

Building a wireless camera from FOSS components

Kieran Kunhya – kierank@obe.tv

Wireless Camera?



Wireless Camera?



€7000 – out of reach for most

Wireless broadcast Camera?



€20000 – out of reach for most

Background Tech

- DVB-T COFDM modulation in both licensed and unlicensed spectrum (1.9-2.7 GHz).
 - Essentially a Vislink wireless transmitter used in news reporting
 - 100m to 1-2km
- Not the same as a “streaming” camera
 - Much lower latency (~100s ms vs ~1-2s)

Well just use WiFi?

- Similar(ish) technology (COFDM)

BUT

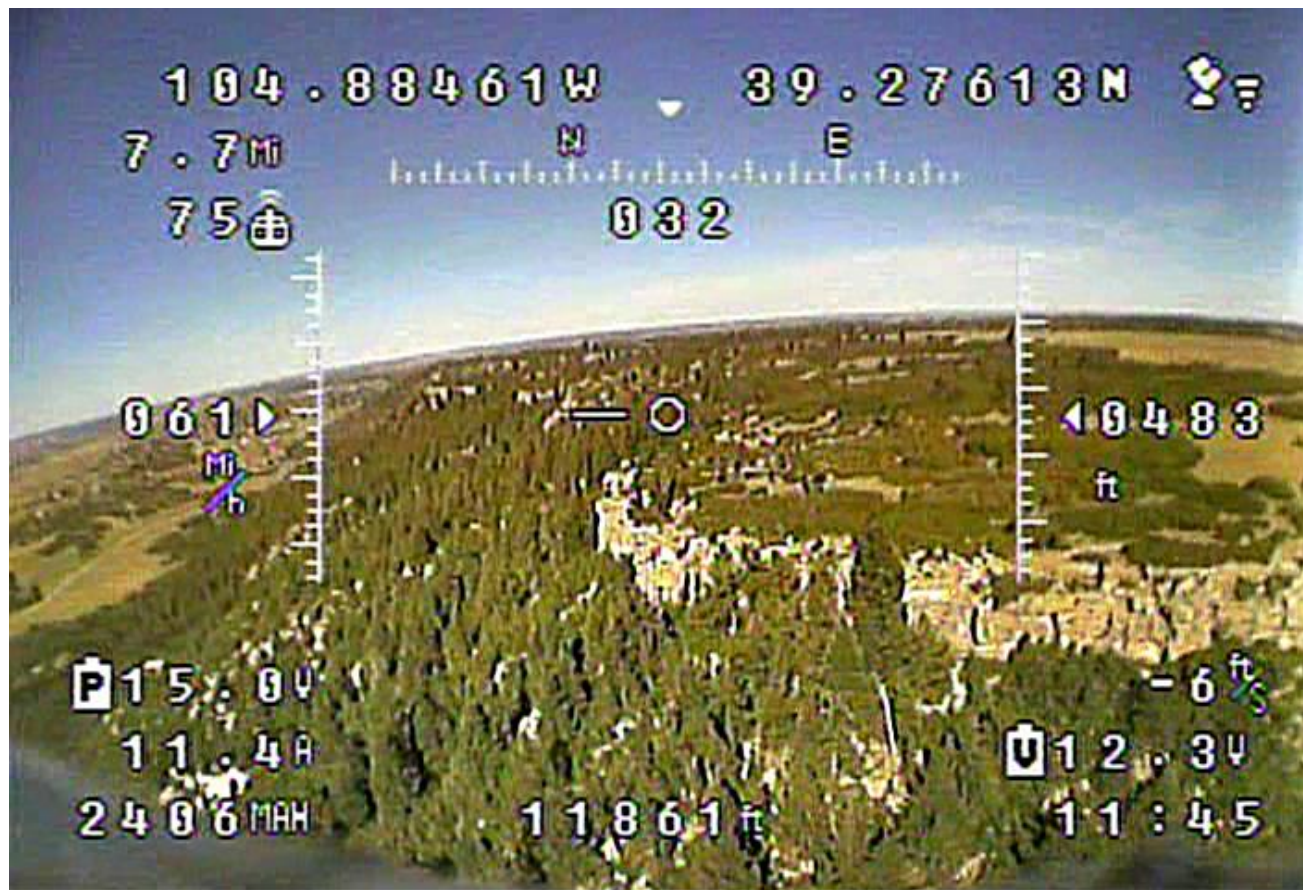
- As soon as device and AP lose association no signal – “digital cliff”
 - Association and de-association repeatedly

Wifibroadcast Project

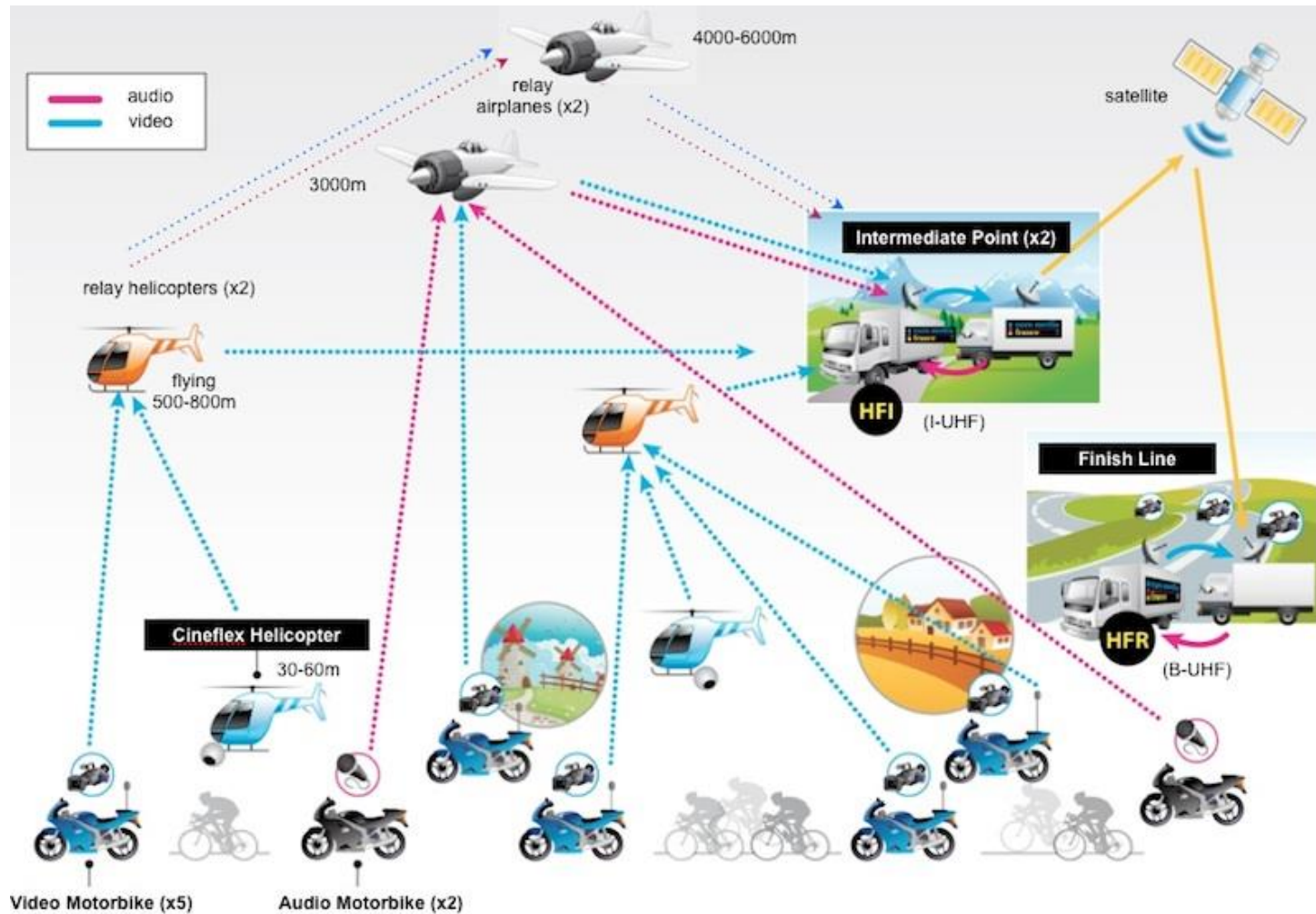
- Makes WiFi more analogue!
 - Transmits irrespective of receiver using packet injection
 - Aided by Atheros Open Source WiFi firmware
 - Accept corrupt (but possibly useful) packets
 - A ton of FEC
- Allows you to have multiple receivers for diversity
- Started by befinitiv for First Person Video (FPV)
 - <https://befinitiv.wordpress.com/wifibroadcast-analog-like-transmission-of-live-video-data/>

First Person Video

- Flying drones remotely



The “pro” world – Le Tour



Buy these wifi dongles very easily!

[view this order](#)



Roll over image to zoom in

Alfa Network AWUS036NHA IEEE 802.11b/g/n wireless USB adapter

by Alfa

★★★★☆ 46 customer reviews | 10 answered questions

Price: £23.86 Prime

In stock.

Want it tomorrow, 29 Jan.? Order it within **18 hrs 2 mins** and choose **Express Delivery** at checkout.

[Details](#)

Sold by **EURO DK** and **Fulfilled by Amazon**. Gift-wrap available.

Note: This item is eligible for **click and collect**. [Details](#)

9 new from £16.69

- Compatible with IEEE 802.11 b/g/n wireless standards.
- 2.4GHz frequency band, MIMO (Multiple Input Multiple Output).
- Complies with Universal Serial Bus Rev. 2.0 specifications.
- High speed transfer TX data rate up to 150 Mbps.
- Supports wireless data encryption with 64/128-bit WEP, WPA, WPA2, TKIP, AES.

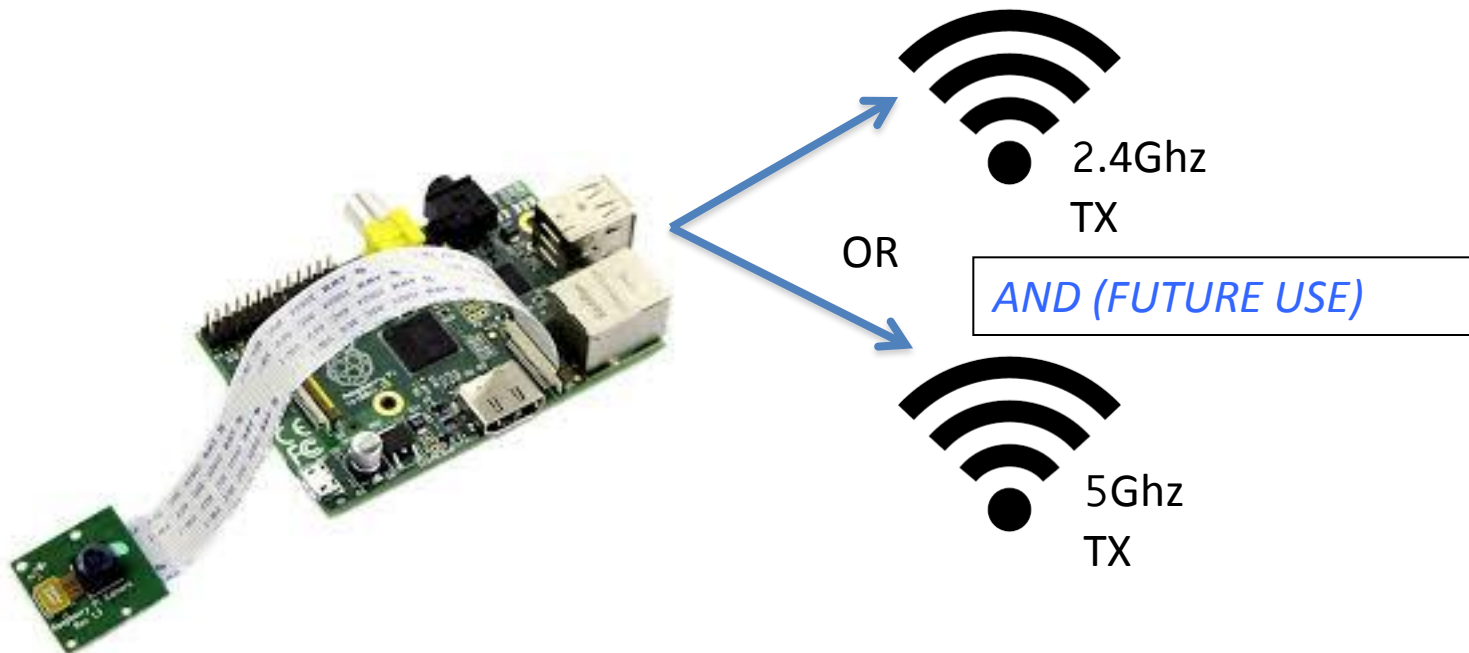
› [See more product details](#)

Things we'd like to have

- General
 - Low-latency
 - High quality
 - Telemetry feed
- “Pro”
 - Some kind of intercom for control room to talk to cameraman
 - Tally
 - Data (CCU control camera)

Raspberry Pi encoding

Picamera (Csi) > RPI(a,b+,2) > wifibroadcast > atheros wifi chipset (usb)



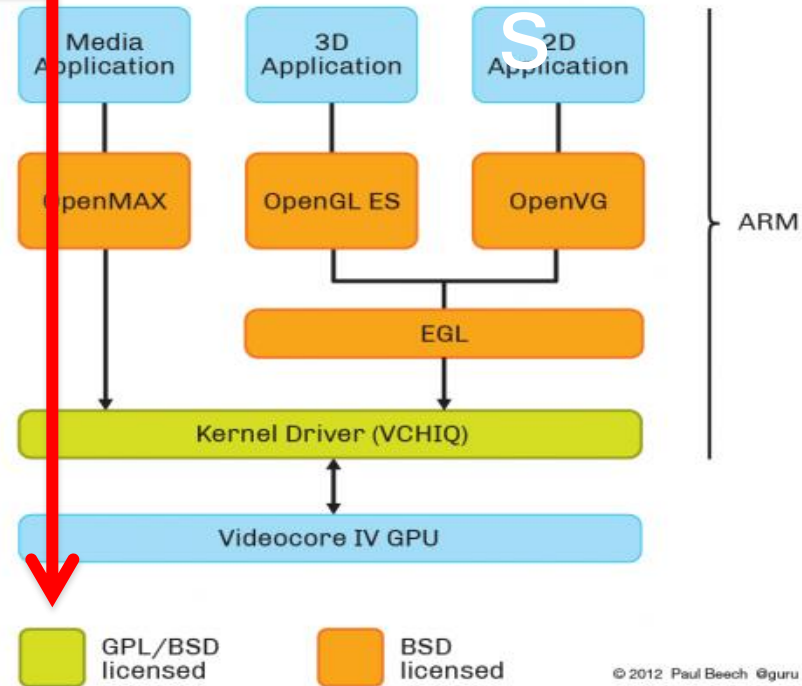
Latency ~100ms (end to end from TX to RX)

Raspberry Pi Software Architecture

Broadcom BCM2835 SoC



picamera



Picamera (1280x720 30fps)

Sensor to GPU **33ms**

Rolling shutter (clear from first line to the last) **20ms**

ISP processing (stab off) **10ms**

Fec encoding + transmission + reception + fec decoding + display **50ms to 100ms**

TOTAL = ~ 110ms to 160ms

Getting pictures from a camera

- Mini-PCIe boards – supported in V4L2



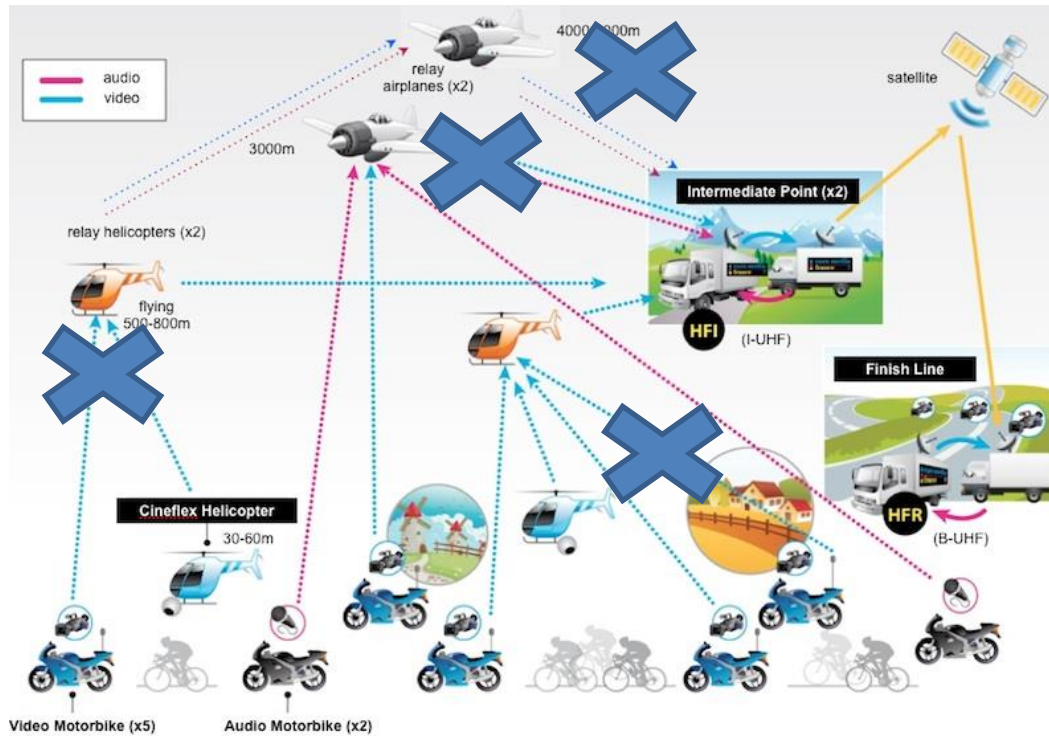
Encoding

- Can use hardware-encoding. Get what you're given basically
- x264 has “intra-refresh” mode – better error resilience
 - Beefy but low-power and portable x86 motherboards
 - Gigabyte Brix, Intel NUC etc

Realistic future

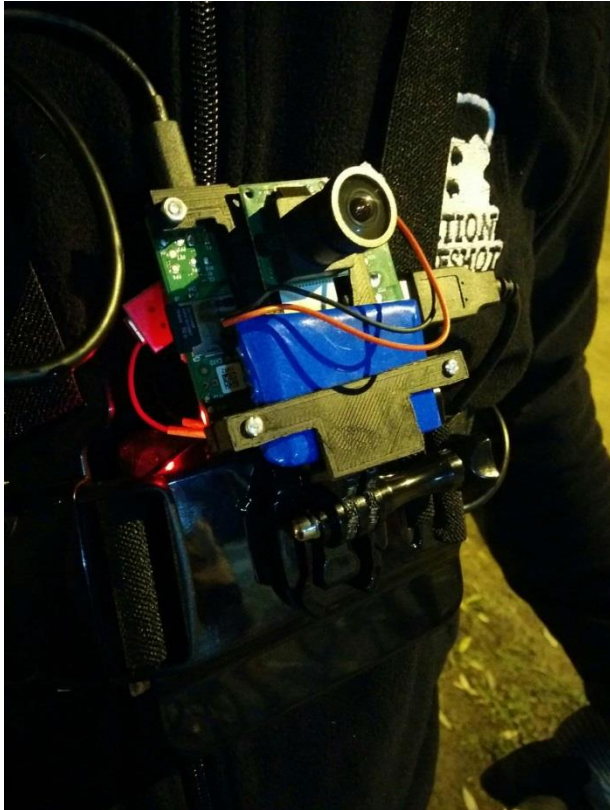
- Wifibroadcast uses a custom protocol
 - Move this all to plain RTP
 - Have diverse receivers connected over ethernet (and perhaps cellular).
 - Receiver (e.g VLC) can detect duplicate and out of order packets
- Multiple channels
- 5GHz (with Dynamic Frequency Selection)
- Less WiFi bandwidth (5mhz or 10mhz)
- 900MHz WiFi for non line of sight applications

Crazy future



Fleet of relay drones carrying RPIs
– (perhaps 4G aided)

Trying it for real!



Trying it for real!



Live demo

- Capturing from SDI camera, encoding with OBE into MPEG-TS, diversity receive and playback with MPlayer.

(Sorry can't do this)