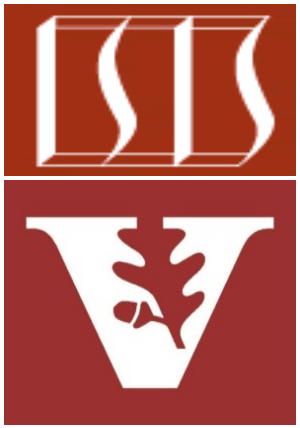
Infrastructure Middleware (Part 1): Hardware Abstraction Layer (HAL)



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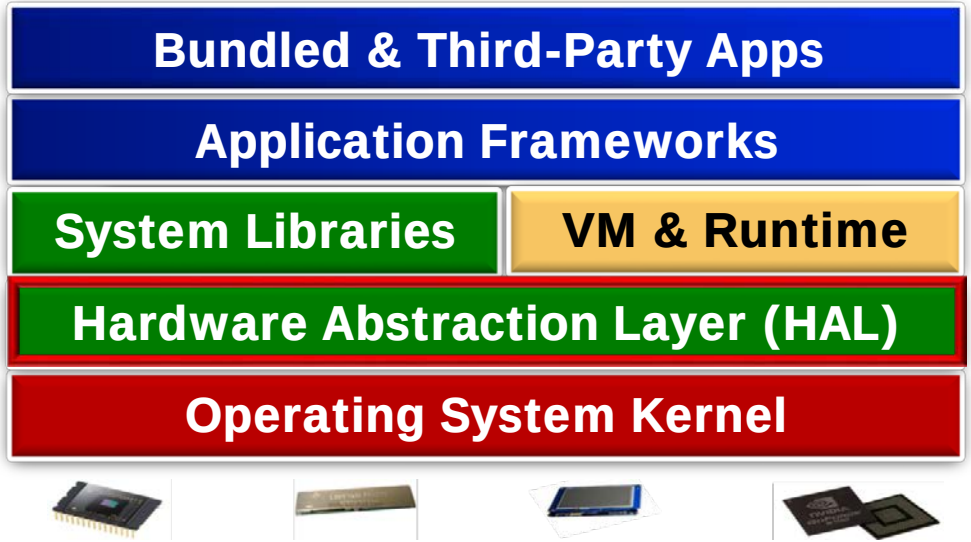
Learning Objectives in this Part of the Lesson

- Understand the role the HAL plays in Android's system architecture



The HAL mediates interactions between the OS kernel layer & higher layers

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- Know the technical & economic factors that motivated Google & its original equipment manufacturer (OEM) partners to add a HAL to the Android software stack

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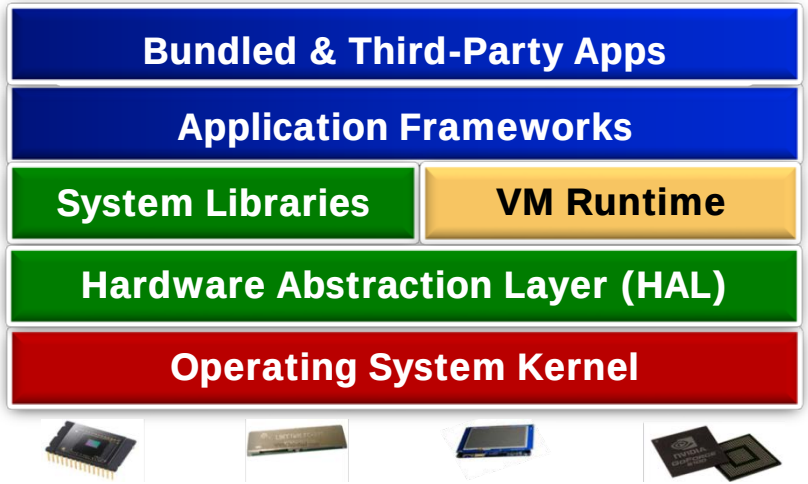
Android apps rarely access the HAL directly, so you needn't know all the details

Overview of Android Hardware Abstraction Layer

The Android Hardware Abstraction Layer (HAL)

- The HAL helps to separate concerns in the Android system architecture



See source.android.com/devices/#Hardware Abstraction Layer

The Android Hardware Abstraction Layer (HAL)

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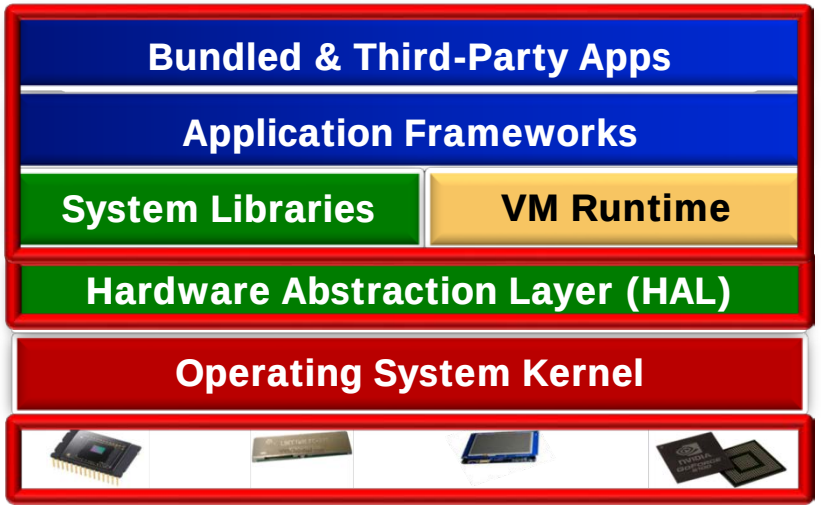
  - Decouples Android platform software from hardware



The Android Hardware Abstraction Layer (HAL)

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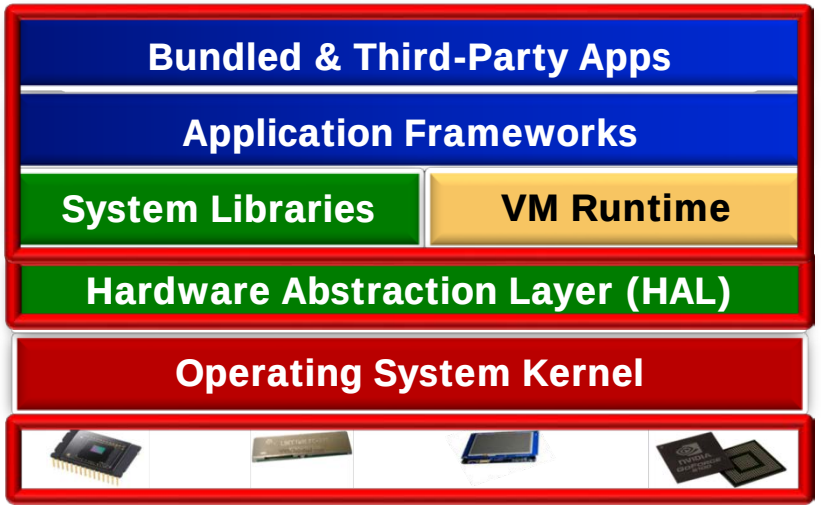
  - Decouples Android platform software from hardware
    - i.e., apps don't break when hardware changes



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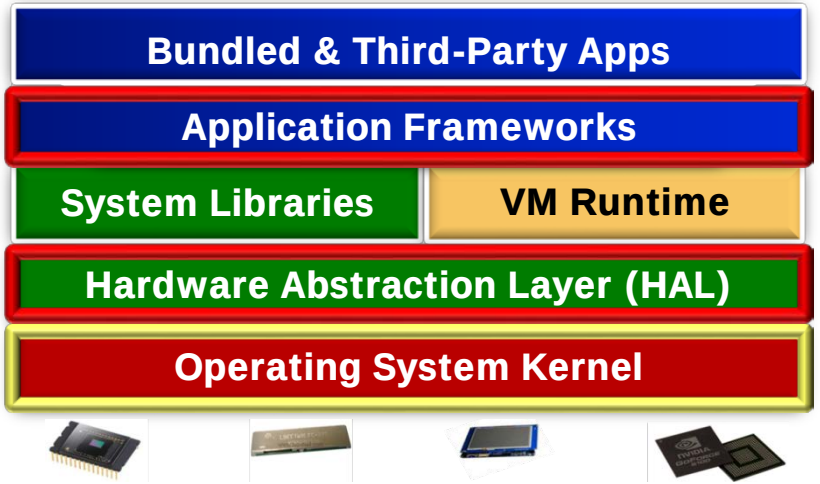
  - Decouples Android framework layer from the operating system layer



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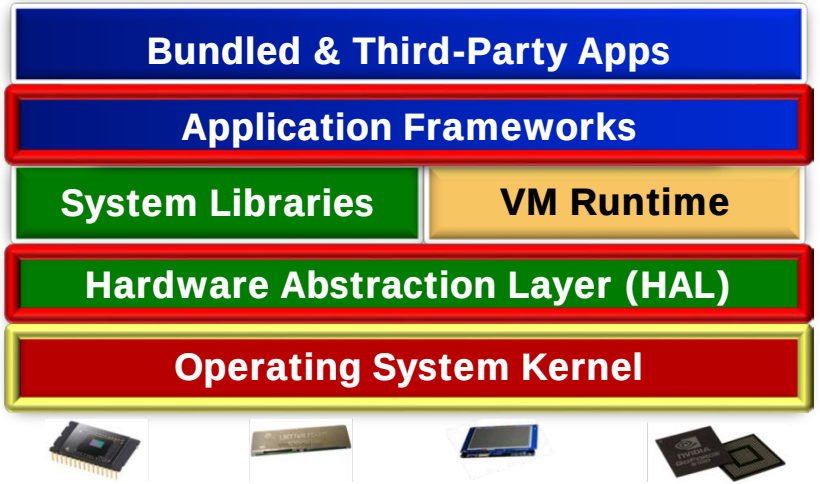
    - e.g., this layer can be programmed via method calls on Java objects, rather than C system function calls



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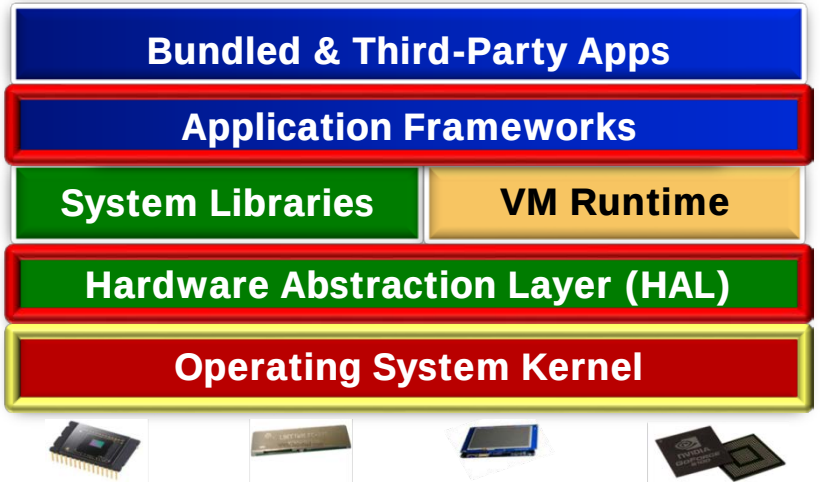
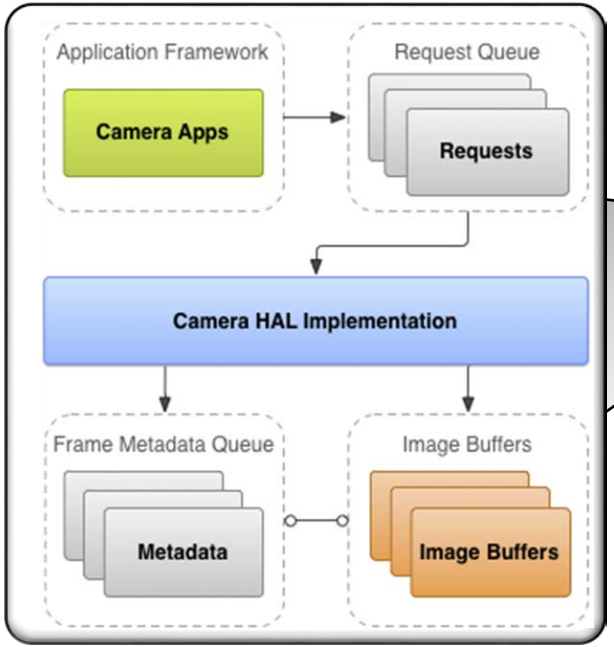
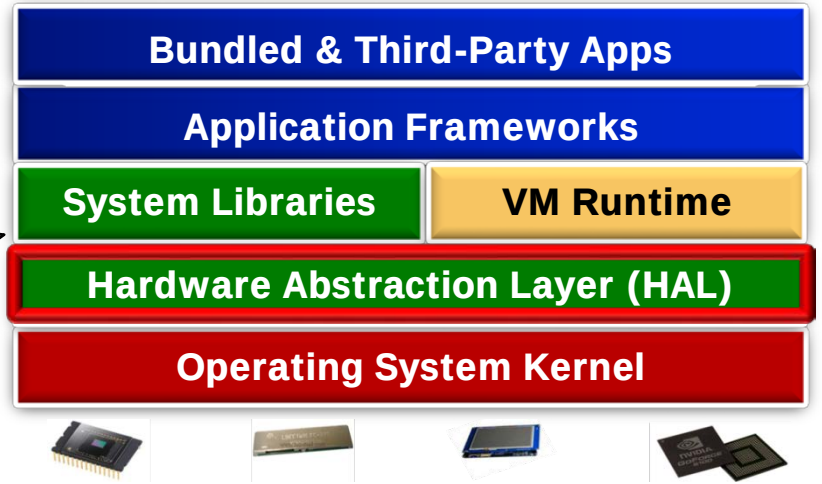


App developers can thus focus on business logic, rather than low-level details

The Android Hardware Abstraction Layer (HAL)

- Android's HAL defines interfaces that driver modules must implement





See source.android.com/devices/#structure

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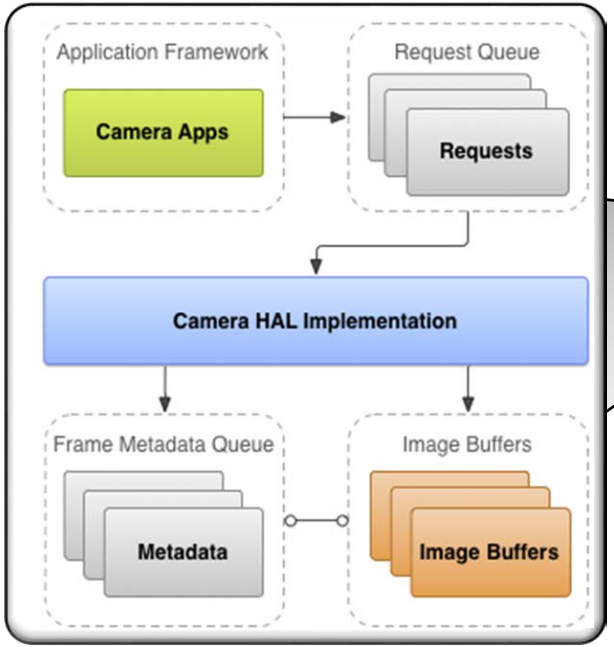
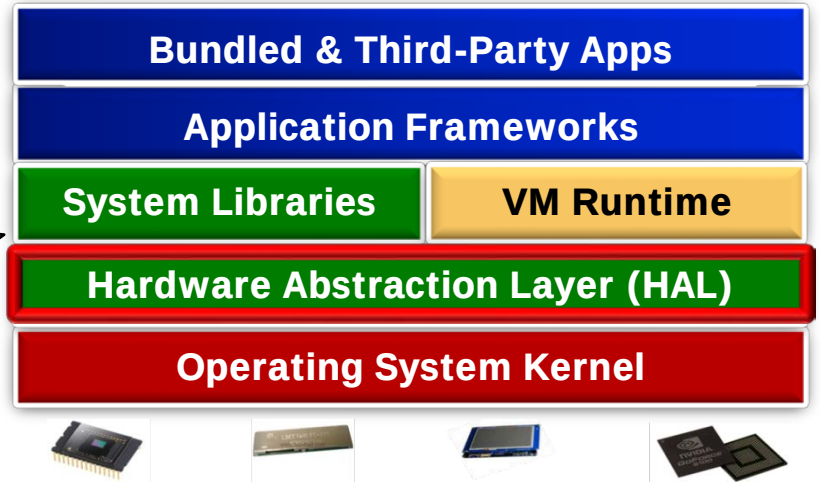
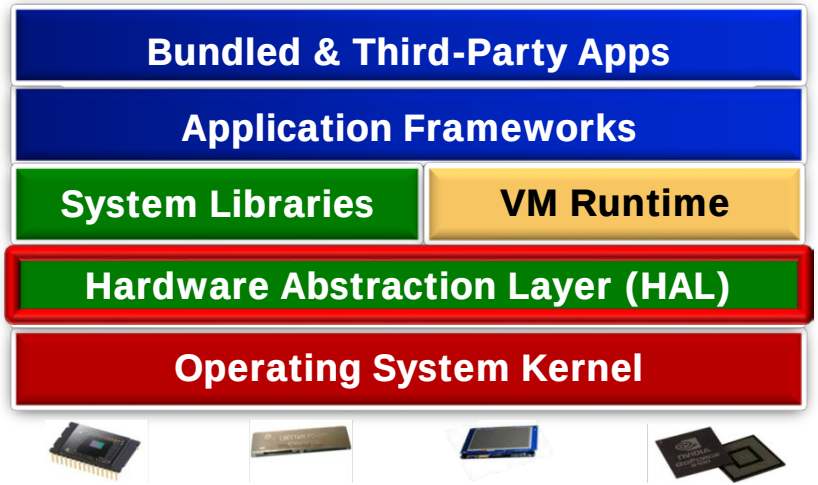




These driver modules do not run in the Android Linux kernel!

The Android Hardware Abstraction Layer (HAL)

- The Android HAL is a *user space* C/C++ library layer, unlike device drivers residing in the Android Linux kernel



See earlier lesson on the “Android Linux Kernel”

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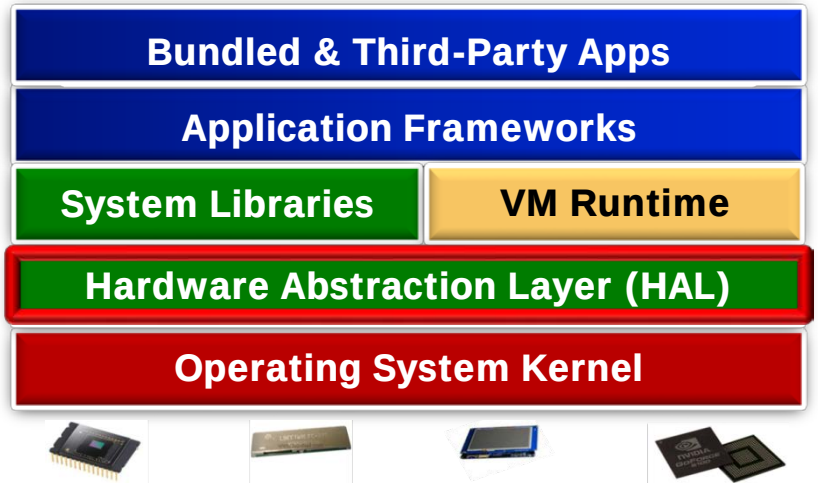
  - User space code can't directly access Android Linux kernel device drivers



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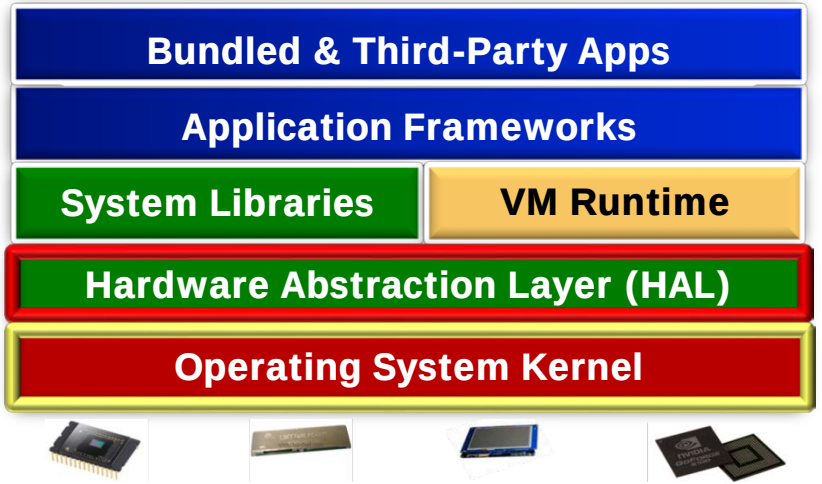
The Android Hardware Abstraction Layer (HAL)

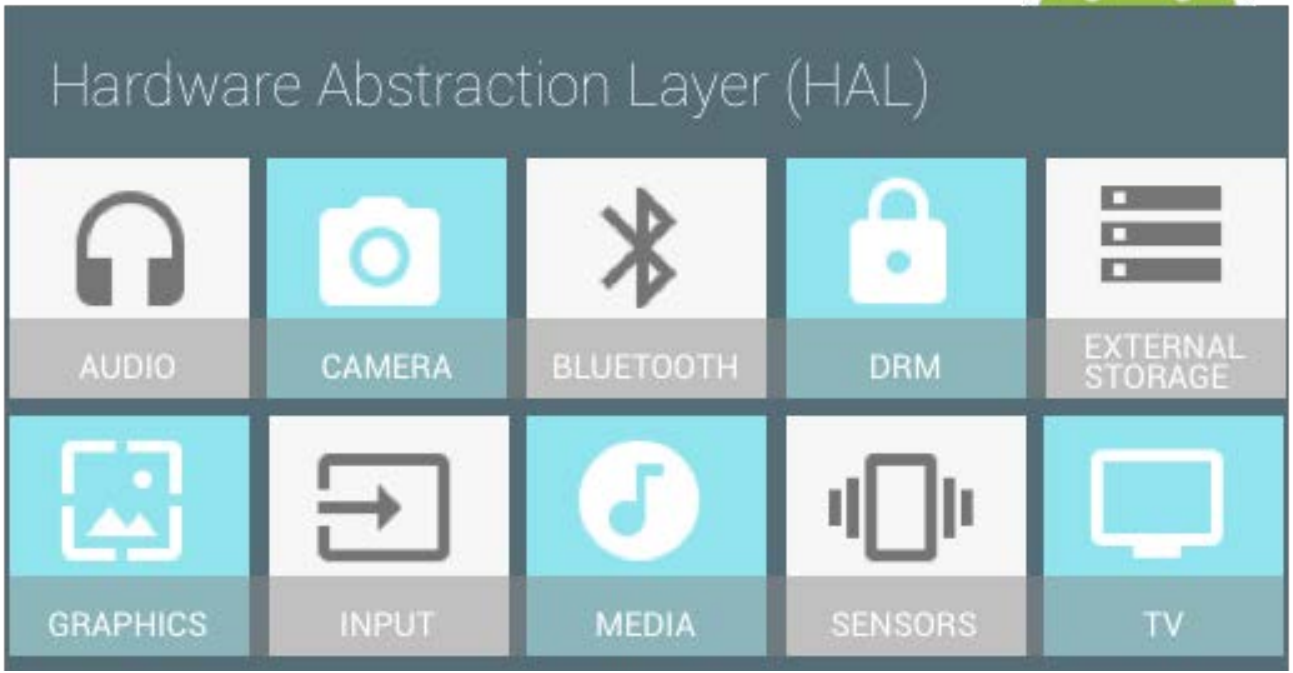
- The Android HAL is a *user space* C/C++ library layer, unlike device drivers residing in the Android Linux kernel
  - User space code can't directly access Android Linux kernel device drivers
  - Therefore apps & system services use the HAL to interact w/kernel drivers



See www.dre.vanderbilt.edu/~schmidt/PDF/Android-HAL.pdf

The Android Hardware Abstraction Layer (HAL)

- OEMs implement HAL driver modules for their proprietary hardware



See source.android.com/devices/#Hardware Abstraction Layer

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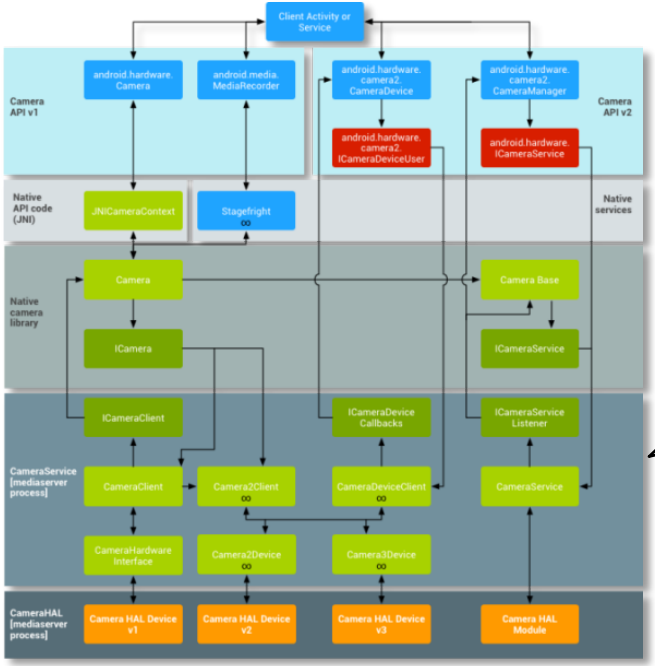
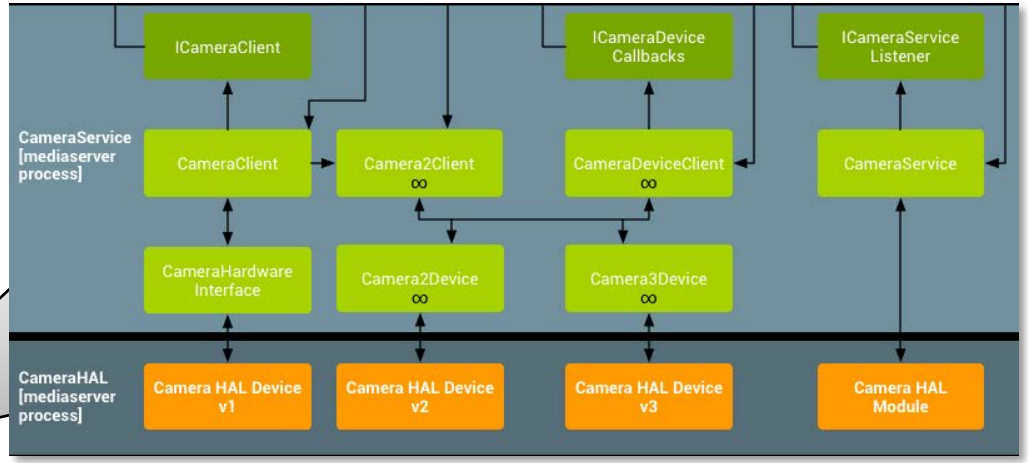


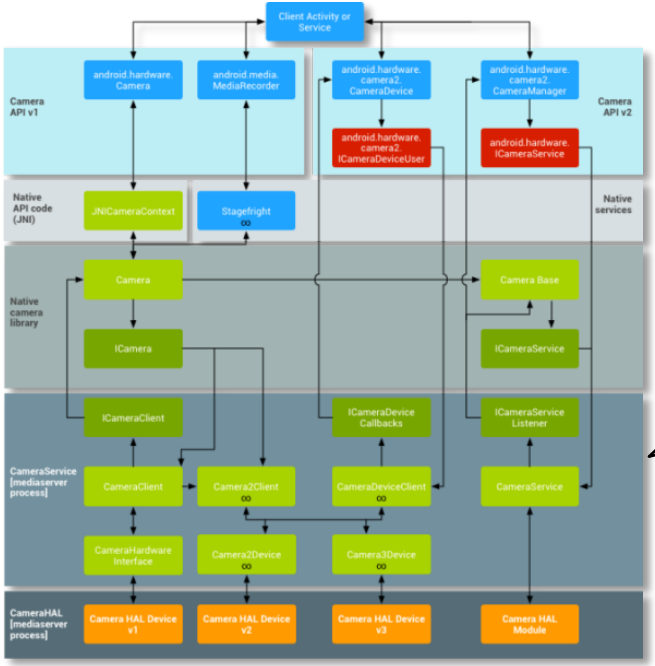


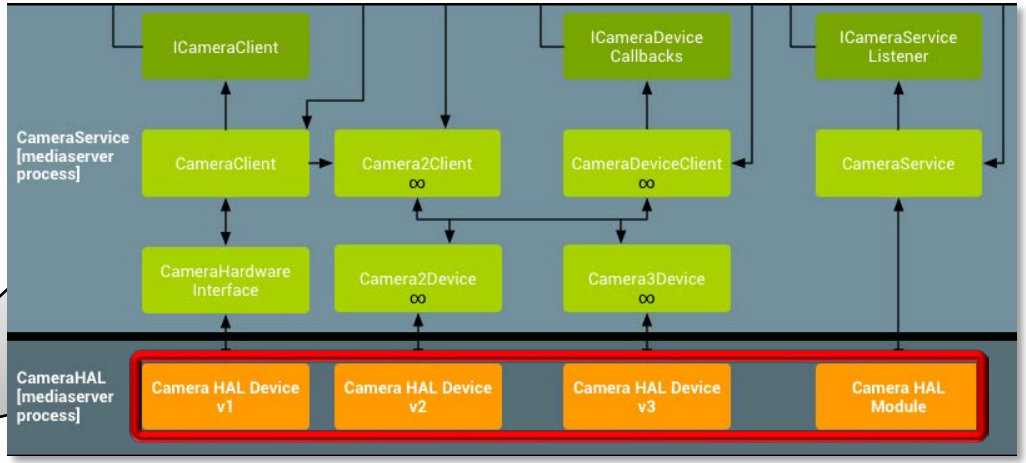
- e.g., camera hardware from an OEM has a camera system service & a camera HAL API

See source.android.com/devices/camera

The Android Hardware Abstraction Layer (HAL)

- Driver modules that implement HAL APIs are linked dynamically by Android





See source.android.com/devices/#modules

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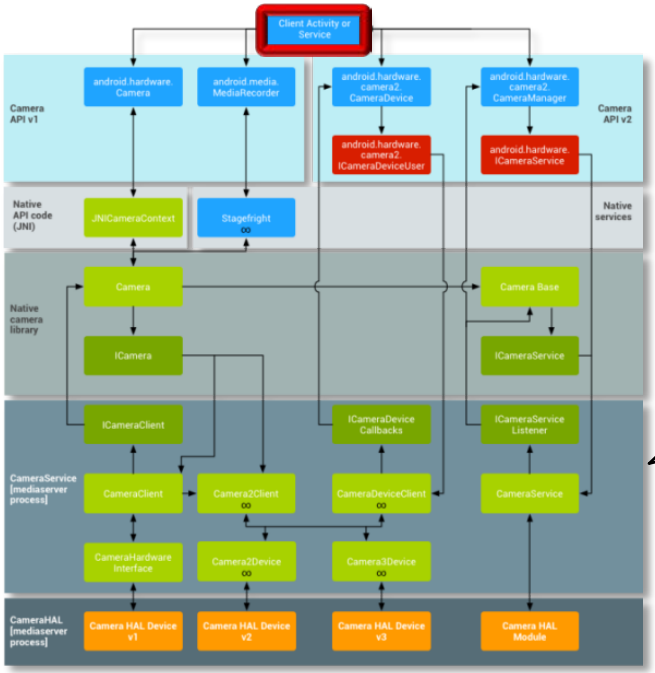

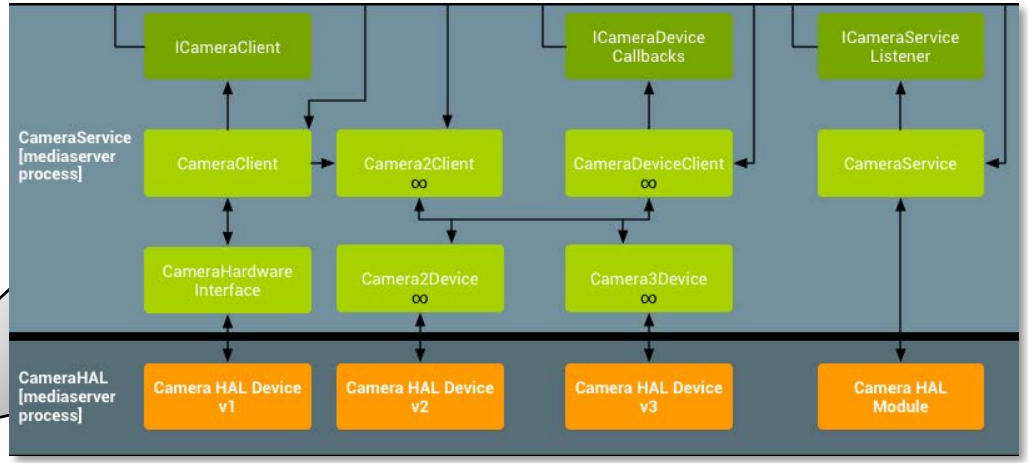

- e.g., when an app first accesses the camera hardware encapsulated by the camera HAL API

See source.android.com/devices/#modules

Motivations for Android's Hardware Abstraction Layer

The Android Hardware Abstraction Layer (HAL)

- There are two types of motivations for Android's user space HAL design

The Android Hardware Abstraction Layer (HAL)

- One motivation is technical

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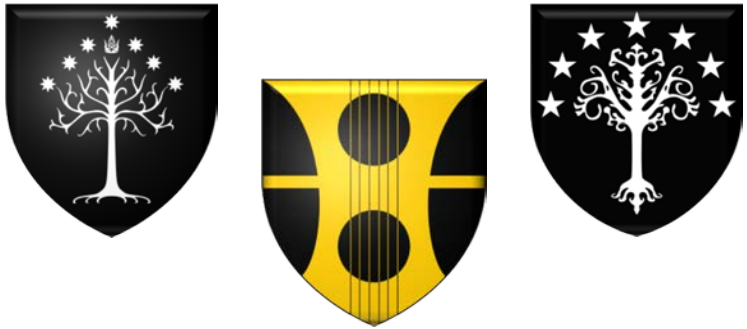
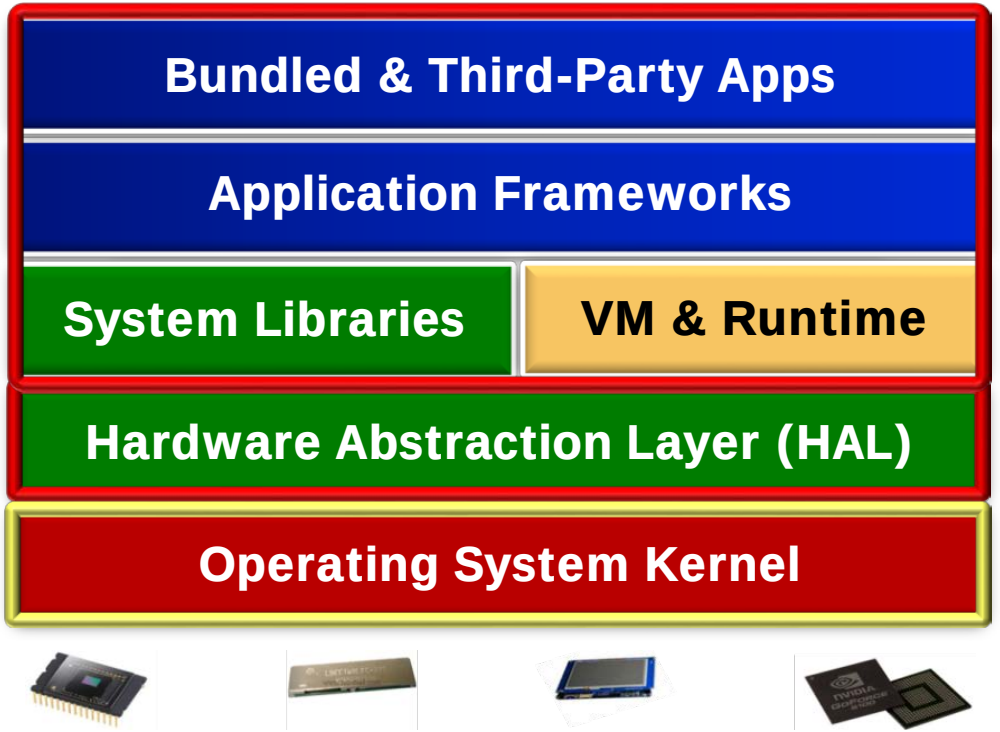
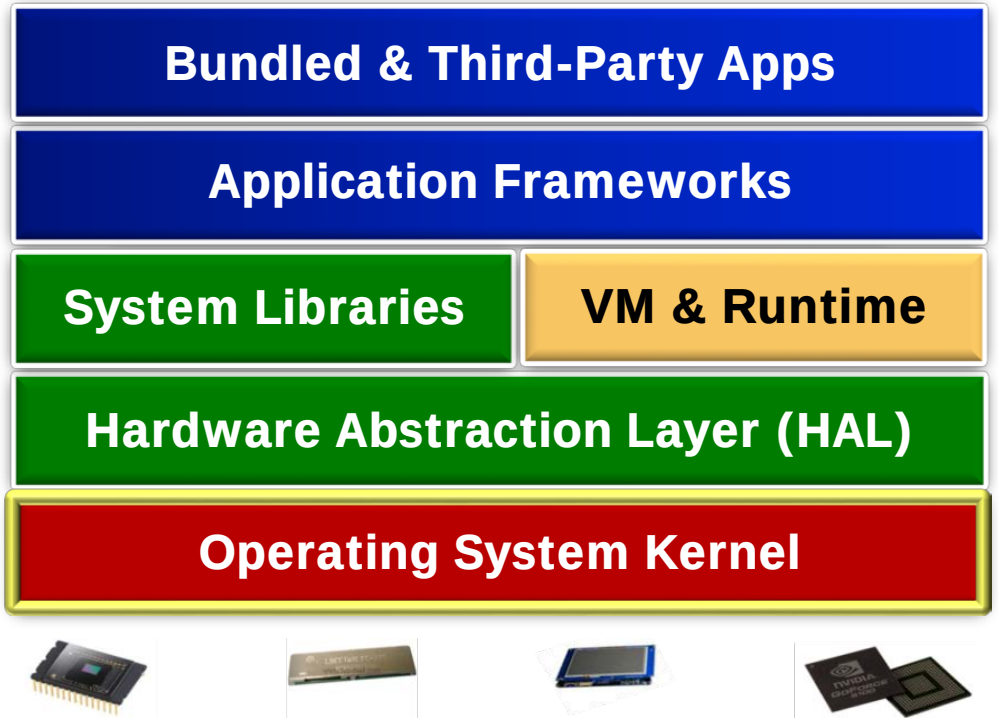
  - Shielding higher layers of Android's software stack from Linux kernel idiosyncrasies





The Android Hardware Abstraction Layer (HAL)

- One motivation is technical
  - Shielding higher layers of Android's software stack from Linux kernel idiosyncrasies
    - GNU Linux device drivers don't provide consistent support for certain types of devices
      - It's historical focus is on laptops/desktops/servers



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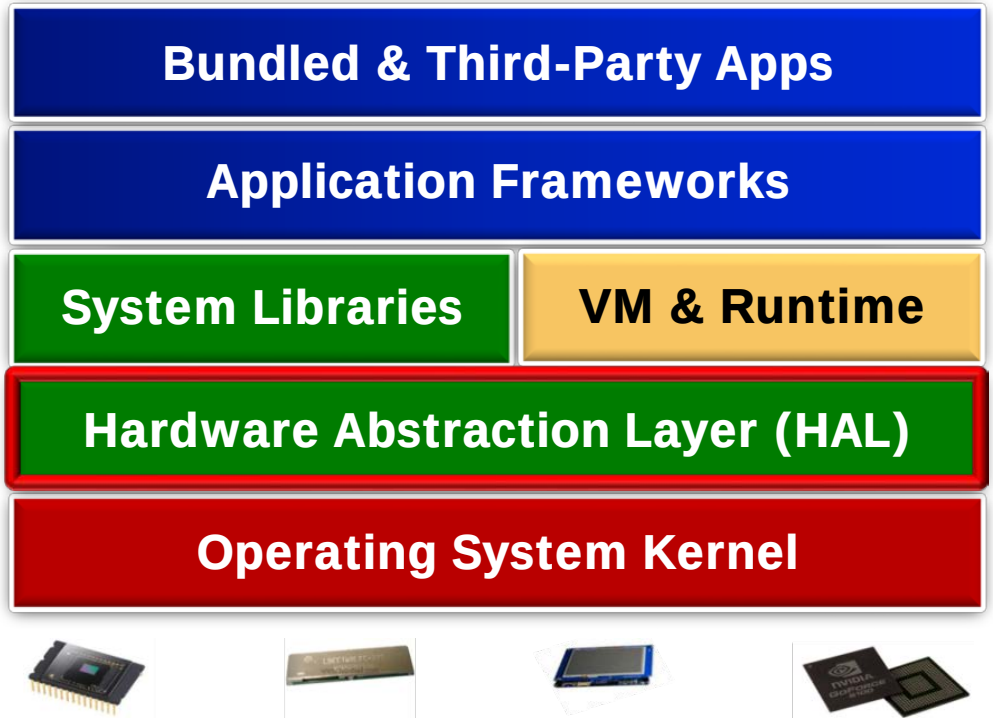
  - Shielding higher layers of Android's software stack from Linux kernel idiosyncrasies
    - GNU Linux device drivers don't provide consistent support for certain types of devices
    - The HAL therefore defines a consistent object-oriented API for these hardware elements



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See en.wikipedia.org/wiki/GNU_General_Public_License

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  - However, Android OEMs often use proprietary drivers
    - i.e., they don’t want to give out the source code for them

See higes.com/android-linux-kernel-drivers

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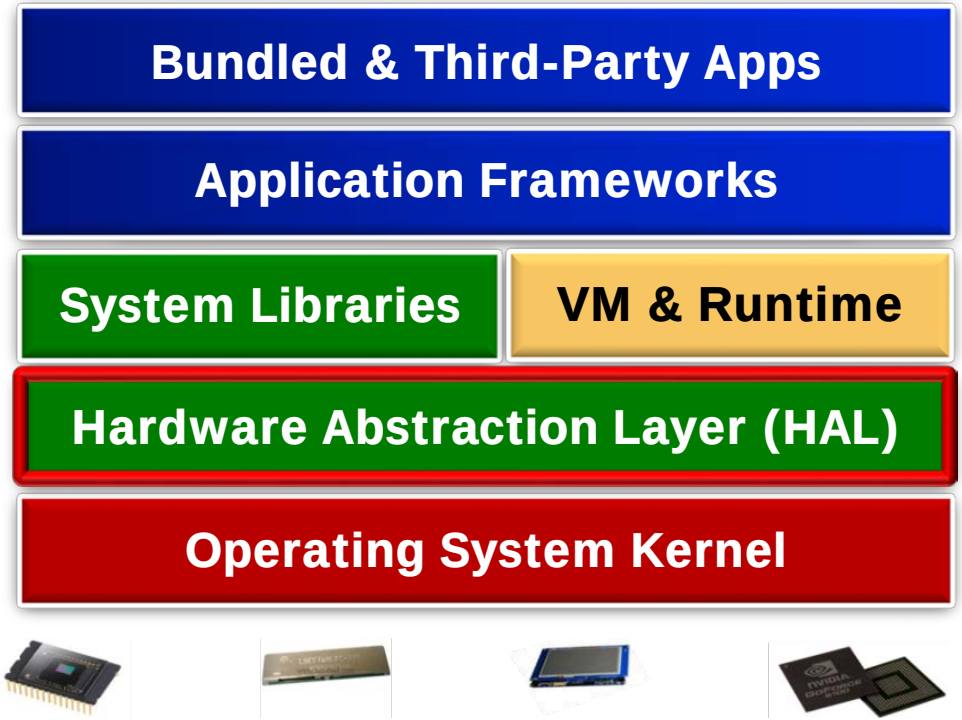
    - Putting driver implementations in user-space HAL enables them *not* to release the source code



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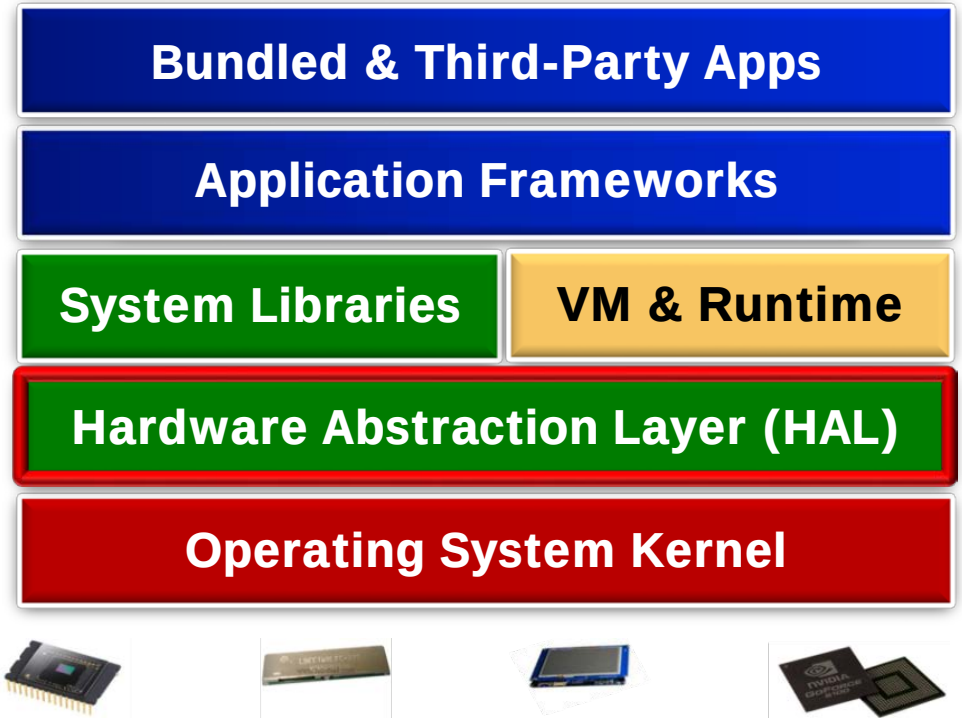
  - See Android licenses for details



See source.android.com/source/licenses.html

End of Infrastructure Middleware (Part 1): Hardware Abstraction Layer