Linux in Mobile Devices

Linux 30 Year Jubilee Seminar
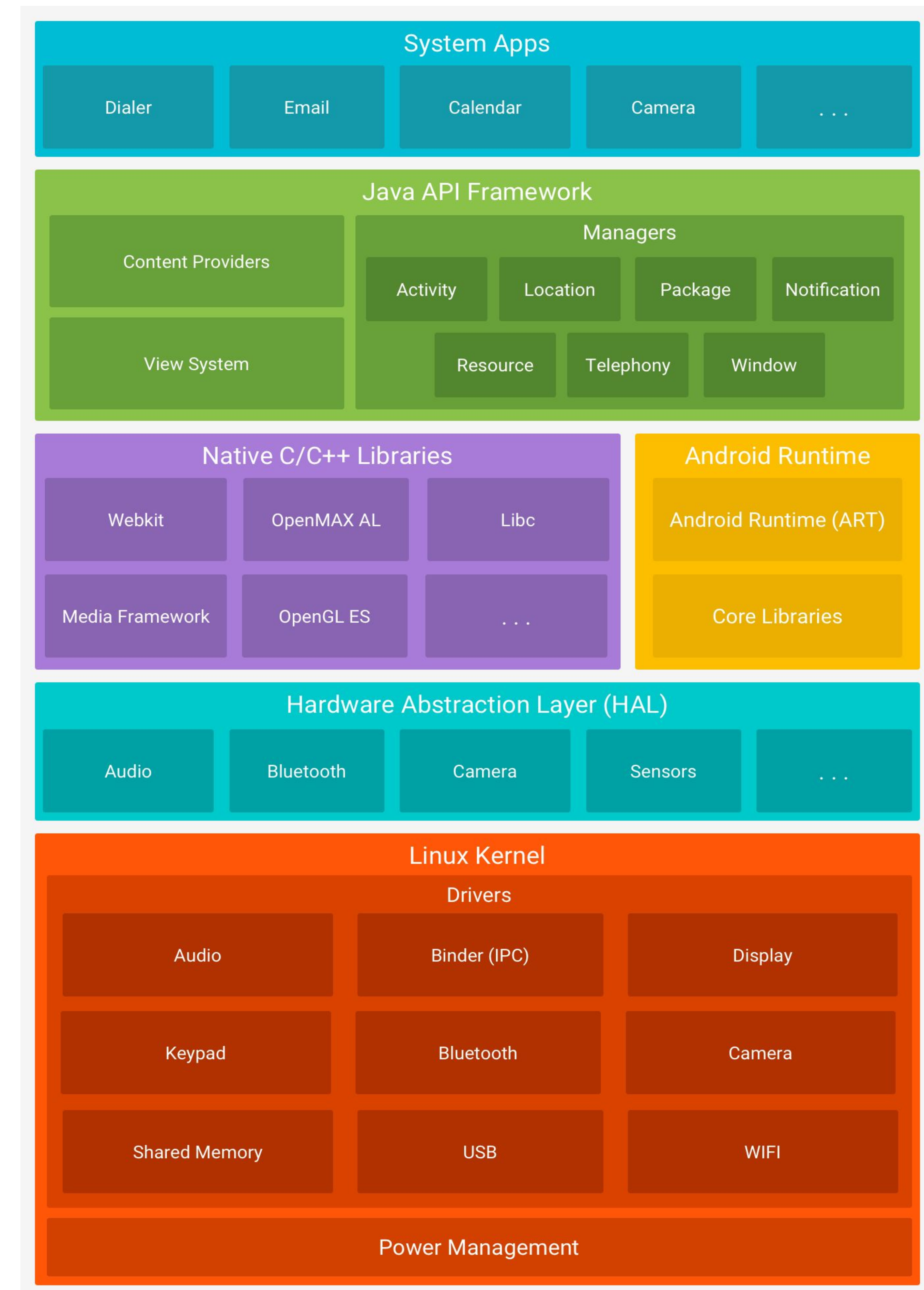Todd Kjos, Google
October 2021

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Android Platform Architecture

Android is an open source, Linux-based software stack created for a wide array of devices and form factors. The following diagram shows the major components of the Android platform.

System Apps

| Dialer | Email | Calendar | Camera | . . . |

Java API Framework

Managers

| Content Providers | Activity | Location | Package | Notification |
| View System | Resource | Telephony | Window | |

Native C/C++ Libraries

| Webkit | OpenMAX AL | Libc |
| Media Framework | OpenGL ES | . . . |

Android Runtime

Android Runtime (ART)

Core Libraries

Hardware Abstraction Layer (HAL)

| Audio | Bluetooth | Camera | Sensors | . . . |

Linux Kernel

Drivers

Audio	Binder (IPC)	Display
Keypad	Bluetooth	Camera
Shared Memory	USB	WIFI

Power Management

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Android Linux Evolution

2008-2017

2017-2019

**2020
(5.4 kernel)**

**2021+
(5.10+ kernel)**

Vendor-specific Kernel

- Android Kernel was a reference only
- No requirements other than expected system calls are implemented

Treble Compatibility

- Device kernel must be downstream of Android Kernel
- Minimum Kernel version requirement for security
- Android kernel gets regular LTS updates

Generic Kernel Image (GKI) Compatibility Testing

- Devices must pass compliance tests with GKI kernel in addition to product kernel

Full GKI

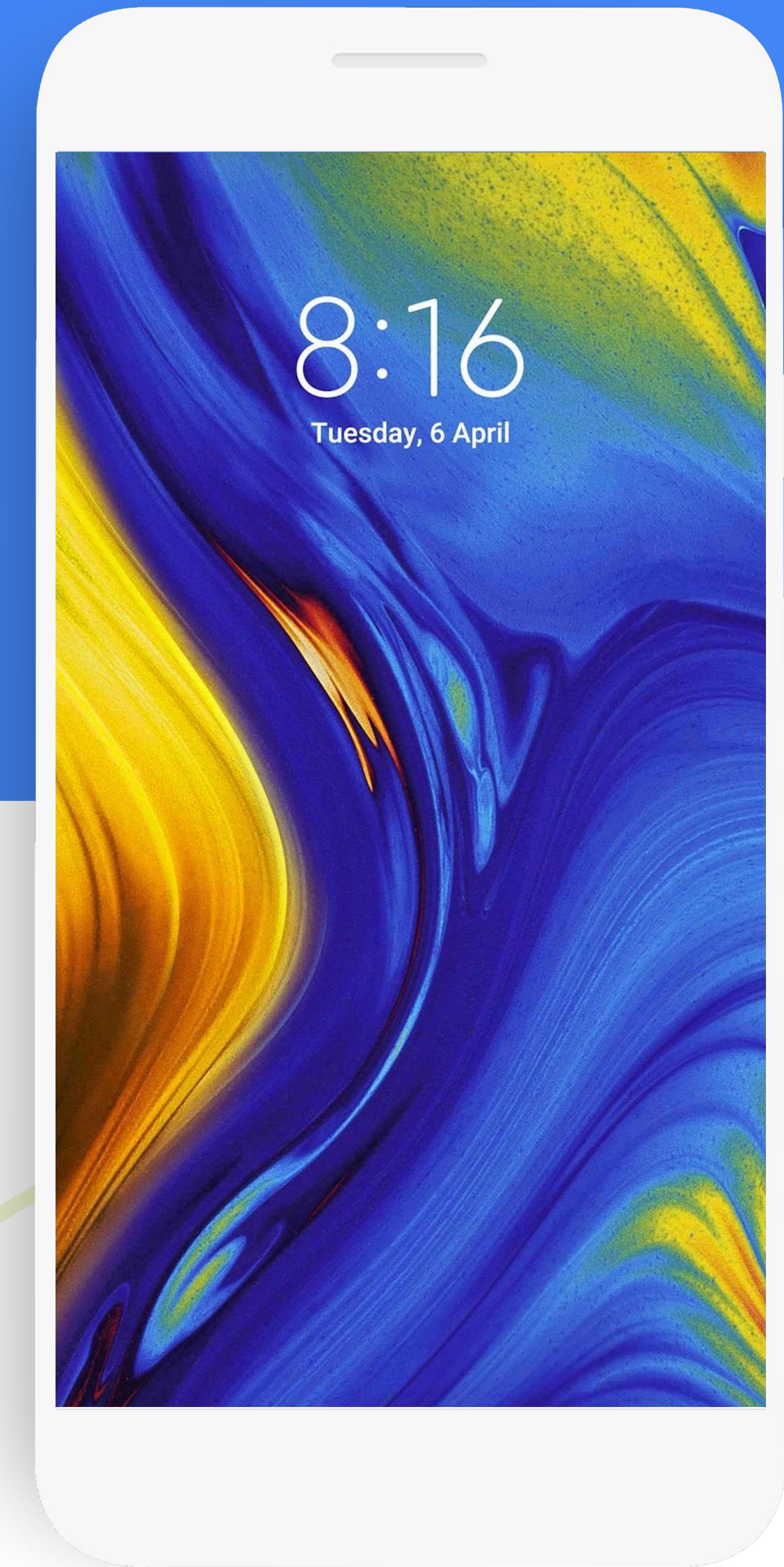- Devices must ship with GKI kernel

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"Upstream First" Development

Co-Developed with Android Community

- Protected KVM (pKVM)

- Energy Aware Scheduler (EAS)

- fw_devlink: dependency expression for module loading efficiency

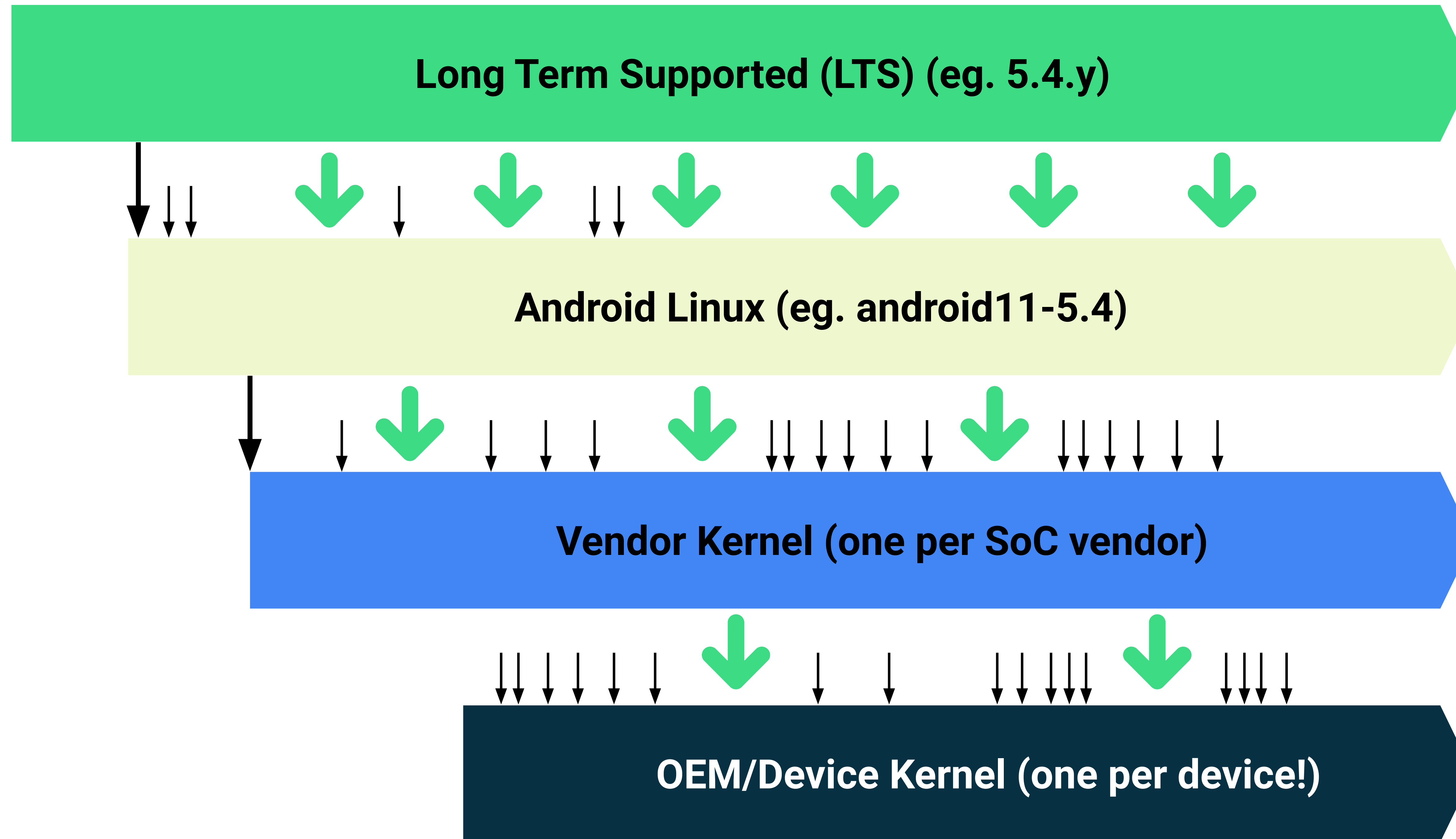- Pressure Stall Information (PSI) enhancements

Adopted by Android Community

- Kernel Low-memory killer replaced by user-space relying on PSI

- Replaced ashmem with memfd

- Replacing ION with dma-buf

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Pre-GKI Android Kernel Hierarchy

Long Term Supported (LTS) (eg. 5.4.y)

Android Linux (eg. android11-5.4)

Vendor Kernel (one per SoC vendor)

OEM/Device Kernel (one per device!)

Clone ⟶ Merge ⟶ Cherry-Pick ⟶

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Cost of Kernel Fragmentation

- Security updates are labor intensive

- Difficult to merge long-term stable updates

- Inhibits Android Platform release upgrades

- Difficult to contribute kernel changes back to upstream Linux

8:16
Tuesday, 6 April
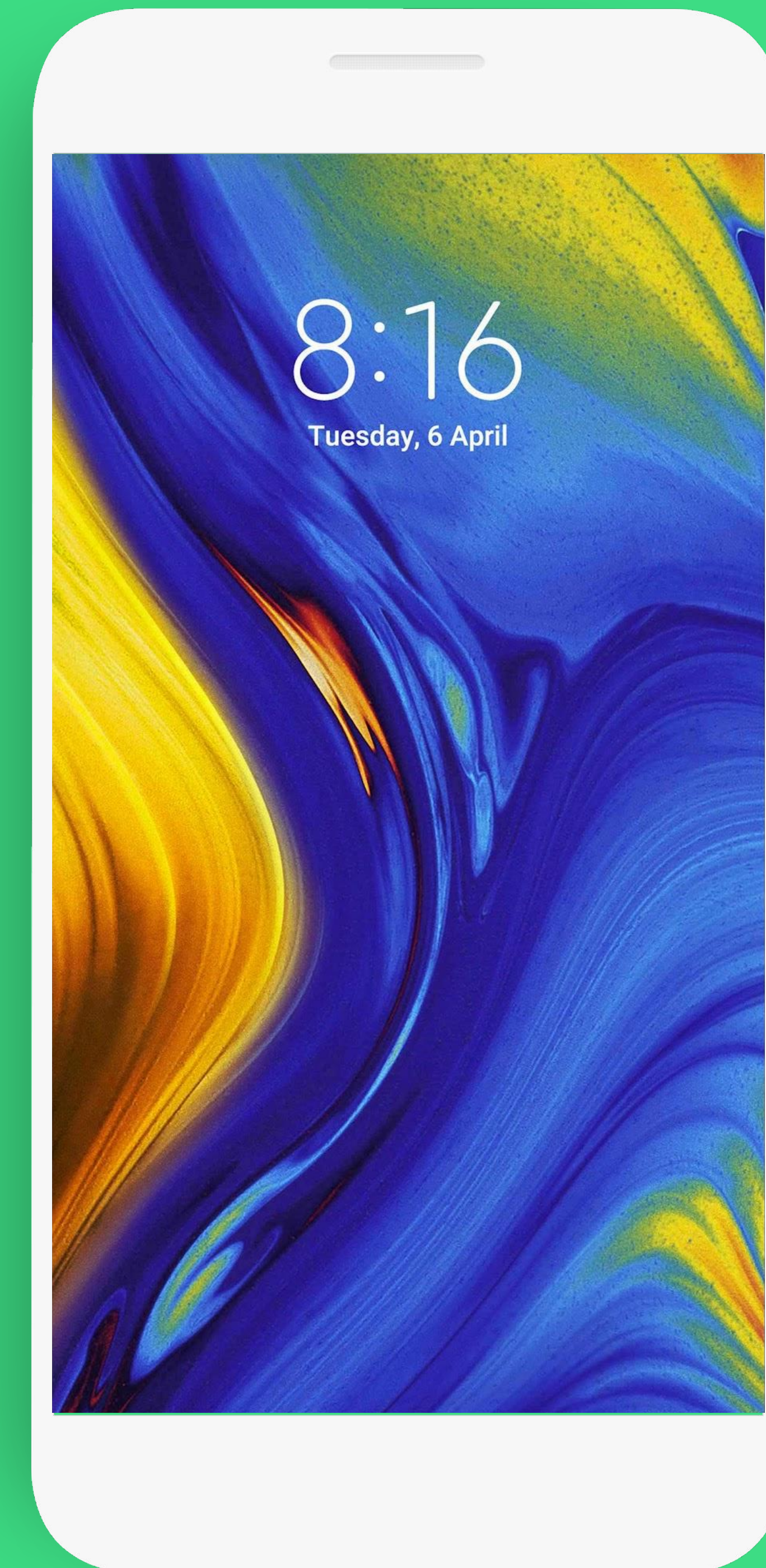
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Root Access Exploit (October 2019)

"Project Zero, a team dedicated to finding security bugs, gave a 'non-exhaustive' list of which phone models running Android 8 or later could be affected by this exploit:

- Pixel 2 with Android 9 and Android 10 preview
- Huawei P20
- Xiaomi Redmi 5A
- Xiaomi Redmi Note 5
- Xiaomi A1
- Oppo A3
- Moto Z3
- Oreo LG phones
- Samsung Galaxy S7, S8, S9"

cnet   COVID-19   BEST PRODUCTS ⌄   REVIEWS ⌄   NEWS ⌄   HOW TO ⌄   FINANCE ⌄   HEALTH ⌄   SMART HOME ⌄   CARS ⌄   DEALS ⌄

Android exploit leaves some Pixel, Galaxy phones vulnerable to hacks

Several other phones are also at risk.

Oscar Gonzalez   Oct. 4, 2019 8:41 a.m. PT

Google has discovered an Android bug that could potentially be abused by hackers.
Angela Lang/CNET

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Fixing Kernel Fragmentation: Generic Kernel Image (GKI)
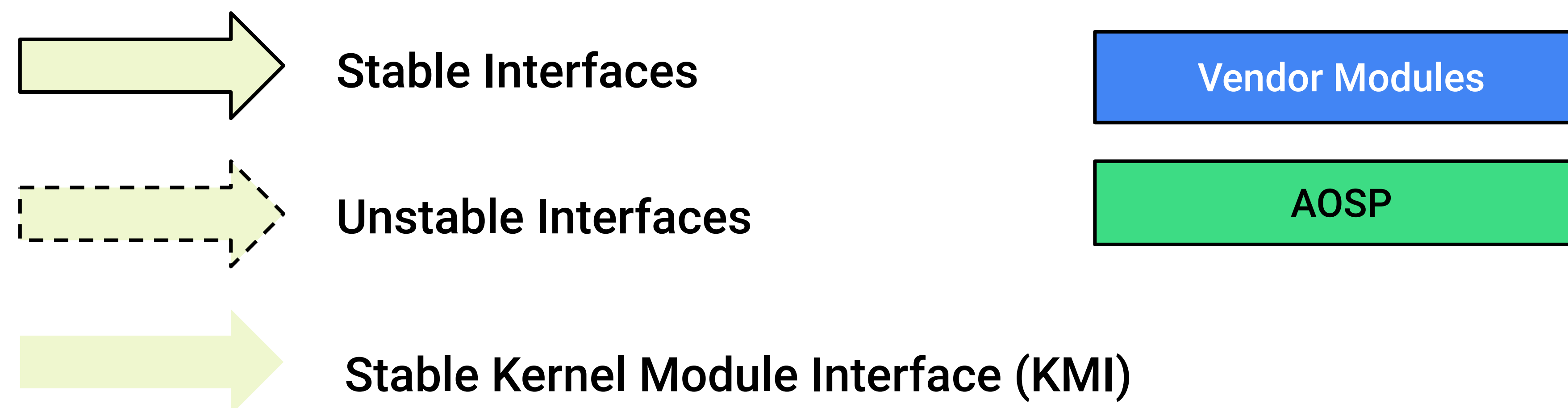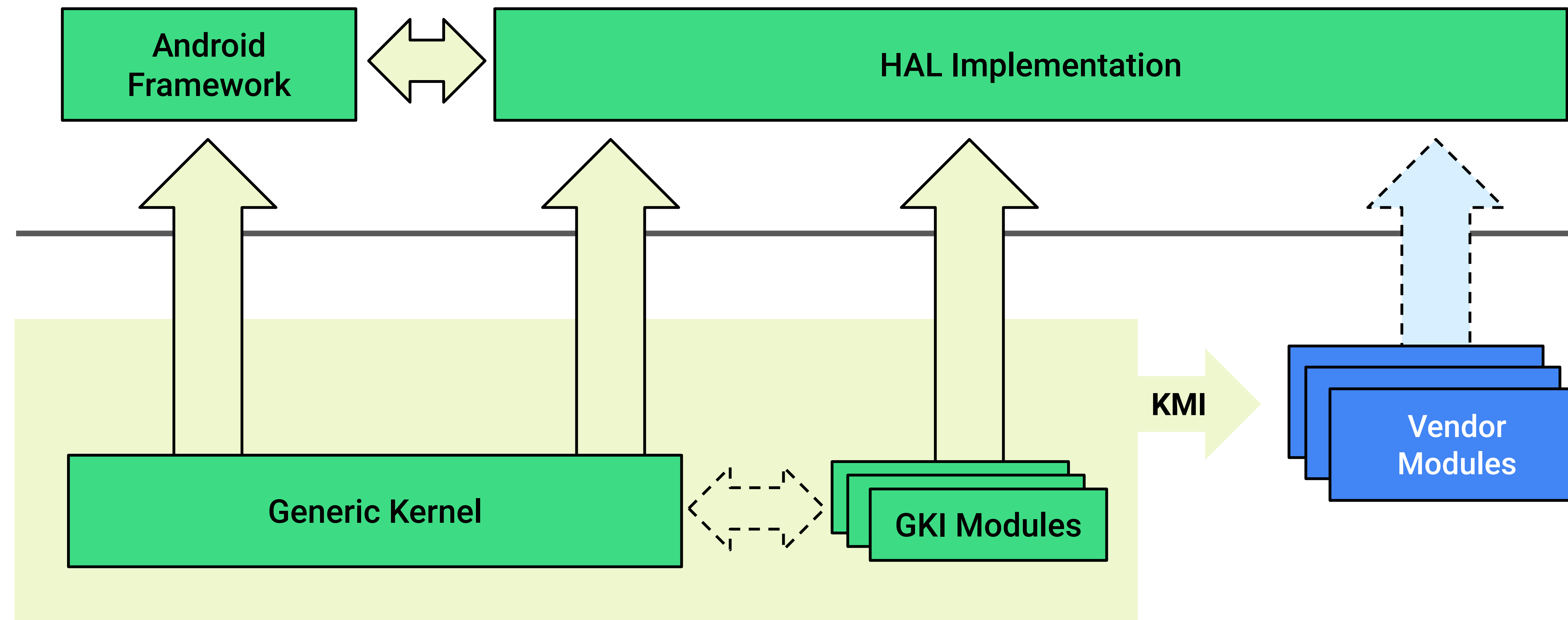
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GKI Deployment

Android 12 Devices running 5.10 Kernel

- Devices ship with GKI boot image
- Binary releases available publicly on ci.android.com
- Compliance Tests check for *certified* image

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The Future: Increased Alignment with Upstream

- 2020-2022: Accumulating ecosystem technical debt in Android Linux (`android12-5.10` and `android-mainline`)
  - Features that were in Vendor or OEM kernels are now
    - Upstreamed, OR
    - Isolated into vendor modules, OR
    - Merged into Android Linux
  - Debt is visible for `android-mainline` as quilt series: https://android.googlesource.com/kernel/common-patches/
- 2023-2024: Reducing Technical Debt
  - *Upstream First* Development model for new features
  - Work toward upstreaming all out-of-tree patches in Android Linux

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Public Documentation

- [Android Linux](#)
- [Generic Kernel Image](#)

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