FOSDEM Video Box

A bespoke HDMI capture device for conferences.

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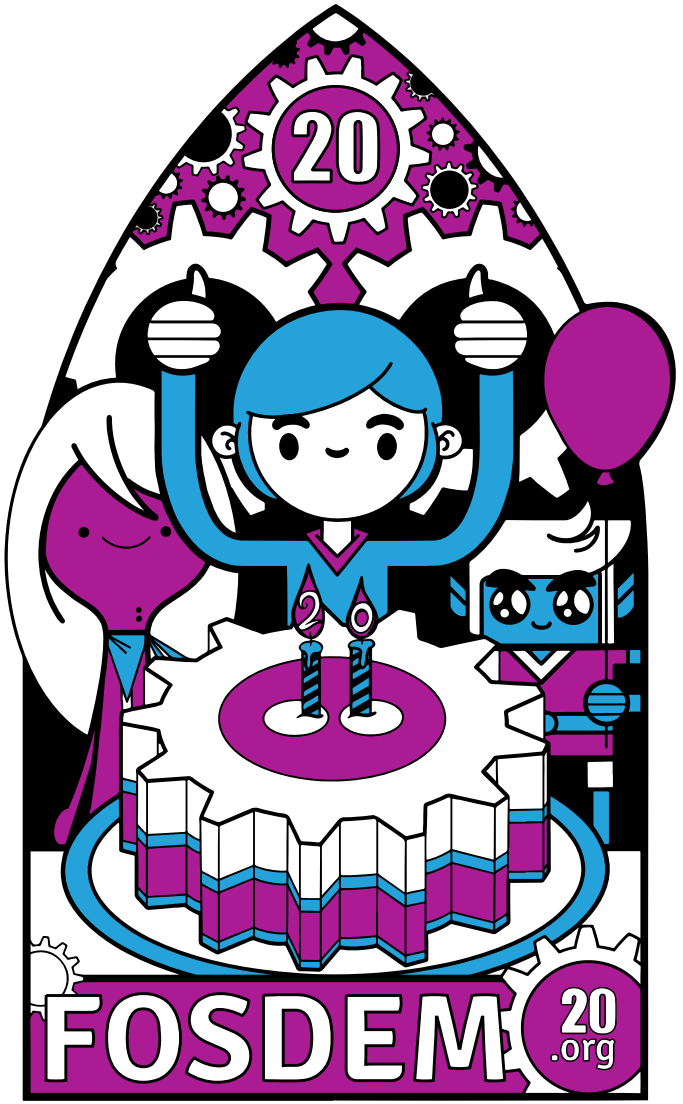
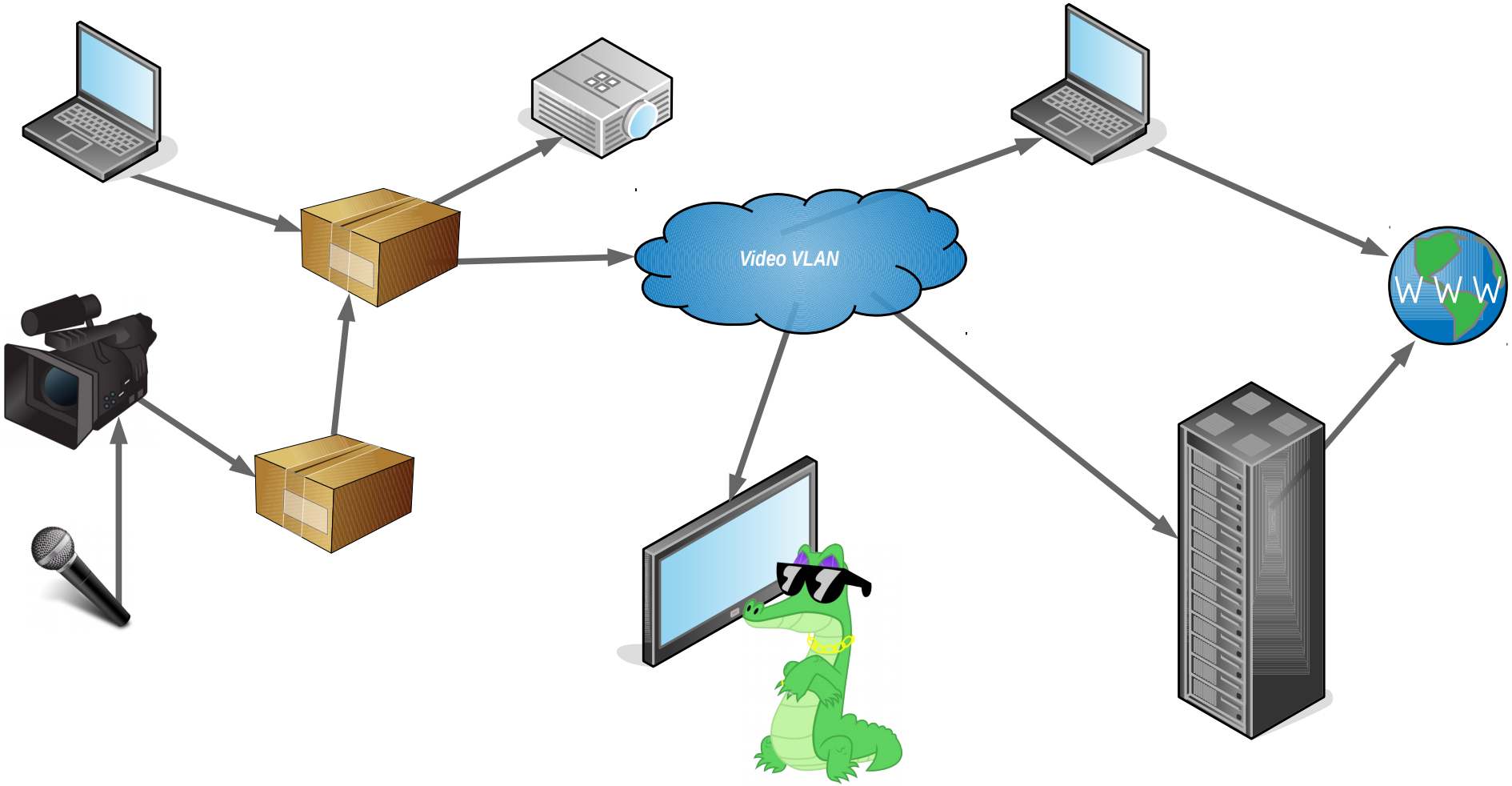
FOSDEM is insane

- 2 days
- 8000+ visitors
- 29 parallel tracks
- 835 talks
- streamed out live!

All on a minuscule budget!



FOSDEM video capture/streaming setup

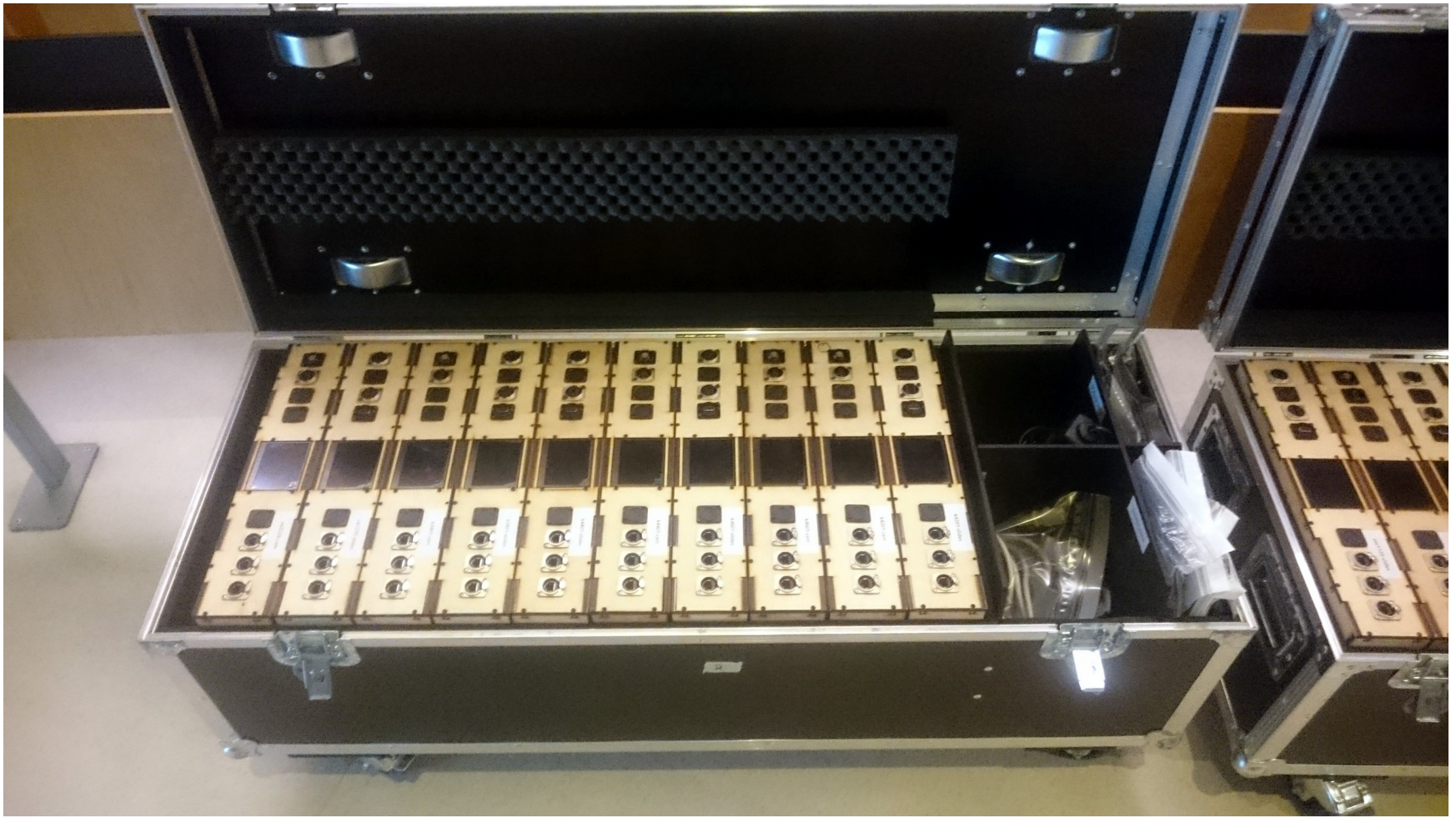


Voctops

Rented cameras, tripods and microphones

35 of 58 Video boxes

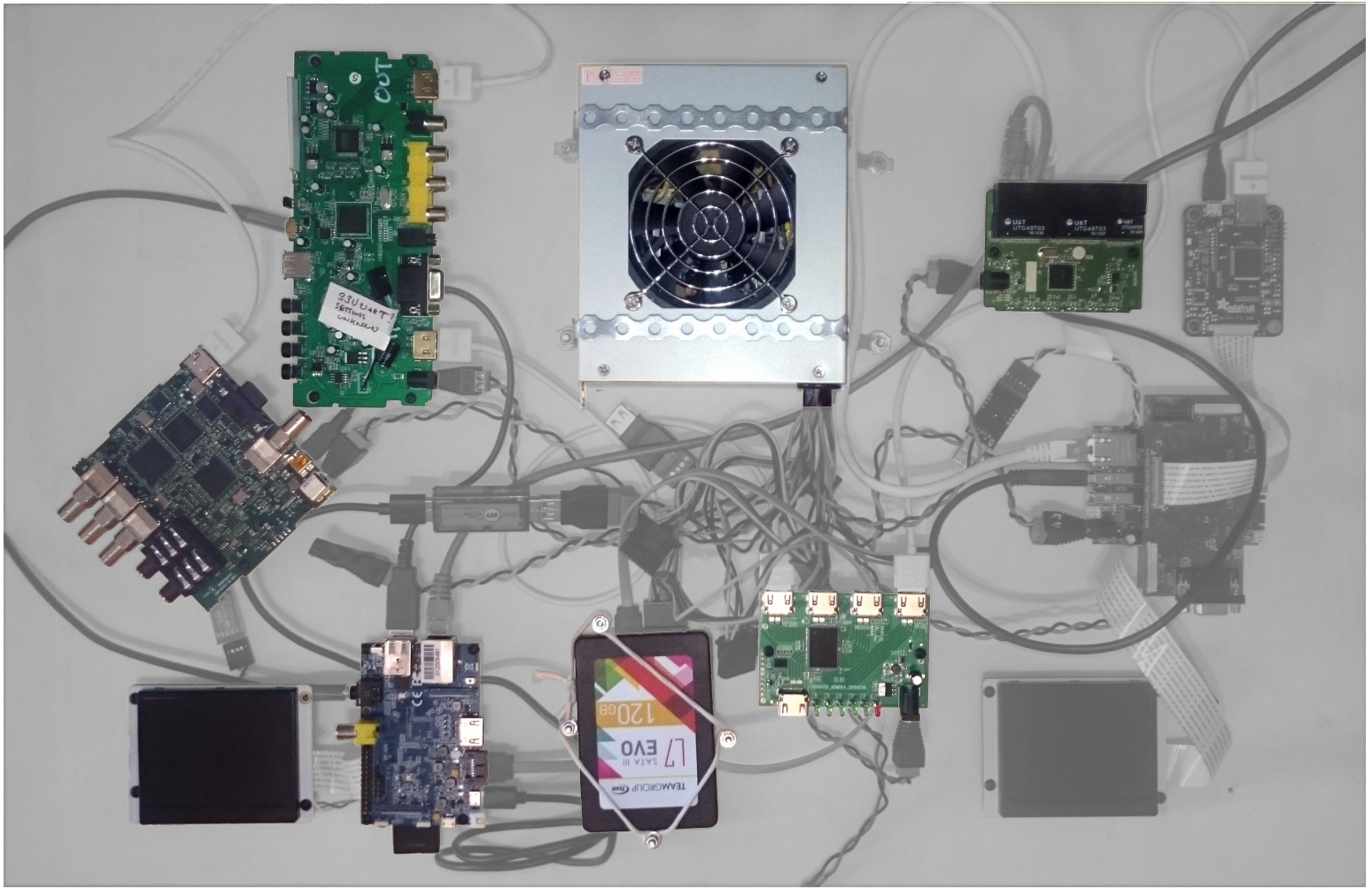
Flightcase with 10 boxes



All flightcases...

A more solitary video box

Video box innards



Lenkeng LKV391MINI

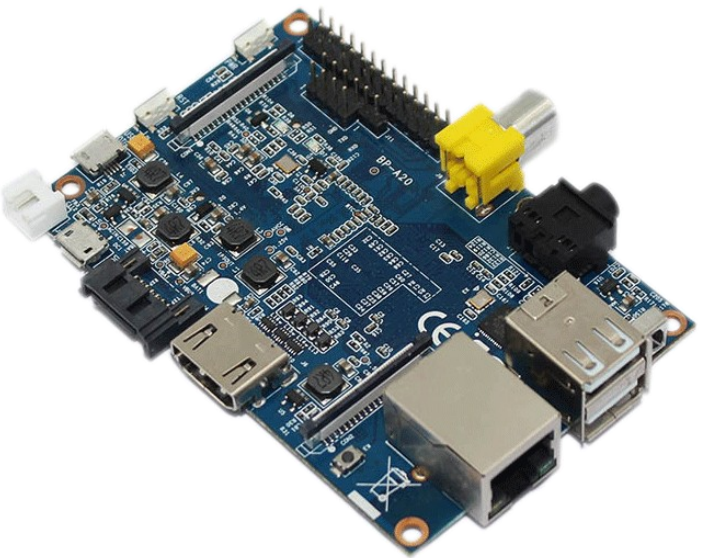
- Normalizes input from anything to 1280x720 HDMI
- Black box with unknown processor architecture
- IRDA for remote control
- From 2015 and no longer available

Blackmagic H.264 pro recorder

- Used as a HDMI → h.264 encoder
- Blackmagic black box
- USB protocol reverse engineered since 2013 by Timo Teräs
- Needs Firmware extracted from proprietary driver
- Expensive!

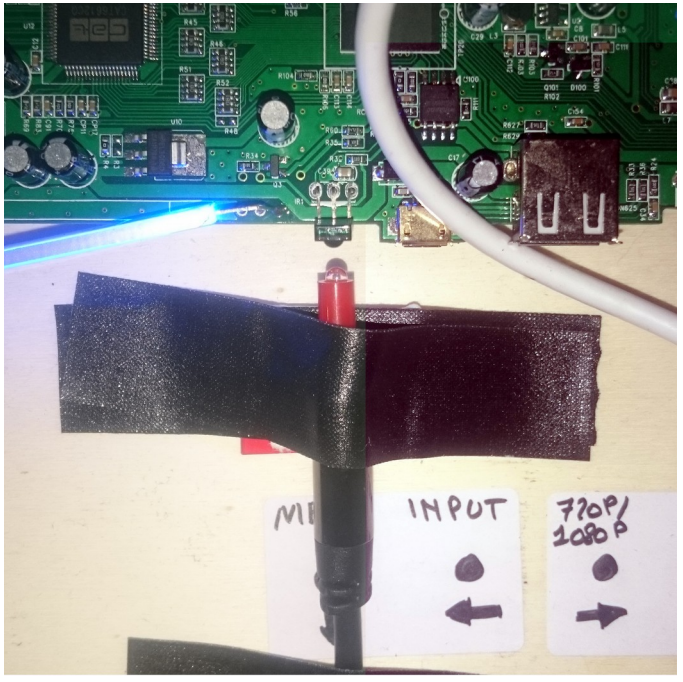
Banana Pi M1

- Gets the h.264 data from blackmagic recorder over usb
- Uses Gigabit Ethernet for the internal stream
- Uses SATA for a local backup
- SD card for filesystem
- Displays status to a 3.5” LCD
- Controls the Scaler
- Runs mainline uboot and kernel on debian buster



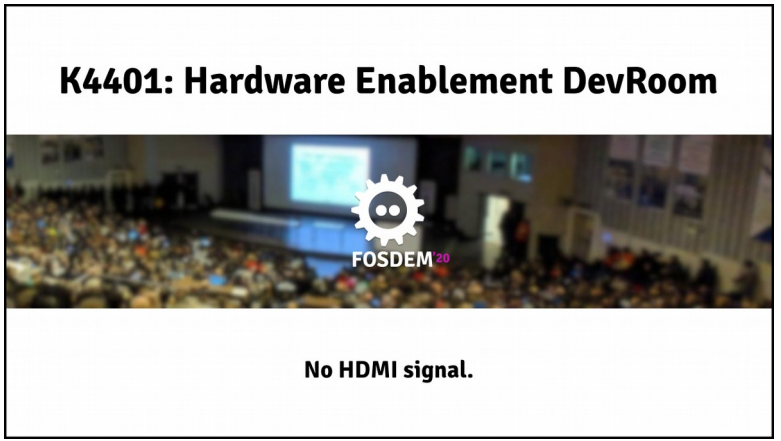
FOSDEM special feature: controlling the scaler!

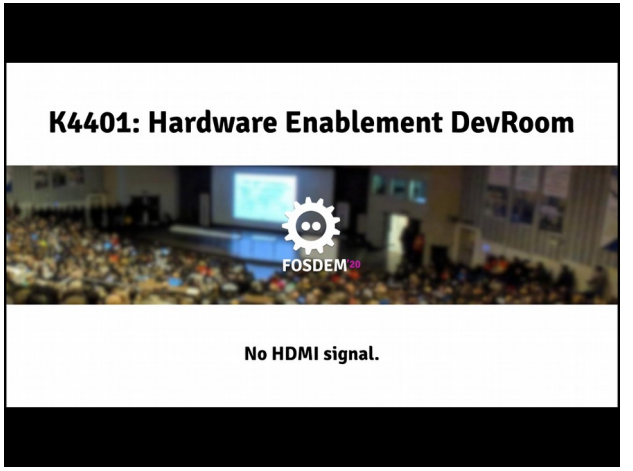
- LKV391 Remote control is through IRDA.
- So get an IRDA led, with a 3.5mm plug
- Attach it to the headphone socket of BPI
- Record waveforms of running through the LK391 menus

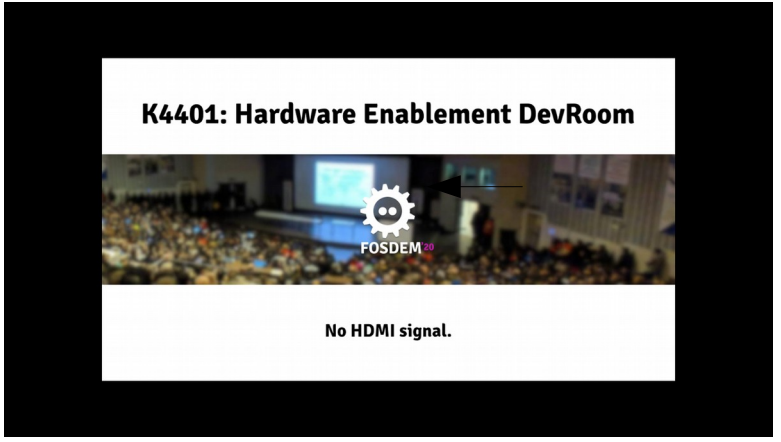


So now you can play specific PCM files for specific scaling resolutions!

The banding dance...







What if we could feed HDMI into an SoC directly...

Then we could:

- Use the display engine to drive the projector properly
- Provide our own EDID to the speaker's laptop
- Use an onboard h.264 encoder for the local stream
- Make it OSHW
- Have mainline software support
- Make it small and cheap

Initial project choices:

- Electronics: Uwe Bonnes
- Minimum resolution: 1280x720
- SoC: Allwinner A20
- Board: Olimex Lime2
- HDMI encoder: Analog Devices ADV7611

Olimex A20-Olinuxino-Lime2

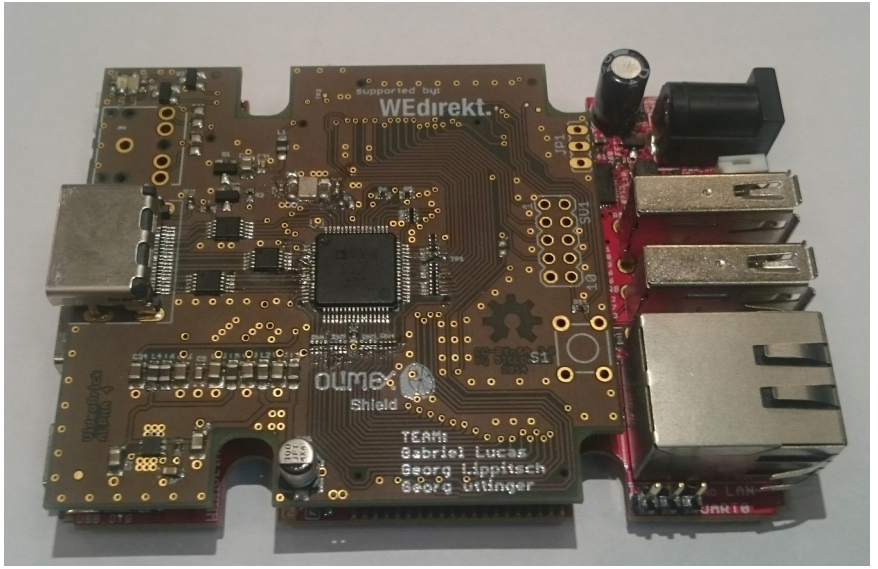
- Allwinner A20
- Linux-sunxi community
- Tsvetan!
- OSHW
- Exposes every required IO pin

https://www.olimex.com/Products/OLinuXino/A20/A20-OLinuXino-LIME2/

The videobrick project

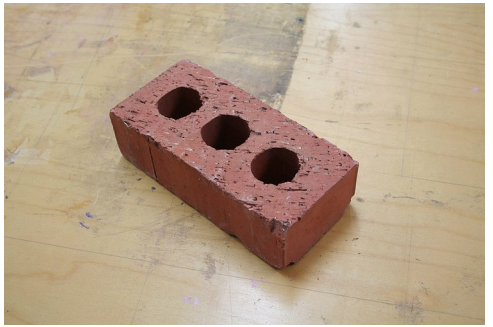
- Georg Oettinger, Georg Lippitsch and Gabriel Lucas
- An ADV7611 daugherboard for the Olimex Lime A10
- OSHW
- Active H2 2014 and H1 2015, and then…
- But their work will live on!

https://videobrick.wordpress.com/



Advantage #1: Hardware

- Low cost
- OSHW
- Long(er) term availability of chips
- No more ratsnest cabling
- Endless spares
- Conveniently backpackable
- Considerably more chuckable



Advantage #2: The projector

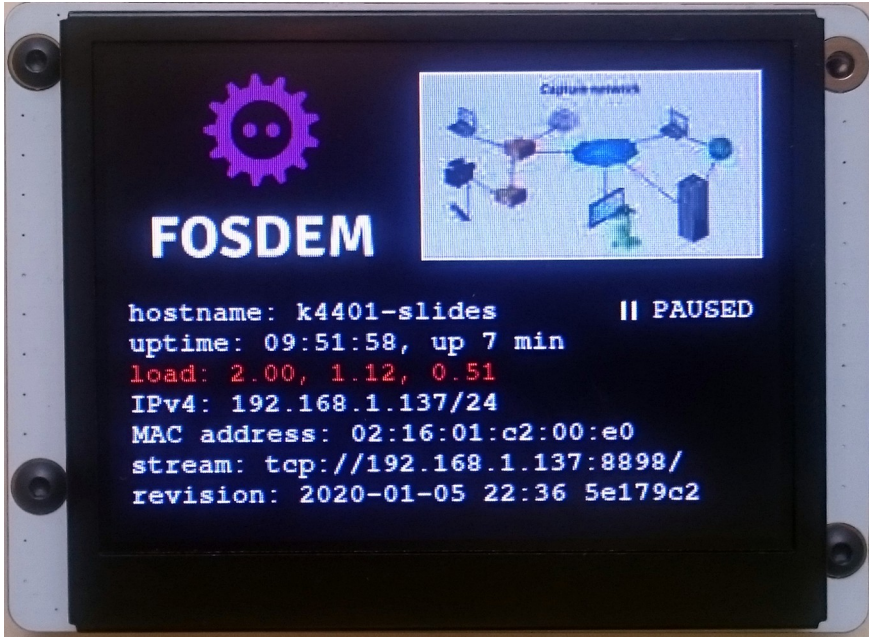
We can wield the full power of a full featured display engine, so we can:

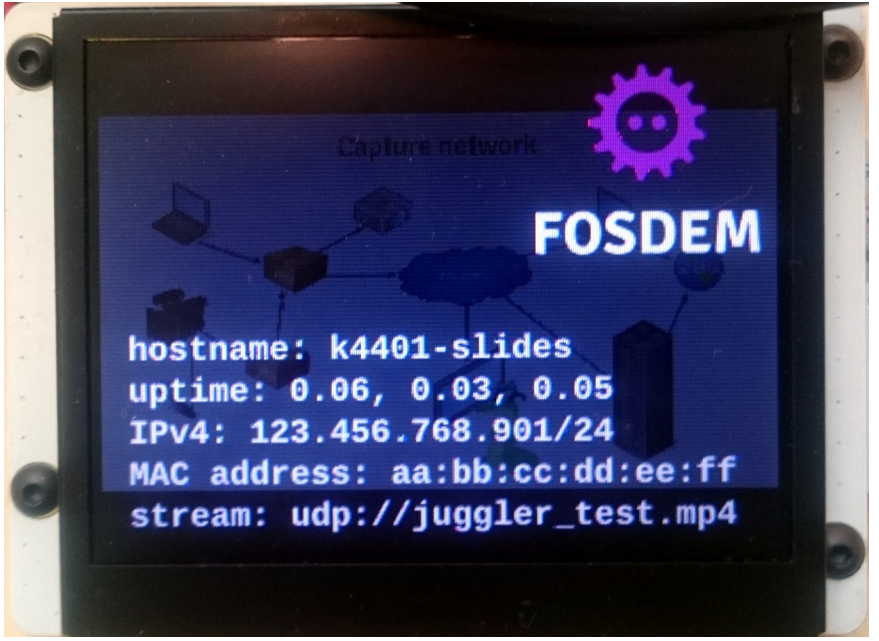
- Always use the native resolution of the projector
- Keep the aspect ratio of the input data
- Scale and band only as needed
- Show branding instead of banding
- Have a useful “No-Input” screen
- Display time left
- Implement a Zombie-attack mode

Advantage #3: Full h.264 bitstream control

- Order I, P, B frames as we see fit
- Manual framerate control
- Have full control of SPS and PPS and other headers
- Free to choose any audio format
- Free to choose any suitable container format

Advantage #4: Status LCD: old vs new





Advantage #5: Audio

The Allwinner A20 has:

- At least 2 channels input
- 2 channels output

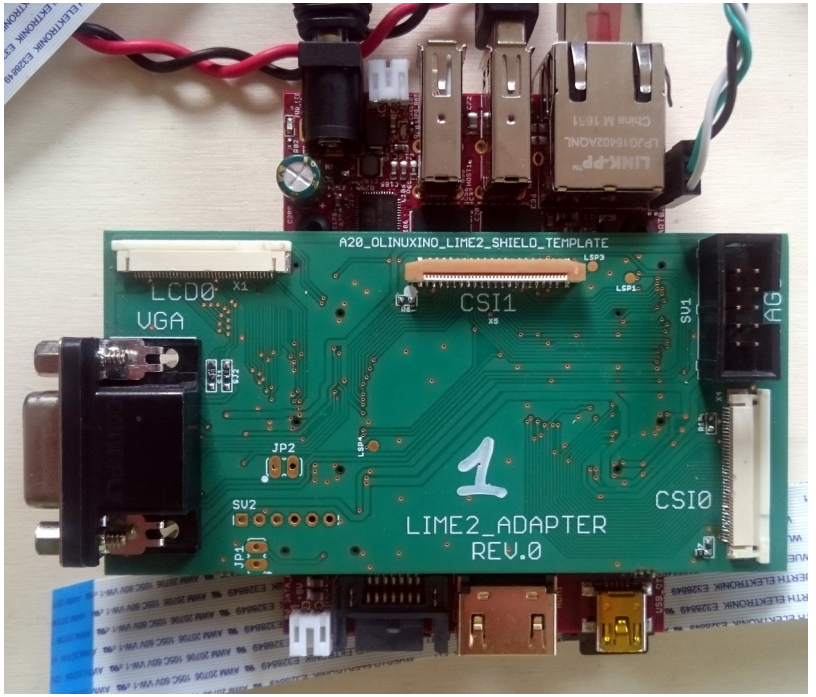
So we could do full remote mixing for room loudspeakers.

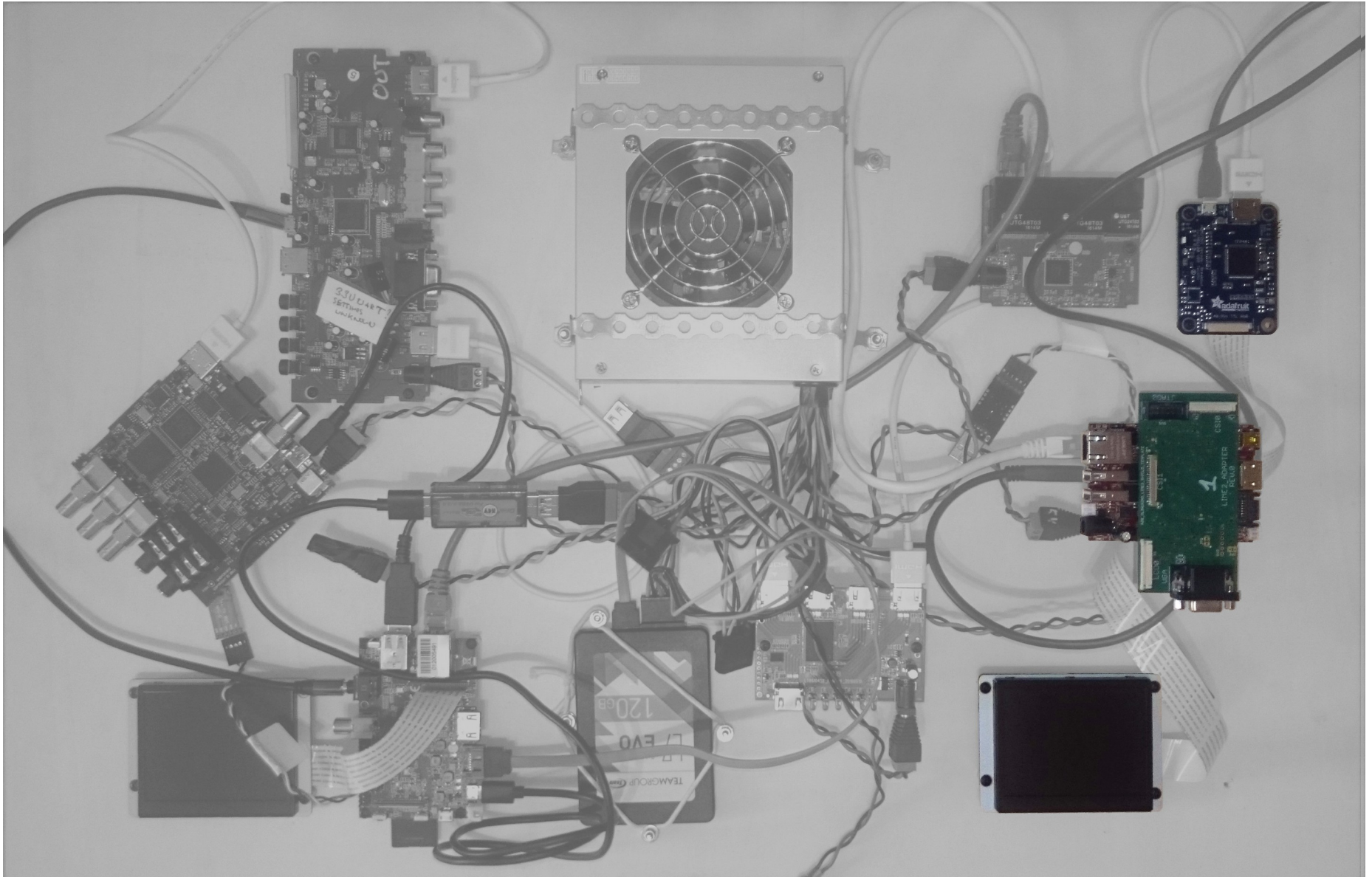
And if we can get latency down, we might get rid of XLR cables...

Test board: testing hw and writing driver support

- Lime2 daughterboard
- Existing adafruit TFP401 module
- Attached to CSI1
- Expose CSI0 for bpi camera module
- LCD connector for bpi compatible modules
- VGA connector (for output)
- And some space left over…

https://github.com/FOSDEM/video-hardware




OUT
3.3V UART
adafruit
LINE2 ADAPTER
REV.B
TEAMGROUP
EVO

Upcoming board design

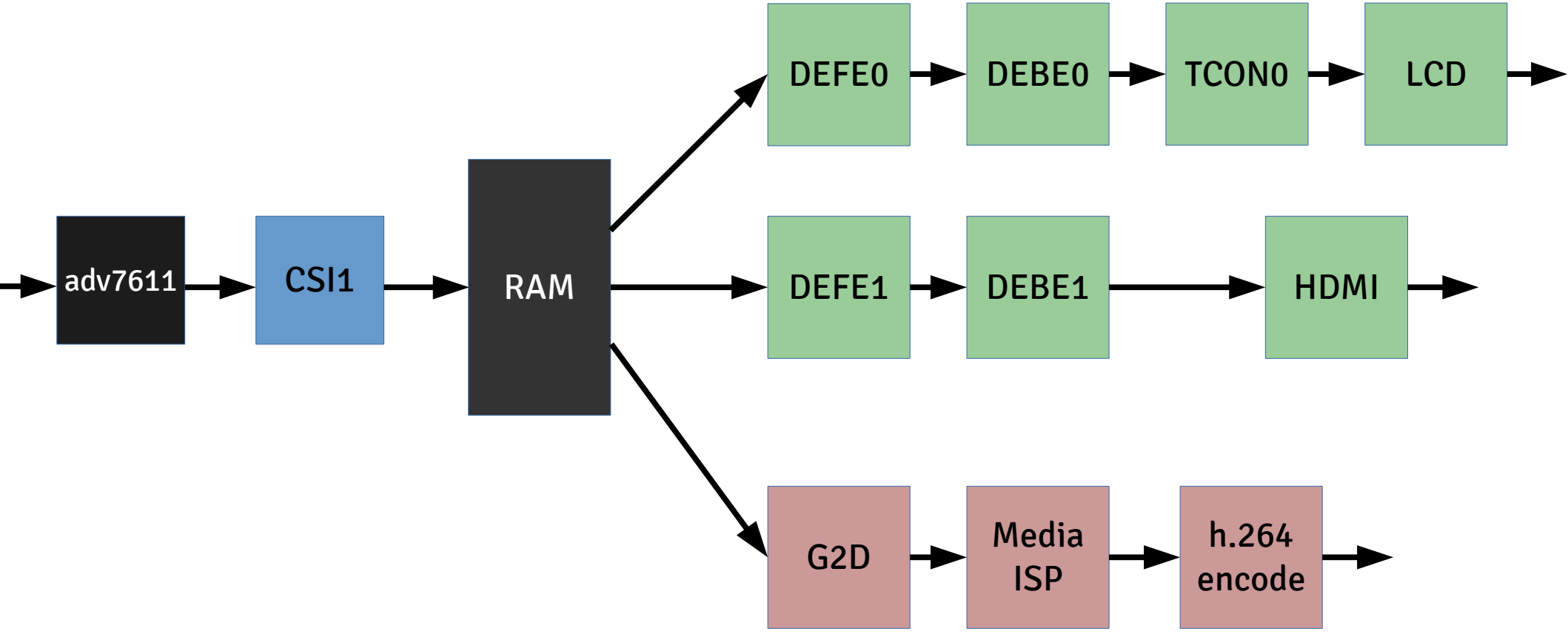
From the Videobrick design:

- HDMI connector (input), with ESD protection
- … tied to an ADV7611…
- … with I2S wired up

Our additions:

- LCD connector
- VGA connector, with ESD protection
- Audio breakout connector

Capture, display and encoding on A20



Work done:

- Test board designed
- 7 kits boards assembled
- LCD connection verified
- Capture Engine (CSI1) implemented
- Verified TFP401 and CSI1 connection (1920x1080@60Hz R8G8B8)
- Fixed up many display driver issues
- Added sprites to display driver
- Written Juggler tool to keep buffers in flight
- Verified H.264 encoder with high bus/memory load

Work ahead...

- Implement HDMI Active signal
- Verify I2S
- Verify both microphone channels
- Verify both headphone channels

Then Uwe can finish his ADV7611 based board design.

And then:

- Add v4l2 infrastructure to H.264 encoder
- Implement R8G8B8 → NV12 conversion

And then... do all the other things….

Future ideas

- Balanced audio for XLR connectors?
- ... and 48V phantom power?
- GigE switch chip attached to the A20 GMAC?
- UART to micro-usb
- All-in-one board?
- Custom case?

Roll out plan

1) 22,23 August 2020: FrOSCon, Sankt-Augustin, Germany

   First deployments in the devrooms: in 1, perhaps 2, or maybe all?

2) November 2020: Openfest, Sofia, Bulgaria

   Full conference, all 6 tracks.

3) 6?,7? February 2021: Undisclosed location

   All 30? main tracks and devrooms?

Then: Every conference or hackerspace near you.

URLs

- Initial design ideas: https://github.com/FOSDEM/video/wiki/hdmi-input-board
- HW Design: https://github.com/FOSDEM/video-hardware
- U-boot: https://github.com/libv/fosdem-video-u-boot
- Kernel: https://github.com/libv/fosdem-video-linux
- User space tool:https://github.com/libv/fosdem-video-juggler

Questions?