Convergent camera applications for mobile Linux devices

FOSDEM 2023

Kieran Bingham
~~Jacopo Mondi~~
~~jacopo.mondi@ideasonboard.com~~

IDEAS ON BOARD

Hello, I’m ~~Jacopo~~ Kieran

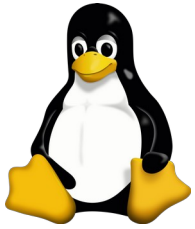
- Embedded camera engineer @ IdeasOnBoard Oy

  - *Video4Linux2*
  - *libcamera*

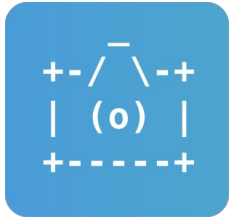
  - *#libcamera on OFTC.net*
    - *https://webchat.oftc.net/?channels=libcamera*
    - *https://matrix.to/#/#_oftc_#libcamera:matrix.org*

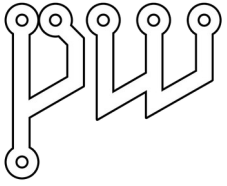
Hello!

A camera stack for Linux systems



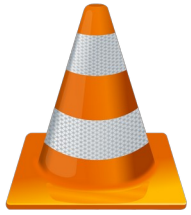
- Mainline Linux camera drivers
- libcamera
- Pipewire and xdg-portal





A camera stack for Linux systems

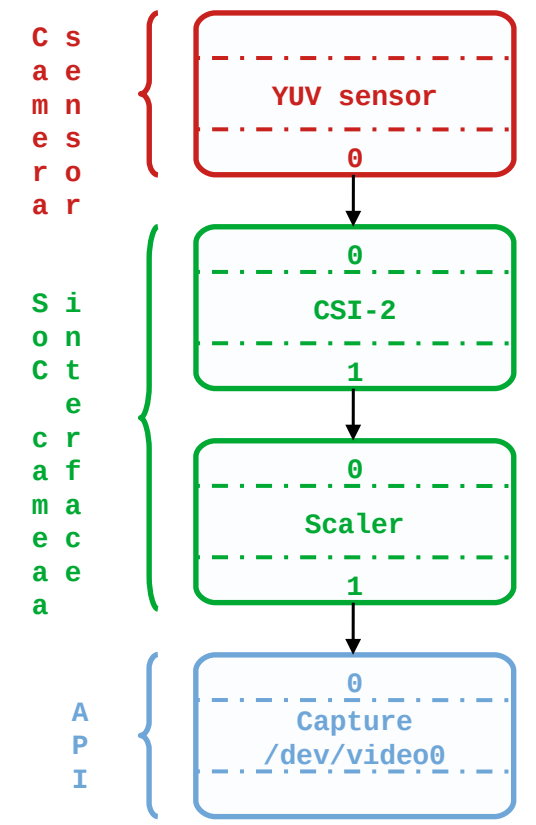
- Run the same software stack on mobile and desktop Linux
- Integrate with standard multimedia tool-kits



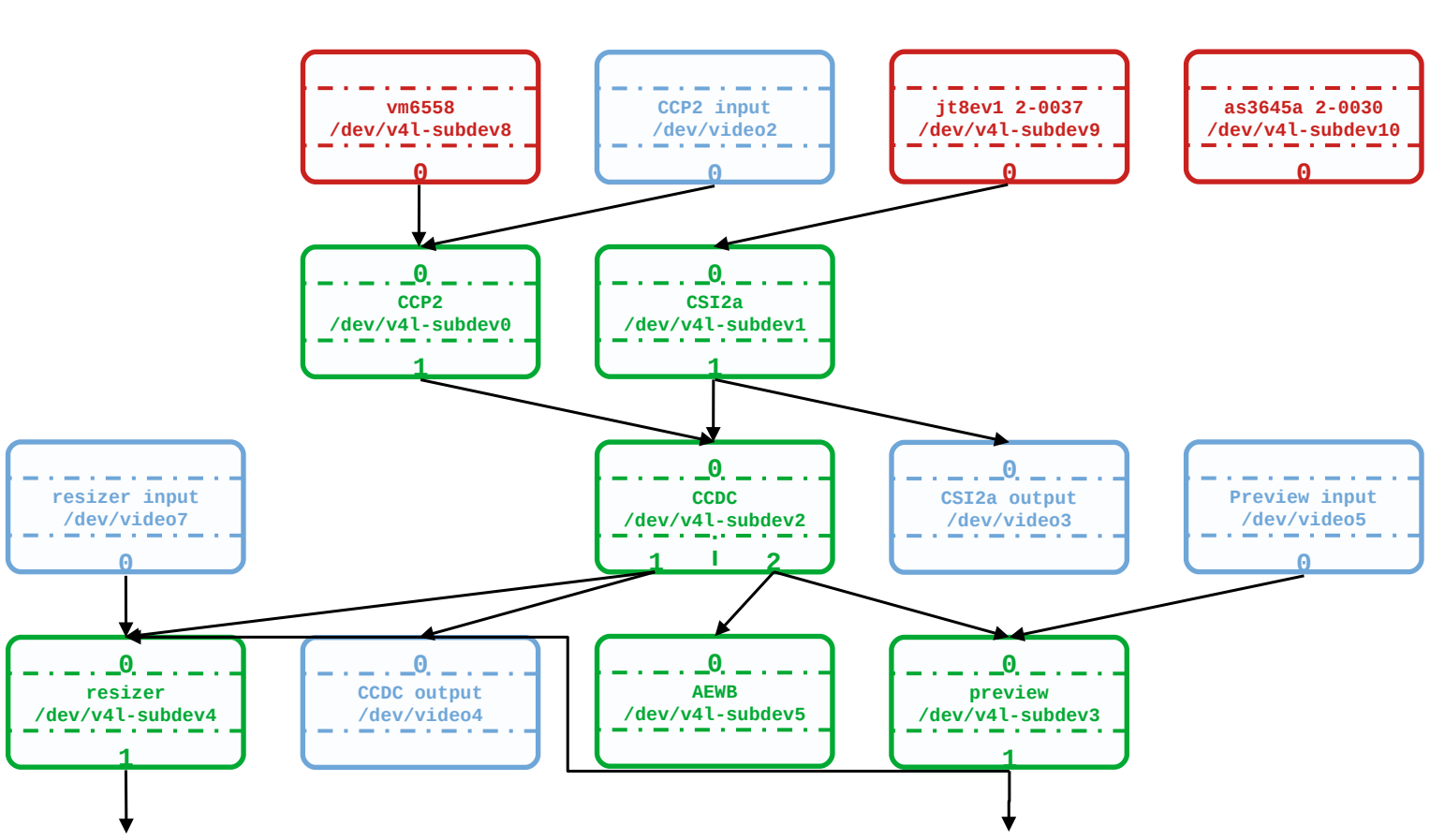
The Linux camera stack

The PinePhone Pro

- Test ground for the mobile Linux ecosystem
- Rockchip RK3399
  - *complex camera* with ISP and RAW sensors
  - Supported by libcamera

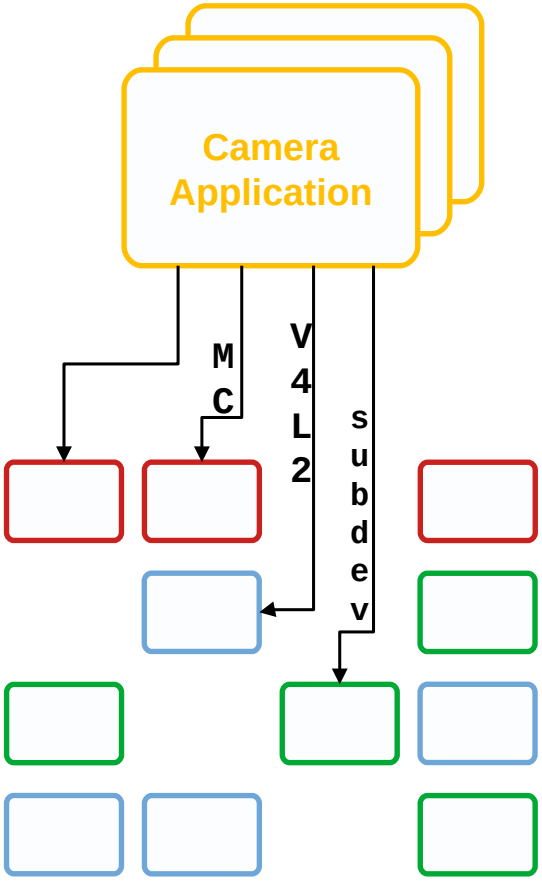


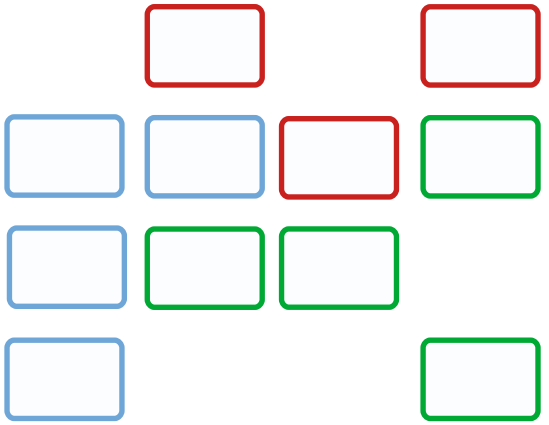
Simple camera

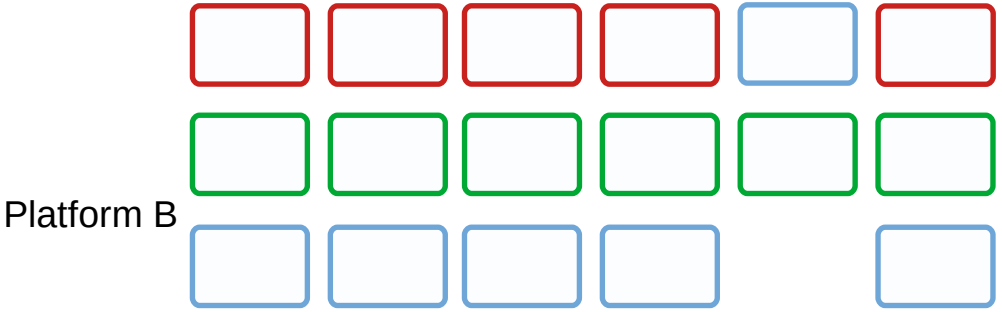


OMAP3 Camera in Nokia N900 **- 2009**

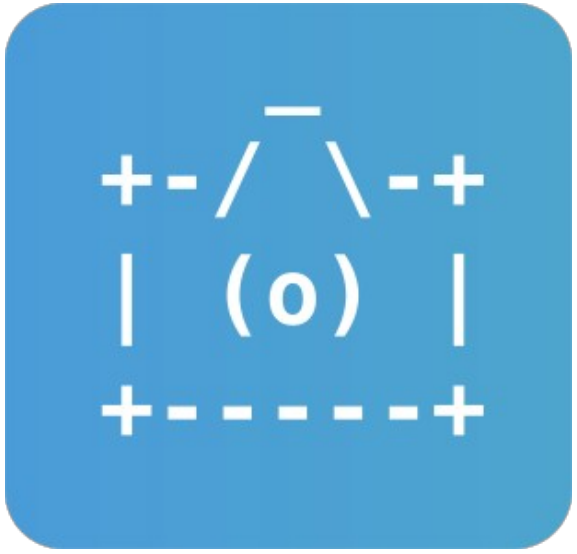
Cameras got complex (a long time ago..)

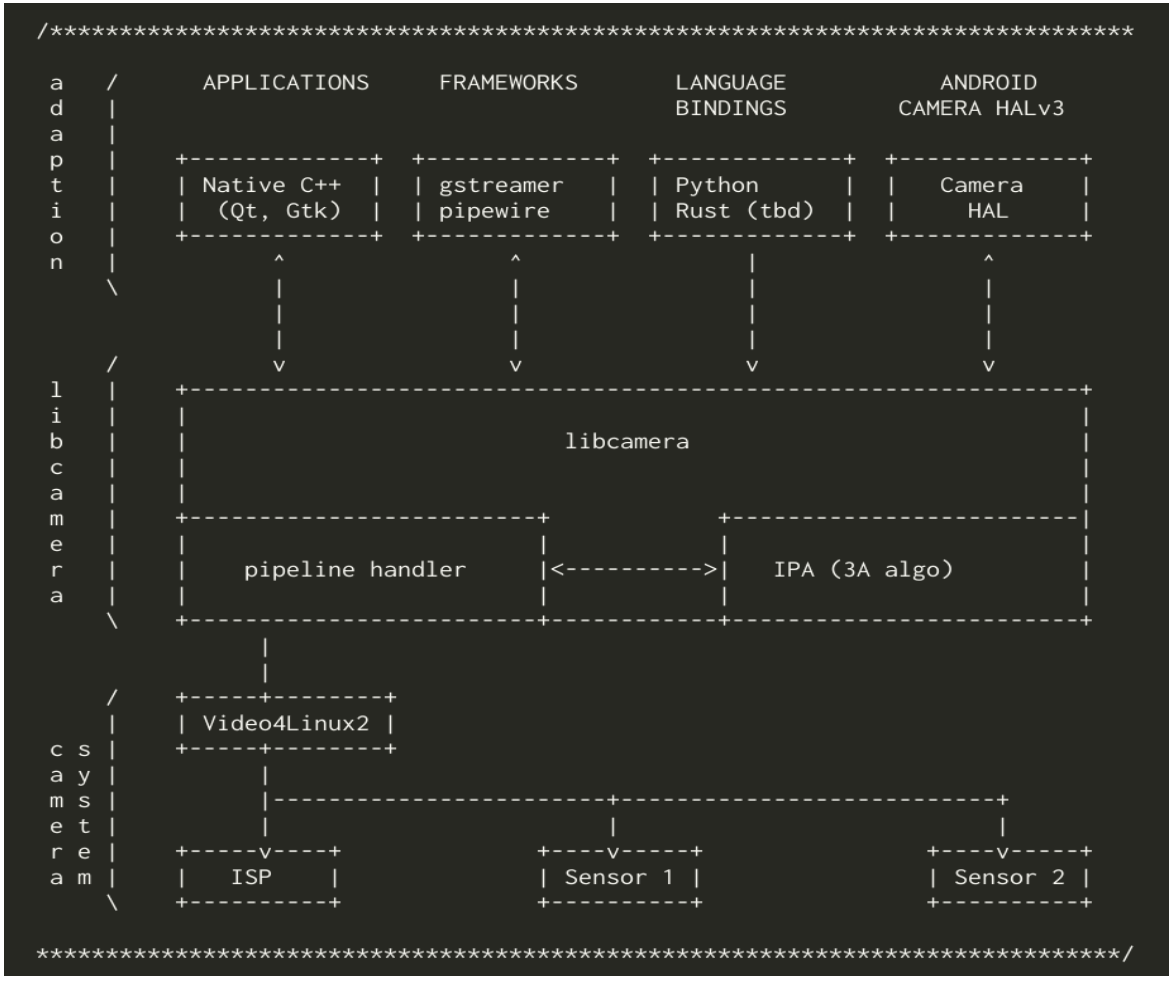






… and applications had to be platform-specific





libcamera fills that gap

Supported by libcamera since 2020

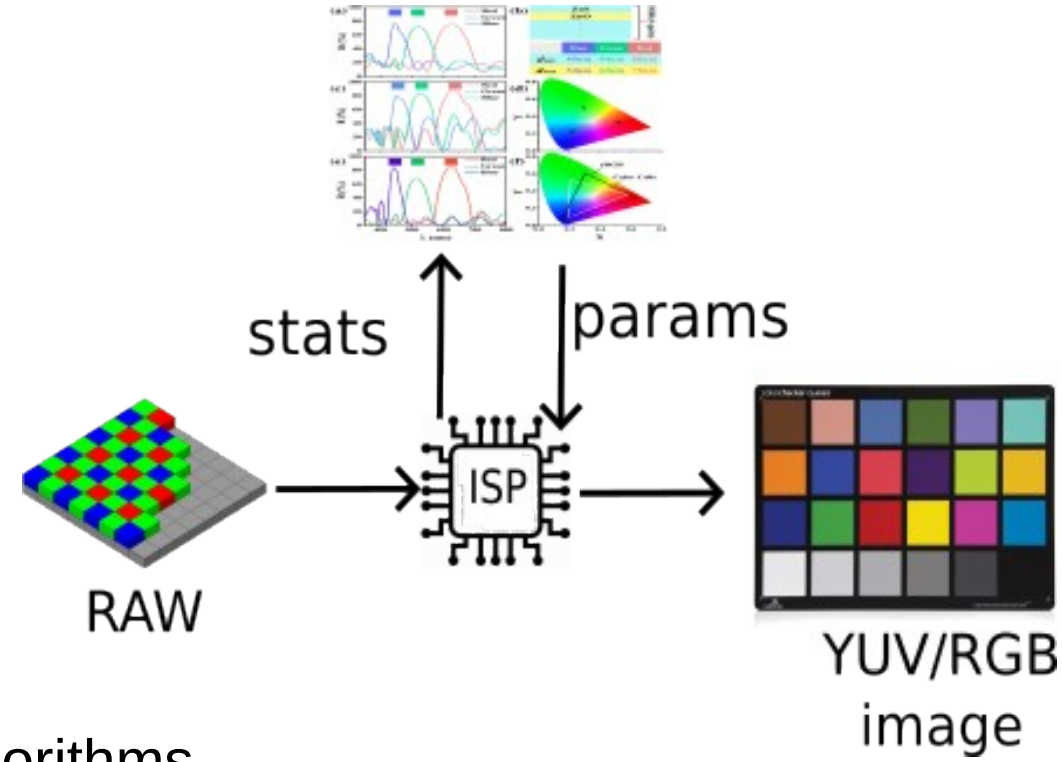
RockPi4

Acer Chrombook Tab 10

(*) The same, unmodified, software stack supports NXP i.MX8MP ISP

An ISP:

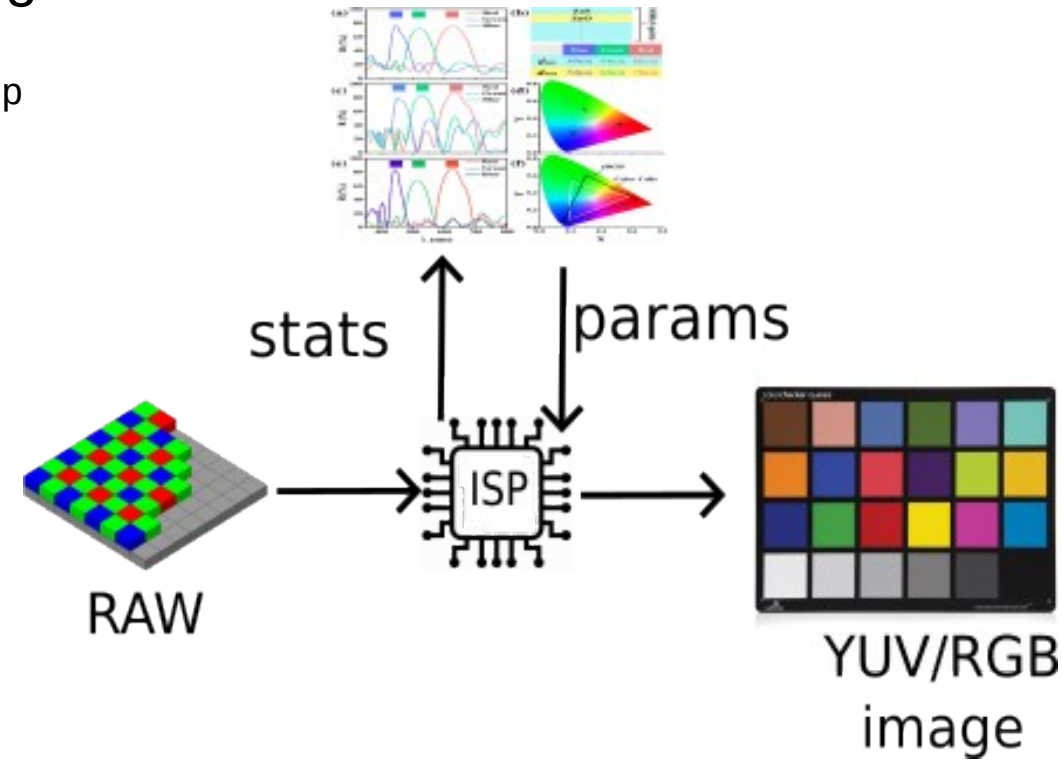
- Fed with raw Bayer frames
- Produces statistics
- Transforms images
  - De-bayering
  - Color gains balancing
  - …



Needs platform specific “3A” algorithms

Libcamera implements the 3A algorithms

```
$ ls -1 src/ipa/rkisp1/algorithms/*.cpp

src/ipa/rkisp1/algorithms/agc.cpp
src/ipa/rkisp1/algorithms/awb.cpp
src/ipa/rkisp1/algorithms/blc.cpp
src/ipa/rkisp1/algorithms/cproc.cpp
src/ipa/rkisp1/algorithms/dpcc.cpp
src/ipa/rkisp1/algorithms/dpf.cpp
src/ipa/rkisp1/algorithms/filter.cpp
src/ipa/rkisp1/algorithms/gsl.cpp
src/ipa/rkisp1/algorithms/lsc.cpp
```



Linux kernel

- Staging driver since v5.6
- De-staged in v5.11

- Still actively developed

```
[GIT PULL FOR v5.10] rkisp1 fixes/enhancements + one cedrus fix
[GIT PULL FOR v5.20] rkisp1 misc fixes and improvements
[GIT PULL FOR v6.1]  rkisp1 fixes and improvements
```

- Front camera: *OmniVision* OV*8858*
  - No driver in mainline Linux
  - No support in libcamera

- Back camera: *Sony IMX258*
  - Driver available in mainline Linux
  - Supported in libcamera but not “tuned”

PinephonePro: sensor drivers

Nicholas Roth started looking into the ov8858 to support camera in Waydroid (*)

Commit Message

Nicholas Roth

```
Currently, libcamera does not have information for the ov8858 sensor
used in the PinePhone Pro, a phone designed to run Linux.

This commit adds metadata, especially that sensor gain is reported and
set in 1/16 discrete increments.

For more information, see "5.8 manual exposure compensation/ manual
gain compensation" in [0] and the driver in [1].

[0] http://www.ahdsensor.com/uploadfile/202008/55322e75316871.pdf
[1] https://github.com/megous/linux/blob/orange-pi-5.19/drivers/media/i2c/ov8858.c

Signed-off-by: Nicholas Roth <nicholas@rothemail.net>
---
 src/ipa/libipa/camera_sensor_helper.cpp    | 11 ++++++++++
 src/libcamera/camera_sensor_properties.cpp | 14 ++++++++++++++
 2 files changed, 25 insertions(+)
```

** we'll get back to this later*

Sensor drivers: ov8858

But it was clear from the very beginning why libcamera mandates drivers to be mainlined

```
>
> +class CameraSensorHelperOv8858 : public CameraSensorHelper
> +{
> +public:
> +       CameraSensorHelperOv8858()
> +       {
> +               gainType_ = AnalogueGainLinear;
> +               gainConstants_.linear = { 1, 0, 0, 16 };
> +       }
> +};
> +REGISTER_CAMERA_SENSOR_HELPER("m00_f_ov8858", CameraSensorHelperOv8858)

"My OV8858 is the second on the rear." Suddenly this doesn't work.
- So we can only use "ov8858" here.
```

So we went and upstreamed the driver (which will land in v6.3)

[v5,2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-16	Jacopo Mondi
[v5,1/2] dt-bindings: media: Add OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-16	Jacopo Mondi
[v4,2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-11	Jacopo Mondi
[v4,1/2] dt-bindings: media: Add OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-11	Jacopo Mondi
[v3,2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-09	Jacopo Mondi
[v3,1/2] dt-bindings: media: Add OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-09	Jacopo Mondi
[v2,2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-06	Jacopo Mondi
[v2,1/2] dt-bindings: media: Add OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-06	Jacopo Mondi
[2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-05	Jacopo Mondi
[1/2] dt-bindings: media: Add schema for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-05	Jacopo Mondi
[v2] media: i2c: ov8858 Add driver for ov8858	[v2] media: i2c: ov8858 Add driver for ov8858	2022-11-06	Nicholas Roth
media: i2c: ov8858 Add driver for ov8858	media: i2c: ov8858 Add driver for ov8858	2022-10-30	Nicholas Roth

And merged the ov8858 support in libcamera (in release v0.0.4)

Jacopo Mondi

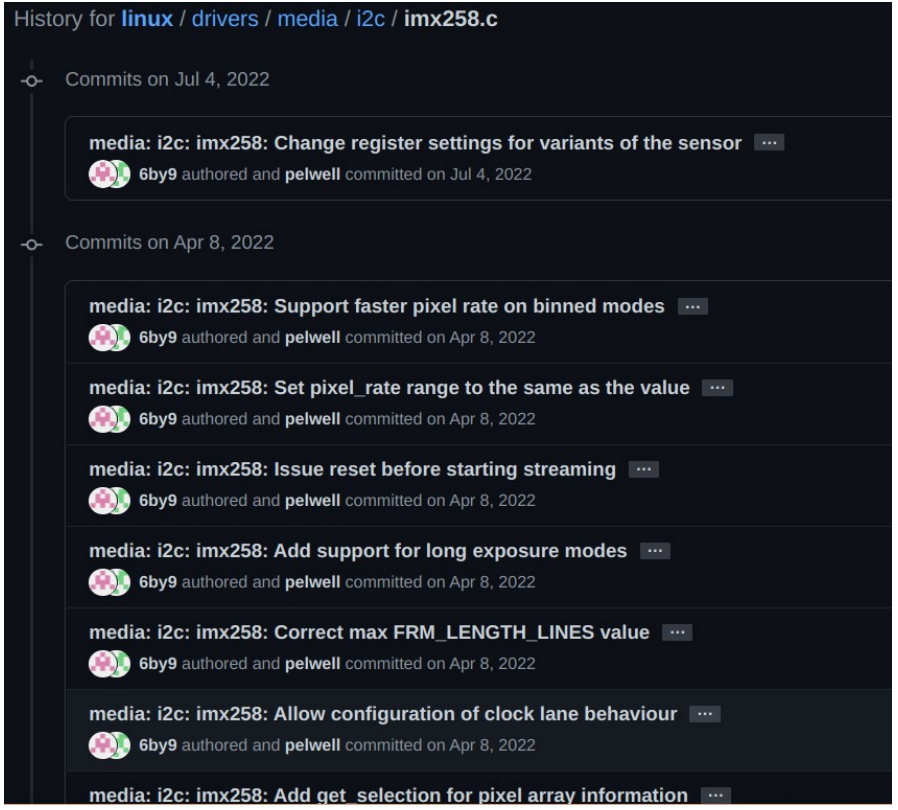
```
From: Nicholas Roth <nicholas@rothemail.net>

Support for the OmniVision OV8858 sensor is scheduled for inclusion in
the Linux kernel in version v6.3.

Add support for the sensor in libcamera by providing static properties
and a camera sensor helper in libipa.

The camera sensor helper expresses analogue gain increments in 1/128
step which differs from what is reported in the sensor documentation in
section "5.8 manual exposure compensation/ manual gain compensation" [0]

A more detailed analysis of the sensor gain model is reported at:
https://patchwork.linuxtv.org/project/linux-media/patch/20221106171129.166892-2-nicholas@rothemail.net/#142267

Record with a \todo note a reference to discussion on the gain model
implementation.

Signed-off-by: Nicholas Roth <nicholas@rothemail.net>
Signed-off-by: Jacopo Mondi <jacopo.mondi@ideasonboard.com>
---

Compared to initial Nicholas' submission:
- Change gain step to 128 (link to the driver discussion)
- Add fadeToGray test patter and adjust comment
```

While a driver exists in mainline, it needs some love

- A long list of patches to be potentially upstreamed from the RaspberryPi kernel

- Shielded pixel correction for the PDAF-capable version of the sensor

- Potential to re-use the sensor tuning file for LSC, black level correction etc developed for RaspberryPi



Sensor drivers: imx258

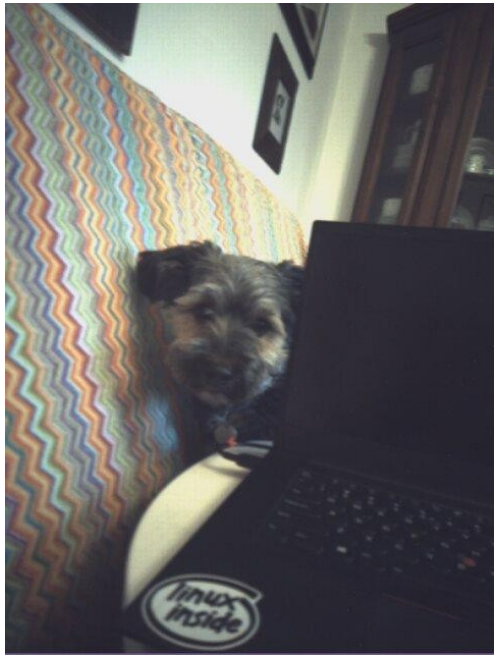
- Improve the ov8858 and imx258 drivers
  - A lot of patches to be up-ported
  - *Good opportunity to contribute upstream*

- Tuning of camera sensor and algorithms
  - Libcamera has a tuning tool named *CTT*
    - Developed by *RaspberryPi* for their ISP
    - Support for other platforms is in progress

- The pinephone community could *really* help here
  - In example, what megi is doing with its *ppp-cam* tuning app seems promising!
  - Get in touch with us !

What’s next ?

```
$ cam -c1 --stream pixelformat=YUYV,width=1920,height=1080 -C
8741.097455 (30.03 fps) cam0-stream0 seq: 000001 bytesused: 4147200
```



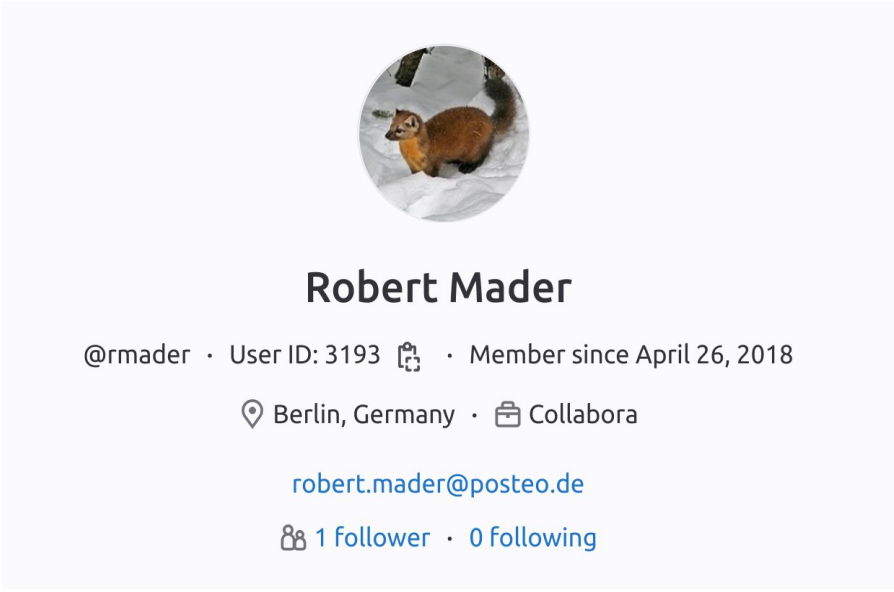
Cute dog from the back and front camera of the Pinephone Pro

Definitely need LSC correction for the imx258 and better gain handling for the ov8858

My job’s done here!

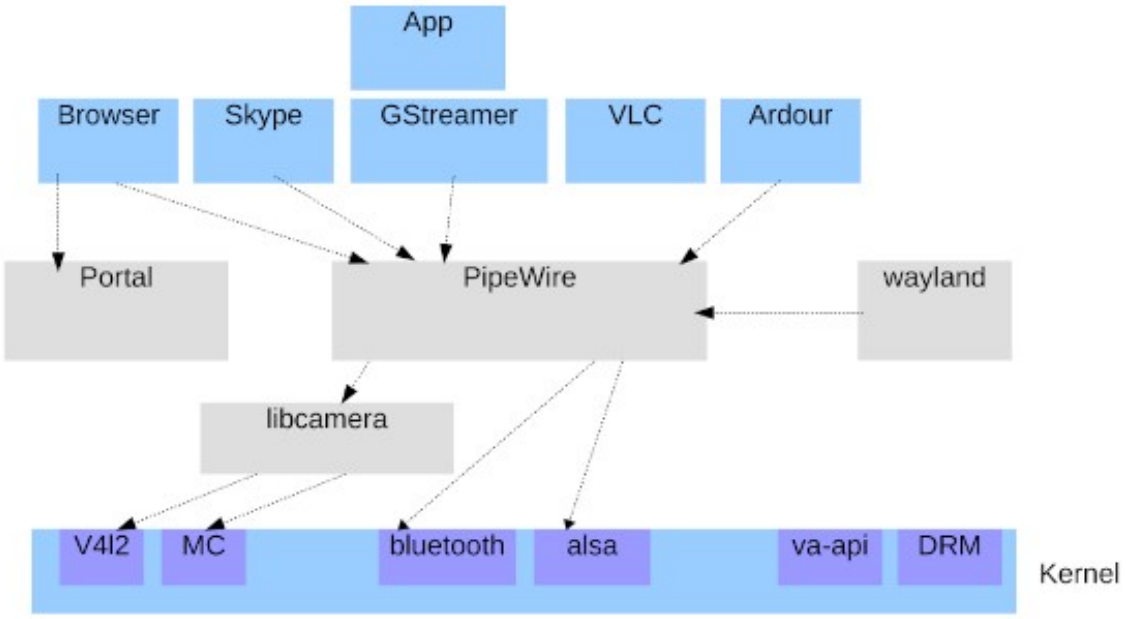
Robert got in touch with the libcamera community to support the Pinephone Pro and use it as a testing ground for the Linux media stack

- *pipewire*
- *gstreamer*
- *xdg-portal*
- *gnome-camera*



… or maybe not ?

The multimedia stack



Robert’s contributions to the stack

James Westman > Camera

Camera

Project ID: 10544

Star 11

53 Commits 8 Branches 0 Tags 71.4 MB Project Storage

Take photos and videos on your computer or smartphone

README.md

Camera

Take pictures and videos on your computer, tablet, or phone

About

This is a simple camera app designed for Phosh or GNOME. It is designed to work well on mobile Linux devices (such as the PinePhone or Librem 5) but it will run on any Linux computer with a connected camera.

IDEAS ON BOARD

gnome-camera: a convergent camera app

Demo video here

Viewable at:
https://twitter.com/libcamera/status/1621558431738986496?s=20&t=a92bB_XkDlEGAgFkPFztjw

- Integration with xdg-portal enables flatpack support
- Application sandboxing with security checks in place

```
# Add the gnome-nightly repo
flatpak remote-add --user --if-not-exists gnome-nightly https://nightly.gnome.org/gnome-nightly.flatpakrepo

# Install the demo build
flatpak install --user camera-devel-aarch64.flatpak
# or
flatpak install --user camera-devel-x86.flatpak
```

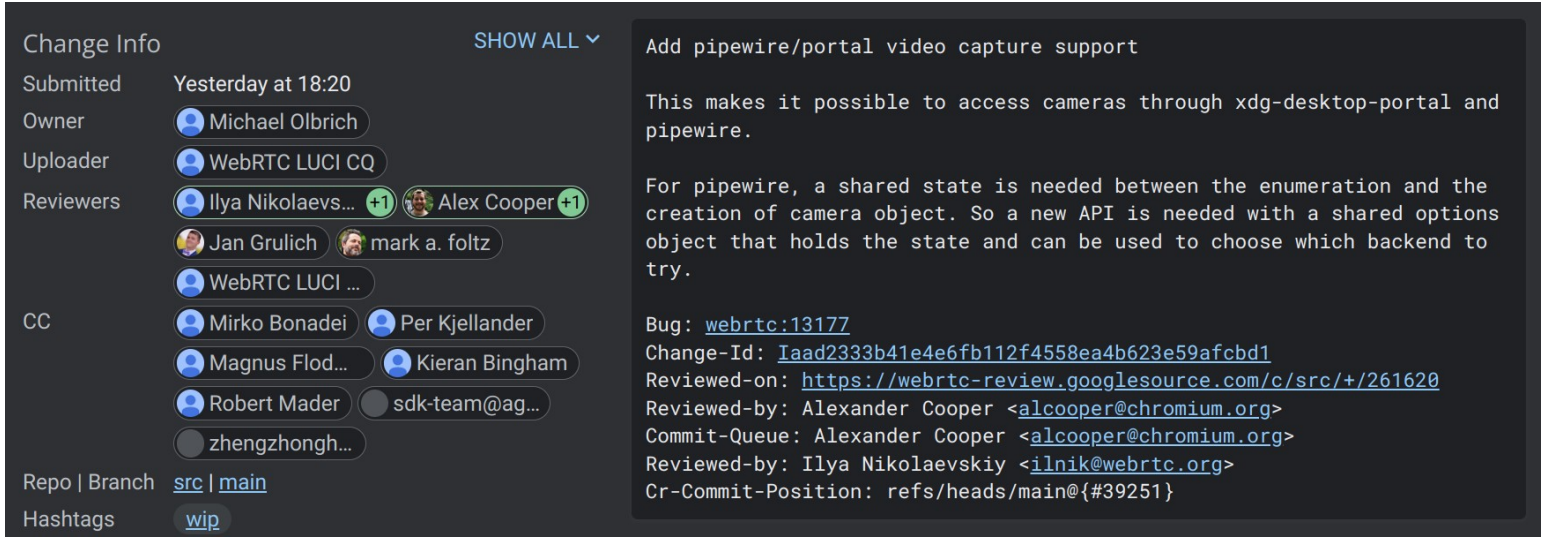
Flatpack support

Gerrit CHANGES YOUR DOCUMENTATION BROWSE

Merged ☆ 261620 Add pipewire/portal video capture support

Support for *video capture through xdg-desktop-portal merged in webRTC* no longer than 2 days ago (02-02-2023)

In a few months (?) you'll be able to access cameras from your browsers !!



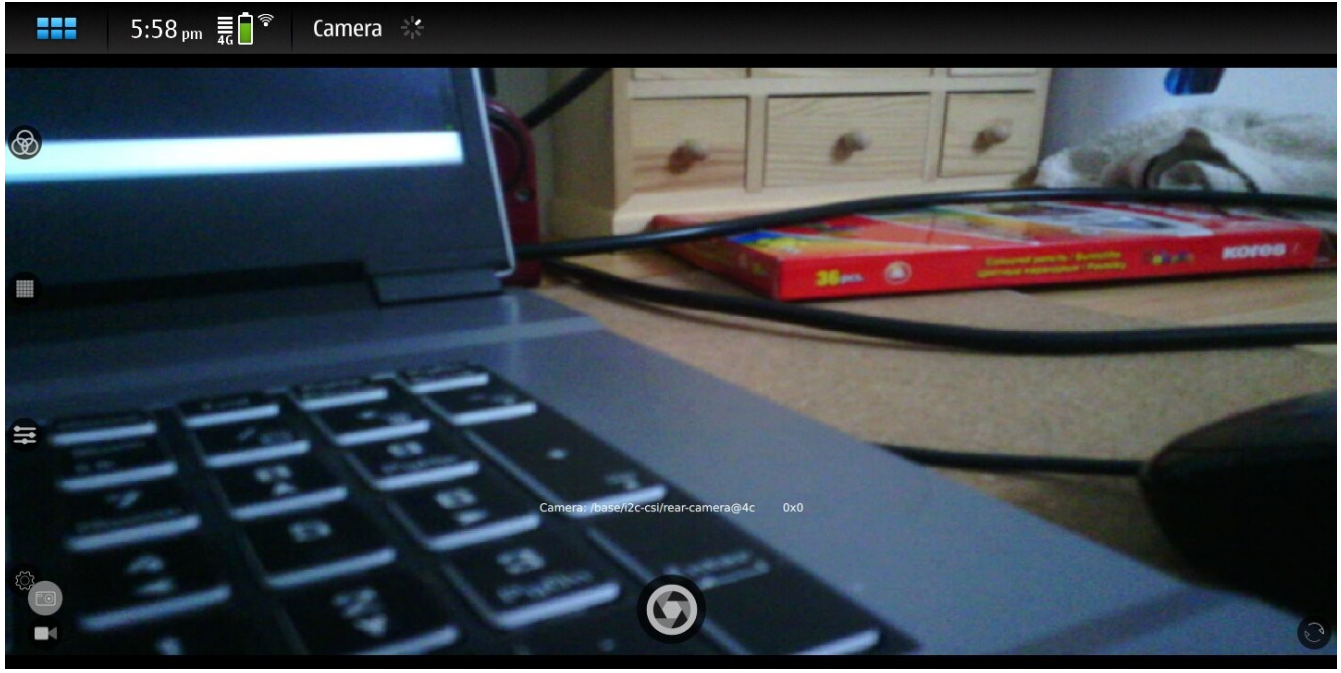
IDEAS ON BOARD

WebRTC now supports xdg-portals!

Adam Piggs' pinhole

- Fork of Sailfish OS *harbour-camera*
- Qt/QML libcamera-based mobile camera application
- Developed for the original PinePhone
  - *But since it uses libcamera it runs un-modified on the Pro*
- Manual controls (exposure time, brightness etc) in the UI

Adam Piggs' pinhole



Maemo Leste developer rafael2k testing pinhole on the Pinephone

Other notable developments: pinhole

Waydroid

Waydroid uses a container-based approach to boot a full Android system on a regular GNU/Linux system

Waydroid

- Libcamera provides a *Camera HAL v3* compatibility layer
- Once the device works with libcamera, it should work on Android

- *Nicholas Roth* integrated libcamera in Waydroid
  - Frames can be captured :)

- But cannot be displayed :(
  - Mainline *mesa* does not support NV12 format
  - Need to “fix” mesa...
  - … or upport Rockchip BSP driver and use ChromeOS minigbm

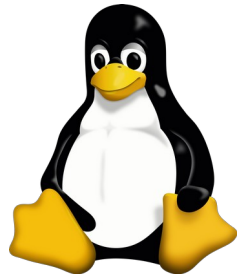
Millipixels

- *Megapixels* fork that uses libcamera
- Developed for *Purism Librem5*
- Dorota Czaplejewicz is working GPU-based debayering

- Pavel Machek's fork with software-based 3A algorithms

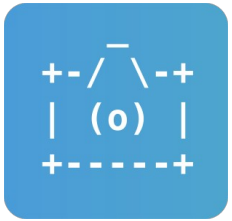
FOSDEM'23

Sharp photos and short movies on a mobile phone



Go mainline!

- Fragmentation is *poison* for software ecosystems
  - Vendor-specific abstractions cannot be supported generically
- Mainlining requires a lot of effort
  - Moves slow compared to downstream
  - Should be planned since the very beginning



libcamera

A standard consumer of the kernel interfaces is the only way to validate the implementation and design of the kernel abstractions

- For a long time kernel APIs have been implemented but not exercised consistently by userspace
- A reference userspace implementation serves to validate design choices made in kernel space
- Increase consistency and completeness of kernel drivers

Lessons learned

Thank you all for the attention

Any question ?

IDEAS ON BOARD

Pinephone Pro: ov8858

- The driver mainlining process was an occasion to (try to) clarify the sensor's gain model

Jacopo Mondi

To continue following up on this

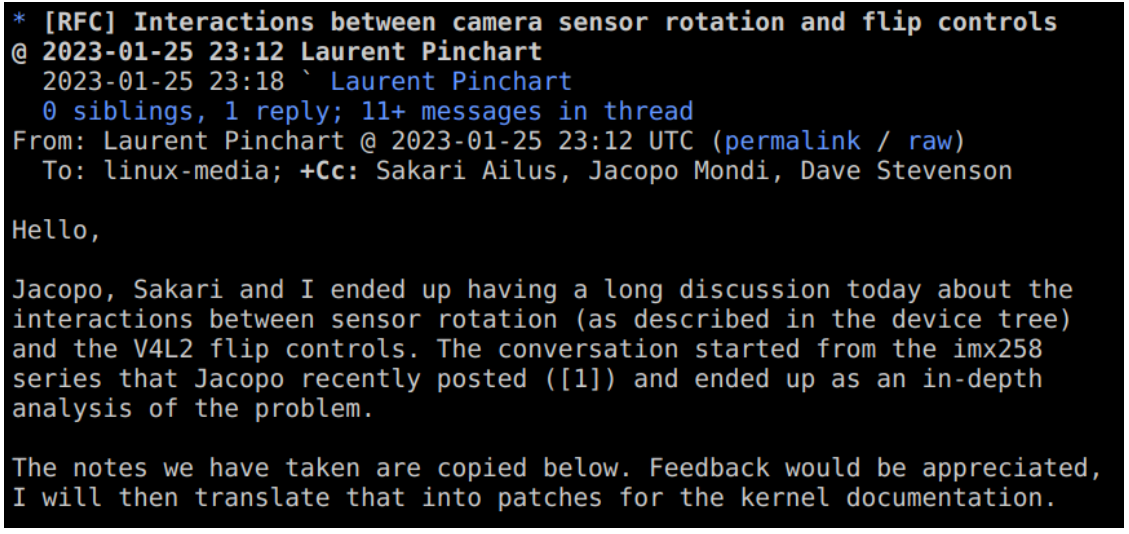
I found an old version of a driver for the 8858 from a very old
android BSP, which mentions
https://android.googlesource.com/kernel/x86/+/android-x86-grant-3.10-marshmallow-mr1-wear-releas

```
        /*
         * [10:7] are integer gain, [6:0] are fraction gain.  For
         * example: 0x80 is 1x gain, 0x100 is 2x gain, 0x1C0 is 3.5x
         * gain

        {OV8858_8BIT, 0x3508, 0x02}, /* long gain = 0x0200 */
        {OV8858_8BIT, 0x3509, 0x00}, /* long gain = 0x0200 *//
```

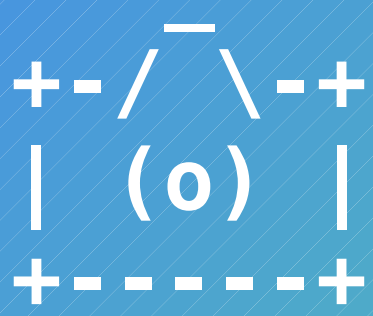
Which suggests the gain format is actually Q4.7

Pinephone Pro: imx258

• Discussion with upstream lead to a better definition of the V4L2 API for flips rotation handling in sensor drivers and to a better implementation of the userspace handling part in libcamera



```
* [RFC] Interactions between camera sensor rotation and flip controls
@ 2023-01-25 23:12 Laurent Pinchart
  2023-01-25 23:18 ` Laurent Pinchart
  0 siblings, 1 reply; 11+ messages in thread
From: Laurent Pinchart @ 2023-01-25 23:12 UTC (permalink / raw)
  To: linux-media; +Cc: Sakari Ailus, Jacopo Mondi, Dave Stevenson

Hello,

Jacopo, Sakari and I ended up having a long discussion today about the
interactions between sensor rotation (as described in the device tree)
and the V4L2 flip controls. The conversation started from the imx258
series that Jacopo recently posted ([1]) and ended up as an in-depth
analysis of the problem.

The notes we have taken are copied below. Feedback would be appreciated,
I will then translate that into patches for the kernel documentation.
```



Convergent camera applications for mobile Linux devices

FOSDEM 2023

Kieran Bingham
~~Jacopo Mondi~~
~~jacopo.mondi@ideasonboard.com~~

Hello, I'm ~~Jacopo~~ Kieran

- Embedded camera engineer @ IdeasOnBoard Oy
  - *Video4Linux2*
  - *libcamera*
  - *#libcamera on OFTC.net*
    - *https://webchat.oftc.net/?channels=libcamera*
    - *https://matrix.to/#/#_oftc_#libcamera:matrix.org*

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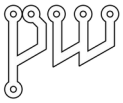


The Linux camera stack

This is where we want to go.

A camera stack for Linux systems

- Run the same software stack on mobile and desktop Linux
- Integrate with standard multimedia tool-kits

The Linux camera stack

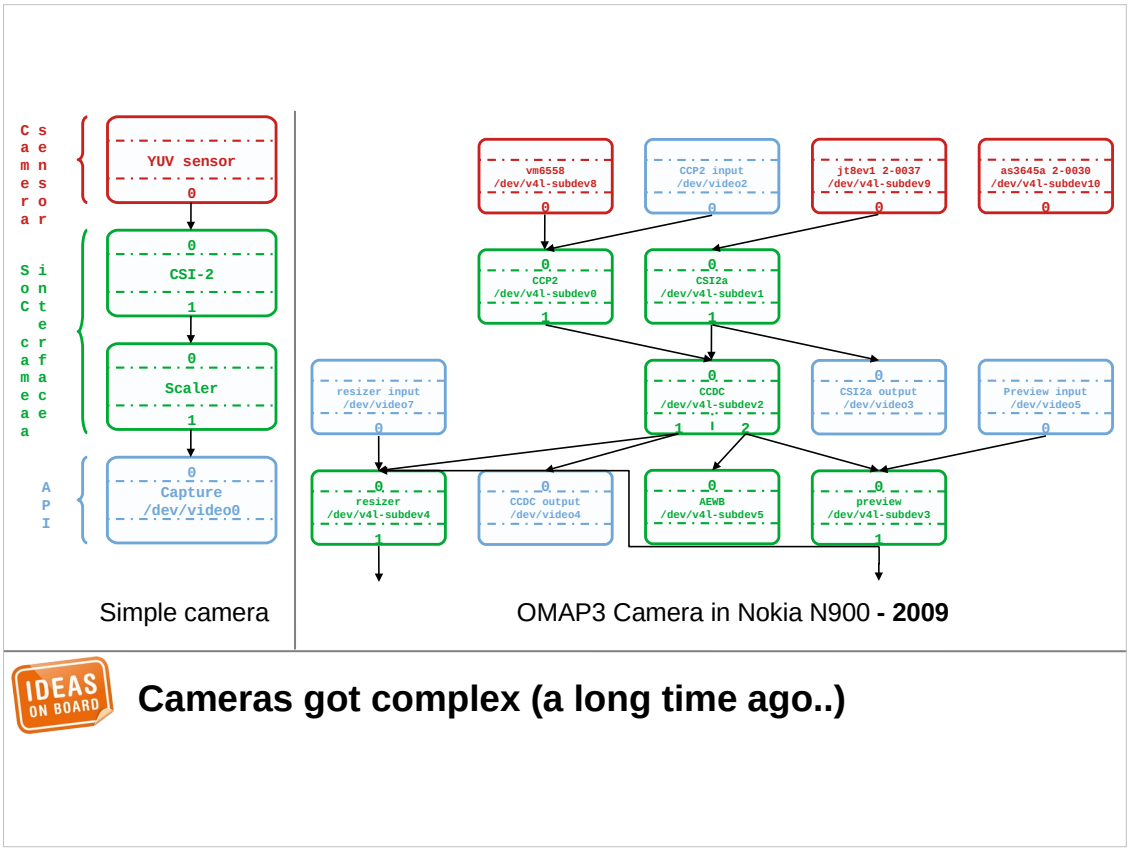
- Test ground for the mobile Linux ecosystem
- Rockchip RK3399
  - *complex camera* with ISP and RAW sensors
  - Supported by libcamera

IDEAS ON BOARD

The PinePhone Pro

Why are we looking at the pine phone pro

It’s a test ground device for mobile development with an SoC that has an ISP already supported by libcamera, and RAW sensors that we could support



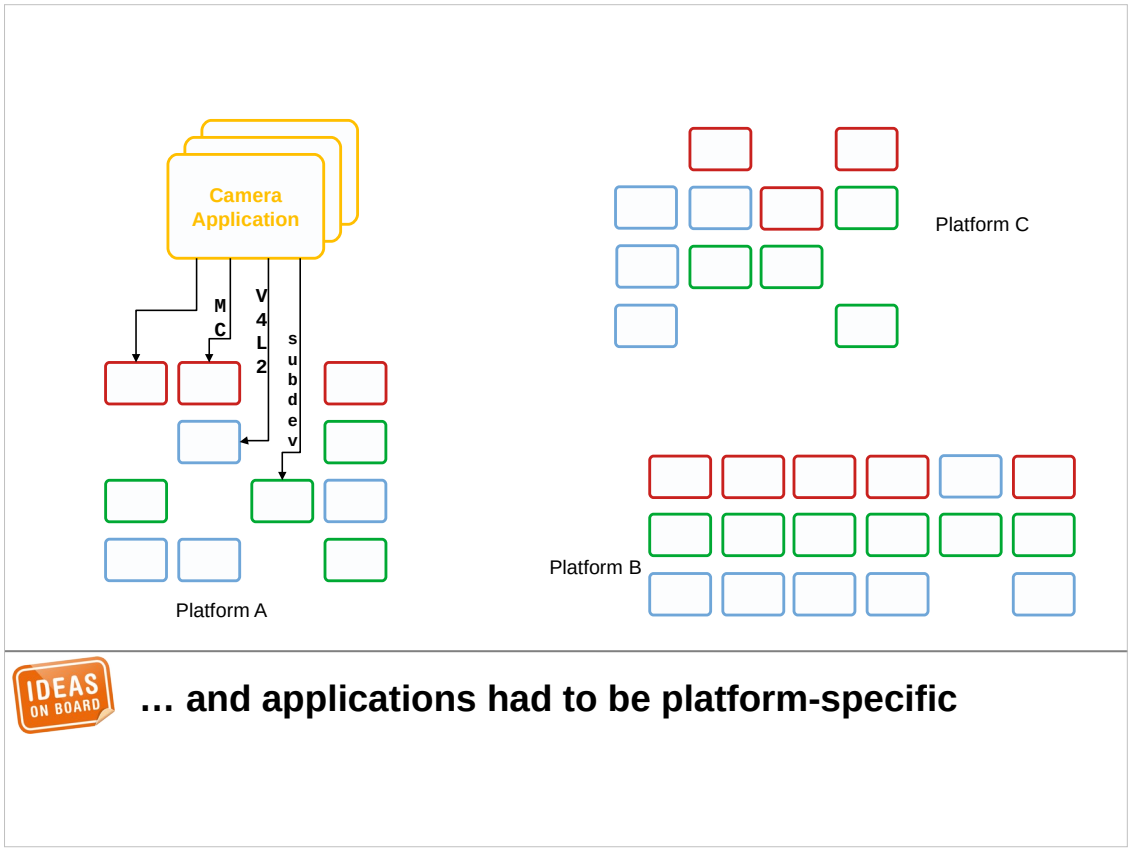
Cameras got complex (a long time ago..)

Cameras started out simple. UVC, or simple grabbers are exposed in the kernel with a single interface. A V4L2 VideoDevice.

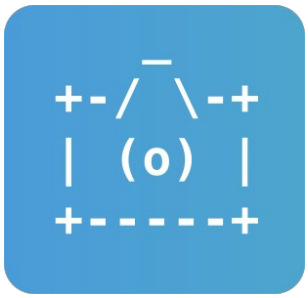
(Well, they used to be a single, even UVC has also become more complex, now with a second ‘metadata’ video node)

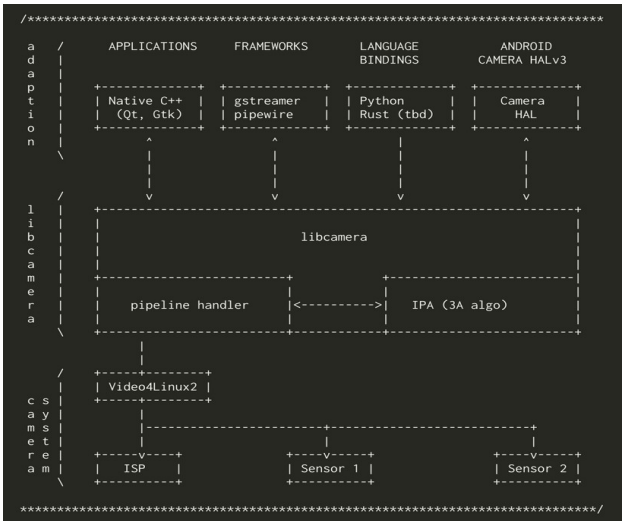
As YUV sensors and CSI2 receivers were introduced, this pipeline grew in complexity - and it didn’t stop.

Multiple sensors, multiple ancillary devices, scalers, dewarp engines, ISPs with multiple dma engines as outputs…



Each platform will have its own building blocks.
And each device configuration or product on a platform can have yet more differences.

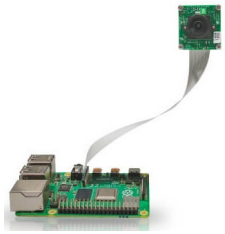




libcamera fills that gap

Supported by libcamera since 2020

RockPi4



Acer Chrombook Tab 10

(*) The same, unmodified, software stack supports NXP i.MX8MP ISP

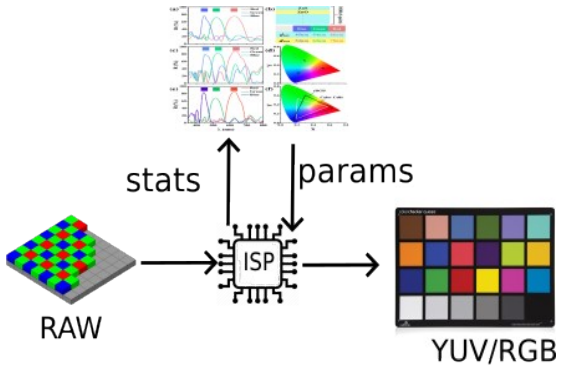
Rockchip RK3399

We started supporting the RK3399 early on in the development of libcamera, with the Acer Chromebook

It’s also widely available on small board computers

An ISP:

- Fed with raw Bayer frames
- Produces statistics
- Transforms images
  - De-bayering
  - Color gains balancing
  - …



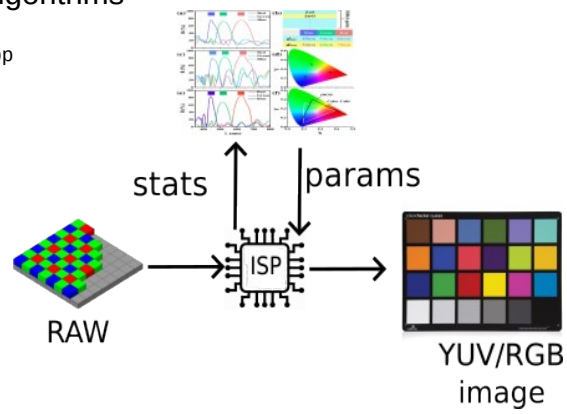
Needs platform specific “3A” algorithms

The RkISP1 ISP

Very quickly, what is an ISP – it’s a component that can operate on the large volume of data produced by a RAW sensor and manage that in realtime.

Libcamera implements the 3A algorithms

```
$ ls -1 src/ipa/rkisp1/algorithms/*.cpp

src/ipa/rkisp1/algorithms/agc.cpp
src/ipa/rkisp1/algorithms/awb.cpp
src/ipa/rkisp1/algorithms/blc.cpp
src/ipa/rkisp1/algorithms/cproc.cpp
src/ipa/rkisp1/algorithms/dpcc.cpp
src/ipa/rkisp1/algorithms/dpf.cpp
src/ipa/rkisp1/algorithms/filter.cpp
src/ipa/rkisp1/algorithms/gsl.cpp
src/ipa/rkisp1/algorithms/lsc.cpp
```



The RkISP1 ISP

And these algorithms live in a module component called the IPA in libcamera.

The IPA is a key and core part of libcamera allowing the implementation of these algorithms to live in a common location for the platform support of the camera pipeline

Linux kernel

- Staging driver since v5.6
- De-staged in v5.11

- Still actively developed

```
[GIT PULL FOR v5.10] rkisp1 fixes/enhancements + one cedrus fix
[GIT PULL FOR v5.20] rkisp1 misc fixes and improvements
[GIT PULL FOR v6.1]  rkisp1 fixes and improvements
```

IDEAS ON BOARD

The RkISP1 ISP

Merged as a staging driver in march 2020, and destaged in February 2021.

PinephonePro: sensor drivers

- Front camera: *OmniVision* OV*8858*
  - No driver in mainline Linux
  - No support in libcamera
- Back camera: *Sony IMX258*
  - Driver available in mainline Linux
  - Supported in libcamera but not “tuned”

Nicholas Roth started looking into the ov8858 to support camera in Waydroid (*)

Commit Message

Nicholas Roth

```
Currently, libcamera does not have information for the ov8858 sensor
used in the PinePhone Pro, a phone designed to run Linux.

This commit adds metadata, especially that sensor gain is reported and
set in 1/16 discrete increments.

For more information, see "5.8 manual exposure compensation/ manual
gain compensation" in [0] and the driver in [1].

[0] http://www.ahdsensor.com/uploadfile/202008/55322e75316871.pdf
[1] https://github.com/megous/linux/blob/orange-pi-5.19/drivers/media/i2c/ov8858.c

Signed-off-by: Nicholas Roth <nicholas@rothemail.net>
---
 src/ipa/libipa/camera_sensor_helper.cpp    | 11 ++++++++++
 src/libcamera/camera_sensor_properties.cpp | 14 ++++++++++++++
 2 files changed, 25 insertions(+)
```

** we'll get back to this later*

Sensor drivers: ov8858

But it was clear from the very beginning why libcamera mandates drivers to be mainlined

```
>
> +class CameraSensorHelperOv8858 : public CameraSensorHelper
> +{
> +public:
> +       CameraSensorHelperOv8858()
> +       {
> +               gainType_ = AnalogueGainLinear;
> +               gainConstants_.linear = { 1, 0, 0, 16 };
> +       }
> +};
> +REGISTER_CAMERA_SENSOR_HELPER("m00_f_ov8858", CameraSensorHelperOv8858)

"My OV8858 is the second on the rear." Suddenly this doesn't work.
- So we can only use "ov8858" here.
```

Sensor drivers: ov8858

So we went and upstreamed the driver (which will land in v6.3)

[v5,2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-16	Jacopo Mondi
[v5,1/2] dt-bindings: media: Add OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-16	Jacopo Mondi
[v4,2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-11	Jacopo Mondi
[v4,1/2] dt-bindings: media: Add OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-11	Jacopo Mondi
[v3,2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-09	Jacopo Mondi
[v3,1/2] dt-bindings: media: Add OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-09	Jacopo Mondi
[v2,2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-06	Jacopo Mondi
[v2,1/2] dt-bindings: media: Add OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-06	Jacopo Mondi
[2/2] media: i2c: Add driver for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-05	Jacopo Mondi
[1/2] dt-bindings: media: Add schema for OmniVision OV8858	media: i2c: Add driver for OmniVision OV8858	2023-01-05	Jacopo Mondi
[v2] media: i2c: ov8858 Add driver for ov8858	[v2] media: i2c: ov8858 Add driver for ov8858	2022-11-06	Nicholas Roth
media: i2c: ov8858 Add driver for ov8858	media: i2c: ov8858 Add driver for ov8858	2022-10-30	Nicholas Roth

Sensor drivers: ov8858

Sensor drivers: ov8858

And merged the ov8858 support in libcamera (in release v0.0.4)

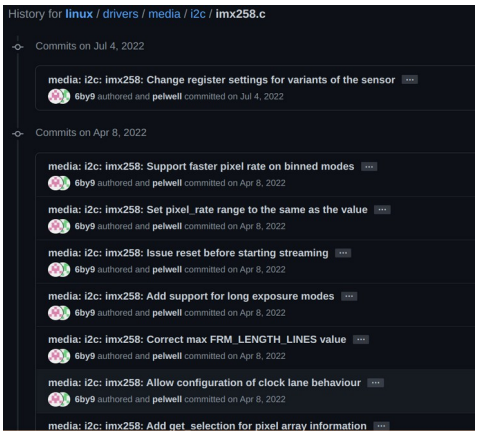
Jacopo Mondi

```
From: Nicholas Roth <nicholas@rothemail.net>

Support for the OmniVision OV8858 sensor is scheduled for inclusion in
the Linux kernel in version v6.3.

Add support for the sensor in libcamera by providing static properties
and a camera sensor helper in libipa.

The camera sensor helper expresses analogue gain increments in 1/128
step which differs from what is reported in the sensor documentation in
section "5.8 manual exposure compensation/ manual gain compensation" [0]

A more detailed analysis of the sensor gain model is reported at:
https://patchwork.linuxtv.org/project/linux-media/patch/20221106171129.166892-2-nicholas@rothemail.net/#142267

Record with a \todo note a reference to discussion on the gain model
implementation.

Signed-off-by: Nicholas Roth <nicholas@rothemail.net>
Signed-off-by: Jacopo Mondi <jacopo.mondi@ideasonboard.com>
---

Compared to initial Nicholas' submission:
- Change gain step to 128 (link to the driver discussion)
- Add fadeToGray test patter and adjust comment
```

Sensor drivers: imx258

While a driver exists in mainline, it needs some love

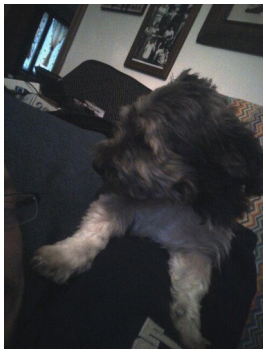
- A long list of patches to be potentially upstreamed from the RaspberryPi kernel
- Shielded pixel correction for the PDAF-capable version of the sensor
- Potential to re-use the sensor tuning file for LSC, black level correction etc developed for RaspberryPi



What’s next ?

- Improve the ov8858 and imx258 drivers
  - A lot of patches to be up-ported
  - *Good opportunity to contribute upstream*
- Tuning of camera sensor and algorithms
  - Libcamera has a tuning tool named *CTT*
    - Developed by *RaspberryPi* for their ISP
    - Support for other platforms is in progress
- The pinephone community could *really* help here
  - In example, what megi is doing with its *ppp-cam* tuning app seems promising!
  - Get in touch with us !

```
$ cam -c1 --stream pixelformat=YUYV,width=1920,height=1080 -C
8741.097455 (30.03 fps) cam0-stream0 seq: 000001 bytesused: 4147200
```



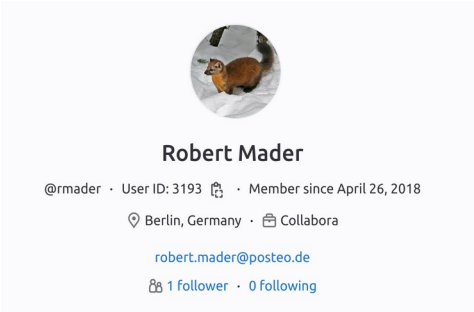
Cute dog from the back and front camera of the Pinephone Pro

Definitely need LSC correction for the imx258 and better gain handling for the ov8858

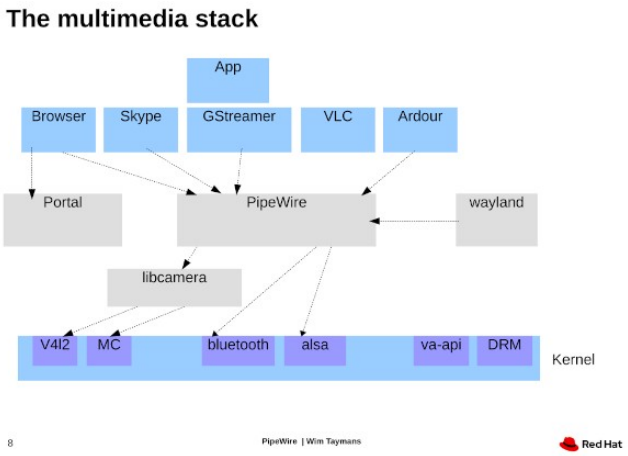
My job’s done here!

Robert got in touch with the libcamera community to support the Pinephone Pro and use it as a testing ground for the Linux media stack

- *pipewire*
- *gstreamer*
- *xdg-portal*
- *gnome-camera*

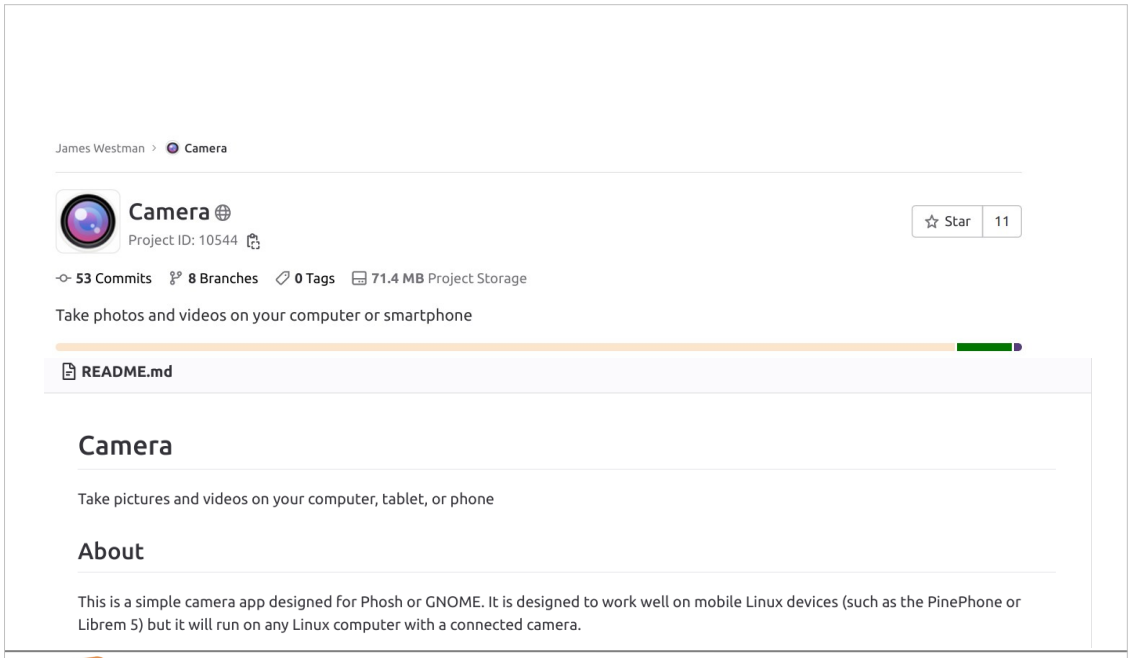


… or maybe not ?



The Linux media stack

Robert's contributions to the stack



IDEAS ON BOARD

gnome-camera: a convergent camera app

Demo video here

Viewable at:
https://twitter.com/libcamera/status/1621558431738986496?s=20&t=a92bB_XkDlEGAgFkPFztjw

Demo

- Integration with xdg-portal enables flatpack support
- Application sandboxing with security checks in place

```
# Add the gnome-nightly repo
flatpak remote-add --user --if-not-exists gnome-nightly https://nightly.gnome.org/gnome-nightly.flatpakrepo

# Install the demo build
flatpak install --user camera-devel-aarch64.flatpak
# or
flatpak install --user camera-devel-x86.flatpak
```

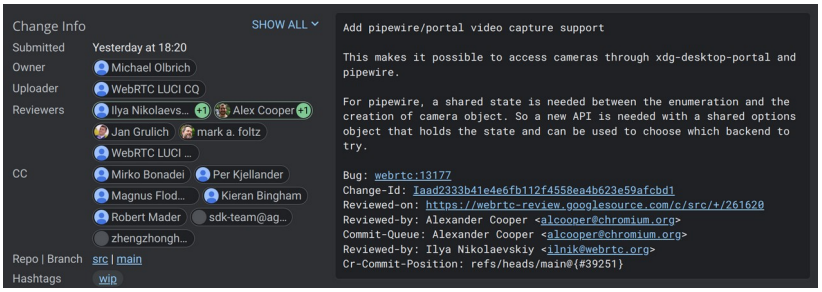
Flatpack support

Gerrit CHANGES YOUR DOCUMENTATION BROWSE

Merged ☆ 261620 Add pipewire/portal video capture support

Support for *video capture through xdg-desktop-portal merged in webRTC* no longer than 2 days ago (02-02-2023)

In a few months (?) you'll be able to access cameras from your browsers !!



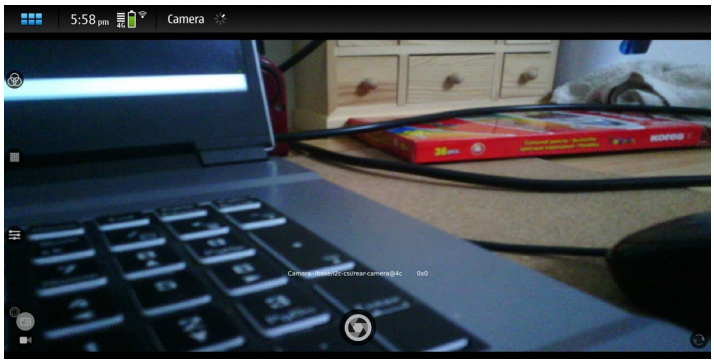
WebRTC now supports xdg-portals!

Adam Piggs' pinhole

- Fork of Sailfish OS *harbour-camera*
- Qt/QML libcamera-based mobile camera application
- Developed for the original PinePhone
  - *But since it uses libcamera it runs un-modified on the Pro*
- Manual controls (exposure time, brightness etc) in the UI

Other notable developments: pinhole

Adam Piggs' pinhole



Maemo Leste developer rafael2k testing pinhole on the Pinephone

Other notable developments: pinhole

Waydroid

Waydroid uses a container-based approach to boot a full Android system on a regular GNU/Linux system

Other notable developments: Waydroid

Waydroid

- Libcamera provides a *Camera HAL v3* compatibility layer
- Once the device works with libcamera, it should work on Android

- *Nicholas Roth* integrated libcamera in Waydroid
  - Frames can be captured :)

- But cannot be displayed :(
  - Mainline *mesa* does not support NV12 format
  - Need to “fix” mesa...
  - … or upport Rockchip BSP driver and use ChromeOS minigbm

Other notable developments: Waydroid

Millipixels

- *Megapixels* fork that uses libcamera
- Developed for *Purism Librem5*
- Dorota Czaplejewicz is working GPU-based debayering

- Pavel Machek's fork with software-based 3A algorithms

FOSDEM'23

Sharp photos and short movies on a mobile phone

Other notable developments

Go mainline!

- Fragmentation is *poison* for software ecosystems
  - Vendor-specific abstractions cannot be supported generically
- Mainlining requires a lot of effort
  - Moves slow compared to downstream
  - Should be planned since the very beginning

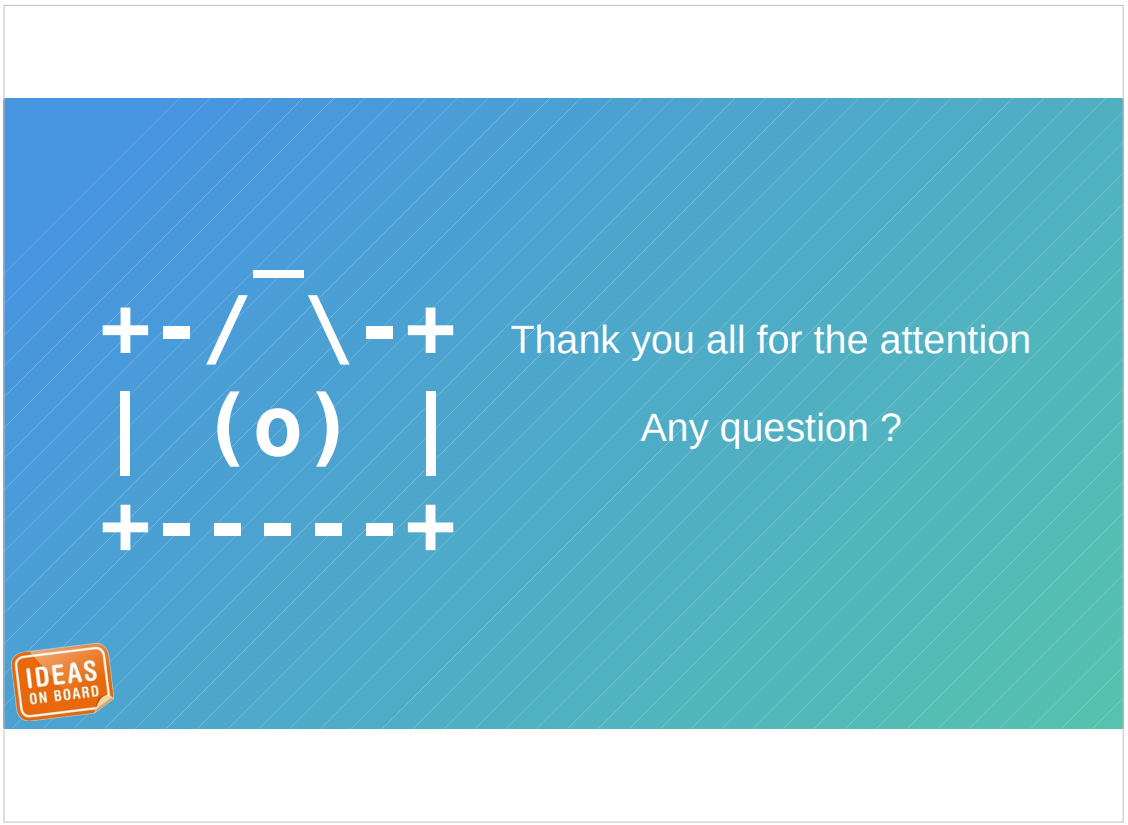
Lessons learned

libcamera

A standard consumer of the kernel interfaces is the only way to validate the implementation and design of the kernel abstractions

- For a long time kernel APIs have been implemented but not exercised consistently by userspace
- A reference userspace implementation serves to validate design choices made in kernel space
- Increase consistency and completeness of kernel drivers

Lessons learned



Hello everybody, and welcome to this presentation about libcamera. For those of you who are lucky enough to join us live from Seattle today, thank you for waking up early. This is the first slot of the day, so I know how difficult it can be.

My name is Laurent Pinchart. I'm the chief architect and project manager of libcamera. Today I'm going to take you on libcamera's fabulous journey.

So let's dive in the subject.

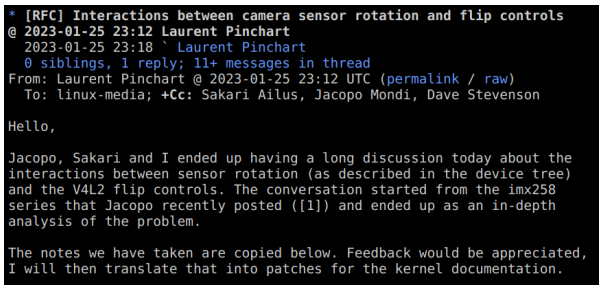
Pinephone Pro: ov8858

- The driver mainlining process was an occasion to (try to) clarify the sensor's gain model

Pinephone Pro support

Pinephone Pro: imx258

• Discussion with upstream lead to a better definition of the V4L2 API for flips rotation handling in sensor drivers and to a better implementation of the userspace handling part in libcamera



* **[RFC] Interactions between camera sensor rotation and flip controls**
@ 2023-01-25 23:12 Laurent Pinchart
2023-01-25 23:18 ` Laurent Pinchart
0 siblings, 1 reply; 11+ messages in thread
From: Laurent Pinchart @ 2023-01-25 23:12 UTC (permalink / raw)
To: linux-media; **+Cc:** Sakari Ailus, Jacopo Mondi, Dave Stevenson

Hello,

Jacopo, Sakari and I ended up having a long discussion today about the interactions between sensor rotation (as described in the device tree) and the V4L2 flip controls. The conversation started from the imx258 series that Jacopo recently posted ([1]) and ended up as an in-depth analysis of the problem.

The notes we have taken are copied below. Feedback would be appreciated, I will then translate that into patches for the kernel documentation.

Pinephone Pro support