CE Linux Forum

Linux DVB API Version 4

http://www.linuxtv.org
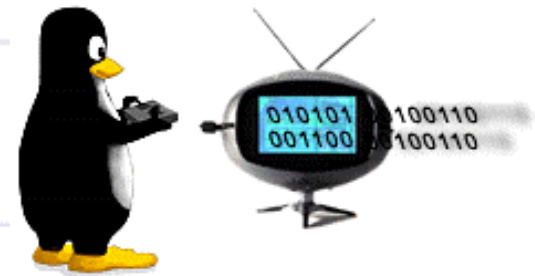
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Contents

- DVB and Digital TV
- History
- About LinuxTV.org
- Linux DVB API v3 status and problems
- Linux DVB API v4 design and structure
- Concepts
- Current status and todo
- Helping the project

What is DVB?

- Digital Video Broadcast http://www.dvb.org/
- delivery of any digitized informations to the home
  - video, audio, subtitles
  - service informations, program guide
  - multimedia applications, ...
- managed by Digital Video Broadcasting Project
  - industry-led consortium of broadcasters, manufacturers, network operators, software developers, regulatory bodies and others
- based on MPEG2 transport streams
- different means of transportation
  - DVB-C ⇨ cable
  - DVB-S ⇨ satellite
  - DVB-T ⇨ terrestrial

Data flow

Broadcaster

End-user
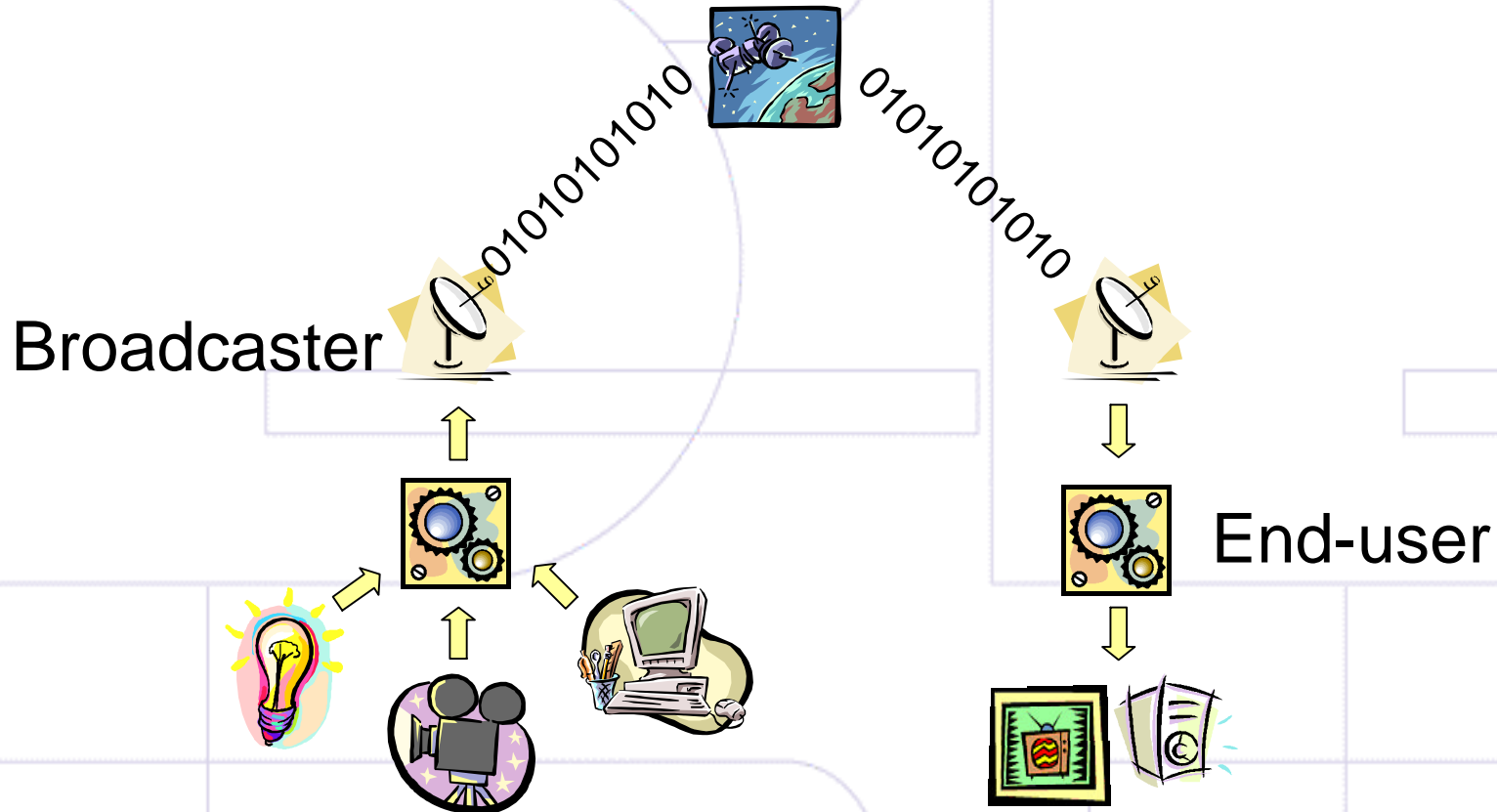
- MPEG2 transport stream (TS)
- data packets with 188 bytes

Related technologies

- IP-over-DVB ("SkyDSL", Internet via satellite)
  - MPE (Multi Protocol Encapsulation, ETSI standard)
  - ULE (Ultra Light Encapsulation, IETF draft)

- DVB-over-IP
  - MPEG2 TS distributed via Ethernet
  - RTP streaming
  - DVB-IPI (ETSI TR 102 033)

- general datacasting
  - SSU (System Software Update)
  - proprietary protocols

- DVD playback (MPEG2-PS and MPEG1)

History

- 1998
  - Technotrend GmbH develops popular DVB PCI card

- 1999
  - Siemens produces cards based on Technotrend GmbH design
  - first Linux driver as diploma thesis,ad hoc API based on Video4Linux

- 2000
  - Nokia develops DVB API for http://www.ostdev.net/
  - Convergence GmbH implements Nokia DVB API for Siemens card
  - community project LinuxTV.org is launched

- 2001
  - ongoing development results in Linux DVB API v3

History

- ## 2002
  - Linux DVB API v3 is included in Linux kernel 2.5.44

- ## 2003
  - Convergence and Toshiba start development of Linux DVB v4 API
  - public discussion of API features on the linux-dvb mailing list

- ## 2004
  - Linux DVB v4 API is nearly fully specified
  - generic core modules and sample driver for Siemens card available

- ## 2005
  - first real-world implementation on Toshiba TC90400 MPEG2 decoder chipset („Donau")

What is LinuxTV.org?

- started and hosted by Convergence GmbH until mid 2004
- community project by DVB enthusiasts and developers interested in Digital TV
- open, independent, non-profit
- hosts other projects related to Digital TV
  - MPEG2 TS/PS multiplexer
  - DSM-CC / MHP object carousel generator

LinuxTV.org goals

- **specify complete API for**
  - set-top-box (STB)
  - Integrated Digital TV (IDTV)

- **standardize support for peripheral hardware**
  - as little as possible proprietary APIs and private extensions

- **promote existing APIs where possible**
  - Linux Input Layer for ir and frontpanel
  - DirectFB for scaler, video encoder, video layer mixer

- **create new APIs where necessary**
  - analog tv integration
  - avmux
  - smartcard interface
  - video encoder and vbi
  - DVD and subtitle processing unit (SPU) support

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Linux DVB

- no complete multimedia framework
  - graphics output and video scalers are handled by DirectFB
  - analog uncompressed video is currently not supported
  - no handling of arbitrary multimedia data

- no support for auxiliary hardware in core API
  - avmux
  - smartcard interface

- means to control digital tv hardware easily and efficiently
  - support for PCI/USB DVB extension cards
  - support for dedicated set-top-box (STB) chipsets
  - support for integrated digital TV (IDTV) solutions

- hardware independent driver framework

- kernel level only

Linux DVB

- **Motivation**
  - make life of software and hardware developers easier
  - provide a consistent abstraction layer for different hardware

- **Benefits**
  - Software companies
    - easier support for different hardware platforms
    - hardware independent applications and middleware
  - Hardware vendors
    - easier software support for existing chipsets
    - smooth transition from one chipset generation to the next
    - new business opportunities by faster time-to-market

Linux DVB API v3 users

- Open-source projects
  - PC
    - vdr (video disk recorder)
    - mplayer and xine
    - kaxtv, mythtv, klear, xawtv 4.0
  - Embedded Linux platforms on PowerPC-based „dbox2"
    - Neutrino, Enigma ⇨ http://wiki.tuxbox.org/ (german)
  - platform independent
    - dvbstream, dvbsnoop

- Commercial users
  - Dreambox using IBM Pallas/Vulcan (PowerPC)

Present situation

- PCs and embedded platforms are diverging
  - "budget" PCI cards on PCs
    - prowide full, raw TS
    - all decoding and processing is done by main CPU
  - Embedded platform STB/IDTV chipsets
    - data is demultiplexed for direct application use
    - specialized hardware or firmware relieves main CPU

- no new „full-featured" DVB PCI/USB card is in sight

- new challenges with supporting embedded platforms running Linux

- ⇨ Linux DVB v4 API heads towards highly-integrated embedded STB and IDTV systems

Linux DVB API v3 problems

- focussed on Siemens DVB card

- namespace inconsistencies

- inconsistent remains of ad-hoc DVD/SPU support

- legacy OSD API designed for Siemens DVB card only

- superfluous internal DVB kernel demux layer

- very limited support for modern hardware
  – multiple frontends, video and audio decoders

- explicit source-sink connections not possible

- no support for special recording hardware and event logging

- all data transfers through ringbuffers, no zero-copy DMA

Linux DVB API v4 design

- Linux/Posix character device interface /dev/dvb/adapter0/...
  - input: frontend, memory
  - processing: ci, demux
  - decoding: video, audio
  - output: audio mixer, spdif, dvb-net

- source/sink connection via I/O controls

- zero copy DMA via `mmap()`
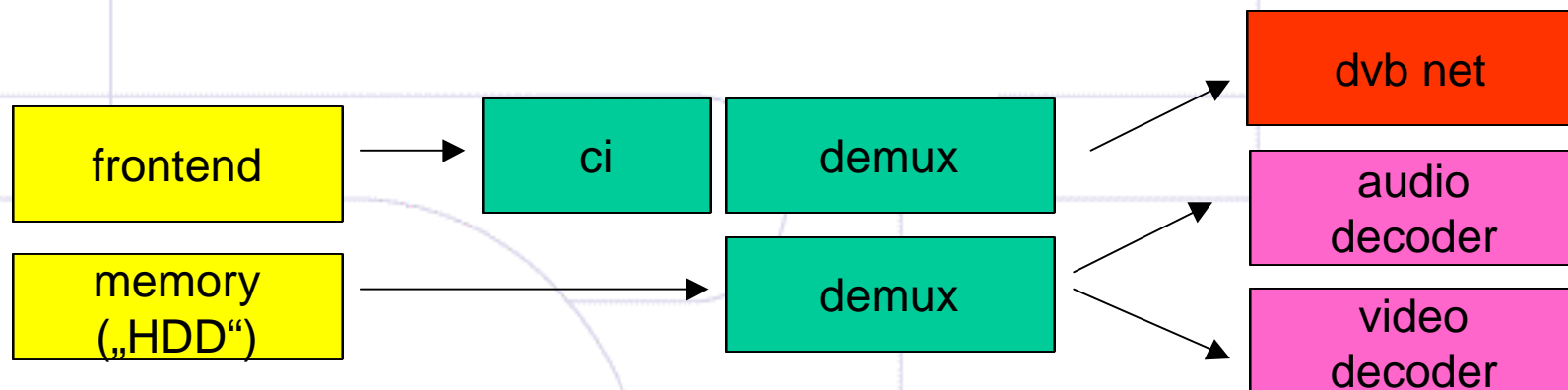
# Implementation structure

- DVB core
  - implements hardware independent functionality
  - does sanity checks and parameter checking
  - enforces policy restrictions
  - different levels of abstraction
    - demux, frontend (high)
    - video (low)

- external APIs
  - graphics, scaler and video output handled by DirectFB

APP

Application

Middleware

Direct FB

KERNEL

DVB core

HW 1 dependent

HARD WARE
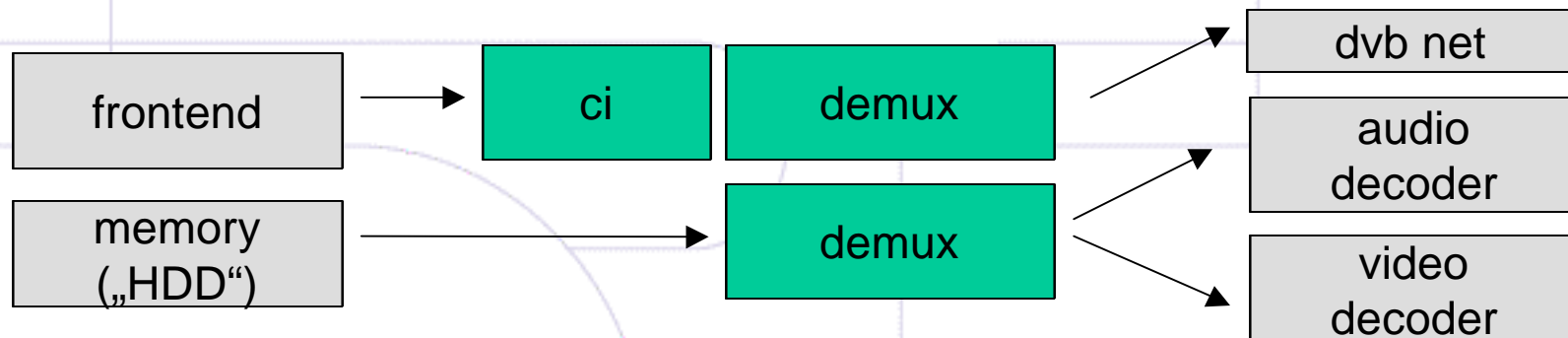
Firmware
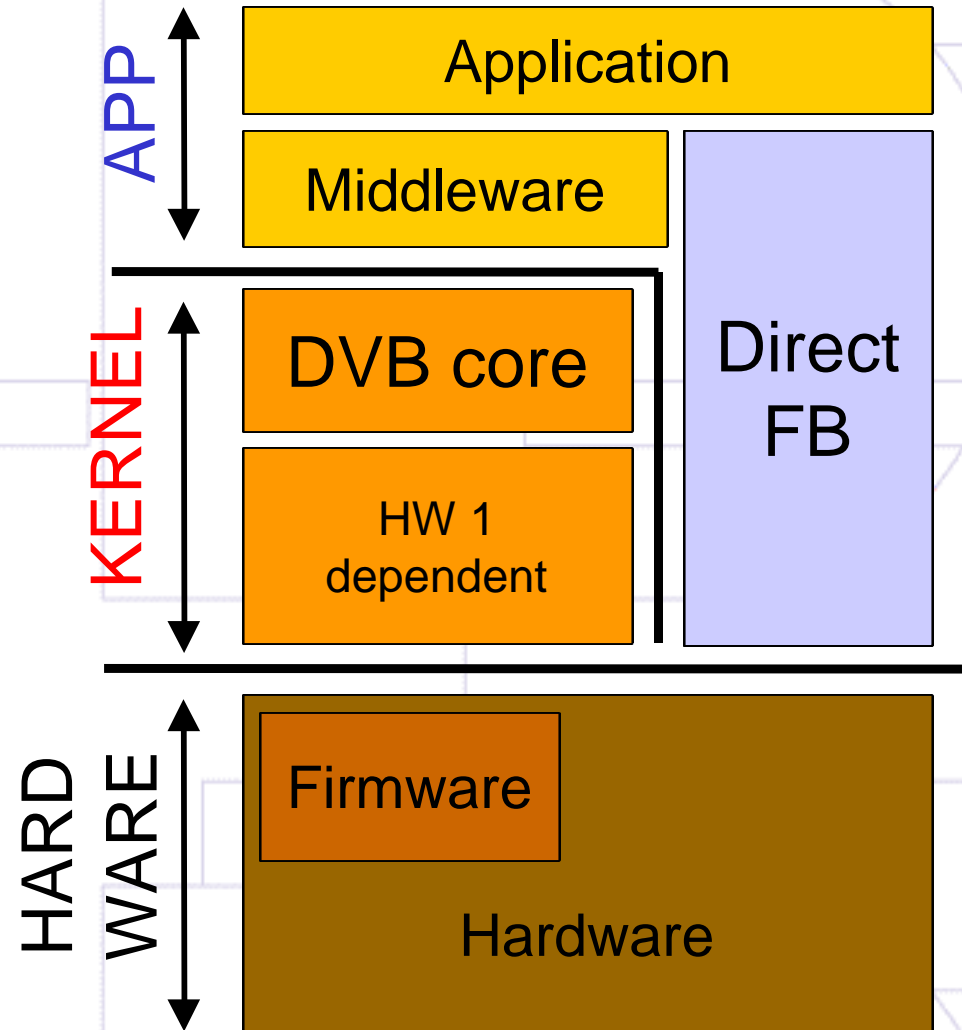
Hardware

Input devices

- provide data for stream processing

- frontend input
  - controls tuner and demodulator hardware
  - supports satellite (DVB-S), cable (DVB-C) and terrestrial (DVB-T)
  - in case of satellite equipment (LNB, dish rotor) control via Eutelsat's DiSEqC protocol

- memory input
  - zero-copy DMA for HDD playback or network streaming
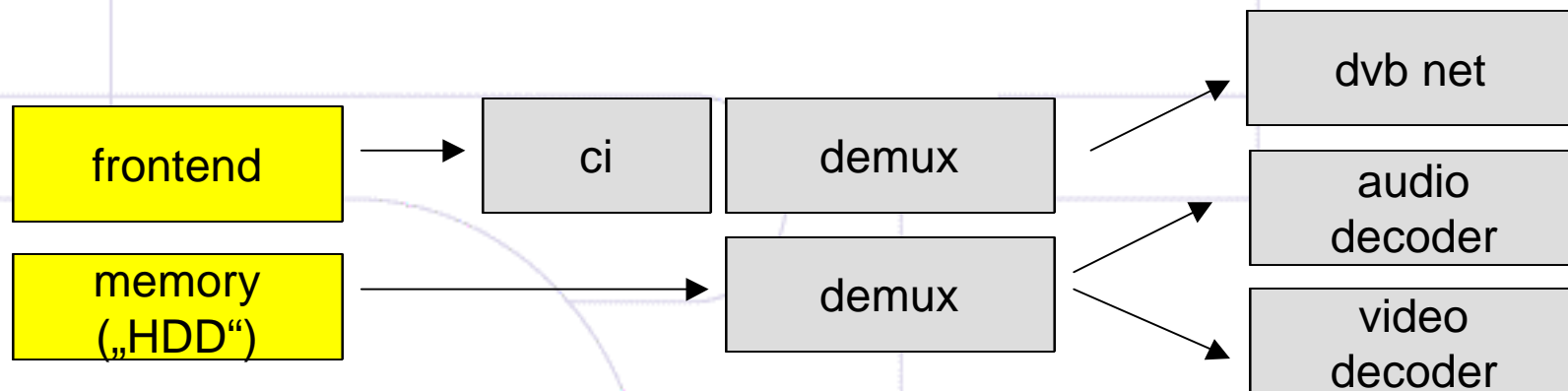
Processing devices

- ci (common interface)
  - slot handling for common interface (CI) PCMCIA slot
  - simple transport layer message interface

- demux (demultiplexer)
  - processes one input stream from frontend or memory input
  - outputs to multiple destinations
  - PID filter (TS packet or payload only), DVB section filter
  - PS and multiplexed PES input with stream id filter
  - recording filter for HDD recording with event logging support
  - decoding feeds for live tv (video, audio, teletext/VBI insertion)

| frontend | → | ci | demux | → | dvb net |
| memory ("HDD") | → | | demux | → | audio decoder |
| | | | | → | video decoder |

Decoding devices

- audio
  - ALSA and OSS are not suitable for embedded STBs/IDTVs
  - provides decoding and downmixing
  - provides PCM playback and optional MP3 playback
  - optional postprocessing
    - virtual surround
    - dynamic compression etc.
  - S/P-DIF and I2S inputs
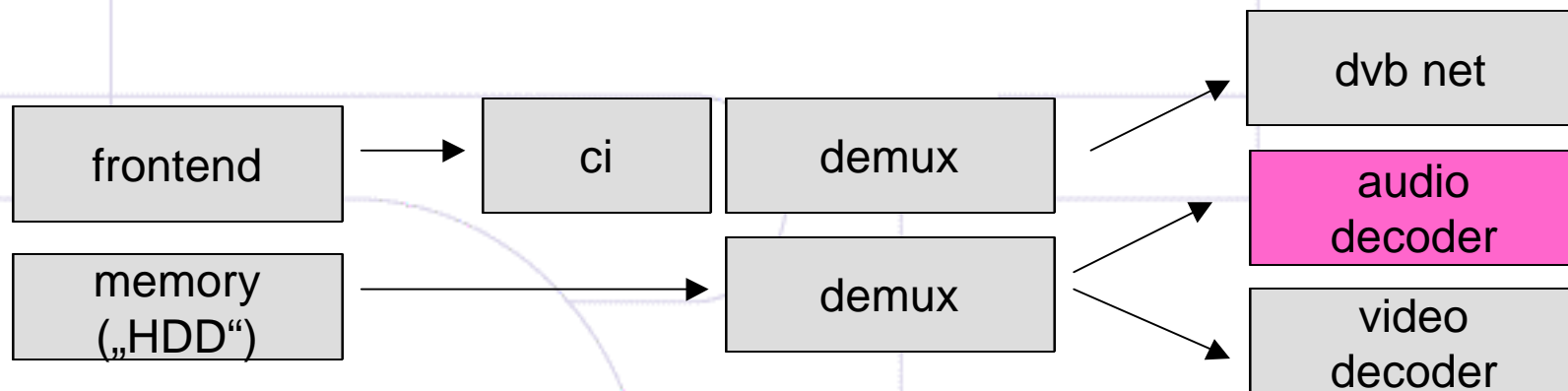
Decoding devices

- video
  - usually MPEG 1/2 decoder
  - limited presentation support
    - auto-scaling, pan & scan
  - trickmode support for memory input
    - fast forward, (fast) reverse, slowmotion
  - stillpicture and dripfeed support
  - video event handling
    - sequence header changes
    - extract user data like active format description (AFD)
  - video frame header meta data query
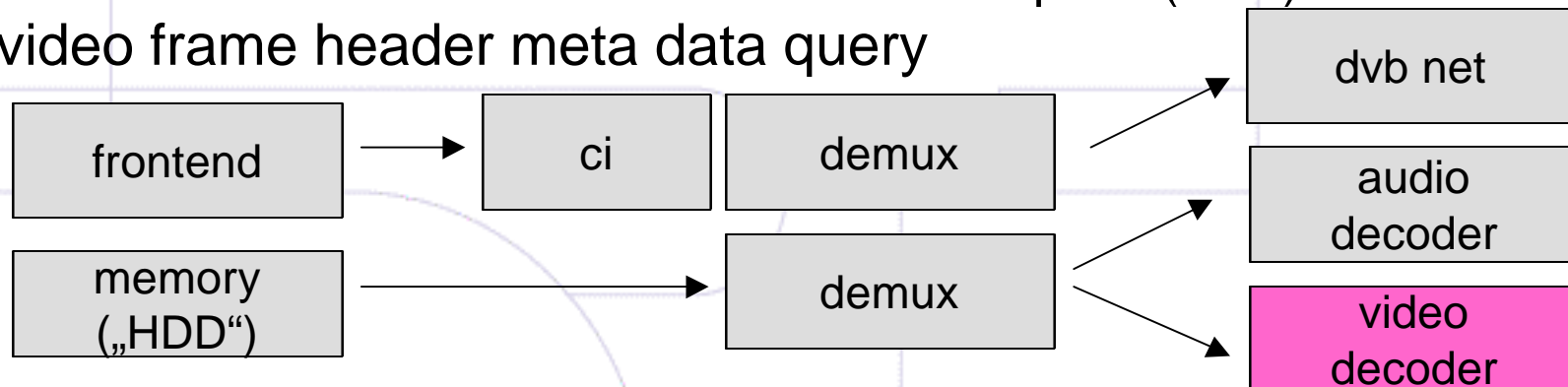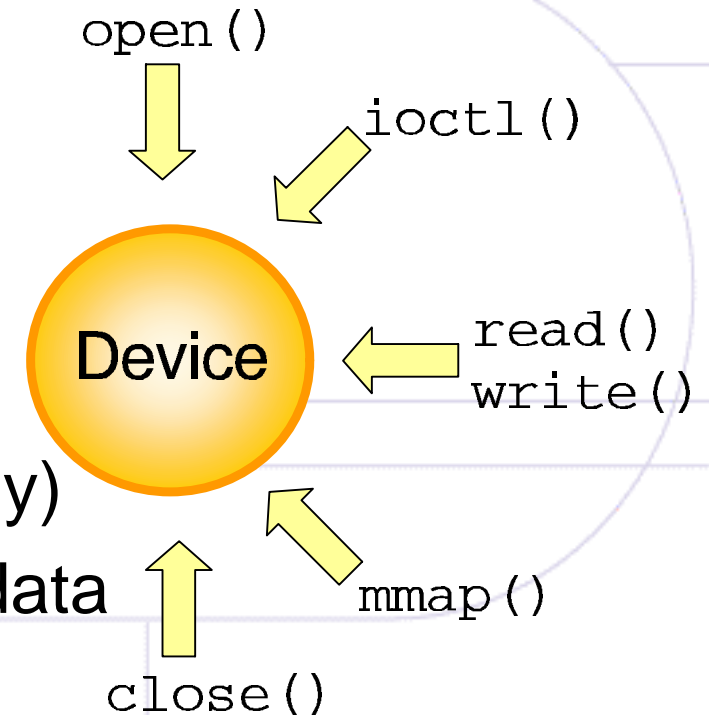
Output devices

- (audio) mixer
  - mix 5.1 and stereo signals to TV, VCR and headphone outputs
  - tone control, speech enhancement, test tone generator, ...

- spdif
  - S/P-DIF header control
  - connectable to various sources

- net
  - MPE and ULE decapsulation
  - data packets are provided to the Linux network stack
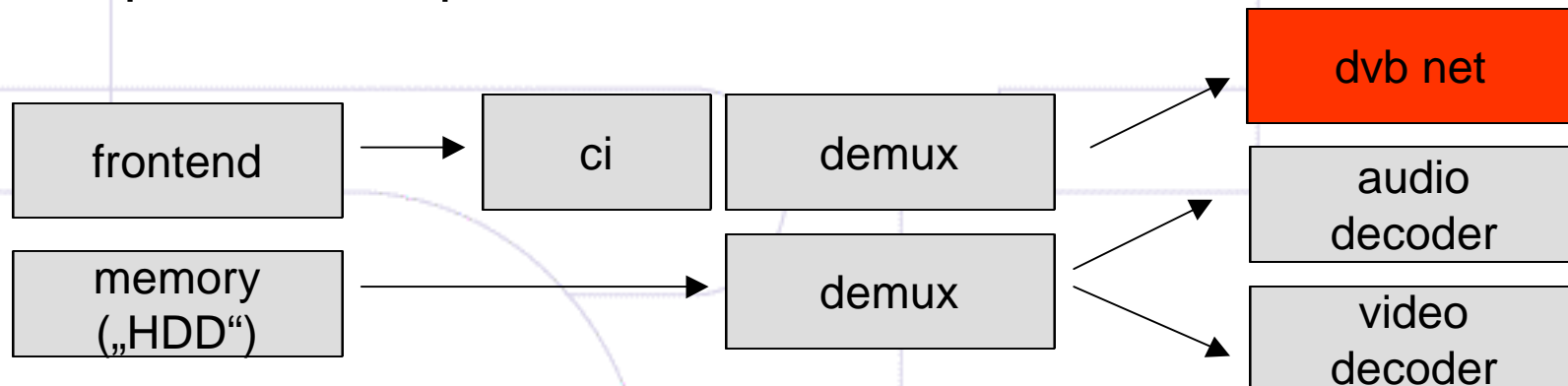
Control concept

- POSIX device interface
- `open()`/`close()` to access devices
  - with "write access" once
  - with "read only" multiple times
- `ioctl()` to control device
- `read()` to pull stream (section filter only)
- `mmap()` for zero-copy DMA access to data
  - get recording data
  - provide playback data

```
open()
        ioctl()

Device        read()
              write()

        mmap()
close()
```

```
fd = open('/dev/dvb/adapter0/video0', O_WRONLY);
ioctl(fd, DVB_VIDEO_PLAY, 1000);
```

Connection concept

- `DVB_xxx_SET_SOURCE` I/O control connects devices to input sources by passing a file descriptor
- common for all processing, decoding and output devices
- only possible on a device open with write permissions

```
src = open('/dev/dvb/.../frontend0', O_RDONLY);
dst = open('dev/dvb/.../demux0', O_WRONLY);
ioctl (dst, DVB_DEMUX_SET_SOURCE, &src);
```

Capability concept

- different hardware has different capabilities
- sometimes even different devices of the same kind have different capabilities
- applications need to be able to distinguish devices and hardware
- `DVB_xxx_GET_CAPS IOCTL` exposes device capabilities

```
vcaps.cap = DVB_VIDEO_CAP_SOURCE_FORMATS;
ioctl(fd, DVB_VIDEO_GET_CAPS, &vcaps);
if (vcaps.val & DVB_VIDEO_xxx_CAPABLE) {
        // device supports xxx
```

Filter concept for demux devices

- opening the demux `O_WRONLY` offers the demux device itself
- opening the demux `O_RDONLY` adds a new filter
  - section filter
  - recording filter
  - PES filter
  - decoding feeds
- specific I/O controls set filter parameters or change them
- closing the filedescriptor removes filter

```
struct dvb_demux_section_filter f;
flt = open('/dev/dvb/adapter/demux0', O_RDONLY);
[... set filter options...]
ioctl(flt, DVB_DEMUX_SET_SECTION_FILTER, &f);
[... do something ...]
close(fd);
```

Current Linux DVB API v4 status

- available via CVS from linuxtv.org ("dvb-kernel-v4")
- supports 2.4 and 2.6 kernels
- major requested functionality is implemented
- continuing discussion on Linux DVB mailing list
  - current and future API development
  - remaining implementation details
- prototype driver for Siemens card
  - PC platform for easy evaluation
  - software emulation to compensate for missing hardware support
- API specification document is work-in-progress
  - auto generated version with few annotations is available
- complete software emulation of DVB device is planned
  - overcome Siemens card drawbacks (no multiple tuner support)

Linux DVB todo

- Linux 2.6 kernel integration
- finish API specification
  - multi client support for section filter data
  - CI routing
  - support for other MPEG2 TS based formats
    - ATSC (USA)
    - ISDB (Japan)
- CE Linux Forum
  - discuss Linux DVB in technical working group

Helping Linux DVB and LinuxTV.org

- open, vendor independent, non-profit project
  - discussions and proposals are very welcome
  - thrives on the contribution of its participants
  - follows the spirit of Linux development model
  - always open to receive proposals for API enhancements

- What you can do
  - subscribe to the linux-dvb mailing list
  - engage in discussions and share your opinion
  - do code review and send patches to the mailing list
  - get a CVS account for larger contributions
  - don't wait for others to do your work

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Thank you

- Thank you for your attention
- Any questions?

Related Links

- http://www.linuxtv.org
- http://www.directfb.org

Abbreviations

- API = application programming interface
- CI/CA = common interface, common access
- CVS = concurrent versioning system
- DMA = direct memory access
- DSM-CC = digital storage media command and control
- DVB = digital video broadcast
- HDD = hard disk drive
- IDTV = integrated digital television
- MHP = multimedia home platform
- OSD = on-screen display
- PES = packetized elementary stream
- PS = program stream
- SPU = subtitle processing unit
- S/P-DIF = Sony/Philips digital interface
- STB = set top box
- TS = transport stream