Music Recording, Production and Distribution with Free Software

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Introduction

The talk explains how it is possible to use software with free source code, also known as open source software, installed on a personal computer with a compatible soundcard, a CDR writer, a printer, and a network card connected to the Internet for audio recording, production and distribution for music content producers who are entering the Internet music business.

These slides were produced using Matt Welsh's TEXslides package with TEX. See `http://www.eecs.harvard.edu/~mdw/proj/texslides/` for details.

Feel free to ask questions during the talk!

The Nyqvist-Shannon Sampling Theorem

Before recording, notice that the following important theorem on audio recording states that the sample recording rate (cycles/second) must be at least twice that of the sampled signal bandwidth's:

If B is the bandwidth and R_s is the sample rate, then

$$2B < R_s$$

Physical Recording Limits

Hardware

- CDDA quality: 16-bits with 44100 cycles/second

- Digital Audio Tape (DAT): 16-bits with 48000 cycles/second

- CS4232 soundcard in IBM Thinkpad 560X: 16-bits at 48000 cycles/second

- RME Hammerfall HDSP: 24-bits at 96000 cycles/second

Human Hearing

- Usually about 20000 cycles/second

- Falls to about 12000 cycles/second over time

Music Is Mathematics

Ancient "wisdom"

- Pythagoras (c. 582 - 497 BC) claimed that each note is a fraction of a string

- The greek 5-note octave come from fractions based on the A string

On the 7-tone octave (the diatonic scale – C, D, E, F, G, A, B)

- A string is tuned to A440 when it vibrate 440 cycles/second

One octave up usually means that

- A halved string vibrates 880 cycles/second

One octave down usually means that

- A double string vibrates 220 cycles/second

A440 Tuning

- One A440 tuning fork of steel produces the note A on the 7-tone octave

- The A440 forks ring somewhere between 440.05 & 439.95 cycles/second

Tuning Precision

- The ring variance is detectable by electronic devices (as computers)

- Tune both the instrument(s) and the kernel before recording music

Tuning the Kernel for Low-Latency Scheduling

Recording audio direct-to-disk is rather I/O intensive

- Ingo Molnar wrote the first Low-Latency Scheduler patches

- `http://people.redhat.com/mingo/lowlatency-patches/`

- Andrew Morton's Linux Scheduling Latency patches

- `http://www.zip.com.au/~akpm/linux/schedlat.html`

Kernel Option Configuration

- See Paul Winkler's Low-Latency with ALSA HOWTO

- `http://www.djcj.org/LAU/guide/Low_latency-Mini-HOWTO.php3`

- Recompile the kernel with `Control low latency with sysctl`

- Enable low-latency schedule in the kernel with `echo 1 >/proc/sys/kernel/lowlatency`

Tuning Musical Instruments

GNU Solfege

- Free Software for practicing ear training

- `http://www.solfege.org/`

GString

- Yet another guitar tuning application by Sam Tannous.

- `http://www.employees.org/~stannous/gstring.html`

- Based on the FFTW C subroutine library from MIT.

- FFTW received the 1999 J. H. Wilkinson Prize for Numerical Software

- `http://www.fftw.org/`

Writing Out Musical Scores

ABC Music Notation Language

- Invented by Chris Walshaw at University of Greenwich.

- ABC home page is at `http://staffweb.cms.gre.ac.uk/~c.walshaw/abc/`

- Convert compositions to MIDI or Postscript

- abcm2ps by Jef Moine available at `http://moinejf.free.fr/`

- Converts Beethoven's 5th symphony (1st mov.) to Postscript in a few seconds

- MIDI playback through playabc

- `http://www.ceolas.org/pub/tunes/playabc-1.1.tar.Z`

GNU Lilypond

- Language for typesetting music to PostScript

- `http://lilypond.org/`

Hammerfall HDSP with ALSA

- High Definition Sound Processing in 24-bits with 96000 cycles/second

- Studio recording in two modules

- PCI or PCMCIA host card

- External I/O sound module with MIDI/ADAT/SPDIF I/Os

- ALSA driver support by Paul Davis hdsploader in alsa-tools

- `http://www.alsa-project.org/alsa-doc/doc-php/template.php?module=hdsp`

Configuring Hammerfall HDSP for Recording

Set all channels to 0dB gain with the ALSA mixer:

- Example:

```
for i in $(seq 1 18); do
amixer -c 1 cset name=Chn,index=$i  32768
done
```

Play audio on two analog channel outputs:

- Example:

```
aplay -D hdsp_analog two-way-travelogue-take-2004-02-20.wav
```

Record from source in DAT quality (16-bits with 48000 cycles/second):

- Example:

```
arecord -D hdsp_analog -f dat two-way-travelogue-take-2004-02-20.wav
```

Add compression/metadata

Ogg Vorbis is a completely open, patent-free audio compression format

See `http://www.vorbis.com/` and `http://www.xiph.org/` for details.

- Install the vorbis-tools package

- Use the oggenc tool to encode the recorded WAV file into a compressed OGG format

- Use the oggdec tool to decode the compressed OGG file to WAV

- Example:

```
oggenc two-way-travelogue-take-2004-02-20.wav \
       -o two-way-travelogue-take-2004-02-20.ogg \
       -a "The Musician" \
       -l "Two Way Travelogue" \
       -d 2004-02-20 \
       -G "Traditional" \
       -q 9 \
       -c "Copyright (C) 2004 The Musician"
```

Recording CDR music discs with Dvdrecord

- **dvdrecord** is a tool that write audio data to CDR

- http://www.freesoftware.fsf.org/dvdrtools/

- Example:

```
ogg123 -d au -f - two-way-travelogue-take-2004-02-20.ogg \
        | dvdrecord speed=4 dev=2,0,0 -audio -pad -nofix -
dvdrecord dev=2,0,0 -fix
```

Printing CD Cover/Tray Inserts

- **cdlabelgen** is written by Brian Fitzpatrick and maintained by Avinash Chopde

- http://www.aczoom.com/tools/cdinsert/

- Outputs CD Cover/Tray in Color PostScript and PDF formats

- Example:

```
cdlabelgen -c "The Musician" -s "Two Way Travelogue" \
           -e logofront.eps \
           -T 0.70 -S 0.70 -f ~/traytext.txt >~/cover.ps
```

The Musician
Two Way Travelogue

2005–08–06

cdlabelgen 3.5.0 © 2001–2005 Avinash Chopde <avinash@aczoom.com>

home page: http://www.aczoom.com/tools/cdinsert/

The Musician
Two Way Travelogue

1. Two Way Travelogue (03:14:15)

Recorded on February 20th, 2004, using Linux.

2005–08–06

The Musician Two Way Travelogue

The Musician Two Way Travelogue

2005–08–06

The Musician Two Way Travelogue

2005–08–06

Publishing Music Online

Bleep

- Independent Record labels

- `http://www.bleep.com/`

- The player is written in PHP

- Linux support

Connect

- Sony BMG Entertainment Group

- `http://www.connect.com/`

- Closed source, the client links to id3lib (Lesser General Public License)

- User-unfriendly DRM Technology, no Linux support.

Challenge

- DRM technology is user-unfriendly

- DRM vendor industry is pushing it heavily

- The musician would like to get paid - this is fair enough

- How to give musicians options on the use of DRM for their records

- Many bands signed on record companies before those introduced DRM

Introducing GOAL - Fairtrade Record Shop module for Apache 2.0

- GOAL is a clean-room implementation of the Apple iTunes Server

- Plugin module for Apache 2.0 written using the Shambhala API

- `http://httpd.apache.org/dev/API.html`

- Loosely based on Sterling Hughes' `mod_haydn`

- `http://haydn.sourceforge.net/`

- AES 128-bits file encryption is disabled by default

- GNU GPL v2

Introducing the Fairtrade Record Shop Protocol 1.0

- First implemented in Apple iTunes and Apple iPod

- Scott Knaster's book Hacking iPod + iTunes (Wiley, ISBN 0764569845)

- Hadley Stern's book iPod & iTunes Hacks (O'Reilly Media, ISBN 0596007787).

- Based on HTTP/1.1 and XML-RPC messaging

- The description of Apple's protocol just lacked upload commands (PUT)

- GOAL is for musicians to set up so they can manage their music business

- GNU/Linux client support is available through SharpMusique by Jon Lech Johansen

- `http://nanocrew.net/?page_id=63`

- Much work still left to be done here

- If you want to hack, you are welcome

Initial version of GOAL to be released soon.

Questions?

The Free Software Song

Join us now and share the software;
You'll be free, hackers, you'll be free. (2x)

Hoarders may get piles of money,
That is true, hackers, that is true.
But they cannot help their neighbors;
That's not good, hackers, that's not good.
When we have enough free software
At our call, hackers, at our call,
We'll throw out those dirty licenses
Ever more, hackers, ever more.

Join us now and share the software;
You'll be free, hackers, you'll be free. (2x)