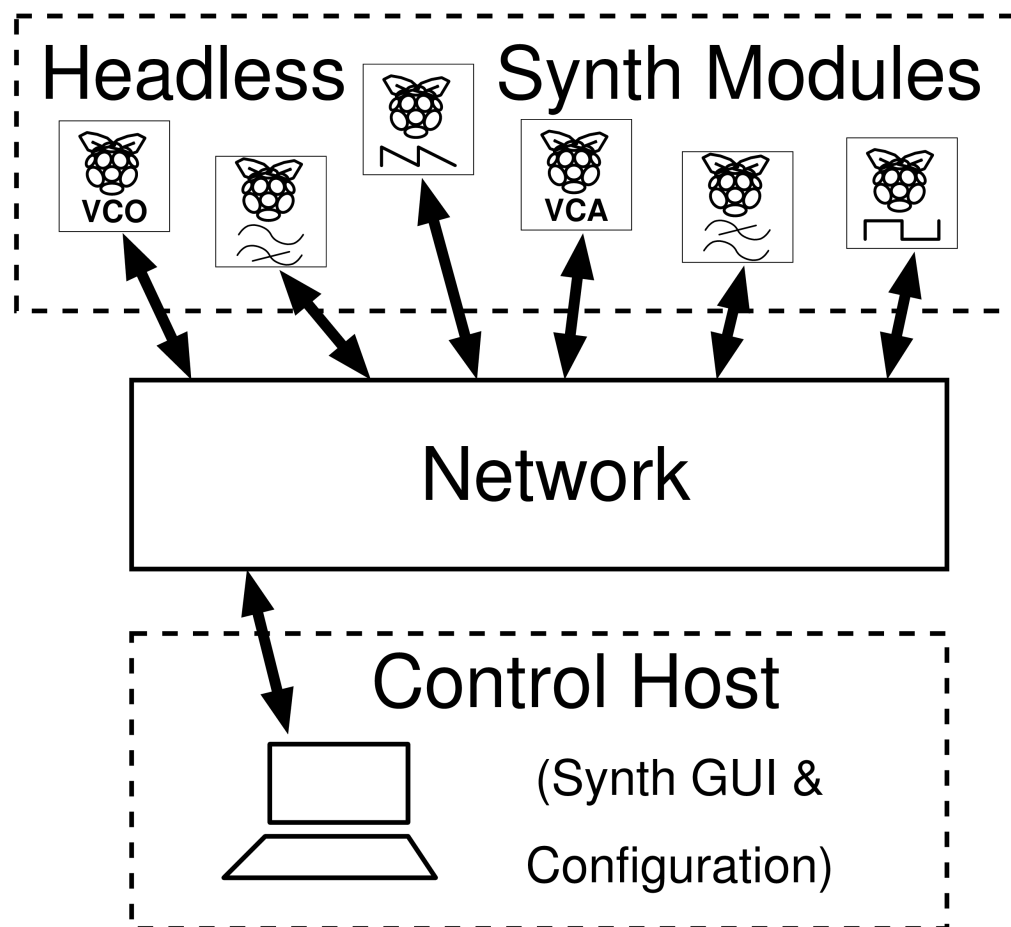# Case Study:
Building an Out Of The Box Raspberry Pi Modular Synthesizer

LAC 2014 /// ZKM
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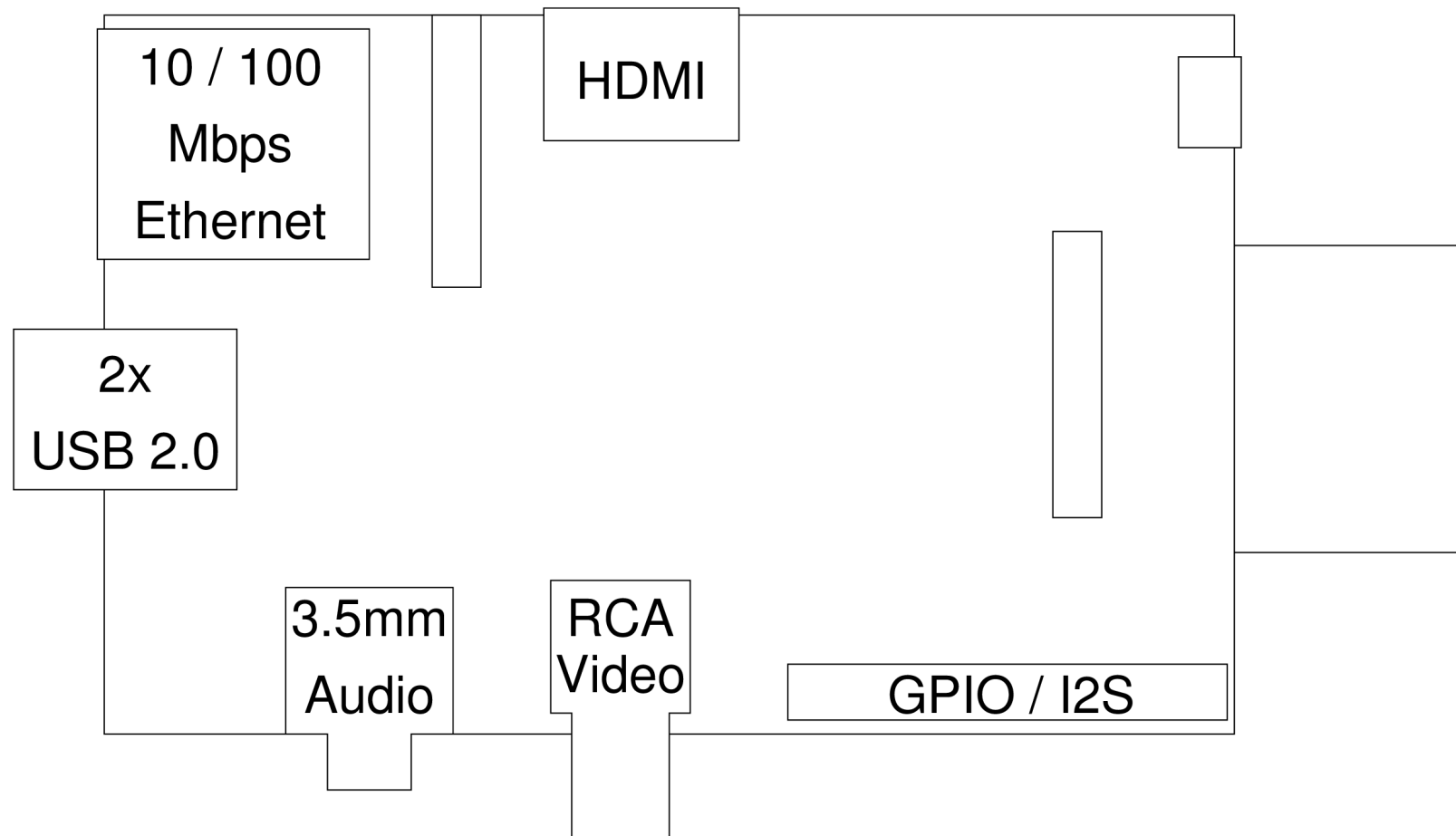
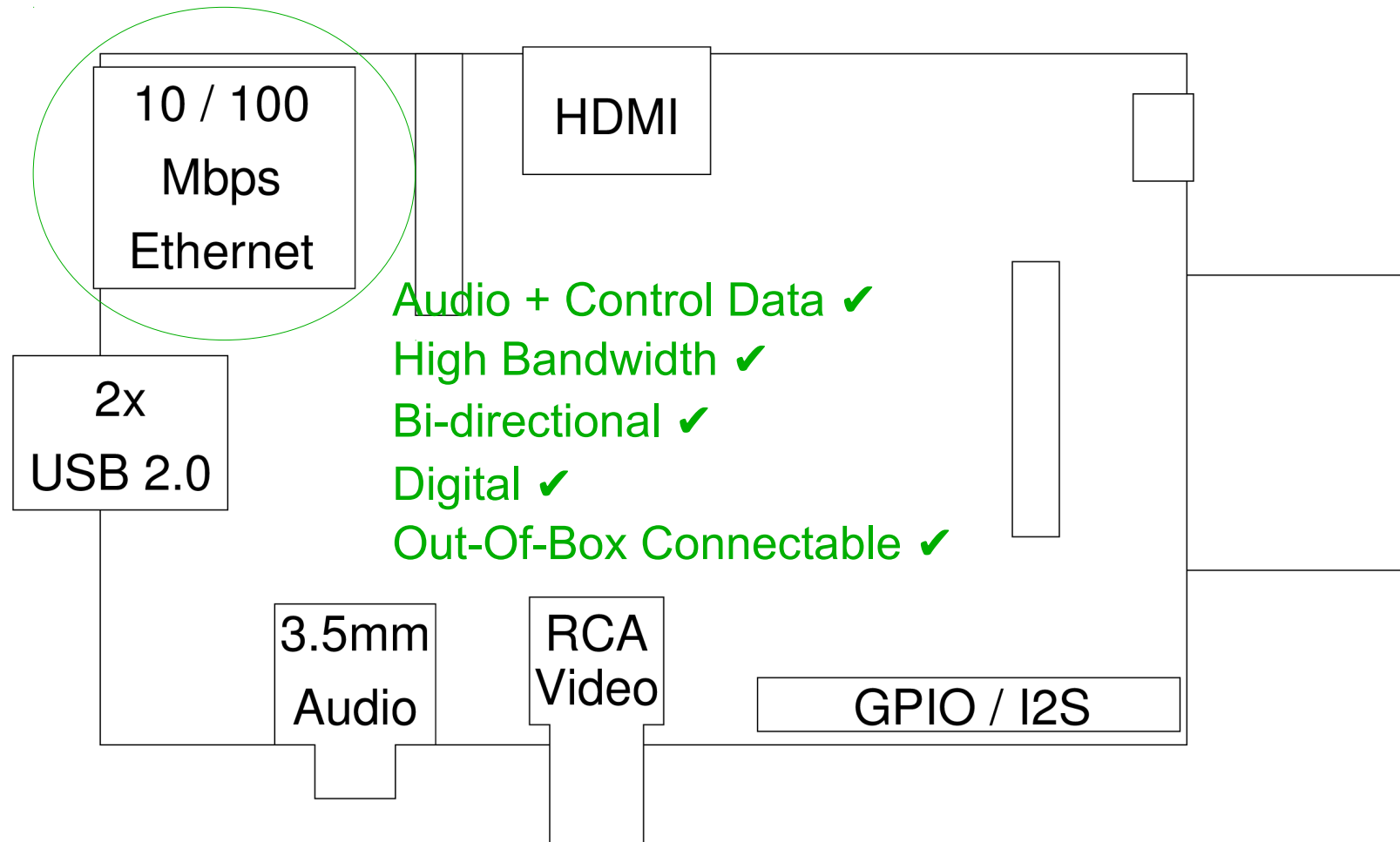# The Idea

It's appealing since...

- … it scales (distributed modular architecture),

- … it looks cool (see all modules & wiring),

- … you can touch all modules (WYSIWYG),

- … you can turn, say, a low pass filter into a reverb effect just by replacing the SD card,

- … bugs have only local impact.

Audio Relevant Sockets

10 / 100 Mbps Ethernet		HDMI	
2x USB 2.0			
3.5mm Audio	RCA Video	GPIO / I2S	

Audio Relevant Sockets

10 / 100 Mbps Ethernet

HDMI

Audio + Control Data ✔
High Bandwidth ✔
Bi-directional ✔
Digital ✔
Out-Of-Box Connectable ✔

2x USB 2.0

3.5mm Audio

RCA Video

GPIO / I2S

Basic Setup

- Tested with NOOBS Raspian Wheezy (Debian 3.10.24+ #614 PREEMPT armv6l kernel)

- Detailed software installation guide → see paper

- 16GB class 4 SD card as HDD

Streaming Software Requirements

- Available for ARMv6

- Optimized for Low Latency

- Headless Use

- Candidates:

  - Network Audio System (NAS)
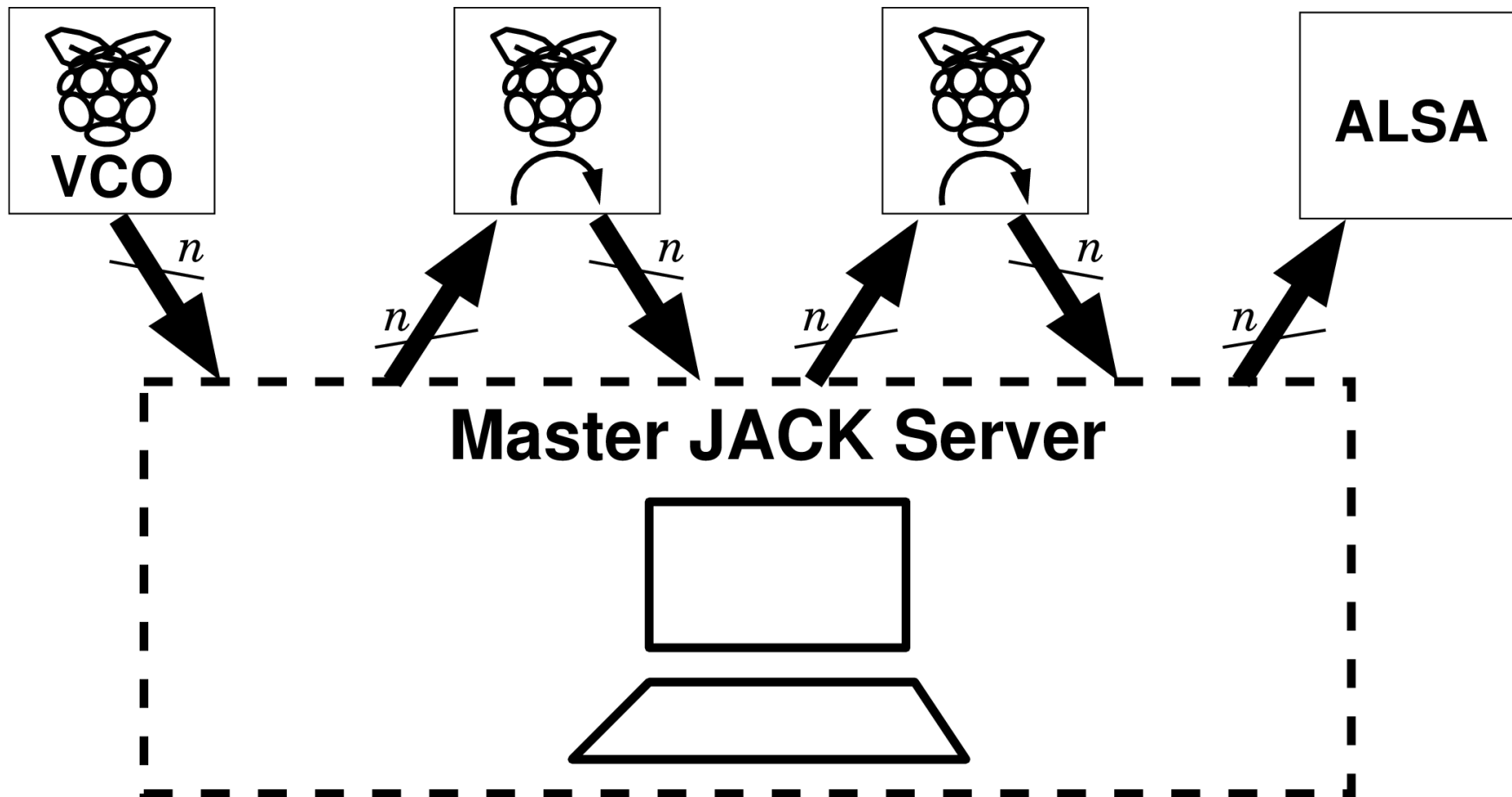
  - PulseAudio

  - JACK with netJACK

Streaming Software Requirements

- Available for ARMv6 ✔

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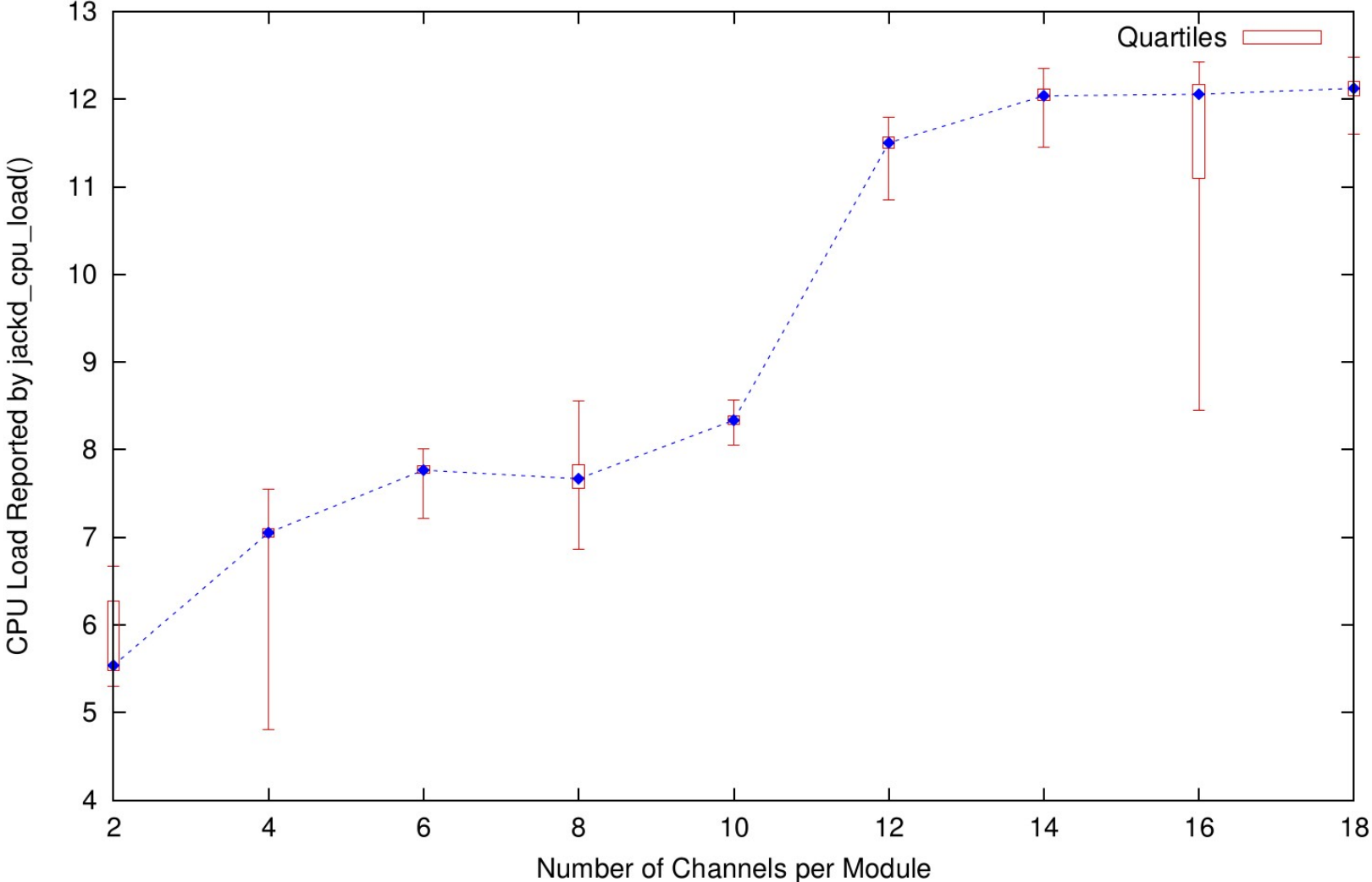
    - JACK with netJACK ✔

Module Software

- In this study: simple clients derived from JACK's `simple_client.c`

- Goal: Use existing plug-ins, e.g. LV^2

- Missing: JACK client for remote export of plug-in lines via netJACK
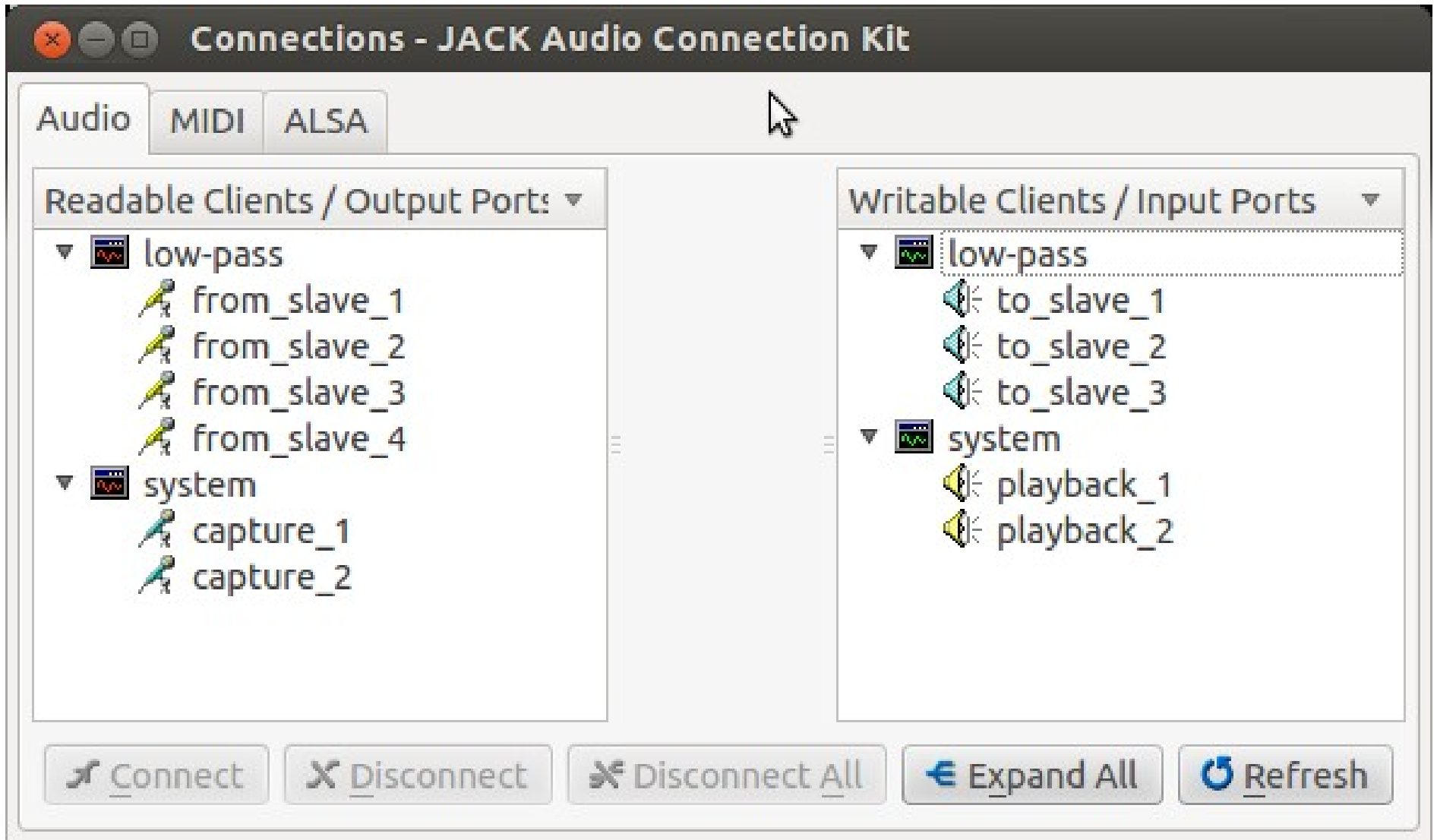
Evaluation Setup
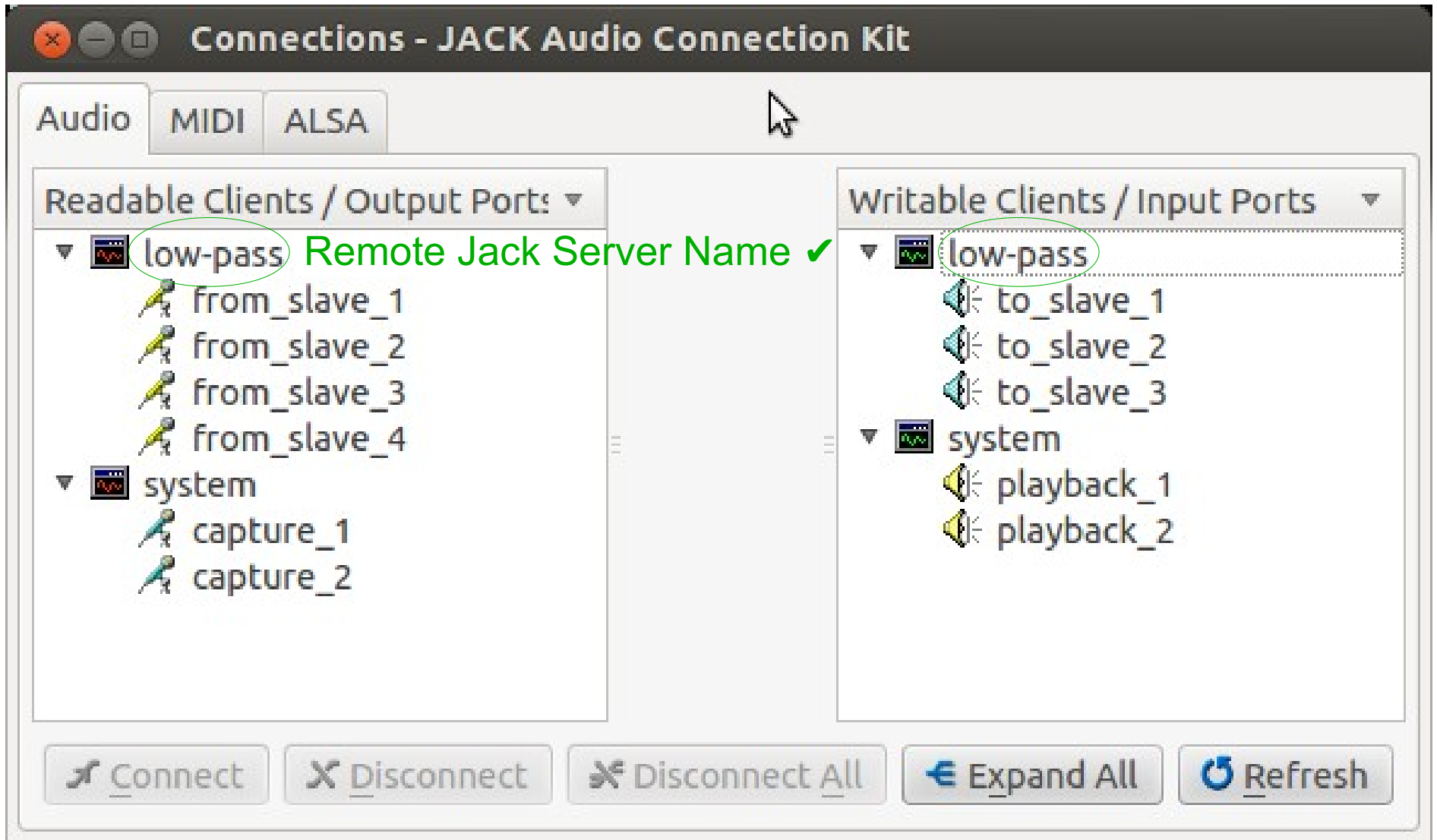
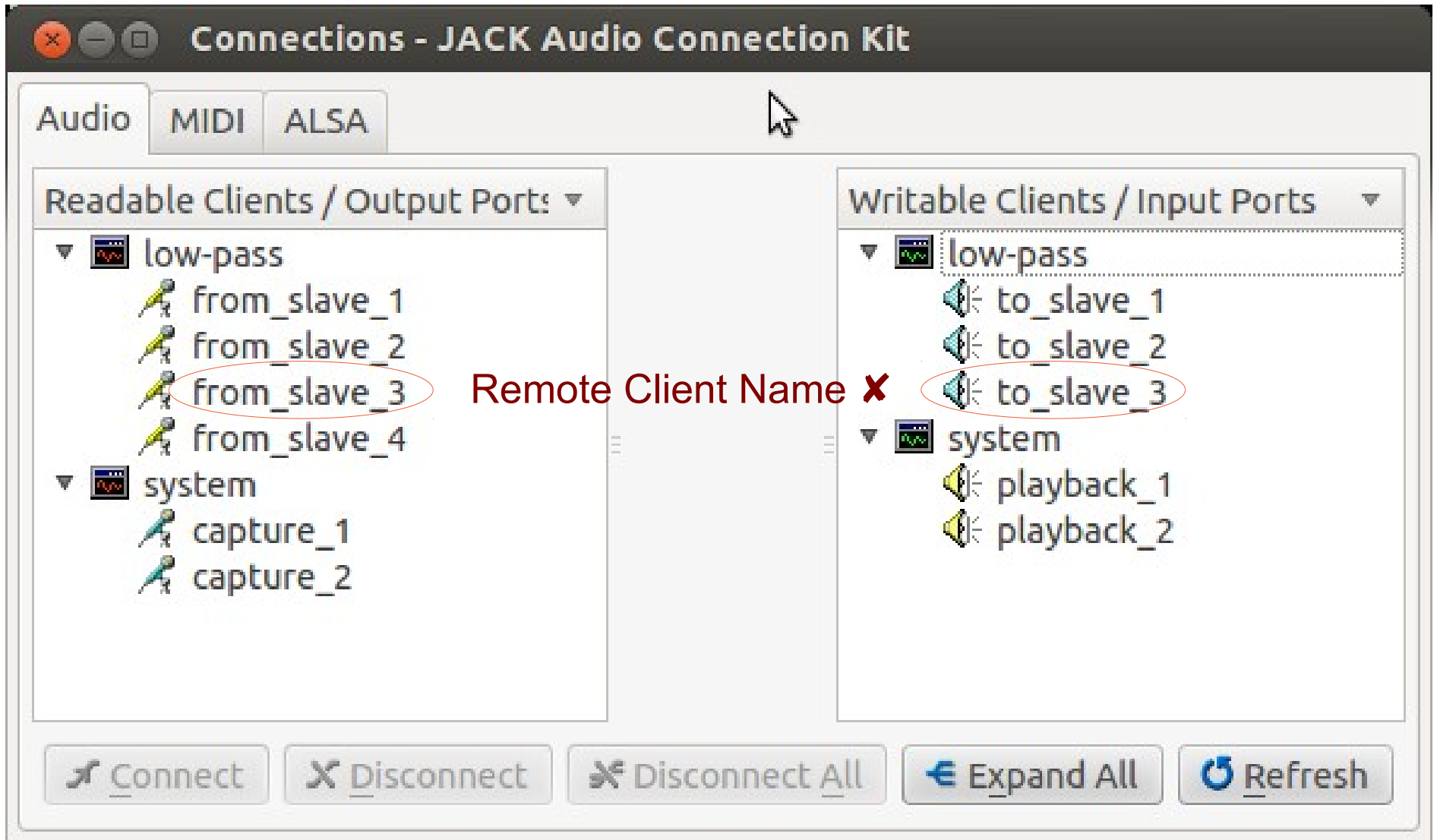# CPU Load Against # of Channels

CPU Load on Master JACK Server
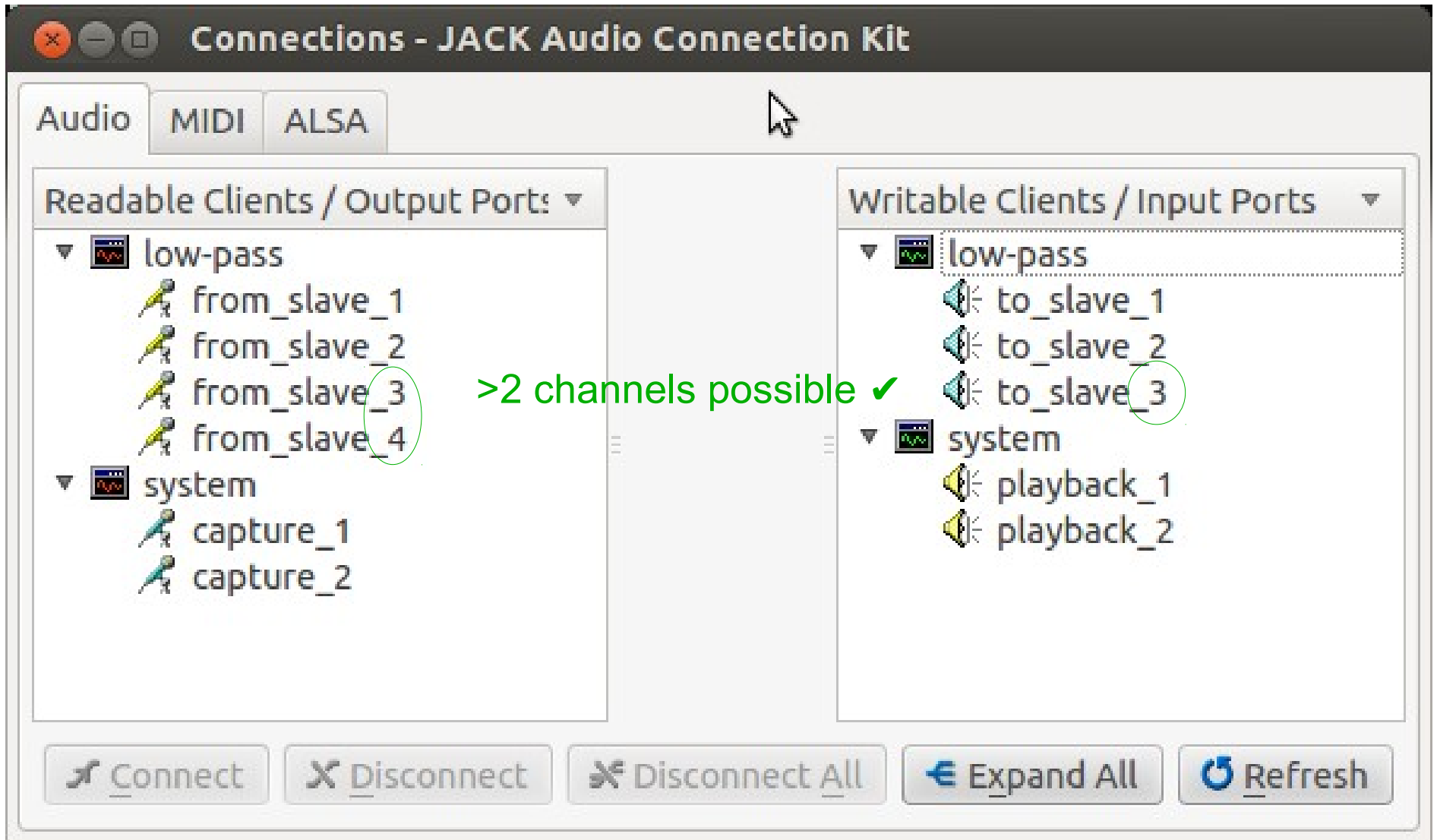
Displaying Routes with `qjackctl`

Displaying Routes with `qjackctl`

Displaying Routes with `qjackctl`

Displaying Routes with `qjackctl`

Module Identification

- Either single SD card with all possible modules

  - Need module selection by software / hardware switch
    → comfortable, but not out-of-the-box

- Or dedicated SD cards with single module

  - Out-of-the-box, but need many SD cards

- Or identification via additional shield

  - Require additional minimal hardware, but can be used
    to provide dedicated input knobs / sliders

Conclusions

- Linux on RPi *almost* ready for out-of-the-box modular synthesizer

- Severest bottleneck: all audio routing via central control host → require remote routes

- Missing remote version of `qjackctl` for setting up remote routes

- Missing JACK client wrapper for e.g. LV² plug-ins

- Need to speed up boot time

- Medium-scale number of open bugs (crashes, hangs, …)

Questions?