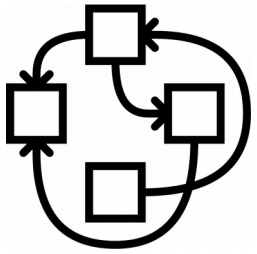# Hurd, Rump kernel, sound, and USB
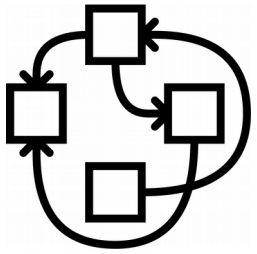
Samuel Thibault

2016 January 30th

It's all about freedom #0

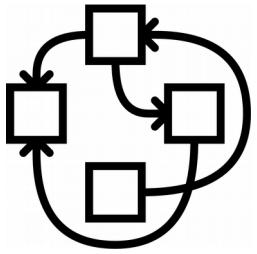"The freedom to run the program, for any purpose"

I.e.:

- Freedom from sysadmin!
  - WTH is fdisk/mke2fs/... hidden in /sbin?
  - I should be able to just work with my disk/network access
- Freedom to innovate
  - Experimental filesystem, personal work-flow, new kind of process combination,...

- Also provide freedom from misbehaving programs and drivers

Micro-kernel layering

ext2fs

auth

pfinet

proc

sh

cp

root
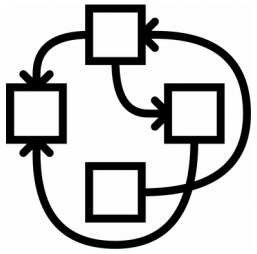
user

Kernel   Tasks, memory, IPC
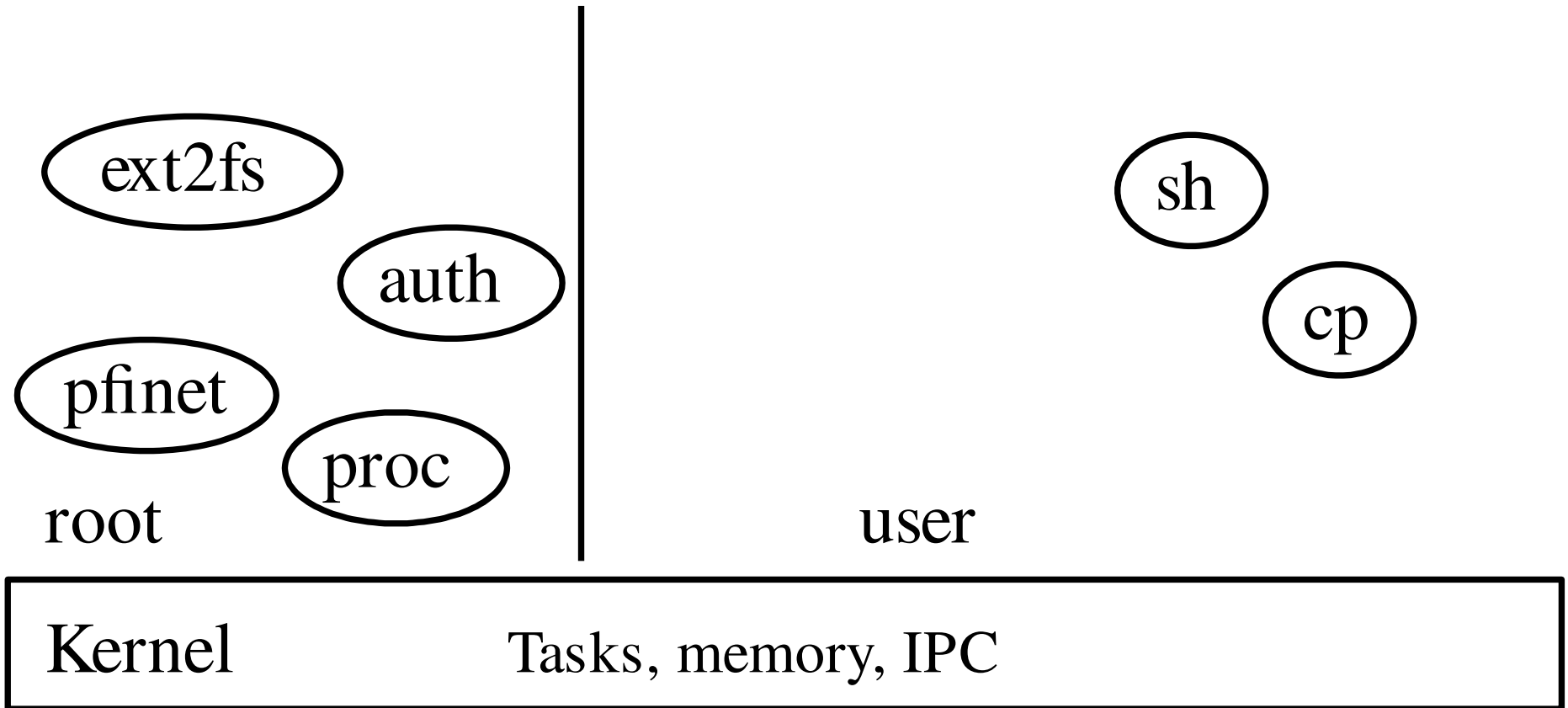
Micro-kernel layering

- Server crash? Not a problem
  - "Computer bought the farm" is just an error, not something-of-the-death
- Easier to debug/tune
  - Just run gdb, gprof, …
- Can dare crazy things
  - The Hurd console has dynamic font support
    - See chinese support in pseudo-graphical mode (actually pure VGA textmode!) of Debian installer.
- Kernel only handles Tasks, memory, IPC

Hurd possibilities

ext2fs

auth

ftpfs

sh

cp

pfinet

proc

isofs

root

user

Kernel
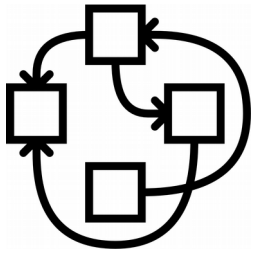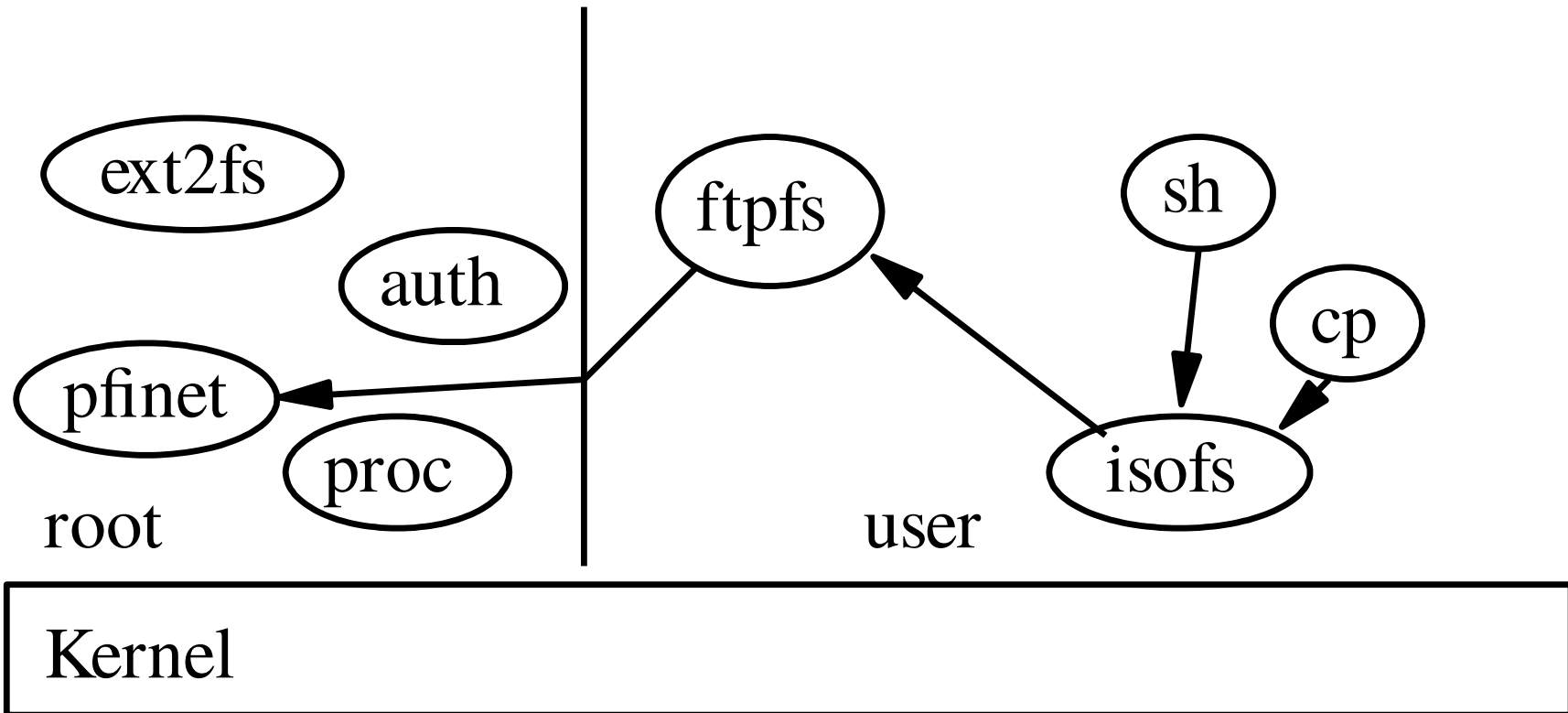
Hurd possibilities

```
€ settrans -c ~/ftp: /hurd/hostmux /hurd/ftpfs /

(just once for good)

€ settrans -a ~/mnt /hurd/iso9660fs
~/ftp://ftp.gnu.org/old-gnu/gnu-f2/hurd-F2-main.iso

€ ls ~/mnt

README-or-FAIL

…
```
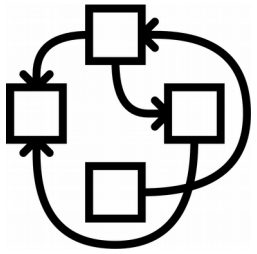
- Only downloads what is needed.
- Can be permanently stored in ext2fs

```
€ settrans ~/.signature /hurd/run /usr/games/fortune
```
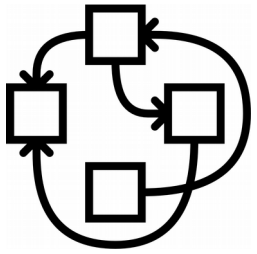
Example: interpose TCP/IP stack

```
€ settrans -ca $HOME/servers/socket/2
   /hurd/pfinet -i $HOME/servers/tun0

€ openvpn … $HOME/servers/tun0 &

€ remap /servers/socket/2
      $HOME/servers/socket/2

€€€ wget www.gnu.org
```

- My own translator

- Can plug my own VPN software

- Only wget accesses it (well, the shell too :))

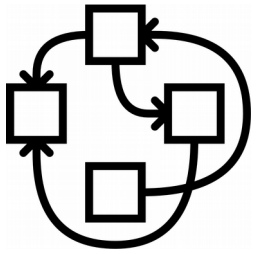# But also
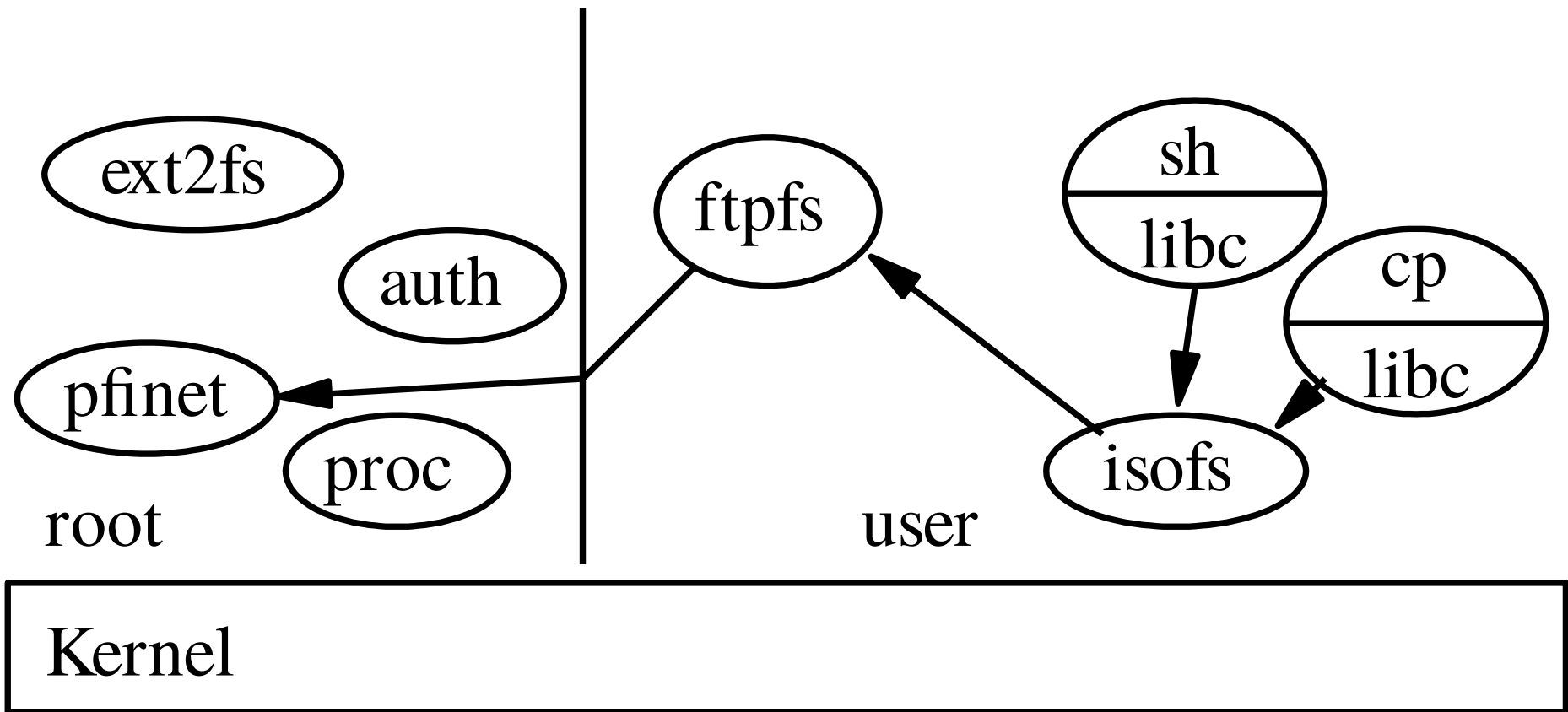
```
€ remap /bin/sh $HOME/bin/sh

€ remap /bin $HOME/unionbin
```
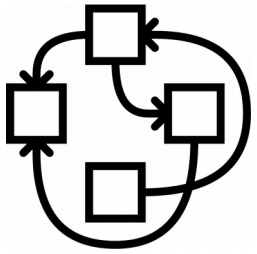
…

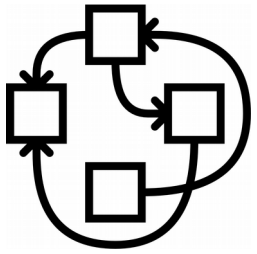- Check out Stow/Nix/Guix!

# How does it work?

root

user

Kernel

Rationale

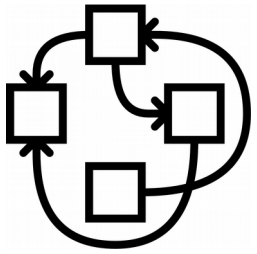- **Everything** is an (interposable) RPC

- Translators exposed in the FS

  - The user gets to decide what/how to interpose

    - Without need for costly ptrace or fragile libc symbols interposition.

    - **Native** fakeroot/chroot

    - Fully virtualized and fine-grained interface

  - Just need to use what's provided by the admin, e.g.

    - $HOME/

    - TCP/IP stack
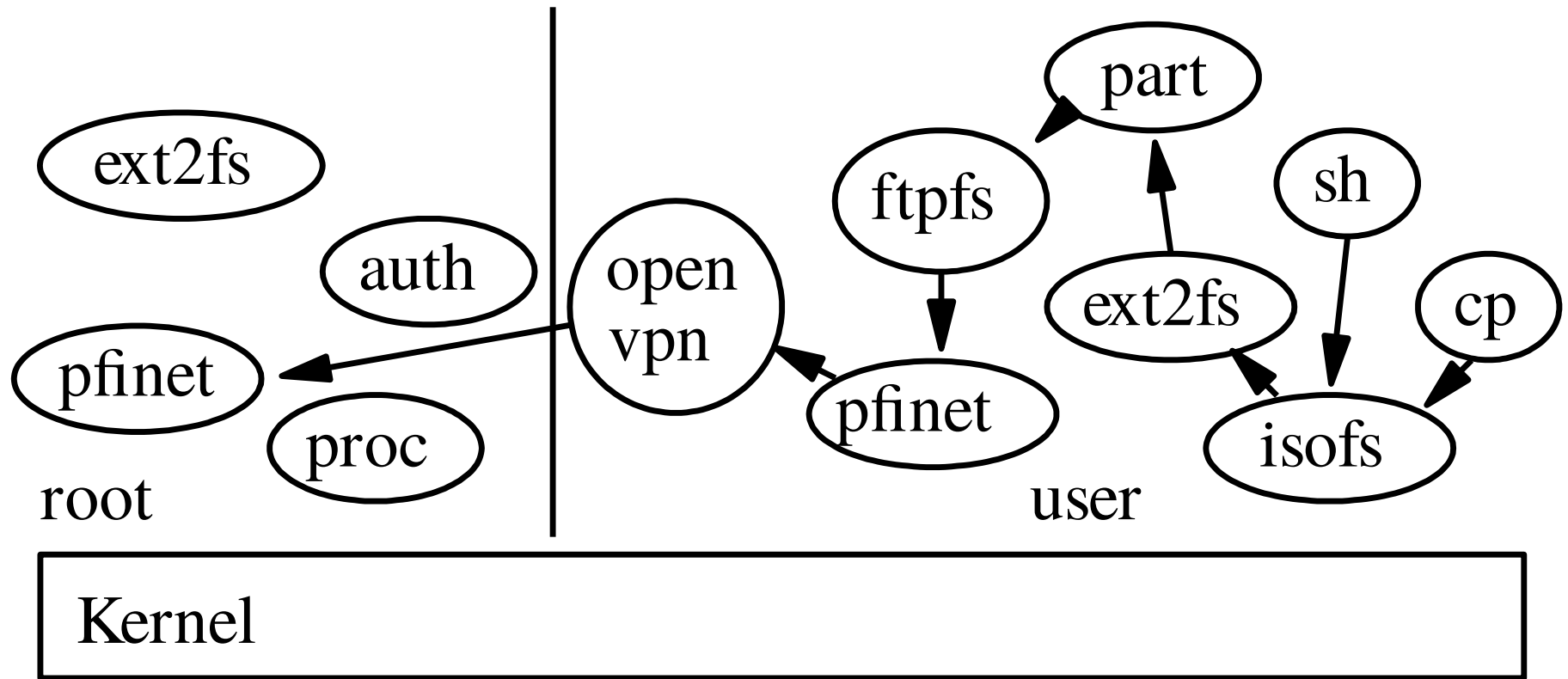
  and pile over it

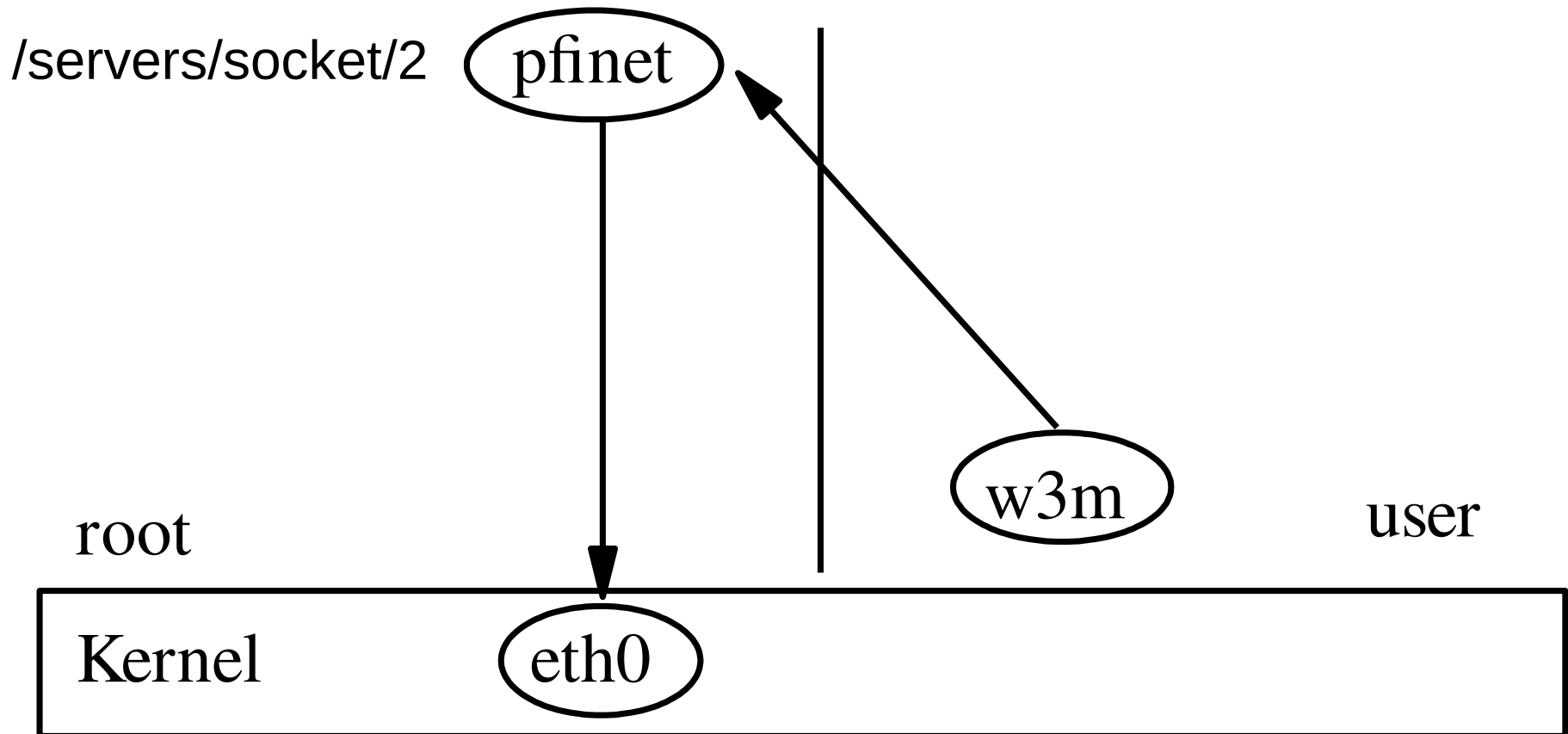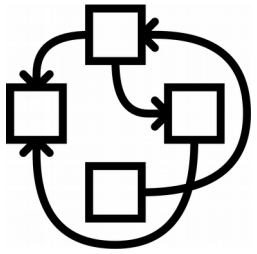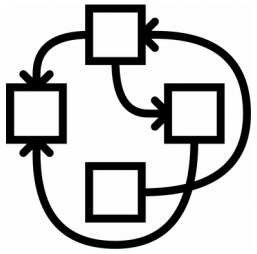# Hurd possibilities (cont'ed)
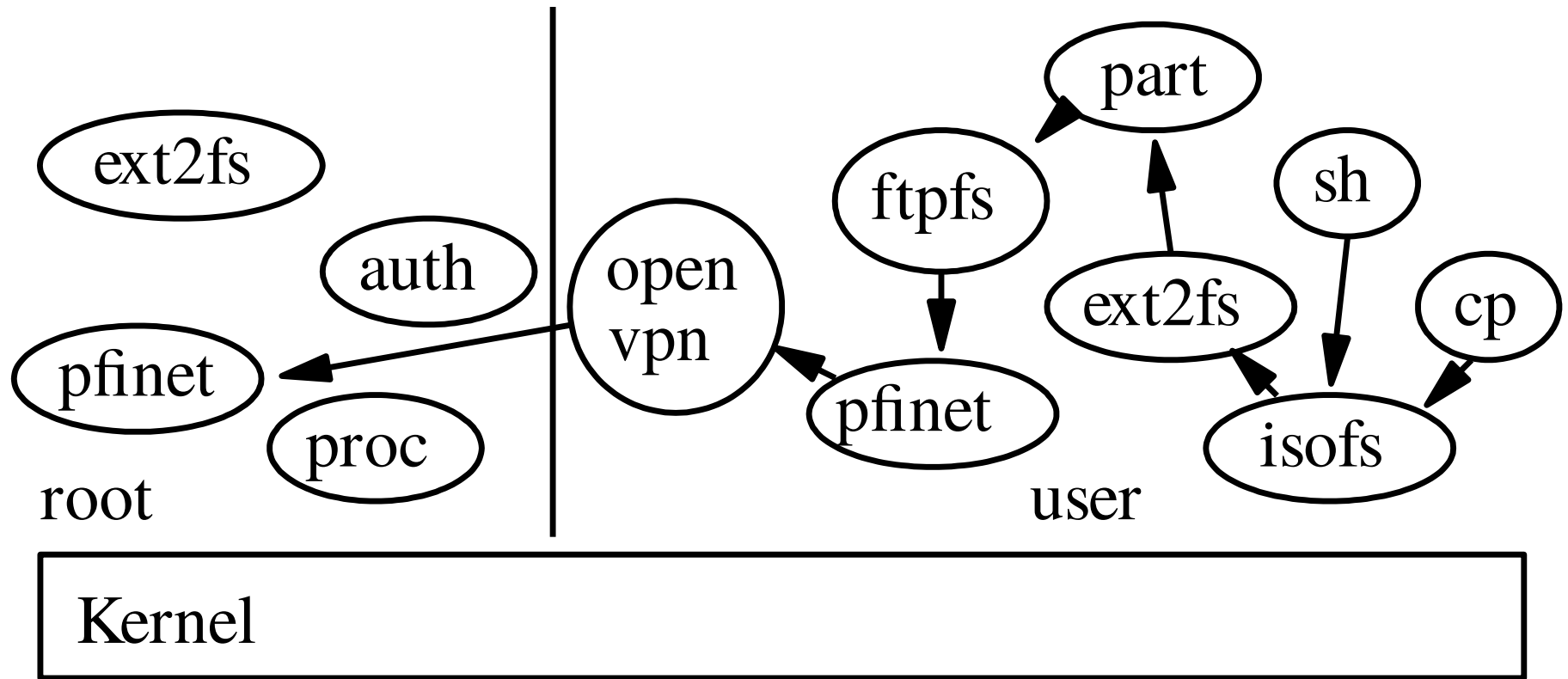
Hurd possibilities (cont'ed)

i.e. ISO image inside a partitioned disk image
on ftp over a VPN

Hurd userland network support

/servers/socket/2

pfinet

w3m

root

user

Kernel   eth0

Hurd userland network support

pfinet

DDE layer
Linux 2.6.32 drivers
/dev/eth0

eth0

w3m

root

user
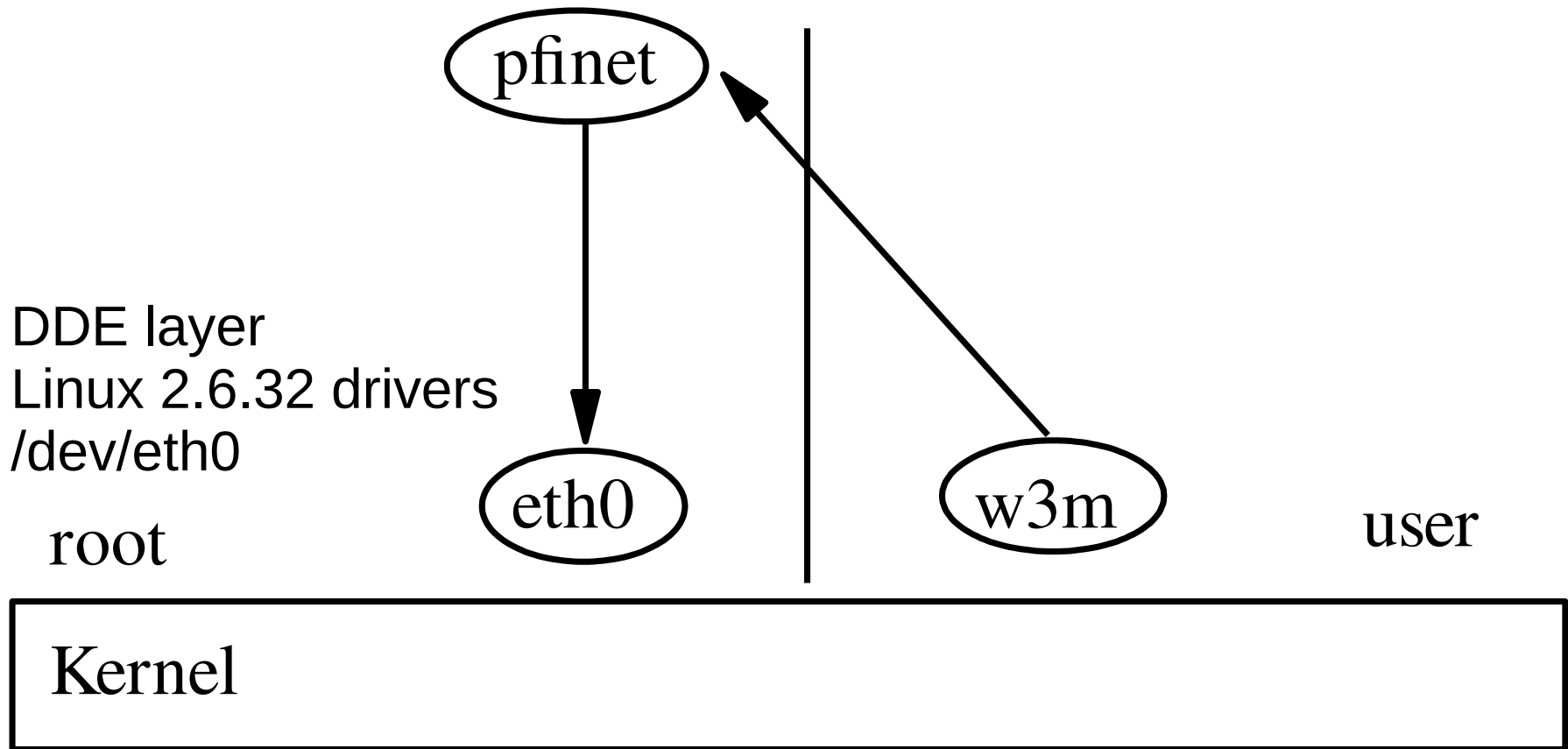
Kernel

DDE stack

Based on TU-Dresden's DDE stack

- Zheng Da's GSOC

- Ported to Mach kernel

- Ported to Mach device interface

- Updated libdde_linux26 for long-term-supported linux 2.6.32

  - Most drivers (and mostly the really useful ones) just work without patches

- Used by default by Debian GNU/Hurd

DDE stack

pfinet

device_read   device_write

Linux drivers

Linux API

pkg_xmit

libdde_linux26   libmachdev

ddekit API   rx_callback

libddekit   netdde

intr   vm_allocate_contiguous   kernel

40
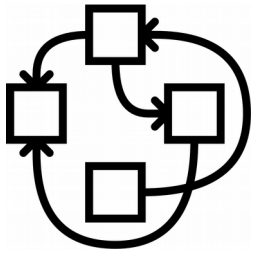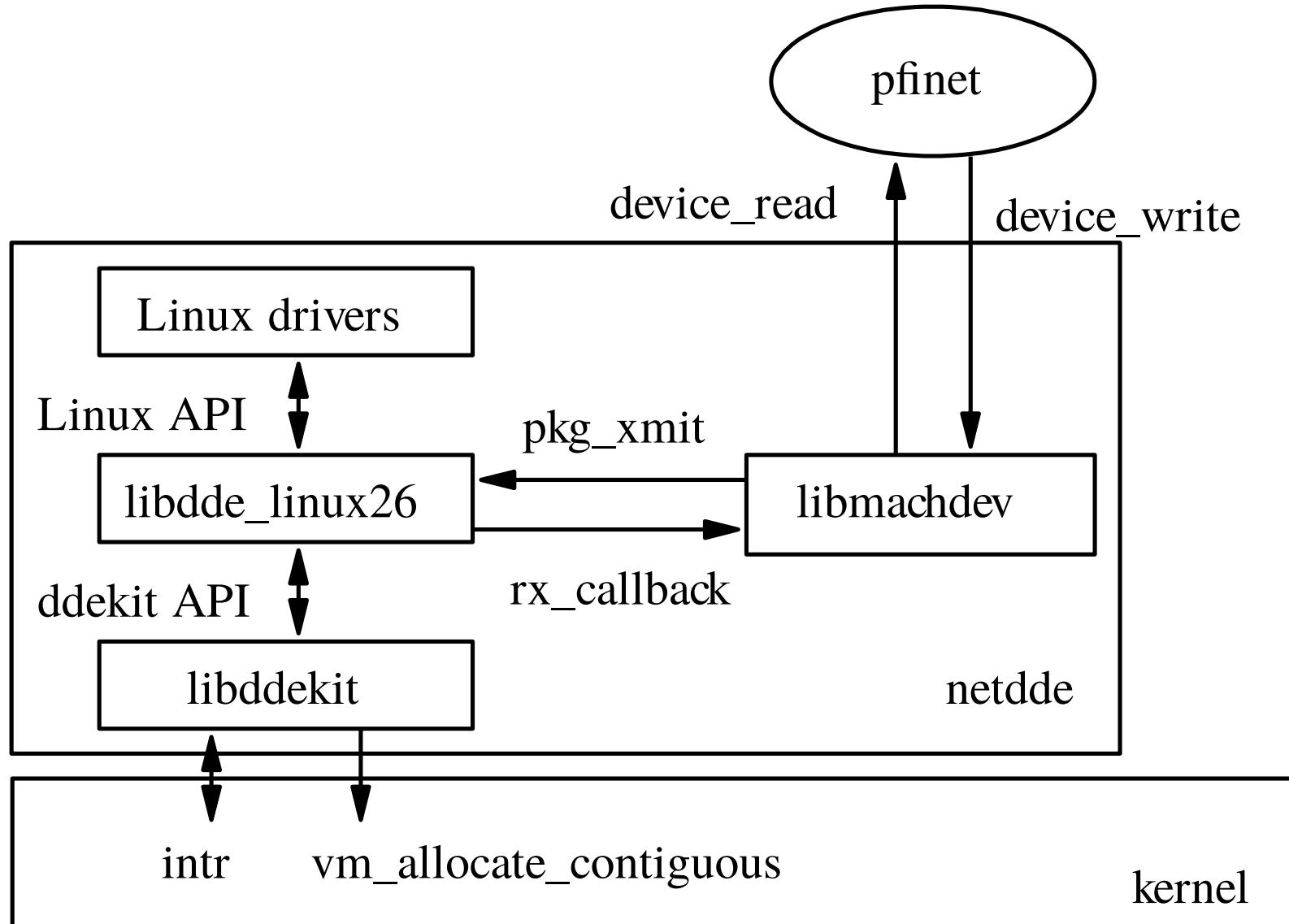
DDE stack

- Only two additions to the kernel

  - Interrupt delivery and masking

  - Physically-contiguous memory allocation

  - (Direct I/O access was already available)

- Performance similar to in-kernel driver

- Driver in a separate process

  - Can just crash and be happy with it...

  - Can easily debug and profile them

  - Stack smashing protection ;)

  - Could benefit from I/O MMU for better isolation.

    - For now drivers can just access all RAM...
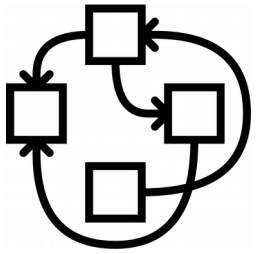
Rump sound support, v0

Rump sound support, v1

librumpuser

BSD

src-gnu

libpciaccess

/dev/pcm

mplayer

intr   vm_allocate_contiguous

kernel

Rump sound support, v2

/home/samy/dev/pcm

/dev/pcm

rumpuser

rumpuser

IOMMU

PCI arbiter

intr   vm_allocate_contiguous

kernel

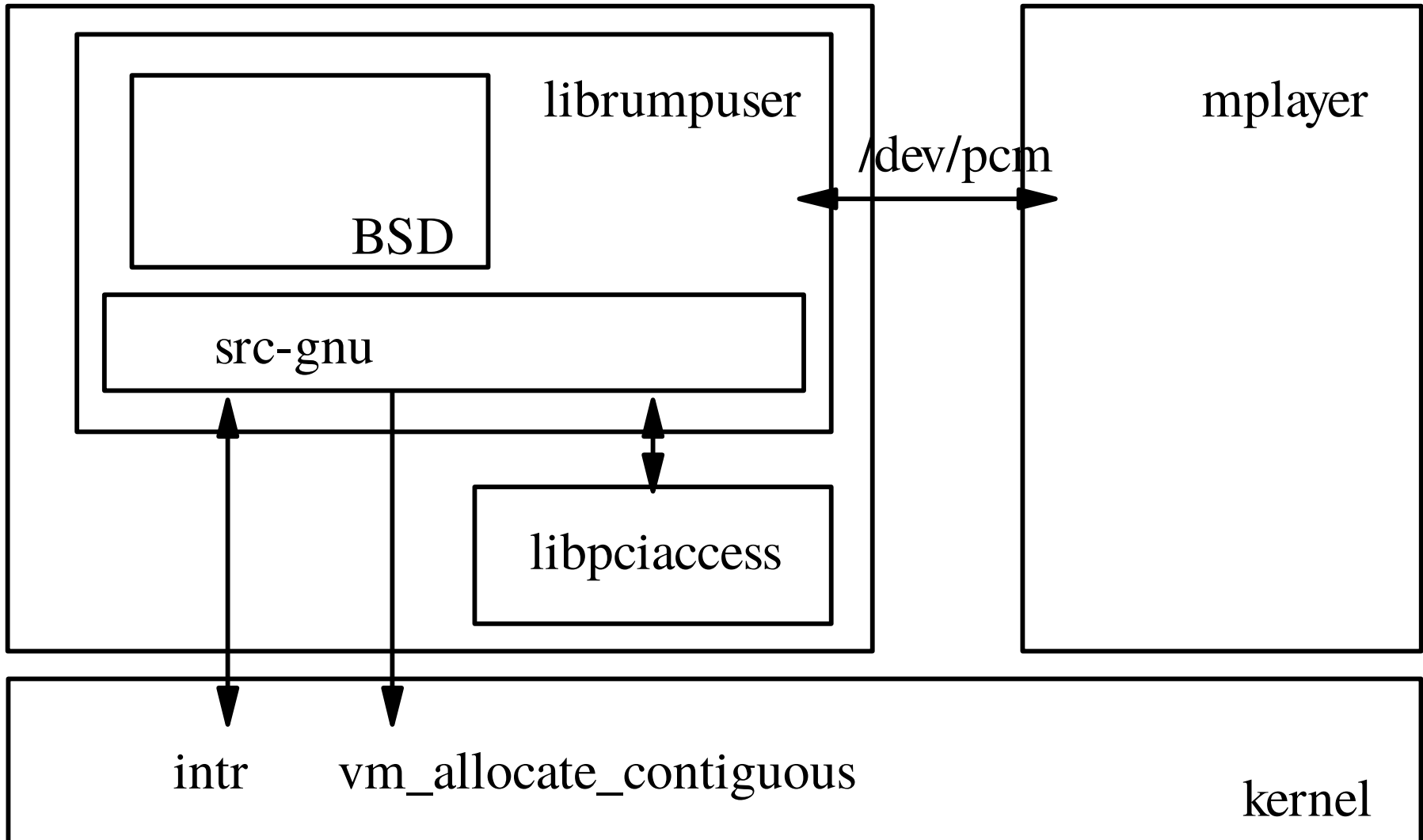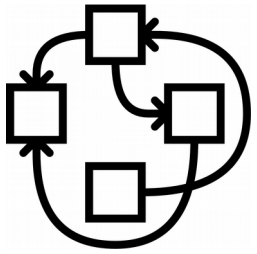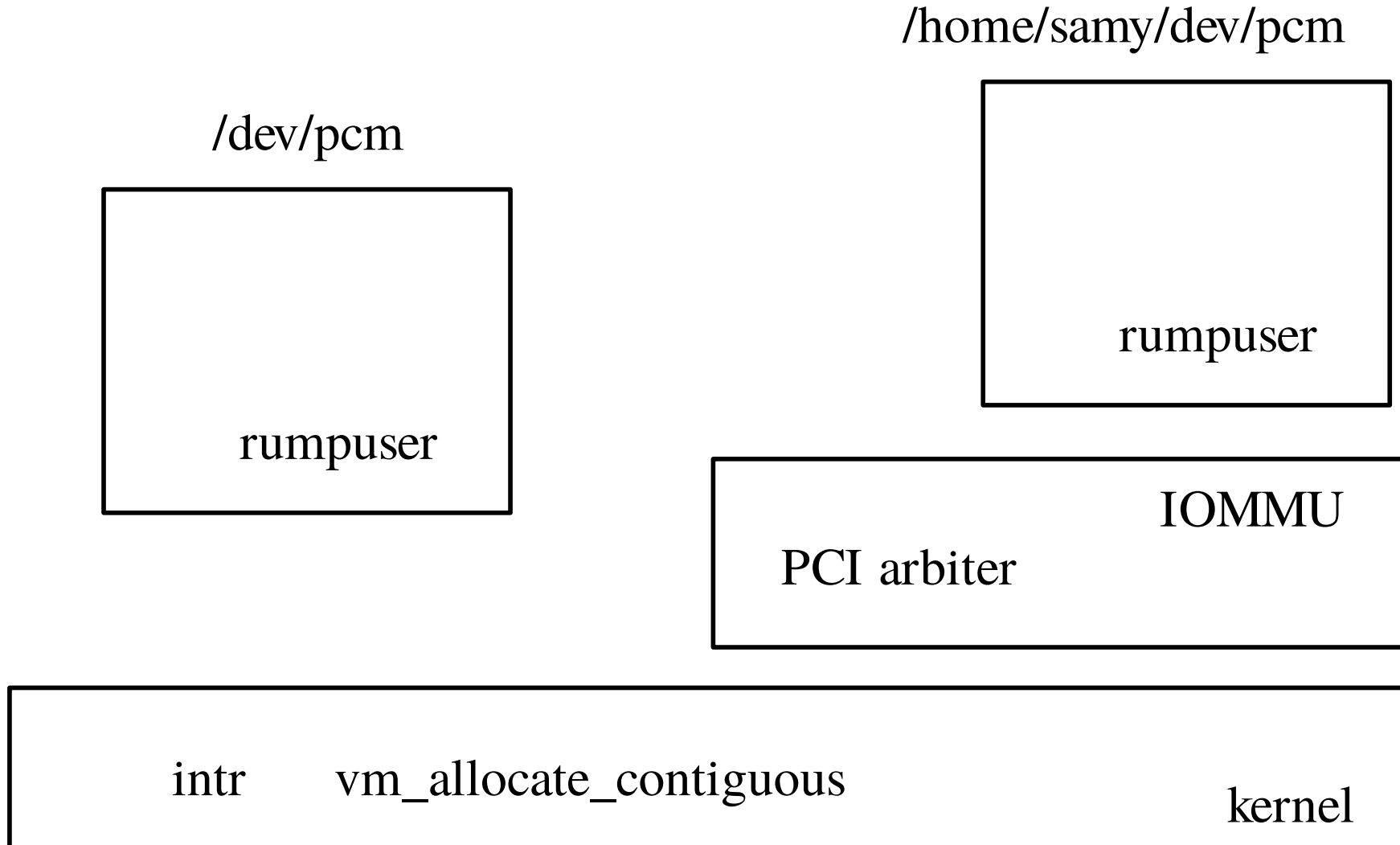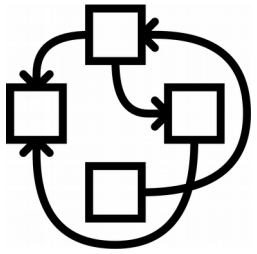# Rump USB support

```
┌─────────────┐
│   ext2fs    │
└─────────────┘
       ↕ /dev/usbd0
┌───────────────────┐
│ rump-usb-storage  │
│      libusb       │
└───────────────────┘
       ↕ /dev/usb
┌──────────────┐      ┌──────────────────────┐
│              │      │              IOMMU   │
│              │ ↔    │   PCI arbiter        │
│   rumpuser   │      │                      │
└──────────────┘      └──────────────────────┘
┌────────────────────────────────────────────┐
│                                             │
│  intr    vm_allocate_contiguous             │
│                                   kernel    │
└────────────────────────────────────────────┘
```

Rump USB support

ext2fs

$\updownarrow$ /dev/usbd0

rump-usb-storage
libusb

$\updownarrow$ /dev/usb

usb-foo

rumpuser

PCI arbiter

ext2fs

usb-storage

rumpuser

IOMMU

intr   vm_allocate_contiguous   kernel

Current State

Hardware support

- i686

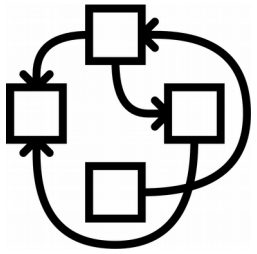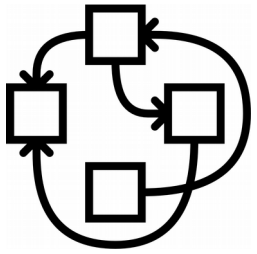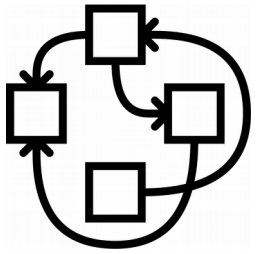- start of 64bit support

  - Kernel boots completely, now missing RPC 32/64bit translation

- DDE Linux 2.6.32 drivers layer for network boards

  - In userland netdde translator!

- IDE, Xorg, …

- AHCI driver for SATA

- Xen PV domU

  - Required GNU Mach changes only

- Preliminary sound support through userland Rump

- No USB yet

Current State

Software support

- Quite stable
  - Have not reinstalled boxes for a decade.
  - Debian buildds keep building packages, no hang after weeks!
- ~80% of Debian archive builds out of tree
  - XFCE, almost gnome, almost KDE
  - Firefox (aka iceweasel), gnumeric, …
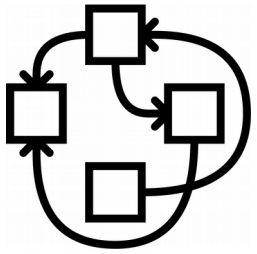- Standard *native* Debian Installer

Recent work

- GNU Guix

- Fixed native fakeroot

- SCM_CREDS

- Various optimizations

  - Node cache

  - Lockless reference counting

  - IPC table → radix tree

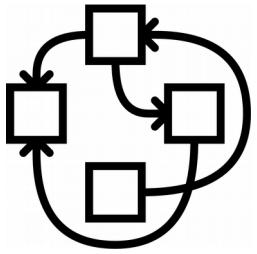 - Kernel memory management

- New rpcscan tool
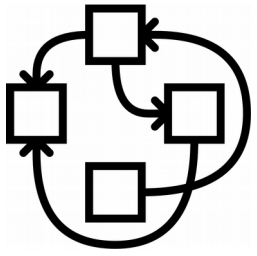
Releases

- Nice 0.401 release on April 2011.
- Arch Hurd LiveCD release on August 2011.
- Hurd 0.6 then 0.7, Mach 1.5 then 1.6, MIG 1.5 then 1.6
- Released Debian-unofficial
  - wheezy/sid snapshot CDs on May 2013 \o/
  - jessie/sid snapshot CDs on May 2015 \o/

Future work

- X86_64 support

- Read-ahead

- {sound,usb} Rump drivers

- GNU system: Guix/Hurd?

- Startup in scheme?

- Your own pet project?

Thanks!

- http://hurd.gnu.org/

- http://www.debian.org/ports/hurd/

- http://people.debian.org/~mbanck/debian-hurd.pdf

- The increasing irrelevance of IPC performance for microkernel-based Operating Systems

  http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.37.9653&rep=rep1&type=pdf