Anatomy of an Embedded KMS Driver

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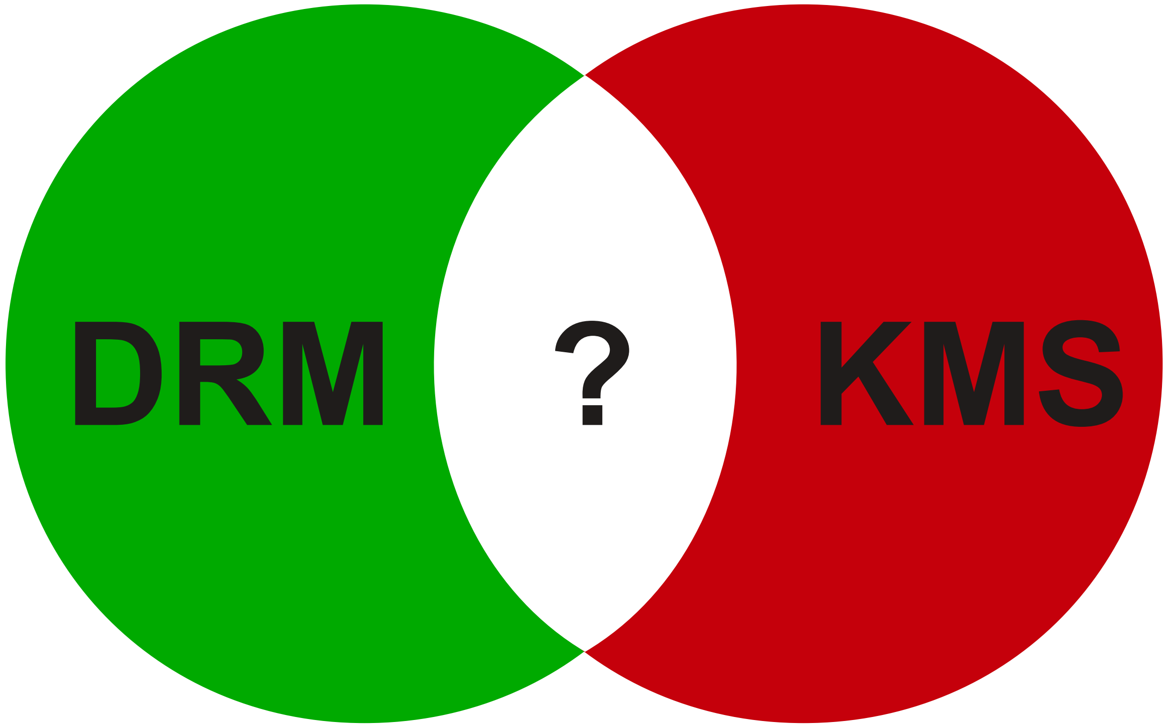


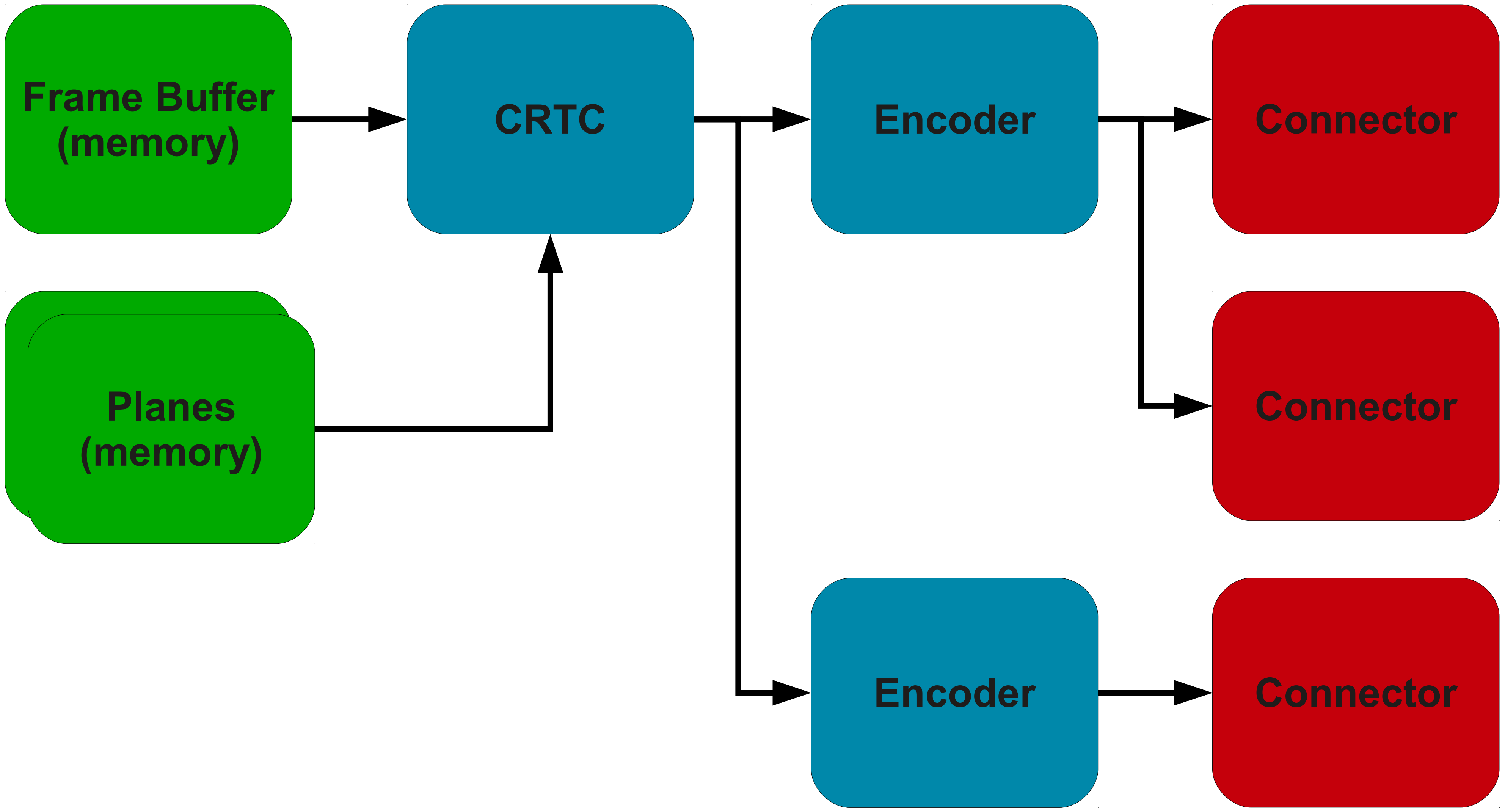
APIs

- Memory Management
- Vertical Blanking
- Version, Authentication, Master, ...

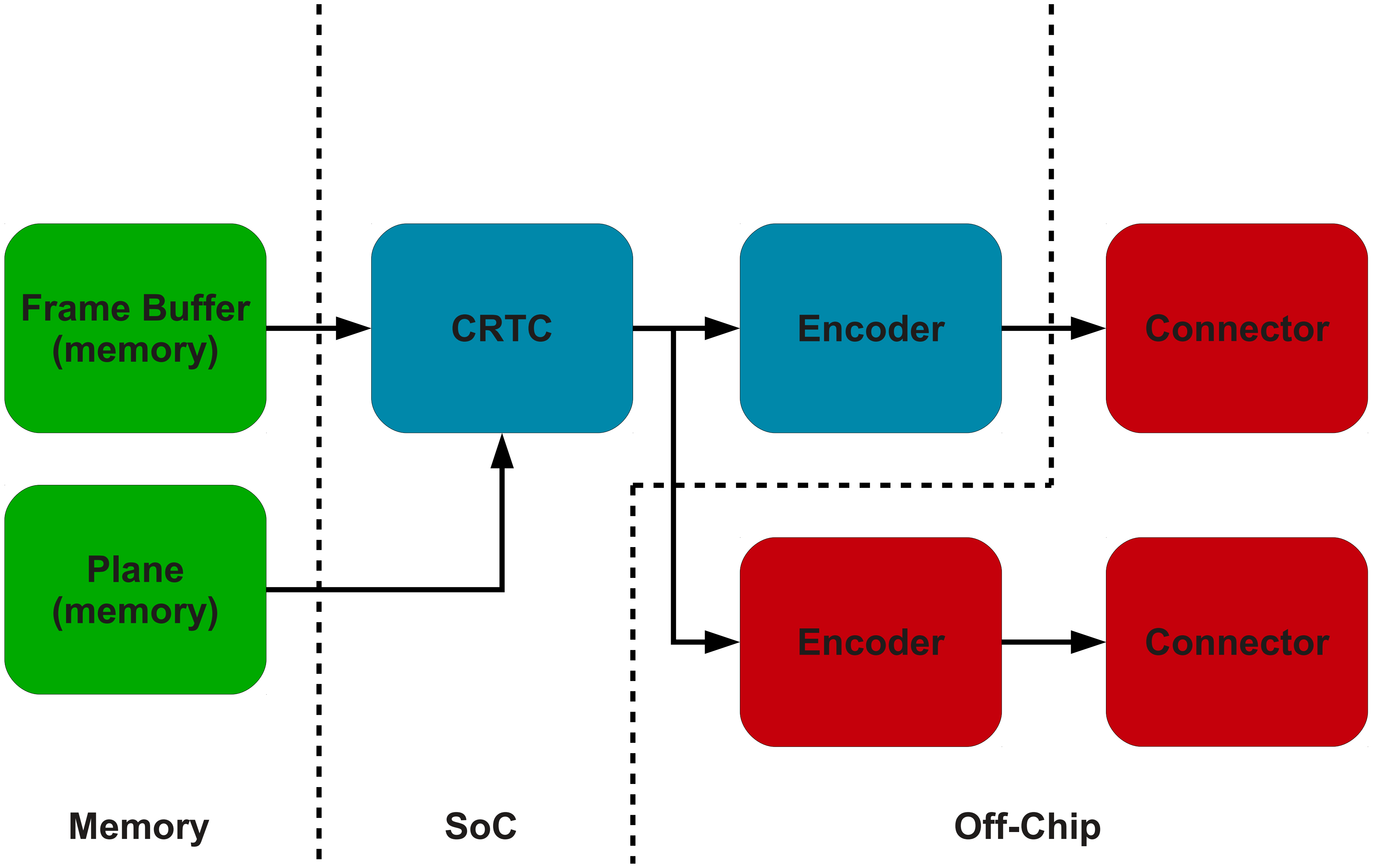
DRM

- Device Model
- Frame Buffer
- Modes
- Page Flip
- Planes
- Cursor, Gamma, ...

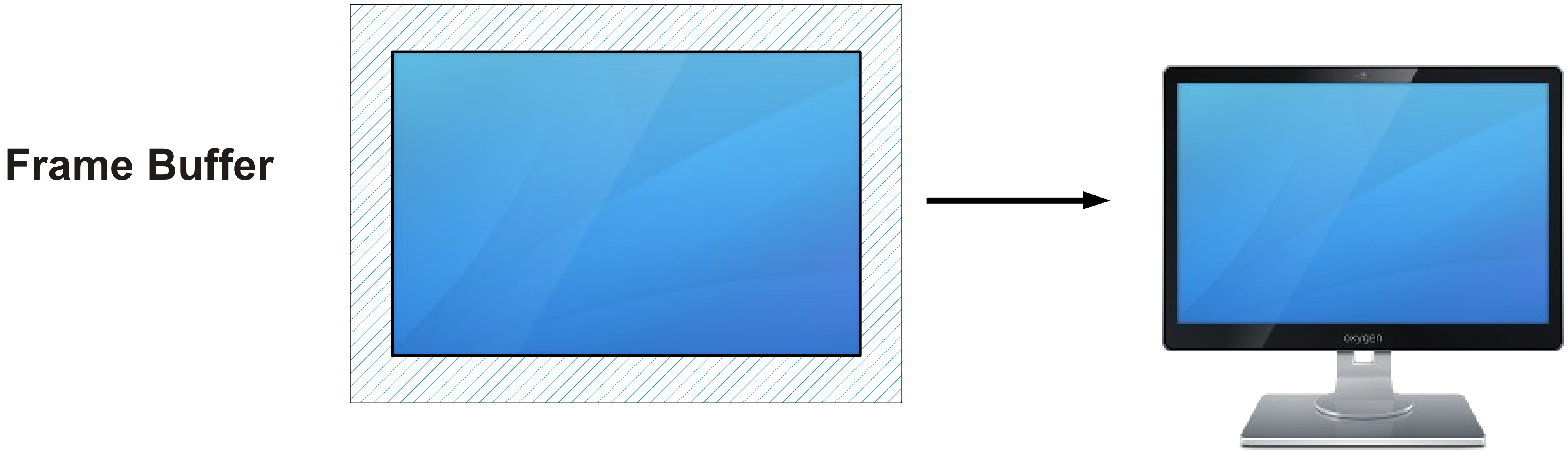
KMS



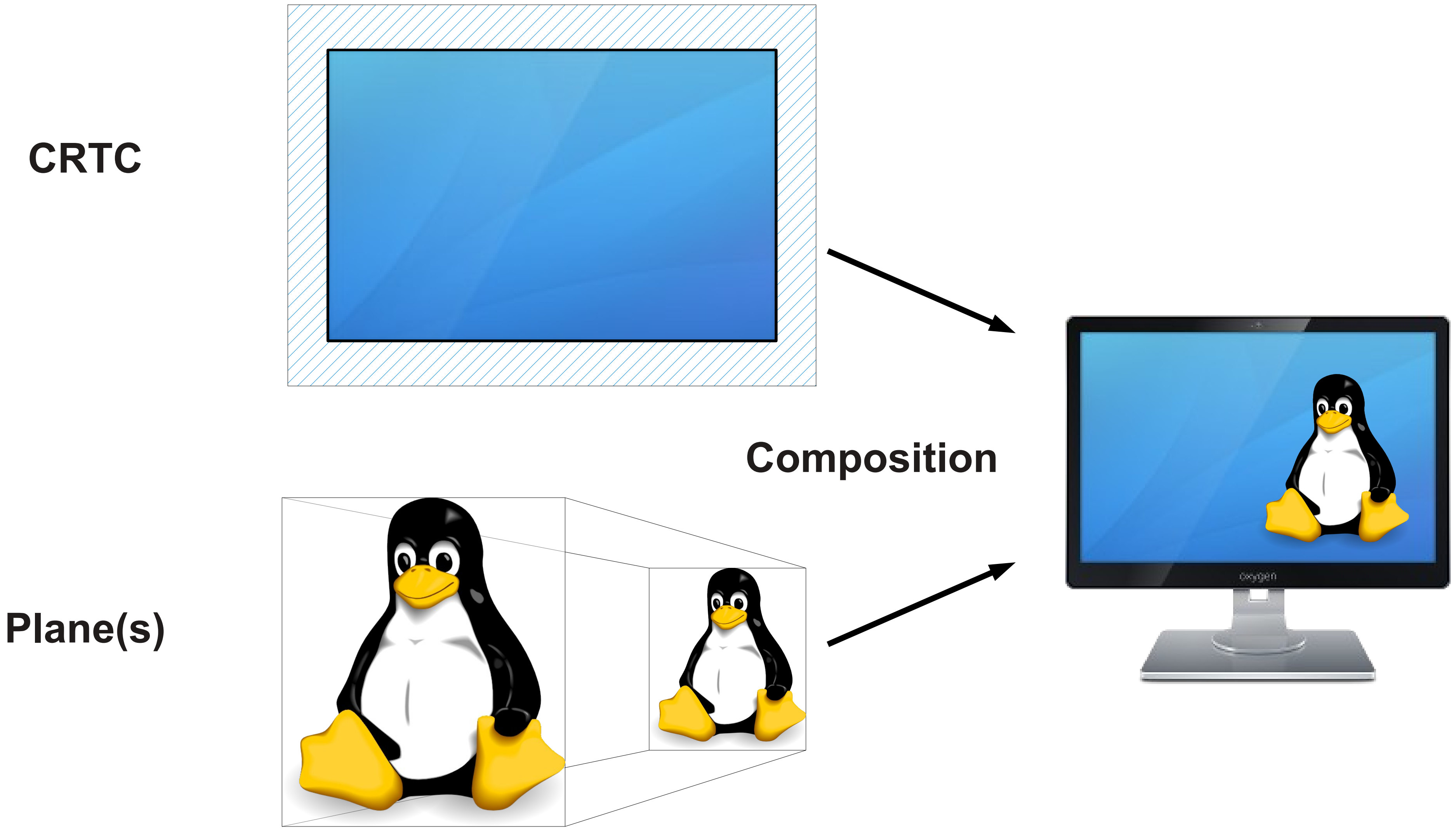
Device Model



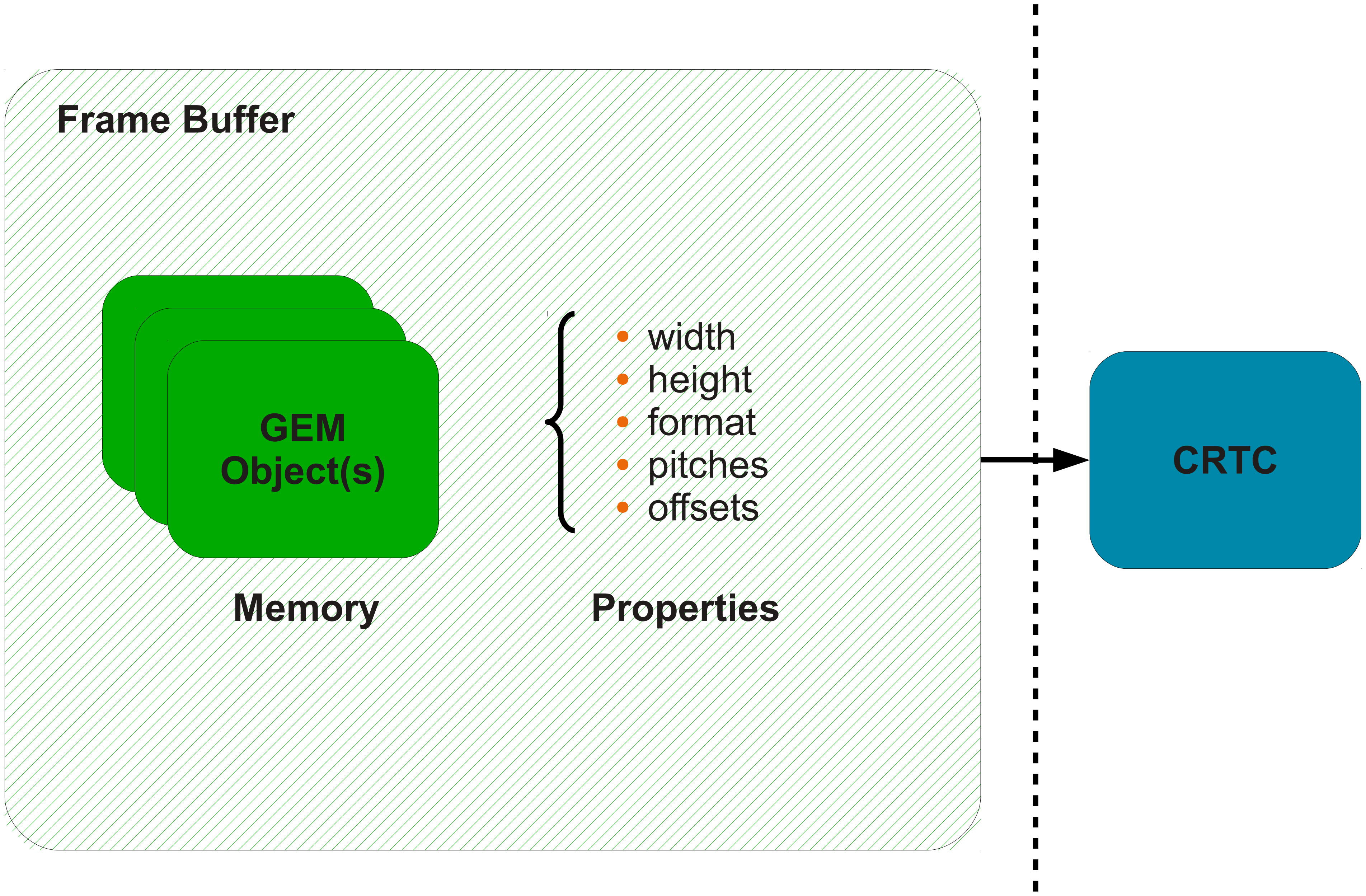
Device Model - SoC



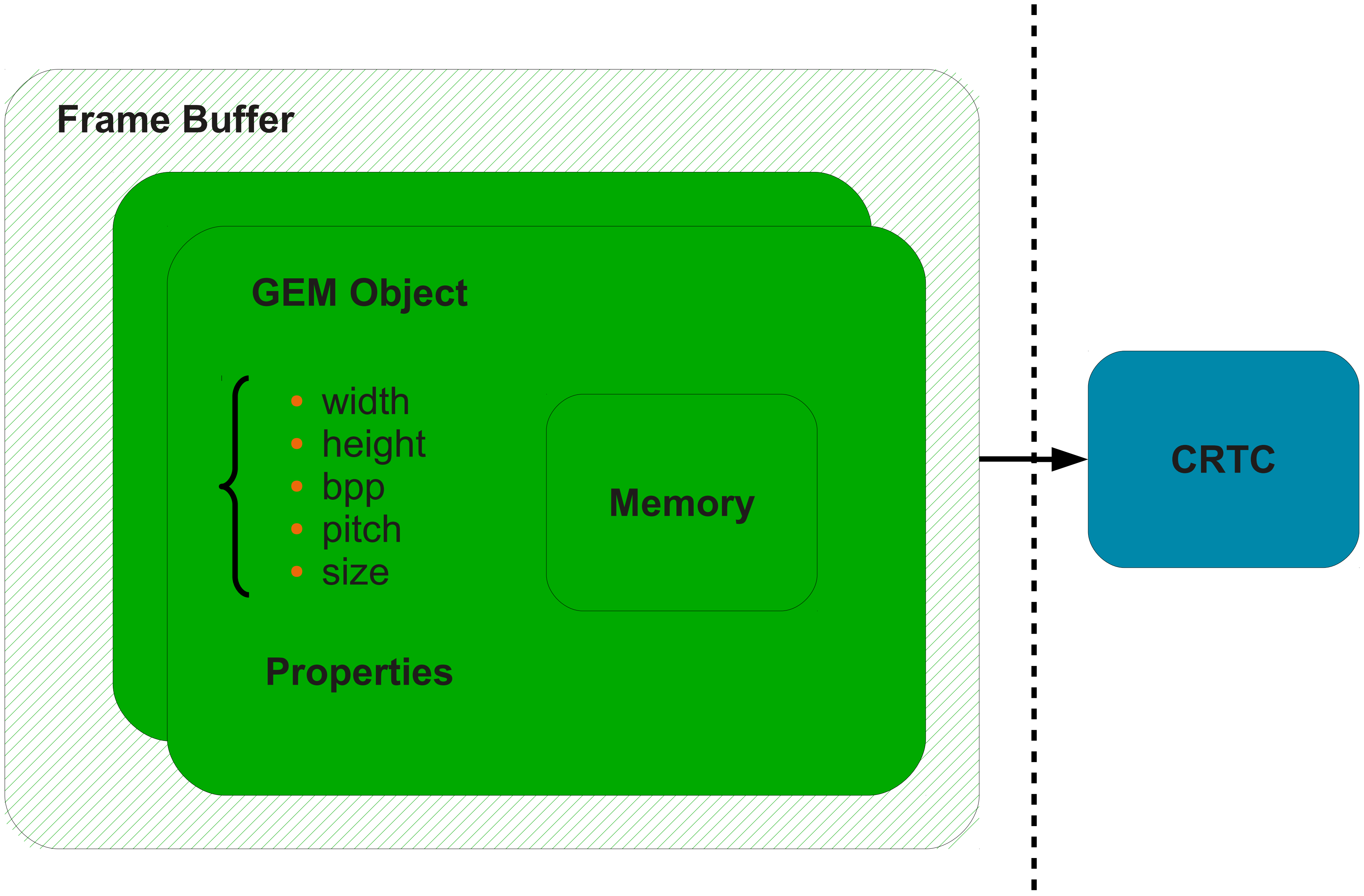
KMS – Scanout



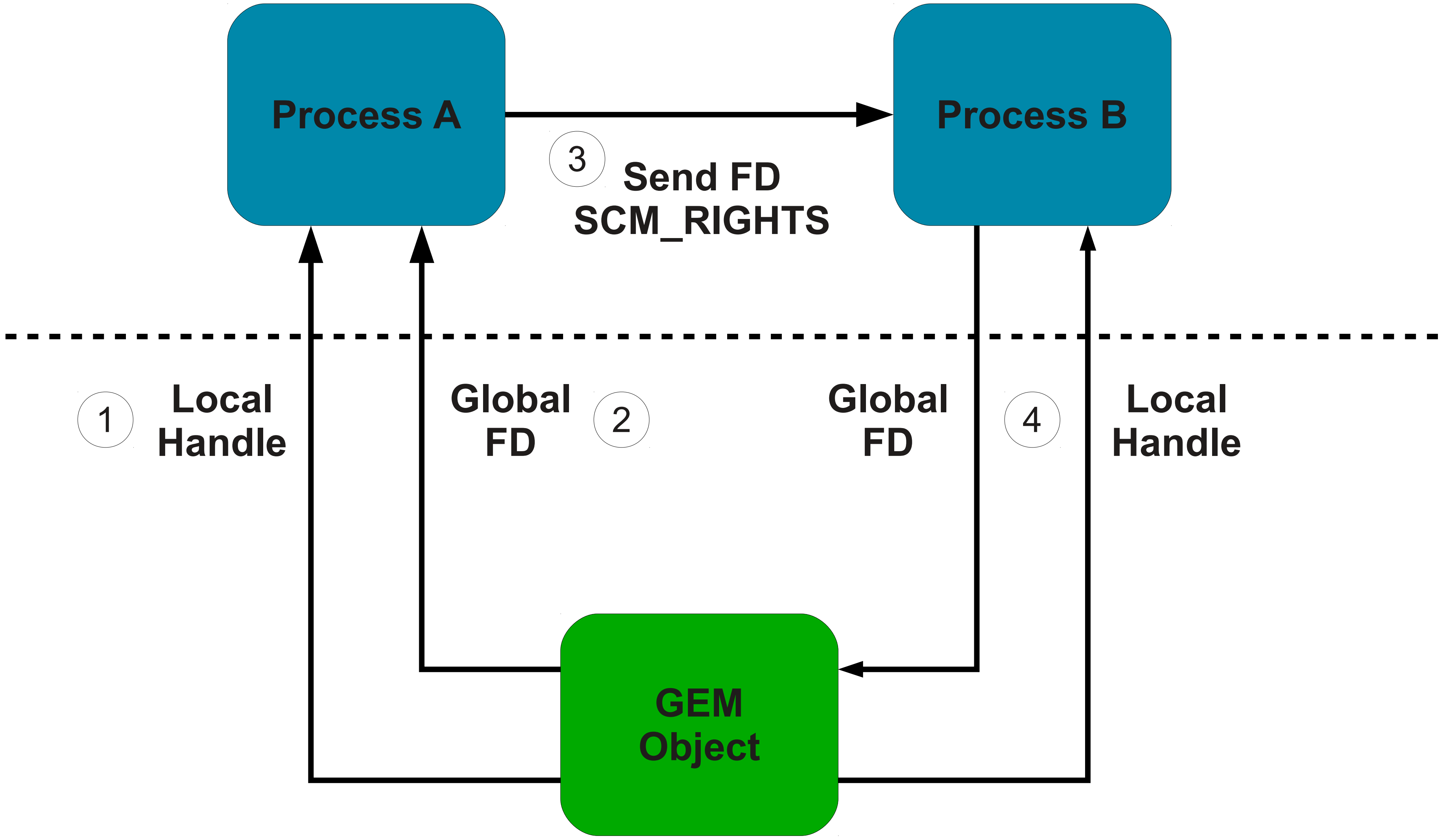
KMS – Composition



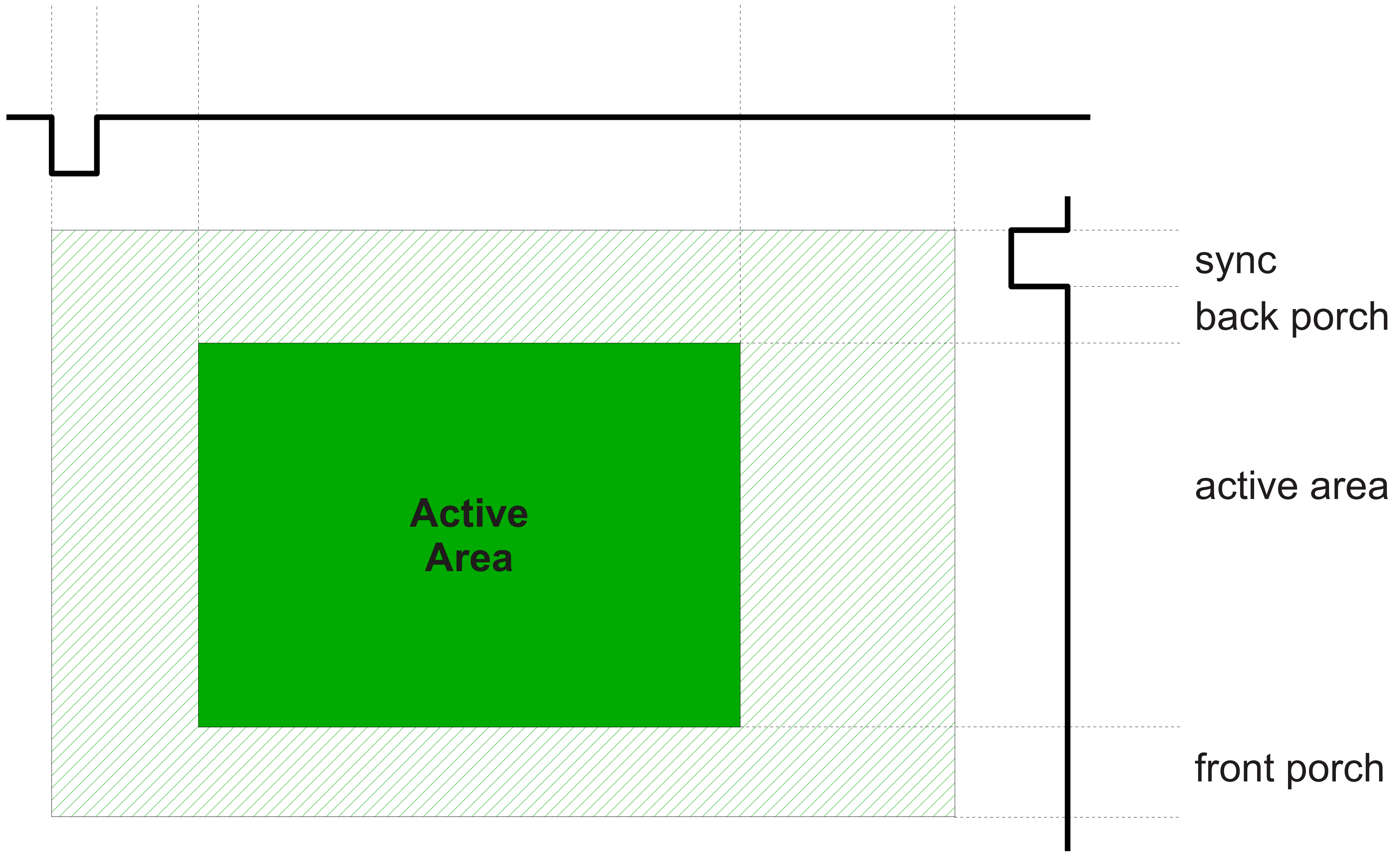
KMS – Frame Buffer



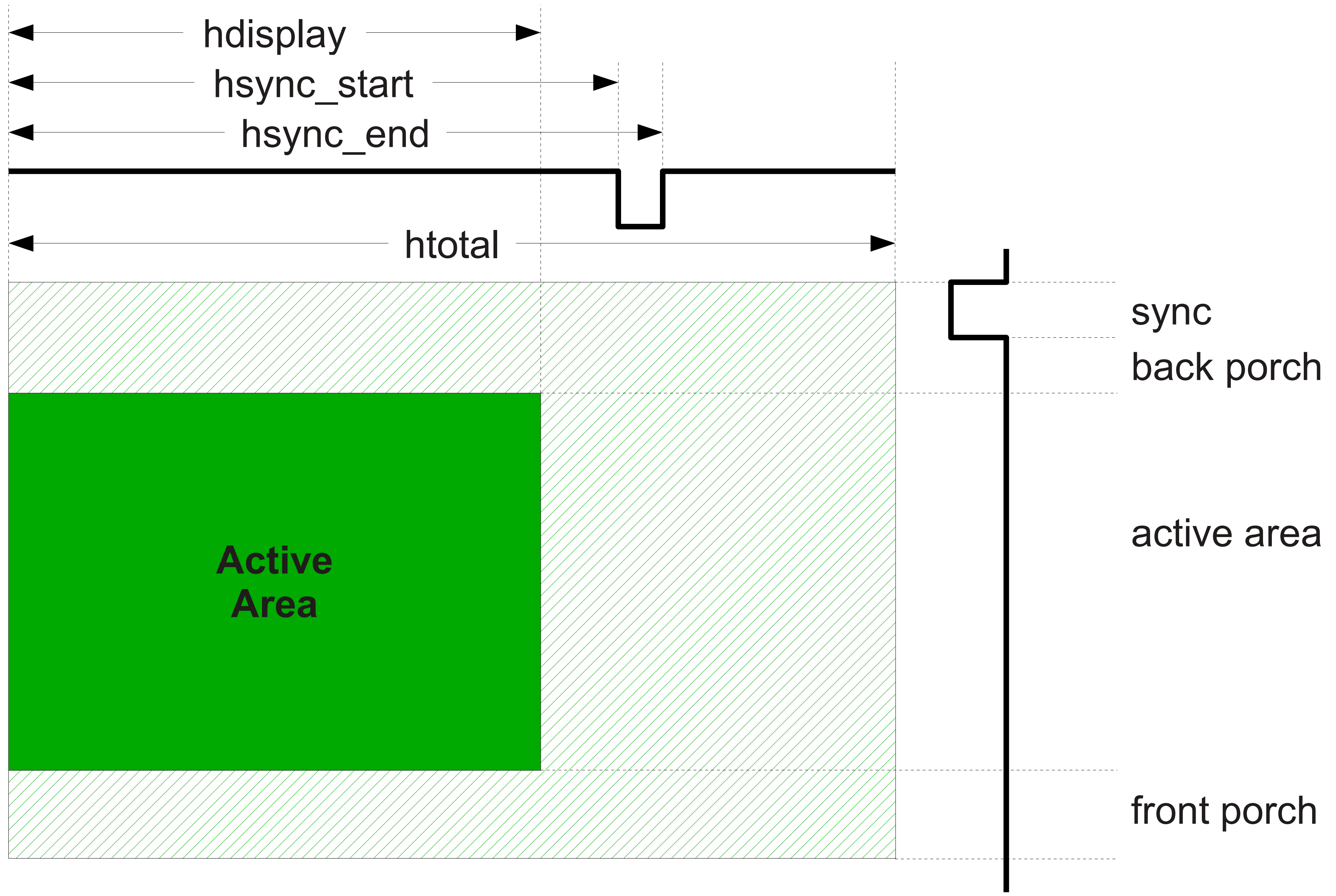
DRM/KMS – GEM Object


Process A
Process B
3
Send FD
SCM_RIGHTS
1
Local
Handle
Global
FD
2
Global
FD
4
Local
Handle
GEM
Object

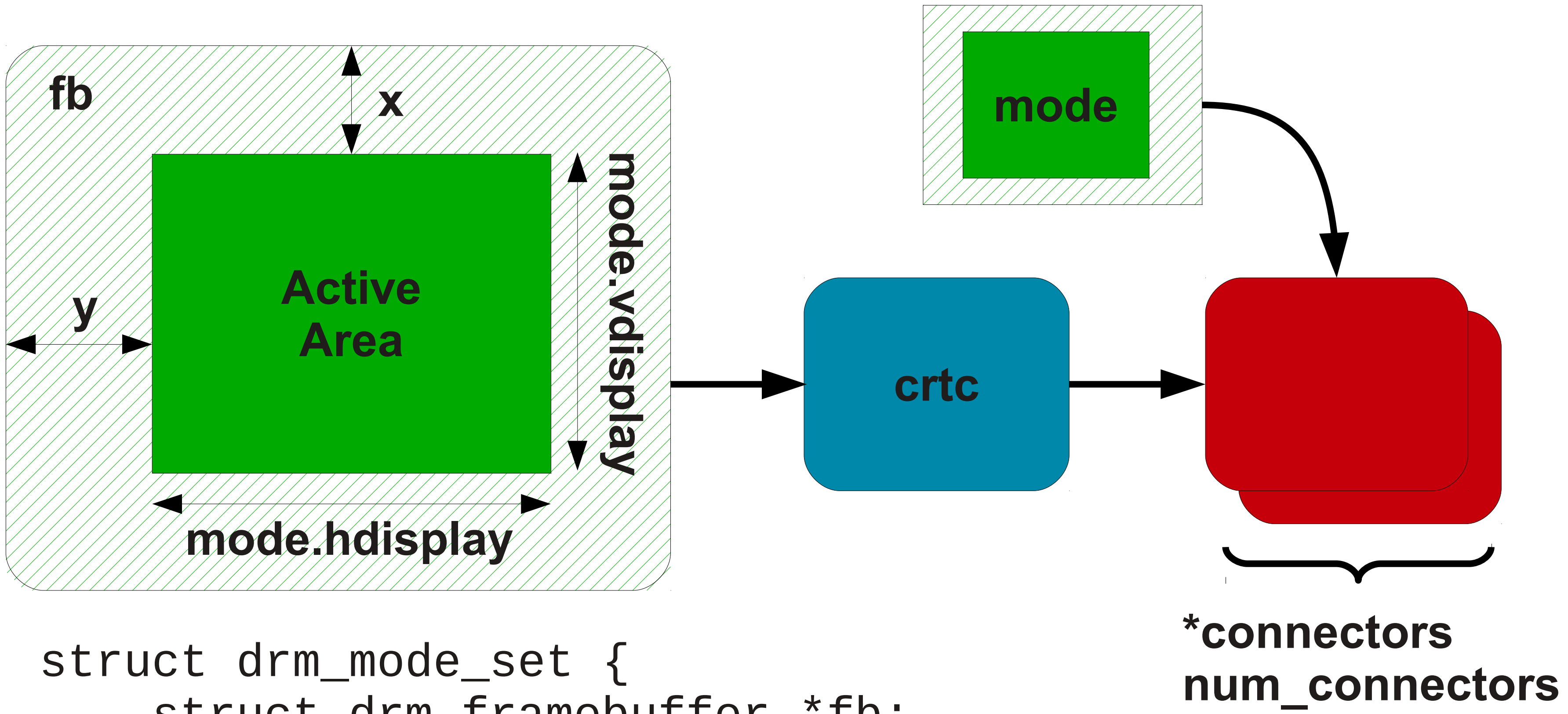
DRM – Handles



KMS – Modes (1/2)


hdisplay
hsync_start
hsync_end
htotal
sync
back porch
Active Area
active area
front porch

KMS – Modes (2/2)



```
struct drm_mode_set {
    struct drm_framebuffer *fb;
    struct drm_crtc *crtc;
    struct drm_display_mode *mode;
    uint32_t x;
    uint32_t y;
    struct drm_connector **connectors;
    size_t num_connectors;
};
```

KMS – Mode Setting

Documentation/ DocBook/drm.tmpl

Please contribute

Code Ahead

Locking and error handling omitted for readability

Disclaimer

```
struct drm_driver rcar_du_driver = {
    ...
};

int rcar_du_probe(struct platform_device *pdev)
{
    return drm_platform_init(&rcar_du_driver, pdev);
}

int rcar_du_remove(struct platform_device *pdev)
{
    drm_platform_exit(&rcar_du_driver, pdev);
    return 0;
}
```

Driver Initialization

```
struct drm_driver rcar_du_driver = {
    .driver_features =
        DRIVER_HAVE_IRQ | DRIVER_GEM |
        DRIVER_MODESET | DRIVER_PRIME,
    .name  = "rcar-du",
    .desc  = "Renesas R-Car Display Unit",
    .date  = "20130110",
    .major = 1,
    .minor = 0,
    .patchlevel = 0,
    ...
};
```

Driver Information

```
struct file_operations rcar_du_fops = {
        .owner          = THIS_MODULE,
        .open           = drm_open,
        .release        = drm_release,
        .unlocked_ioctl = drm_ioctl,
        .compat_ioctl   = drm_compat_ioctl,
        .poll           = drm_poll,
        .read           = drm_read,
        .fasync         = drm_fasync,
        .llseek         = no_llseek,
        .mmap           = drm_gem_cma_mmap,
};

struct drm_driver rcar_du_driver = {
        .fops           = &rcar_du_fops,
};
```

File Operations

```
int rcar_du_load(struct drm_device *dev,
                 unsigned long flags)
{
    struct platform_device *pdev =
        dev->platformdev;
    struct rcar_du_device *rcdu;

    rcdu = devm_kzalloc(&pdev->dev,
               sizeof(*rcdu), GFP_KERNEL);
    dev->dev_private = rcdu;

    /* Memory, clocks, regulators, ... */
}

struct drm_driver rcar_du_driver = {
    .load = rcar_du_load,
};
```

Driver Load

```
int rcar_du_load(struct drm_device *dev,
                 unsigned long flags)
{
    ...
    drm_irq_install(dev);
    /* Behind the scene:
     * request_irq(platform_get_irq(..., 0))
     */
    ...
}

struct drm_driver rcar_du_driver = {
 /* .irq_preinstall */
    .irq_handler = rcar_du_irq,
 /* .irq_postinstall */
};
```

IRQ Installation

```
int rcar_du_load(struct drm_device *dev,
                 unsigned long flags)
{
    ...
    drm_mode_config_init(dev);

    dev->mode_config.min_width = 0;
    dev->mode_config.min_height = 0;
    dev->mode_config.max_width = 4095;
    dev->mode_config.max_height = 2047;
    dev->mode_config.funcs =
        &rcar_du_modecfg_funcs;
    ...
}
```

Mode Config

```
drm_framebuffer *
rcar_du_fb_create(struct drm_device *dev,
                  struct drm_file *file_priv,
                  struct drm_mode_fb_cmd2 *mode_cmd)
{
    /* Validate the pixel format, size and pitches */
    ...
    return drm_fb_cma_create(dev, file_priv,
                             mode_cmd);
}

struct drm_mode_config_funcs rcar_du_modecfg_funcs =
{
    .fb_create = rcar_du_fb_create,
};
```

Frame Buffer

```
struct drm_crtc_funcs crtc_funcs = {
    .destroy = drm_crtc_cleanup,
    .set_config = ...,
    .page_flip = ...,
};

int rcar_du_load(struct drm_device *dev,
                 unsigned long flags)
{
    struct drm_crtc *crtc;
    ...
    drm_crtc_init(dev, crtc, &crtc_funcs);
    ...
}
```

CRTC

```
struct drm_encoder_funcs encoder_funcs = {
    .destroy = drm_encoder_cleanup,
};

int rcar_du_load(struct drm_device *dev,
                 unsigned long flags)
{
    struct drm_encoder *encoder;
    ...
    drm_encoder_init(dev, encoder, &encoder_funcs,
                     DRM_MODE_ENCODER_DAC);
    ...
}
```

Encoder

```
struct drm_connector_funcs connector_funcs = {
    ...
};

int rcar_du_load(struct drm_device *dev,
                 unsigned long flags)
{
    struct drm_connector *connector;
    ...
    drm_connector_init(dev, connector,
        &connector_funcs, DRM_MODE_CONNECTOR_VGA);
    drm_sysfs_connector_add(connector);
    drm_object_property_set_value(&connector->base,
        dev->mode_config.dpms_property,
        DRM_MODE_DPMS_OFF);
    drm_mode_connector_attach_encoder(connector,
        encoder);
}
```

Connector

```
struct drm_crtc_funcs crtc_funcs = {
    .set_config = ...,
};

int (*set_config)(struct drm_mode_set *set);

struct drm_mode_set {
    struct drm_framebuffer *fb;
    struct drm_crtc *crtc;
    struct drm_display_mode *mode;
    uint32_t x;
    uint32_t y;
    struct drm_connector **connectors;
    size_t num_connectors;
};
```

Mode Setting (1/4)

```
struct drm_crtc_funcs crtc_funcs = {
    .set_config = drm_crtc_helper_set_config,
};

int rcar_du_load(struct drm_device *dev,
                 unsigned long flags)
{
    ...
    drm_crtc_helper_add(crtc, &crtc_helper_funcs);
    drm_connector_helper_add(connector,
        &connector_helper_funcs);
    drm_encoder_helper_add(encoder,
        &encoder_helper_funcs);
    ...
}
```

Mode Setting (2/4)

```
struct drm_crtc_helper_funcs crtc_helper_funcs = {
    .mode_fixup = rcar_du_crtc_mode_fixup,
    .prepare = rcar_du_crtc_mode_prepare,
    .commit = rcar_du_crtc_mode_commit,
    .mode_set = rcar_du_crtc_mode_set,
    .mode_set_base = rcar_du_crtc_mode_set_base,
    .disable = rcar_du_crtc_disable,
};
```

Mode Setting (3/4)

```
struct drm_encoder_helper_funcs encoder_helper_funcs = {
    .mode_fixup = rcar_du_vga_encoder_mode_fixup,
    .prepare = rcar_du_vga_encoder_mode_prepare,
    .commit = rcar_du_vga_encoder_mode_commit,
    .mode_set = rcar_du_vga_encoder_mode_set,
};

struct drm_connector_helper_funcs connector_helper_funcs =
{
    .best_encoder = rcar_du_vga_connector_best_encoder,
};
```

Mode Setting (4/4)

```
struct drm_connector_funcs connector_funcs = {
    .fill_modes = ...,
};

int (*fill_modes)(struct drm_connector *connector,
         uint32_t max_width, uint32_t max_height);
```

Modes Discovery (1/2)

```
struct drm_connector_funcs connector_funcs = {
    .fill_modes = drm_helper_probe_single_connector_modes,
};

struct drm_connector_helper_funcs connector_helper_funcs =
{
    .get_modes = rcar_du_vga_connector_get_modes,
    .mode_valid = rcar_du_vga_connector_mode_valid,
};
```

Modes Discovery (2/2)

```
struct drm_connector_funcs connector_funcs = {
    .dpms = ...,
};

void (*dpms)(struct drm_connector *connector,
             int mode);

#define DRM_MODE_DPMS_ON        0
#define DRM_MODE_DPMS_STANDBY   1
#define DRM_MODE_DPMS_SUSPEND   2
#define DRM_MODE_DPMS_OFF       3
```

DPMS (1/2)

```
struct drm_connector_funcs connector_funcs = {
    .dpms = drm_helper_connector_dpms,
};

void rcar_du_crtc_dpms(struct drm_crtc *crtc, int mode)
{
    ...
}

struct drm_crtc_helper_funcs crtc_helper_funcs = {
        .dpms = rcar_du_crtc_dpms,
};

void rcar_du_vga_encoder_dpms(struct drm_encoder *encoder,
                              int mode)
{
    ...
}

struct drm_encoder_helper_funcs encoder_helper_funcs = {
    .dpms = rcar_du_vga_encoder_dpms,
};
```

DPMS (2/2)

```
int rcar_du_load(struct drm_device *dev,
                 unsigned long flags)
{
    ...
    drm_vblank_init(dev, 1);
    ...
}

irqreturn_t rcar_du_irq(int irq, void *arg)
{
    struct drm_device *dev = arg;

    drm_handle_vblank(dev, 0);
}
```

Vertical Blanking (1/2)

```
int rcar_du_enable_vblank(struct drm_device *dev,
                          int crtc)
{
    /* Enable the vblank interrupt for the CRTC */
    return 0;
}

void rcar_du_disable_vblank(struct drm_device *dev,
                            int crtc)
{
    /* Disable the vblank interrupt for the CRTC */
}

struct drm_driver rcar_du_driver = {
    .get_vblank_counter = drm_vblank_count,
    .enable_vblank      = rcar_du_enable_vblank,
    .disable_vblank     = rcar_du_disable_vblank,
};
```

Vertical Blanking (2/2)

```
int rcar_du_crtc_page_flip(struct drm_crtc *crtc,
              struct drm_framebuffer *fb,
              struct drm_pending_vblank_event *event)
{
    struct rcar_du_crtc *rcrtc = to_rcar_crtc(crtc);

    if (rcrtc->event != NULL)
        return -EBUSY;

    crtc->fb = fb;
    rcar_du_crtc_update_base(rcrtc);

    if (event) {
        event->pipe = 0;
        rcrtc->event = event;
        drm_vblank_get(crtc->dev, 0);
    }
    return 0;
}
```

Page Flipping (1/2)

```
void rcar_du_crtc_finish_page_flip(struct rcar_du_crtc *rcrtc)
{
    struct drm_pending_vblank_event *event;
    struct timeval vblanktime;

    event = rcrtc->event;
    rcrtc->event = NULL;
    if (event == NULL)
        return;

    event->event.sequence =
        drm_vblank_count_and_time(dev, 0, &vblanktime);
    event->event.tv_sec = time.tv_sec;
    event->event.tv_usec = time.tv_usec;

    list_add_tail(&event->base.link,
                  &event->base.file_priv->event_list);
    wake_up_interruptible(&event->base.file_priv->event_wait);

    drm_vblank_put(dev, 0);
}
```

Page Flipping (2/2)

```
struct drm_plane_funcs rcar_du_plane_funcs = {
    .update_plane = rcar_du_plane_update,
    .disable_plane = rcar_du_plane_disable,
    .destroy = drm_plane_cleanup,
};

uint32_t formats[] = {
    DRM_FORMAT_RGB565, ...
};

int rcar_du_load(struct drm_device *dev,
                 unsigned long flags)
{
    struct drm_plane *plane;
    ...
    drm_plane_init(dev, plane, 1,
                   &rcar_du_plane_funcs, formats,
                   ARRAY_SIZE(formats), false);
}
```

Planes (1/2)

```
int rcar_du_plane_update(struct drm_plane *plane,
    struct drm_crtc *crtc,
    struct drm_framebuffer *fb,
    int crtc_x, int crtc_y,
    unsigned int crtc_w, unsigned int crtc_h,
    uint32_t src_x, uint32_t src_y,
    uint32_t src_w, uint32_t src_h)
{
    ...
}

int rcar_du_plane_disable(struct drm_plane *plane)
{
    ...
}
```

Planes (2/2)

- Properties
- FBDEV Emulation
- Atomic Mode Setting
- ...

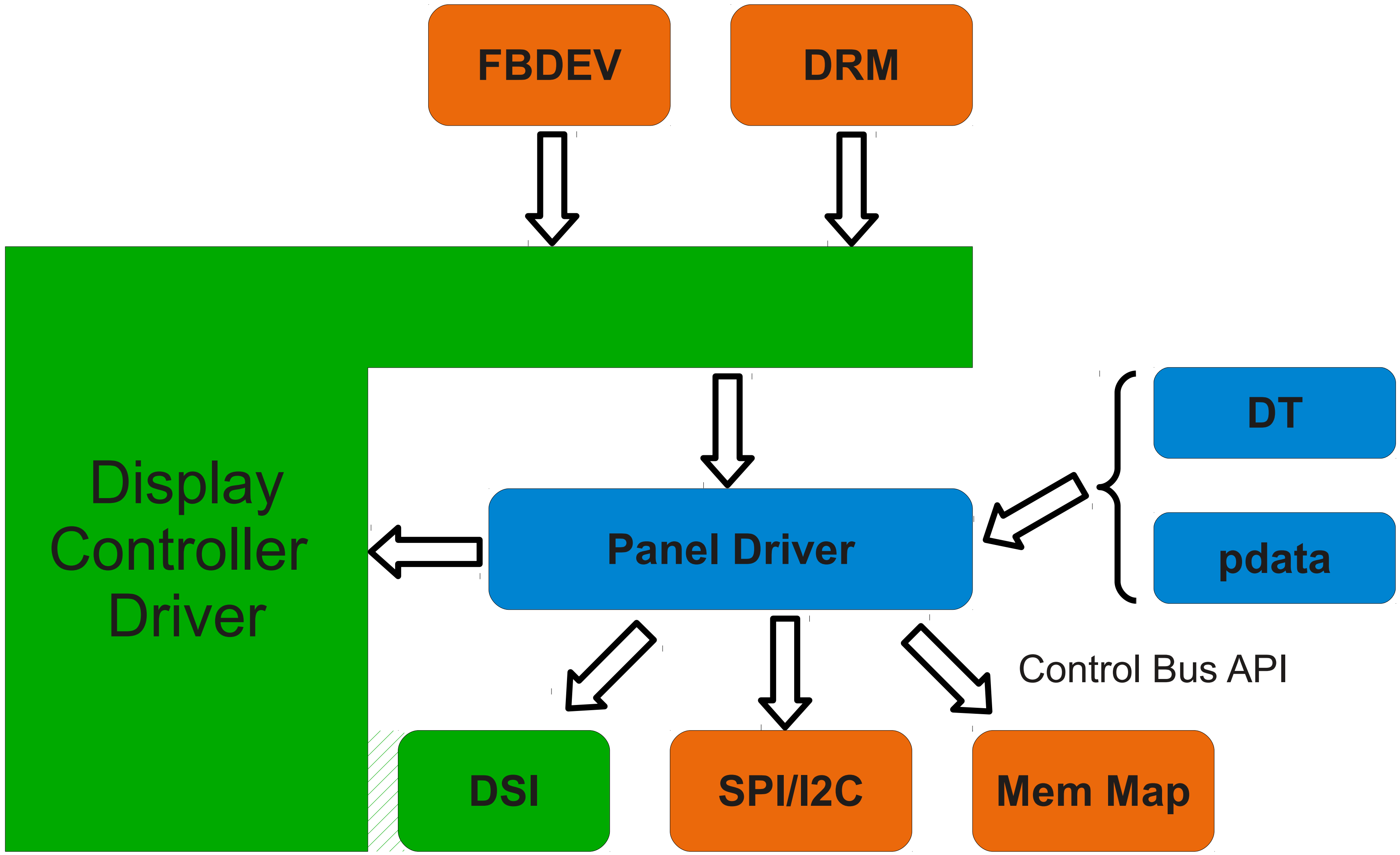
And Much More...

Source: http://www.flickr.com/photos/buckaroobay/3721809183/

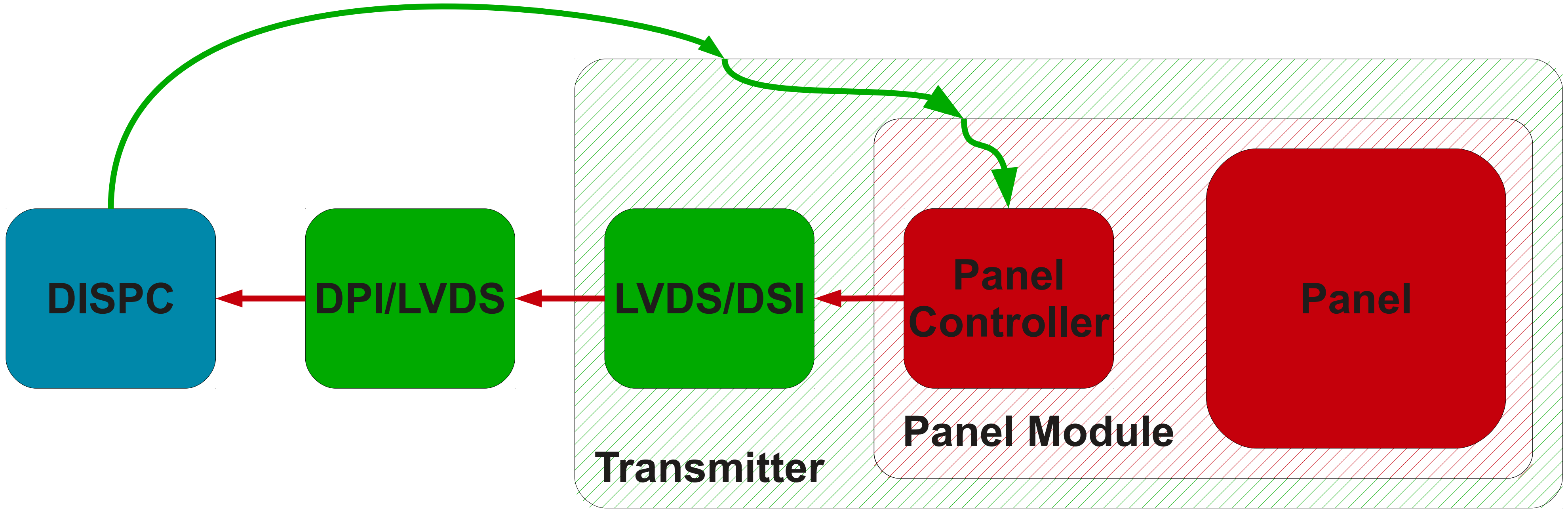
Generic ~~Panel~~ Display Framework

http://lwn.net/Articles/512363/

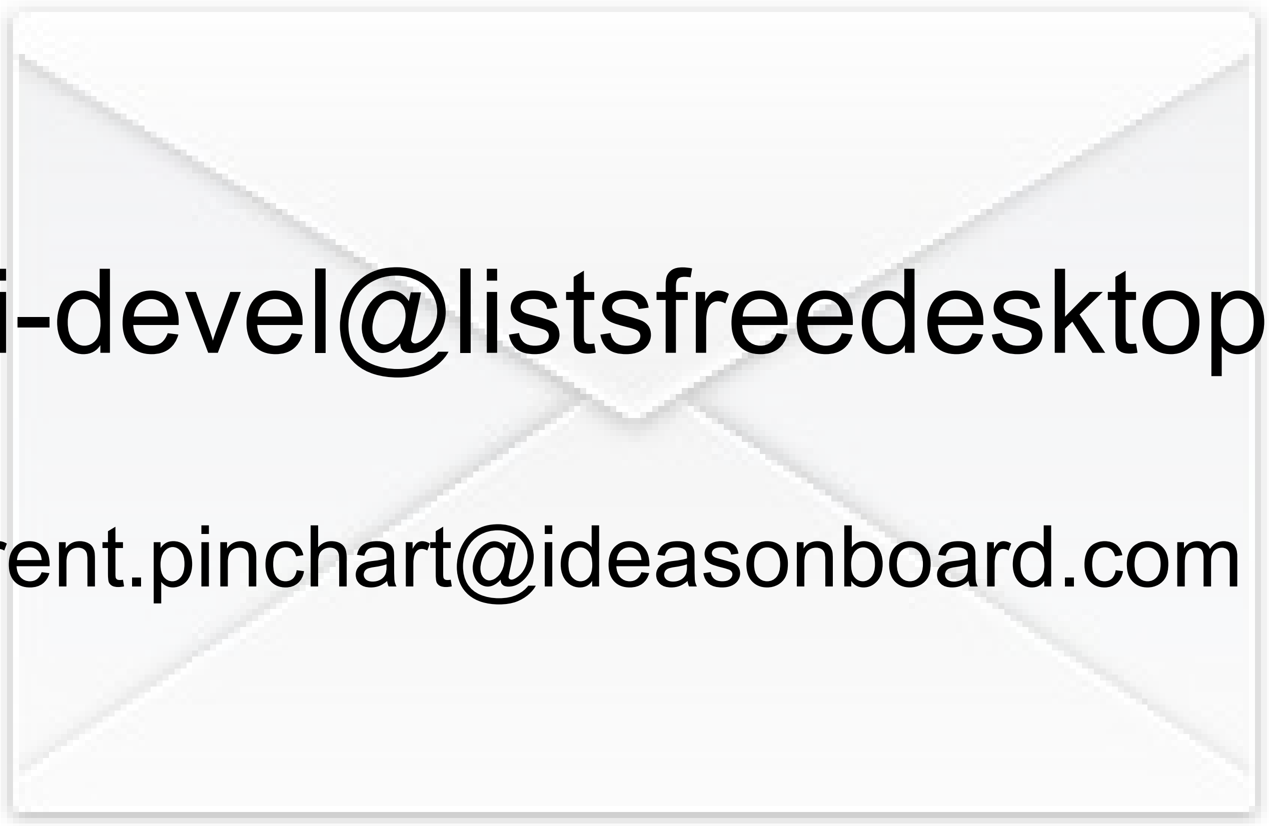
! BoF session tomorrow @4PM !



WIP – Display Framework



WIP – Display Framework



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Contact

? !

IDEAS ON BOARD

thx.