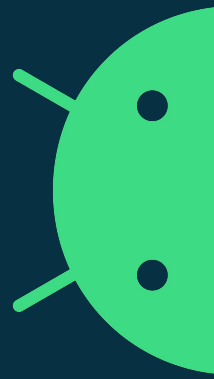
DRM/KMS for Android



Kernel display & graphics, testing update

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android

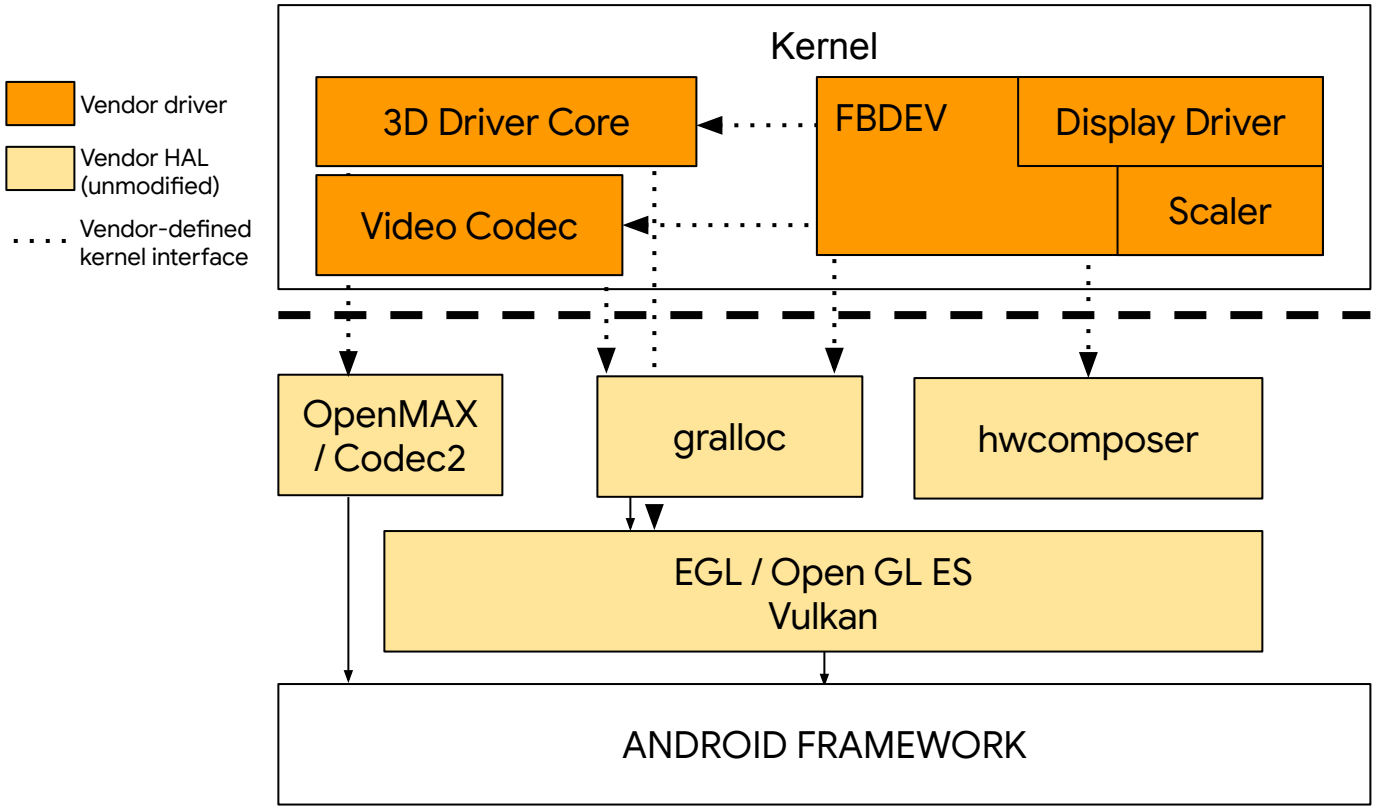
Overview

- Who am I?
  - Working at Google with the Android Systems / Kernel team
  - Responsible for the Cuttlefish Virtual Device (CVD)
  - Also work on dev board support in the Android Open Source Project (AOSP)

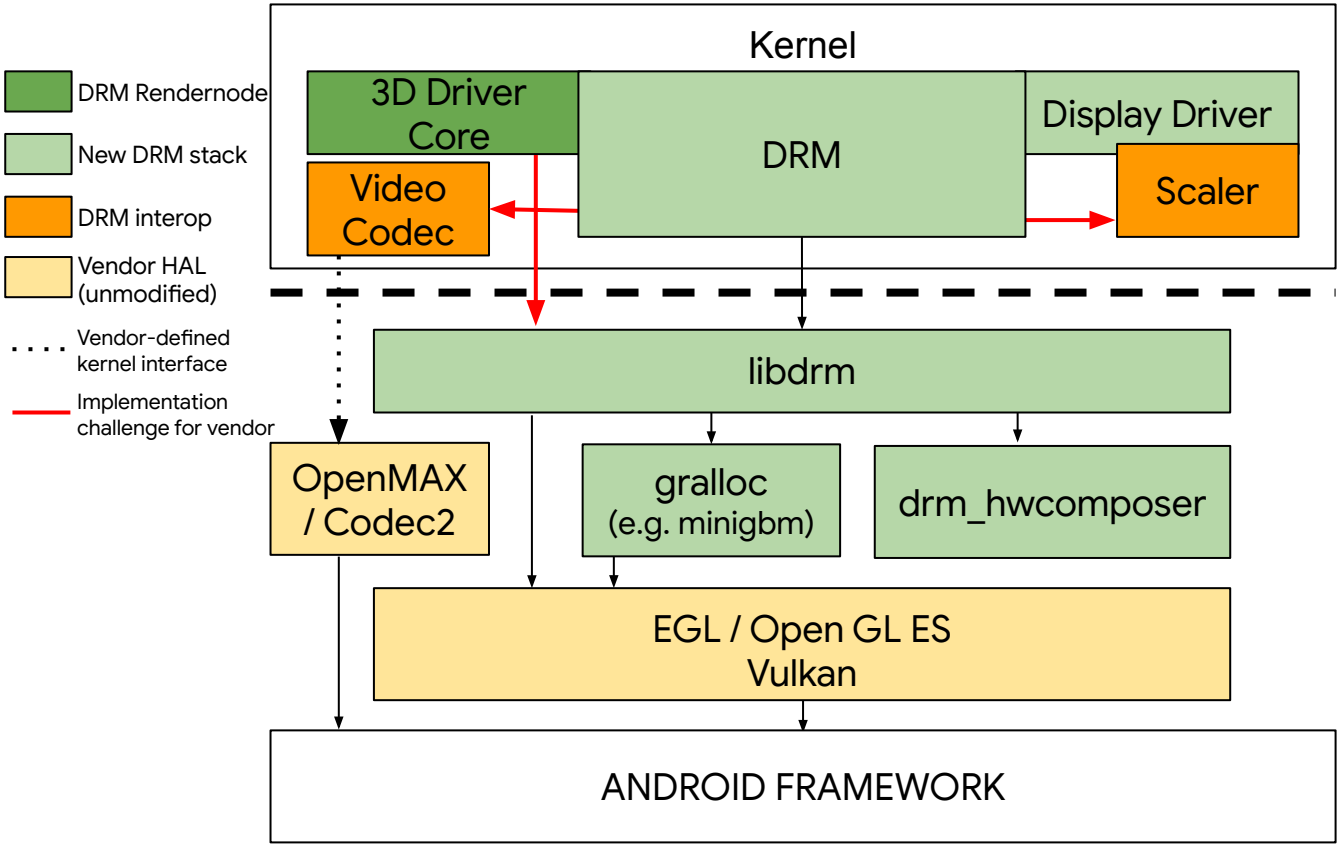
- Trying to standardize display/graphics/multimedia stacks
  - More examples of open source / upstream stacks in AOSP
  - Virtual platform should use the same interfaces
  - Conformance testing for display via Vendor Test Suite (VTS)

- Talk will mostly look at the problem from a kernel PoV

Android on a Legacy Stack

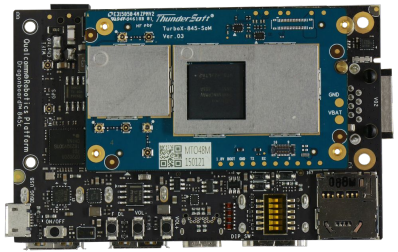


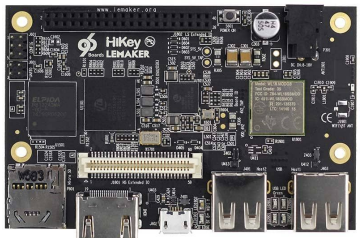
Android on an Upstream Stack

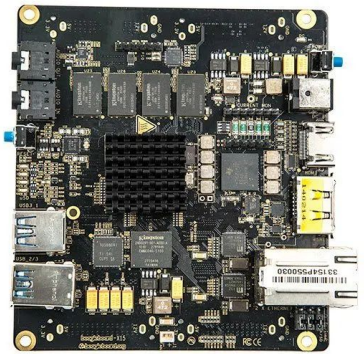


Upstream stacks in AOSP

- Pixel 3 / 3a / +
- DragonBoard 845c (under review)
  - Same SoC as Pixel 3, but not the same driver
  - Proves Android can run on upstream driver
- Other platforms: Hikey, Hikey960, BeagleBoard X15, Cuttlefish







Cuttlefish Virtual Device (CVD)

- Android for Google Cloud
  - KVM based, built on top of crosvm virtual machine monitor
  - Used by Google for continuous integration testing of changes to Android
  - When you upload to AOSP review, your change is tested on cuttlefish

- Cuttlefish uses an upstream graphics stack
  - Can boot upstream kernels (just a defconfig)
  - SwiftShader, for software GPU use cases
  - Mesa (virgl) for hardware acceleration

```
$ launch_cvd -gpu_mode=drm_virgl
```

  - minigbm (gralloc), drm_hwcomposer

- Planned features
  - Vulkan support
  - More KMS planes, more pixel formats

Upstream stacks for vendors?

- VTS enforces shipping one of three kernels for newly launching devices
  - Android P - 4.4, 4.9, 4.14
  - Android 10 - 4.9, 4.14, 4.19
  - Android 11 - 4.14, **4.19, 5.4 (GKI)**

- Devices get two years of upgrades too
  - Lots of kernels to test
  - Android 11 - **4.4, 4.9**, 4.14, **4.19, 5.4**

- Vendor kernels might make it worse (more on this later)
  - Inconsistent uapi / kernel feature set, no LTS fixes, more difficult to test

Vendor A
Linux 4.14
ion from 4.9
drm from 4.17
v4l2 from 4.14

Vendor B
Linux 4.14
ion from 4.14
drm from 4.14
v4l2 from 4.19

Vendor C
Linux 4.14
…

Generic Kernel Image (GKI)

Generic ARM64 kernel for all Android devices

Branches	Configuration	Toolchain	Scope
○ android-mainline ○ android-4.19 ○ android-5.4 (soon)	○ Single Kernel Configuration (gki_defconfig) ○ Suitable for all ARM64 based devices	○ Single Toolchain (Clang) ○ Hermetic Build	○ All ARM64 Android devices ○ Validation only on x86_64

https://lwn.net/Articles/771974/

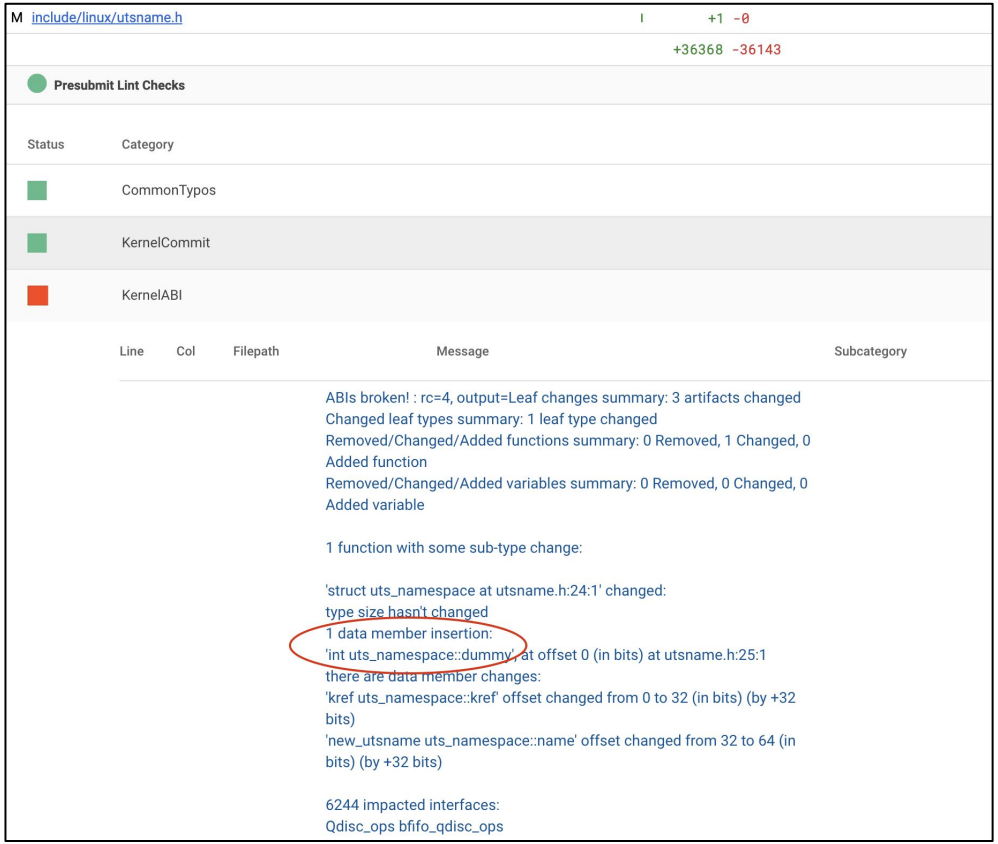
tl;dr Aims are to reduce fragmentation, provide security patches for everybody

GKI - ABI Monitoring

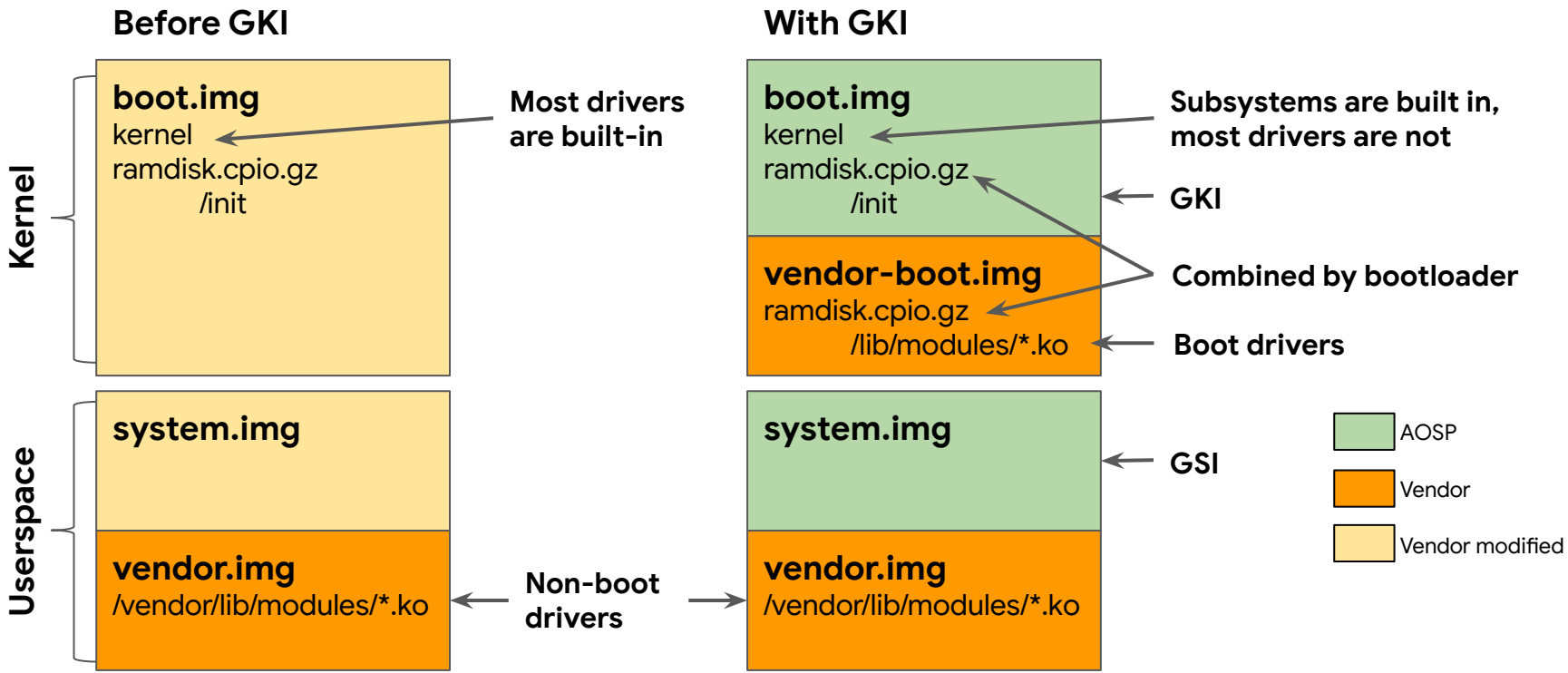
- Define a baseline ABI
- Keep it along with your sources
- Establish ABI checking (e.g. build_abi.sh) as mandatory test before merging
- Changes targeting Android Common Kernels have to pass this test in AOSP Gerrit

```
--- a/include/linux/utsname.h
+++ b/include/linux/utsname.h
@@ -22,6 +22,7 @@ struct user_namespace;
 extern struct user_namespace init_user_ns;

 struct uts_namespace {
+       int dummy;
        struct kref kref;
        struct new_utsname name;
        struct user_namespace *user_ns;
```



GKI - Compliance Structure



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GKI - Implications for Display/GPU

- Display drivers are modules, can't be built-in
  - Stable ABI within LTS release (4.19.x through 4.19.y)
    - Maintained by Android kernel team
    - Not the whole kernel, some security changes might break compat
  - Modules can still be patched by vendors as before

- dma-buf, drm, etc. *is* built in
  - Will get security + bugs fixes via LTS
  - We might backport subsystems to older kernels

- Display/GPU drivers not using DRM/KMS will be vendor's responsibility
  - Can only use symbols exported by GKI

- Verified as part of Android VTS

Testing upstream stacks

- Not just a kernel effort
  - drm_hwcomposer used on many AOSP platforms
    - hikey, hikey960, cuttlefish, db845c
  - Mesa used on cuttlefish (virgl) and db845c (freedreno)
  - Teams at Linaro keeping these projects up to date in AOSP

- `igt-gpu-tools` has been added to AOSP
  - Enables whole DRM subsystem testing from userspace
  - Made some Android build system / porting changes
    - https://android-review.googlesource.com/q/topic:igt-android
  - Still working on baseline test plan for AOSP platforms, Pixel

- Detection of DRM display driver will be added to Android VTS
  - Detection will trigger `igt-gpu-tools` on those display drivers

- Can be tough to test upstream when device ecosystem runs older kernels
  - Virtual and AOSP platforms can help keep us honest

Porting IGT to Android (again)

```
cc_binary {
    name: "gem_blt",
    srcs: [
        "benchmarks/gem_blt.c",
        "lib/drmtest.c",
        "lib/igt_aux.c",
        "lib/igt_core.c",
        "lib/igt_debugfs.c",
        "lib/igt_dummyload.c",
        "lib/igt_kmod.c",
        "lib/igt_sysfs.c",
        "lib/ioctl_wrappers.c",
        "lib/i915/gem_mman.c",
    ],
    cflags: [
        "-Wall",
        "-Werror",
        "-Wno-missing-field-initializers",
        "-Wno-unused-parameter",
        "-Wno-unused-variable",
        "-DHAVE_GETTID",
        "-DHAVE_LIBGEN_H",
        "-DHAVE_MEMFD_CREATE",
    ],
    local_include_dirs: [
        "lib",
        "lib/stubs/drm",
        "prebuilt-intermediates",
    ],
    static_libs: ["libelf", "libelf_headers", "libkmod"],
    shared_libs: ["libdrm", "libunwind"],
    stl: "none",
}
```

- IGT needs to run natively on Android
  - Requirement for VTS integration
  - Have to use Blueprint files (no meson)
- Changes to AOSP to expose dependencies
  - `libkmod libelf libunwind`
- Mock implementations
  - `libcairo libglib2.0 libpciaccess`
- WIP
  - ifdef/mock/add `libudev libprocps`
  - Getting more tests to run on HW
- Future
  - Chamelium testing w/ AOSP devices?

Backporting subsystems?

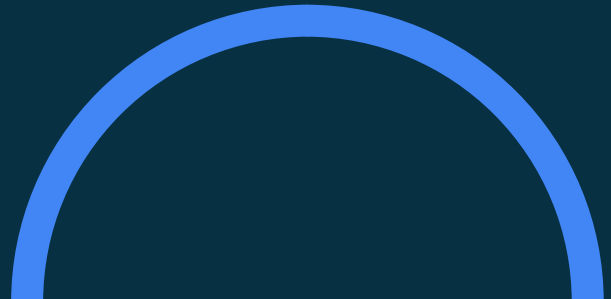
- Display/graphics/multimedia especially fragmented
  - Vendors forward-port or backport subsystems anyway
  - ‘Upstream first’ isn’t really working for mobile SoCs

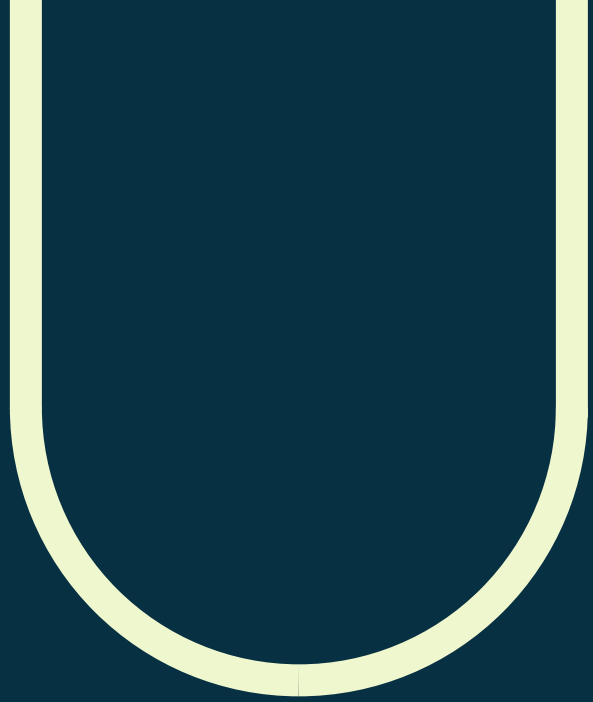
- Backporting DRM core from latest LTS to older LTS kernels
  - For Android 11: android-{5.4,4.19,..} with same DRM core?
  - Will it help ‘upstream first’, display/graphics/multimedia fragmentation?

- Other technical debt
  - Deprecate ion, replace with dma-buf heaps (will miss 5.4)
  - Backport dma-buf from 5.5 to android-{5.4,4.19,..}?
  - V4L2 Request API (for Codec2)

- Future
  - Reusable syncs (like DRM syncobj) for all drivers
  - Start looking at codecs, camera

Questions?





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