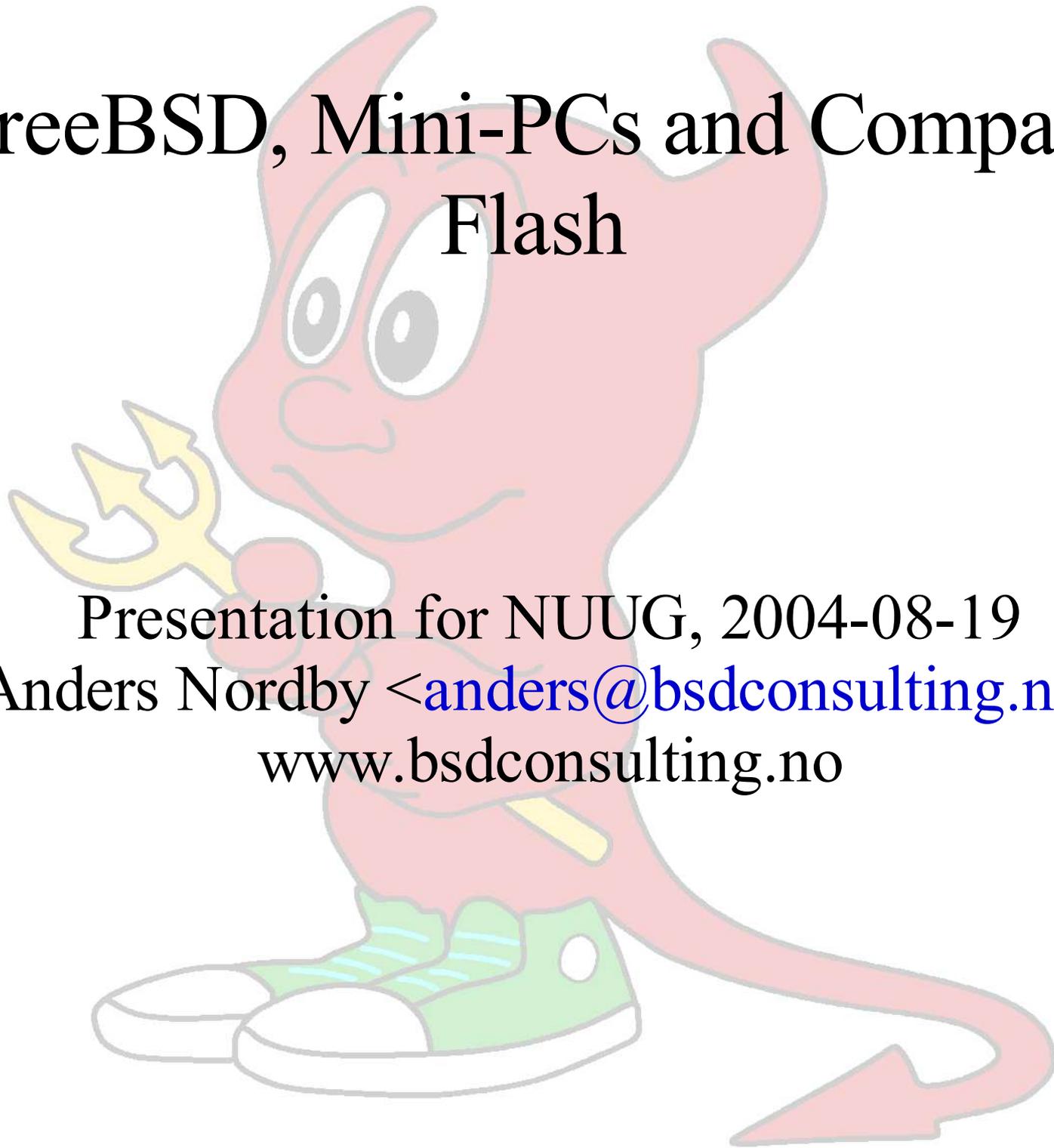


# FreeBSD, Mini-PCs and Compact Flash

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# Anders Nordby?

- Has worked with UNIX system administration and security since 1999, for companies like Skrivervik Data, Tiscali World Online and now Aftenposten AS.
- Responsible for the NUUG server Nerdhaven and nuug.no Internet services since 1999.
- FreeBSD ports committer, works on expanding the wealth of software available for FreeBSD and its general usability.



# A small PC? Welcome, Mini ITX.

- Mini ITX dates back to 1999, when VIA bought Cyrix from National Semiconductor.
- Mini ITX form factor mainboard reference design, the second ITX iteration, was released november 2001. It requires mainboards to be max. 170\*170mm.
- VIA makes processors for Mini ITX: C3 and Eden. C3 is faster, Eden typically comes in a fanless configuration. They are both low on power consumption, one of their main features.
- Mini ITX and Via C3/Eden is mainstream, cheap and available through plenty of normal PC shops.



# Compact Flash

- “CompactFlash® is a small, removable mass storage device. First introduced in 1994, CompactFlash cards weigh a half ounce and are the size of a matchbook. They provide complete PCMCIA-ATA functionality and compatibility.”
- Has no movable parts, providing better safety for your data and system than any magnetic disk drive (harddrive).
- Requires little power, makes no noise.
- One disadvantage: limited number of write operations per memory cell. Not suitable for swapping! 500000/1000000 write operations normal.



# I want a small and noiseless firewall, what hardware do I get?

What I settled for:

- High Green Cupid 3688 Silver cabinet. A small, pretty-looking Mini ITX cabinet with external power-supply (no fan!).
- VIA EPIA CL6000E mainboard with 600 MHz fanless Eden CPU. Integrated dual NIC, perfect for a firewall.
- 128 MB TwinMOS Compact Flash card, 36x. Yields around 1,5 MB per second when writing to it sequentially.
- PC Engines Compact Flash to ATA converter.
- Total price: around 3000 NOK.



# FreeBSD?

- A source-oriented UNIX-like operating system for I386, Alpha, AMD64, SPARC64 etc.
- Fully self contained. Rebuildable kernel and OS when installed with source.
- The normal upgrade procedure is to “make world”: build the OS, build the kernel, install them, and upgrade /etc using the included tool mergemaster.
- FreeBSD source code is kept in a central CVS repository, distributed internationally through a network of cvsup mirrors for rapid and bandwidth-friendly synchronization.



# Preparing for the build

- Synchronize FreeBSD's src-all cvsup collection (all the source) using the CVS tag RELENG\_4 for FreeBSD 4-STABLE. I use FreeBSD 4 for conservative reasons, not wanting to change my CF building environment more than necessary.
- Locate the make variables to make our FreeBSD installation small by exercising make buildworld looking for NO\* variables in all Makefiles (grep is your friend).
- On your build system, consider getting a PCMCIA or USB card writer, as you can hot-plug CF cards to them (you can not with a CF to ATA adapter).



# Kernel configuration

- Copy `/usr/src/sys/i386/conf/GENERIC` to a new file, e.g. `CFBSD`, and modify it.
- Disable IPv6 (and its pseudo-device companions `gif` and `faith`) if you don't use it.
- Add `IPFILTER`, `IPFILTER_LOG` and `IPFILTER_DEFAULT_BLOCK` for a IP Filter based firewall.
- Add options `NO_SWAPPING`, to completely disable swapping.



# What not to build? (make.conf)

My choice of what to not build (not needed for my firewall) is:

```
NOPROFILE=yes  NOMAN=yes  NOGAMES=yes  NO_TCSH=yes  
NO_CVS=yes  NO_BIND=yes  NO_GDB=yes  NO_CXX=yes  NO_OBJC=yes  
NO_CPP=yes  NO_GCOV=yes  NO_I4B=yes  NO_LPR=yes  
NO_FORTRAN=yes  NOSHARE=yes  NOINFO=yes  NOLIBC_R=yes  
NO_INET6=yes  NORADIUS=yes  NOATM=yes  NO_MODULES=yes
```

This keeps the installation around 80-85 MB.

`NO_MODULES` drops kernel modules.



# Building CFBSD

1) Go to `/usr/src`.

2) Build the world:

```
make __MAKE_CONF=/path/cfbsd-make.conf  
MAKEOBJDIRPREFIX=/space/cfobj buildworld
```

3) Build the kernel:

```
make KERNCONF=CFBSD __MAKE_CONF=/path/cfbsd-make.conf  
MAKEOBJDIRPREFIX=/space/cfobj buildkernel
```

`__MAKE_CONF` overrides which `make.conf` to use  
(separate `make.conf` is practical),  
`MAKEOBJDIRPREFIX` sets a object destination dir  
different from the system one (`/usr/obj`).



# Installing CFBSD

- 1) Go to `/usr/src`.
- 2) Install the directory hierarchy:  
`make XXX hierarchy`
- 3) Install the FreeBSD world (userland):  
`make XXX installworld`
- 4) Install the `/etc` configuration directory:  
`cd etc; make XXX distribution`
- 5) Install the custom kernel:  
`cd ../; make XXX KERNCONF=CFBSD installkernel`

**XXX** is `DESTDIR=/space/cfroot`

**\_\_MAKE\_CONF** `=/path/cfbsd-make.conf`  
**MAKEOBJDIRPREFIX** `=/space/cfobj`.



# Post-installation

Relative to your temporary installation directory:

1) Add pre-made config-files, extra binaries etc..

2) Edit the central configuration file `/etc/rc.conf`:

- `update_motd="NO"` (`/` is read-only)
- `varsize="<512-byte blocks>"` (`/var` filesystem size)
- `diskless_mount="/etc/rc.diskless2"` (what script to use for diskless mounting)
- `root_rw_mount="NO"` (mount root read-only)
- `weekly_whatism_enable="NO"` (do not update whatism database)



## Post-installation (2)

3) `/etc/fstab`: Add root file-system with device `/dev/ad0s1a` (`ad2s1a` if on the secondary IDE controller) and mount options `ro` (read-only). Do NOT add a swap device. Keep `/proc` not mounted by default (`noauto`) for security.

4) Copy the `/usr/share` files you want from a system running the same release/OS version:

- `syscons/fonts/iso*` (console fonts)
- `syscons/keymaps/norwegian.iso`
- `syscons/screenmaps/iso*` (screenmap)



## Post-installation (3)

- 4) Add `/boot.config` with contents `-Dh` for a dual serial/keyboard console, edit `/etc/ttys` to have a `ttyd0` (COM1) console login service enabled.
- 5) Set the root password.
- 6) Add a root mail alias, run `newaliases`.
- 7) Patch `rc.diskless2` to not run `newaliases`, modify the `mount_md` subroutine to mount memory filesystems with mount option “noexec”.



## Make the image

We want to write the CF card sequentially to write as few times per memory cell as possible, so we need to generate a binary image. For a 128 MB TwinMOS card, I need a fixed geometry due to USB/IDE CF card reader incompatibilities. Image size (for dd) equals sectors reported by FreeBSD \* 512 (block size).

### Variables:

```
fdiskconf=fdisk.tmos128; size=251904
```

Geometry (fdisk option file - 984 cylinders/16 heads/16 sectors):

```
g c984 h16 s16
p 1 165 16 251888
a 1
```



# Make the image (2)

Create the image file, configure it as a virtual node  
(vn) device :

```
dd if=/dev/zero of=cfbsd.img bs=512 count=$size  
vnconfig -s labels -c vn0 cfbsd.img
```

## Partition/label/make filesystem:

```
fdisk -f $fdiskconf -v vn0  
disklabel -rw vn0s1 auto  
disklabel vn0s1 >dlb  
egrep -v '^ [a-h]: ' dlb >dlbnew  
egrep '^ c: ' dlb | sed -E "s|^ c: | a: |;s|unused|  
4.2BSD|" >>dlbnew  
egrep '^ c: ' dlb >>dlbnew  
disklabel -RB vn0s1 dlbnew  
newfs -i 1000 -m 0 /dev/vn0s1a
```



# Populate and write the image

Mount the virtual filesystem created:

```
mkdir /cfbsd; mount /dev/vn0 /cfbsd
```

Copy everything over:

```
tar -cpf - -C /space/cfroot . | tar -xpf - -C /cfbsd
```

Unmount and unconfigure the vn device:

```
umount /cfbsd; vnconfig -u vn0
```

Write the image file to your SCSI (USB mass storage devices pop up like SCSI devices in FreeBSD) device:

```
dd if=cfbsd.img of=/dev/rda0 bs=8k
```



# Voila!

Insert your Compact Flash card into the CF to ATA adapter, boot your system and enjoy!

Your PC will recognize the CF card as a plain IDE disk, and booting will work with no BIOS or other changes if you properly bootstrapped and partitioned it.



# Links

Mini ITX: [www.mini-itx.com](http://www.mini-itx.com)

High Green cabinets: [www.highgreen.nl](http://www.highgreen.nl)

VIA Technologies, Inc: [www.viavpsd.com](http://www.viavpsd.com)

TwinMOS: [www.twinmos.com](http://www.twinmos.com)

Compact Flash: [www.compactflash.org](http://www.compactflash.org)

PC Engines: [www.pcengines.ch](http://www.pcengines.ch)

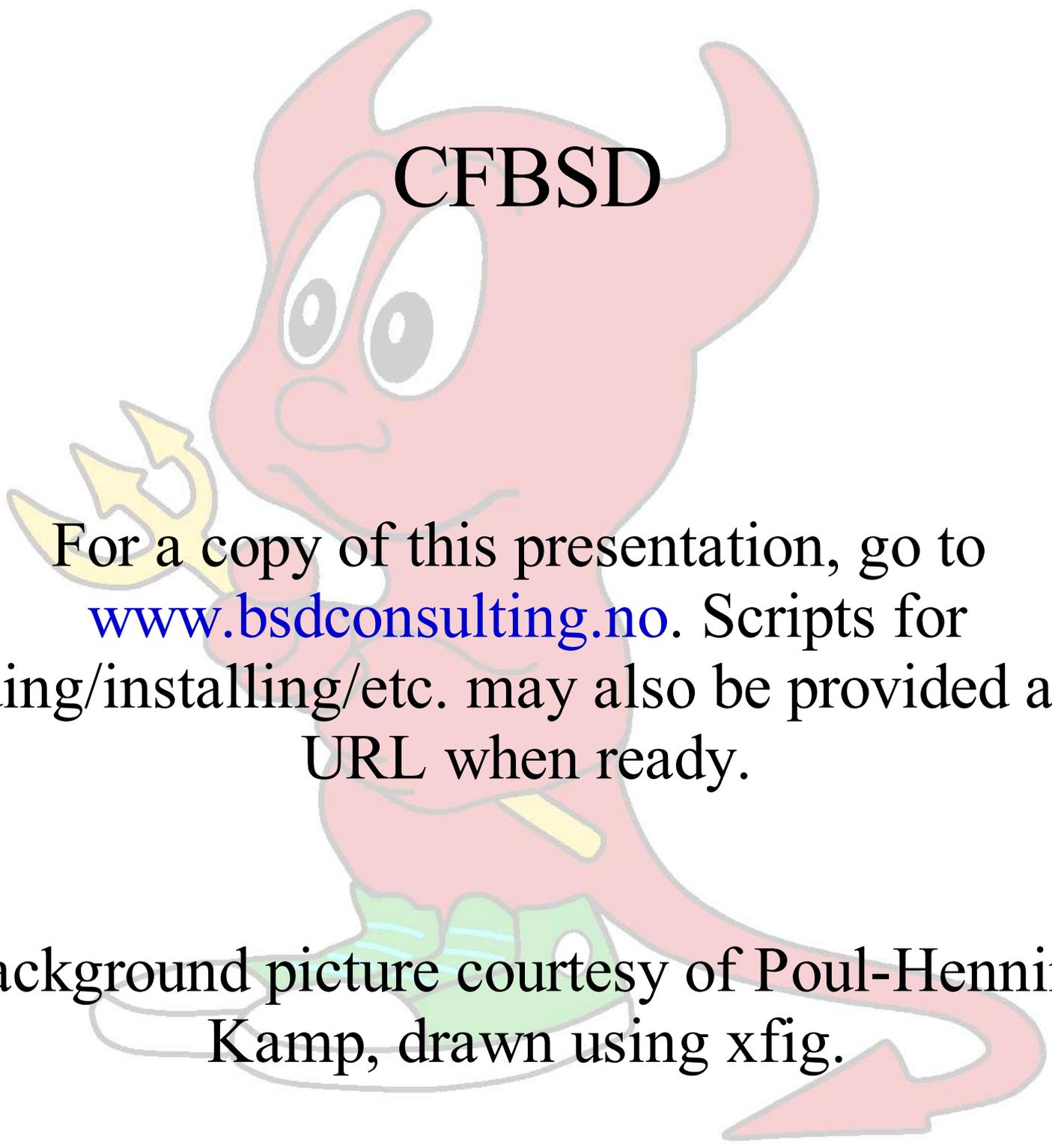
FreeBSD: [www.freebsd.org](http://www.freebsd.org)

IP Filter firewall: [www.ipfilter.org](http://www.ipfilter.org)

CVSUP: [www.cvsup.org](http://www.cvsup.org)

FreeBSD CVSUP information:

<http://www.freebsd.org/doc/en/books/handbook/cvsup.html>



CFBSD

For a copy of this presentation, go to [www.bsdconsulting.no](http://www.bsdconsulting.no). Scripts for building/installing/etc. may also be provided at this URL when ready.

Background picture courtesy of Poul-Henning Kamp, drawn using xfig.