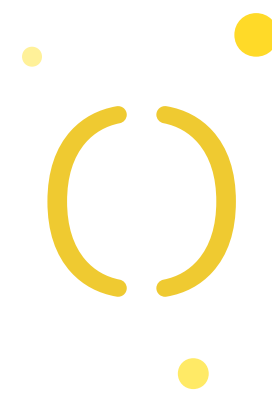


cerno

Linux video and graphics stack explained

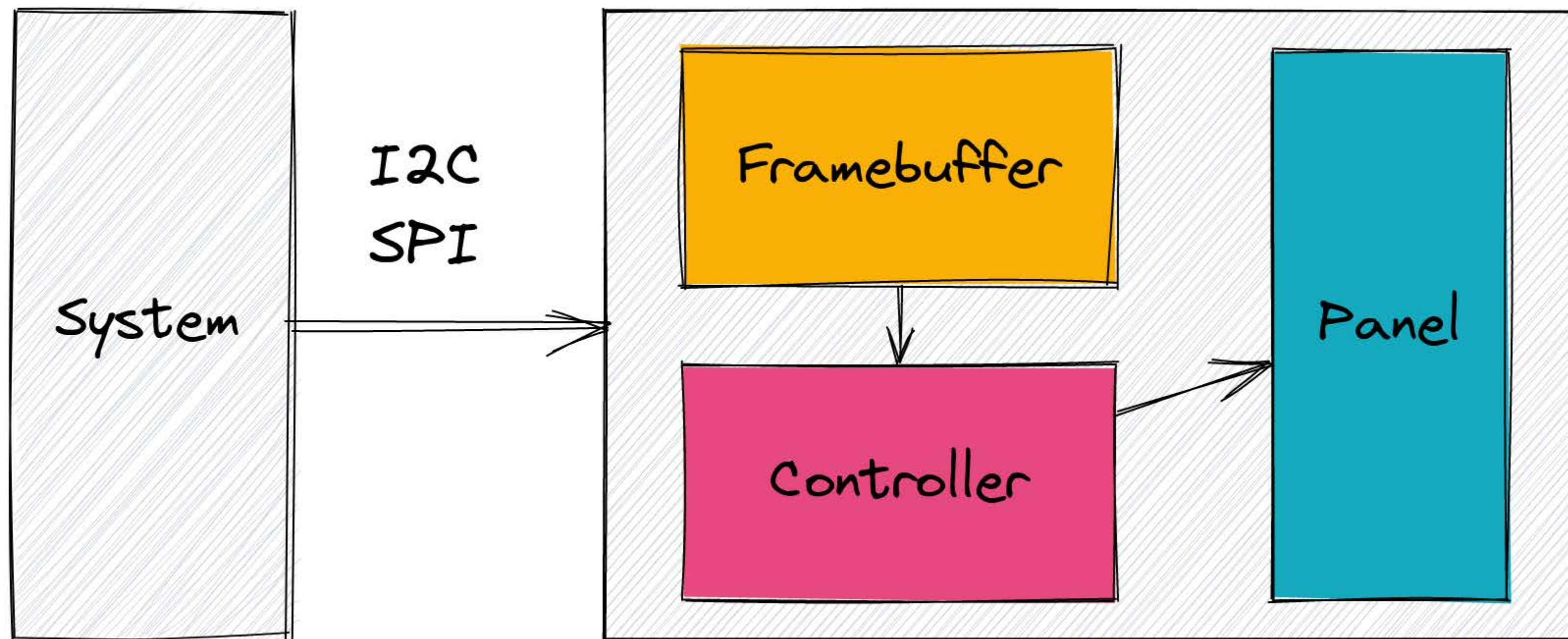
Embedded Recipes - Maxime Ripard

30/05/2022 - Paris, France

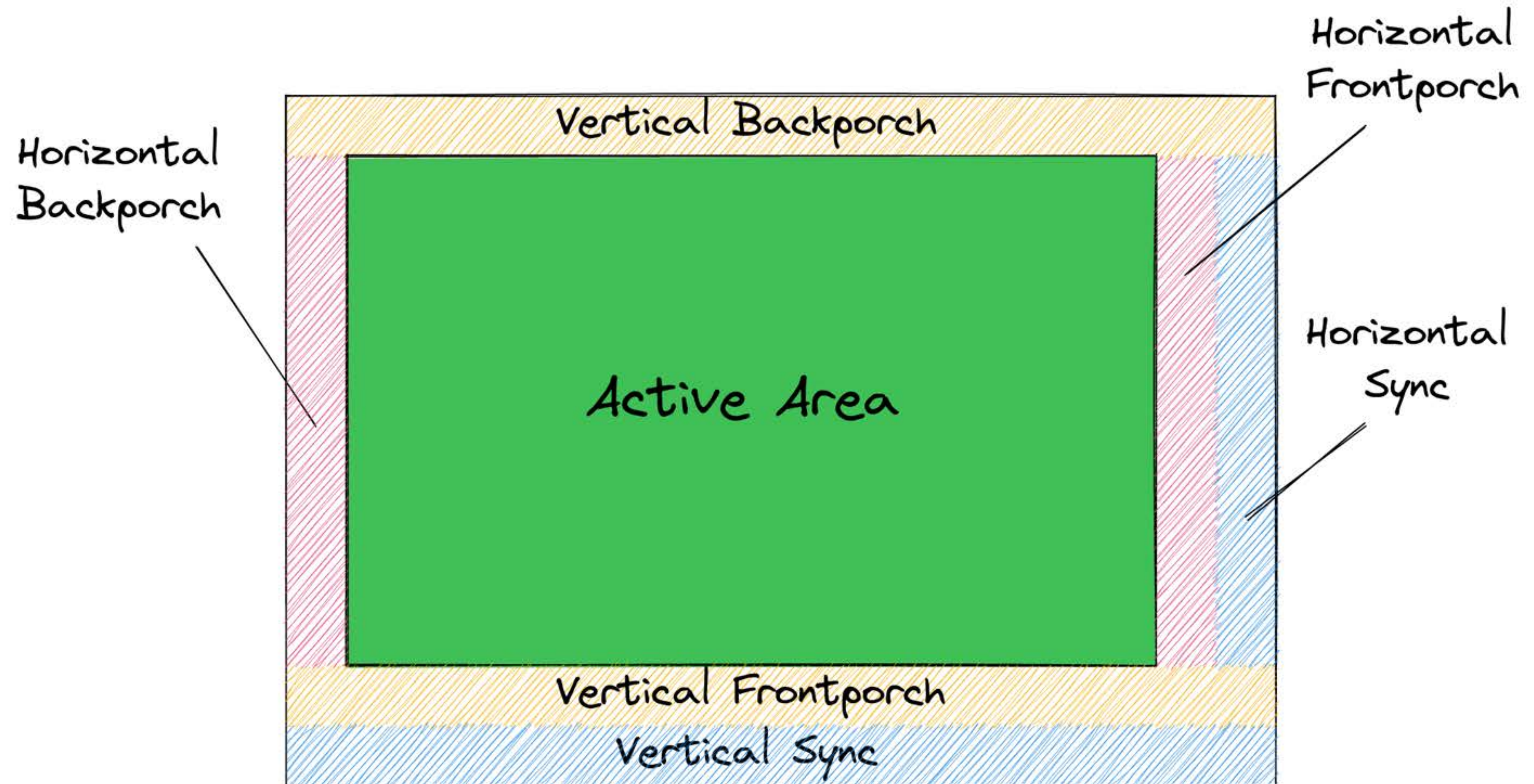


Show and Tell

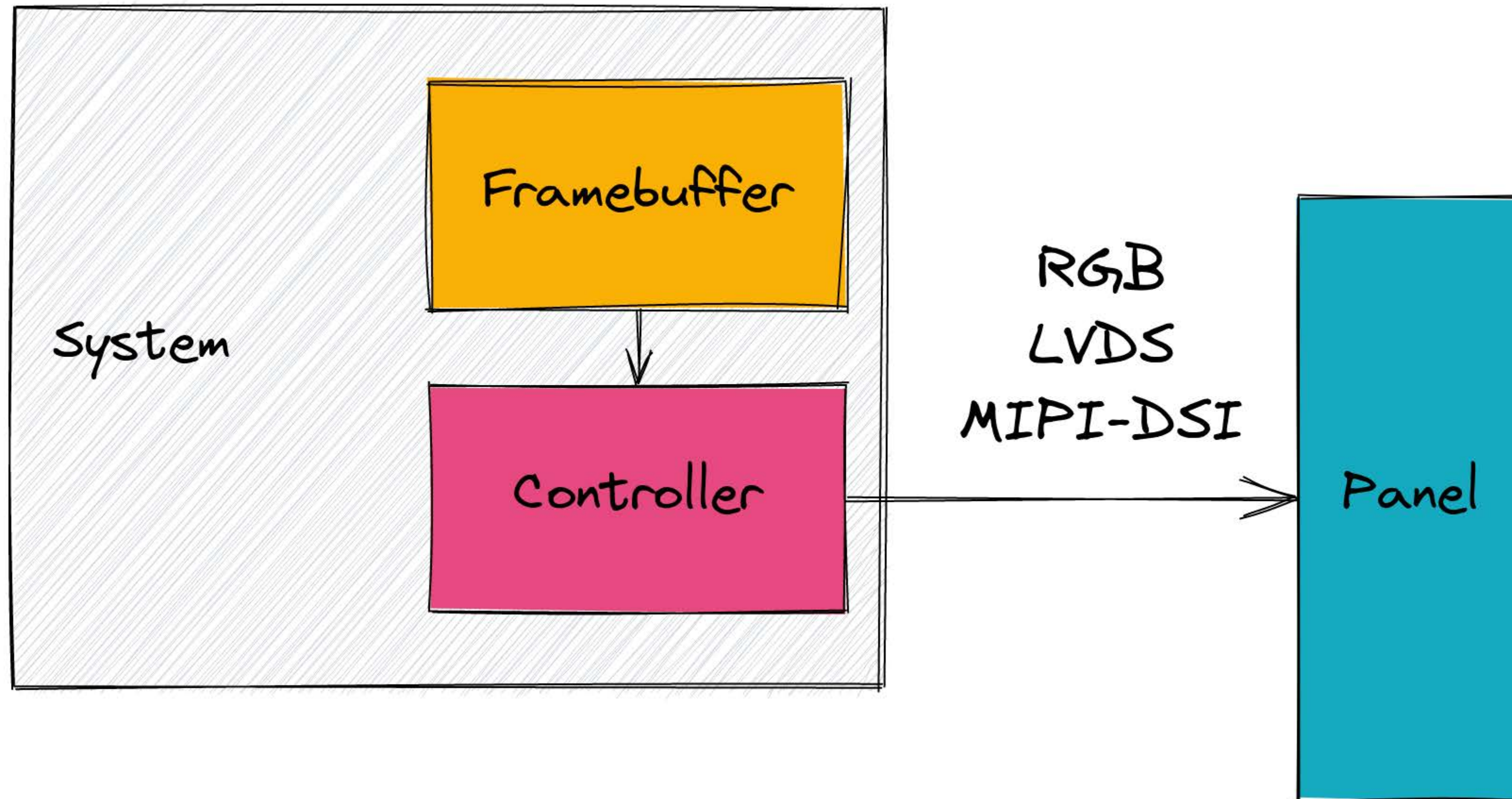
Very Simple Display



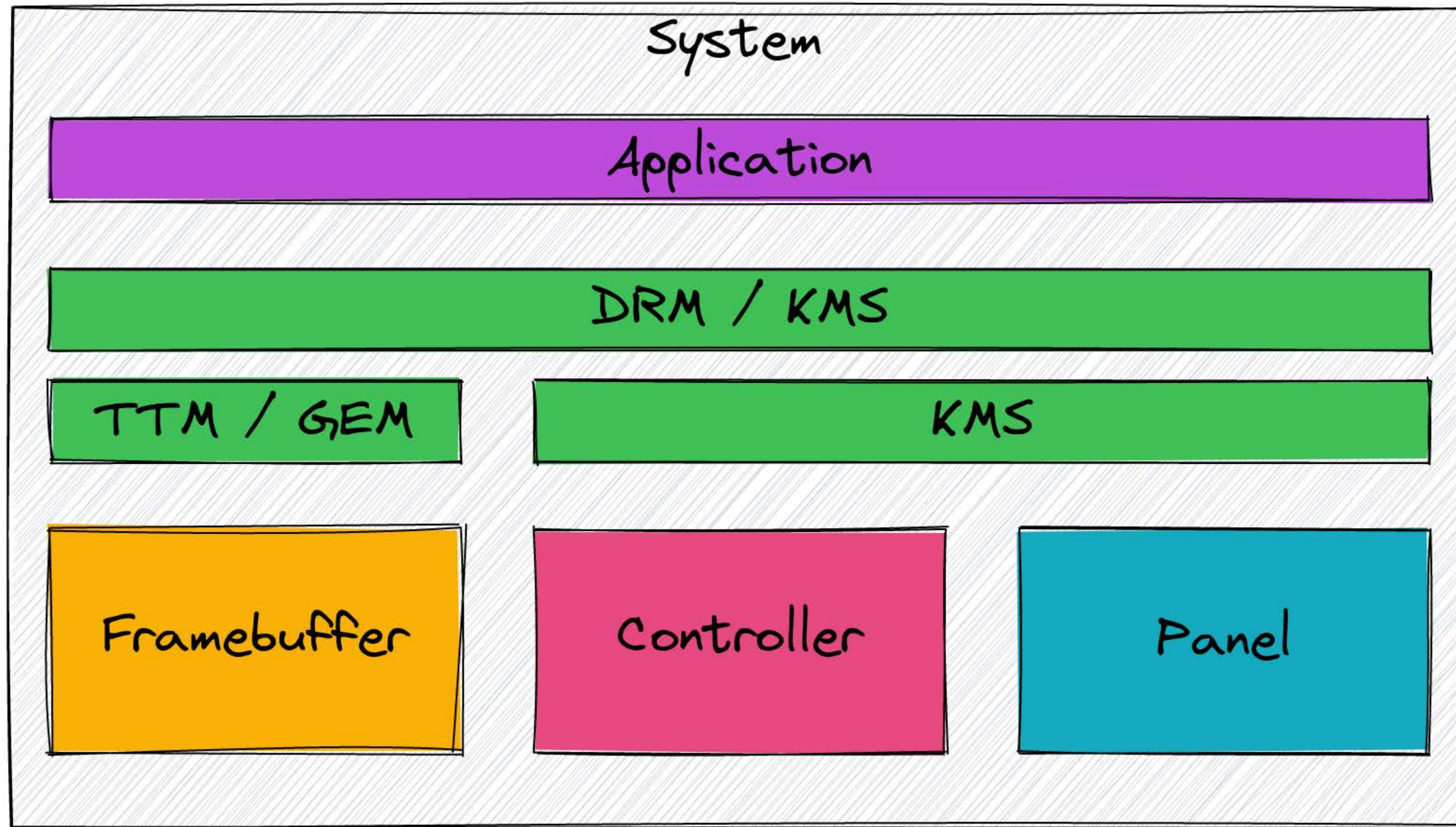
Timings



Panel



* KMS has entered the chat *

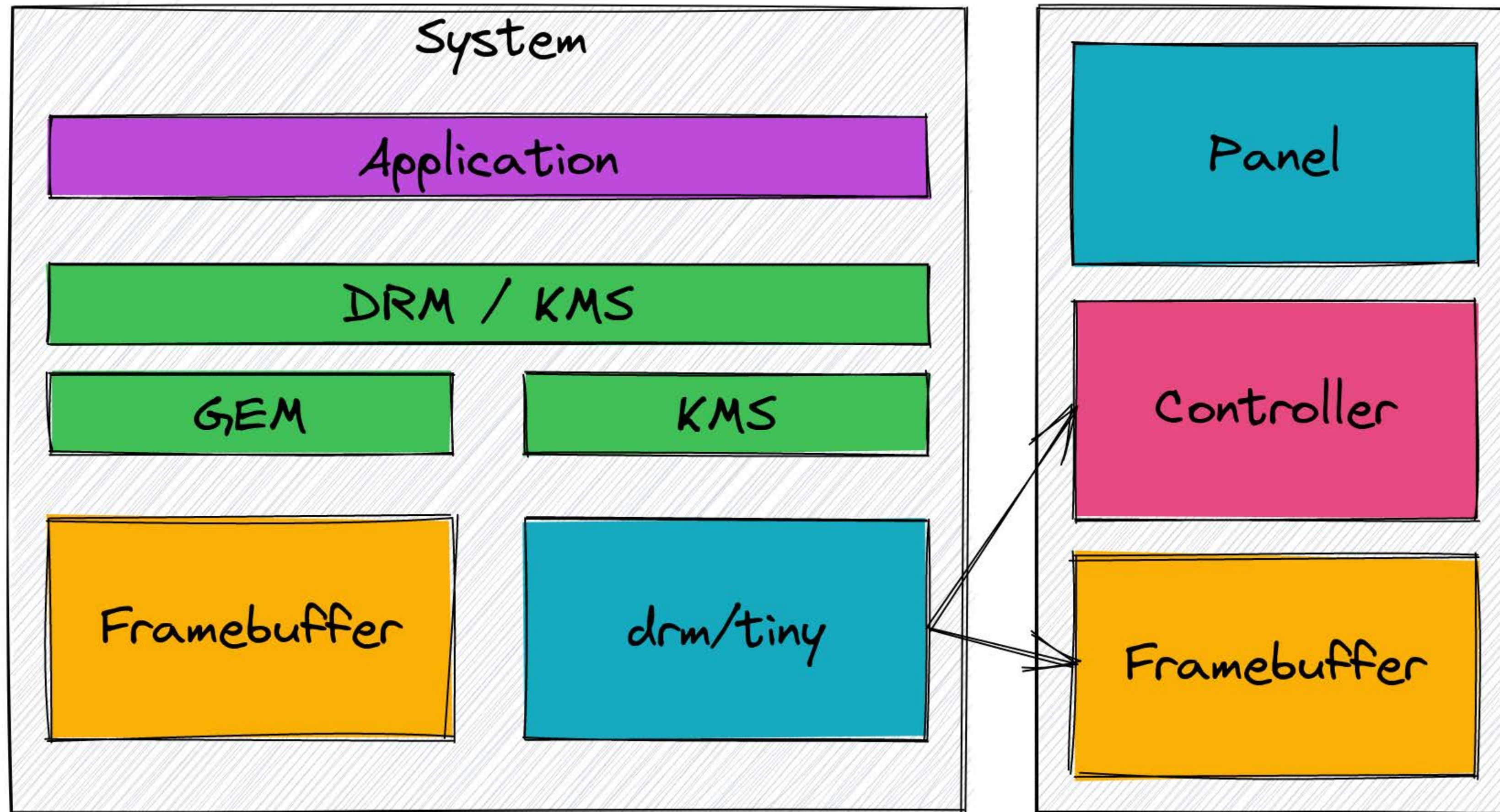


Panel Drivers

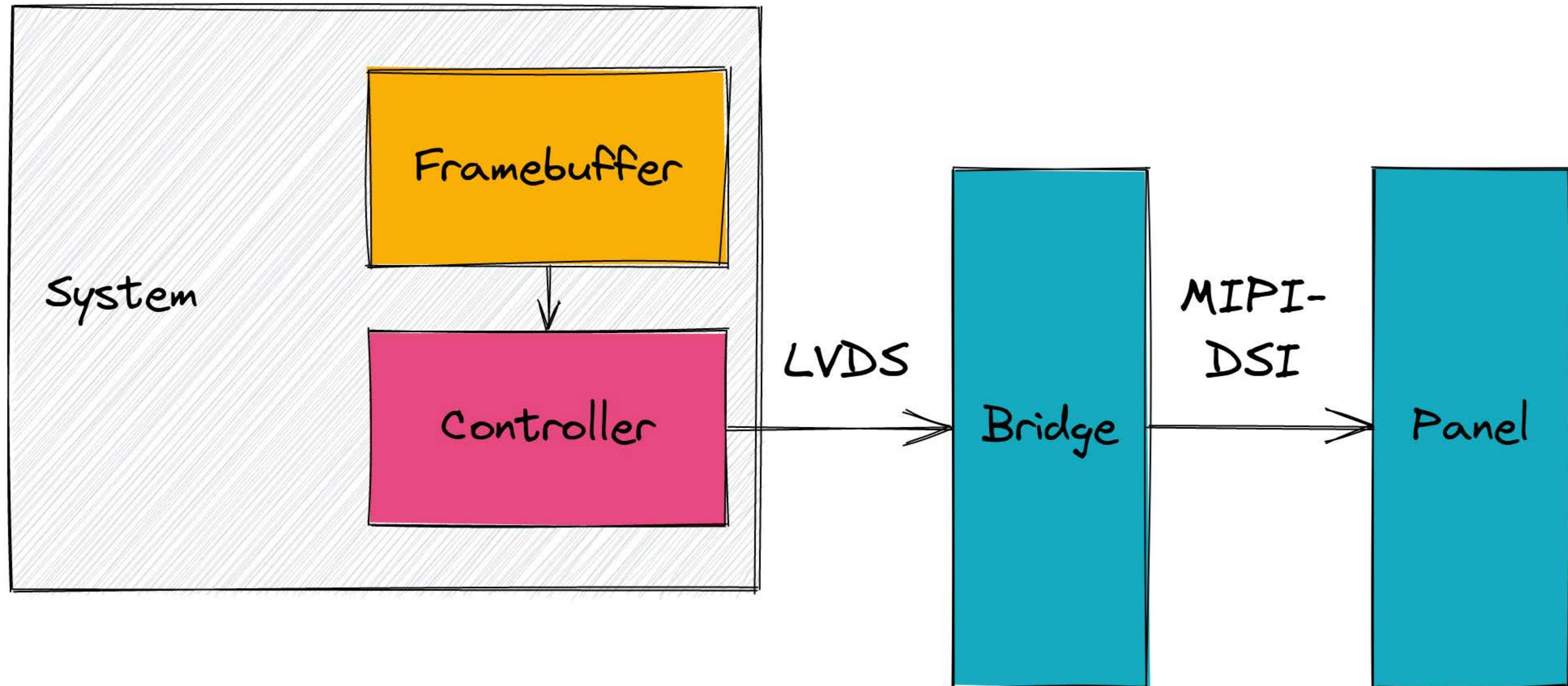
- All the panel drivers are generic and can be reused across controllers
- Different cases:
 - Completely generic drivers: panel-dpi, panel-edp, panel-lvds
 - Generic driver, with panel-specific quirks: panel-simple
 - Custom drivers



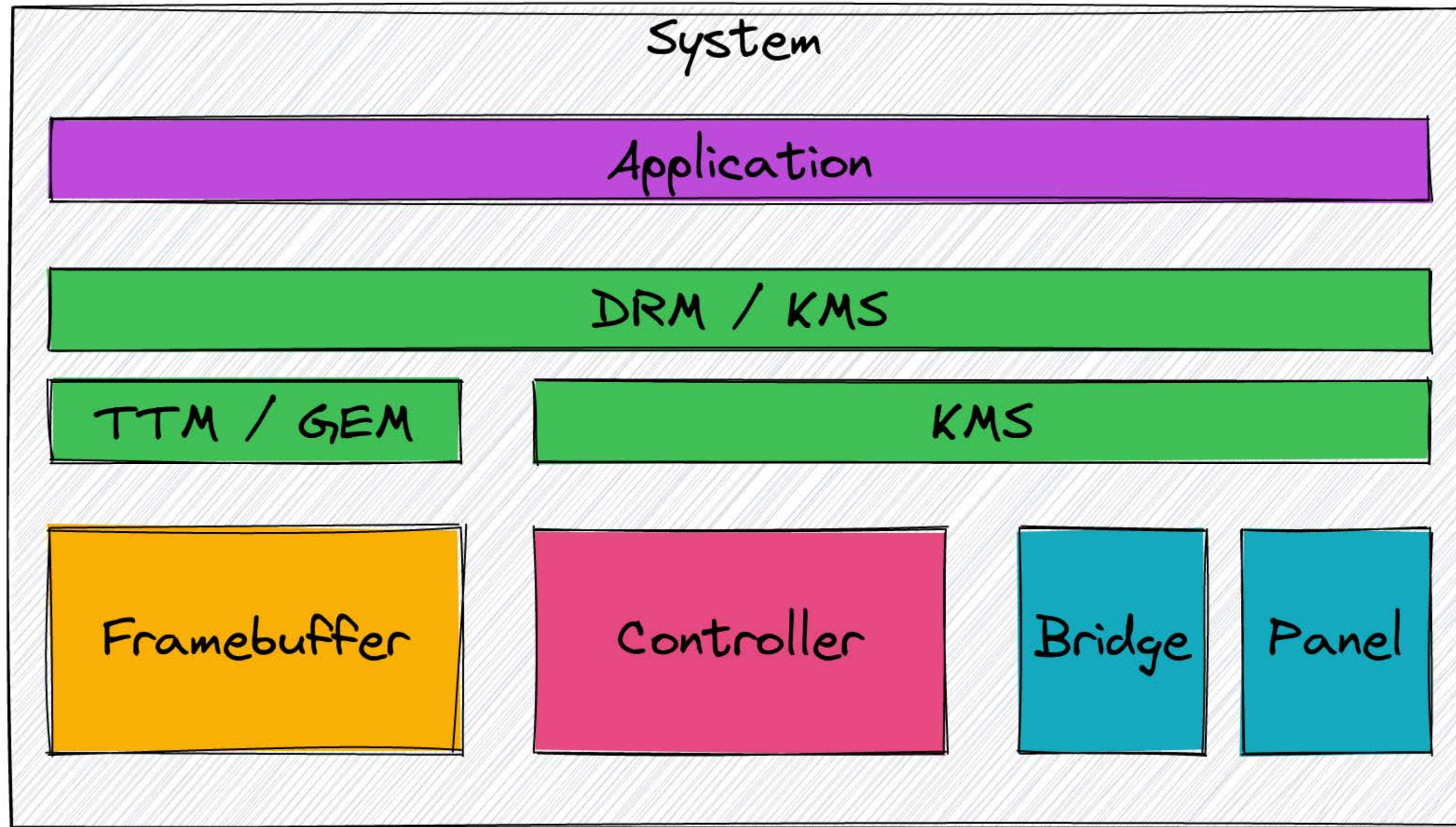
Back to our I2C/SPI Panel



Bridges



KMS Architecture for bridges

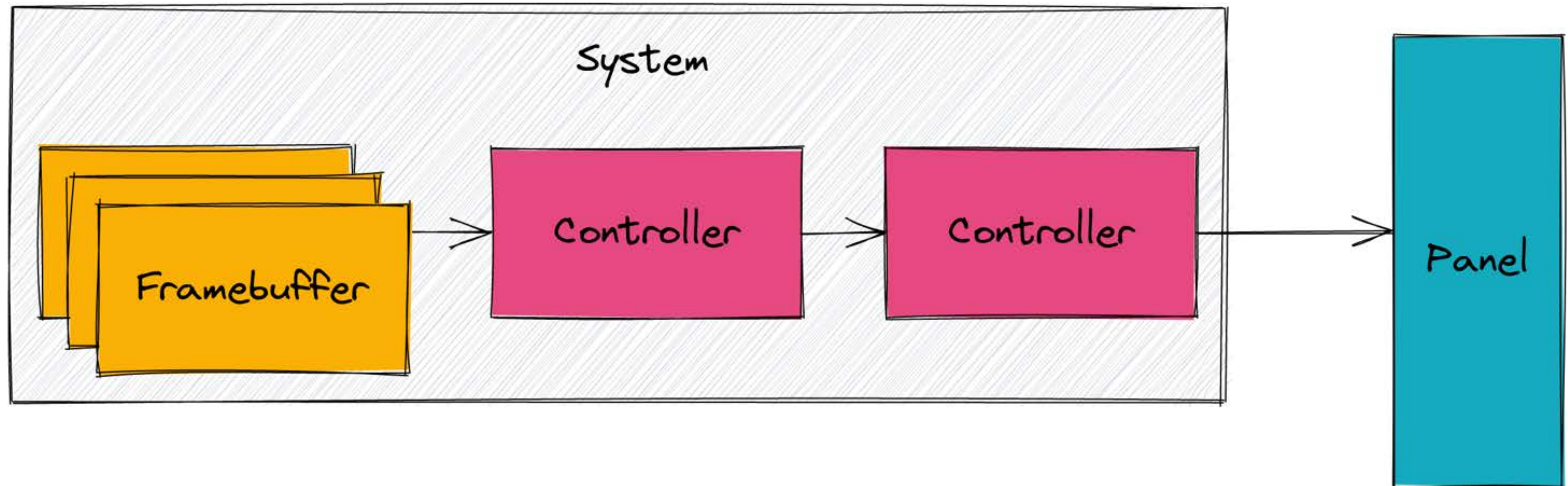


Bridge Drivers

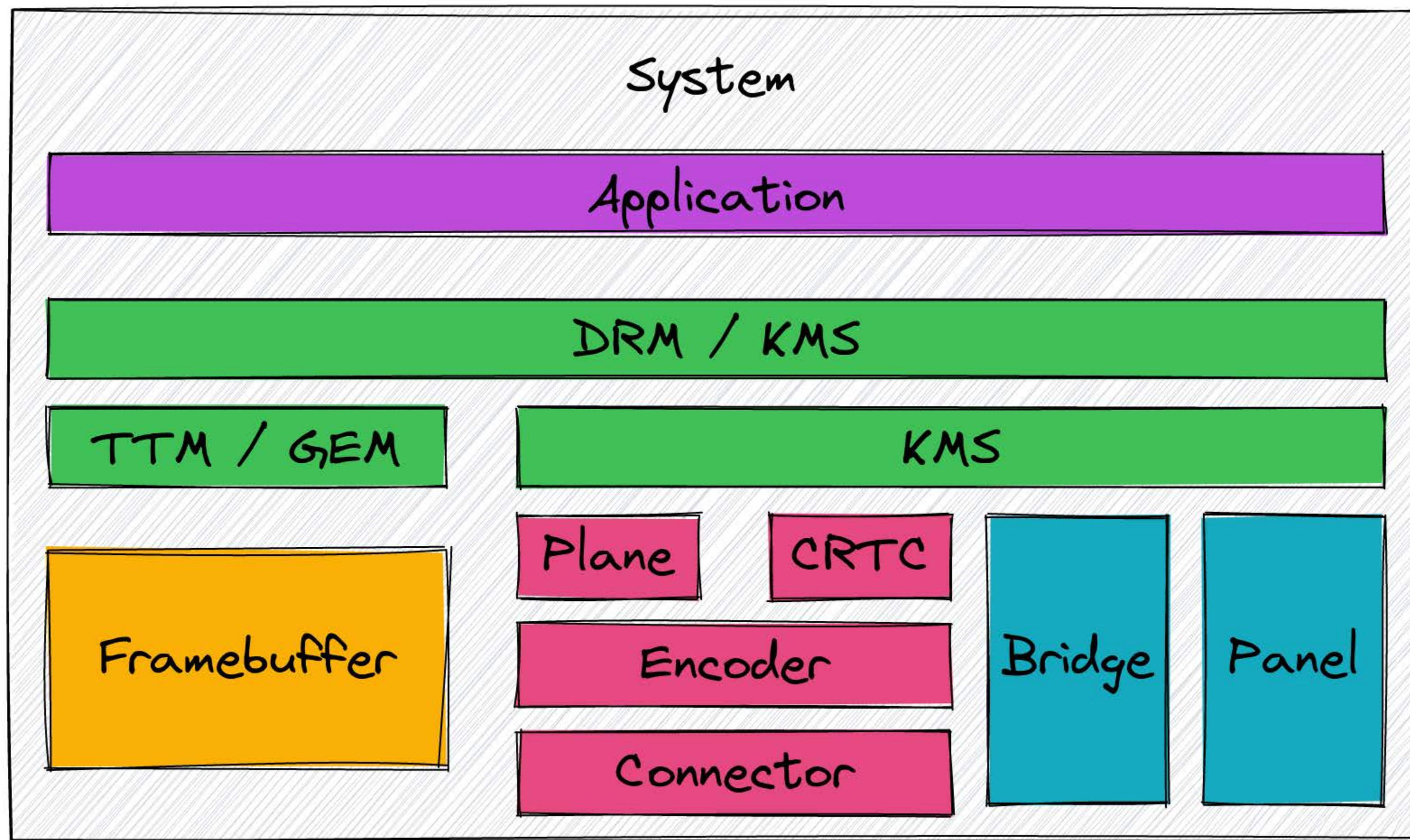
- Chains of converters between one interface and another one
- All independent drivers, only the last in the chain is exposed to userspace
- Negotiation between all the components in the chain to find the proper resolution



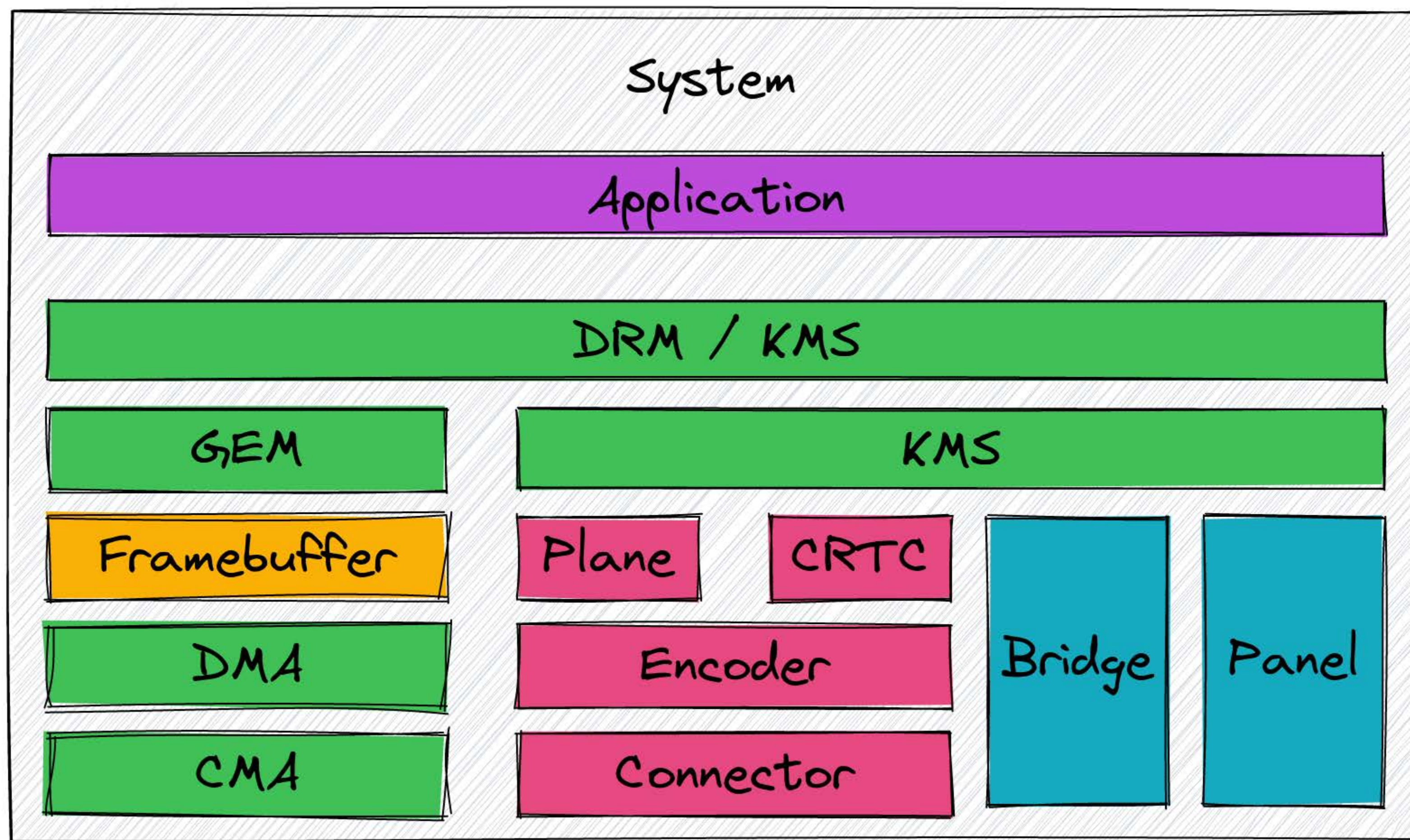
Typical Display Controller



Typical KMS Architecture



Typical KMS Architecture, Bis

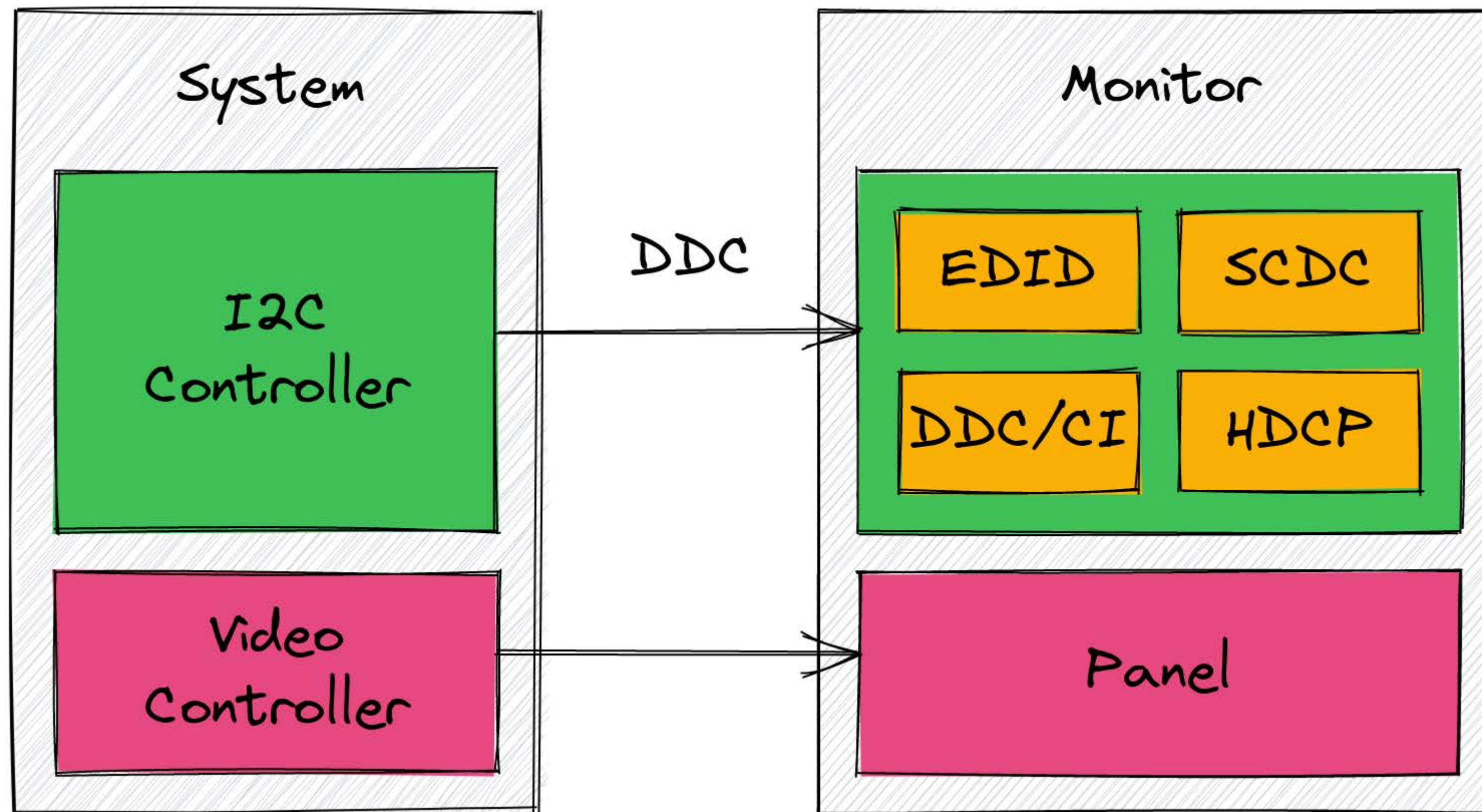


External Display

- Several interfaces: VGA, DVI, HDMI, DisplayPort
- Similar to panels, but:
 - Connection status is reported by the connector
 - EDID/DisplayID describe the monitor capabilities
 - EDID retrieved by the connector (and somewhat standardized)
 - No further setup is expected
- Usually also contain other features: CEC, Audio, etc.
 - Handled by their respective framework of choices: CEC, ALSA (hdmi-codec)



External Monitor Architecture

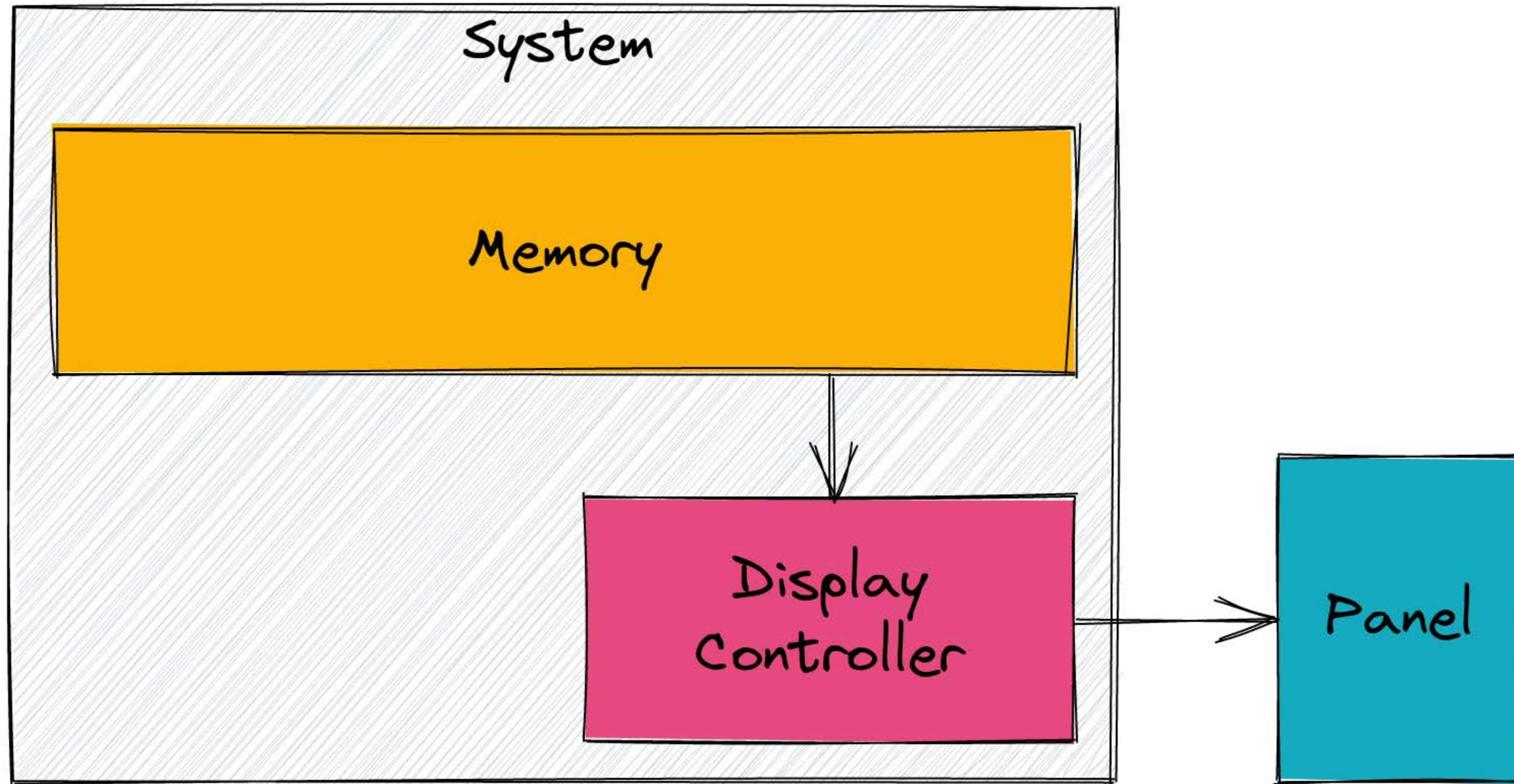


18 - <https://www.cer>

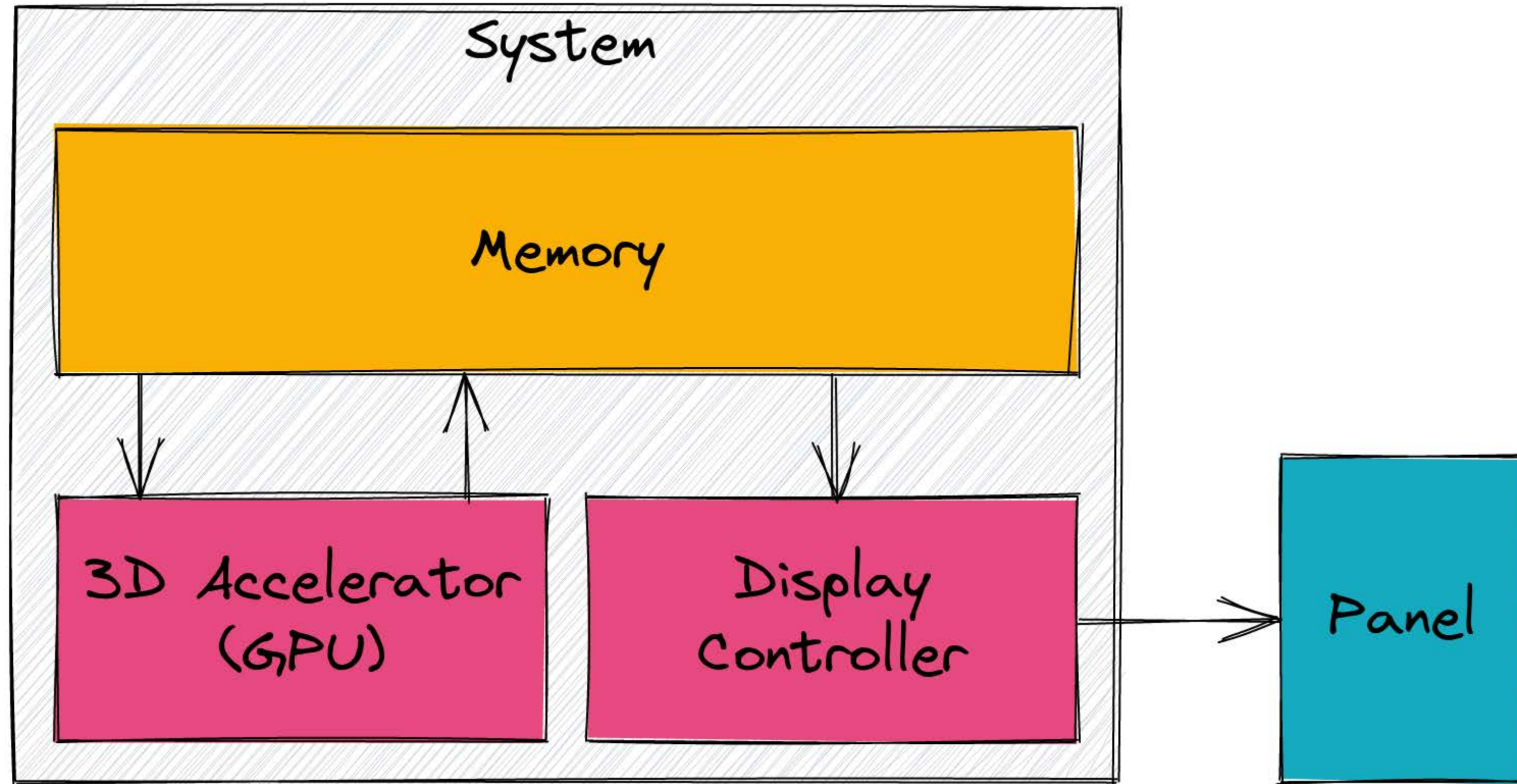


Accelerators

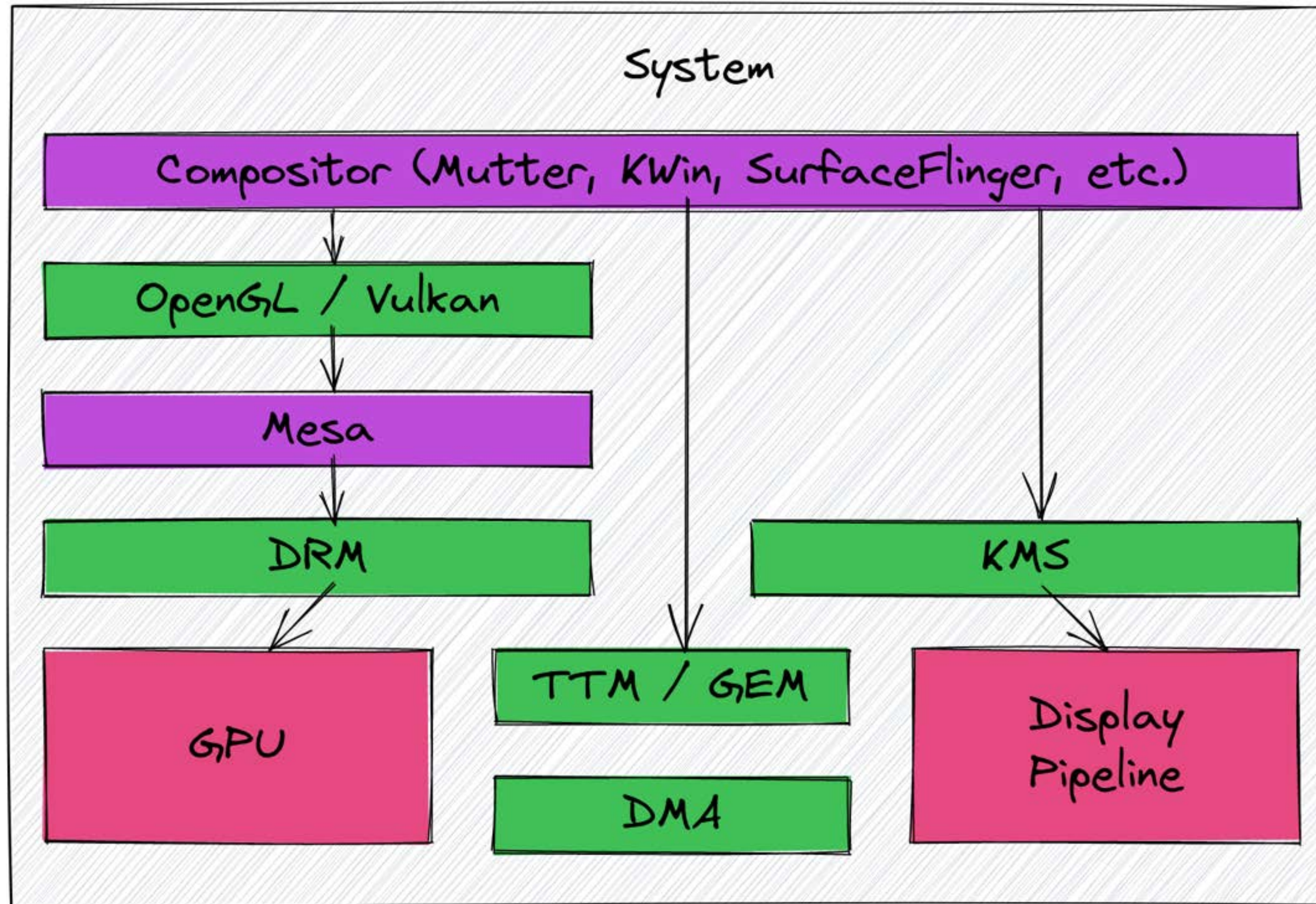
Basic system



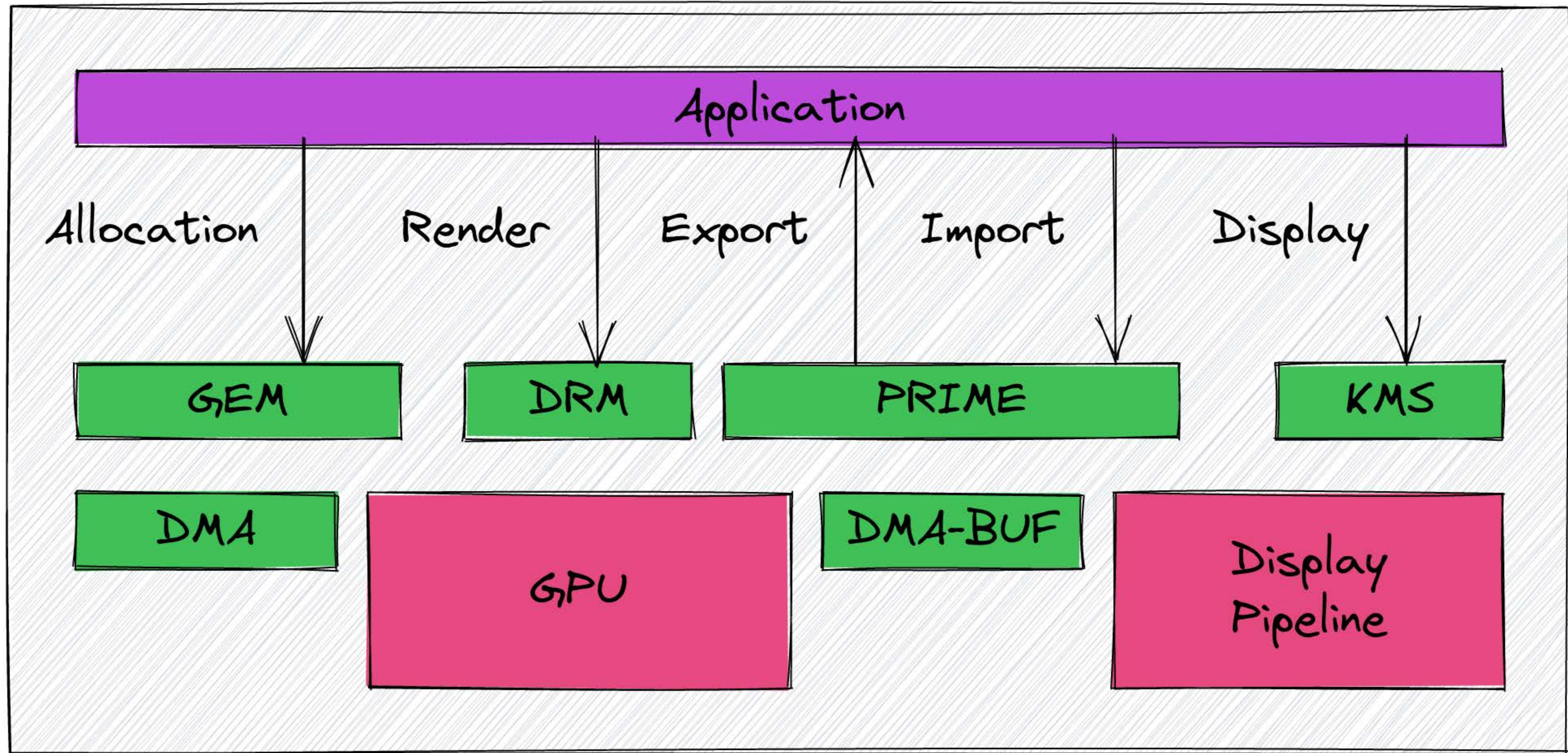
3D Rendering



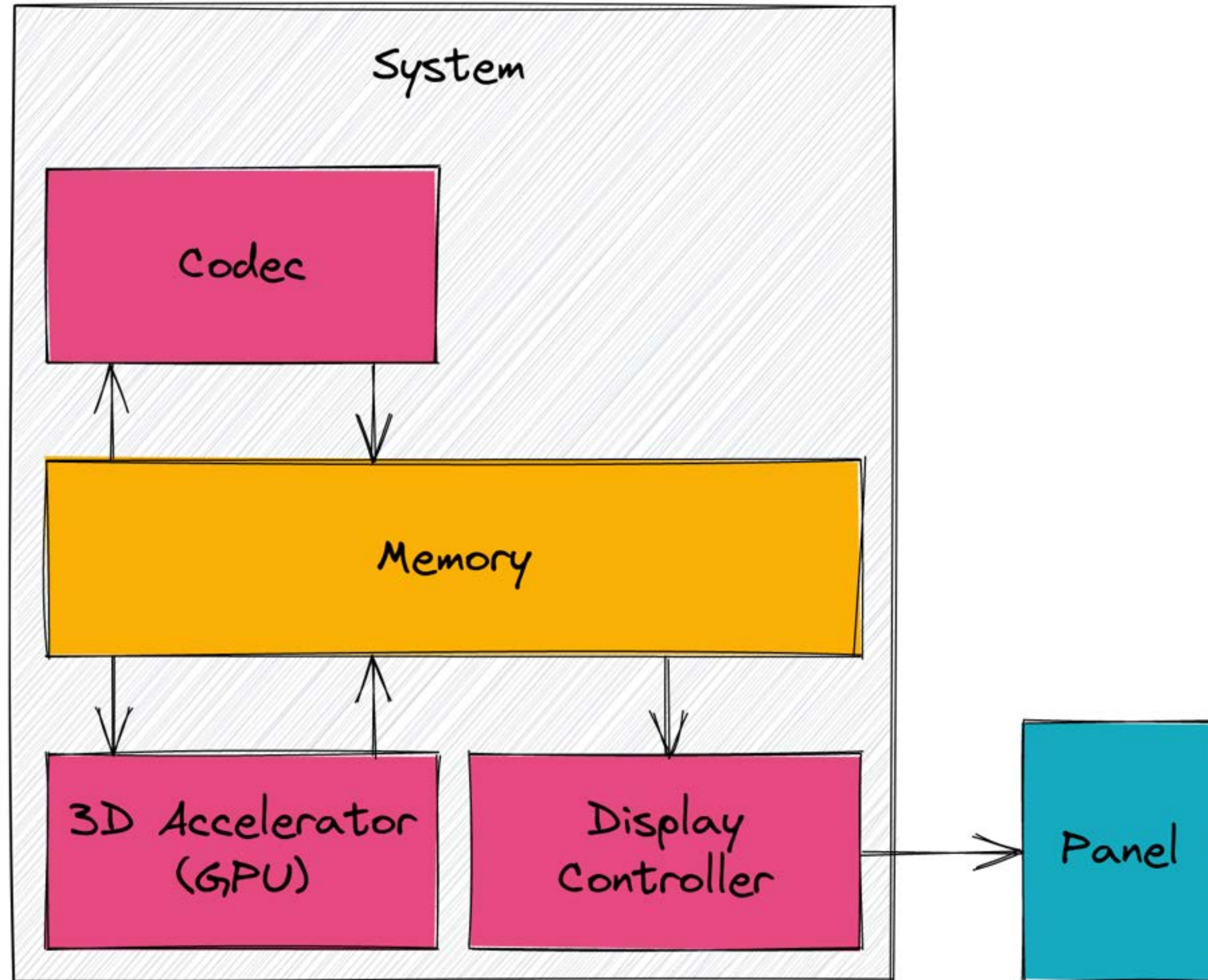
3D Rendering, Integration



Zero Copy



Hardware Codec

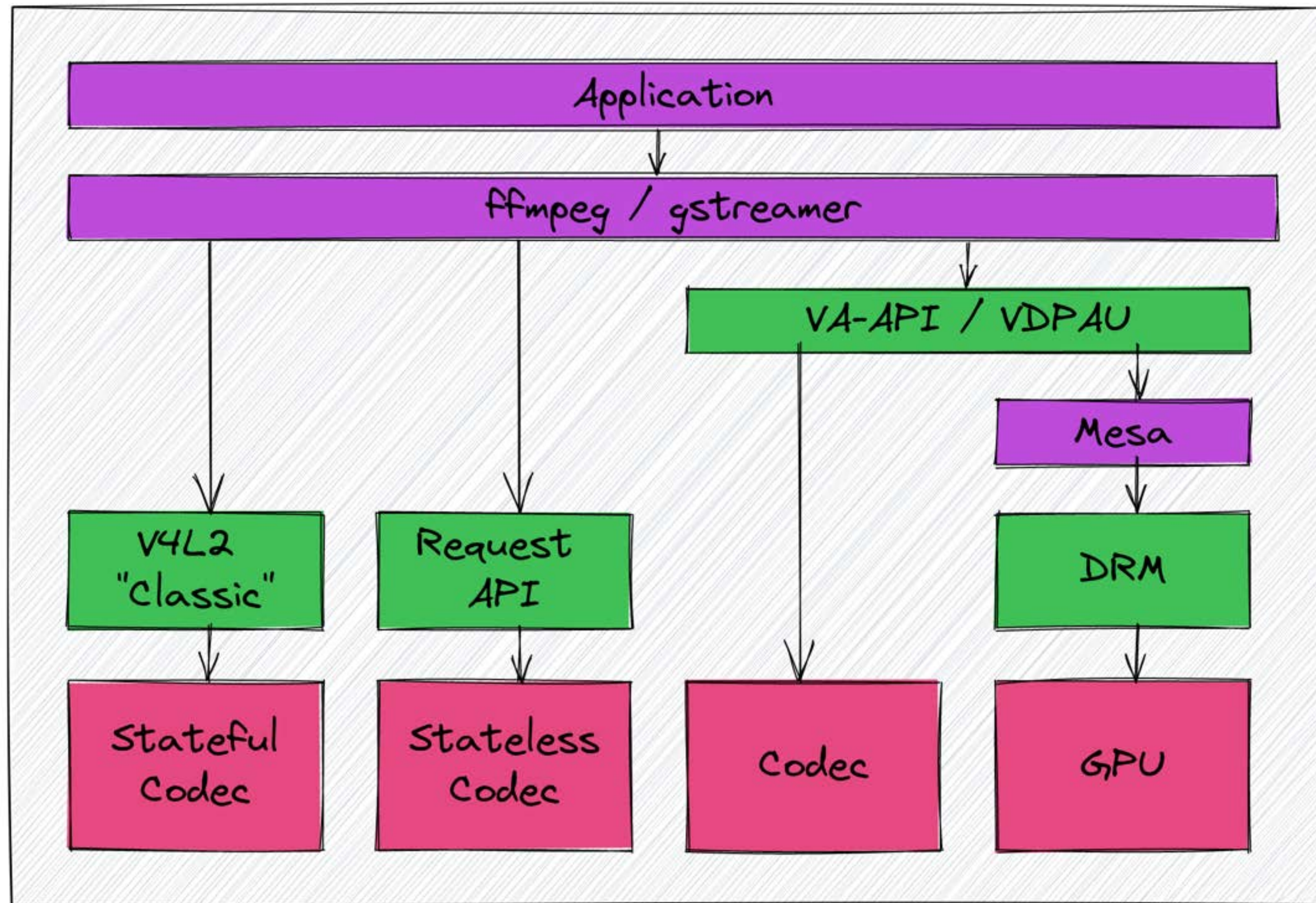


Hardware Codec, Context

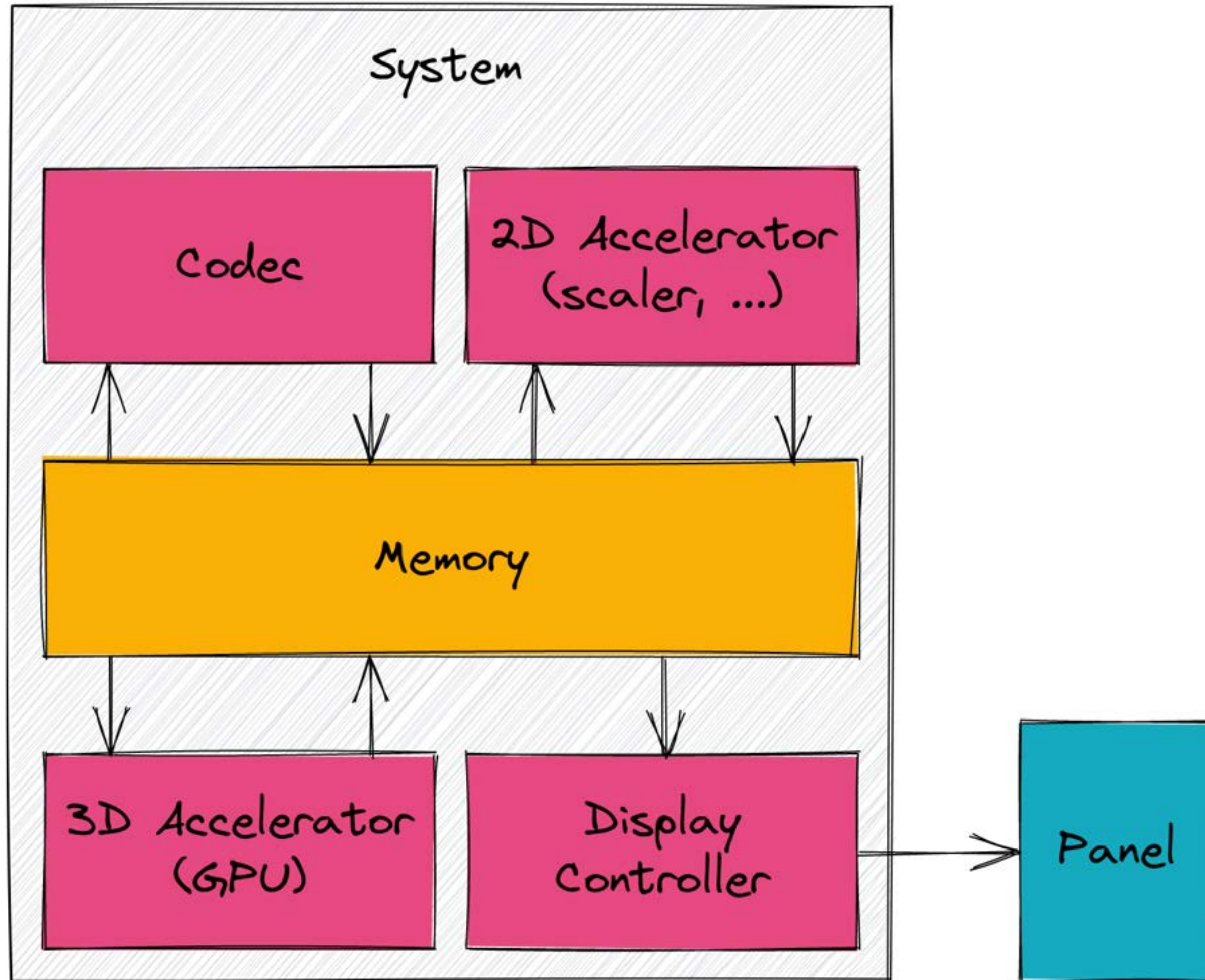
- Stateful
 - Takes the raw bitstream
 - Decoding state is maintained by the hardware
 - Supported by V4L2
- Stateless
 - Needs to parse the bitstream in software
 - Decoding state is maintained by the software
 - Supported by V4L2 through the Request API
 - Formerly introduced in 5.11 (H264), 5.13 (VP8), 5.14 (MPEG2), 5.17 (VP9)
 - Not upstream for FFmpeg, Gstreamer 1.19.1 (Jun 2021) for H264, 1.19.2 (Sep 2021) for VP8



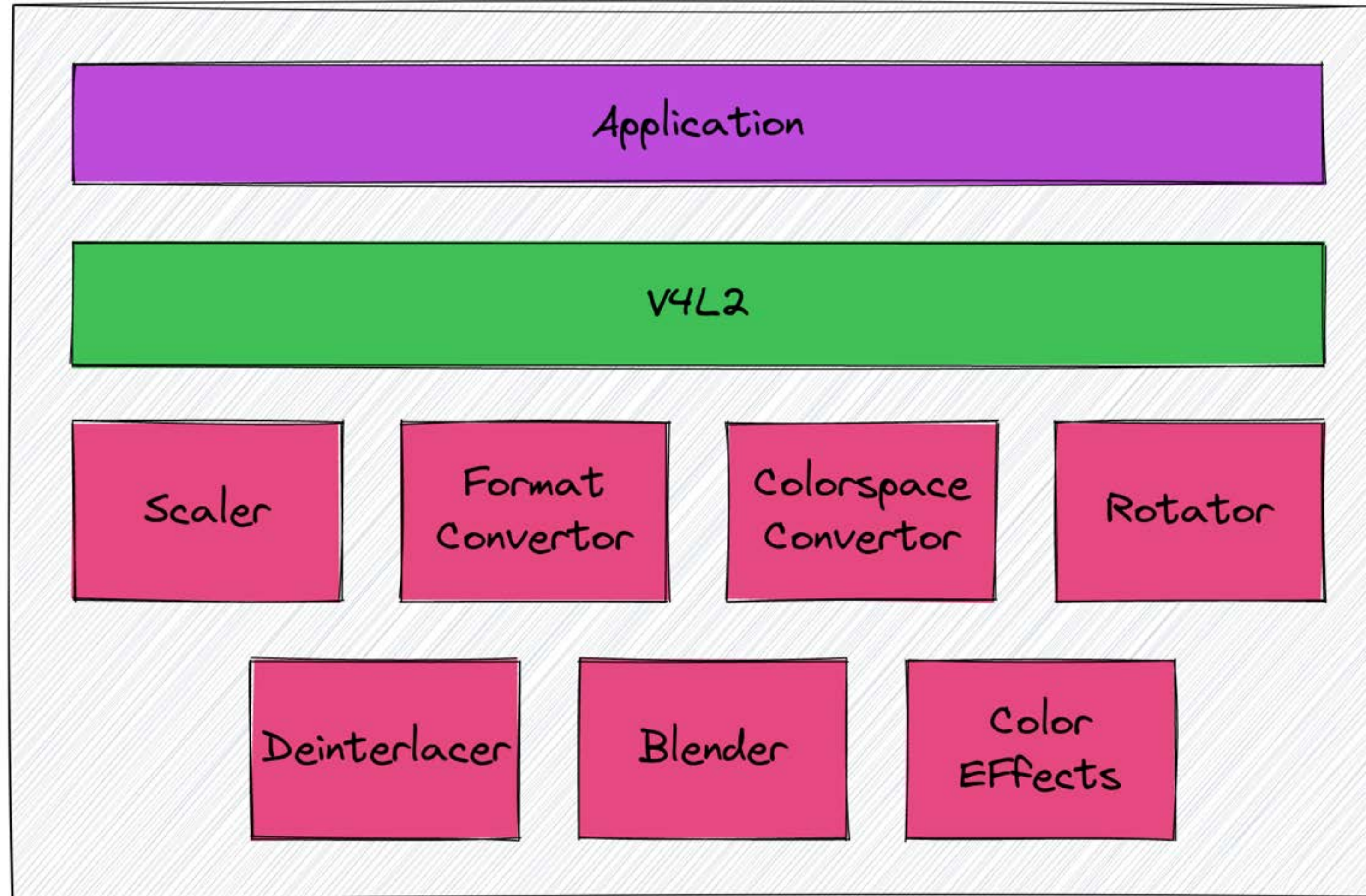
Hardware Codec, Integration



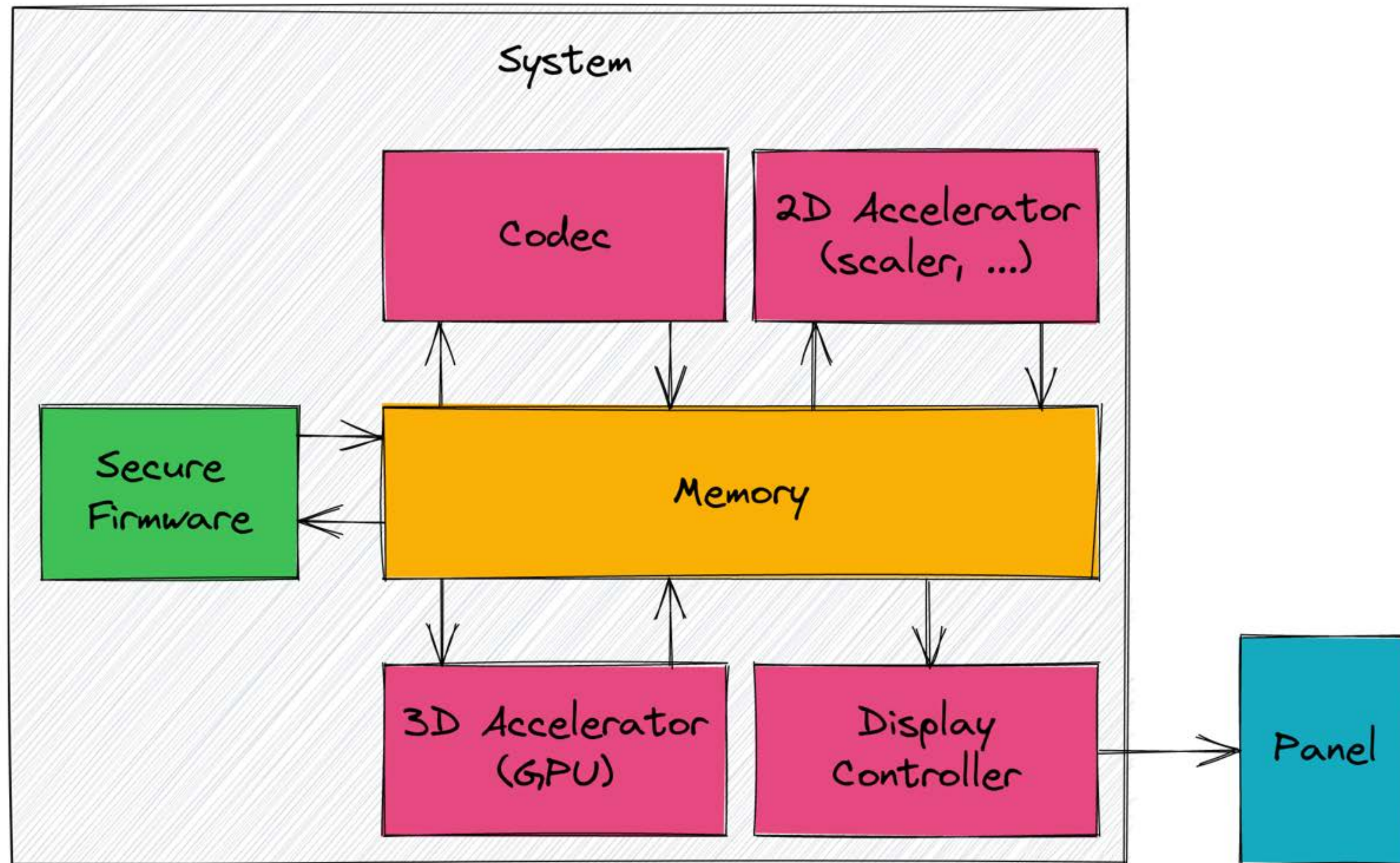
2D Accelerators



2D Accelerators, Integration



Secure Playback

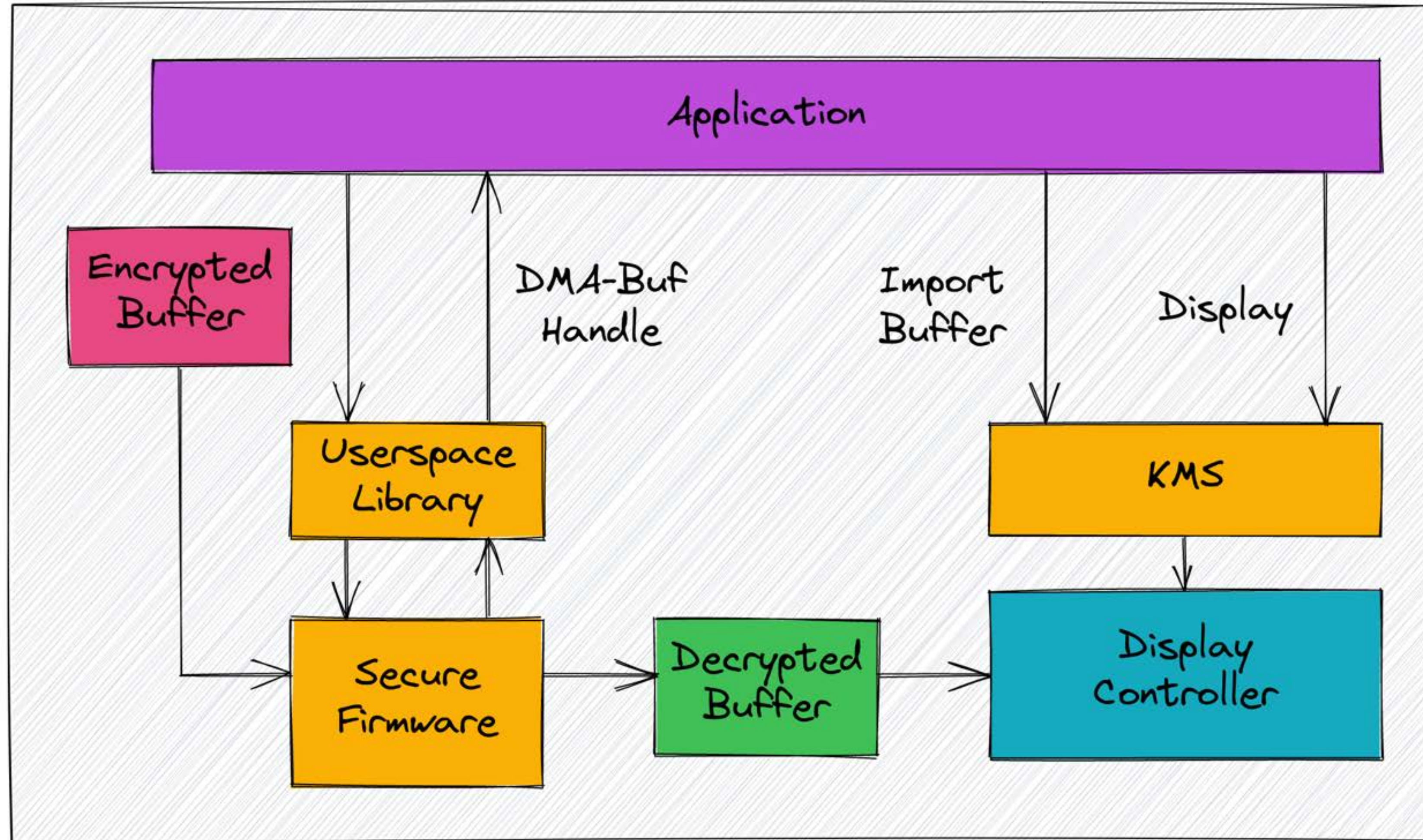


Secure Playback

- Secure as in Secure Environment, not Secure Component
- Firmware drives at least
 - a hardware crypto engine
 - a hardware codec
 - and will enforce memory bus permissions for the system
- The secure codec and crypto engine can access non-secure buffers
- The display controller can access in read-only secure buffers
- The non-secure system (Linux) cannot access secure buffers



Secure Playback, Integration



Any Questions?



Contact

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 [in/mripard](https://www.linkedin.com/in/mripard)