

Audio in embedded Linux systems

Audio in embedded Linux systems

Michael Opdenacker

Free Electrons

<http://free-electrons.com>

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Scope of this training

▶ Audio in embedded Linux systems

This training targets the development of audio-capable embedded Linux systems. Though it can be useful to playing or creating sound on GNU/Linux desktops, it is not meant to cover everything about audio on GNU/Linux.

▶ Linux 2.6

This training only targets new systems based on the Linux 2.6 kernel. This way, you leverage the most advanced technology and don't learn about something getting obsolete.



Contents (1)

Introduction

- ▶ Glossary
- ▶ Audio codecs and file formats

System perspective

- ▶ System overview
- ▶ Advanced Linux Sound Architecture (ALSA)
 - ▶ ALSA kernel drivers
 - ▶ Kernel low latency requirements for sound
 - ▶ ALSA userspace interface
 - ▶ Sound servers - JACK



Contents (2)

Free Software audio

- ▶ Audio players
 - ▶ For the GNU / Linux workstation
 - ▶ For the embedded Linux target
- ▶ Audio encoders
- ▶ Misc
 - ▶ Speech synthesis
 - ▶ References



Quick Glossary

▶ **PCM:** Pulse Code Modulation

Digital audio encoding, representing the amplitude of a signal at uniform intervals.

▶ **Codec:** coder / decoder

Program or device coding and / or decoding a data stream or a signal.

▶ **MIDI:** Musical Instrument Digital Interface.

Standard to control electronic musical instruments.

See <http://wikipedia.org> for details!



Audio in embedded Linux systems

Free Software Audio Audio codecs and file formats



MP3

MPEG-1 Audio Layer III from the Fraunhofer Society

- ▶ Lossy audio format
- ▶ Bitrates from 32 to 320 kbit/s
- ▶ Quality depends on the bitrate:
128-192: good, 192-224: very good,
224-320: excellent
- ▶ Depends also pretty much on the
encoder and on the source.
- ▶ Depends on the listener too!

See <http://en.wikipedia.org/wiki/Mp3> for details

- The most popular. Users have lots of files in this format.
- Free Software encoders and decoders exist
- But relies on patented algorithms. Depending on which country you sell to, you may have to pay for a license.
- Licenses can apply to encoding, decoding or even songs!
- Ask for legal advice!



AAC

Advanced Audio Coding MPEG-4 Audio

- ▶ Standard format from the MPEG group: Dolby, Fraunhofer, AT&T, Sony, and Nokia
- ▶ Lossy audio format
- ▶ Designed to replace MP3. Consistently better audio quality than MP3 at lower bitrates.
- ▶ Can be DRM encrypted (FairPlay)

- Used on some on-line music stores (Apple iTunes) and portable players (Apple iPod).
- Also burdened by patents, like MP3. License needed to encode and read this format.
- Free Software decoders available
- Just one Free Software encoder available (faac)



More details on http://en.wikipedia.org/wiki/Advanced_Audio_Coding



RealAudio

From RealNetworks

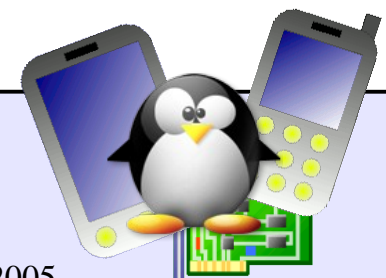
<http://realnetworks.com/>



- ▶ Lossy audio format
- ▶ Proprietary format
- ▶ Designed for very low bandwidth connections
- ▶ Bitrates: 12 to 800 kbit/s
Now uses AAC at 128 kbit/s and more
- ▶ Lossless format also supported

- Free Software decoders available (Helix, mplayer)
- Mainly used for streaming, used by a significant number of on-line media. Useful for mobile devices connecting to these media.
- Only proprietary encoders. RealNetworks encoder free of charge only for personal use.

More details on http://en.wikipedia.org/wiki/Real_Audio



WMA

Windows Media Audio

- ▶ Microsoft proprietary, as a alternative to MP3 (patented by somebody else) and now AAC.
 - ▶ Almost always encapsulated in an Advanced Systems Format (ASF) file
 - ▶ File extensions: `asf` or `wma`
 - ▶ Supports constant and variable bitrates, and lossless compression.
 - ▶ Can be DRM encrypted
- Now supported by more and more digital players and on-line music stores. Users may ask for WMA playing capability.
 - Lack of Free Software players (except `libavcodec`) and encoders
 - Relies on patented algorithms.
 - Licenses may apply to encoding, decoding or even songs, though MS is still very tolerant so far (to achieve dominance).

See <http://en.wikipedia.org/wiki/WMA> for details



Ogg Vorbis

From the Xiph foundation

<http://xiph.org/>

- ▶ Ogg: container for multimedia streams
- ▶ Vorbis: lossy audio format
- ▶ Open, patent and royalty free!
- ▶ Bitrates from 45 to 500 kbit/s
- ▶ Variable bitrate
- ▶ Achieves better quality than MP3 at low bitrates

- Growing in popularity. More and more hardware players available.
- Xiph.org releases libraries under a BSD-style license and GPL for tools.
- Various Free Software decoders and encoders available. Supported by many proprietary players too.

See for http://en.wikipedia.org/wiki/Ogg_vorbis details



Ogg Speex

From the Xiph foundation

<http://www.speex.org/>

▶ Ogg: container

Usual file extension: **.spx**

▶ Speex: lossy audio dedicated to speech encoding.

▶ Targets Voice over IP applications, voice mail archival, audio books...

▶ Open, patent and royalty free!

▶ Constant or variable bitrate, from 2 to 44 kbit/s

▶ Listen to samples on

<http://www.speex.org/samples.html>

● Free Software encoder, decoders and applications available.

● Even supported by proprietary tools (e.g. MS NetMeeting)

See <http://en.wikipedia.org/wiki/Speex> for details



Flac

<http://flac.sourceforge.net/>

Supported by Xiph.org

- ▶ Lossless audio compression format
Compress audio files at no risk!
- ▶ Preferred format for trading live music on-line
- ▶ Supports streaming
- ▶ Ogg: also used as a container
- ▶ Integer-only coder and decoder available.

- Libraries available under a BSD-like license, and tools under the GPL.
- Free Software players available
- Even starts to be supported by hardware players



See <http://en.wikipedia.org/wiki/FLAC> for details



Compression rate example comparison (1)

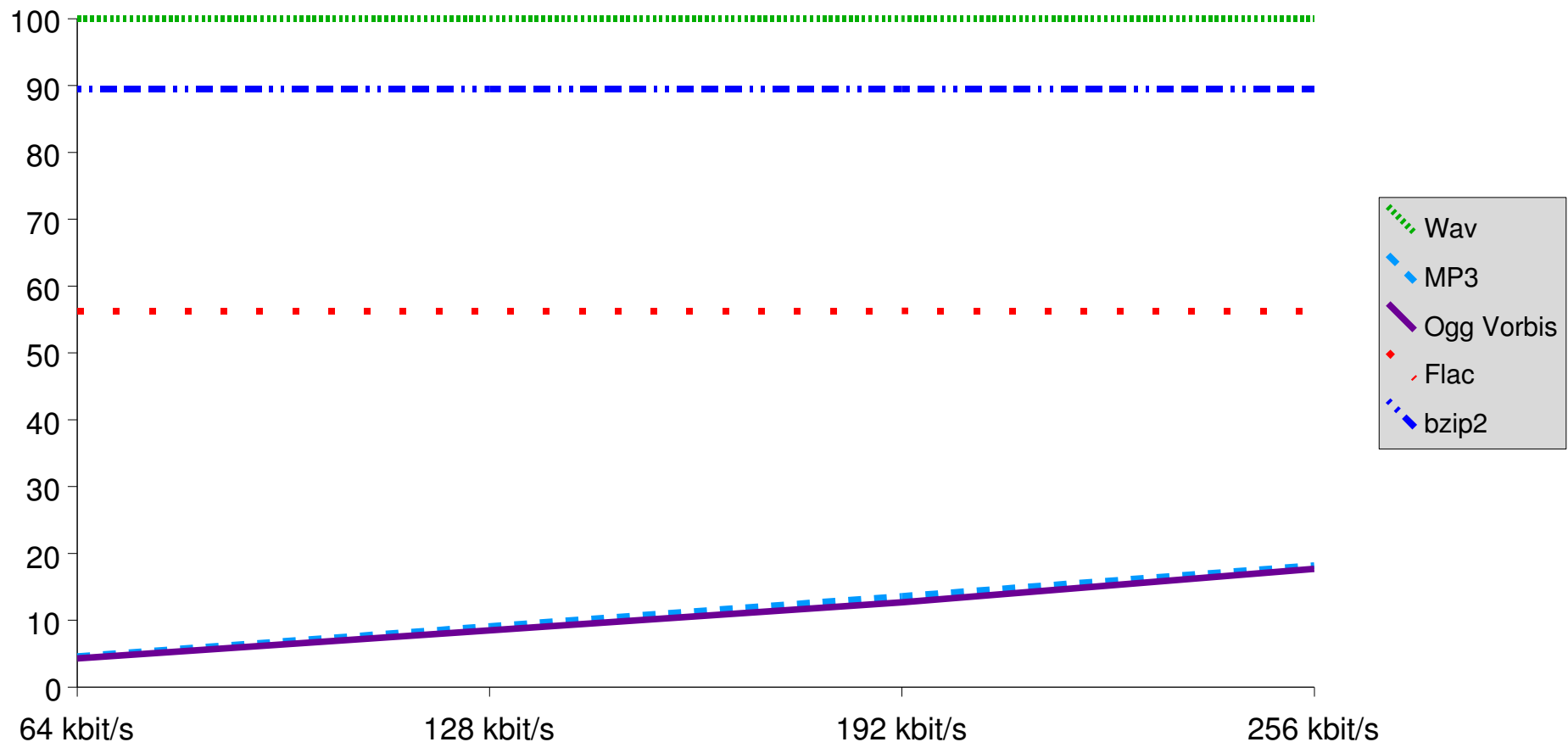
<i>Format / bitrate</i>	<i>64 kbit/s</i>	<i>128 kbit/s</i>	<i>192 kbit/s</i>	<i>256 kbit/s</i>
Wav	100.00%			
MP3 (lame 3.96.1)	4.6% (22:1)	9.1% (11:1)	13.6% (7:1)	18.2% (5:1)
Ogg Vorbis (oggenc 1.0.1)	4.3% (23:1)	8.5% (12:1)	12.7% (8:1)	17.7 % (6:1)
Flac (flac 1.1.0)	56.30%			
bzip2 (1.0.2)	89.50%			

Source: Omara Portuondo, Flor de Amor (Cuban Salsa)



Compression rate example comparison (2)

Compression rate (same example)

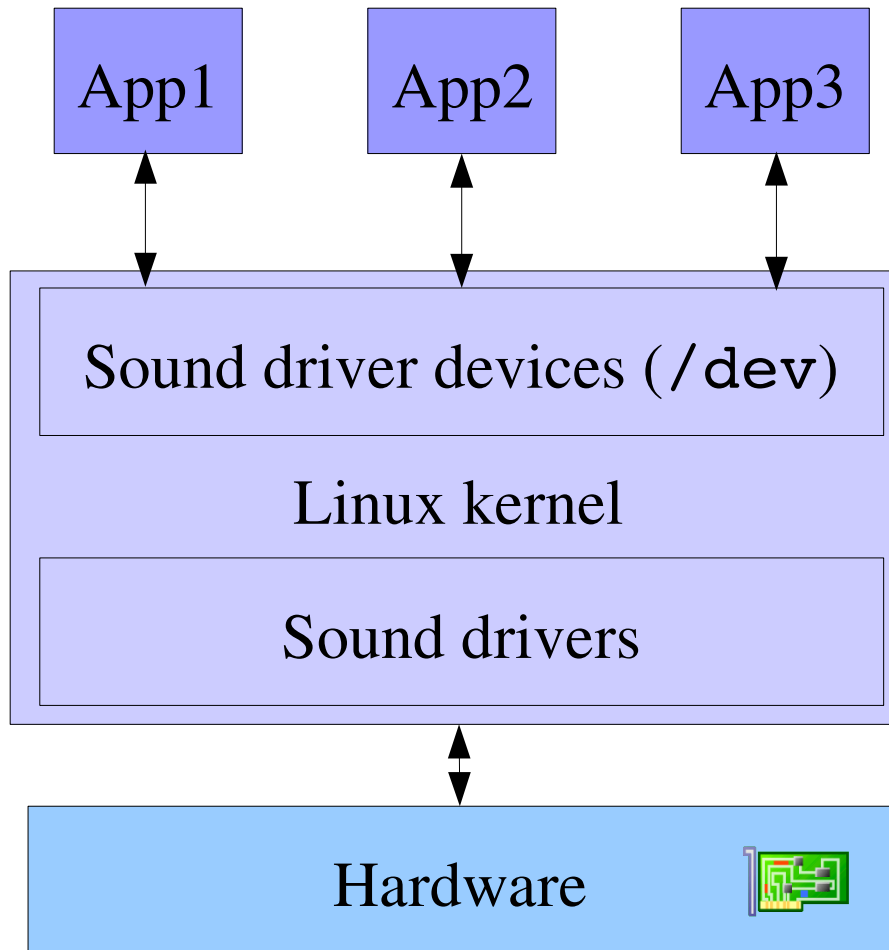


Audio in embedded Linux systems

System perspective



Traditional system architecture



User applications
(concurrent access
to resources)



OSS

The Open Sound System

- ▶ Old sound card support system in Linux versions up to 2.4.
- ▶ Didn't take advantage of the full capabilities of sound cards.
- ▶ Devices: `/dev/audio`, `/dev/mixer`, `/dev/dsp...`
- ▶ Originally created by 4Front Technologies, a company that also ships a proprietary and enhanced version of OSS, also targeting other Unix systems (such as Solaris).



Audio in embedded Linux systems

System perspective
ALSA kernel drivers



ALSA

Advanced Linux Sound Architecture

<http://www.alsa-project.org/>



- ▶ Project to provide audio and MIDI functionality to Linux.
Official Linux sound system since Linux 2.6
- ▶ Started in 1998 by Jaroslav Kysela, to fully support all the features of the Gravis Ultrasound card.
- ▶ OSS emulation: fully supports applications originally created for OSS (still accessing `/dev/sound`, `/dev/dsp` or `/dev/mixer`)
- ▶ Device files in `/dev/snd/`. Don't need to be used! Use `alsa-lib`!



ALSA kernel space features

- ▶ Efficient and full support for consumer sound cards to professional multichannel audio interfaces.
OSS often couldn't support the full hardware features.
- ▶ Supports SMP (multiprocessor) systems
- ▶ Consistent and generic control API for managing hardware controls
- ▶ Fully modularized sound drivers. Shares code for similar chipsets.



ALSA /proc interface

- ▶ `/proc/asound/version`

ALSA version

- ▶ `/proc/asound/cards`

List of available sound cards

```
0 [I82801DBICH4 ]: ICH4 - Intel 82801DB-ICH4
                  Intel 82801DB-ICH4 with STAC9750/51 at 0xf4fff800, irq 5
1 [Modem        ]: ICH-MODEM - Intel 82801DB-ICH4 Modem
                  Intel 82801DB-ICH4 Modem at 0xb400, irq 5
```

- ▶ `/proc/asound/card<i>/id`

Card identifier

- ▶ `/proc/asound/card<i>/pcm[c|p]<j>/info`

Information about a capture (c) or playback (p) PCM device.

- ▶ See by yourself!



ALSA and Linux 2.6 sources

- ▶ Official Linux 2.6 sources now use ALSA
- ▶ However, Linux releases don't always include the latest ALSA releases.
- ▶ Linux 2.6.10 (Dec 24, 2004) includes ALSA 1.0.6 (Aug 15, 2004), and not ALSA 1.0.7 (Nov 15, 2004).
- ▶ How to check the ALSA version in your kernel sources?
See `include/sound/version.h`
- ▶ How to check the ALSA version in your running system?
`cat /proc/asound/version`
- ▶ If needed, you may install a more recent ALSA version.



Writing ALSA drivers

Useful references

- ▶ "Writing an ALSA Driver", Takashi Iwai

<http://www.alsa-project.org/~iwai/writing-an-alsa-driver/>

A very comprehensive guide!

- ▶ ALSA driver API reference

<http://www.alsa-project.org/~iwai/alsa-driver-api/>



Audio in embedded Linux systems

System perspective Kernel requirements for sound



Real-time requirements for audio

Very low latency requirements in some audio applications

- ▶ < 3 ms, when the output is combined with the original signal. Otherwise, “comb filtering”.
- ▶ Audio applications need high priority, so that the output devices are always fed. Otherwise: choppy audio.
- ▶ Musicians: need to hear immediately what they are playing.
- ▶ When audio needs to be in sync with video.
- ▶ Audio communications



Reducing Linux latency

- ▶ Standard Linux: latency can reach a 100 ms magnitude
- ▶ Typical target latency: 1 to 5 ms
- ▶ Hard-realtime Linux (such as RTAI) would complicate application development too much.
- ▶ Since Linux 2.2 and 2.4, low latency patches have been used by audio users.
- ▶ Better responsiveness in Linux 2.6, but not enough yet.
 - ▶ Lots of solutions have been proposed and debated. Many rejected: clean solution required in a general-purpose operating system.
 - ▶ Most popular solution so far: real-time security module



Real-time Linux Security Module

<http://kerneltrap.org/node/4471>

- ▶ Built using Linux Security Modules (LSM), to grant special privileges to special programs. Used by SELinux, in particular.
- ▶ Allows selected non-root programs to run tasks with real-time permissions.
- ▶ Example: group id based setup (29: audio group)
`modprobe realtime gid=29`
- ▶ Caution: programs with such permissions can easily eat-up all system time and resources!



Audio in embedded Linux systems

System perspective
ALSA userspace interface

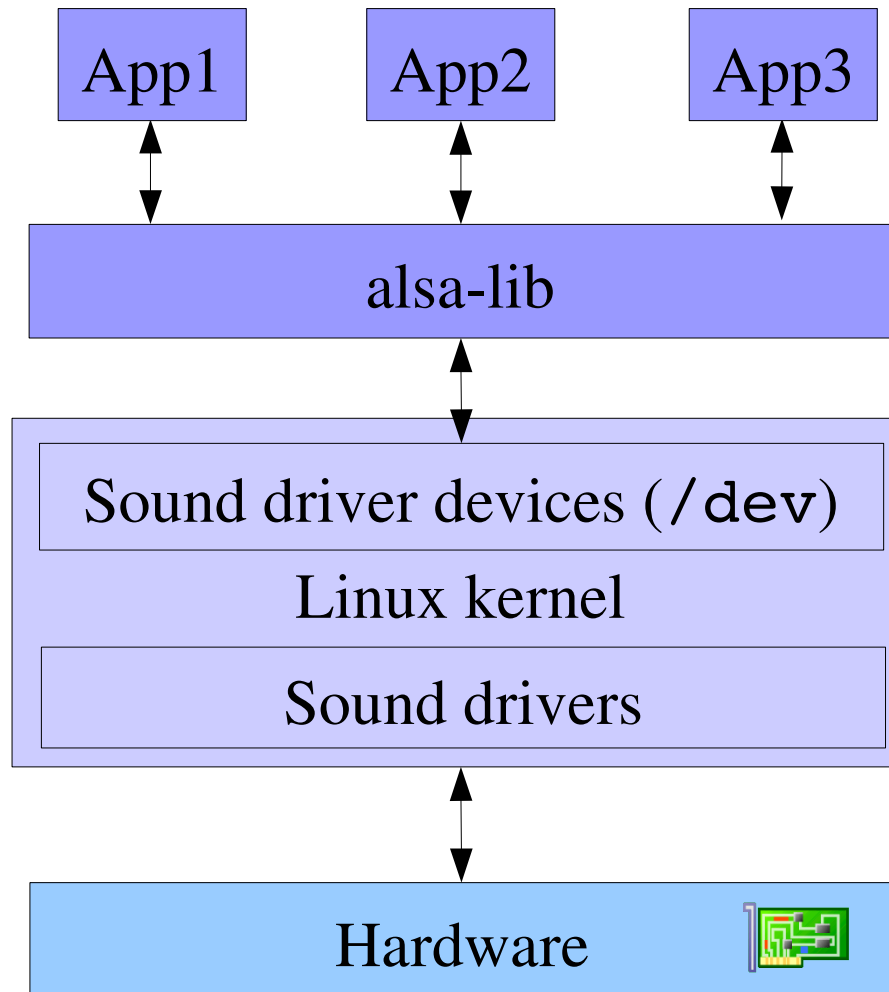


ALSA user space features

- ▶ User space library (`alsa-lib`) to delegate sound control to user space.
- ▶ Lots of functionalities provided to user programs, such as software mixing (`dmix`)
- ▶ Support for the older OSS API, providing binary compatibility for most OSS programs.
- ▶ Supports user-specific configuration (`$HOME/.asoundrc`)
- ▶ Multi-thread safe
Essential capability for the design of modern audio applications



ALSA system architecture

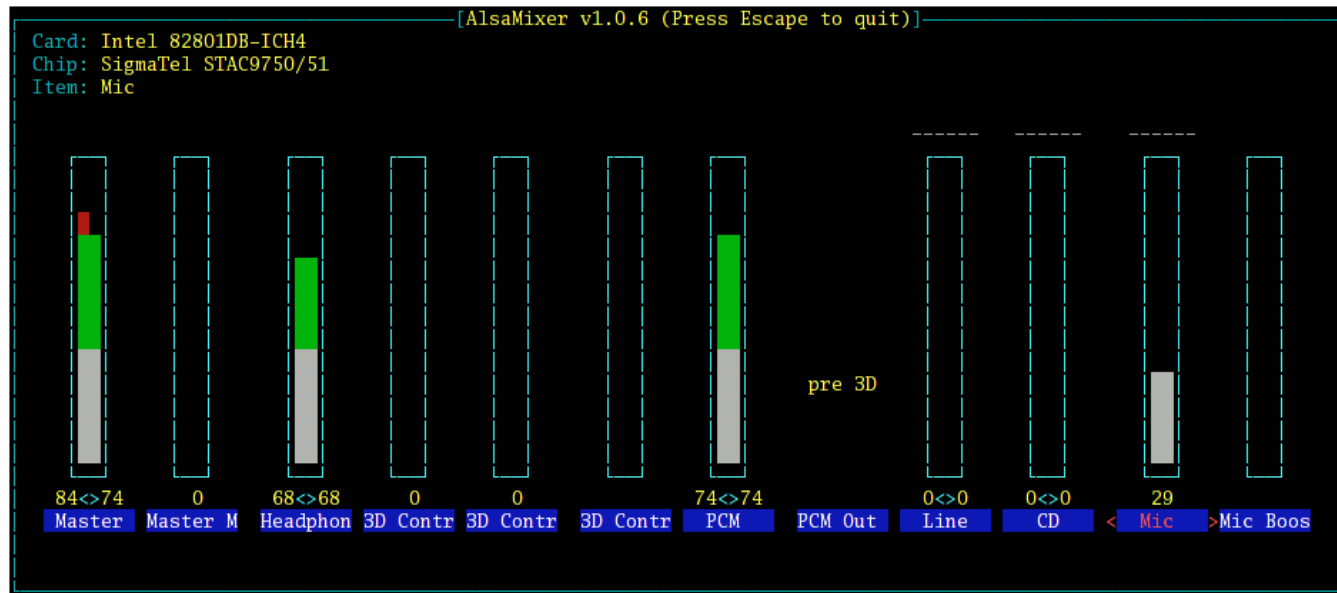


User applications
(concurrent access
to resources)

No longer needed
to access
/dev/ files!



alsamixer



- ▶ User interface to set channel volume control, and microphone input level.
- ▶ Text only (`ncurses`). Easy to use in embedded systems!

- ▶ Easy to use:
 - Left and right arrow keys to select the channel
 - Up and down arrow keys to change the values



alsactl

Command available to the root user

- ▶ `alsactl store [card_num]`
Stores the current `alsamixer` settings in `/etc/asound.state`.
Otherwise, not saved after reboot.
- ▶ `alsactl restore [card_num]`
Restores the saved `alsamixer` state
- ▶ `alsactl power [card_num] [state]`
Displays / sets the power state of soundcards



alsa-lib API (1)

Offers 100% of the kernel API and more!

- ▶ Control interface: general-purpose facility for managing registers of sound cards and querying available devices.
- ▶ PCM interface: managing digital audio capture and playback.
- ▶ Mixer interface: controls the devices on sound cards that route signals and control volume levels. Built on top of the control interface.
- ▶ Timer interface: access to timing hardware on sound cards, used for synchronizing sound events.



alsa-lib API (2)

- ▶ Raw MIDI interface: access to a MIDI bus on a sound card. Works directly with the MIDI events. Protocol and timing management up to the programmer.
- ▶ Sequencer interface: a higher-level interface for MIDI programming and sound synthesis than the raw MIDI interface. Handles much of the MIDI protocol and timing.



alsa-lib configuration

Elaborate PCM stream handling can be defined by each user!

- ▶ `/etc/asound.conf`
System wide definitions
- ▶ `$HOME/.asoundrc`
User specific definitions



ALSA device naming

- ▶ `alsa-lib` uses logical device names rather than device files
- ▶ Device names:
 - ▶ Either hardware devices: `hw:i,j`
 - `i`: card number
 - `j`: device number on the card
 - `hw:0,0` is the first sound device.
 - ▶ Or aliases
(defined in `/etc/asound.conf` or in `$HOME/.asoundrc`)
`default:hw:0,0`
 - ▶ Or plugins



alsa-lib PCM plugins

User interface to `alsa-lib` for use in the command line or in `/etc/asound.conf` or `$HOME/.asoundrc`

- ▶ Extend the functionality and features of PCM devices. Correspond to `alsa-lib` library functions
- ▶ Accept parameters, which can also be passed through the command line

See http://www.alsa-project.org/alsa-doc/alsa-lib/pcm_plugins.html



A few plugin examples

- ▶ `Copy`: copies the contents of a PCM stream to another
- ▶ `Null`: discards the contents of a PCM stream
- ▶ `File`: stores the contents of a PCM stream to a file
- ▶ `dmix`: mixes several streams
- ▶ `More`: rate and format conversion, soft volume, etc.



Software mixing example

ALSA makes it easy to mix several audio sources in userspace, even if there is no hardware mixer.

Run the below 2 commands:

▶ `alsaplay -d plug:dmix simon.ogg`

▶ `alsaplay -d plug:dmix garfunkel.ogg`

There's no theoretical limit to the number of such processes that you can run!

Similarly, you can access other plugins and set their parameters from the command line.



ALSA documentation

- ▶ Kernel sources:
Documentation/sound/alsa
- ▶ Official ALSA documentation
<http://www.alsa-project.org/alsa-doc/>
- ▶ ALSA Wiki: lots of resources!
<http://alsa.opensrc.org/>

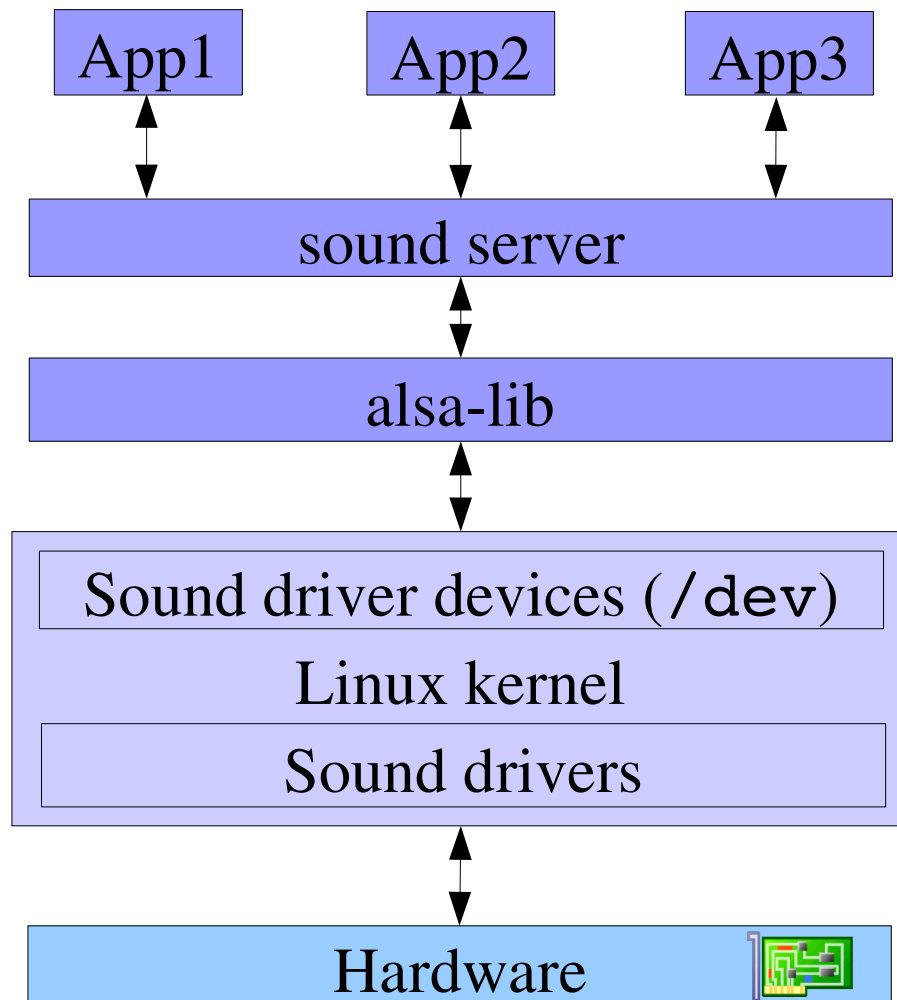


Audio in embedded Linux systems

System perspective Sound servers



Sound server based system architecture



Sound servers take care of handling sound resource access and sound flows between apps



Traditional sound servers

Handle multiple audio streams, but primarily designed for incidental sound support such as desktop event sounds and lightweight game sound.

- ▶ aRts (`artsd`) - an Analog Real-Time Synthesizer

Used by KDE

<http://www.arts-project.org/>

- ▶ esound (`esd`) - the Enlightened Sound Daemon

Used by Gnome

<http://www.tux.org/~ricdude/Esound.html>

Both projects have achieved their goals. No active development



Jack Audio Connection Kit

<http://jackit.sourceforge.net/>

- ▶ New sound server designed from the ground up for professional audio work
- ▶ Supports POSIX compliant operating systems, such as GNU/Linux and MacOS X.
- ▶ Main focus
 - ▶ Low latency operation, taking advantage of Linux low latency capabilities
 - ▶ Synchronous execution of all clients



JACK's audience

JACK targets audio application developers

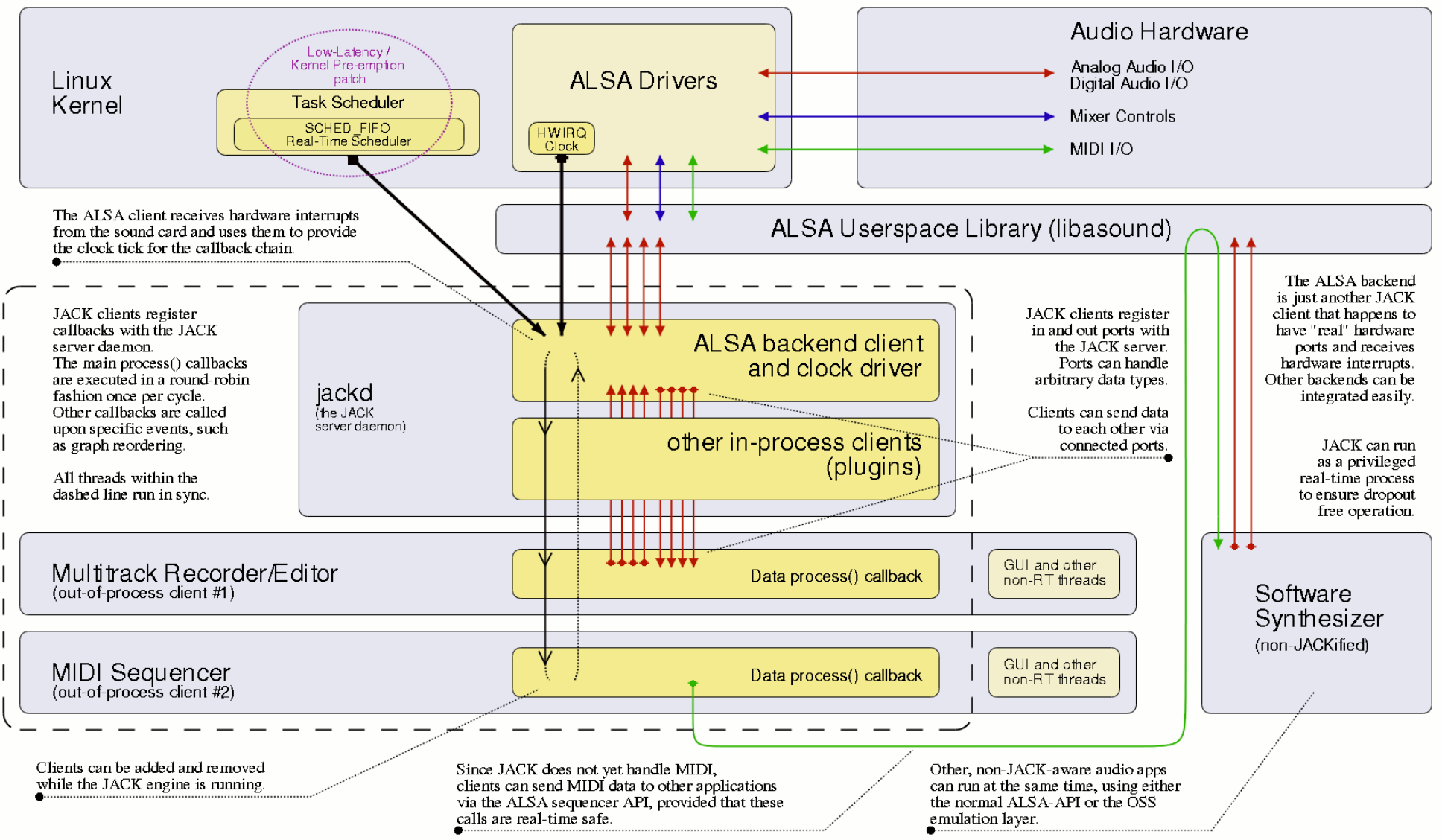
- ▶ JACK allows to connect several applications to an audio device, but also to share audio between themselves.
- ▶ Each JACK application can be considered as a virtual device with at least one IN and / or one OUT.
- ▶ Digital audio streams can be created with JACK enabled applications.
- ▶ JACK applications can run standalone as server clients or within the server as plugins.





The JACK Audio Connection Kit

Hooking up audio applications in real-time and sample-synchronized



Last updated May 11, 2007 by Jörn Nettingsmeier <joern@fokwang-biochemie.de>
Proprietary with LISA v. 0.951 (http://www.guest42.de/~jnettsme/)

Created by Jörn Nettingsmeier.

Source and license available on <http://jackit.sourceforge.net/docs/diagram/>

JACK applications

Feb 2005: almost 100 applications already support JACK!

See <http://jackit.sourceforge.net/apps/>

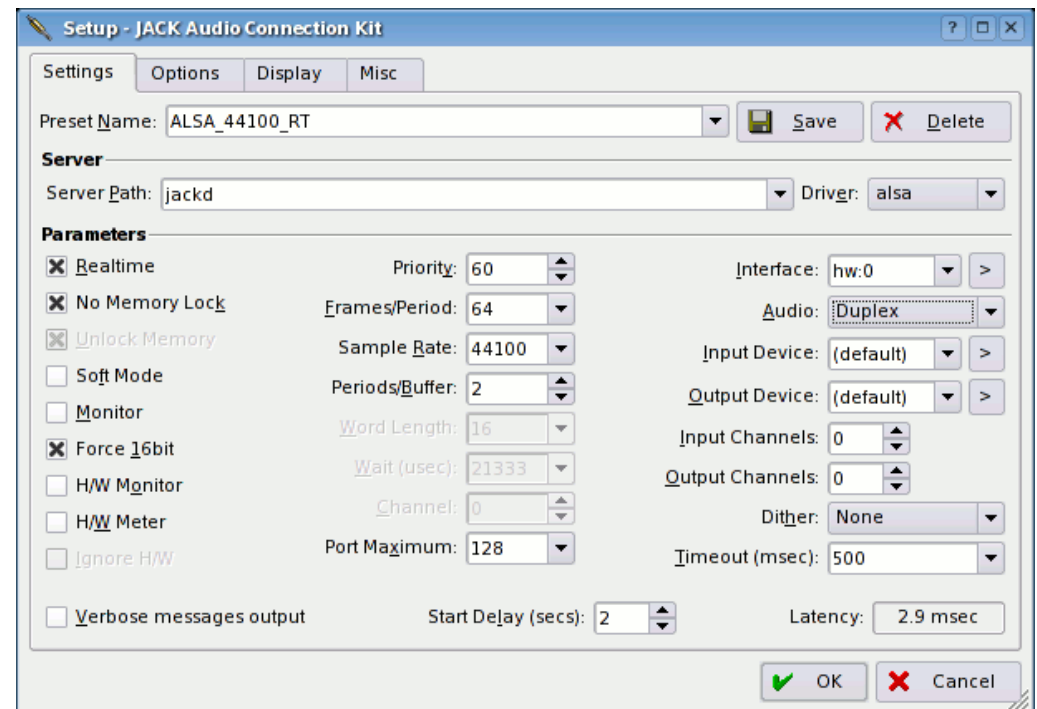


qjackctl

<http://qjackctl.sourceforge.net/>

A GUI to start, stop and control the JACK daemon and to set its parameters.

Good to make a working prototype on the PC before deploying it on the target embedded system.



Audio in embedded Linux systems

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Audio in embedded Linux systems

Free Software Audio Players



Audio in embedded Linux systems

Free Software Audio
Audio players
for the GNU/Linux workstation
or x86 embedded systems



xmms

X Multi Media System

<http://xmms.org/>

- ▶ Quite similar to WinAmp (originally called X11Amp)
 - ▶ Plugin based
Useful to keep modules with patents separate
 - ▶ Lots of audio codec plugins:
CD player, Wav, MP3, Ogg Vorbis, Flac, AAC, WMA...
 - ▶ ALSA / JACK support plugins
- ▶ Lots of visualization plugins
Make it easy to design an embedded x86 audio system with your own look and feel.
 - ▶ Supports live audio streams (and recording to files)
 - ▶ And lots of other features!



AlsaPlayer (1)

AlsaPlayer

<http://www.alsaplayer.org/>

- ▶ A new type of PCM player!
- ▶ Heavily multi-threaded. Tries to exercise the ALSA library and driver features.
- ▶ Plugin based for most features
- ▶ Supported file formats:
Ogg, CDDA, WAV, MP3, Flac and more
- ▶ Supported sound systems:
ALSA, OSS, JACK, ESD, NAS (Network Audio Server), Sparc and SGI audio outputs.
- ▶ Supports live audio streams
- ▶ And more!



AlsaPlayer (2)

- ▶ Designed from the ground up to be suitable for professional audio work.
- ▶ Supports speed (pitch) control, both positive and negative! Can be used for DJ scratching.
- ▶ Interface plugins, concurrent visual scopes. Accurate scope/audio syncing.



- ▶ Sound effect support
- ▶ Remote control from another application
- ▶ Low latency mode (on capable soundcards latency can be as low as 1.3ms!)



xine

<http://www.xinehq.de/>

- ▶ Very popular Free Software video player
- ▶ Supports most audio formats.
- ▶ Can be used as an audio-only player too.
- ▶ Plugin based
- ▶ Lots of skins available.

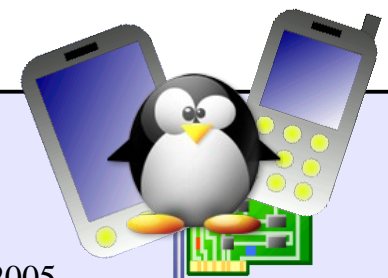


MPlayer

<http://www.mplayerhq.hu/>

- ▶ Another very popular Free Software video player
- ▶ Command line based, easy to build graphical front-ends
- ▶ Supports most audio formats (ogg vorbis, mp3, flac, real audio, wma...).
- ▶ The best / easiest command line audio player in GNU/Linux!
- ▶ ALSA and Jack support

```
mike@localhost:~/ogg/omara_portuondo/flor_de_amor - Terminal - Konsole
Session  Édition  Affichage  Signets  Configuration  Aide
Playing 13_he_venido_a_decirte.flac.
Audio file detected.
=====
Opening audio decoder: [ffmpeg] FFmpeg/libavcodec audio decoders
[flac @ 0x8599030]STREAM HEADER
[flac @ 0x8599030] metadata block: flag = 0, type = 0, size = 34
[flac @ 0x8599030]  Blocksize: 4608 .. 4608 (0)
[flac @ 0x8599030]  Framesize: 693 .. 13544
[flac @ 0x8599030]  Samplerate: 44100
[flac @ 0x8599030]  Channels: 2
[flac @ 0x8599030]  Bits: 16
[flac @ 0x8599030] metadata block: flag = 0, type = 3, size = 396
[flac @ 0x8599030] metadata block: flag = 0, type = 4, size = 40
[flac @ 0x8599030] metadata block: flag = 1, type = 1, size = 4096
AUDIO: 44100 Hz, 2 ch, 16 bit (0x10), ratio: 100000->176400 (800.0 kbit)
Selected audio codec: [ffflac] afm:ffmpeg (FFmpeg FLAC audio decoder)
=====
Checking audio filter chain for 44100Hz/2ch/16bit -> 44100Hz/2ch/16bit...
AF_pre: af format: 2 bps, 2 ch, 44100 hz, little endian signed int
AF_pre: 44100Hz 2ch Signed 16-bit (Little-Endian)
AO: [oss] 44100Hz 2ch Signed 16-bit (Little-Endian) (2 bps)
Building audio filter chain for 44100Hz/2ch/16bit -> 44100Hz/2ch/16bit...
Video: no video
Starting playback...
A: 85.2 (01:25.2) 1.0%
```

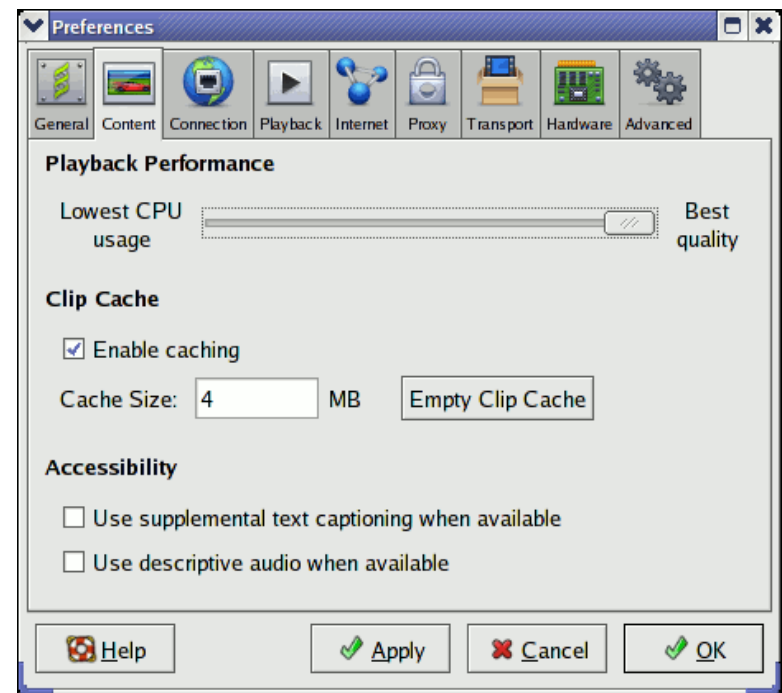
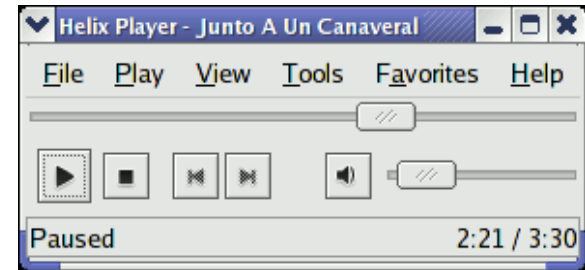


Helix

Real Networks' Open Source player

<http://player.helixcommunity.org/>

- ▶ Supports audio and video
Targets Open Source formats such as Vorbis, Theora...
- ▶ Real Player for Linux is based on Helix and adds support for proprietary formats (Real Audio, MP3...)
- ▶ Plugin based.



Misc desktop audio players

- ▶ Totem: Gnome multimedia player based on xine
<http://www.hadess.net/totem.php3>
- ▶ Rhythmbox: Gnome integrated music management application
<http://www.rhythmbox.org/>
- ▶ And many more!
See the FreeBSD audio software catalog
<http://www.freebsdsoftware.org/index.php?c=audio>
for an extensive list of Unix programs for audio.



Audio in embedded Linux systems

Free Software Audio Audio players for the embedded Linux target



Console based sound players

- ▶ `alsaplayer -i text`

AlsaPlayer's text interface. Universal and powerful. Can be built without GTK.

- ▶ `mplayer`

Already described. Another universal solution. Most formats supported through plug-ins. Even supports on-line streams!

- ▶ `ogg123`

Ogg/Vorbis player from Xiph.org



Other console based sound players

- ▶ `aplay`

From the ALSA project.

Supported formats: wav, au (Sun), voc (Sound Blaster)

- ▶ `bplay`

<http://www.amberdata.demon.co.uk/bplay/>

Supported formats: wav, voc



Integer-only audio decoders

Targeted to architectures with no hardware floating point units
(such as ARM ones)

- ▶ Tremor library (BSD license, from Xiph.org)

<http://svn.xiph.org/trunk/Tremor/README>

Can play any Ogg Vorbis file or stream

- ▶ MAD: MPEG Audio Decoder (GNU GPL)

<http://www.underbit.com/products/mad/>

Can decode MPEG Audio layer I, II and III.

Library (`libmad`) and command-line front-end (`madplay`)



Audio in embedded Linux systems

Free Software Audio Encoders



LAME

LAME Ain't an Mp3 Encoder: <http://lame.sourceforge.net/>

- ▶ License: LGPL
- ▶ MPEG1,2 and 2.5 layer III encoding.
Constant and variable bitrates supported
- ▶ Quality comparable to Fraunhofer encoding engines and substantially better than most other encoders.
- ▶ GPL **GPSYCHO** psycho acoustic and noise shaping model
- ▶ Available as a shared library, embedded in many applications
- Use subject to patents in some countries!



Misc mp3 encoders

- ▶ BladeEnc: <http://bladeenc.mp3.no/>

No longer supported by his author, but still available

- ▶ GOGO: <http://freshmeat.net/projects/gogo/>

Patch against LAME doubling its speed, using MMX, 3D Now!, and SSE if supported by your processor.



Ogg Vorbis encoder

OggEnc

- ▶ Released with Ogg Vorbis software from Xiph.org
- ▶ Simple example:

```
oggenc input.wav -b 128 -M 160 -o output.ogg
```
- ▶ No integer-only encoder available yet. Relies heavily on floating-point computation.



Speex encoder

speexenc

- ▶ Released with the speex package from <http://speex.org/>
- ▶ Simple example:
`speexenc --quality 7 input.wav output.spx`
- ▶ See `man speexenc` for full command line options
- ▶ No integer-only encoder available yet



Flac encoder

flac



- ▶ Available from <http://flac.sourceforge.net>
- ▶ Same command for encoding and decoding
- ▶ See `man flac` for command line options
- ▶ You can choose the compression rate. Just slower to encode, of course no quality loss at all!
- ▶ The encoder and decoder can now be compiled in integer-only mode!



Audio in embedded Linux systems

Free Software Audio Misc



Speech synthesis

Festival: <http://www.cstr.ed.ac.uk/projects/festival/>
from the University of Edinburgh, UK

- ▶ A very serious research project!
The number 1 speech synthesis system for Unix
- ▶ Very flexible framework for speech synthesis or research in speech synthesis
- ▶ Supports multiple voices, languages, tones...
- ▶ Scheme language scripting interface.



Misc applications

- ▶ Ecasound: <http://www.eca.cx/ecasound/>
Multitrack audio processing package. Can be used for simple tasks like audio playback, recording and format conversions, as well as for multitrack effect processing, mixing, recording and signal recycling. Supports a wide range of audio inputs, outputs and effect algorithms
- ▶ LADSPA (Linux Audio Developer's Simple Plugin API)
<http://www.ladspa.org/>
A plugin audio processor framework. Several sound effect plugins available (reverb, etc.)



Audio distributions

▶ Agnula: <http://www.agnula.org/>



GNU/Linux Free Software distribution dedicated to music and audio production at a professional level.



Useful reading

- ▶ Introduction to Linux Audio, by Filippo Pappalardo

http://www.osnews.com/story.php?news_id=6720

A very nice and synthetic review. Good summary.

- ▶ A brief introduction to ALSA, JACK and LADSPA

http://www.agnula.org/documentation/dp_tutorials/alsa_jack_ladspa/

Another nice summary for the Agnula project.



Useful links

- ▶ Sound & MIDI Software For Linux

<http://sound.condorow.net/>

The most exhaustive catalog of Linux audio projects, programs and articles!

- ▶ FreeBSD audio software catalog

<http://www.freebsdsoftware.org/index.php?c=audio>

An extensive list of Unix programs for audio.

- ▶ Linux Audio User Guide

<http://www.djcj.org/LAU/guide/index.php>

A collection of documents and HOWTOs. Now quite outdated.



Conclusion

The major strength of the Linux sound solution is again its modularity. Each module takes care of a single task, and does it very well.

- ▶ ALSA: provides a unified interface to the hardware
- ▶ Jack sound server: takes care of managing shared access to sound resources by sound applications
- ▶ Sound libraries: decode, encode, or transform sound
- ▶ User applications: provide given functionalities to the end user.

Another strength is that the whole software solution can be developed on the PC host in parallel with the embedded hw and sw development.



Related documents

This document belongs to the more than 900 page materials of an embedded GNU / Linux training from Free Electrons, available under a free documentation license.

<http://free-electrons.com/training>

- ▶ Introduction to Unix and GNU / Linux
- ▶ Embedded Linux kernel and driver development
- ▶ Development tools for embedded Linux systems
- ▶ Audio in embedded Linux systems
- ▶ Multimedia in embedded Linux systems

<http://free-electrons.com/articles>

- ▶ Embedded Linux from Scratch... in 40 min!
- ▶ Java in embedded Linux systems
- ▶ Introduction to uClinux
- ▶ Real-time in embedded Linux systems
- ▶ Free Software development tools
- ▶ What's new in Linux 2.6?
- ▶ Linux on TI OMAP processors
- ▶ How to port Linux on a new PDA



How to help

If you support this work, you can help ...

- ▶ By sending corrections, suggestions, contributions and translations
- ▶ By asking your organization to order training sessions performed by the author of these documents (see <http://free-electrons.com/training>)
- ▶ By speaking about it to your friends, colleagues and local Free Software community.
- ▶ By adding links to our on-line materials on your website, to increase their visibility in search engine results.



Thanks

- ▶ To the OpenOffice.org project, for their presentation and word processor tools which satisfied all my needs.
- ▶ To the Handhelds.org community, for giving me so much help and so many opportunities to help.
- ▶ To the members of the whole Free Software and Open Source community, for sharing the best of themselves: their work, their knowledge, their friendship.

