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War Story: Using Mainline Linux for an Android TV BSP

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Timeline

- Android & Mainline
- HAL story
- GPU war story
- Boot Flows
- Other integration issues
- Conclusion

Scope of the project

- Build an “Upstream” AOSP BSP for new Amlogic SoC
- Targets (for now) the TV profile (for Android TV)
- Will use Android 4.19 as initial kernel base
- New SoCs from Amlogic, not yet supported in mainline
- Team had AOSP port experience on very early Android releases (~1.6)

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Android & Mainline Linux

Android & Mainline

- Android has a long a complex history with mainline Linux
- Recently, Google outlines multiple efforts
  - Project Treble: kernel ABI as “vendor interface” to have a “Generic System Image”
  - “One kernel to boot them all” project to leverage common kernel build

Android & Mainline

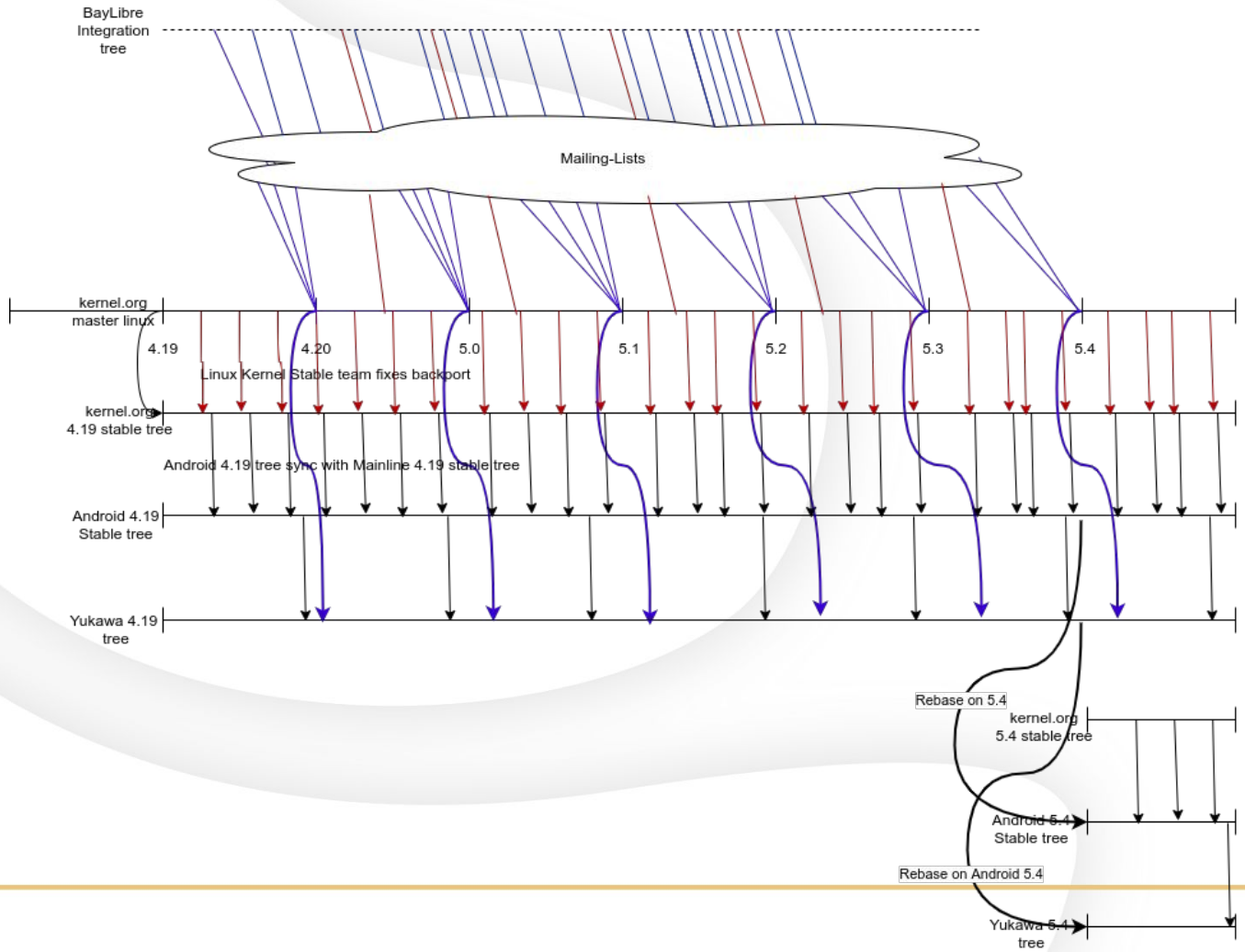
- AOSP 10 can run using pure vanilla kernel
- But we still use an Android derived branch with:
  - Android specific kernel config
  - Android specific kernel patches/fixes
  - Android kernel build YAML

Android & Mainline

- Our use case ?
  - No vendor, only mainline
  - New SoCs:
    - S905X2
    - S905X3
  - We need to push the support upstream and backport

Android & Mainline

- The upstream process ?
  - As usual
  - But, we need to backport the upstream patches to the Android tree
  - Using ChromeOS kernel rules for commit message
    - UPSTREAM
    - BACKPORT
    - FROMLIST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Integration
tree
Mailing-Lists
kernel.org
master linux
4.19
4.20
5.0
5.1
5.2
5.3
5.4
Linux Kernel Stable team fixes backport
kernel.org
4.19 stable tree
Android 4.19 tree sync with Mainline 4.19 stable tree
Android 4.19
Stable tree
Yukawa 4.19
tree
Rebase on 5.4
kernel.org
5.4 stable tree
Android 5.4
Stable tree
Rebase on Android 5.4
Yukawa 5.4
tree

Android & Mainline

- But, why upstream-first ?
  - Easy maintenance
  - Fast rebase (git will drop backports)
  - Ensure code quality
- Cons ?
  - Slow
  - More work to be accepted upstream
  - Upstream won't accept complex hacky features

Android & Mainline

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Upstream won't accept complex hacky features ?!

- Not an issue !
- WiP patches can be applied from List
  - So we can take more time to polish them
- Non-upstreamable patches are also possible
  - But we try to limit these
  - We tag them with "ANDROID:"

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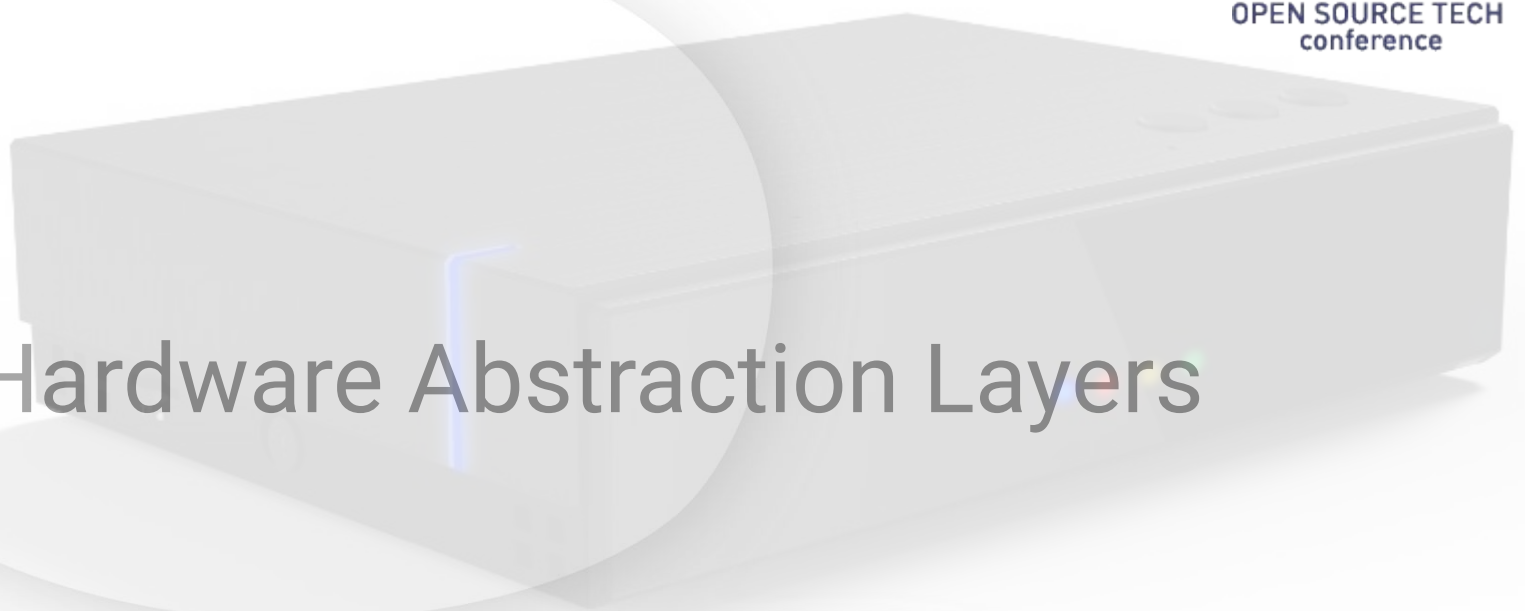
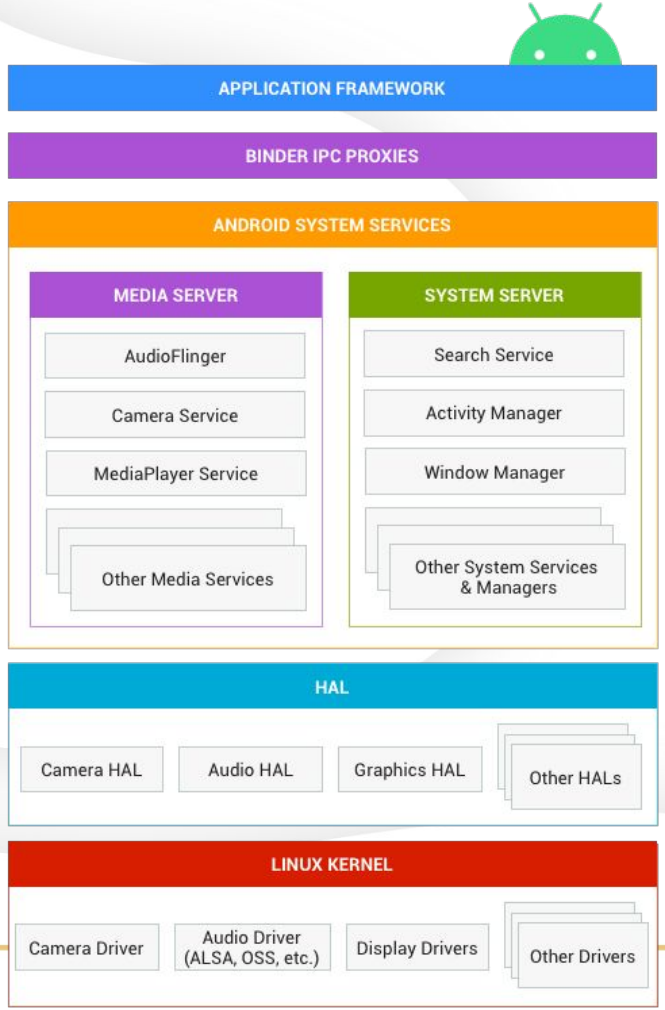
Hardware Abstraction Layers



HAL story

- Android based on Frameworks and HALs
- HALs translates the Frameworks high level system needs into system calls
- Why ?
  - At the time, ARM mainline Linux was very limited
    - No dynamic graphic stack (only fbdev)
    - No sensor framework
    - Very limited Runtime Power Management
    - ...

HAL story



HAL story

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- With the limited mainline Linux kernel
  - Vendor wrote their own HAL for display, GPU, …
  - Google wrote their own PM, syslog… drivers
- It tooks a very long time until AOSP could run on vanilla
  - It took time for Kernel dev to push alternatives
  - It took time for Google to use these alternatives
  - The DRM framework took time to mature
  - There is still a lot of work...

HAL story

- Our HAL usage ?
- The Yukawa project uses the default HALs for
  - drm-hwcomposer (was a huge blocker)
  - bluetooth
  - Wifi, ...
- Custom HALS :
  - Gralloc for the ARM Mali integration
  - HDMI-CEC, but could be generic
  - Lights

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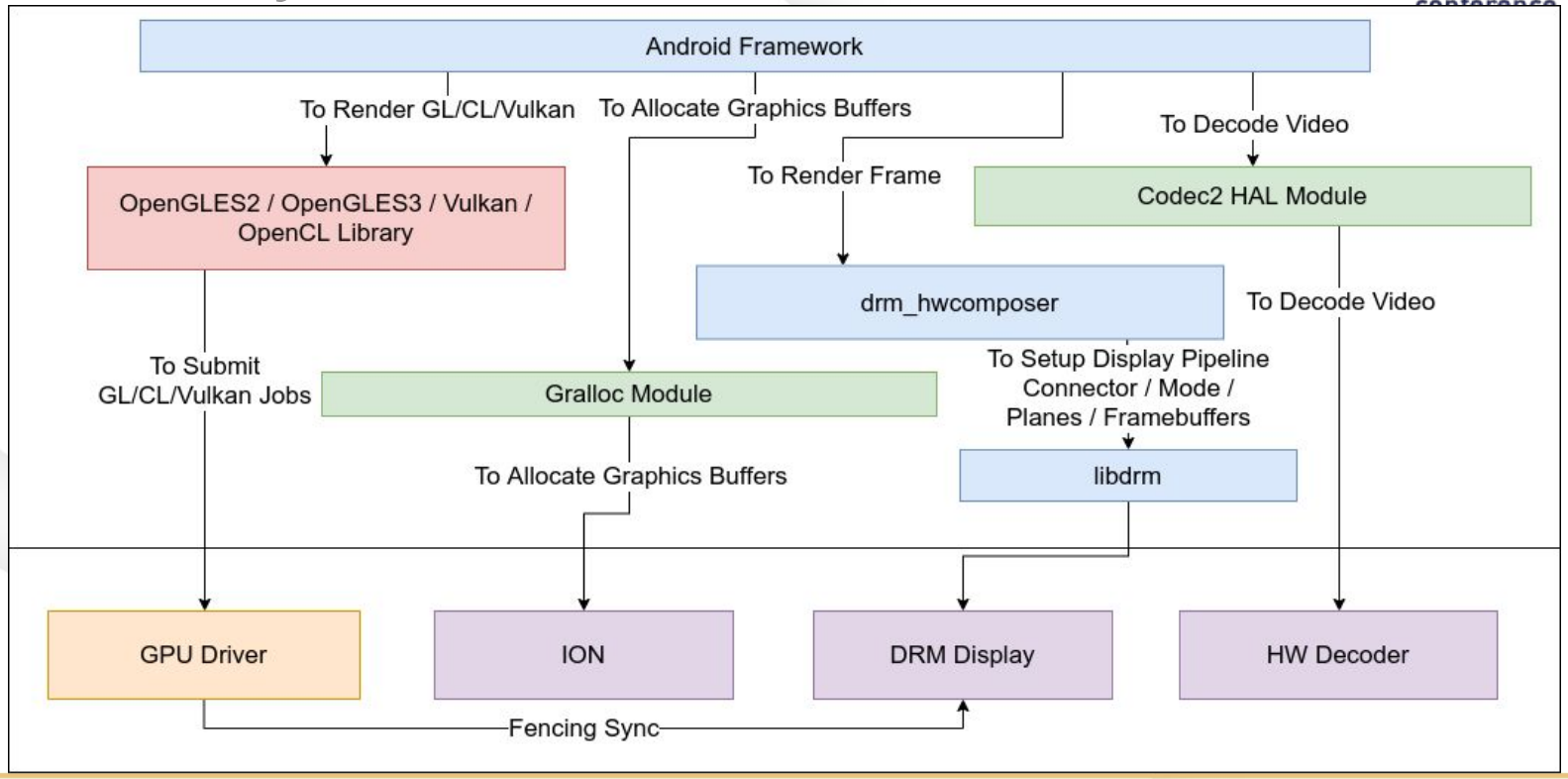
GPU Integration

GPU war story



GPU war story

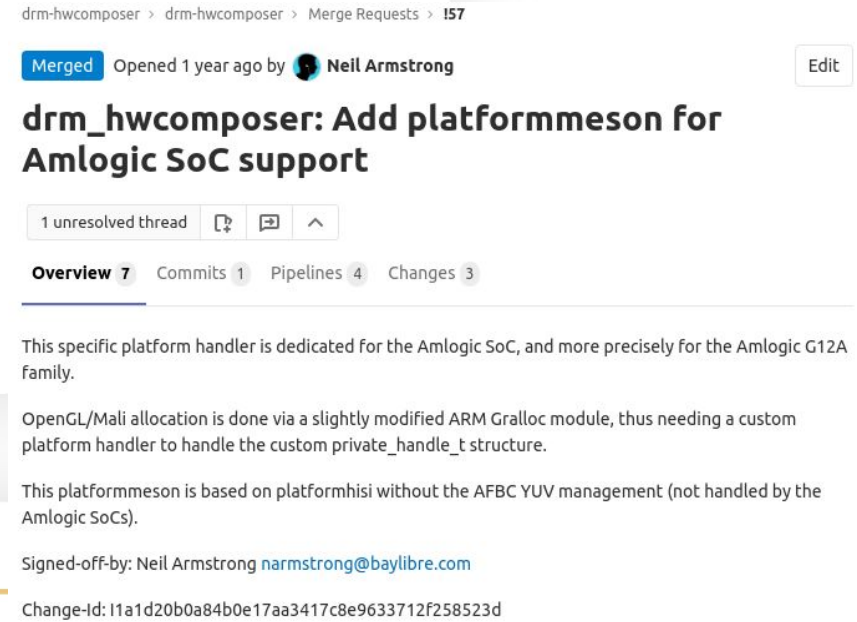
- GPU library <-> gralloc <-> hwcomposer relationship
  - Google made their own OpenGL API
  - A private vendor “private_handle_t” structure is added
  - Is added by gralloc to be used by the HWComposer module
  - Can also be used by the OpenGL library
  - Contains properties of the allocated GPU buffer

GPU war story

- Mali ?
  - ARM provides a vendor Gralloc module
  - The Gralloc module *version* is **tied** to the OpenGL library *version*
  - E.g: Amlogic modified the *private_handle_t* structure
  - **We are tied to use the Amlogic derived Gralloc module**
- The drm-hwcomposer also needs a vendor implementation
  - Using the vendor gralloc *private_handle_t* define
  - Using the *private_handle_t* structure to import the buffer into DRM

GPU war story

- But
  - drm-hwcomposer is an external “generic” HAL
  - So -> upstream first !



GPU war story

- We still have an issue !
- Low-cost Android TV vendors (Amlogic, Allwinner, Rockchip, …) SoCs usually cannot handle a full 4K UI layer
  - So they limit the Android UI in 1080p max
  - This is done in their Hardware Composer HAL module
- So, can we do the same with drm-hwcomposer ?
  - No
  - It needs a complete HWC API change to separate the
    - Display Mode
    - UI Layer dimensions
  - This are not distinguished as today
  - So we need to “lie” to Android and give a fake “1080p mode” for all 4K modes

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Boot Flows

Boot Flows

- Old way (pre-Android 9)
  - Kernel as bootimg + initrd (DT added at the end of kernel zImage)
  - Mounts system, mounts vendor and boots
  - Can still be used for Android 9
- New Way v1 (system-as-root)
  - Kernel as bootimg (DT as “second” payload) + eventual DTBO
  - Mounts system using UUID, finds vendor in DT and mounts it
  - Optional for Android 9, Mandatory for Android 10 if not using “New Way v2”
- New Way v2 (dynamic partitions support)
  - Kernel as bootimg (DT as dtb payload) + initrd (required for dm-linear) + eventual DTBO
  - Mounts system & vendor from the “Super” partition and boots
  - Mandatory for Android 10 if not using “New Way v1”

Boot Flows

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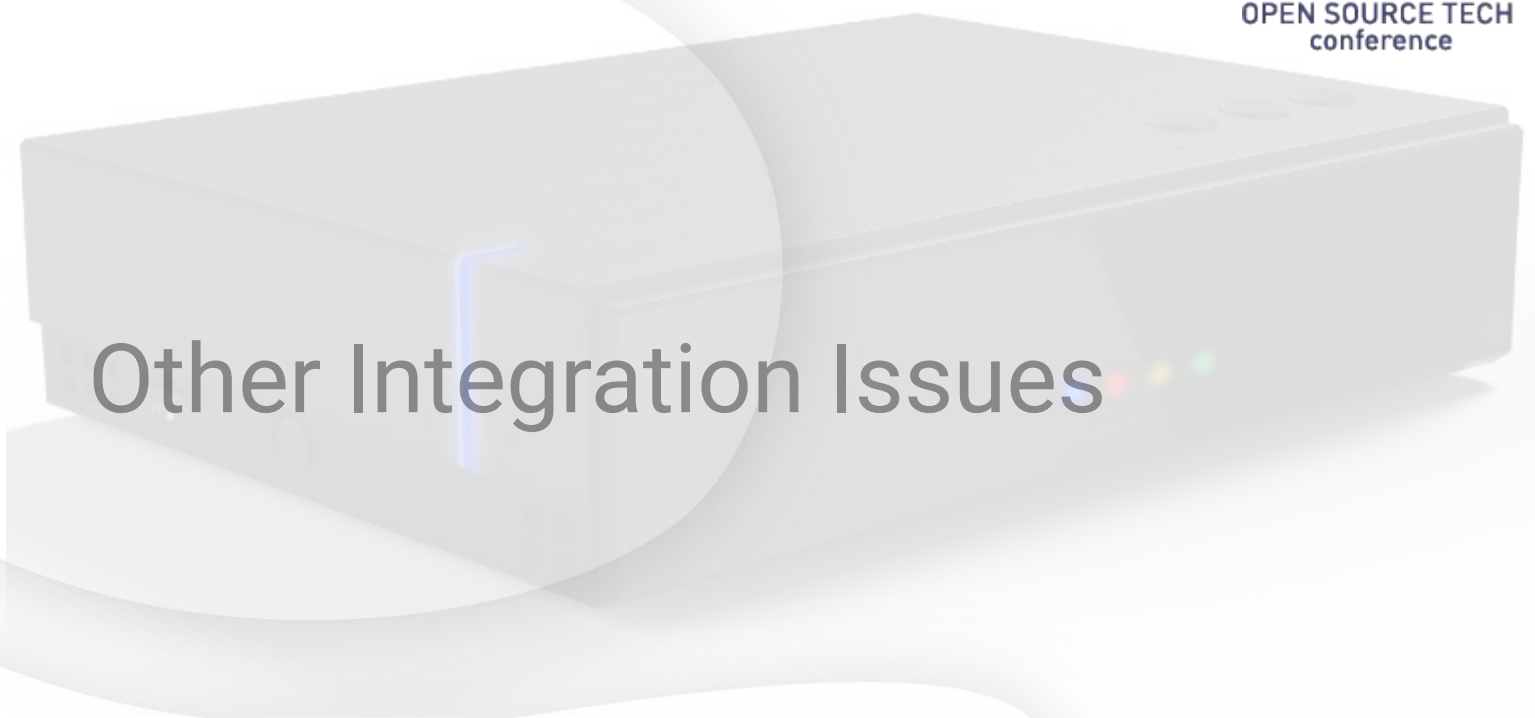
- Supporting all boot flows in a single codebase is very hard
- Simplest is to support the last one: Android 10 + System-as-root
- U-boot has regular patchset to support these feature
    - Pushed by Google, TI or other vendors
    - But those are very generic
    - Still needs a complex boot flow script !

Boot Flows

- The reference board are support in mainline U-Boot \o/
- But we still needs a few hacks on top to meet the complete Android boot flow :-(



Other Integration Issues

Other issues

- Audio
  - It's a mess, Google develops a complete HAL API
  - But no generic ALSA HAL, **at all** !
  - Solution ? re-use the old https://github.com/CirrusLogic/tinyhal
- WiFi
  - It's a mess, don't look at it, they still rely(ied ?) on their old wpa-supplicant fork
  - Hopefully it's moving forward ?
- Similar Display Modes
  - You can't provide multiple display modes with same width X height X freq
  - No Interlaced support...

Conclusion

- https://android.googlesource.com/device/amlogic/yukawa/
- Android is much more Mainline Linux friendly
- Common modern Kernel APIs are being adopted
- Still a long road before having:
  - Single kernel for multiple boards
  - Mainline based kernel with very few patches
- Hopefully Panfrost will solve the GPU nightmare
- HWComposer needs some adaptations