R-CAR GEN3

RENESAS ANDROID SOFTWARE

(UNDER NDA)

09/2018
REV 3.12
AIS & ADAS MARKETING & SOLUTIONS
AUTOMOTIVE BUSINESS GROUP
RENESAS ELECTRONICS EUROPE

BIG IDEAS
FOR EVERY SPACE

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AGENDA

- Introduction

- Collaboration with Google

- R-Car Android Automotive Offer:
  - Summary
  - Android BSP
  - R-Car Reference Package for Android 8.1
  - Android Automotive Features
    - Multi Display
    - Ethernet Virtual Display

- Google Automotive Services

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RENESAS ANDROID SOLUTION SUMMARY

- Oct 5th Renesas Press release
  - ➜ **Renesas Delivers R-Car Reference Package for Android Supporting Android™ 8.1**

- Relationship to Google
  - ➜ **Renesas recognized as a major player and further collaboration engaged for 2018**

- Renesas Android BSP Release plan
  - ➜ **Focus on sustainability**

- Renesas Android Automotive Reference Package
  - ➜ **Project is engaged and Renesas Ecosystem will enhance it further**

- Virtualization of Android
 - ➜ **Demos and SW deliverables available for GHS Multivisor and other Hypervisor vendors**

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COLLABORATION WITH GOOGLE

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GOOGLE COLLABORATION SCHEME
2017 ACHIEVEMENTS

R-Car Ecosystem Android Oreo adoption
for
- Automotive OEMs Platform development
- Integrated Cockpit ECU development

Automotive OEMs

Automotive Tier1

Google

RENESAS Achievements

- **R-Car Gen3 adoption by a broad number of T1 and OEMs**

- **Android Code Early Drop access** ahead of traditional partners

- **Shorten availability** of **high performance** R-Car Gen3 Android SW release after AOSP (eg. Cold boot performance)

- **Technology lead** to get **Android Virtualized** with Robust Graphic sharing

- **Reference Package for Android 8.1 (SK +KF) available**, publicly announced 1 month after AOSP and available for delivery to lead OEM and Google

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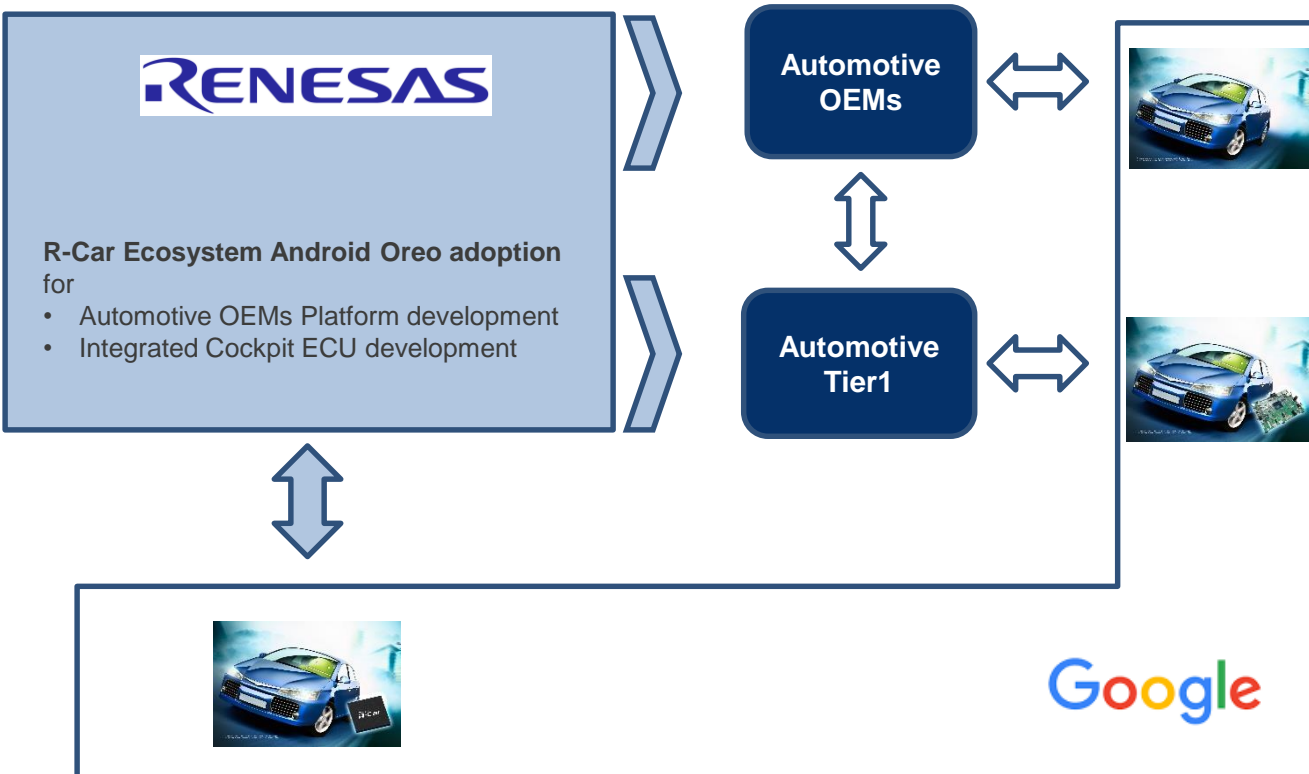
GOOGLE COLLABORATION SCHEME
2018 FOCUS
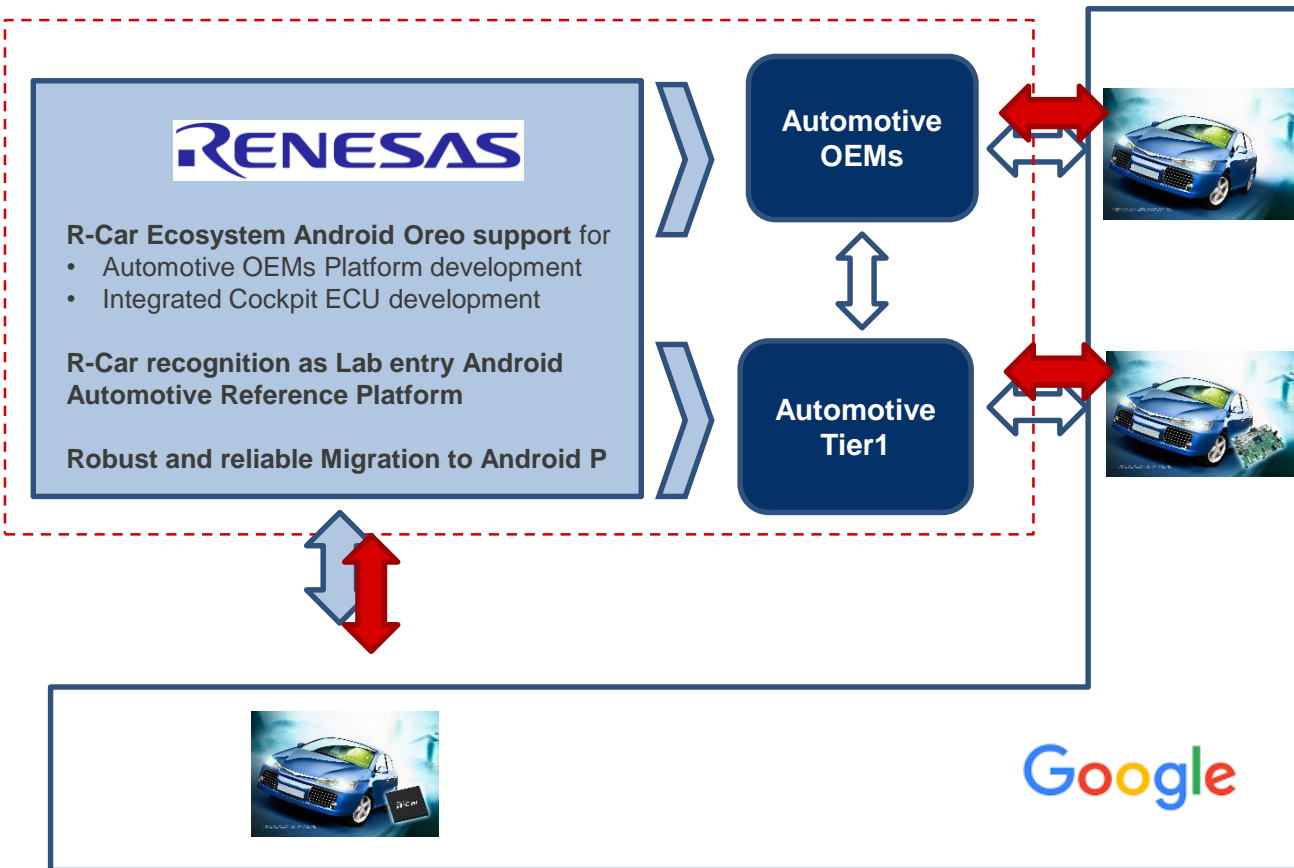
RENESAS 2018 focus

- **Reference Package for Android 8.1 (SK +KF)** distributed at larger scale and enhanced to further support Google with Android Code development and evaluation
  - Google is planning to create reference Android Auto Projected(AAP) Head Unit running android automotive. Renesas proposed Ref. PKG to AAP reference.
  - SK + KF Specification requirements discussion proposed to Google

- Collaboration with Tier1 and Google for **GAS evaluation on actual ECUs** and with OEMs for **evaluation on actual vehicle:**
  - Several ECU candidates available on R-Car H3 and R-Car M3
  - Google IO 2018 as an opportunity to demo

- **Android P Early access** to lead customers and **shorten availability for the complete R-Car line-up**

- **Renesas is positive to contribute in Project Keystone for Automotive.**

- **Fully available and mature Android 8.1 and P Virtualization frameworks** for Integrated Cockpit ECUs development

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RENESAS R-CAR ANDROID OFFER

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RENESAS R-CAR ANDROID AUTO POLICY

- Open Automotive Alliance member and continuous close collaboration with Google for Android Automotive projects

- Renesas R-Car Linux LTSI based BSP as homeground for developing Renesas Android embedded deliverables

- Focus on compatibility to AOSP and technology solutions to meet Automotive use cases requirements

- Collaboration with Dedicated Automotive System Integrators, OSS partners and Technology partners at early stage

Renesas ready to support
R-Car adopters for Android Auto projected mode and AOSP based projects

With Complete and Maintainable Android embedded deliverables

R-Car Android Platform brings robust pieces to Android Auto based IVI systems

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R-CAR GEN3 ANDROID AUTOMOTIVE OFFER
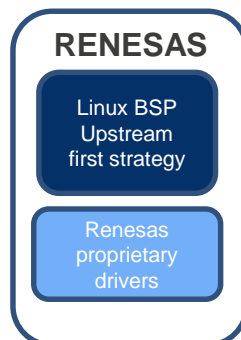
SUSTAINABLE
Android BSP Release Roadmap

High quality Android Native Build
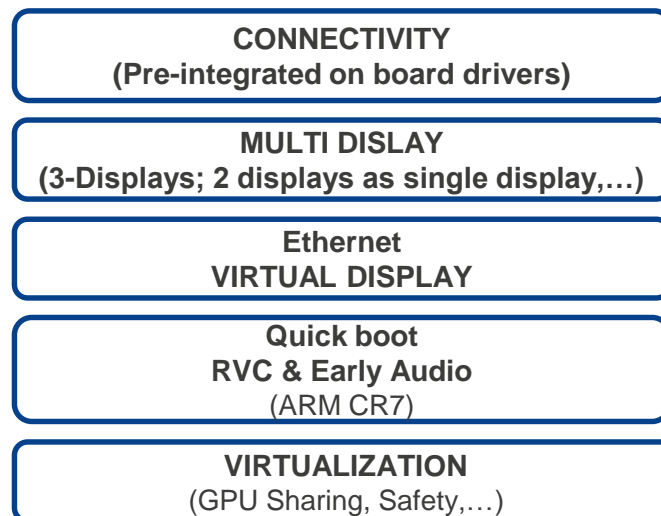Guide for R-Car Gen3 targets

AOSP, Google Proprietary deliverables
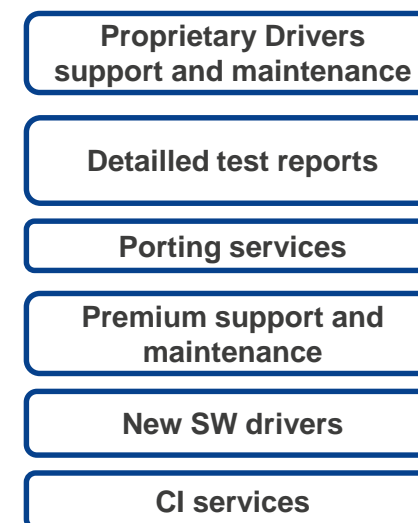
Sustainable Linux BSP (Yocto, LTSI)

GOOGLE
- Google Proprietary
- Android Automotive Early Access code
- AOSP

RENESAS
- Linux BSP Upstream first strategy
- Renesas proprietary drivers

LEADING-EDGE
Android Automotive Reference Package

Android Automotive usecases fulfilled thanks to leading-edge SOC features and tools

CONNECTIVITY
(Pre-integrated on board drivers)

MULTI DISLAY
(3-Displays; 2 displays as single display,…)

Ethernet
VIRTUAL DISPLAY

Quick boot
RVC & Early Audio
(ARM CR7)

VIRTUALIZATION
(GPU Sharing, Safety,…)

RELIABLE
Software Services for secured customer TAT & maintenance

Proprietary Software Licensing Renesas
Single Window OSS SW Services

Proprietary Drivers support and maintenance

Detailed test reports

Porting services

Premium support and maintenance

New SW drivers

CI services

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ANDROID AUTOMOTIVE SUPPORT
RENESAS ANDROID DEVELOPMENT WORKFLOW

RENESAS CONFIDENTIAL BIG IDEAS FOR EVERY SPACE

R-Car Gen3 Android BSP Life Cycle

BSP development cadence basis : 12 months cycle

Pre-migration Phase:

When New Android "Early drop" is available (expected Early Feburary), Renesas create a base port on one R-Car Device up to demo quality level (R-Car H3 or R-Car M3)

BSP Development Phase:

As soon as Google release Android AOSP (expected August), Renesas prepare alpha release (target August) and Beta release (Full functional, Target December)

Quality Test Phase:

Business cases and customers demands are driving the product level qualification of Renesas Android deliverables

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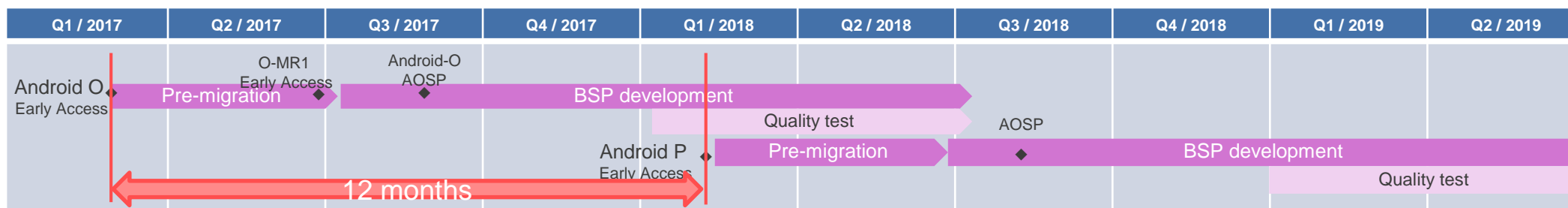
R-Car Gen3 Android BSP Development workflow
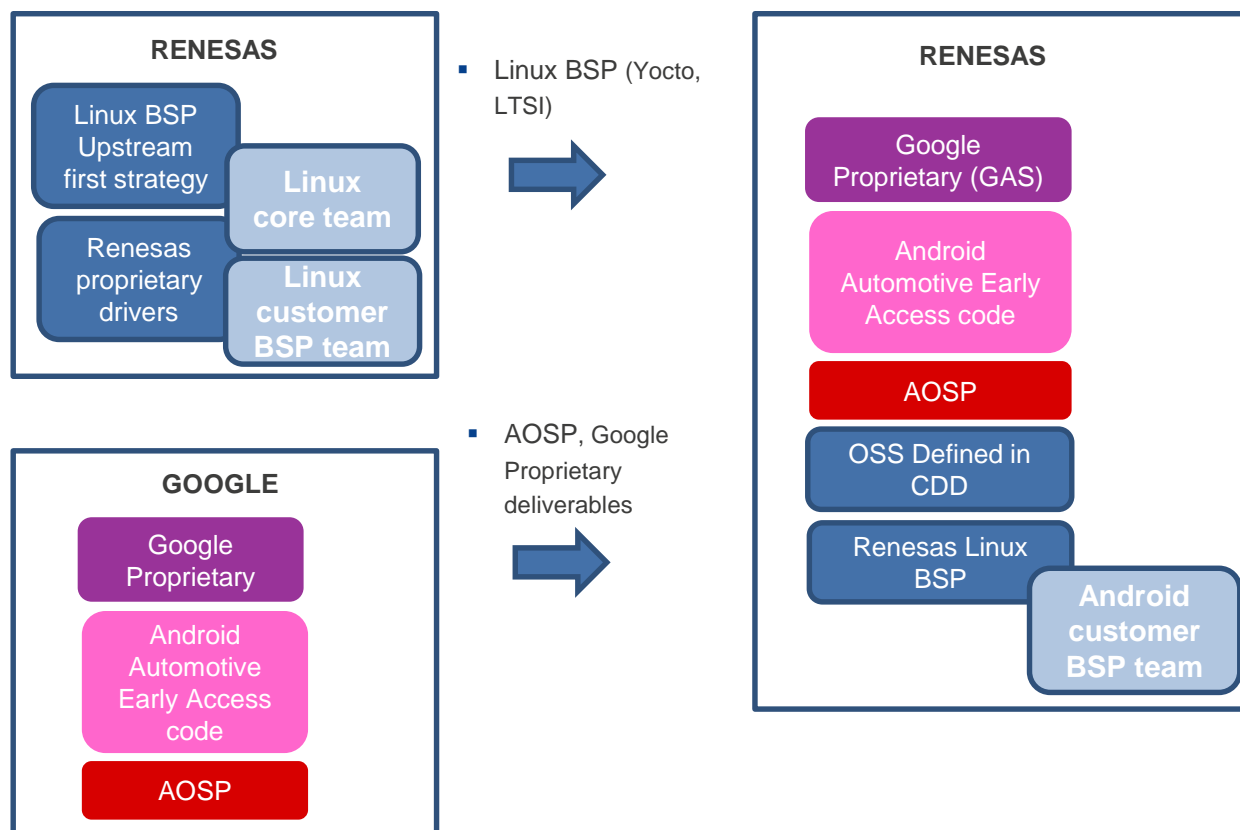
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- Linux BSP Upstream first strategy
- Renesas proprietary drivers
- **Linux core team**
- **Linux customer BSP team**

- Linux BSP (Yocto, LTSI)

GOOGLE

- Google Proprietary
- Android Automotive Early Access code
- AOSP

- AOSP, Google Proprietary deliverables

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- Google Proprietary (GAS)
- Android Automotive Early Access code
- AOSP
- OSS Defined in CDD
- Renesas Linux BSP
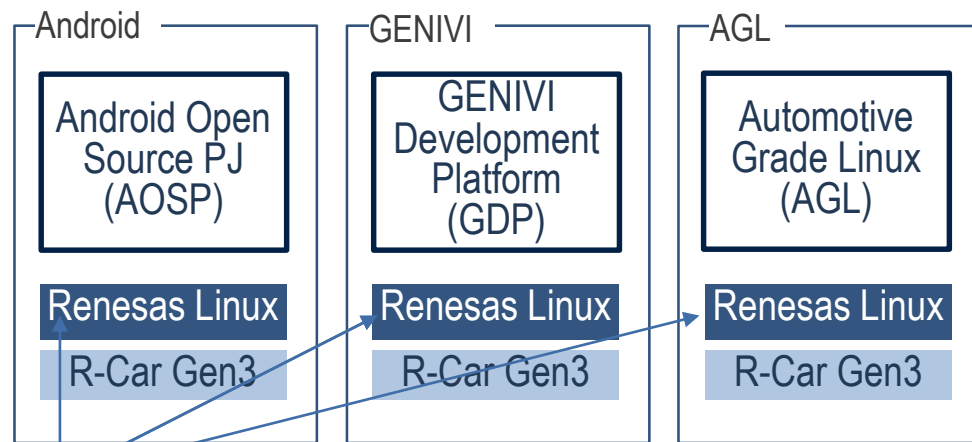- **Android customer BSP team**

Renesas:

- adapt Renesas Linux BSP and proprietary drivers to fit Android architecture (eg. ion driver, …etc)

- Integrate Renesas deliverables, OSS deliverables and Google specific deliverables

- Confirm CTS/VTS Pass for functions defined in CDD

- To ensure high quality, Renesas test GAS on top of the reference platform

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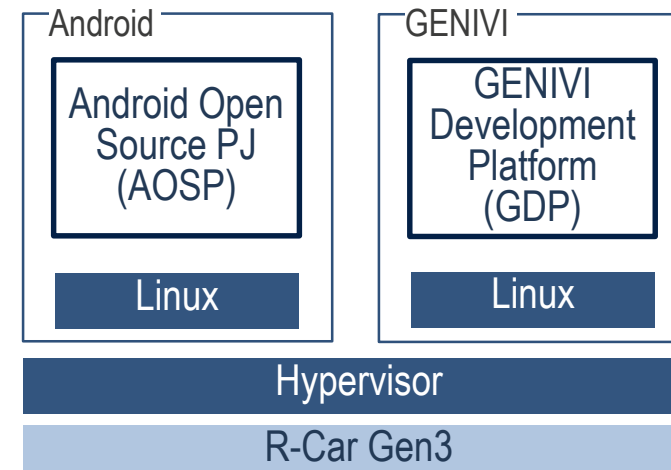**RENESAS**

OVERVIEW OF R-CAR GEN3 SOFTWARE

- Clean Linux BSP for R-Car Gen3 is the base for Android, GENIVI and AGL.
  Renesas equally supports the application framework on Linux, i.e. Android, GENIVI and AGL.

- Hypervisor can be used for supporting both Android and GENIVI on one SoC.
  Software asset can be re-used for the next generation system

Renesas' Linux Software as base of app. framework

Android
- Android Open Source PJ (AOSP)
- Renesas Linux
- R-Car Gen3

GENIVI
- GENIVI Development Platform (GDP)
- Renesas Linux
- R-Car Gen3

AGL
- Automotive Grade Linux (AGL)
- Renesas Linux
- R-Car Gen3

- Same Linux BSP is used.
- Renesas' Linux BSP is genuine with up-stream first policy.
  No dirty branches from the main stream of Linux.

System Integration for the next generation

Android
- Android Open Source PJ (AOSP)
- Linux

GENIVI
- GENIVI Development Platform (GDP)
- Linux

Hypervisor

R-Car Gen3

- GENIVI and Android can be integrated into one system with hypervisor, to maximize the portability of the design assets.

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ANDROID AUTOMOTIVE SUPPORT

RENESAS ANDROID BSP RELEASE PLAN

 BIG IDEAS FOR EVERY SPACE

Software block for Android (from Android O.MR1 Alpha (Kernel 4.14))

- Renesas Android S/W is built based on the R-Car Gen3 Linux BSP.
- Renesas offers the adaptation S/W to operate AOSP on R-Car reference board.

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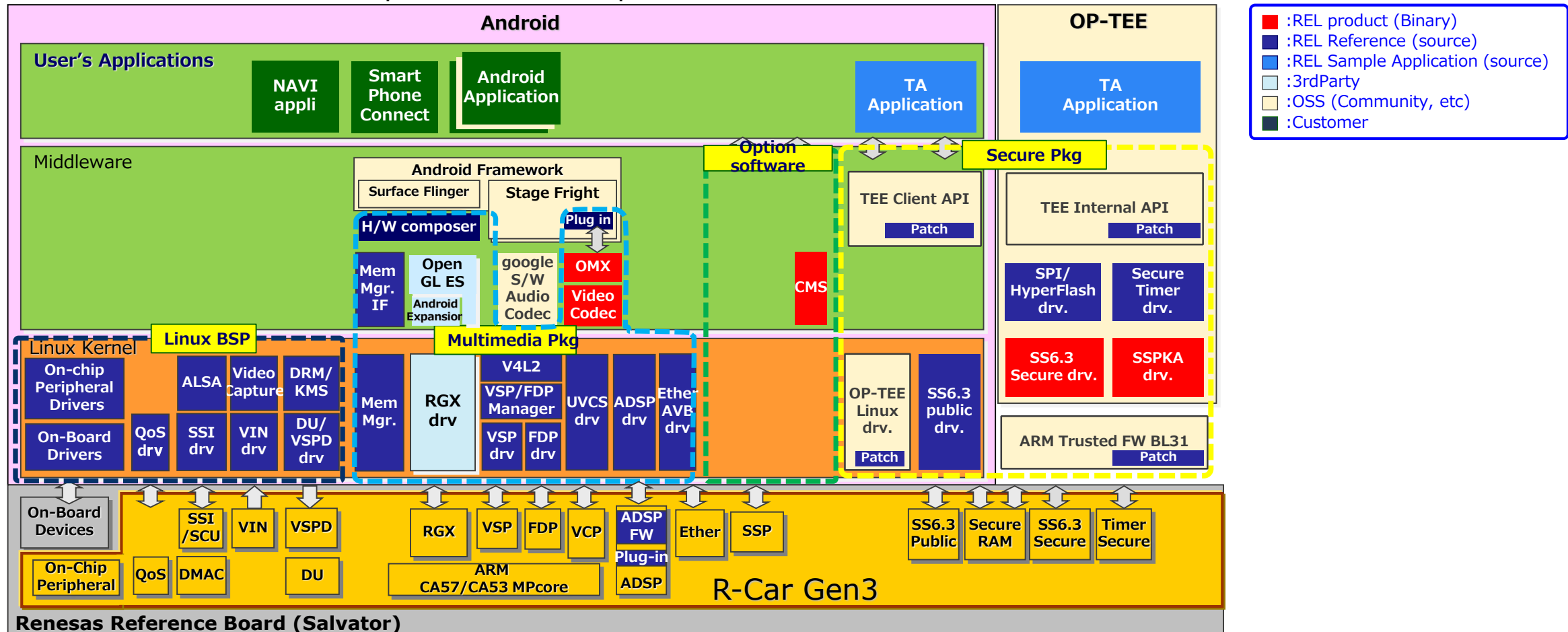
Android Version VS RCAR devices targets

<mark>Yellow boxes</mark> means commercial software targeted.
(Yes) means that evaluation level(α、β), and no commercial development plan at this moment.

Android Pkg ver	OS ver	kernel	Yocto pkg ver	Target LSI										Note.
				H3		H3N	M3			M3N		E3		
				v2.0	v3.0	v1.0	v1.1	v1.2	v3.0	v1.0	v1.1	v1.0	v1.1	
V2.x.x	Oreo (Android 8.0)	4.9	V2.23.0	(Yes)	-	-	(Yes)	-	-	-	-	-		
v3.x.x	O.MR1 (Android 8.1)	4.9	v2.23.1	(Yes)	-	-	(Yes)	-	-	-	-	-		
v4.x.x	O.MR1 (Android 8.1)	4.14	v3.15.0	(Yes)	Yes	Yes	(Yes)	Yes	-	-	-	-		
v5.x.x	P (Android 9.x)	4.14	v3.19.0	(Yes)	Yes	Yes	-	Yes	Yes	(Yes)	Yes	(Yes)	Yes	

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Android Pkg SW list

● : Android specific、○ : Linux as is 、× : no support

No	Category	Sub Category	Development Module	Android OMR1 (4.9) M3N	Android OMR1 (4.14) H3/H3N/M3	Android P H3/H3N/M3/M3N/E3	Note
1	IPL	IPL	Initial Program Loader	○	○	○	
2	Linux BSP	Linux BSP/U-boot	Linux driver, U-boot	○	○	○	・U-Boot、Android patch
3	Android BSP	Android kernel	Android kernel merge	●	●	●	
		Hardware Composer	HardwareComposer				
4	Multimedia	Video Processing	VSP Manager	○	○	○	
		System Control	Memory Manager				
		QoS	QoS driver				
5	Multimedia	EthernetAVB	AVB Streaming Driver				
			Media Streaming Engine				
			Cllok Recovery Handler	×	×	×	・No plan to support
			Simple Application				
			Launcher Application				
6	Audio	ADSP framework	ADSP driver				
			ADSP framework	×	●	●	
			ADSP plug-in				
7	Graphics	Graphics Library	(H3/H3N)OpenGL ES 1.1/3.1/3.2 Lib	×	●	●	
			(H3/H3N)Device driver				
			(M3)OpenGL ES 1.1/3.1/3.2 Lib	×	●	●	
			(M3)Device driver				
			(M3N)OpenGL ES 1.1/3.1/3.2 Lib	●	×	●	・v3.x M3N: Custom project only
			(M3N)Device driver				
			(E3)OpenGL ES 1.1/3.1/3.2 Lib	×	×	●	
			(E3)Device driver				

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No	Category	Sub Category	Development Module	Android OMR1 (4.9) M3N	Android OMR1 (4.14) H3/H3N/M3	Android P H3/H3N/M3/M3N/E3	Note
8	Video	OMX Common	OMX Common Library	●	●	●	
		Video Decode	OMX Video Decoder Common Library	●	●	●	
			OMX H.264 Decoder	●	●	●	
			OMX H.265 Decoder	●	●	●	
			OMX H.263 Decoder	●	●	●	
			OMX MPEG4 Decoder	●	●	●	
			OMX MPEG2 Decoder	●	×	×	
			OMX VC-1 Decoder	●	×	×	
			OMX RealVideo Decoder	●	×	×	
			OMX VP8 Decoder	●	●	●	
			OMXVP9 Decoder	×	●	●	VP9 dec :M3/M3N/E3 only
		Video Encode	OMX Video Encoder Common	●	●	●	
			OMX H.264 Encoder	●	●	●	
			OMX VP8 Encoder	●	●	●	
		Video Decode / Encode	UVCS/VCP Driver(Kernel)	●	●	●	
9	Audio	Audio Decode	aacPLUS Decoder	×	×	×	・No plan to support
10	CMS	Color Management	Basic color Management				・Option
			Dynamic Gamma Correction for VSP	×	●	●	
			Backlight Control for DU				
11	DTV	DTV for ISDB-T	DTV middleware	×	×	×	・No plan to support
			scu/src/ssp/tddmac/tsif driver				
12	Secure	Security BSP	ARM trusted firmware BL31				
			OP-TEE				
			SPI / HyperFlash driver	○	○	○	
			Timer driver				
			OP-TEE Linux driver				
			SS6.3-Public Driver for Linux				
		Secure OS drivers	SS6.3-Secure Driver for OP-TEE	○	○	○	
			SSPKA Driver for OP-TEE				

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R-Car Gen3 Android Development Status

- Renesas has successfully released R-Car BSP for Android Oreo AOSP (8.1) end of January, 2018.

- The Android BSP v3.1.1(alpha ver.) is supporting following board:
  - Salvator-XS
  - Starter Kit Premier + Kingfisher Advanced model

- Android O.MR1 BSP, Renesas is supporting following new features (some known issues):

  - Energy Aware Scheduler(EAS)
  - Verify Boot, Multi Display, Bluetooth, 9-axis sensor
  - Camera, Early RVC, A/B System Update.
  - Treble (*on going – target support in Android O.MR1 based on 4.14 release)

- Latest Release is Beta Version Android O.MR1 BSP (Linux kernel 4.9) (See Schedule page)

- Renesas is now engaged in Android P Early Access Phase
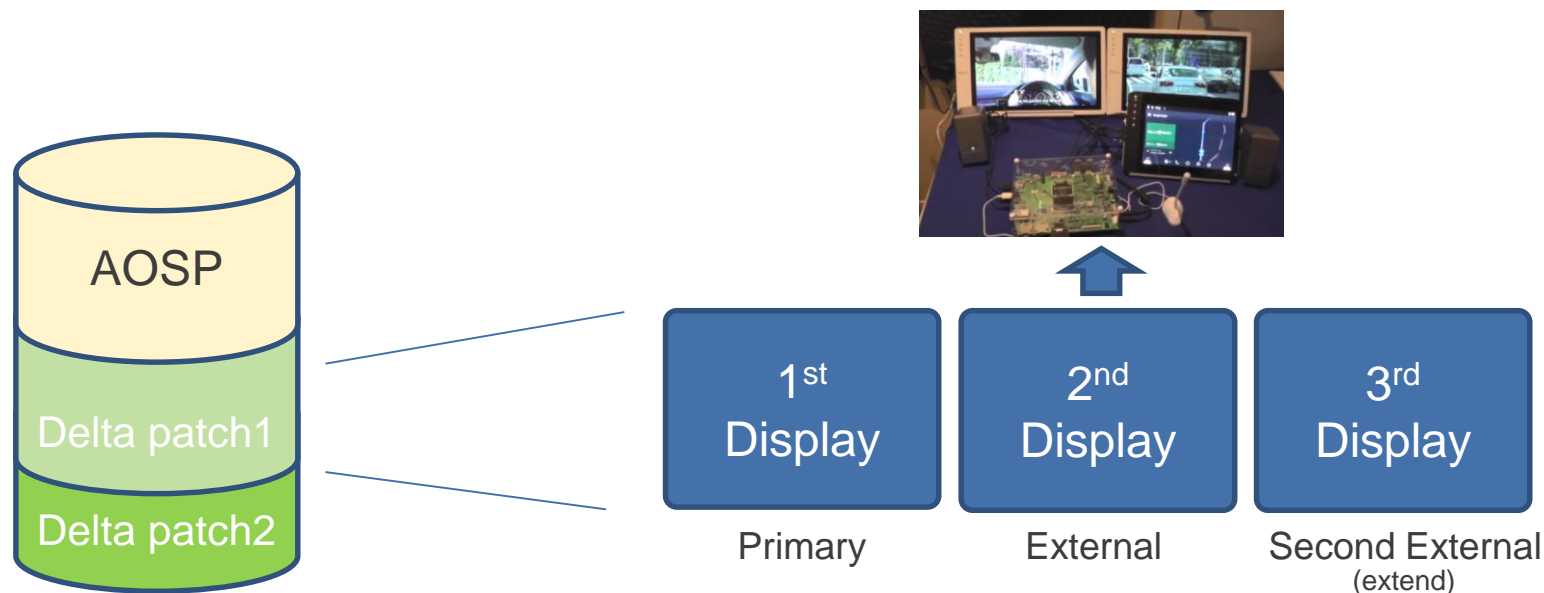
AOSP DELTA PATCHES

Renesas Android BSP applies the minimum patches to Google's AOSP code to adapt to R-Car Gen3 platform.

In the latest Android O-MR1 BSP, Renesas apply **59 patches** (as Delta patch1) to AOSP code android-8.1.0_r14.

- 64bit Media Server support/Verified boot on uboot/Some bugfix of Android O-MR1.

The customer can also enable some additional patches (as Delta patch2):

- Multiple display support (**4 patches**)

AOSP			
Delta patch1			
Delta patch2			

1st Display	2nd Display	3rd Display
Primary	External	Second External (extend)

R-CAR GEN3 ANDROID RELEASES PLAN

Release version	Release criteria			Android code
	Function	Renesas software test	CTS/VTS	
Pre Alpha	Basic function implemented and verified	Pass Sanity tests for aimed functions at the release	Running	EAP
Alpha	Basic function implemented and verified	Pass Sanity tests for aimed functions at the release	Running	AOSP
Beta Candidate	All functions implemented - Primary functions verified	Pass Normal Test Running Abnormal Test implemented functions	Pass rate : 80%	AOSP
Beta	All functions implemented - Primary functions verified	Pass Normal Test Running Abnormal Test implemented functions	Pass rate : 90%	AOSP
Final Candidate	All functions implemented - Primary functions verified	Pass Normal Test Running Abnormal Test implemented functions	Pass rate : 100%	AOSP
Final	All functions implemented and verified	Normal test and Abnormal Test Verified on Mass production final SOC	Pass rate : 100%	AOSP

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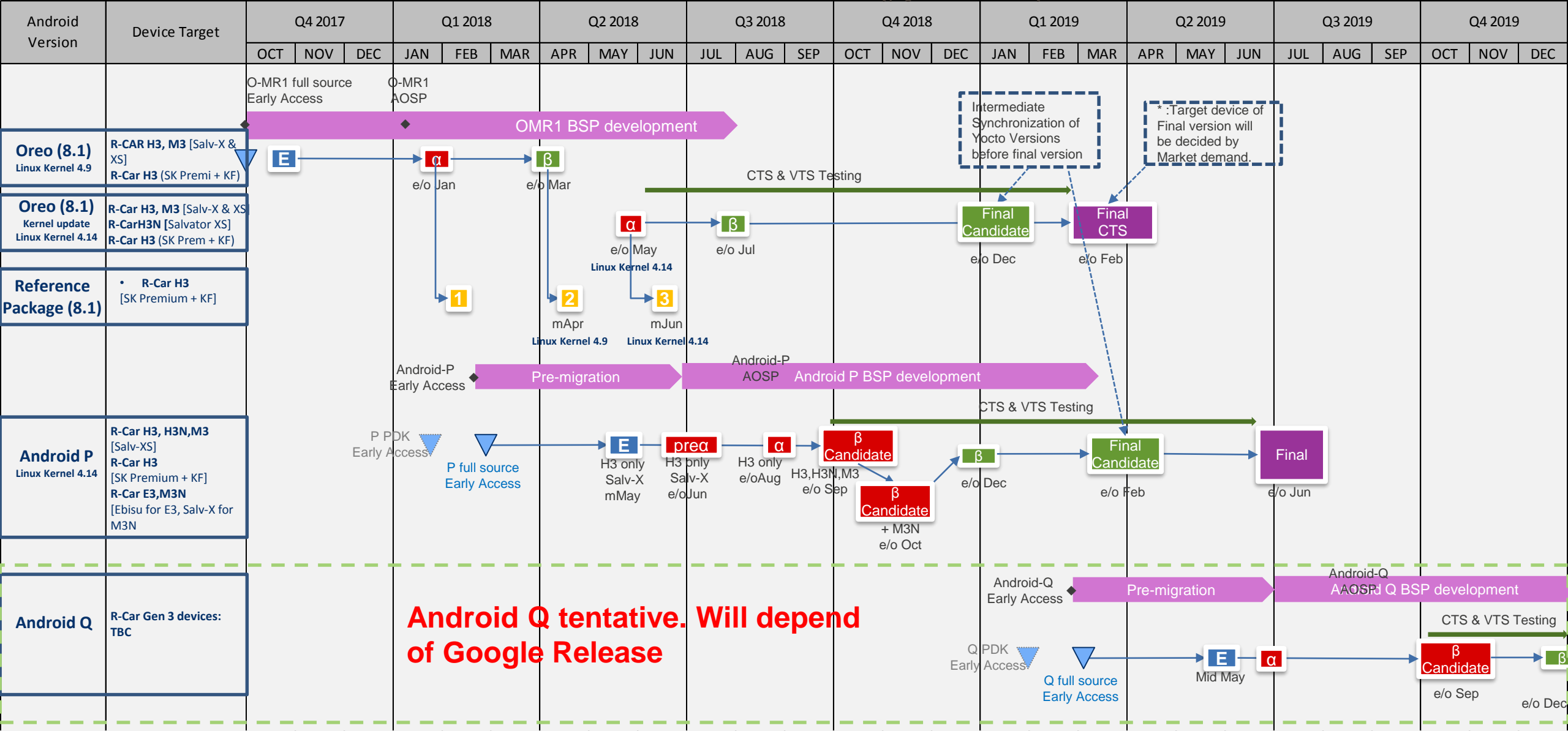
R-CAR GEN3 ANDROID RELEASE PLAN
FOR GENERAL CUSTOMERS UNDER NDA

All Dates have dependencies, including Google deliverables, and are subject to change without notice.
Early release availability depends on Google authorization

E Note: Early release milestone on Android P based on Oreo experience (+8 weeks from Google Drop)

Note 2: "Renesas Mypages" releases delivery would be done 2 weeks maximum after indicated Release Date.

Android Q tentative. Will depend of Google Release
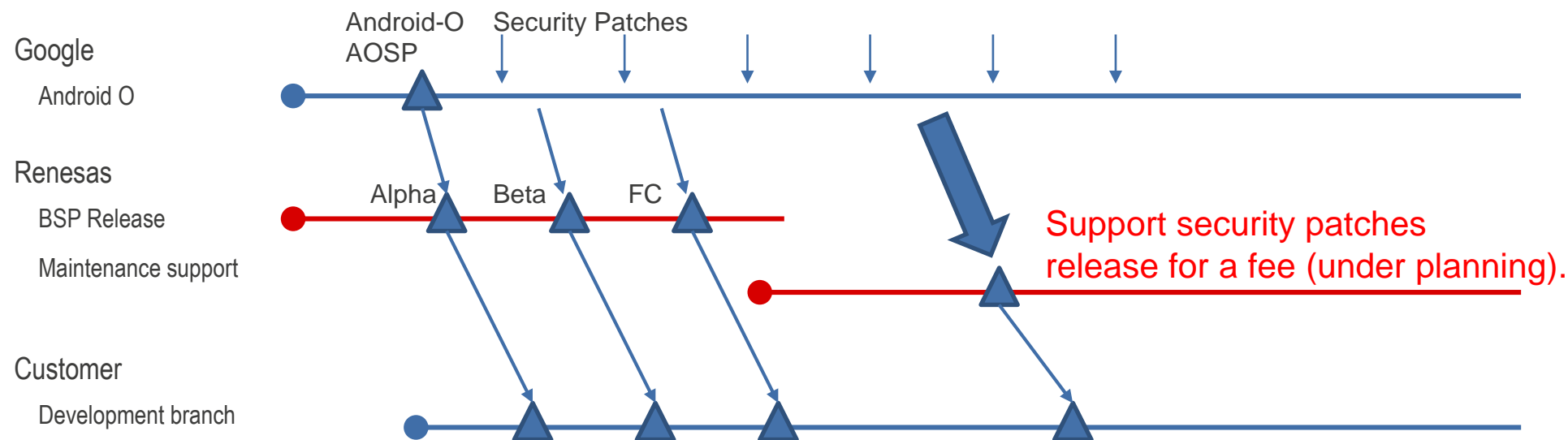
Intermediate Synchronization of Yocto Versions before final version

* : Target device of Final version will be decided by Market demand.

Android Version	Device Target
Oreo (8.1) Linux Kernel 4.9	**R-CAR H3, M3** [Salv-X & XS] **R-Car H3** (SK Premi + KF)
Oreo (8.1) Kernel update Linux Kernel 4.14	**R-Car H3, M3** [Salv-X & XS] **R-CarH3N** [Salvator XS] **R-Car H3** (SK Prem + KF)
Reference Package (8.1)	• **R-Car H3** [SK Premium + KF]
Android P Linux Kernel 4.14	**R-Car H3, H3N,M3** [Salv-XS] **R-Car H3** [SK Premium + KF] **R-Car E3,M3N** [Ebisu for E3, Salv-X for M3N]
Android Q	**R-Car Gen 3 devices:** TBC

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(Note 1) Subject to commercial offer - Please contact Renesas
(Note 2) Early release availability depends on Google authorization
(Note 3): "Renesas Mypages' releases delivery would be done 2 weeks maximum after indicated Release Date

Updated 03.09.2018

R-CAR GEN3 ANDROID RELEASES PLAN

Android version	Android releases	Package ver.	Release plan	Based Yocto version	LSI				
		() : past description			H3	H3N	M3	M3N	E3
Oreo(Android 8.0) on Kernel 4.9	Alpha	v2.1.1 (1.2.1)	Oct. 27th, 2017	v2.23.0	v2.0(v1.1)	-	v1.1(v1.0)	-	-
	Alpha2	v2.1.3 (1.2.3)	Nov. 30th, 2017	v2.23.0	v2.0(v1.1)	-	v1.1(v1.0)	-	-
O-MR1(Android 8.1) on Kernel 4.9	Alpha	v3.1.1	Jan. 31st, 2018	v2.23.1	v2.0(v1.1)	-	v1.1(v1.0)	-	-
	Beta	v3.1.3	Mar. 30th, 2018	v2.23.1	v2.0(v1.1)	-	v1.1(v1.0)	-	-
O-MR1(Android 8.1) on Kernel 4.14	Alpha	v4.1.0	May. 31st , 2018	v3.7.0	v2.0(v1.1)	-	v1.2(v1.1)	-	-
	Beta	v4.1.1	Jul. 31st, 2018	v3.9.0	v3.0(v2.0)	v1.0	v1.2(v1.1)	-	-
	Beta2	v4.1.2	Dec 28th, 2018	v3.13.0	v3.0(v2.0)	v1.0	v1.2(v1.1)	-	-
	Final	v4.2.0	Feb/e, 2019	v3.15.0	v3.0(v2.0)	v1.0	v1.2(v1.1)	-	-
P(Android 9.x) on Kernel4.14	Alpha	v5.0.0.8	Aug 31st, 2018	v3.9.0	v3.0(v2.0)	-	-	-	-
	Beta-candidate	v5.1.0	Sep 28th, 2018	v3.9.0	v3.0(v2.0)	v1.0	v1.2(v1.1)	-	-
	Beta-candidate	v5.1.1	Oct 31st, 2018	v3.9.0	v3.0(v2.0)	v1.0	v1.2(v1.1)	v1.1(v1.0)	-
	Beta	v5.1.2	Dec 28th, 2018	v3.13.0	v3.0(v2.0)	v1.0	v1.2(v1.1)	v1.1(v1.0)	v1.0
	Final-candidate	v5.1.3	Feb/e, 2019	v3.15.0	v3.0(v2.0)	v1.0	v1.2(v1.1)	v1.1(v1.0)	v1.0
	Final	v5.2.0	Jun/e, 2019	v3.19.0	v3.0(v2.0)	v1.0	v3.0/v1.2	v1.1(v1.0)	v1.1(v1.0)

() brackets: that one-pass testing only on actual SoC.
* :Target device of Final version will be decided by Market demand. If there are no customers which are mass-production, skip the final version.

R-Car Gen3 Android BSP Long Term Support

- Google continually releases security patches. Also they are committed to support for GAS for over 5 years.

- Renesas takes in security patches from Google to Android BSP, and carry out CTS, then release the BSP.

- As for the support plan after FC (Final candidate) release of Android BSP, Support of security patches can be offered via Renesas OSS premium maintenance support services

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ANDROID TEST DESCRIPTIONS

Quality Factor	Description
Functional	Functional test aims to evaluate each unit whether it functions or not. It is tested for >20 categories. (e.g.: 3D graphics, Audio playback, boot, Image capture , System)
Robustness	Stress tests that are targeted to evaluate system stability by executing same action many times in a row (generally >1000+ iterations).
MTBF	(Mean Time Between Failure). Test suite that executes previously defined actions (audio/video playback, image view, file transfer, etc) in random order. Main criteria of quality is average time of execution before system crush.
Performance	Following tests are planned to evaluate system performance: system boot time measurement, UI fps measurement, video average fps measurement, benchmarks' execution, camera metrics measurements.
CTS	The Compatibility Test Suite (CTS) is a commercial-grade Google test suite that represents the "mechanism" of compatibility.
CTS Verifier	Supplement to the Compatibility Test Suite (CTS). While CTS checks those APIs and functions that can be automated, CTS Verifier provides tests for those APIs and functions that cannot be tested on a stationary device without manual input, like audio quality, touchscreen, accelerometer, camera, etc.
VTS	The Vendor Test Suite (VTS) automates HAL and OS kernel testing. VTS ensures a consistent, low-level API that can be used by different versions of the Android Framework.

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RENESAS SOFTWARE TEST DESCRIPTION

Category	Items	Definition	Software Product	OSS (Linux)	OSS (Android)
Defect detections (Code Quality)	Static Analysis	- Static code analysis by tools, e.g. QAC™ - Checking division by zero, uninitialized variable and infinite loop.	X	-	-
	Code Coverage	- C0/C1 coverage	X	-	-
	OSS License	- Checking OSS license contamination by tools, e.g. Black duck™	X	-	-
Unit test	C-function unit test	- Unit test at C language function level	X	X[#1]	
	API	- API function behavior test with normal, boundary and error parameters - API means public interface of the Software	X	X[#1]	
Integration test	Use case	- API sequence test and stream test to verify use cases described in a users manual	X	X[#1]	
	Conformance	- Khronos conformance test (OpenGL ES and OpenMAX IL) - Codec standard conformance test (H.264, etc)	X	-	-
	Memory	- Stack usage, memory usage and leakage check	X	-	-
System test	Sanity test ("smoke test")	- Basic functional test, Regression test	X	-	X
	Processing performance	- Throughput and real time performance measurement	X	-	X
	Stress	- Multiple processing (multiple instance) test - Long running test, Robustness test	X	-	X
	MTBF	- Executes previously defined actions (audio/video playback, image view, file transfer, etc) in random order	-	-	X
	CTS tests	- CTS, CTS verifier	-	-	X
	VTS tests	- VTS	-	-	X

#1: Covered by Linux OSS test

Android Specific

R-CAR GEN3 ANDROID BSP RELEASE CRITERIA
OVERVIEW

✓ Renesas releases each Android BSP with the following maturity level
✓ The kernel baseline of Android BSP is the latest version of Linux BSP which was verified on Renesas.

Category1	Categrory2	Alpha	Beta	Final
Linux	Defect detections (Code Quality)	N/A	95%	100%
	Unit test	N/A	100%	100%
	Integration test	N/A	100% (Normal test)	100%
	System test	Sanity test 100%(note*1)	100% (Normal test)	100%
Android	CTS	N/A	98%	100%
	VTS	N/A	98%(note*2)	100%
	Function	Sanity test 100%(note*1)	100% (Normal test)	100%
	Robustness	N/A	N/A	100%
	MTBF	N/A	N/A	100%
	Performance	N/A	100%	100%

*1 Sanity test ("smoke test"): Basic functional test, Regression test which Renesas defined.
*2 Google has not officially released VTS yet.

In case of Android O BSP, Renesas use the final release of Linux BSP. All tests of Linux BSP are passed.

ANDROID R-CAR REFERENCE PACKAGE

BIG IDEAS FOR EVERY SPACE

RENESAS

INTRODUCTION

Renesas Delivers R-Car Reference Package for Android Supporting Android 8.1

Easy Development of Android-based Automotive Software

- No experience with automotive systems
- No Android development experience

Easy software development by R-Car Reference Package for Android

Renesas	Android 8.1
Renesas R-Car	First version including Automotive required functions
Robust and highly secure automotive SoC	▪ Ecosystem ▪ Many developers
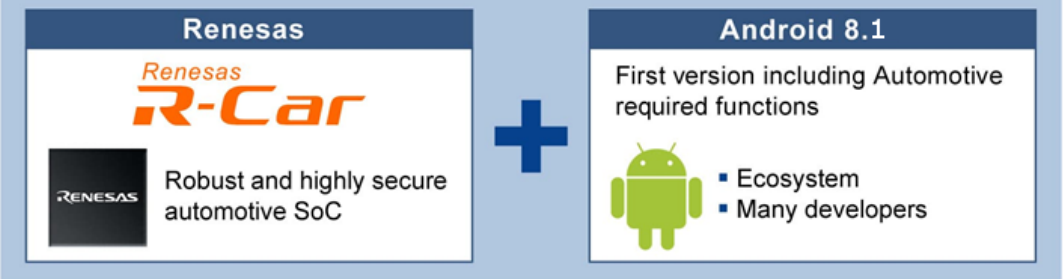
The Android robot is reproduced or modified from work created and shared by Google and used according to terms described in the Creative Commons 3.0 Attribution License

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R-CAR REFERENCE PACKAGE FOR ANDROID
-OVERVIEW, CONCEPT-

- R-Car Reference package for Android combines Android Automotive features and IVI specific features.

- Although Android Automotive has been enhanced and improved for IVI system (eg. Android 8.1 "Treble" support which makes OS update easy) it does NOT include all features required by Automotive customers.

- Renesas will enable customer to best benefit from R-Car features capabilities by providing reference implementation of specific IVI use cases.

- Key concept of R-Car Reference package for Android is:

  - Compatibility with AOSP: Ensuring sustainability & maintainability

  - Focus to IVI: Providing reference implementations of essential IVI specific features included in Android 8.1 **PLUS** not supported by Android 8.1.

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R-CAR REFERENCE PACKAGE FOR ANDROID -EXTENSION SOFTWARE OVERVIEW-

- Extension software is providing reference implementations of essential IVI specific features included in Android 8.1 PLUS not supported by Android 8.1.
  - ✓ Offer App, Vender implementation, drivers and patches for Android function support.
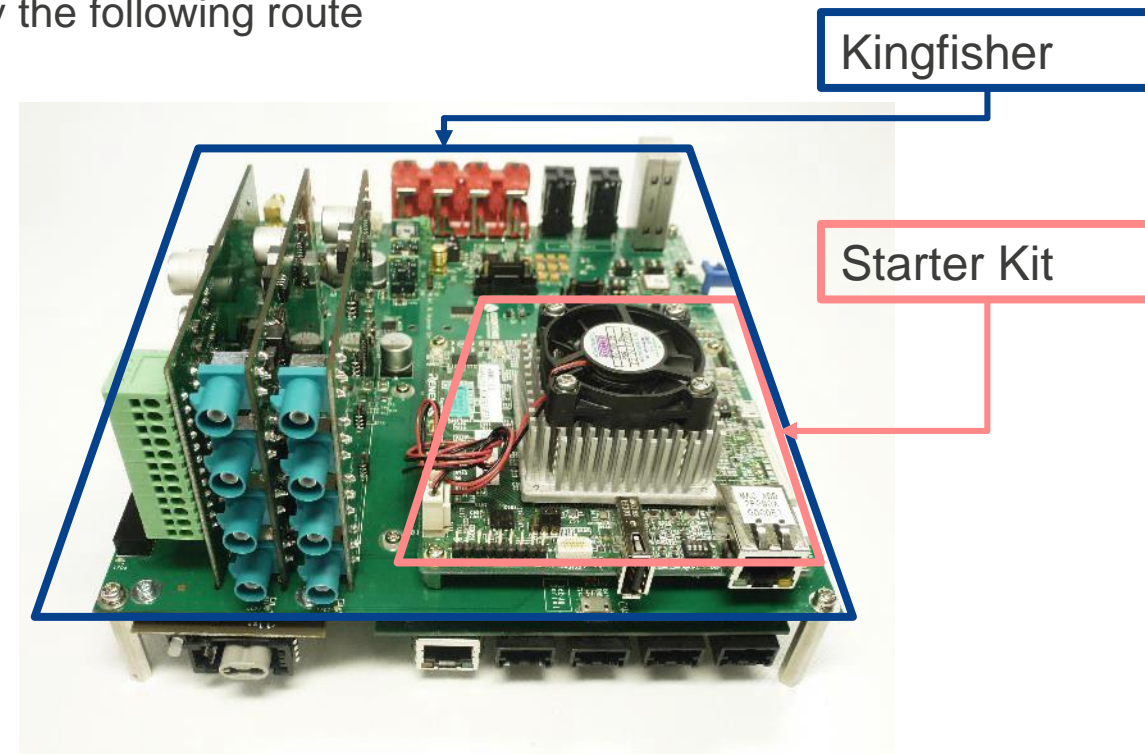 - ✓ Offer App, drivers and 2nd OS for boot sequence.

Extension software

| Application |
| Vender implementation |
| Drivers, Patches |

→

Sensors
Camera
Connectivity
Multi display

| Application on 2nd OS |
| Drivers on 2nd OS |
| 2nd OS (RTOS or Linux) |

→

Automotive boot up sequence

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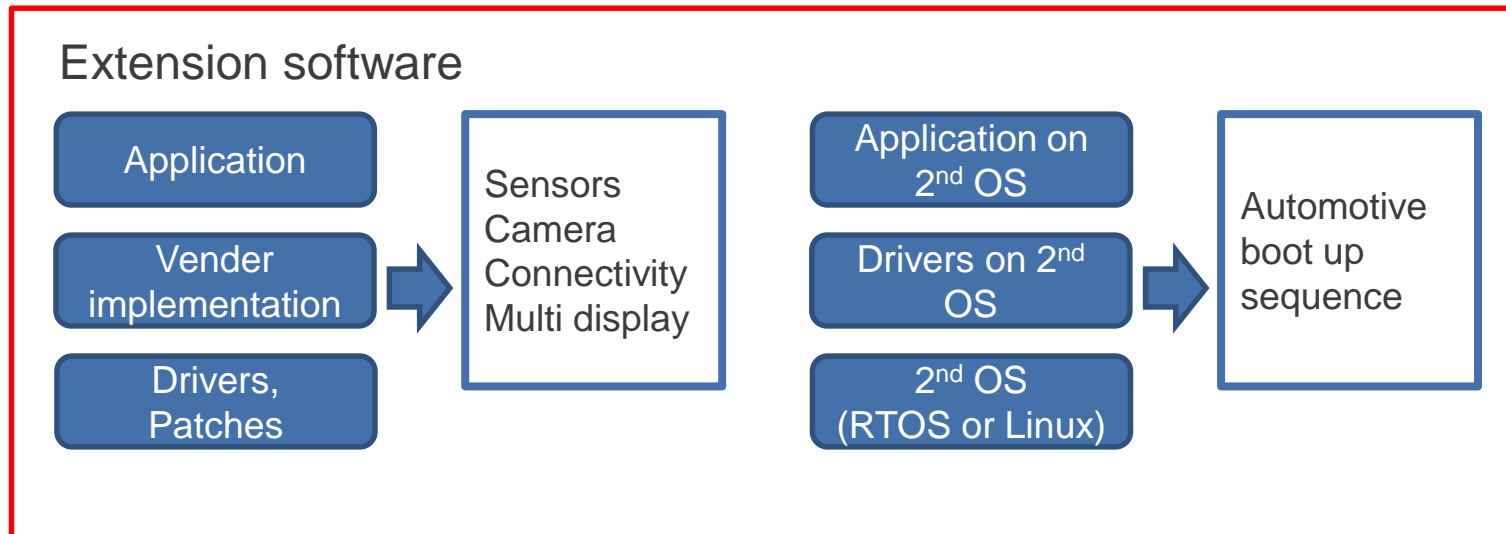
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R-CAR REFERENCE PACKAGE FOR ANDROID TARGET ENVIRONMENT

- Renesas will develop the reference package based on R-Car H3 model Starter Kit Premier & Kingfisher. Also, this package will supports peripherals and on board chip sets

- Starter Kit Premier and Kingfisher can be purchased by the following route

Item		Content
Starter Kit Premier	Vendor	Renesas
	Model Number	RTP0RC7795SKB00010S
Delivery	Flow	Web(chip1stop, marutsu)-> Customer
	Target Date	Now available

Item		Content
Kingfisher)	Vendor	Shimafuji
	Model Number	SBEV-RCAR-KF-M04 (Advanced Model)
Delivery	Flow	Shimafuji -> Customer
	Target Date	Now available

Kingfisher

Starter Kit

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R-CAR ANDROID BSP, REFERENCE PACKAGE
## - ANDROID OMR1 BASED FEATURE LIST -

Legend:
- 🟩 Already available
- 🟦 Planned
- 🟪 Under Planning

		"MUST" features defined in Android 8.1 CDD	"SHOULD" features defined in Android 8.1 CDD	IVI specific features not defined in CDD but "essential"	Reference package Starter Kit and Kingfisher		
					Milestone 1	Milestone 2	Milestone 3
Multi display	Enable three displays	N	N	Y	Y (HDMI + HDMI + LVDS)	Y (HDMI + HDMI + LVDS)	Y (HDMI + HDMI + LVDS
	Use the two displays as one integrated display	N	N	Y	N	N	N
Sensors	3-axis accelerometer	N	Y	N	Y	Y	Y
	3-axis Gyroscope	N	Y	N	Y	Y	Y
	3-axis Compass	N	Y	N	Y	Y	Y
	GPS/GNSS receiver	N	Y	N	Y	Y	Y
Android Automotive-only sensors	Current Gear	N	Y	N	N	N	Y
	Day Night Mode	Y	N	N	N	N	Y
	Driving Status	Y	N	N	N	N	Y
	Wheel Speed	Y	N	N	N	N	Y
Camera	Exterior View System	N	N	Y	N	Y (RPI Camera)	Y (GMSL camera) 1 Camera
	Surround View	N	N	Y	N	N	Y (GMSL camera) 1 Camera

However, Android P BSP will support multiple Camera

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R-CAR ANDROID BSP, REFERENCE PACKAGE
- ANDROID OMR1 BASED FEATURE LIST -

	Already available
	Planned
	Under Planning

		"MUST" features defined in Android 8.1 CDD	**"SHOULD"** features defined in Android 8.1 CDD	**IVI specific features** not defined in CDD but "essential"	Reference package Starter Kit and Kingfisher		
					Milestone 1	Milestone 2	Milestone 3
Connectivity	IEEE 802.11 (Wi-Fi)	N	Y	N	Y	Y	Y
	Bluetooth	Y	N	N	Y (HFP voice is not handled by audio HAL)	Y	Y
	Radio (e.g. AM/FM, DAB)	N	N	Y	Y (not connected to audio HAL)	Y	Y
	In vehicle network (e.g. CAN, …)	Y	N	N	Y	Y	Y
	Ethernet Remote Display	N	N	Y	Y (Not in the package, provided separately)	Y	Y

R-CAR ANDROID BSP, REFERENCE PACKAGE
- ANDROID OMR1 BASED FEATURE LIST -

■ Already available
■ Planned
■ Under Planning

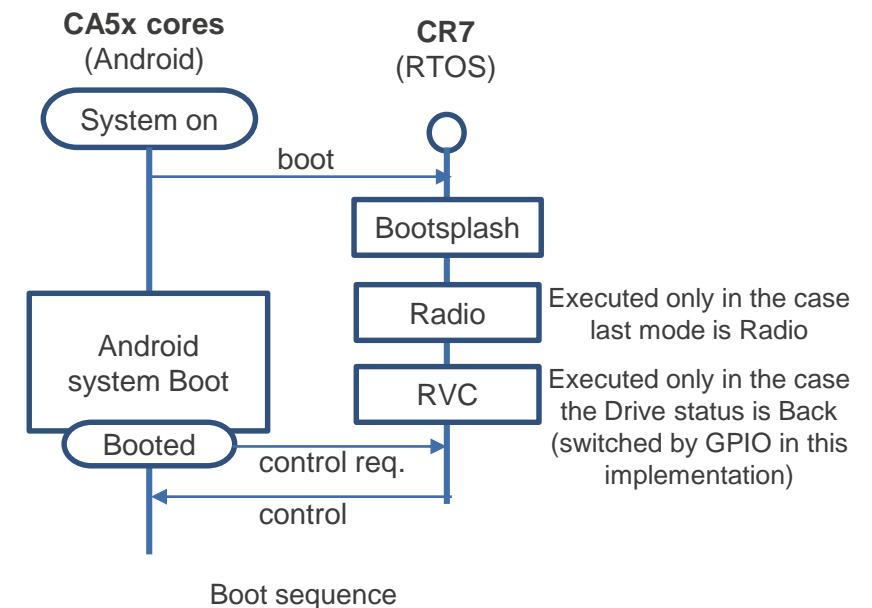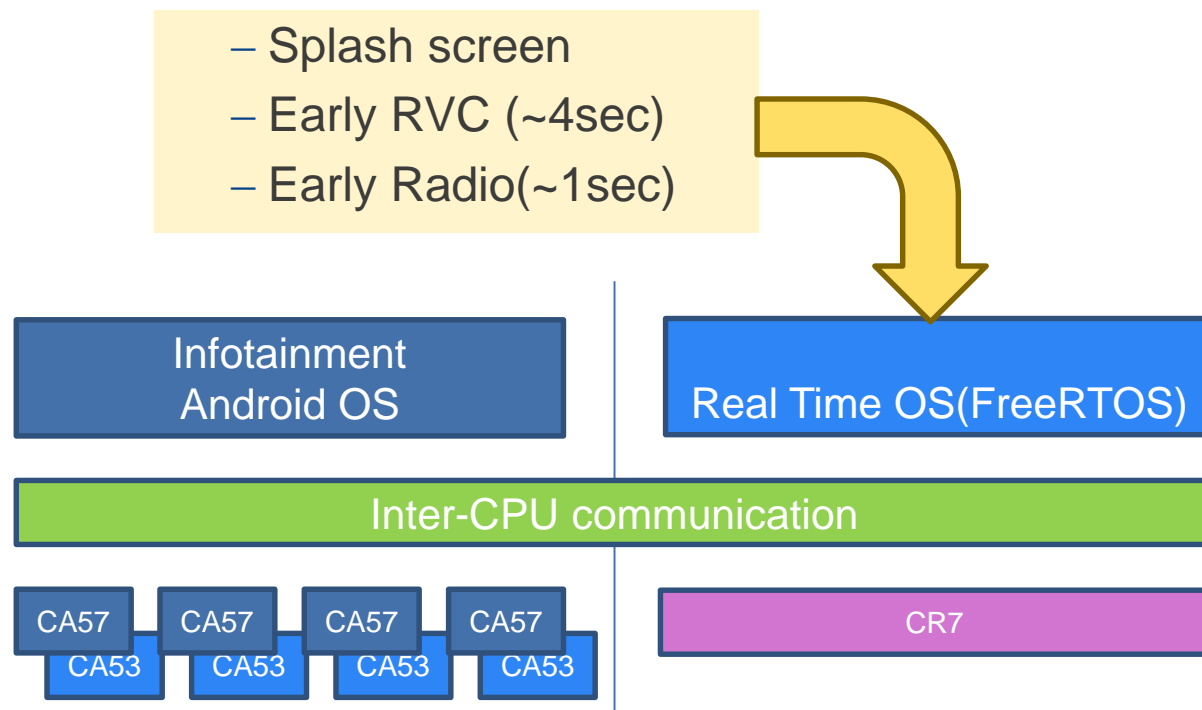|		"MUST" features defined in Android 8.1 CDD	"SHOULD" features defined in Android 8.1 CDD	IVI specific features not defined in CDD but "essential"	Reference package Starter Kit and Kingfisher		
					Milestone 1	Milestone 2	Milestone 3
Automotive boot up sequence	Boot splash	N	N	Y *target KPI: below 1s	N	Y	Y
	Early RVC	N	N	Y *target KPI: CAN Wake-up to RVC in less than 4s.	N	Y CR7 FreeRTOS Based solution	Y CR7 FreeRTOS Based solution
	Early Radio	N	N	Y *target KPI: CAN Wake-up to Early Audio (last tuned Analog radio) in less than 1s)	N	Y CR7 FreeRTOS Based solution	Y CR7 FreeRTOS Based solution
	Cold Boot	N	N	Y *target KPI: CAN Wake-up to Android UI in less than 9s.	N	N	Y Partner to be introduced for optimization of Android on CA5x
	Warm boot (Suspend to RAM)	N	N	Y	N (SK+KF doesn't support DDR back up)	N (SK+KF doesn't support DDR back up)	N (SK+KF doesn't support DDR back up)

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ANDROID AUTOMOTIVE FEATURE

BOOT OPTIMIZATION POC:

COLDBOOT WITH SPLASH SCREEN, EARLY RVC, EARLY

RADIO

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SPLASH SCREEN, EARLY RVC, EARLY RADIO

This POC intends to realize IVI features of improved "Power On cold boot" timing by using CR7 to realize Splash Screen, Radio and/or RVC while CA5x will be starting Android system. After Android booted the CR7 (RTOS) transmit device control to CA5x (Android OS) via Inter-CPU communication.

- Splash screen
- Early RVC (~4sec)
- Early Radio(~1sec)

Infotainment Android OS

Real Time OS(FreeRTOS)

Inter-CPU communication

| CA57 | CA57 | CA57 | CA57 |
| CA53 | CA53 | CA53 | CA53 |

CR7

CA5x cores (Android)   **CR7** (RTOS)

System on

boot

Bootsplash

Android system Boot

Radio — Executed only in the case last mode is Radio

RVC — Executed only in the case the Drive status is Back (switched by GPIO in this implementation)

Booted

control req.

control

Boot sequence

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KEY POINTS OF IMPLEMENTATION

Early RVC

- Video capture and camera module will be initialized by CR7 beside normal boot up sequence.
- Camera and Display functions will be handled by CR7 for early RVC.
- There should be a mechanism to switch the control of RVC function to Android side.
- Switching the camera control back to Android should be seamless (means no blink, no black screen)
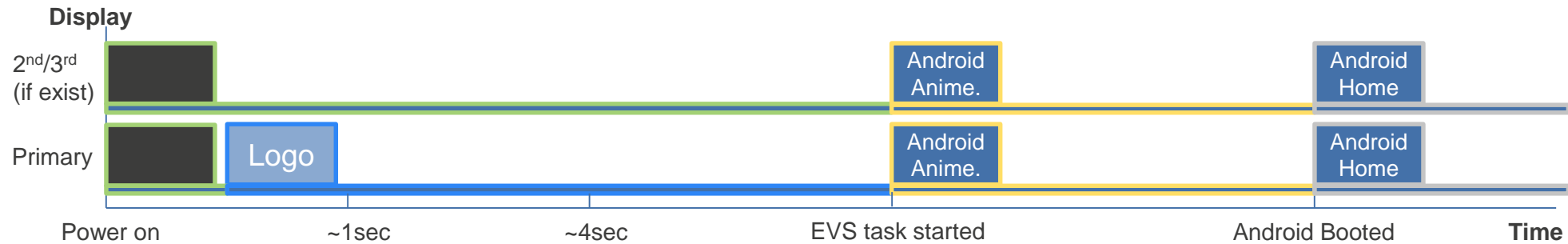- Camera image should be composed with Android image.

Early Radio

- U-boot checks whether start radio function based on last media source, and send related information to CR7.
- If the last media source is radio, the station, frequency and volume information must can be restored in u-boot.
- The tuner and codec on Kingfisher board and all the on chip audio hardware need to be initialized by CR7.
- CR7 will handle all the operation during boot up phase.
- The control of tuner and other audio hardware will transfer to Android after audio HAL service is started.
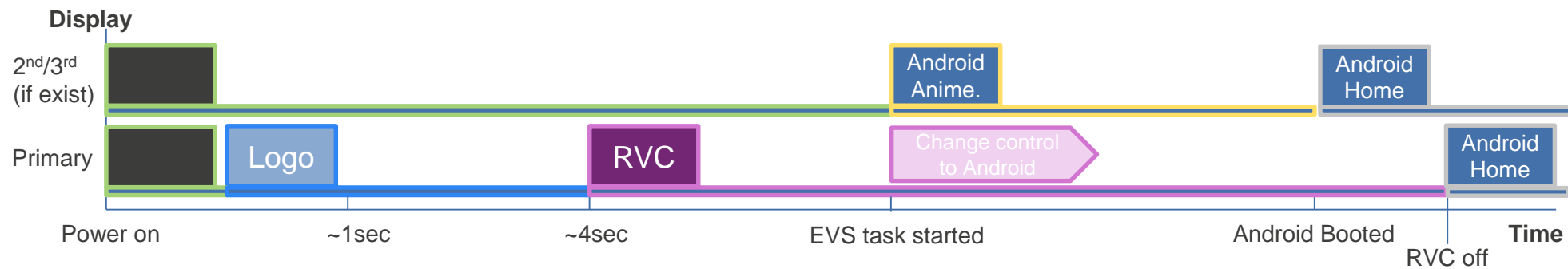
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USE CASE CONSIDERATION

No.	Boot optimization Use-case	Target spec
1	Cold Boot with Splash screen	- The splash logo on the primary screen(HDMI0). - After launching the Android boot animation, the splash logo is stopped, and continue to display the Android boot animation.
2	Cold Boot with Splash screen + RVC	- The splash logo on the primary screen(HDMI0). - A Camera image is displayed on the primary screen from splash log. It will be started within 4 seconds. - After launching EVS task on Android OS, should seamlessly pass the camera and display access control from CR7 to the EVS task.
3	Cold Boot with Splash screen + early Radio	- The splash logo on the primary screen(HDMI0). - A Radio audio is started within 1 second. - Last mode*: under consideration.
4	Cold Boot with Splash screen + RVC + early Radio	- This is combination of use-case 2 and 3.

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TIME CHART OF EARLY IVI FUNCTION POC (1)

- **Use Case 1: Cold Boot without RVC/early RADIO**

Display

2nd/3rd (if exist)

Primary | Logo | Android Anime. | Android Home

Power on | ~1sec | ~4sec | EVS task started | Android Booted | **Time**

- **Use Case 2: Cold Boot with RVC only**

Display

2nd/3rd (if exist)

Primary | Logo | RVC | Change control to Android | Android Home

Power on | ~1sec | ~4sec | EVS task started | Android Booted | RVC off | **Time**

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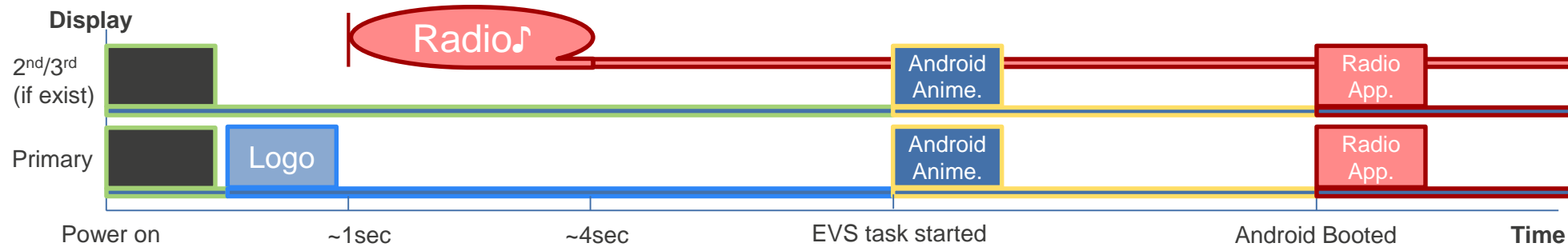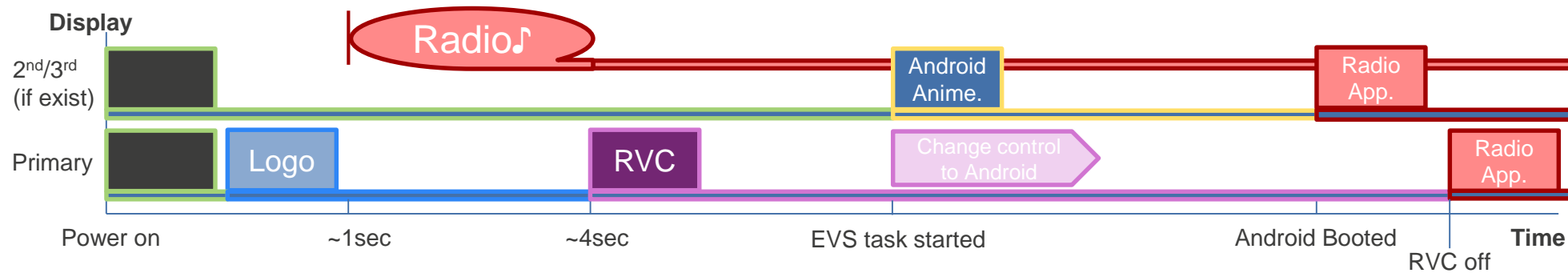
TIME CHART OF EARLY IVI FUNCTION POC (2)

- **Use Case 3: Cold Boot with early RADIO only**

- **Use Case 4: Cold Boot with RVC/early RADIO**

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TIME CHART OF EARLY IVI FUNCTION POC (1)

- **Use Case 1: Cold Boot without RVC/early RADIO**

Display

2nd/3rd (if exist)

Primary

| | | | | Android Anime. | | Android Home |
| Logo | | | | Android Anime. | | Android Home |

Power on   ~1sec   ~4sec   EVS task started   Android Booted   **Time**

- **Use Case 2: Cold Boot with RVC only**

Display

2nd/3rd (if exist)

Primary

Logo   RVC   Change control to Android

Android Anime.   Android Home

Android Home

Power on   ~1sec   ~4sec   EVS task started   Android Booted   RVC off   **Time**

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TIME CHART OF EARLY IVI FUNCTION POC (2)

- **Use Case 3: Cold Boot with early RADIO only**

Display

2nd/3rd
(if exist)

Radio♪

Android Anime. — Radio App.

Primary

Logo — Android Anime. — Radio App.

Power on ~1sec ~4sec EVS task started Android Booted **Time**

- **Use Case 4: Cold Boot with RVC/early RADIO**

Display

2nd/3rd
(if exist)

Radio♪

Android Anime. — Radio App.

Primary

Logo RVC Change control to Android Radio App.

Power on ~1sec ~4sec EVS task started Android Booted **Time**
RVC off

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PERFORMANCE RESULTS

- **Cold Boot without RVC/early RADIO**

  - From power on to splash logo displayed is about 0.93 seconds

Basic Operation Step	Expected Result	Test Result	Detail Data	
			Splash Logo	
			0.81	
1.Set SW2-2 OFF, SW2-3 OFF, SW2-4 OFF 2.Power on	1.FreeRTOS boot 2.Splash logo show on display screen within 2 seconds	Splash logo show is 0.932 seconds	0.89	
			1.02	
			1.1	
			0.84	

<div align="right">Average of Measurement samples   Measurements samples</div>

- **Cold Boot with RVC/early RADIO**

  - From power on to camera image displayed is about 1.1 seconds
  - From power on to radio paly is about 1.4 seconds

Basic Operation Step	Expected Result	Test Result	Detail Data	
			Early RVC	Early Radio
			1.11	1.37
1.Set SW2-2 ON,SW2-3 ON, SW2-4 ON 2.Power on	1.FreeRTOS boot 2.Radio play as last mode within 1 second 3.RVC image show on display screen within 4 second 4.Android boot 5.Early RVC control change from FreeRTOS to Android	RVC image show is 1.106 seconds Radio play is 1.396 seconds	1.15	1.39
			1.03	1.42
			1.13	1.4
			1.11	1.4

<div align="right">Average of Measurement samples   Measurements samples</div>

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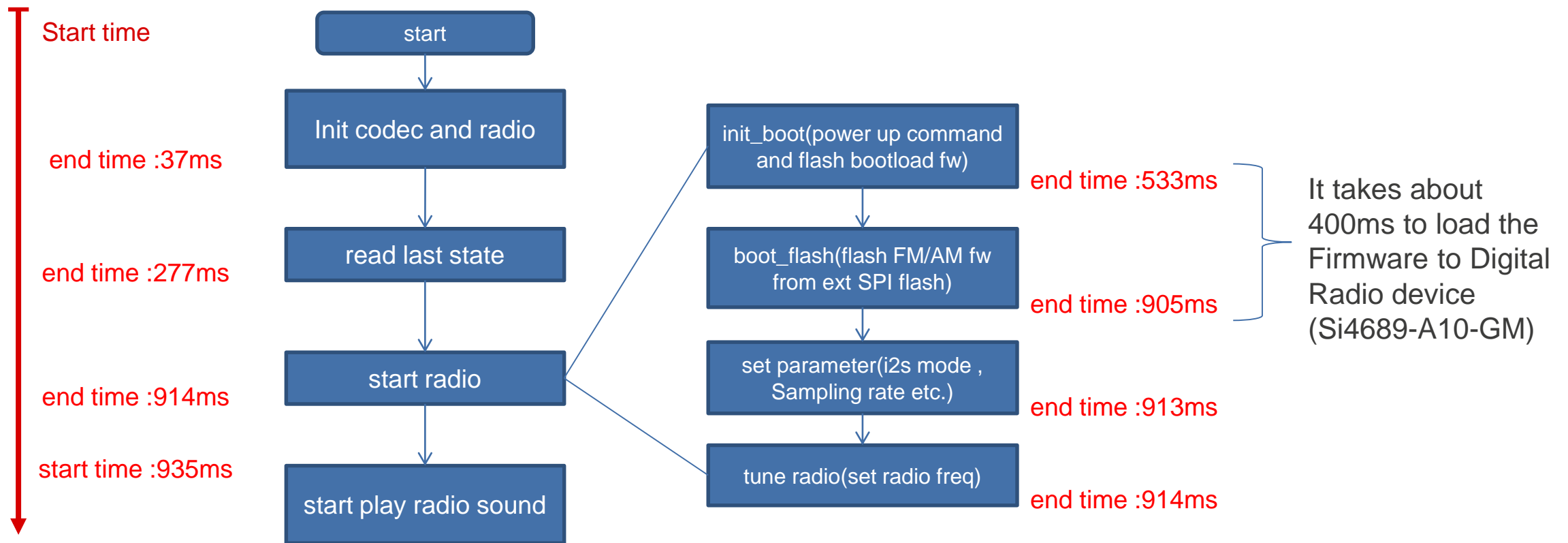**RENESAS**

PERFORMANCE RESULTS

- **Cold Boot with RVC only**
  - From power on to camera image displayed is about 0.94 seconds

Basic Operation Step	Expected Result	Test Result	Detail Data
1.Set SW2-2 OFF, SW2-3 ON, SW2-4 ON 2.Power on	1.FreeRTOS boot 2.RVC image show on display screen within 4 seconds 3.Android boot 4.Early RVC control change from FreeRTOS to Android	RVC image show is 0.94 seconds	Early RVC 1.1 0.85 1.07 0.83 0.85

<div align="right">Average of Measurement samples   Measurements samples</div>

- **Cold Boot with early RADIO only**
  - From power on to radio paly is about 1.4 seconds

Basic Operation Step	Expected Result	Test Result	Detail Data
1.Set SW2-2 ON,SW2-3 OFF, SW2-4 OFF 2.Power on	1.FreeRTOS boot 2.Splash logo show on display screen 3.Radio play as last mode within 1 second	Radio play is 1.434 seconds	Early Radio 1.45 1.47 1.43 1.42 1.4

<div align="right">Average of Measurement samples   Measurements samples</div>

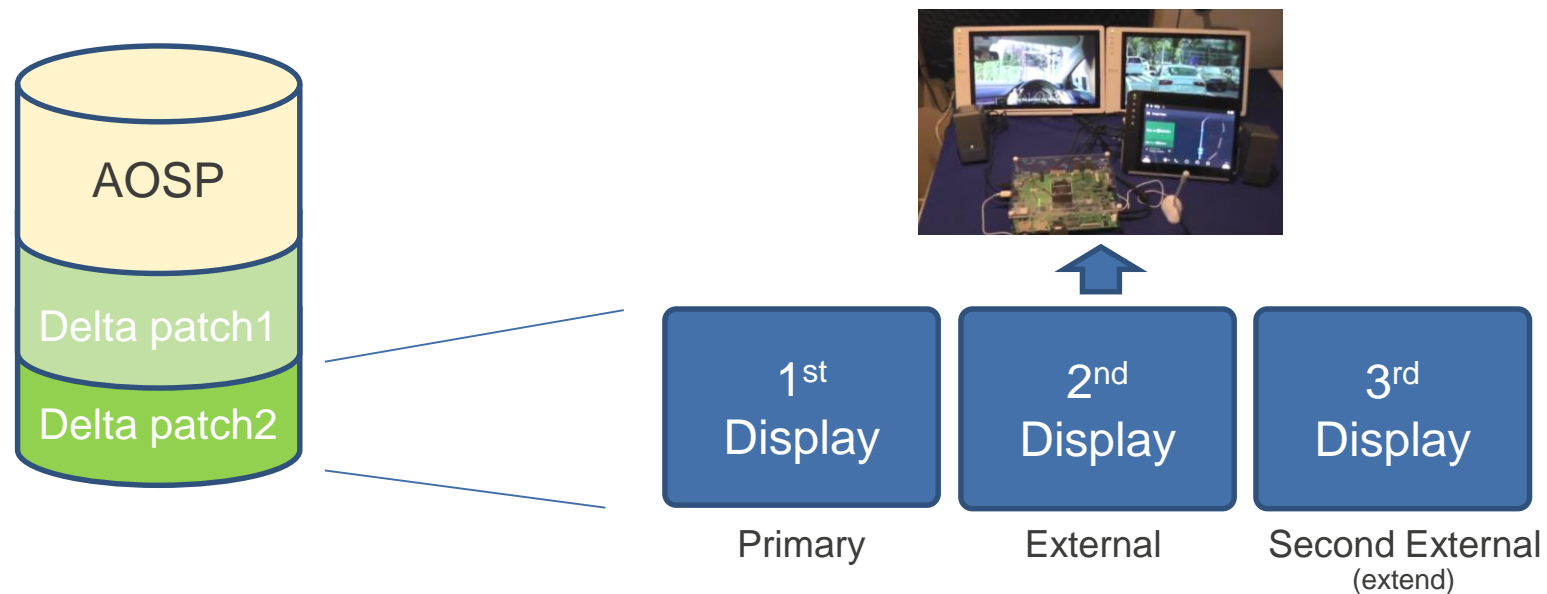RENESAS

ANALYSIS OF EARLY RADIO PERFORMANCE

Start time

end time :37ms

end time :277ms

end time :914ms

start time :935ms

start

Init codec and radio

read last state

start radio

start play radio sound

init_boot(power up command and flash bootload fw)

end time :533ms

boot_flash(flash FM/AM fw from ext SPI flash)

end time :905ms

set parameter(i2s mode , Sampling rate etc.)

end time :913ms

tune radio(set radio freq)

end time :914ms

It takes about 400ms to load the Firmware to Digital Radio device (Si4689-A10-GM)

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ANDROID AUTOMOTIVE FEATURE

MULTI DISPLAY SUPPORT

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AOSP DELTA PATCHES

- The customer can enable some additional patches (as Delta patch2):
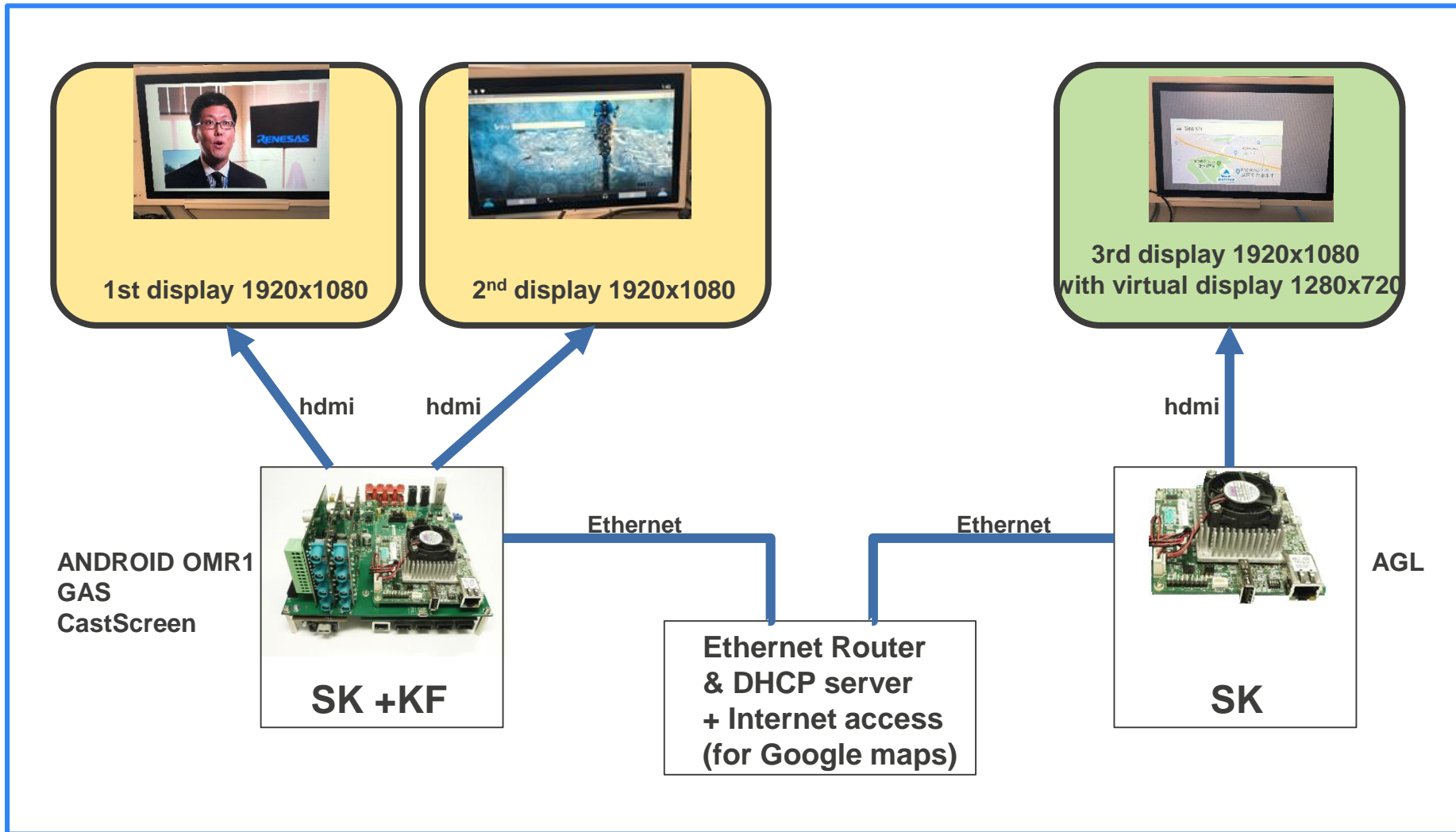 - Multiple display support (**4 patches**)

AOSP

Delta patch1

Delta patch2

1st Display	2nd Display	3rd Display
Primary	External	Second External (extend)

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ANDROID AUTOMOTIVE FEATURE
ETHERNET – VIRTUAL DISPLAY

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Android Demo with Virtual Display over Ethernet

1st display 1920x1080

2nd display 1920x1080

3rd display 1920x1080
with virtual display 1280x720

hdmi

hdmi

hdmi

ANDROID OMR1
GAS
CastScreen

SK +KF

Ethernet

Ethernet Router
& DHCP server
+ Internet access
(for Google maps)

Ethernet

AGL

SK

Features:

- "Master platform" running Native Android OMR1 + Google Automotive Services (GAS) on StarterKit + Kingfisher boards and direct dual screen display.

- "Slave platform" running AGL on Starter Kit board for Virtual Display

- Using 'CastScreen' application published in github.

- A virtual output buffer is encoded by Renesas OMX H.264 encoder on Master and transmit via Ethernet using RTP (Remote Transfer Protocol).
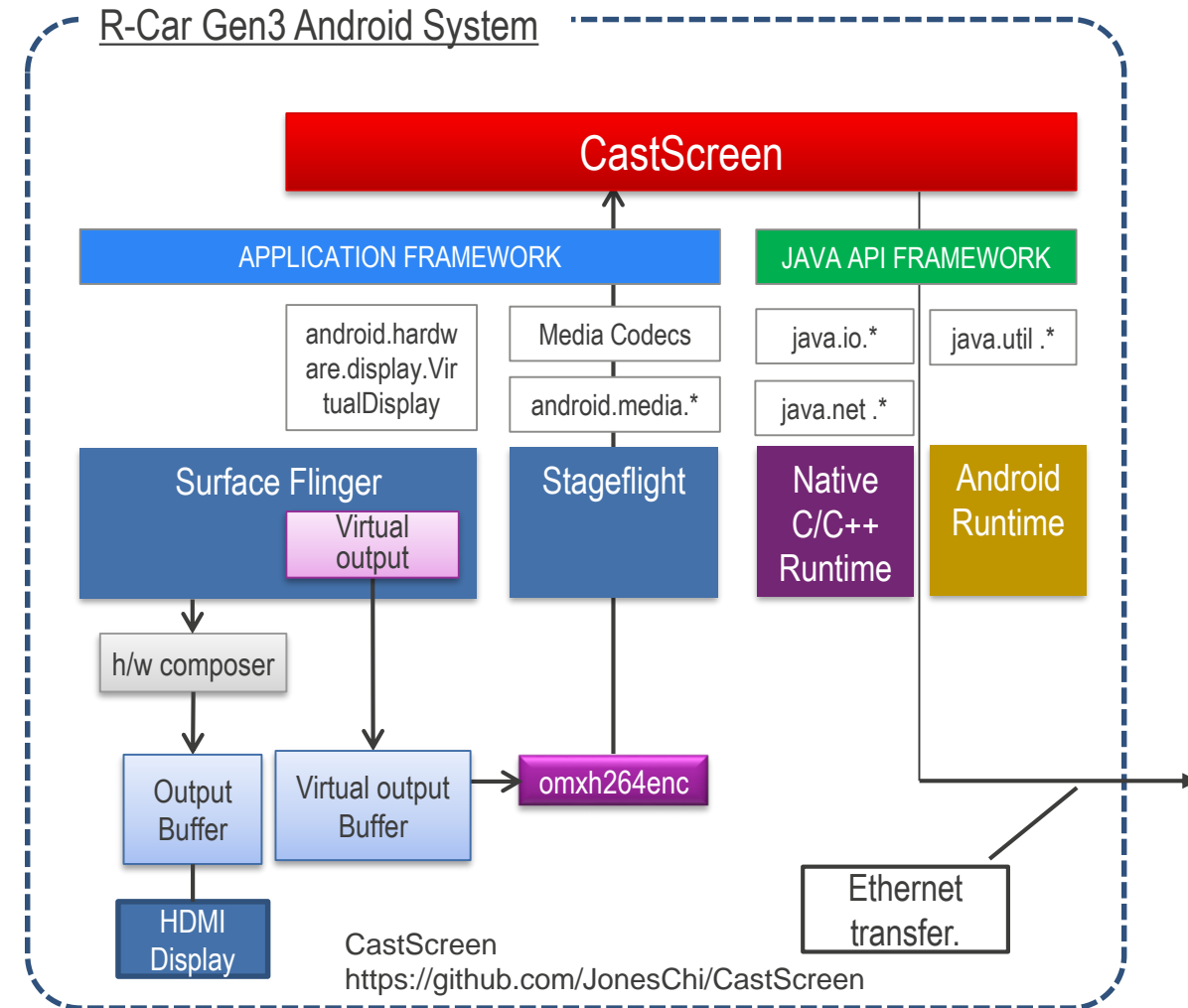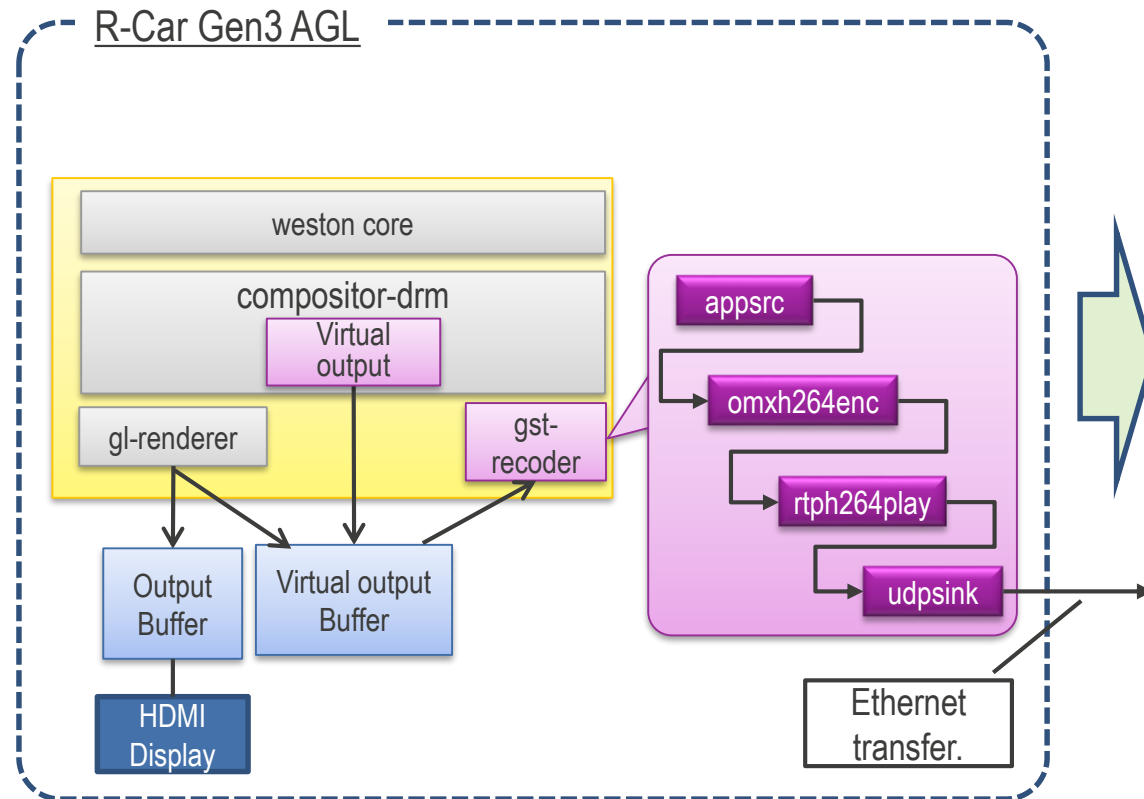
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ANDROID-O MULTI-DISPLAY

✓ Renesas plans to use Android-O multi-display framework as it is.

Android O multi-display topology

Slide from boot camp, Jun. 20th, 2017.

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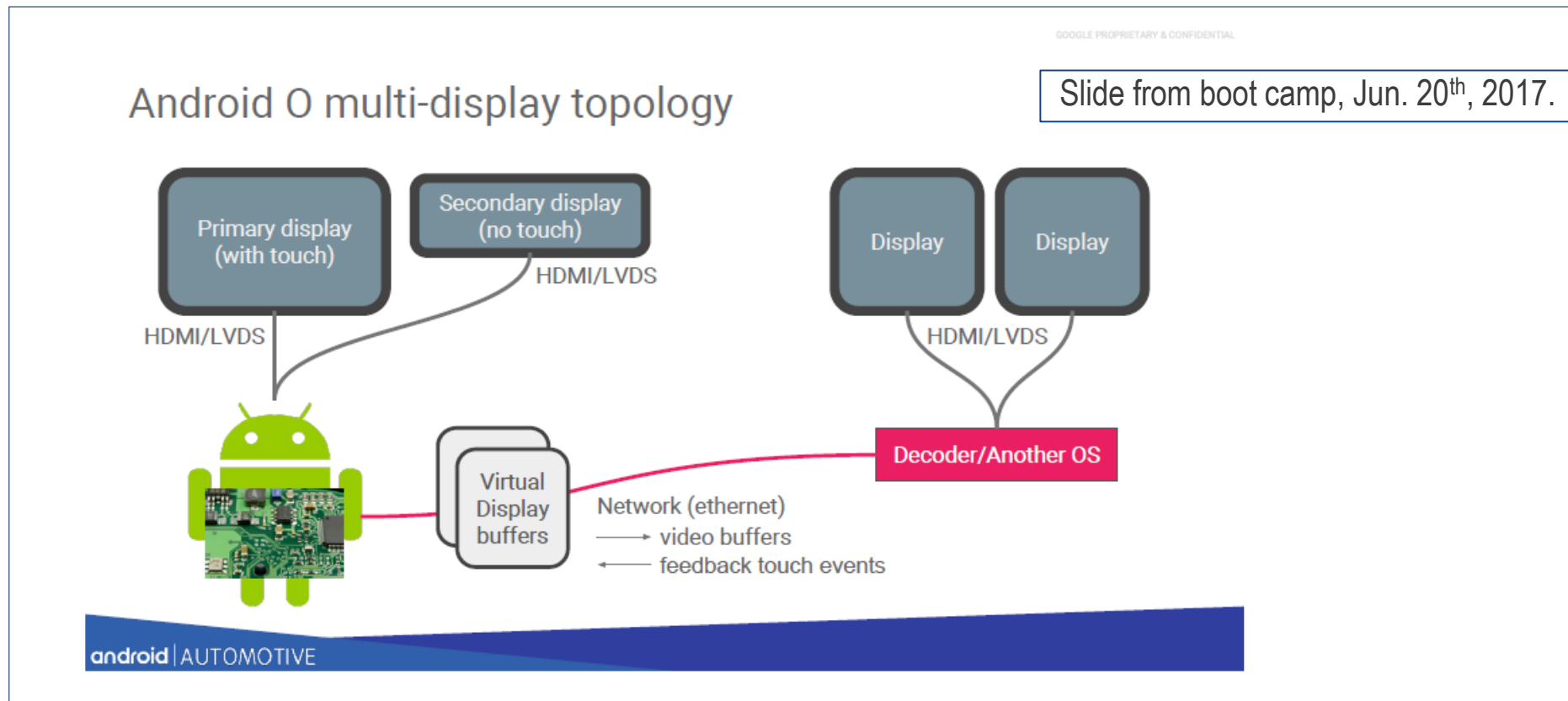
IMPLEMENTATION OF ETHER DISPLAY FOR ANDROID

- We ported 'CastScreen' application published in github.
- A virtual output buffer is encoded by Renesas OMX H.264 encoder and transmit via Ethernet using RTP(Remote Transfer Protocol).

R-Car Gen3 AGL

weston core

compositor-drm

Virtual output

gl-renderer

gst-recoder

appsrc

omxh264enc

rtph264play

udpsink

Output Buffer

Virtual output Buffer

HDMI Display

Ethernet transfer.

R-Car Gen3 Android System

CastScreen

APPLICATION FRAMEWORK

JAVA API FRAMEWORK

android.hardware.display.VirtualDisplay

Media Codecs

android.media.*

java.io.*

java.net .*

java.util .*

Surface Flinger

Virtual output

Stageflight

Native C/C++ Runtime

Android Runtime

h/w composer

Output Buffer

Virtual output Buffer

omxh264enc

HDMI Display

Ethernet transfer.

CastScreen
https://github.com/JonesChi/CastScreen

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ETHER DISPLAY FOR R-CAR GEN3 AGL

- Create "Virtual output Display".

  – compositor-drm.c: Append "Virtual output" structure as wl_output. It's drown gl-renderer.

- Virtual output buffer is encoded by gst-recorder.

  – New create gst-recorder.c.
  – Read from output Buffer and convert NV12 format. The buffer is read from Encoder HW.
  – It support Cropping(size, position), position for rectangle.

- Encode buffer as H.264 is transferred via Ethernet as udp.

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GOOGLE AUTOMOTIVE SERVICES
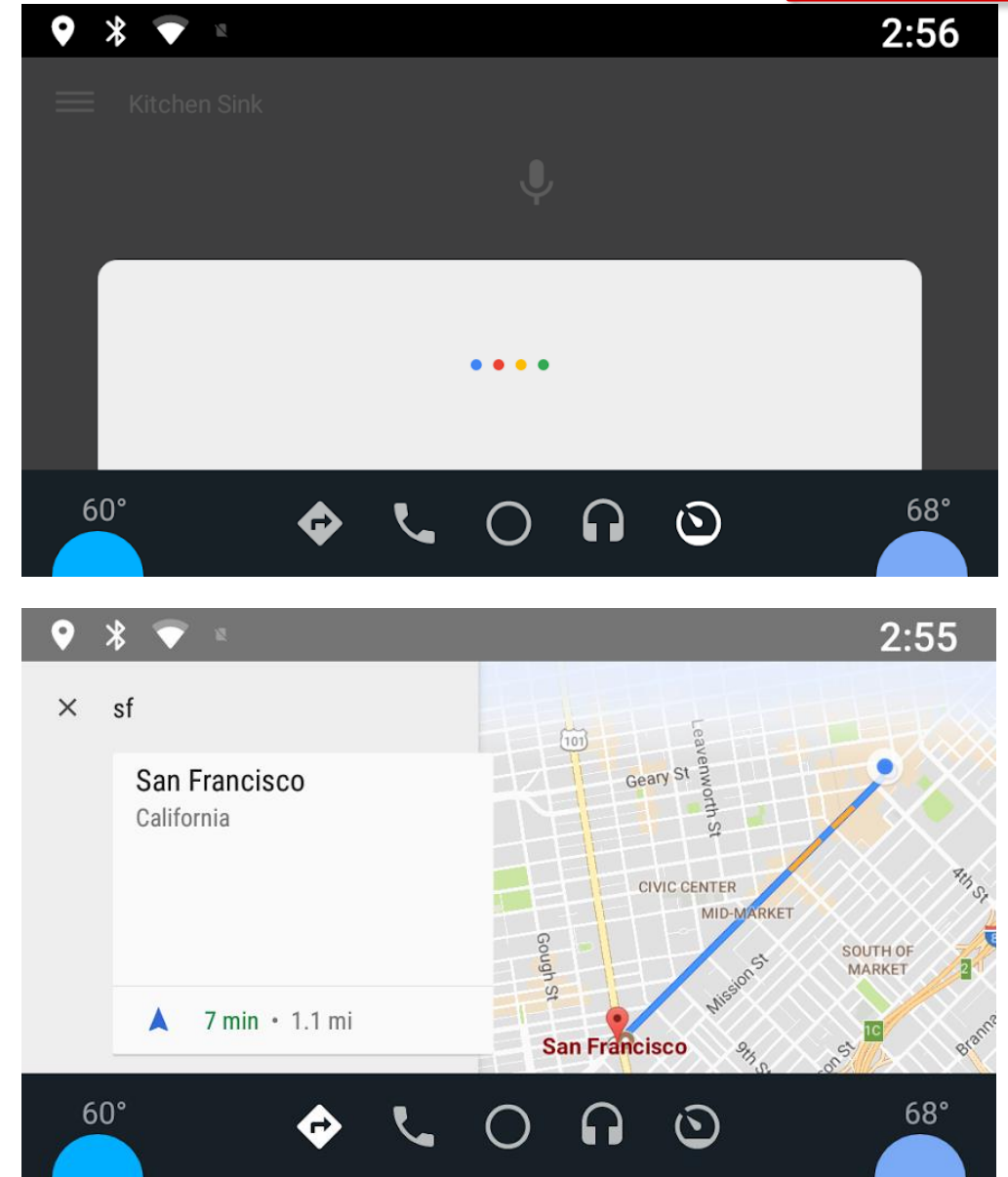
BIG IDEAS FOR EVERY SPACE

RENESAS
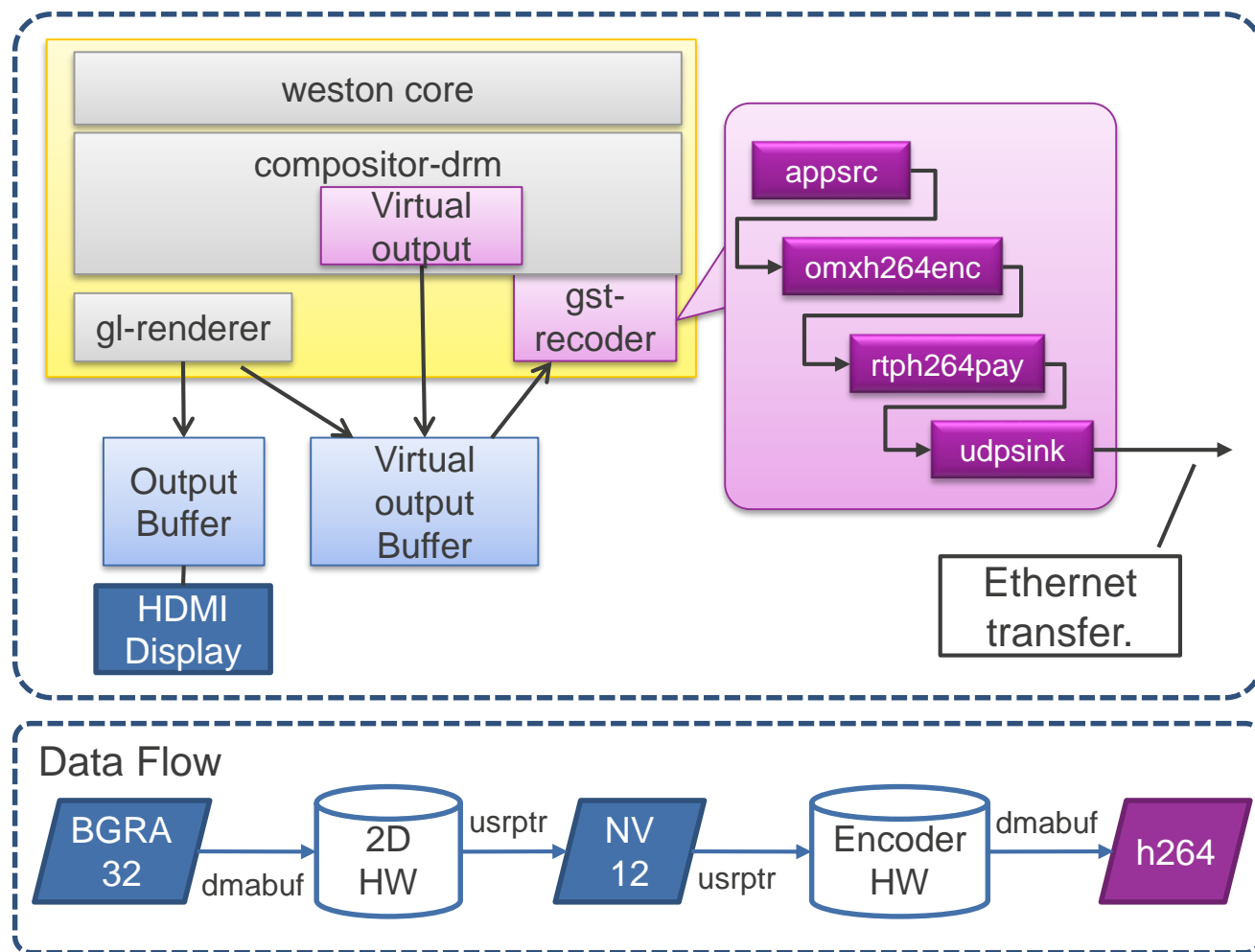
android AUTOMOTIVE

Google Automotive Services (GAS)

What is GAS?

Google Automotive Services (GAS) is a collection of applications and services that automotive OEMs can choose to **license** and integrate into their in-vehicle infotainment (IVI) systems. (Like Maps, Assistant, Phone, ...).

Gas can be use only on **Android P** onwards (Qualification to be done by google on final system level)

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Renesas.com

RENESAS