V4L2 Media Controller Request API

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The Need for Media Request API

V4L2 Control

- Powerful control API for V4L2 Video Devices and Subdevices
- Asynchronous in design
  - SET_CTRL can be called any time
  - GET_CTRL can be called any time
- Very hard to time a SET_CTRL and GET_CTRL to specific frame
- Unable to be used as metadata
- Unable to be used to apply to specific frame

Decoder Needs

- With advent of stateless decoders, hardware becomes stateless
- State maintenance moved to user space
- User space parses bitstream and sets parameter on a per frame basis or gets per frame metadata
- Higher-level decoding libraries like
  - Vulkan Video Extensions
  - Intel VAAPI
  - GStreamer
- Drivers need to be able to support setting of decoder parameters on per frame basis or getting per frame metadata like
  - V4L2_CID_MPEG_VIDEO_BITRATE
  - V4L2_H264_SPS_*
  - V4L2_H264_PPS_*
- Parameters (controls) applicable or relevant to a given frame only.

Complex Camera/ISP Pipeline Needs

- Cameras can always benefit from per frame metadata like
  - Exposure for a given frame
  - Gain for given frame
  - Dynamic Crop Applied to a given frame
- Per frame settings can also help accomplish computational photography use cases like
  - HDR framing with low and high exposure capture
  - Multi Focal Point Capture
  - Burst Capture with varying per frame ISP settings on each

Media Request API

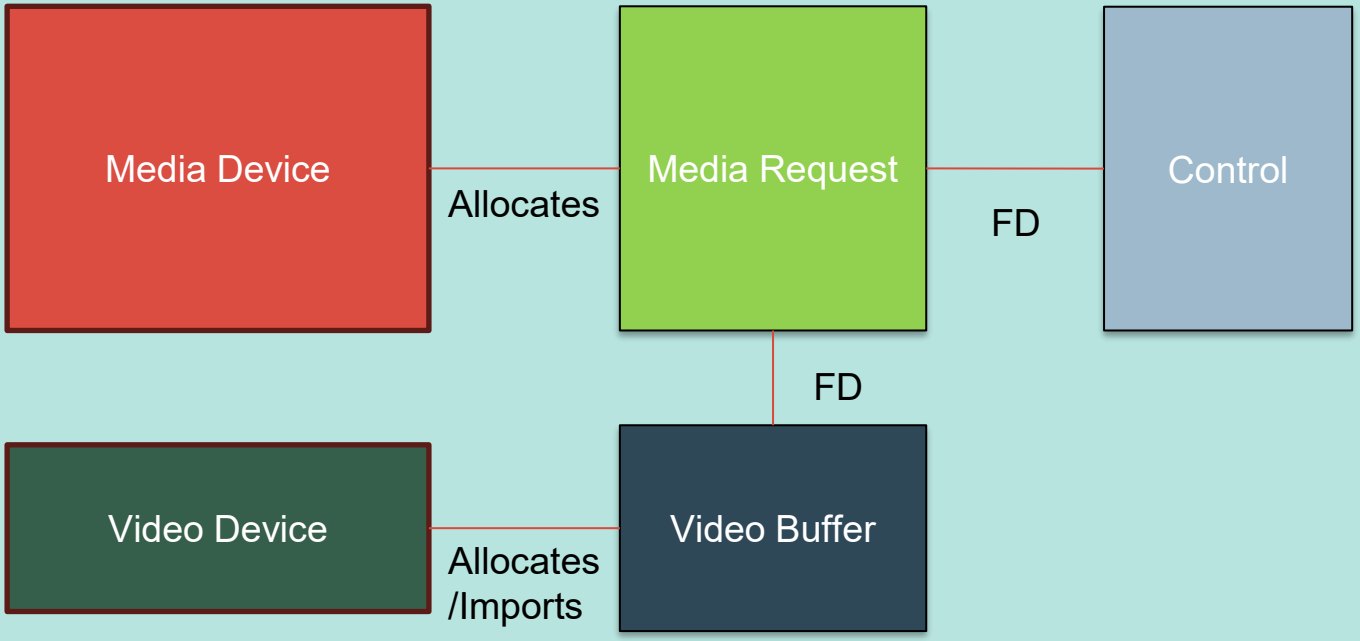
Media Controller Request API

- Designed to allow V4L2 to support devices such as
  - Stateless Codecs
  - Complex Camera ISP pipelines
- Brings in the following concepts to V4L2 Media Controller Devices
  - Per Frame Settings (VIDIOC_S_CTRL)
  - Per Frame Metadata (VIDIOC_G_CTRL)
- Without Request API media pipelines would have to
  - Flush media pipeline
  - Reconfigure new settings for next frame
  - Wait till frames arrive for new setting

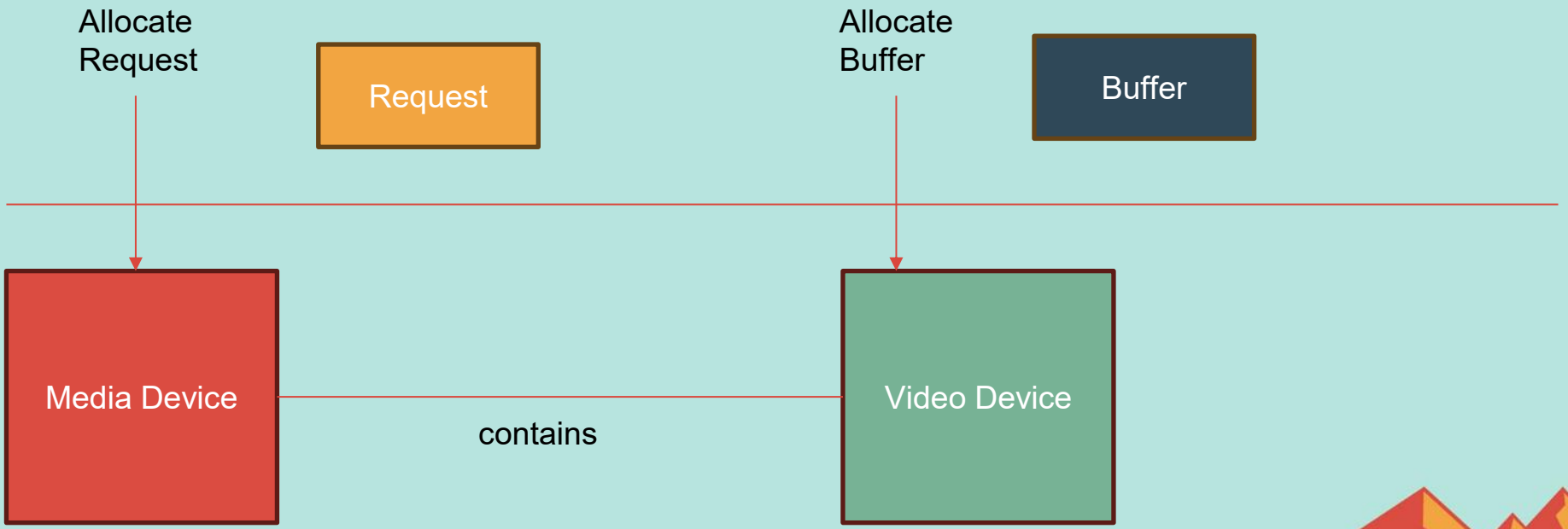
Request API Basics

- Allocate Media Request on media node
- Make control/s call on media request file descriptor
  - VIDIOC_S_EXT_CTRLS
  - VIDIOC_G_EXT_CTRLS
- Queue the Media Request object along with video buffer
- Media Driver will make sure per frame request/per frame metadata is applied in a timely manner on the video buffer (in the media pipeline)
- Once buffer returned, wait for media request to complete and query the controls to get per frame metadata

Media Request to Media Device Relationship



Request API Basics



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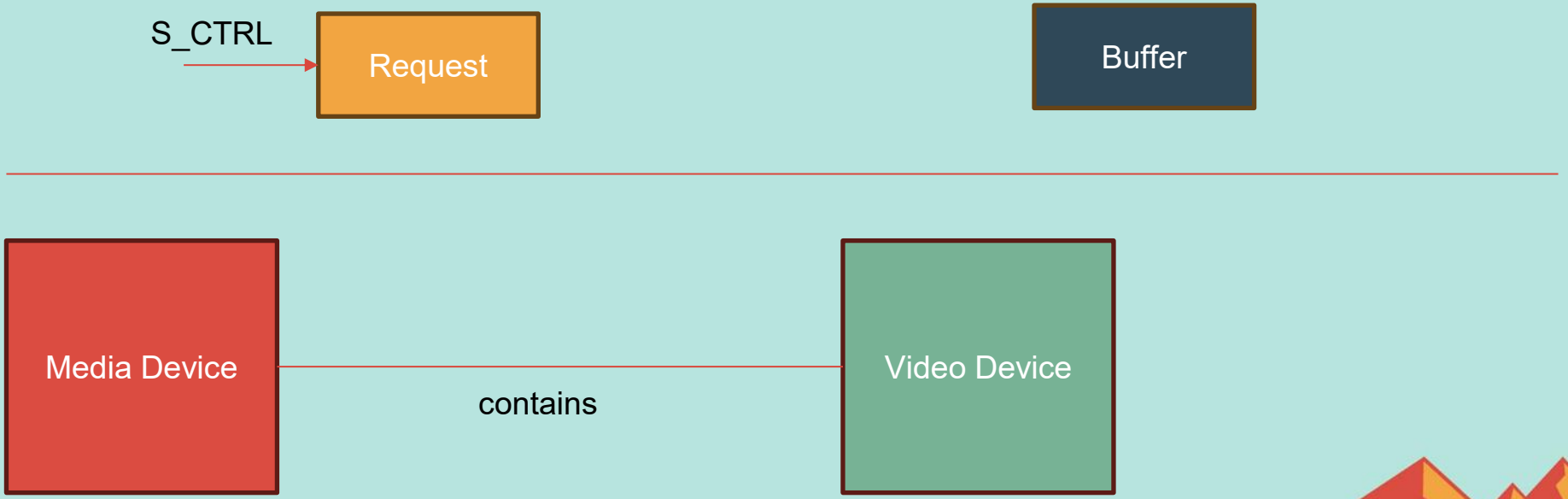

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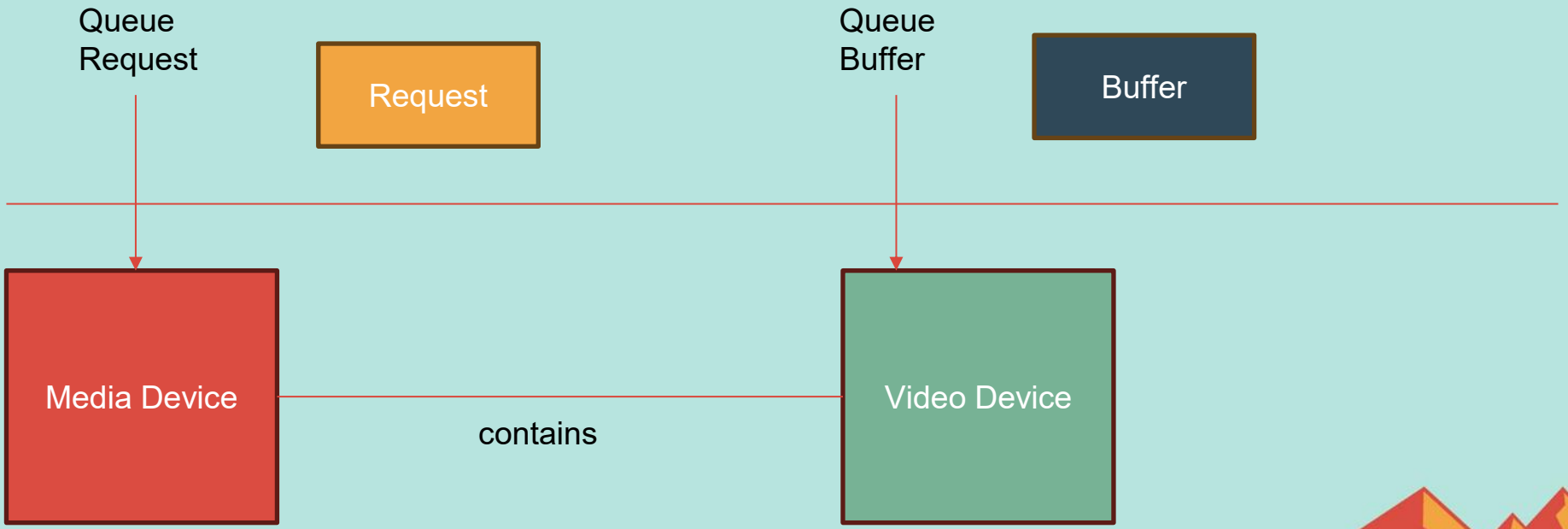

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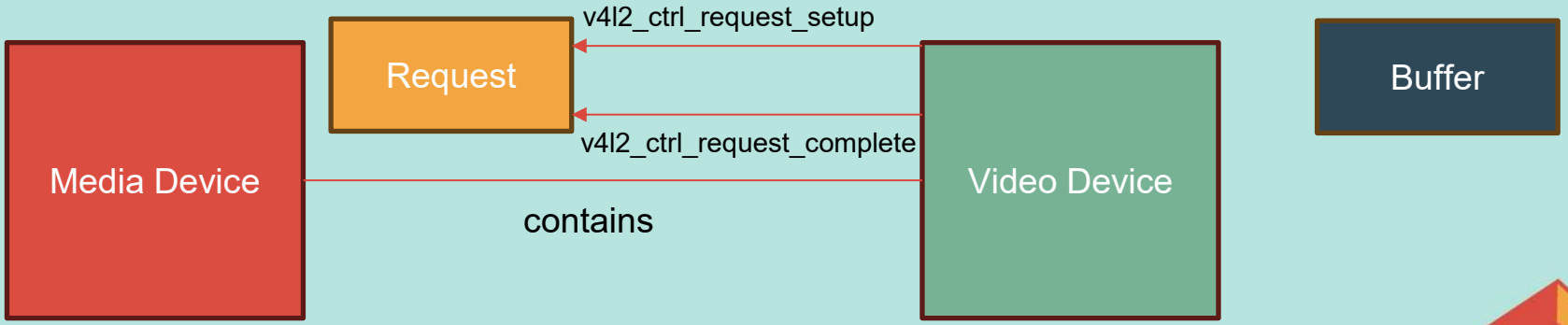

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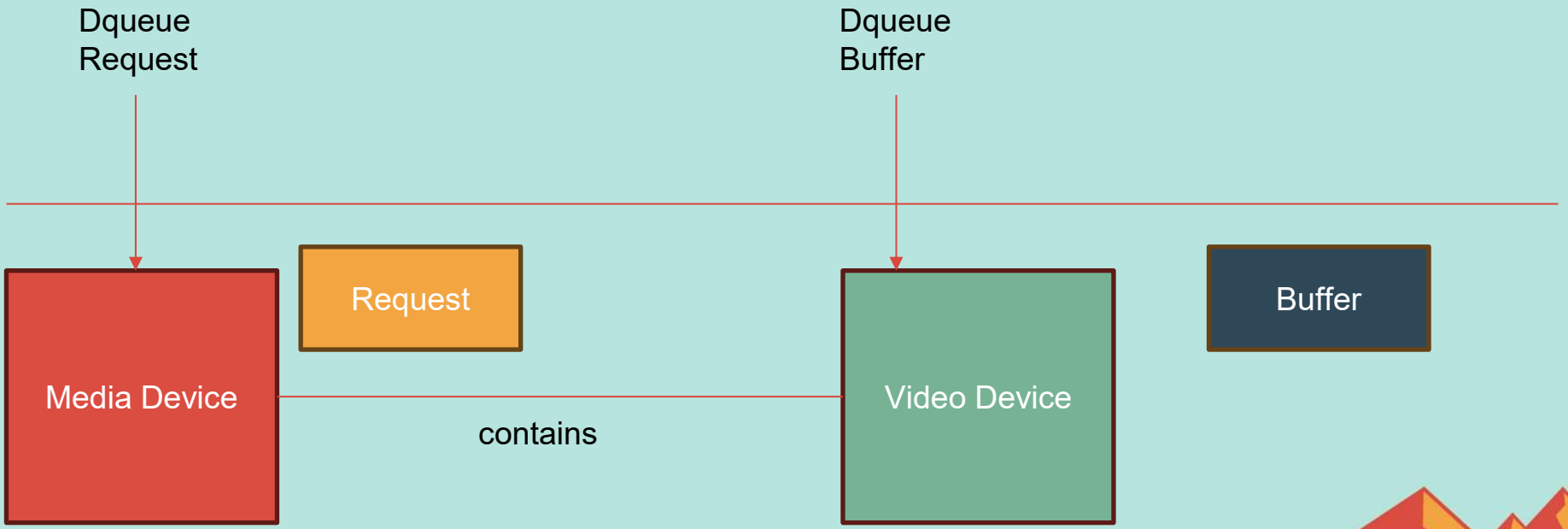

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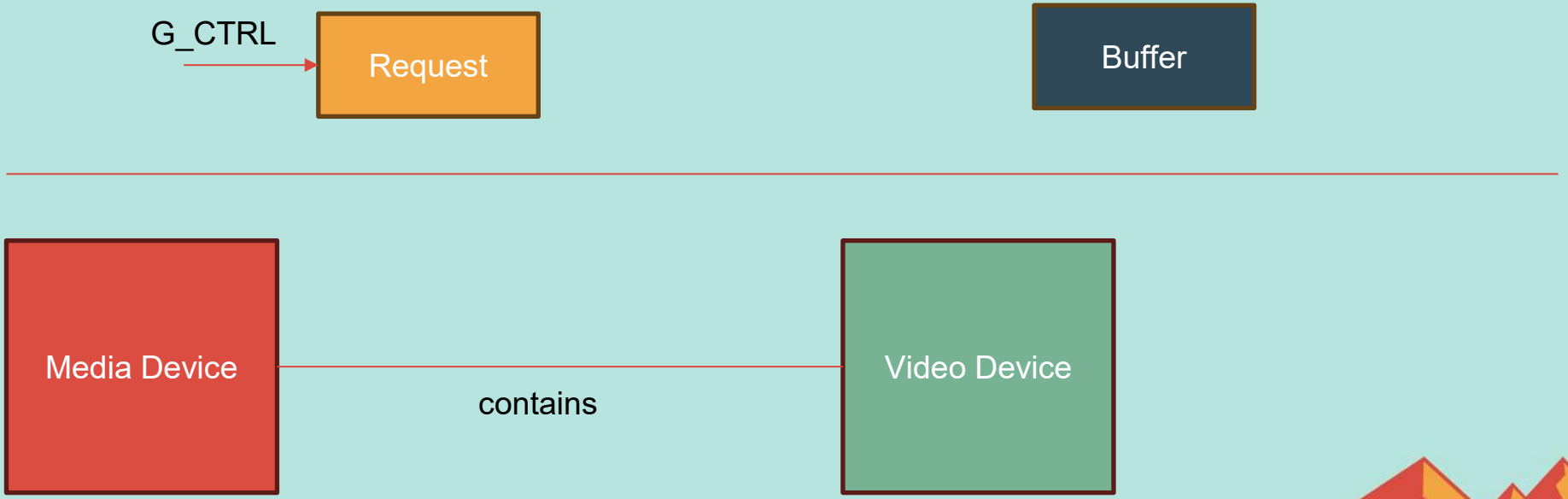


Request API Basics

```
struct v4l2_buffer buf;
struct v4l2_ext_controls ctrls;
int req_fd;
...
if (ioctl(media_fd, MEDIA_IOC_REQUEST_ALLOC, &req_fd))
        return errno;
...
ctrls.which = V4L2_CTRL_WHICH_REQUEST_VAL;
ctrls.request_fd = req_fd;
if (ioctl(codec_fd, VIDIOC_S_EXT_CTRLS, &ctrls))
        return errno;
...
buf.type = V4L2_BUF_TYPE_VIDEO_OUTPUT;
buf.flags |= V4L2_BUF_FLAG_REQUEST_FD;
buf.request_fd = req_fd;
if (ioctl(codec_fd, VIDIOC_QBUF, &buf))
        return errno;
```

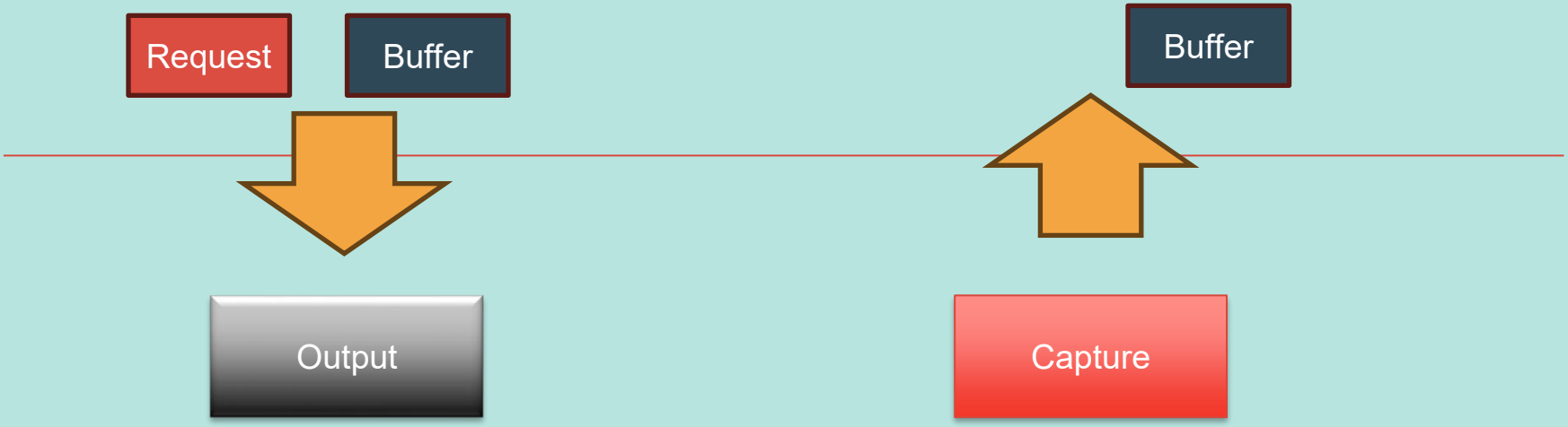
Request API Basics

```
if (ioctl(req_fd, MEDIA_REQUEST_IOC_QUEUE))
        return errno;
```

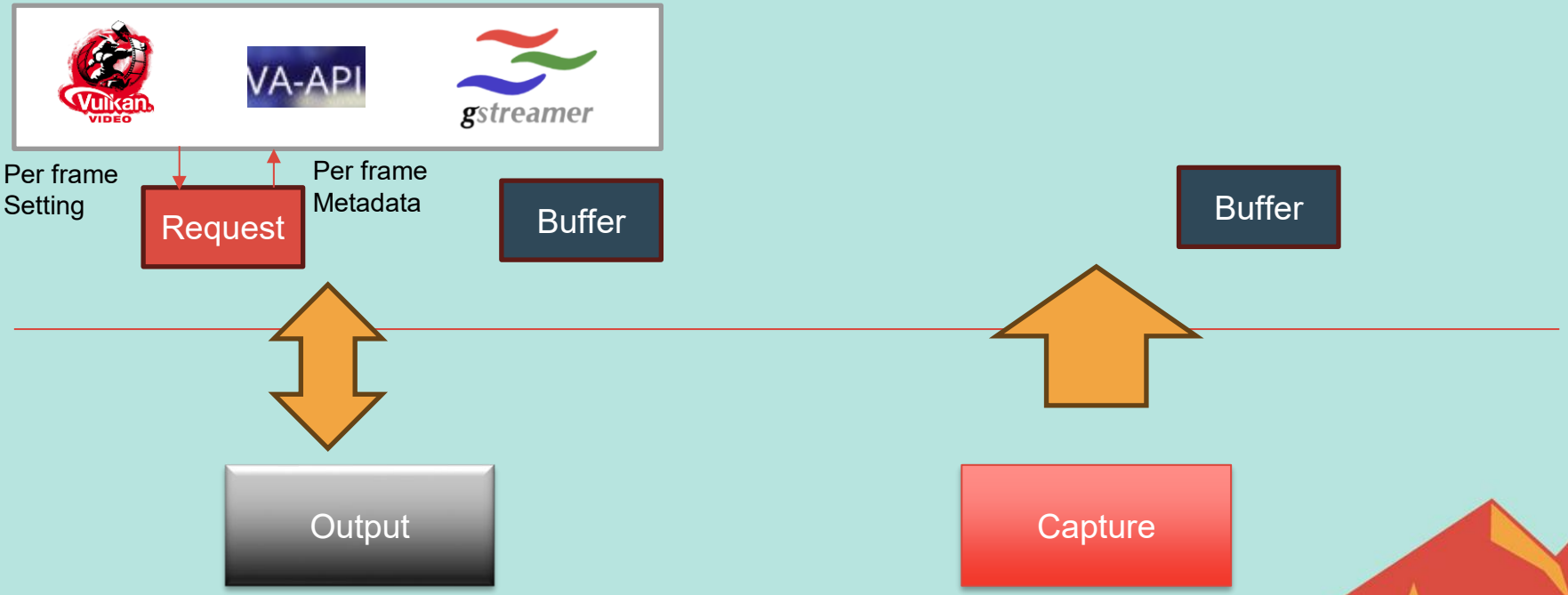
```
struct v4l2_buffer buf;

memset(&buf, 0, sizeof(buf));
buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
if (ioctl(codec_fd, VIDIOC_DQBUF, &buf))
        return errno;
```

```
struct pollfd pfd = { .events = POLLPRI, .fd = req_fd };
poll(&pfd, 1, -1);
...
ctrls.which = V4L2_CTRL_WHICH_REQUEST_VAL;
ctrls.request_fd = req_fd;
if (ioctl(codec_fd, VIDIOC_G_EXT_CTRLS, &ctrls))
        return errno;
```

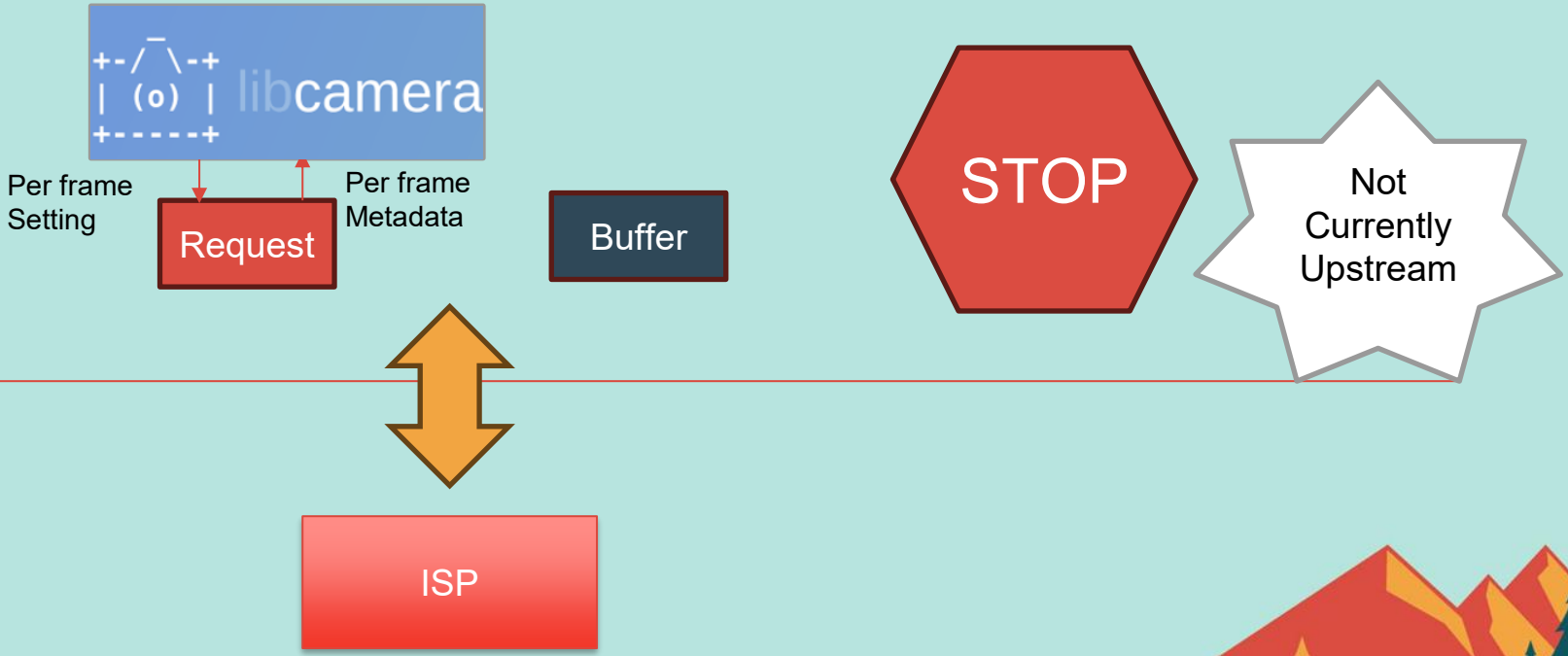
Generic V4L2 M2M Example



V4L2 Stateless Decoder



Complex Camera/ISP



References

- https://docs.kernel.org/userspace-api/media/mediactl/request-api.html
- https://docs.kernel.org/userspace-api/media/v4l/dev-stateless-decoder.html
- https://docs.kernel.org/driver-api/media/v4l2-controls.html#c.v4l2_ctrl_request_setup
- https://docs.kernel.org/driver-api/media/v4l2-controls.html#c.v4l2_ctrl_request_complete

Questions ?