

HOME RECORDING

WITH LINUX

EDWARD DIEHL



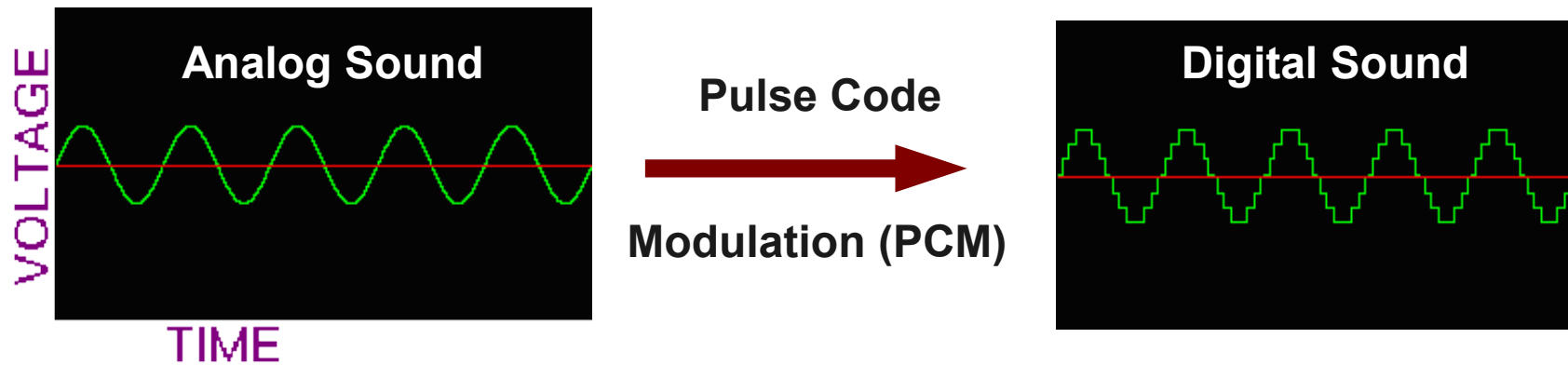
WHAT CAN YOU DO? A LOT.

Free Software

Native Non-Free

- Edit/modify sound files: *Audacity, mhwaveedit*
- Multitrack recording (to hard disk), mixing, mastering with Digital Audio Workstations (DAW): *Ardour2/3, Qtractor, Rosegarden, Muse, ecasound/NAMA (command line!), Mixbus*
- MIDI sequencing: *Ardour3, Rosegarden, OOMidi, Muse, Seq24, Hydrogen, LMMS, Sunvox, Renoise*
- Play virtual instruments/synthesizers with a midi keyboard: *Linuxsampler, Yoshimi, Aeolus, Bristol, Phasex, Pianoteq, Aspect, Discovery*
- Write musical scores (+playback): *Musescore, Denemo, Frescobaldi, Lilypond, Impro-visor, Rosegarden, GuitarPro*
- Play guitar with amp emulation and effects processing: *Guitarix, Rakarrak*
- Algorithmic music composition: *Csound, Supercollider, Pure Data*
- Lots of other stuff: tuners, loopers, arpeggiators, DJ software (*Mixxx*), radio station software (*Rivendell*), *Jamin* mastering tool, many effects plugins...
- *Can run some Windows music software via wine/wine-asio*

DIGITAL AUDIO



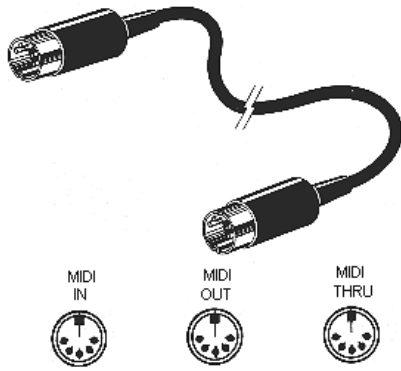
- Sound is digitized by sampling (measuring) the analog wave form at some frequency, a process called Pulse Code Modulation (PCM).
- Common sampling frequencies are 44.1kHz (CD audio), 48kHz (DVD audio) and multiples (88.2, 96, 192 kHz).
- For playback digitized sound is sent through filters which restores frequency content up to $\frac{1}{2}$ the sampling frequency, e.g. 44.1kHz works up to 22.05 kHz. The human hearing range is 20-20kHz.
- The sampled pulse heights are stored with various resolutions (“sample depths”), e.g. 16 bit (CD audio), 24 bit, 32 bit floating point. Humans are sensitive to dynamic ranges up to ~20bits.
- There are many formats for sound files which are either exact (e.g. wav, flac) or lossy (compressed by removing “inaudible content”, e.g. mp3, ogg, AAC)

MIDI: MUSICAL INSTRUMENT DIGITAL INTERFACE

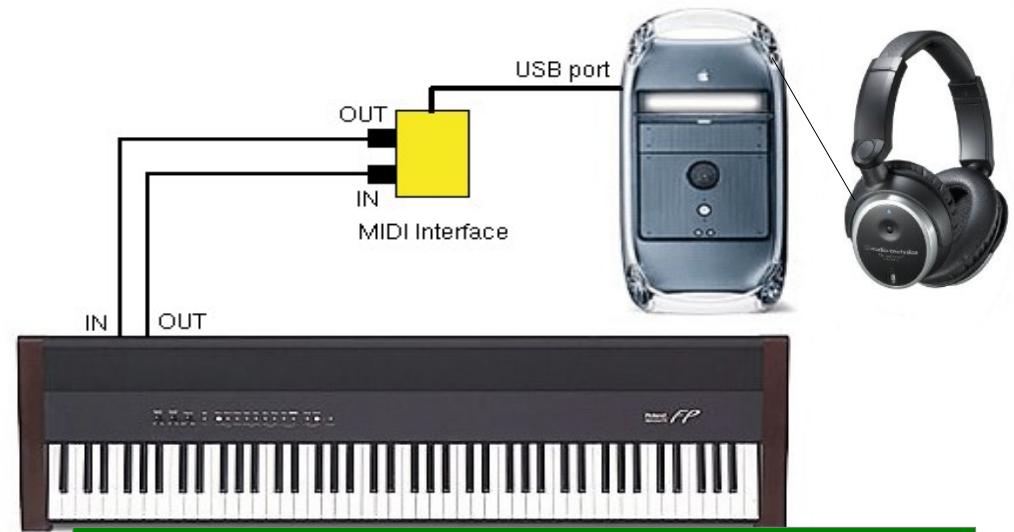


- MIDI is a system for interconnecting musical devices storing musical data.
- MIDI has only information about notes being played, not actual sound. MIDI messages describe:
 - Which note is playing (“middle C”)
 - Start and stop times of a note
 - Volume of note, called “velocity” which has values between [0..127]
 - Lots of other information possible, messages, control information...
- To make sound MIDI information must be sent to hardware or software which generates the sound based on the MIDI data.
- Nearly all electronic keyboards will transmit/receive MIDI via USB or special MIDI cables.
- MIDI data is easily edited, manipulated (e.g. transposed), and compact.
- Composing/recording is done with midi “sequencers”.

MIDI



Standard MIDI cable



**Simple MIDI setup:
Midi piano “controller” ⇒
Computer ⇒ software synthesizer ⇒
headphones.**

Qtractor “Pianoroll” midi editor

17.954	ch 1	Note 079 Off (G4)	veloc: 0
18.299	ch 1	Note 053 On (F2)	veloc: 55
18.303	ch 1	Note 059 On (B2)	veloc: 47
18.306	ch 1	Note 063 On (D#3)	veloc: 40
18.325	ch 1	Controller 64	value: 0
18.360	ch 1	Note 063 Off (D#3)	veloc: 0
18.363	ch 1	Note 059 Off (B2)	veloc: 0
18.363	ch 1	Note 053 Off (F2)	veloc: 0

MIDI data print out

AUDIO INTERFACES

- Serious recording may require a better soundcard to provide more input/output channels (with 1/4" and/or XLR mic jacks), high quality AD/DA converters, MIDI connectivity, pre-amps, hardware mixing, ...
- There are Linux drivers for a many cards, but far from all. Investigate capability carefully before buying.
- ALSA provides drivers for PCI, USB cards. Check ALSA webpage for support.
- For USB there are several audio standards supported by Linux:
 - USB1.1 = Excellent support, but only 2 channel recording possible (due to USB bandwidth limitations)
 - USB2 = Standard supported (kernel \geq 2.6.34) but not used by all USB2 cards!
- FFADO supports firewire. Check FFADO webpage for supported cards.
- Check also: http://apps.linuxaudio.org/wiki/current_audio_gear
- Also recommended: studio monitors, good headphones. microphones, \$\$\$..

Focusrite Saffire Pro24 (firewire)



1/4"/XLR
inputs

Preamp
gain

Output
Volume



MIDI

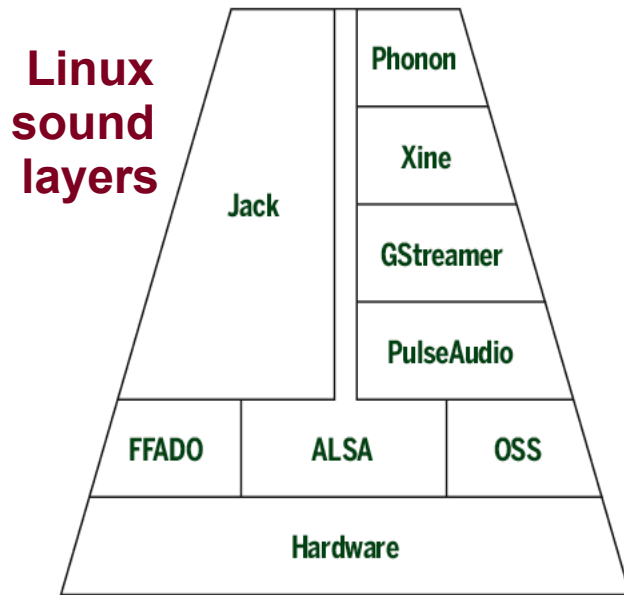
More 1/4"
Input/outputs

LINUX AUDIO DISTRIBUTIONS

- Any Linux distribution can be used for audio work, but some configuration tweaking is recommended – see http://wiki.linuxmusicians.com/doku.php?id=system_configuration
- I recommend using a dedicated linux audio distro: optimizations already done & these provide lots of music applications (several of which should be compiled from development versions for newest features [firewire+linuxsampler])
 - AVLinux (my favorite), Debian-based
 - Ubuntu-based: Dreamlinux, TangoStudio, Ubuntu+kxstudio ppa or Ubuntu studio. (straight Ubuntu not especially recommended)
 - Arch or Gentoo + ProAudio overlay
 - Fedora + CCRMA repositories
 - Dyne-bolic, RemixOS, Musix, puredyne, PuppyStudio. GNUGuitarINUX, 64Studio, Apodio



LINUX SOUND



- The Linux sound infrastructure is a bit complicated.
- The hardware drivers are supplied by **ALSA** (PCI, USB) or **FFADO** (firewire). It is possible to interact with ALSA directly, but then only one process can use audio at a time.
- On top of the driver level several “sound” servers/APIs are available to provide higher-level access to sound functions – for sharing, interconnecting audio devices, streaming audio, etc

- The JACK sound server is the best choice for professional audio. It provides:
 - Works with any soundcard which has an ALSA or FFADO driver.
 - Easily configured, low latency access to audio/midi hardware
 - Interconnection of audio/midi applications – applications define input/output ports which can be easily connected to each other.
 - Methods for synchronizing audio applications (even over the network)
 - Jack represent a unique strength for Linux audio.
 - *But, Jack may be confusing at first and may conflict with PulseAudio/other servers which are trying to access the same hardware.*

COMMAND LINE AUDIO

Just a sampling...

Alsa (lots of comands beginning with “a”)

- **aplay**: play sound files, list Alsa output devices
- **arecord**: record sound , list Alsa input devices
- **amidi**: send midi commands to Alsa midi devices
- **alsamixer**: mixer to configure Alsa soundcards
- **aconnect**:: create connection between Alsa apps.
- **\$HOME/.asoundrc**: ALSA config file, optional, powerful, and arcane

Jack (lots of comands beginning with “jack”)

- **jackd**: start Jack sound daemon
- **jack_lsp**: list Jack ports
- **jack_connect**: connect Jack audio/midi ports
- **aj2midid**: create bridge between Jack/Alsa midi
- **aj-snapshot** save/restore all current Jack connections

Misc

- **ecasound, sox, snd, sndfile-XXX**: => other sound-related programs



JACK SOUND SERVER

- Jack can be controlled by several GUI applications: *QjackCtl*, *Cadence*, *Patchage*, *ladish*...
- To complicate matters Jack comes in 2 flavors, Jack1 and Jack2, which are functionally equivalent. A given distro will use one or the other.
- Also, both Jack and Alsa can control MIDI. These can be used at the same time and interconnected using the *aj2midid* program.
- Jack must be started before any music applications. The sample rate and *latency* can be configured.
- Latency refers to the time delay in processing sound. Latencies above ~10ms are noticeable so for realtime music production (playing midi keyboard, adding overdubs) it is desirable to have low latency. At low latencies buffer over/under runs may occur ("xruns") resulting in audio glitches. A lot of time can be spent optimizing to avoid xruns...
- Many people suggest removing PulseAudio because it often interferes with Jack. But there is a Pulse-to-Jack bridge which can also be used.
- Lets look how to configure Jack with QJackCtl

QJACKCTL

- QjackCtl is used to stop/start Jack, monitor Xruns, and make audio/midi connections between applications.

Start/Stop Jack Server

Xruns

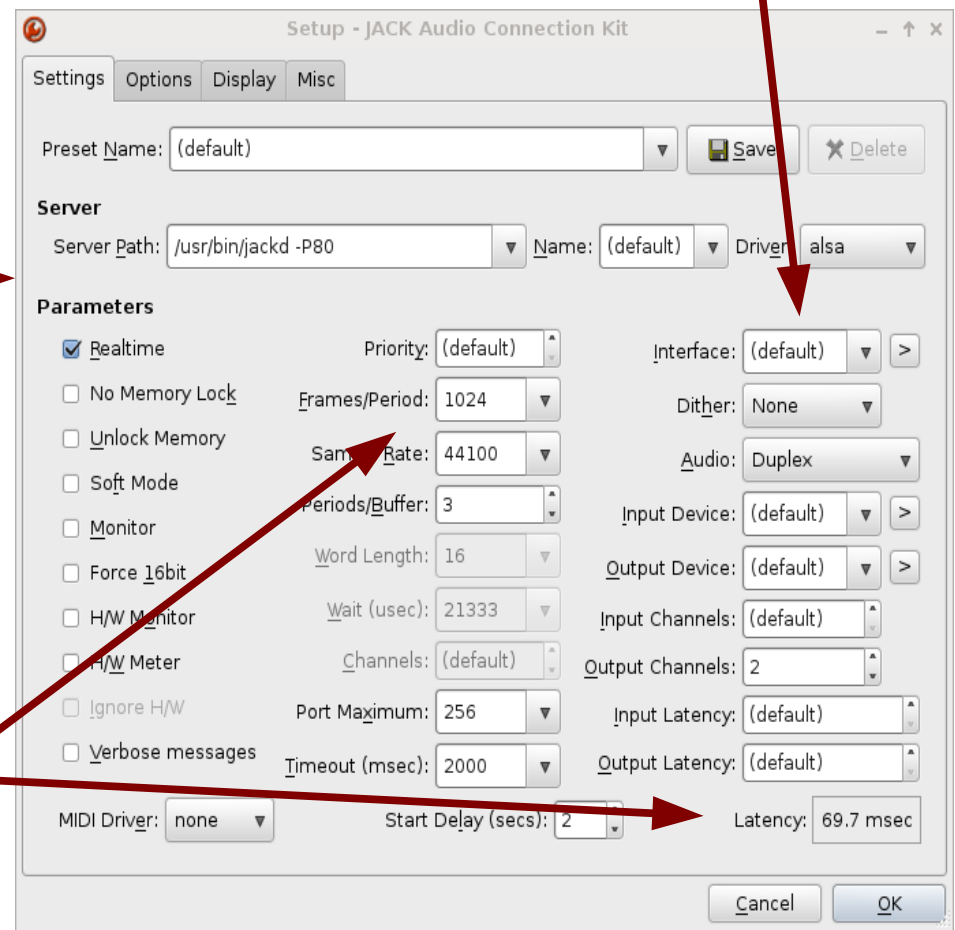
Device setup



Open audio/midi Connection panel

Jack synchronization

Save/restore setup



Choose sample rate and other parameters.
$$\text{Latency} = \frac{(\text{Frames/period}) * (\text{period/buffer})}{\div (\text{sample rate})}$$

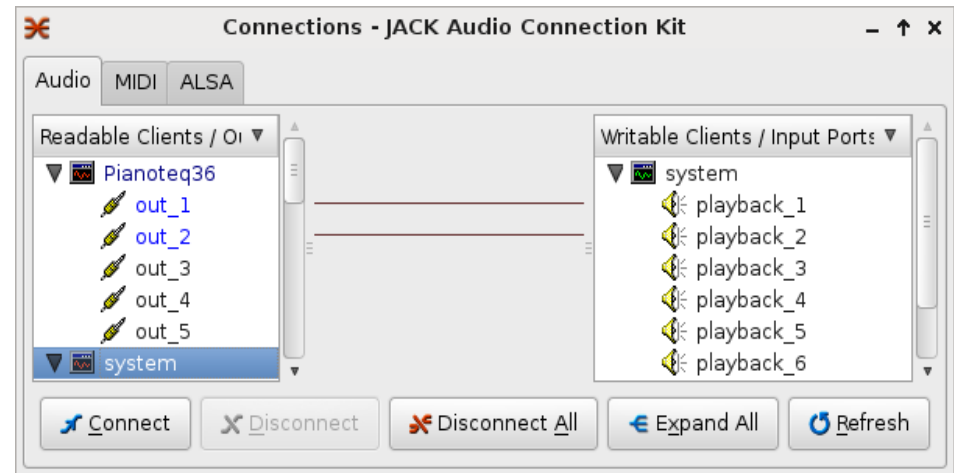
QJACKCTL SETUP FOR MIDI PIANO

Setup: Connect midi Keyboard to my Firewire interface and Play using the program Pianoteq (c.f. Slide 6)

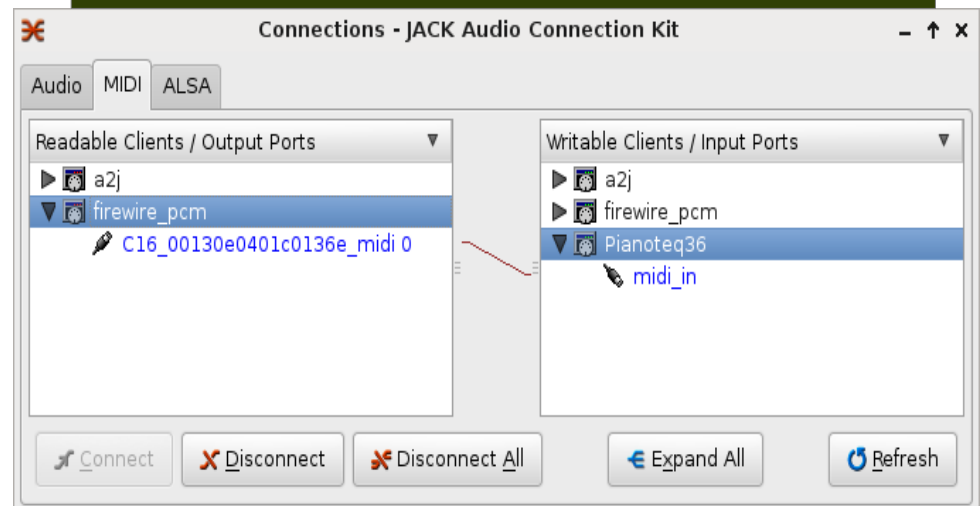


Pianoteq: Nonfree Piano Emulation program

QjackCtl Audio Tab: Connect Pianoteq Output to system out (speakers)
Drag mouse to make connections



QjackCtl (Jack) Midi Tab: Connect firewire (keyboard) To Pianoteq midi input.



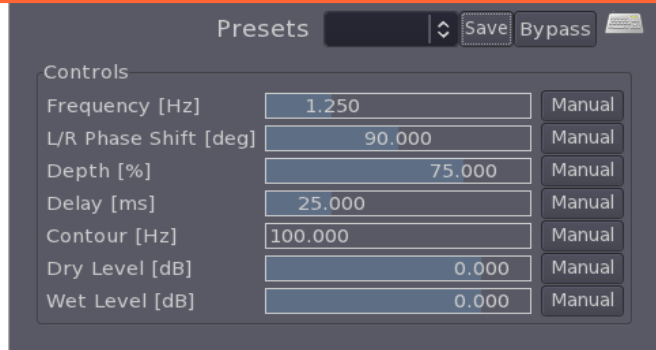
AUDIO PLUGINS

- Plugins provide additional audio processing such as adding reverberations, equalization, ... others provide virtual instruments played via midi.
- Plugins may be added to DAW tracks or run in standalone “hosts” (*Jackrack, LV2Rack, CalfRack, Carla, Festige*). Support varies by program.
- Linux supports several plugin standards:
 - **Ladspa** – oldest, no native GUI (generated by host)
 - **DSSI** – For virtual instruments, now deprecated
 - **LV2** – Newest, supports GUI, for both effects and instruments
 - **Linux VST** – native Linux version of Windows plugin standard. Certain licensing headaches apply.
 - **Windows VSTs** – Many Windows VSTs work with Wine+FST/festige or dssi_vst.

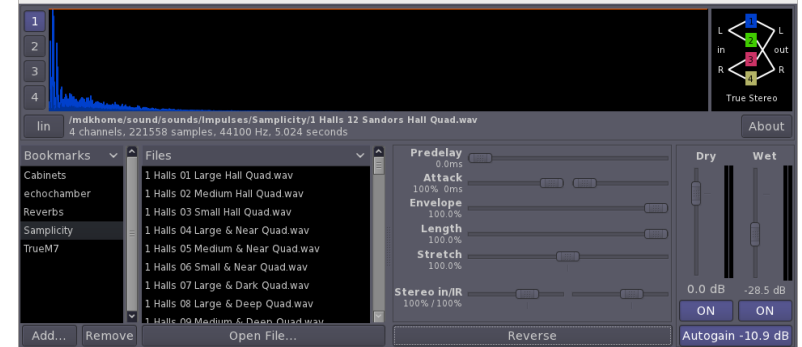
PLUGIN EXAMPLES

a few random selections from hundreds available...

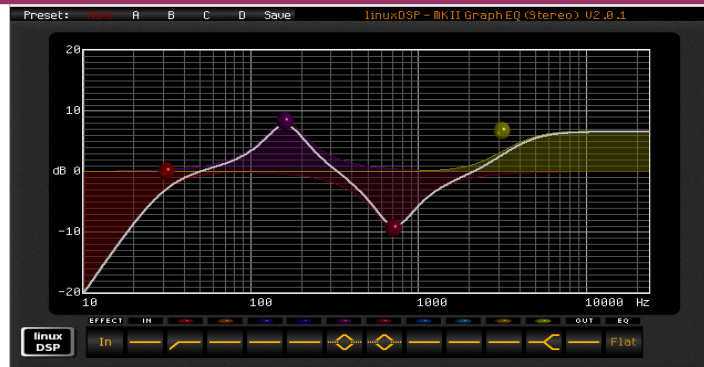
TAP Chorus/Flanger (Ladspa)



IR – Impulse Response Reverb (LV2)



LinuxDSP Equalizer (LV2-Nonfree)



Invada Compressor (LV2)



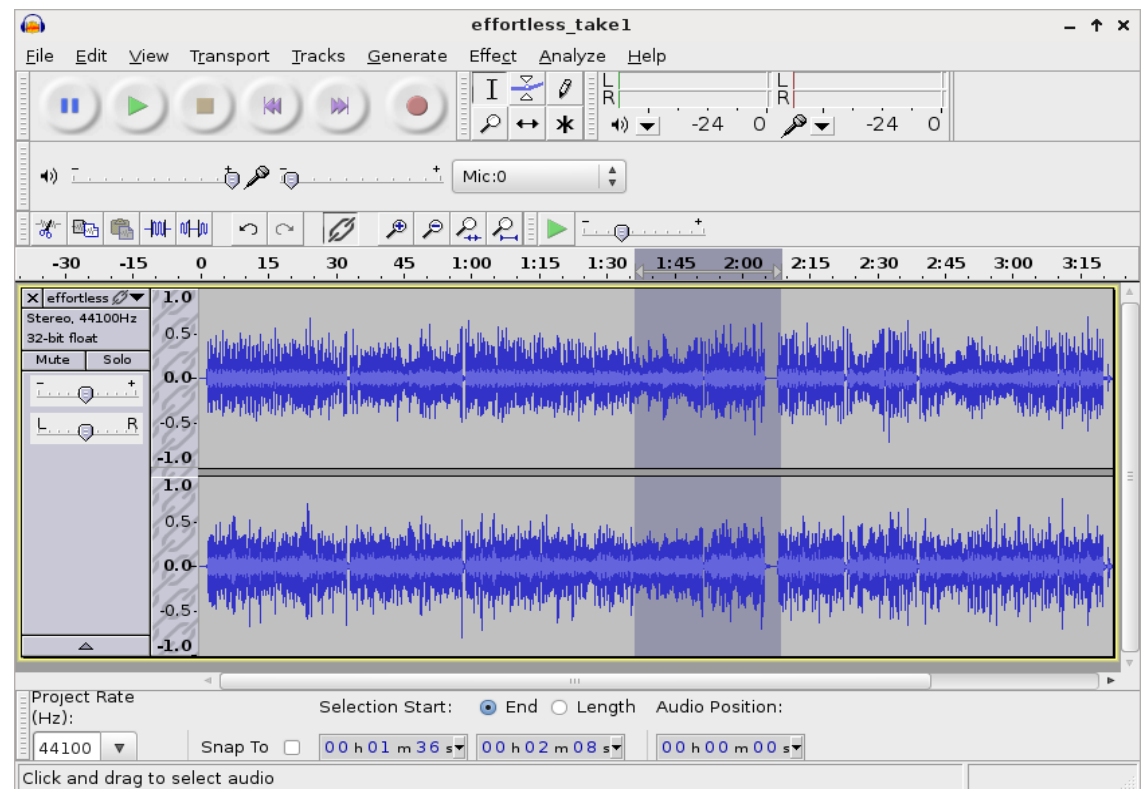
Calf Monosynth (LV2 instrument)



AUDACITY

- Audacity is a very capable audio file editor support multitrack editing/recording. Jack support is modest, so use standalone.
- Has builtin plugins + LADSPA support
- Is a good choice for podcasts, simple music editing, phono to CD conversion (good noise reduction plugin).
- Good website and several books provide excellent documentation

- **Audacity with a stereo music file loaded.**
- **One region is highlighted (by selecting with a mouse)**
- **Can apply an effect to the highlighted region using the “Effect” menu.**
- **Can cut and paste waveform to edit audio.**



ARDOUR

- Ardour is an excellent, full-featured DAW, more capable (but far more complicated) than Audacity.
- Do multitrack recording, mixing, mastering. Supports Ladspsa, LV2, LinuxVST, Windows VST plugins. Effects can also be added by using Jack to connect tracks to external software or hardware.
- 3 flavors: **Ardour2** – stable, audio-only, **Ardour3**: development version adding midi support, **Mixbus**: Non-free version of Ardour2, with built-in high quality plugins from Harrison Consoles.
- Can do movie soundtracks when used with xjado (Jack used to synchronize audio/video)
- Nice tutorial: <http://en.flossmanuals.net/ardour>

Plugin

Ardour3
Supports
Audio
And midi
Recording,
Unlimited
Tracks,
Many plugins



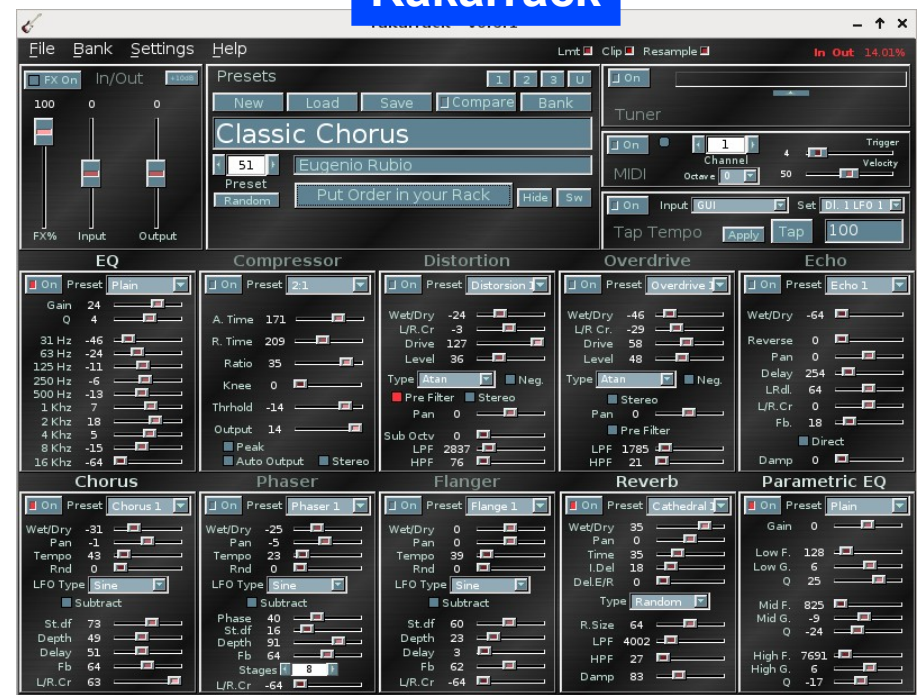
GUITARIX & RAKARRACK

- Guitarix & Rakarrack are 2 different programs for amp emulation and guitar effects processing.
- In each you can build a “rack” of amps and effects and create a wide variety of sounds.
- Can be used for live play with a guitar or as “inserts” in Ardour/other DAWs to do effects on pre-recorded guitar.

Guitarix



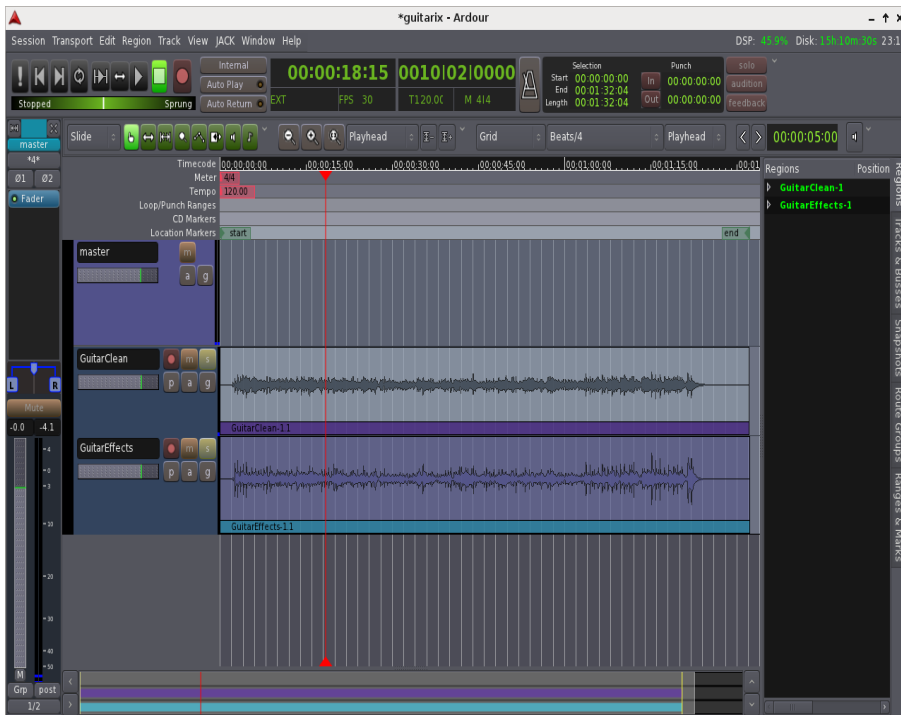
Rakarrack



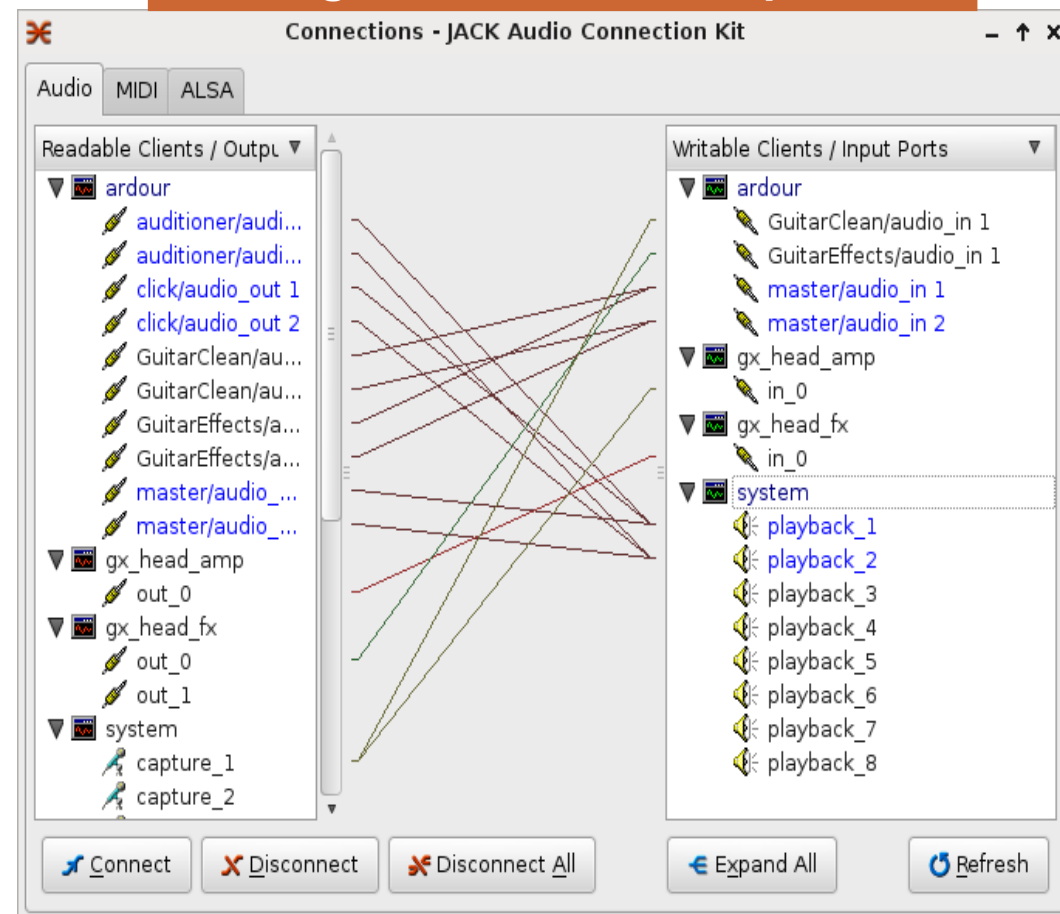
JACK CONNECTIONS WITH GUITARIX & ARDOUR

- Setup: Record 2 guitar tracks in Ardour– one track has effects from Guitarix, one is “dry”.
- Jack connections become much more complicated. QjackCtl can store complicated routing in it “Session” panel.

Ardour with “wet” and “dry” guitar tracks

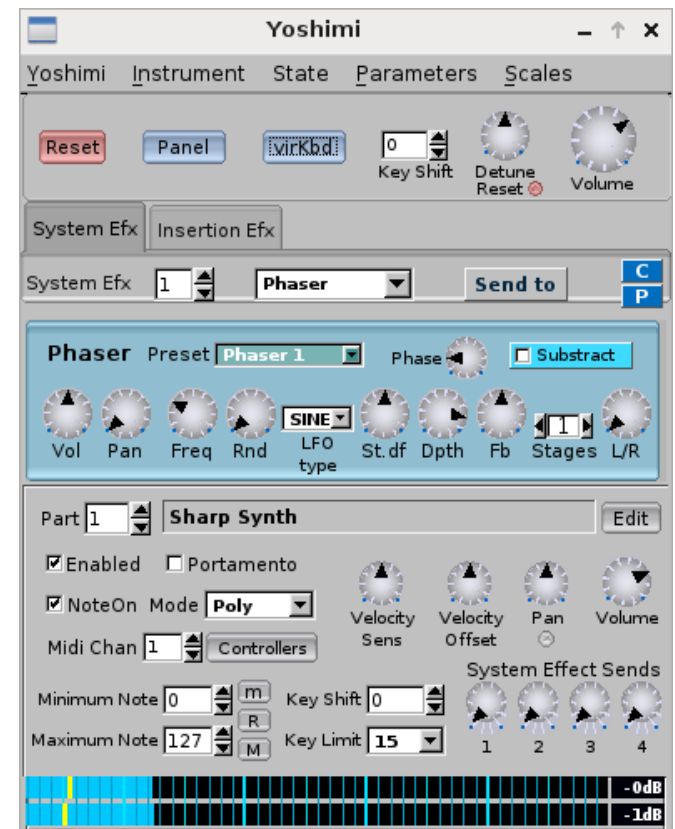


QjackCtl Jack Audio connections Routing is somewhat complicated



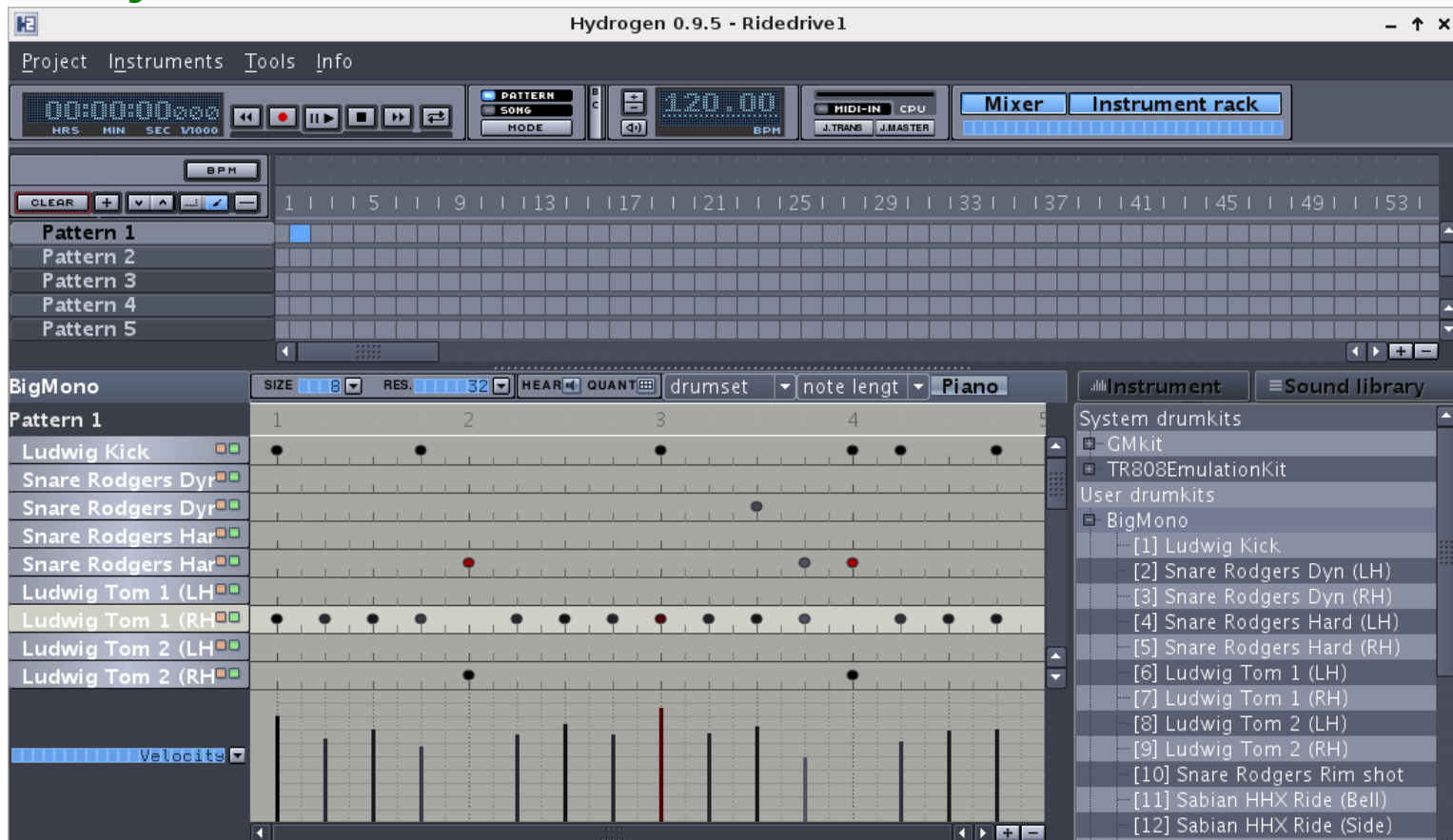
MAKE SOME SOUNDS: LINUXSAMPLER & YOSHIMI

- **Linuxsampler** plays samples – prerecorded notes from real instruments. Supports sound formats: Gigasampler, SoundFont, and SFZ. Free and non-free samples are available in these formats.
- **Yoshimi** is a capable synth with a wide sound range, and highly configurable. Based on another synth, ZynAddSubFX, but with better Jack support.



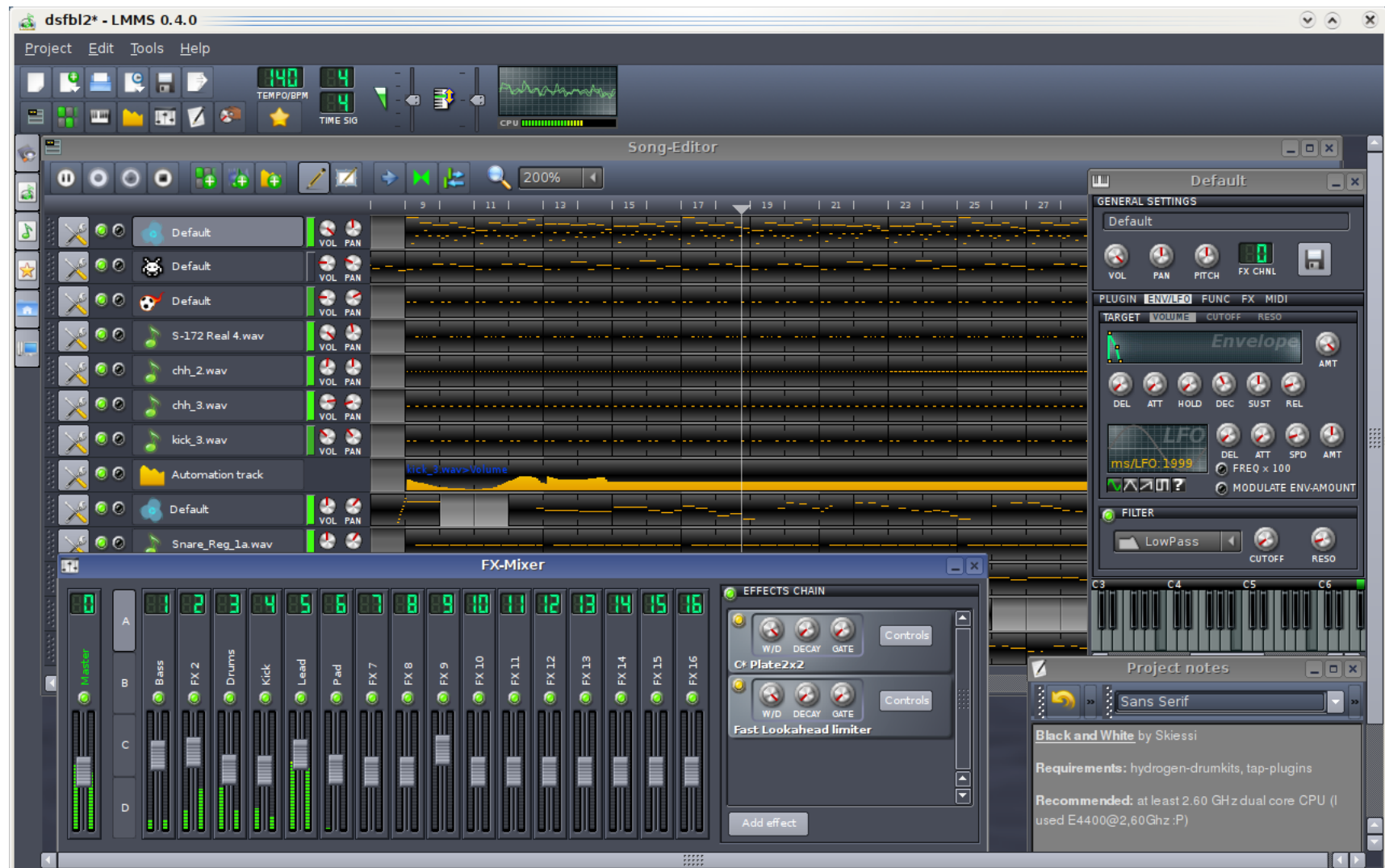
HYDROGEN DRUM MACHINE

- Hydrogen a sequencer for drum sounds (or any sound you load into it). It also can be triggered by external midi input from another program or midi keyboard.



LMMS: LINUX MULTIMEDIA STUDIO

- LMMS is an “all in one” music creation program with song editor, beat editor, piano-roll sequencer, mixer, effects, similar to “Fruity-loops” on Windows.



RESOURCES

- Documentation is perhaps not Linux's strong suit so it can be frustrating getting started. Much can be learned forums, blogs, email lists.
- Most distros/applications have websites (some with help forums)
- Youtube can be helpful see especially <http://filmsbykris.com/wordpress/>
- Recommended websites
 - Good forum: <http://www.linuxmusicians.com/>
 - Linux audio email lists: <http://linuxaudio.org/>
 - Good blogs:
 - <http://linuxhomerecording.blogspot.com>
 - <http://wootangent.net/>
 - Compendium of linux sound software: <http://linux-sound.org/>
 - Dave Phillip's excellent Linux Journal articles on linux audio: <http://www.linuxjournal.com/users/dave-phillips>
 - Fedora Musicians Guide (mostly applies to any distro) http://docs.fedoraproject.org/en-US/Fedora/14/html/Musicians_Guide/index.html

CONCLUSIONS

- Linux is a highly capable music production platform with a wide variety of software available.
- It offers usual Linux strengths of great configurability/customizability some great free software but also the typical weaknesses of modest documentation, and little commercial support.
- The Jack Audio Server is a particular strength of Linux Audio since it permits easy interconnections of audio applications (it is the “pipe” of audio). You can easily connect hardware, synths, DAWs, effects...
- Linux audio community is small but enthusiastic and it is possible in interact directly with developers.
- Happy recording!...

