Google

Android Automotive OS

Guru Nagarajan, March 25, 2021

Agenda

- Android Automotive OS Platform
- Virtualization
- LTS & Security
- Performance & Reliability

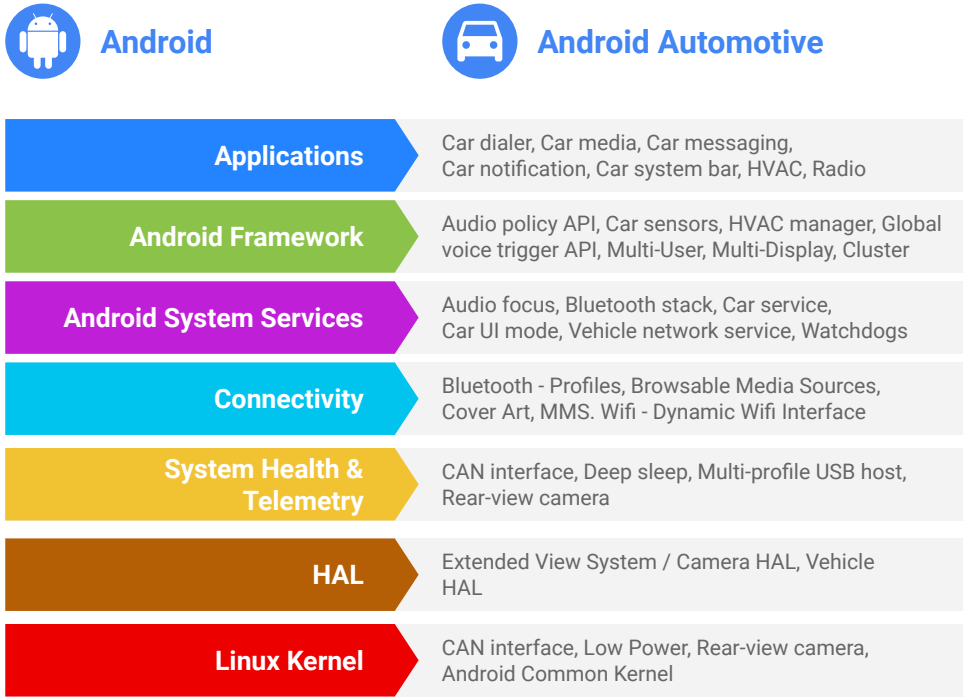
Google

Android Automotive OS | OS for Automotive Infotainment

The **Android Operating System,** optimized and extended into a built-in platform for automotive infotainment systems

Rich set of developer tools and SDK to enable application development

Multi-layer Security to protect the user



Android Automotive OS | Overview of Features

Android P

- Basic rotary support
- Multi stream audio routing
- Multiple IP network support
- Bluetooth improvements
- EV API
- ADAS/Maps data integration
- Driving state & UX Restrictions
- Suspend to RAM
- Flash wear management

And more...

Android 10 (Q)

- Multi-display capability
- Multi-zone audio
- Multi-user support
- Themeable system apps
- Updated system UI
- Remote SIM (SMS via BT)
- Identity mgmt via trusted device
- Multiple UX restriction configs
- Garage mode integration
- Passenger Mode API
- Improvements to VHAL, user media mgmt
- Watchdogs & Reliability

And more...

Android 11 (R)

- Multi-zone Audio input, Per user Audio Zone, Multi-display
- Early Camera, Surround View
- CVML framework to support execution across discrete HW, Virt env
- Trusted Execution Support
- VirtIO based subsystems
- Metrics
- Vehicle Integration to abstract vehicle bus (ex: CAN)
- Cover Art, MMS (Bluetooth)

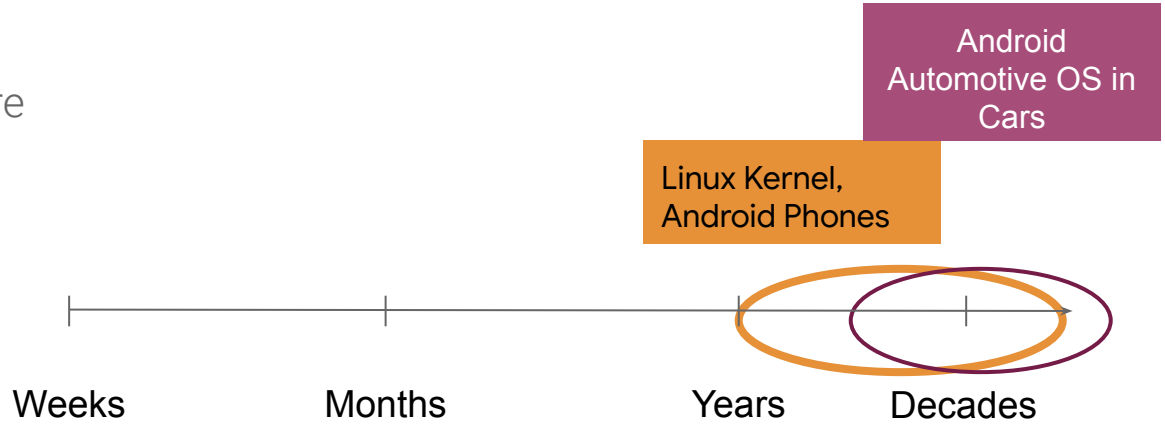
And more...

2018 | 2019 | 2020

** Current best assessment of plans. It is possible that the final list of delivered features is different than what is listed here as planning and development continue to unfold.*

Development, Sustaining & Security

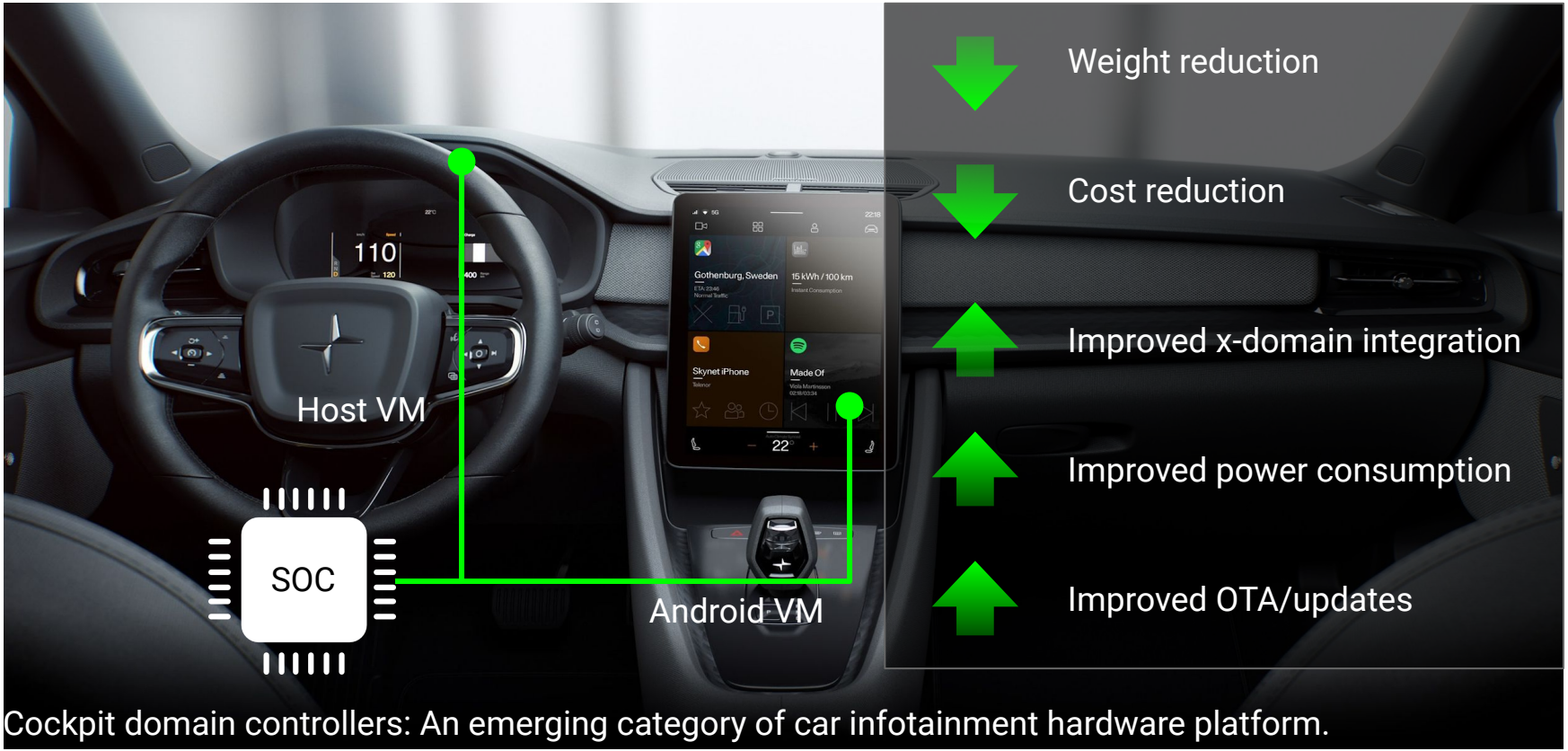
- Software in Cars have a lifetime of a decade or more
- To protect the user and ensure user experience, sustaining performance and tooling are critical.
  - Performance
  - Reliability
  - LTS
  - Security
  - Virtualization



- Virtualization
- LTS & Security
- Performance & Reliability

Virtualization

Virtualization



Cockpit domain controllers: An emerging category of car infotainment hardware platform.

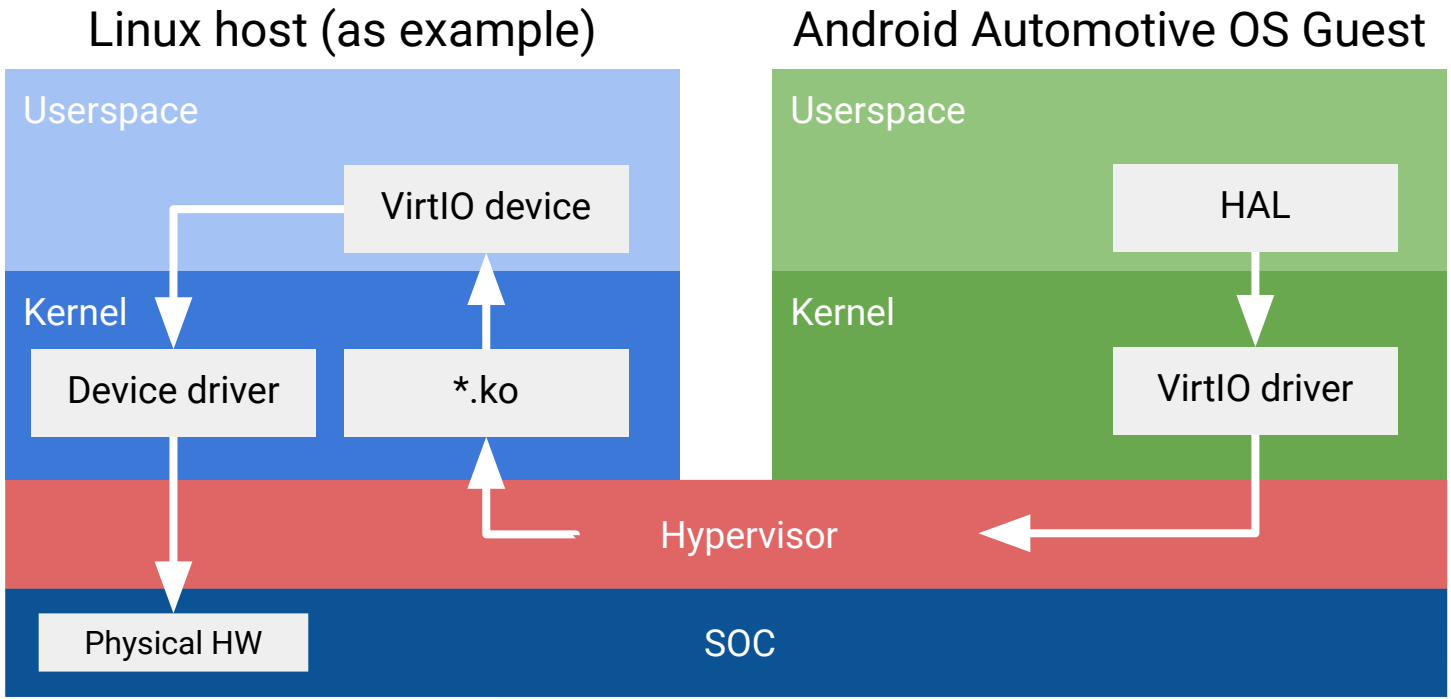
Virtualization | Automotive Drivers

- Cockpit consolidation is a real trend: Lower BOM cost, lower vehicle weight
- Ever more powerful SoCs enable more use cases
- Some use cases are critical (for example, interrupt response guarantees, memory isolation)
- Shared hardware access imposes unique challenges (for example, which network does one Wi-Fi adapter connect to?)

Our Approach to Virtualization

- Standards based and Open Platform
  - VirtIO, Open standard for virtualized devices
    - Started in 2008, is maintained and improved by an open committee
    - Google is a member of the OASIS committee
  - Portability across implementations, Easier Updates
- Leverage virtio where possible
- Extend it as needed (for example, `virtio-snd`, `virtio-scmi`)
- HAL virtualization where it makes sense (Vehicle HAL)
- Passthrough for Android-only devices (for example, connectivity)

Virtualization | Architecture



Virtualization | VirtIO Devices

- VirtIO has origins in the cloud/desktop world
- Supports common devices such as disk (`virtio-blk`), network (`virtio-net`), and random number generators (`virtio-rng`) among others
- Multimedia device support is under active development:
  - `virtio-snd` (new standard in v1.2)
  - `virtio-gpu` (standard + extensions)
  - `virtio-video` (WiP in v1.2)
  - `virtio-scmi` (WiP in v1.2)
- Automotive use cases are a key driver for these new specifications

Virtualization | Vehicle HAL

- Android can work without direct access to vehicle bus
- Host-side runs a HAL server and communicates to Android through **vsock**
- Vehicle HAL really does two things:
  - Management of property subscriptions and overall state
  - Communication to and from vehicle
    - Discover properties configuration
    - Receiving updated property value
    - Set property value
- Only the latter needs to change for virtualization

Virtualization | GPU

- `virtio-gpu` is sufficient for many use cases
- Performance is key. SOCs can have optimized paths for guest VMs (for example, dedicated command queue). Focus on providing performance semantics, but providing a standardized protocol.
- Plan to enable vendor extensions; allow additional virtqueues to be negotiated for vendor-specific commands

Virtualization | Security

- Goal is to integrate Arm TrustZone
- Requires vendor / hypervisor support
- Planned for mid-2021

LTS & Security

LTS Background

- A Long Term Stable (LTS) kernel is a version of the upstream Linux kernel that is maintained for an extended period of time (versions selected for use with Android receive 6 years of support).
- Security and functional fixes are regularly checked in.
- Android and other major Linux distributions (e.g., Ubuntu, Debian, Red Hat) typically base their releases on a Linux LTS kernel in order to ensure updates and support for the lifetime of the product.

What happens today?

- Many security vulnerabilities that are fixed on upstream Linux are not fixed until much later on Android, putting users and the Android brand at risk.
- The Android Security team makes a best effort to identify fixes that address security vulnerabilities and to require them for Security Patch Level (SPL) compliance in the monthly security bulletins.
- However, we are limited to issues that are explicitly flagged as security vulnerabilities or that researchers bring to our attention as security vulnerabilities affecting Android.
- An analysis in 2019 showed that 92% of Linux kernel security vulnerabilities that are required for SPL compliance were already fixed in the LTS kernel at the time they were identified as security vulnerabilities.

SoC ecosystem & LTS updates

- Starting with Android 9, new device launches are required to ship with the most recent LTS release
- SoCs update the kernel to the required LTS version to support new device launches
- Android Common Kernels are updated regularly with the latest LTS kernel and tested/verified on all hardware and virtual platforms associated with them.
- SoC partners acknowledge the merge of the latest ACK and report any issues they encounter and are provided support by the Android kernel team.
- LTS update requirements are published in the partner security bulletin after we have confirmed with SoCs that the LTS version is merged in and tested

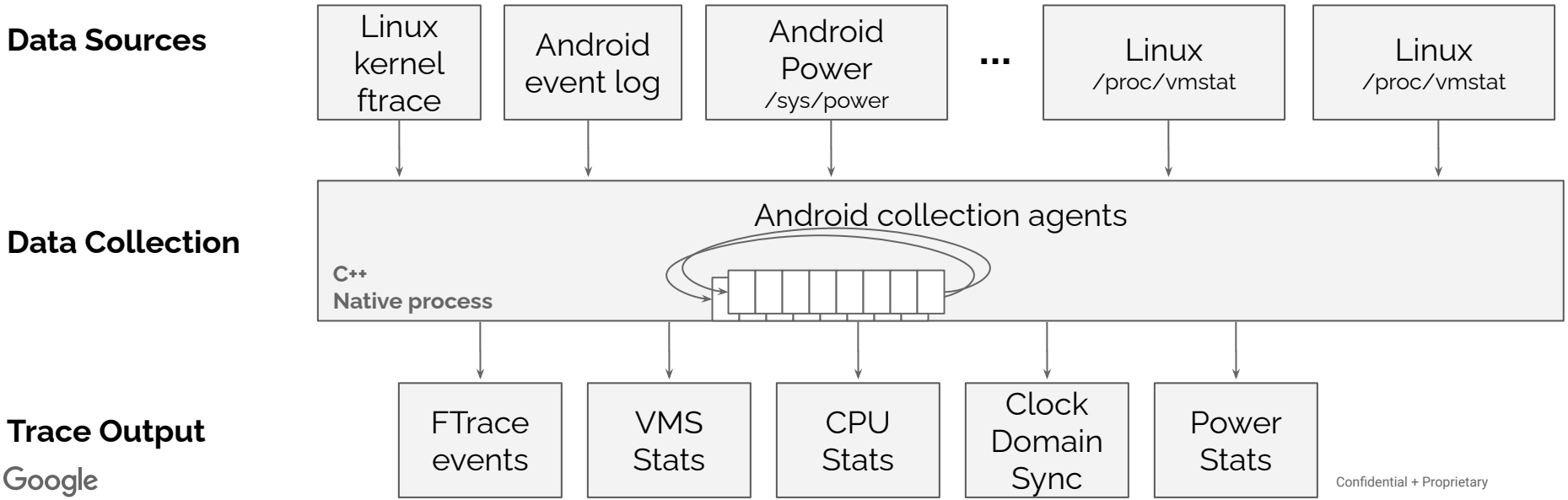
Performance & Reliability

Performance

- Performance is key
- Challenges
  - User needs are evolving, new use cases are pushing the boundaries
  - Benchmarks are not always representative of real-world interactions
  - Creation of a representative use cases that can be used to evaluate our priorities are a start
- Need to prepare early for “future killer apps”, ensure headroom

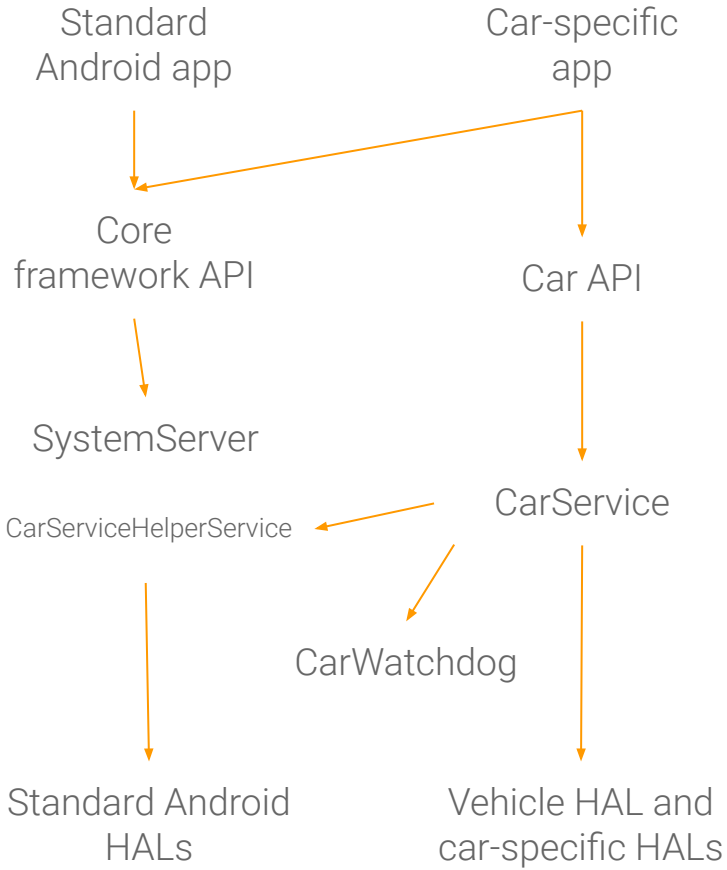
Performance & Reliability | Building Blocks

- Throughput and Latency both are critical in Cars
- Power and Energy Consumption, as in mobile are critical
- Standardize on the counters, tools, and HALs



Performance & Reliability | Watchdog

- Android Automotive OS introduced a Watchdog (CarWatchdog) for ensuring reliability
- CarWatchdog is a service that monitors system health and identifies/terminates badly behaving processes
- Monitors I/O performance at boot time, at periodic intervals, or at a custom duration.
- CarWatchdog is different from activity lifecycle monitoring for detecting Android Application Not Responding (ANR) - native services and Android services are the clients
- Facilities for managing restarts and process control are provided



Thank you!