

Complex Cameras (were) complex

Jacopo Mondi

FOSDEM 2019

Hello, I'm Jacopo

- Embedded Linux software engineer
- I mostly work on integrating cameras and multimedia devices

- *jacopo@jmondi.org*
- *irc: jmondi freenode.net*

Rapidly increasing complexity of image capture process is moving from the embedded and mobile space to the more canonical personal computing space (say, laptops and tablets).

Are Linux systems ready for this?

Rapidly increasing complexity of image capture process is moving from the embedded and mobile space to the more canonical personal computing space (say... laptops).

Are Linux systems ready for this?

No they're not

(I wouldn't be giving this presentation otherwise :p)

Digital imaging is a computational expensive process!

- complexity in the acquisition
de-bayering, enhancing, pixel encoding
- complexity in quality tuning
3A, calibrations, general tuning
- -big- buffers
1080p in YUYV format is 4MB of data

Smarter ISPs

Today: Smarter ISPs

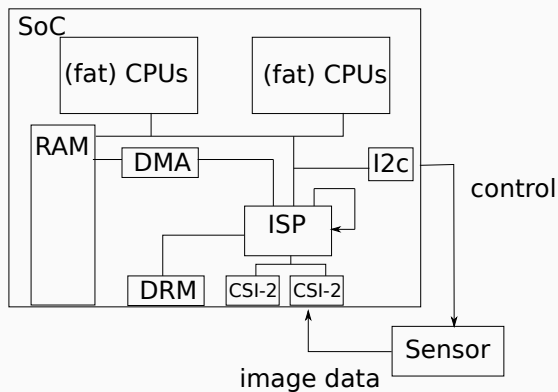
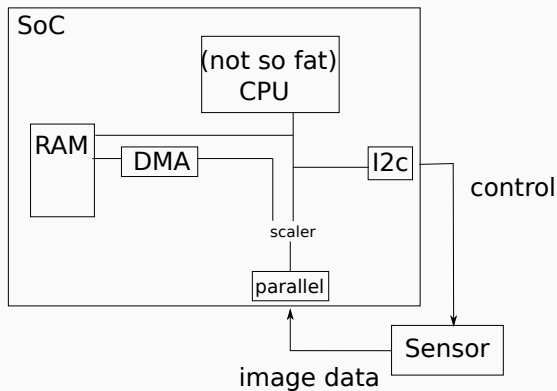


Image Signal Processor

- system peripheral that operates on digital images
- composed by configurable processing blocks
 - DMA and memory interfacing
 - resizing, scaling, cropping, composing
 - format conversion
 - *advanced image processing (3A and reprocessing)*
- very efficient: high speed interconnections, high operating frequency
- the design is *very* platform specific

Smart sensors

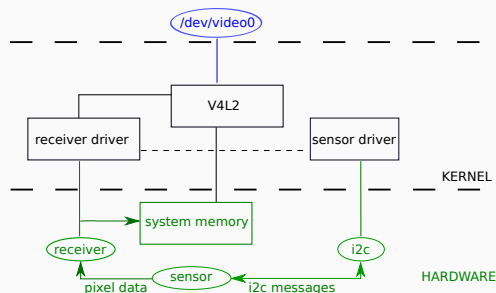
10 years ago: smart sensors



Media Controller

The V4L2 APIs are designed for 'simple' device

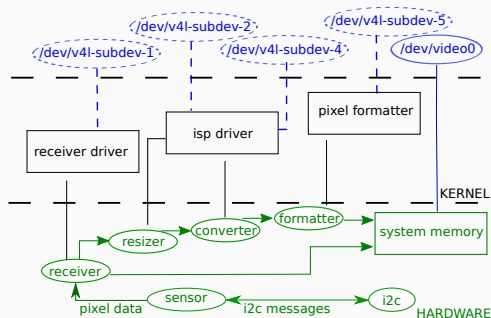
- The *single device node* abstraction



Media Controller

Support for more complex devices, as ISPs

- the media controller exposes ISP processing blocks to userspace



Nice, but....

- the system boots in unusable state
- applications are requested to know a lot of details on the underlying hardware
- triggering capture operations requires precise setup of the whole pipeline

Media Controller - now on laptops!

Nice, but....

- the system boots in unusable state
- applications are requested to know a lot of details on the underlying hardware
- triggering capture operations requires setup of the whole pipeline

This is (sort of) acceptable for embedded systems

Is it for consumer devices?

Media Controller - now on laptops!

Until today, cameras in laptop have usually been USB cameras

- smart sensor: they talk USB!
- fit well in the single device node abstraction
- well supported by *libv4l2*

Media Controller - now on laptops!



Ubuntu linux package

Overview Code **Bugs** Blueprints Translations Answers

Dell 7275 integrated webcam not detected

Bug #1812114 reported by Tom Chiverton on 2019-01-16

This bug affects 1 person



Affects	Status	Importance	Assigned to	Milestone
linux (Ubuntu)	Confirmed	Undecided	Unassigned	

Also affects project Also affects distribution/package Nominate for series

Bug Description

Duel booting with Windows shows the hardware works out-of-the-box there. Windows device manager calls it 'Intel AVSteam Camera 2500' on 'Intel HD Graphics 515'.

It claims the attach path is video\ven_8086\subsys\06D61028

Upgrading to the 18.04 HWE kernel hasn't changed things.

syslog, lspci and lsusb attached.

"Re: Webcams not recognized on a Dell Latitude 5285 laptop"

<https://www.spinics.net/lists/linux-media/msg131388.html>

This laptop embeds one of these new "complex" cameras from Intel. They requires IPU3 driver. Though, unlike traditional webcam, you need special userspace to use it (there is no embedded firmware to manage focus, whitebalance, etc, userspace code need to read the stats and manage that). As of now, there is no good plan on how to support this in userspace.

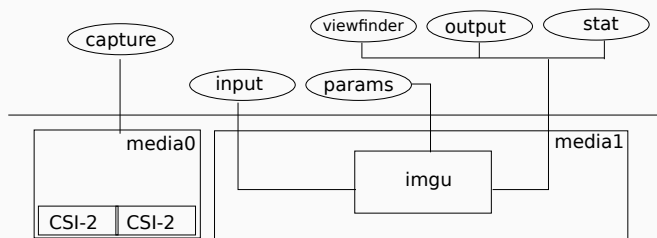
N. Dufresne, April 1st 2018

Intel IPU3

- Intel is now shipping processors with powerful ISPs
- (some) KabyLake and (some) SkyLake platforms have IPU3 ISP
- patches on linux-media and now in staging to mainline: yey!

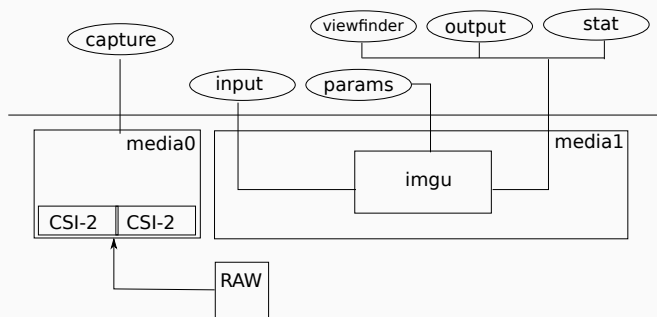
Media Controller - now on laptops!

(simplified) IPU3 media graph



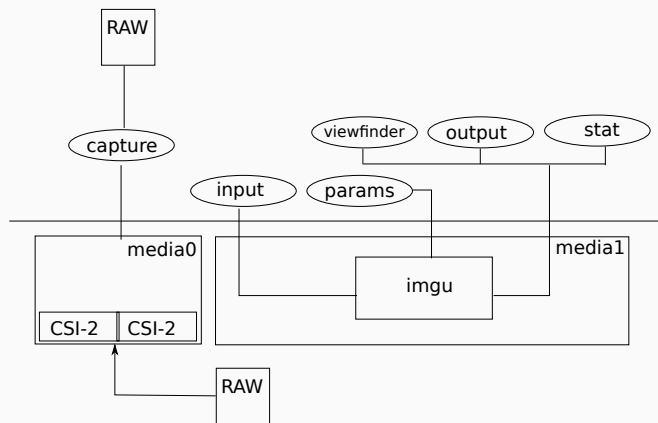
Media Controller - now on laptops!

(simplified) IPU3 media graph



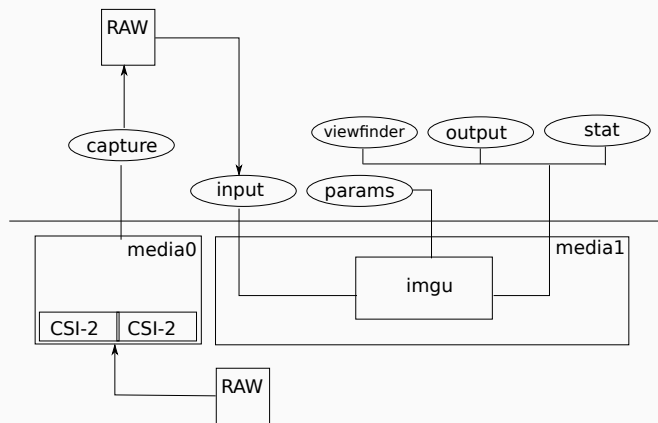
Media Controller - now on laptops!

(simplified) IPU3 media graph



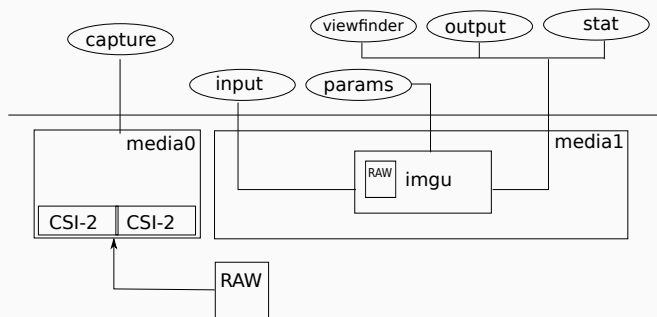
Media Controller - now on laptops!

(simplified) IPU3 media graph



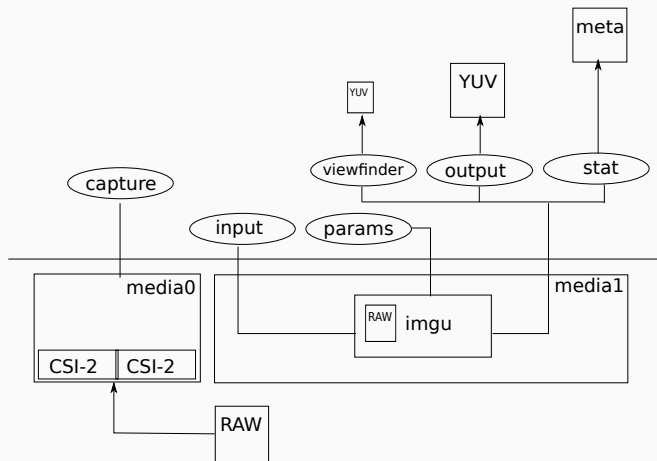
Media Controller - now on laptops!

(simplified) IPU3 media graph



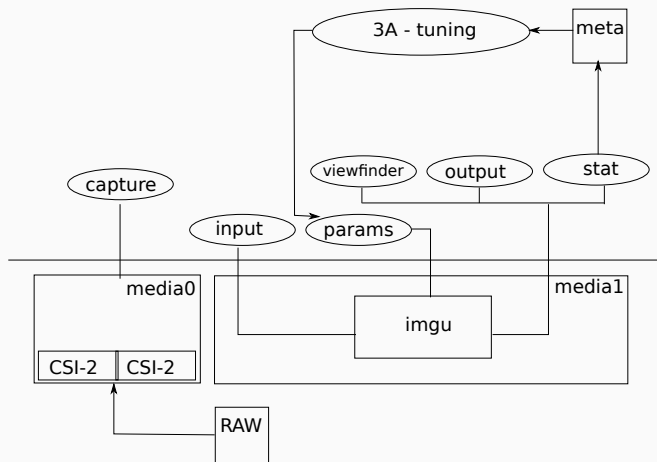
Media Controller - now on laptops!

(simplified) IPU3 media graph



Media Controller - now on laptops!

(simplified) IPU3 media graph

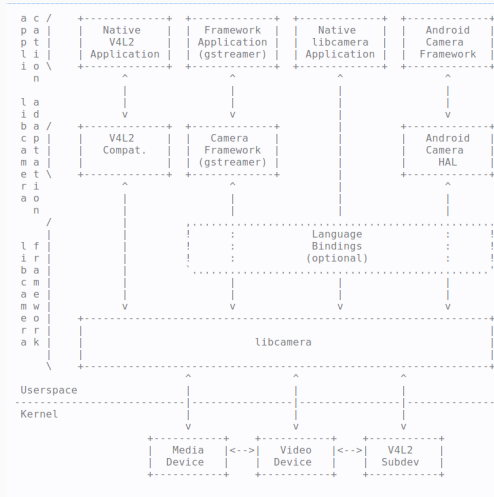


- *Meeting notes on the Tokyo complex cameras workshop*
<https://linuxtv.org/news.php?entry=2018-07-13.mchehab>
- *Complex Cameras on Linux*
Mauro Carvalho Chehab, Samsung

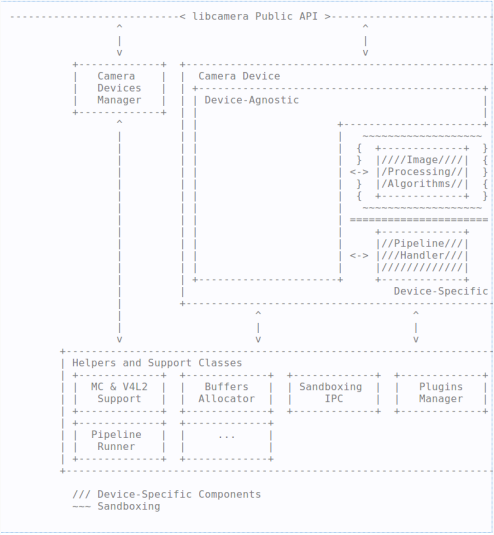
Libcamera is a complete user space camera stack

- *Abstract away from application all interfacing with V4L2 and Media-Controller*
- *Aims to be compatible with Linux V4L2-based applications, Android and ChromeOs*
- *Why Embedded Cameras are Difficult, and How to Make Them Easy*
Laurent Pinchart, Ideas on Board

Libcamera!



Libcamera!



Libcamera: how do we do that

- [git://linuxtv.org/libcamera.git](https://linuxtv.org/libcamera.git)
- mail based development: mailing list + patchwork
- we use Meson and Ninja, and they're great
- we enforce a coding style: OCD vs C++
- we love picky reviews!
- we (try to) be serious at documentation and testing

Libcamera: where are we

- we support UVC and Intel IPU3
- we can list (hot-pluggable) cameras
- we can capture frames !

Libcamera: where do we want to go

- support more ISPs (-all- ISPs :)
- support Android HALv3 with per-frame control
- have third-party contributions from vendors

Please join!

- read the doc: <http://libcamera.org/docs.htm>
- read patches: <git://linuxtv.org/libcamera.git>
- have a chat: #libcamera on freenode
- we welcome inputs from anyone working with cameras!

Thanks!

Questions?