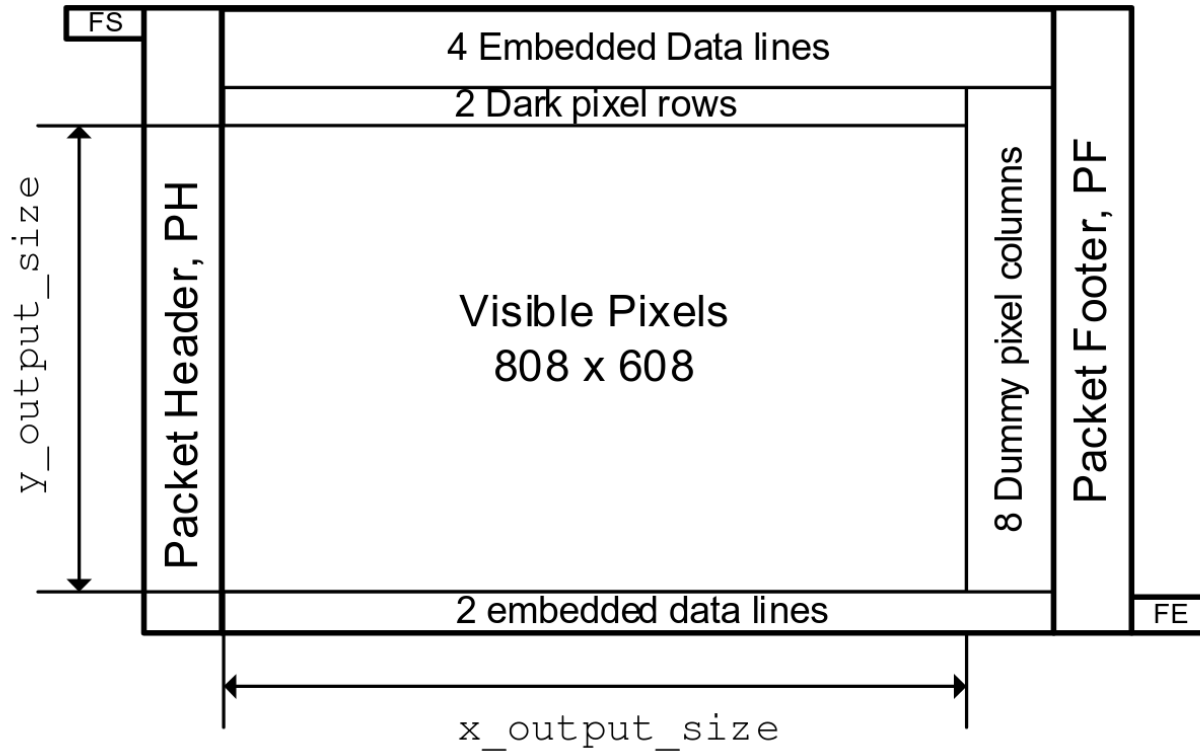# Generic line-based metadata

Sakari Ailus
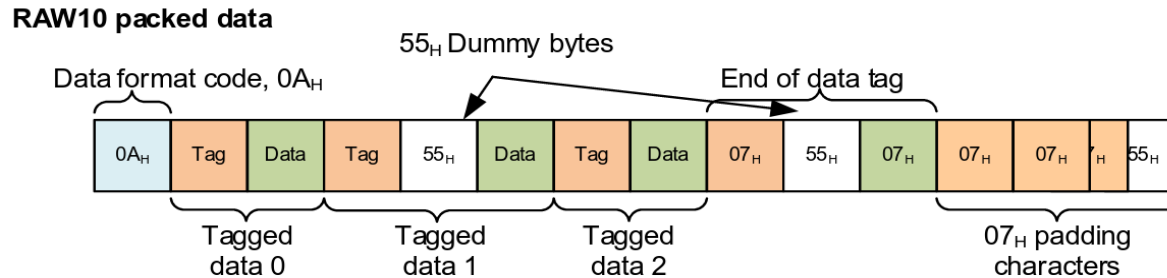<sakari.ailus@linux.intel.com>
2023-06-26

CSI-2 frame example

Source: MIPI CCS 1.1

Embedded data

- Typically a few lines before the image data, may be after the image as well

- Almost always sensor register values

  - Register addresses vary

  - So does how the data is encoded

  - Virtually no standardisation apart from CCS

  - Often poorly documented

Source: MIPI CCS 1.1

Other types of sensor metadata

- PDAF data (PDAF pixel values)
  - Unprocessed PDAF pixel values
  - Processed PDAF data
    - Vendor/device specific
- Histograms

Metadata and media pipeline

- Should any CSI-2 receiver driver be aware of device specific metadata formats?

- Generally metadata is processed in software
  - Drivers for individual hardware blocks along the pipeline only need to know the bit depth of the data

- Provide generic mbus code and pixelformat definitions for hardware that does not need access to specific formats

Specific and generic line-based metadata mbus codes

- Specific mbus codes define the exact content of the metadata

  - These are used by sensor device

  - E.g. 8-bit CCS metadata packed in 10 bits per sample

- Generic mbus codes define metadata bit depth

  - Define bit depth only

sensor	→	CSI-2 RX

"Sensor X embedded data"   "Some 8-bit metadata"

Generic metadata V4L2 pixelformats

- Define metadata packing in memory
  - Some hardware only supports unpacked formats
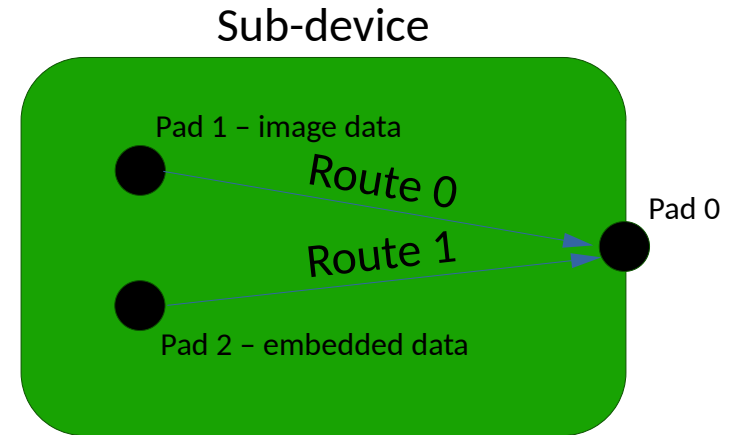 - CSI-2 packing introduces padding bytes

CSI-2 RX → memory

"Some 8-bit metadata,
DMA specific packing"

Internal pads

- A new concept of internal pads allow access to sub-device internals
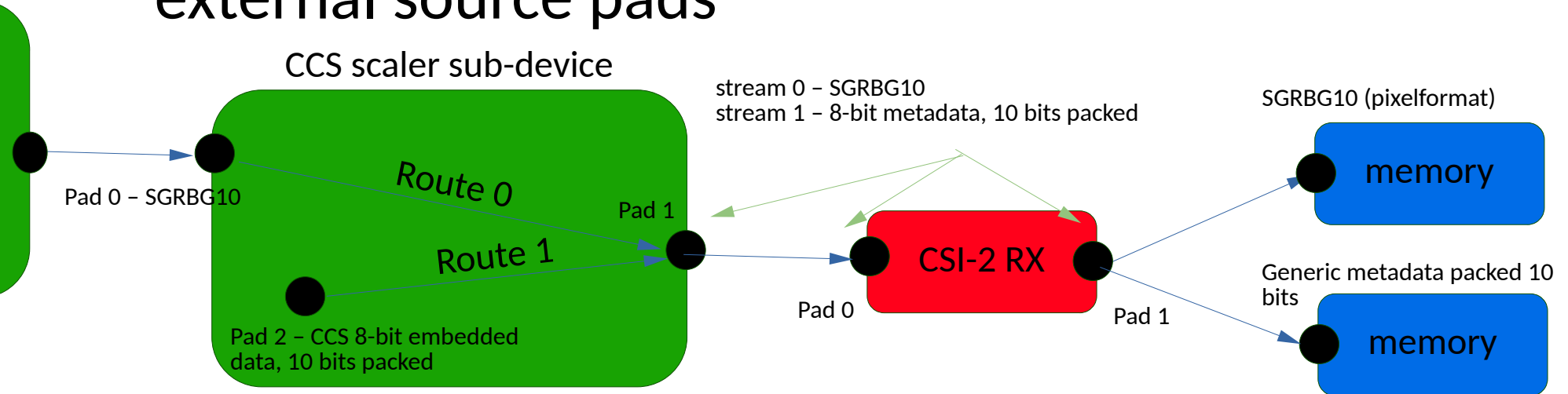 - Integrates well with existing S_ROUTING IOCTL

```
#define MEDIA_PAD_FL_SINK               (1U << 0)
#define MEDIA_PAD_FL_SOURCE             (1U << 1)
#define MEDIA_PAD_FL_MUST_CONNECT       (1U << 2)
#define MEDIA_PAD_FL_INTERNAL_SOURCE    (1U << 3)

struct v4l2_subdev_route {
        __u32 sink_pad;
        __u32 sink_stream;
        __u32 source_pad;
        __u32 source_stream;
        __u32 flags;
        __u32 reserved[5];
};
```

Sub-device

Pad 1 – image data

Route 0

Route 1

Pad 0

Pad 2 – embedded data

Internal pads

- V4L2 sub-device format present on internal pads

- Cropping and scaling inside a sub-device with only external source pads

CCS scaler sub-device

stream 0 – SGRBG10
stream 1 – 8-bit metadata, 10 bits packed

SGRBG10 (pixelformat)

memory

Pad 0 – SGRBG10

Route 0

Route 1

Pad 1

Pad 0

CSI-2 RX

Pad 1

Pad 2 – CCS 8-bit embedded data, 10 bits packed

Generic metadata packed 10 bits

memory

Internal pads and metadata mbus codes and pixelformats

- Internal pads are only visible to the user space, not to other device drivers in the pipeline

- Internal pads on a sensor sub-device may thus have a specific metadata mbus code without a CSI-2 RX driver having to be aware of that format
  - Generic mbus code defines the format of the data across the pipeline

- Generic metadata pixelformats define the layout of the data in memory but not the content itself