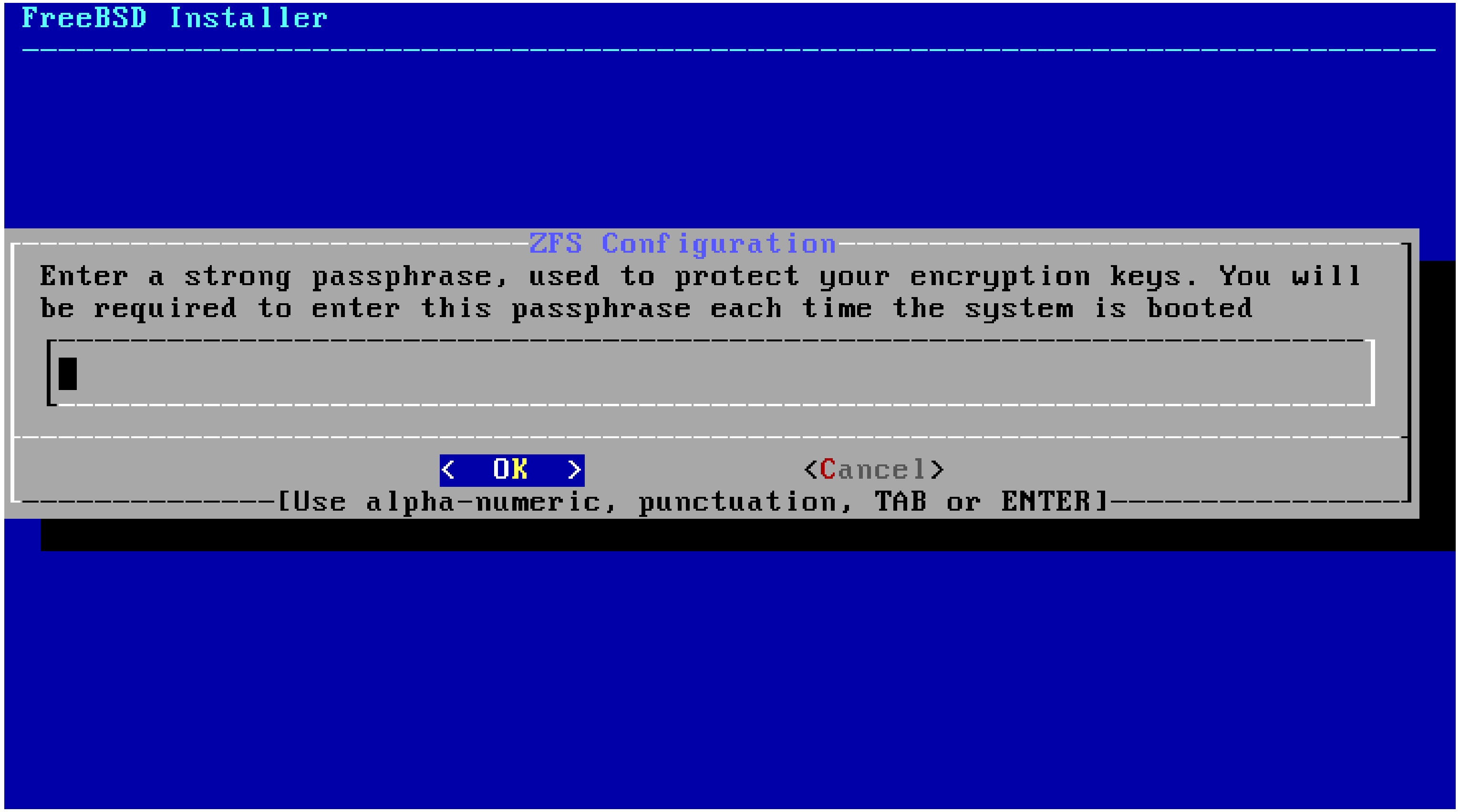
What to choose in **`bsdinstall`** to create such ZFS root GELI encrypted setup.



```
FreeBSD Installer
------------------------------------------------------------------------

                    ZFS Configuration
  Configure Options:

     >>> Install                Proceed with Installation
     T Pool Type/Disks:         stripe: 1 disk
     - Rescan Devices           *
     - Disk Info                *
     N Pool Name                zroot
     4 Force 4K Sectors?        YES
     E Encrypt Disks?           YES
     P Partition Scheme         GPT (BIOS)
     S Swap Size                0
     M Mirror Swap?             NO
     W Encrypt Swap?            NO

                <Select>          <Cancel>

Create ZFS boot pool with displayed options
```

New LUA based `loader` in FreeBSD 12.x

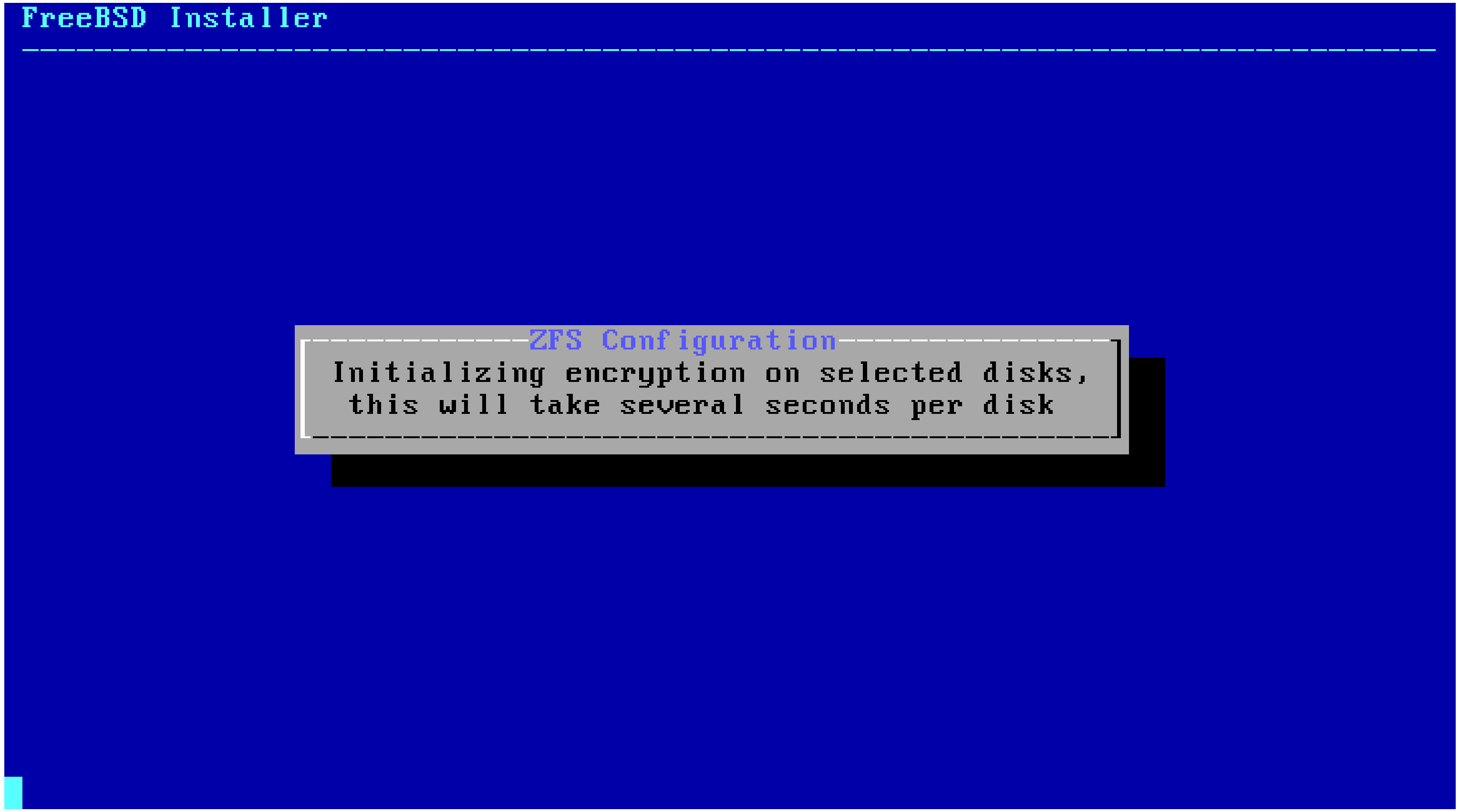
Now type in GELI password you want to use.



```
FreeBSD Installer

ZFS Configuration
Enter a strong passphrase, used to protect your encryption keys. You will
be required to enter this passphrase each time the system is booted

<  OK  >                 <Cancel>
[Use alpha-numeric, punctuation, TAB or ENTER]
```

New LUA based `loader` in FreeBSD 12.x

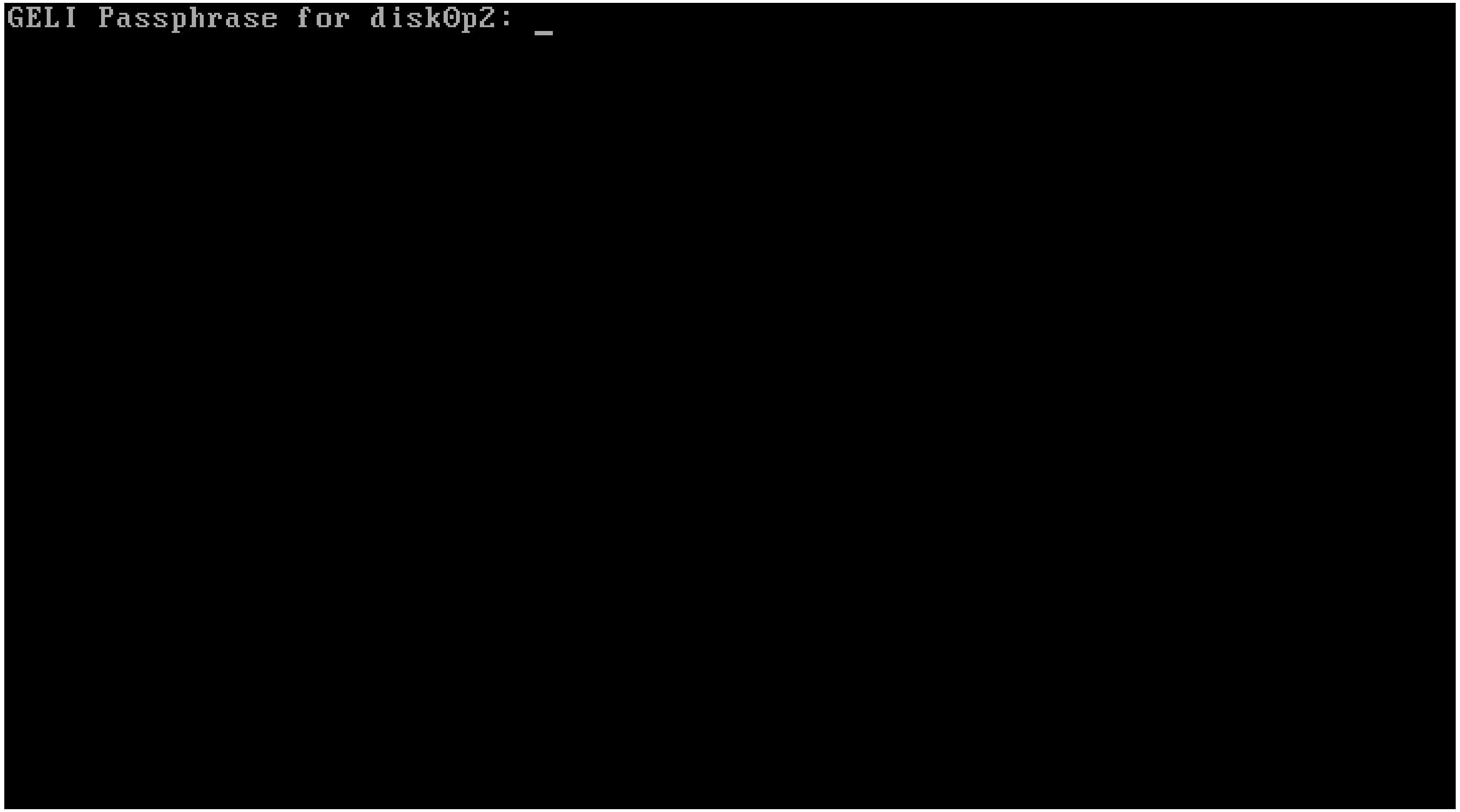
... and wait till GELI finishes the initialization.



```
FreeBSD Installer

                    ZFS Configuration
      Initializing encryption on selected disks,
       this will take several seconds per disk
```

New LUA based `loader` in FreeBSD 12.x

Here is how boot of such GELI encrypted password prompt looks like on BIOS type.



```
GELI Passphrase for disk0p2: _
```

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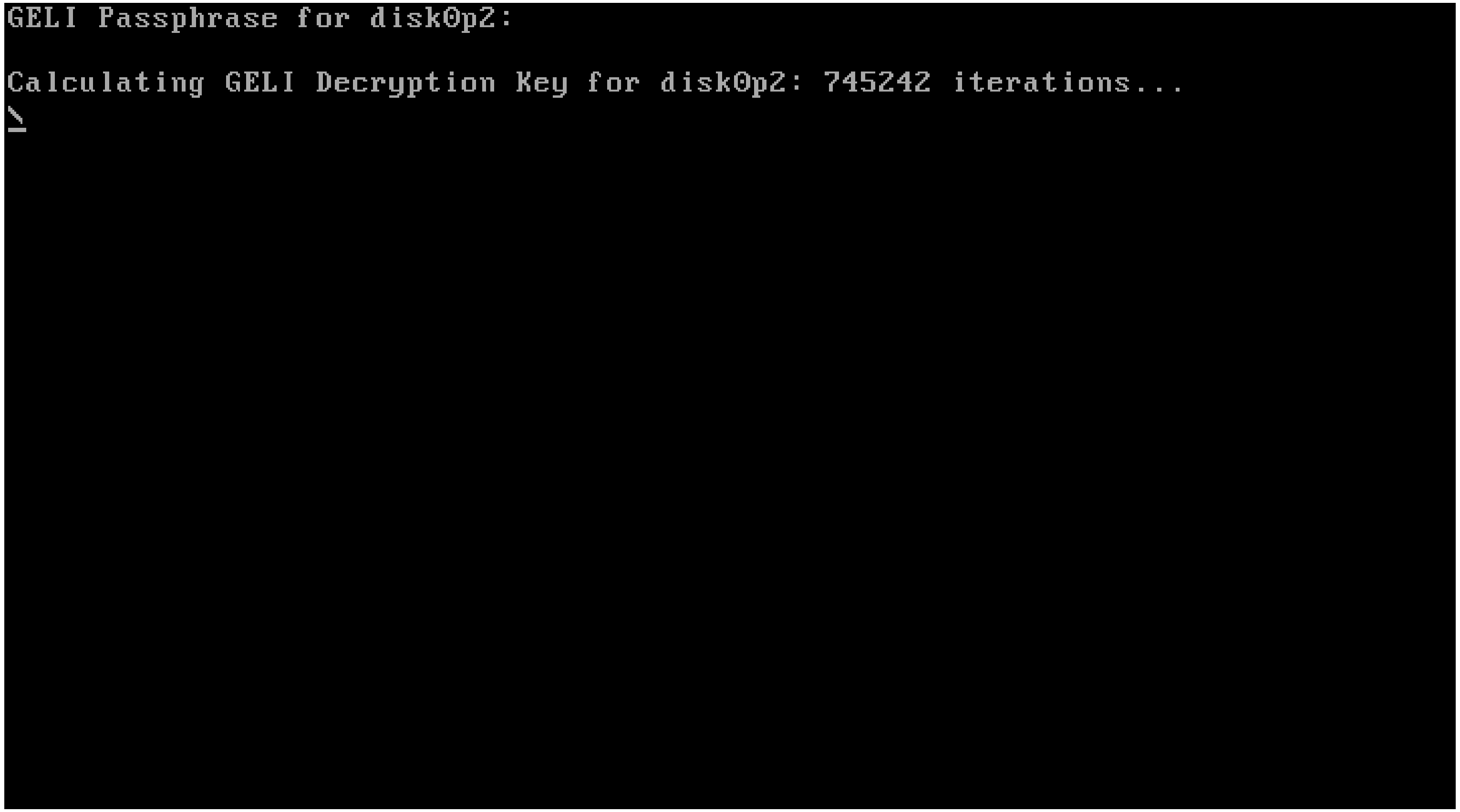
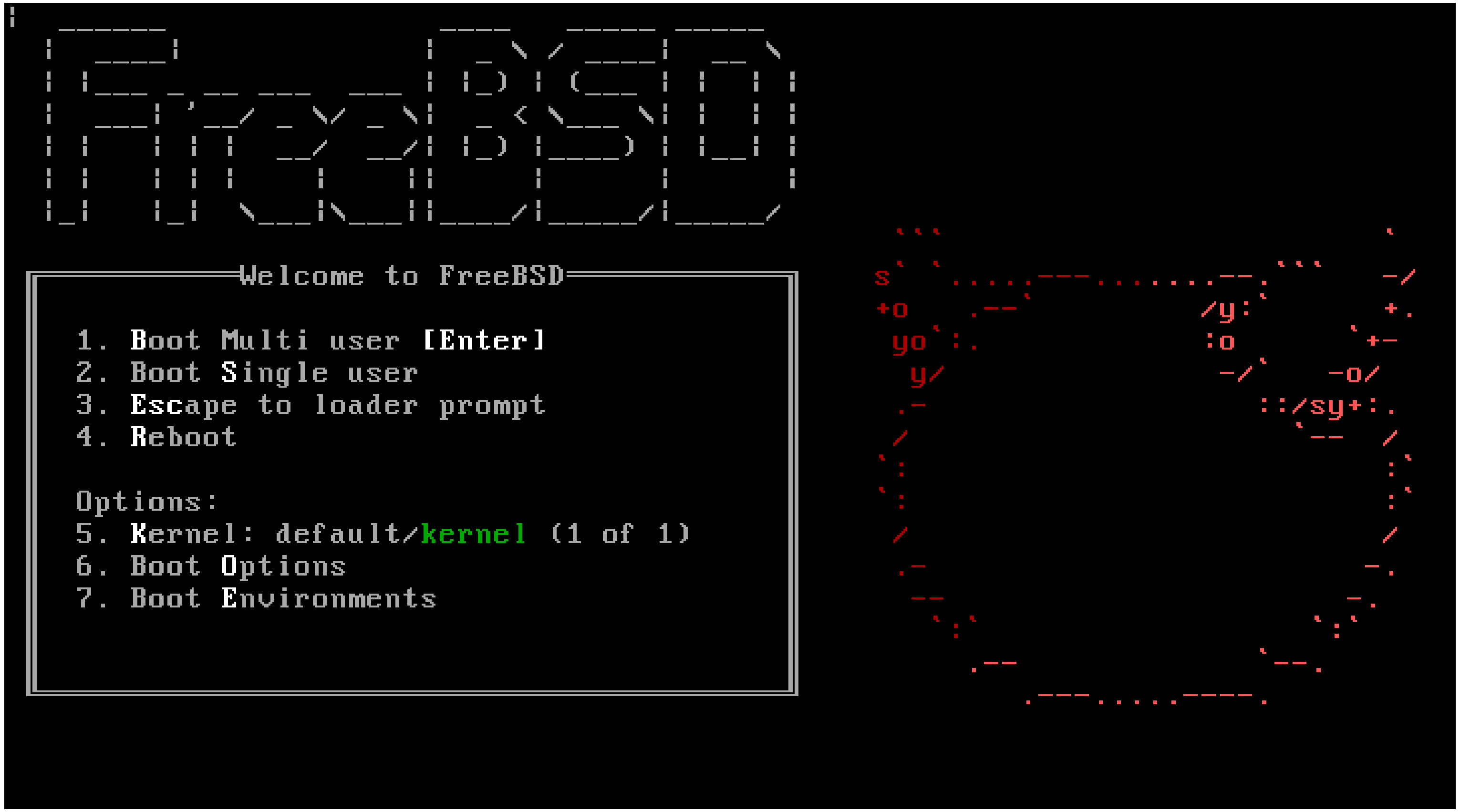


```
GELI Passphrase for disk0p2:

Calculating GELI Decryption Key for disk0p2: 745242 iterations...
\
```

New LUA based `loader` in FreeBSD 12.x

... and after the password is being accepted you get the **`loader`** FreeBSD menu.



```
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 Options:
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```
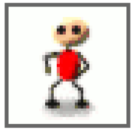

Questions?

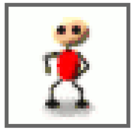
Sławomir Wojciech Wojtczak



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

https://is.gd/BECTL

Thank You!



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