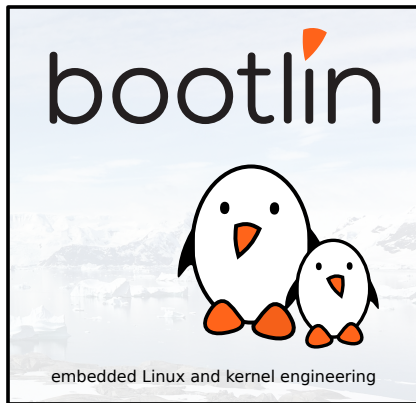




Bringing display and 3D to the C.H.I.P computer

Maxime Ripard
maxime@bootlin.com

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Corrections, suggestions, contributions and translations are welcome!





- ▶ Embedded Linux engineer and trainer at Bootlin
 - ▶ Embedded Linux **development**: kernel and driver development, system integration, boot time and power consumption optimization, consulting, etc.
 - ▶ Embedded Linux **training**, Linux driver development training and Android system development training, with materials freely available under a Creative Commons license.
 - ▶ <http://bootlin.com>
- ▶ Contributions
 - ▶ **Co-maintainer for the sunXi SoCs** from Allwinner
 - ▶ Contributor to a couple of other open-source projects, **Buildroot**, **U-Boot**, **Barebox**
- ▶ Living in **Toulouse**, south west of France



Introduction



C.H.I.P. ?

- ▶ 9\$ SBC
- ▶ Based on an Allwinner R8 (equivalent to A13)
- ▶ 1GHz Cortex-A8 CPU
- ▶ Mali 400 GPU
- ▶ Plenty of GPIOs to bitbang stuff (and real controllers too!)
- ▶ Running mainline-ish Linux kernel (4.3, soon to be 4.4)



Development effort

- ▶ A significant part of the work already done
- ▶ But key features for a desktop-like application were missing
 - ▶ Audio
 - ▶ NAND support
 - ▶ Display
- ▶ Plus board specific developments
 - ▶ Wifi regulators
 - ▶ DIP



How to display things in Linux?



Doing display things

- ▶ Different solutions, provided by different subsystems:
 - ▶ FBDEV: Framebuffer Device
 - ▶ DRM/KMS: Direct Rendering Manager / Kernel Mode Setting
 - ▶ More exotic ones: V4L2, auxdisplay
- ▶ How to choose one: it depends on your needs
 - ▶ Each subsystem provides its own set of features
 - ▶ Different levels of complexity
 - ▶ Different levels of activity



Which one to choose?

- ▶ DRM
 - ▶ Actively maintained
 - ▶ Provides fine grained control on the display pipeline
 - ▶ Widely used by user-space graphic stacks
 - ▶ Provides a full set of advanced features
- ▶ FBDEV
 - ▶ Deprecated?
 - ▶ Does not provides all the features found in the modern display controllers (overlays, sprites, hw cursor, ...)



Bringing display and 3D to the C.H.I.P computer

DRM/KMS

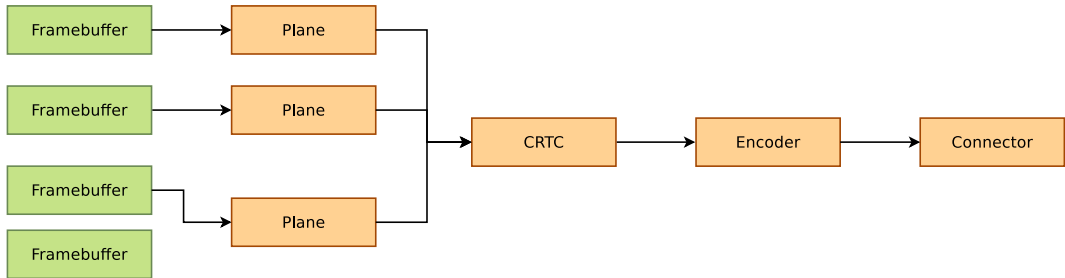


DRM/KMS: Definition

- ▶ DRM stands for Direct Rendering Manager and was introduced to deal with graphic cards embedding GPUs
- ▶ KMS stands for Kernel Mode Setting and is a sub-part of the DRM API
- ▶ Though rendering and mode setting are now split in two different APIs (accessible through `/dev/dri/renderX` and `/dev/dri/controlDX`)
- ▶ KMS provide a way to configure the display pipeline of a graphic card (or an embedded system)
- ▶ KMS is what we're interested in when looking for an FBDEV alternative



DRM/KMS pipeline



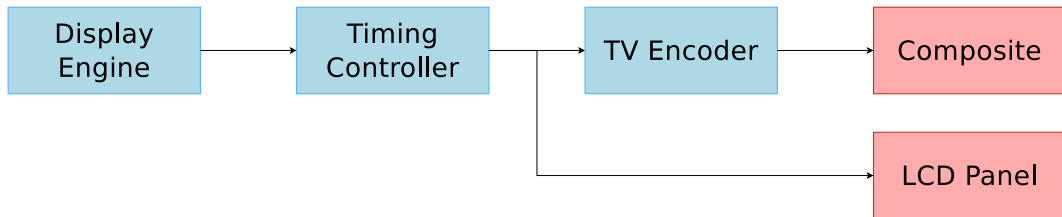


KMS components

- ▶ Planes
 - ▶ Image source
 - ▶ Associated with one (or more!) framebuffers
 - ▶ Holds a resized version of that framebuffer
- ▶ CRTC
 - ▶ Take the planes, and does the composition
 - ▶ Contains the display mode and parameters
- ▶ Encoders
 - ▶ Take the raw data from the CRTC and convert it to a particular format
- ▶ Connectors
 - ▶ Outputs the encoded data to an external display
 - ▶ Handles hotplug events
 - ▶ Reads EDIDs

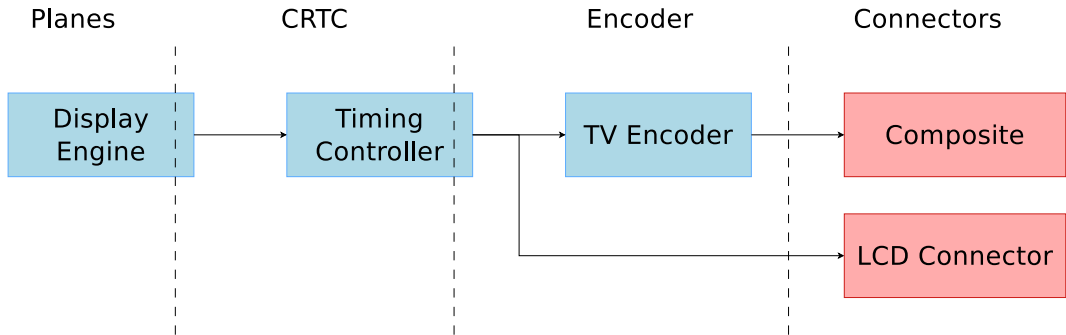


Allwinner display pipeline



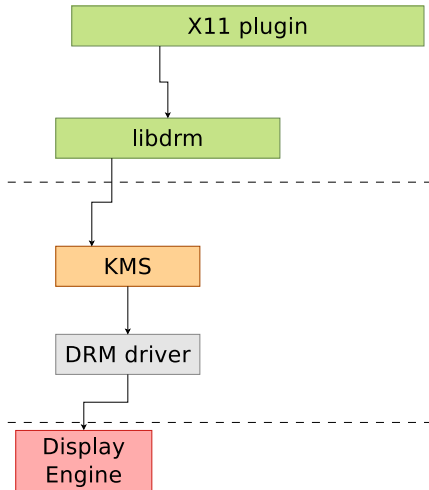


DRM vs SoC pipeline



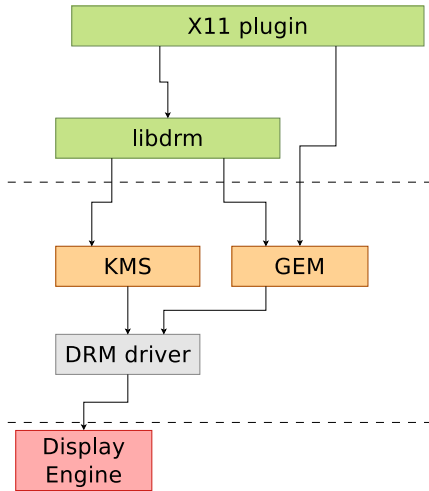


DRM Stack: KMS



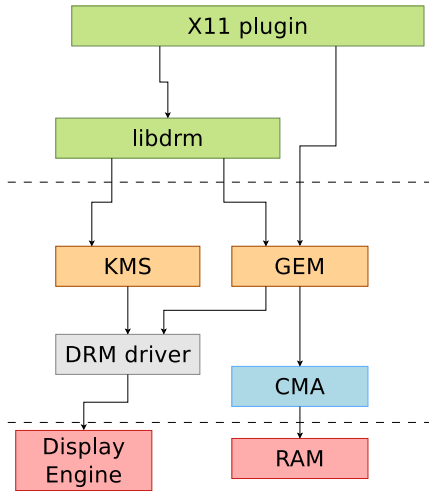


DRM Stack: GEM



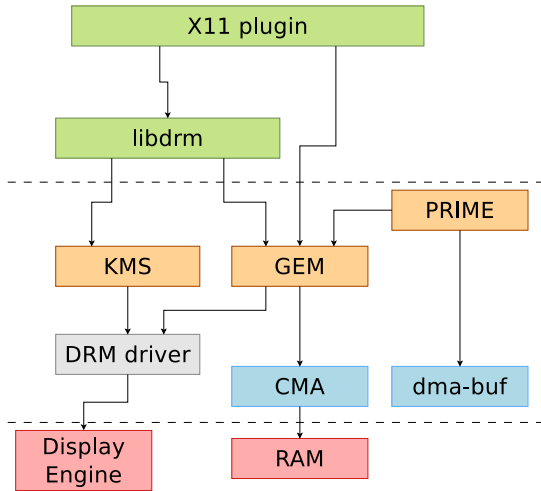


DRM Stack: CMA





DRM Stack: PRIME





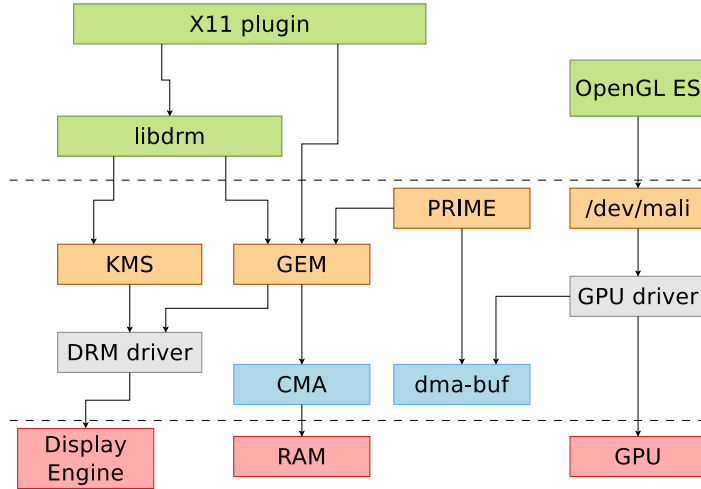
GPU integration



- ▶ The GPU found in most Allwinner SoCs is the Mali-400 from ARM (with a variable number of cores)
- ▶ There are two options to support that GPU:
 - ▶ Lima
 - ▶ Reversed engineered proof-of-concept
 - ▶ Triggered the reverse engineering effort of the GPUs (freedreno, etnaviv, etc.)
 - ▶ Development (closed to?) stopped two years ago
 - ▶ ARM-Provided support
 - ▶ Featureful
 - ▶ Two parts: GPL kernel driver and proprietary OpenGL ES implementation



DRM Stack: GPU





- ▶ Everything is provided by ARM on their website (if you're lucky)
- ▶ On the userspace side, you just need to put the library they provided on your system
- ▶ On the driver side, you need to create a platform glue that will deal with:
 - ▶ Memory mapping
 - ▶ Interrupts
 - ▶ Clocks
 - ▶ Reset lines
 - ▶ Power Domains
 - ▶ Basically everything needed for the GPU to operate properly on your SoC



X11 integration

- ▶ We need a DDX (Device Dependent X) driver
- ▶ `xf86-video-modesetting` is working on top of KMS and MESA (Gallium3D)
- ▶ ARM developped `xf86-video-armsoc` for SoC using a 3rd party GPU (Mali, PowerVR, Vivante, etc.)
- ▶ Relies on KMS for the display configuration, driver-specific ioctl for buffer allocations and vendor-provided OpenGL ES implementation
- ▶ Just have to write a small glue to use your driver allocator, and give some hints to X about what your hardware support (hw cursor, vblank, etc.)

Questions? Suggestions? Comments?

Maxime Ripard
maxime@bootlin.com

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<http://bootlin.com/pub/conferences/2016/elc/ripard-drm>