Android Automotive Audio

Introduction

Bartosz Bialek

Senior Software Engineer
Tieto, PDS BU Automotive & Smart Devices
bartosz.bialek@tieto.com

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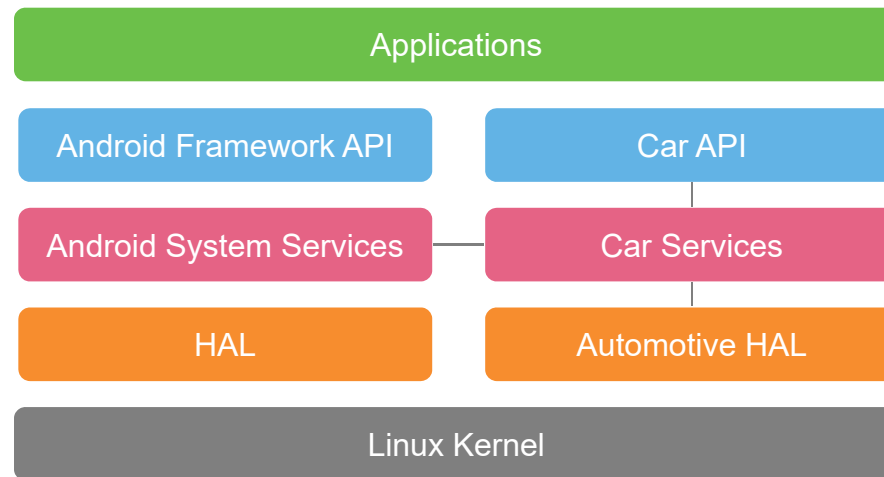- Audio HAL interfaces

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Audio Framework

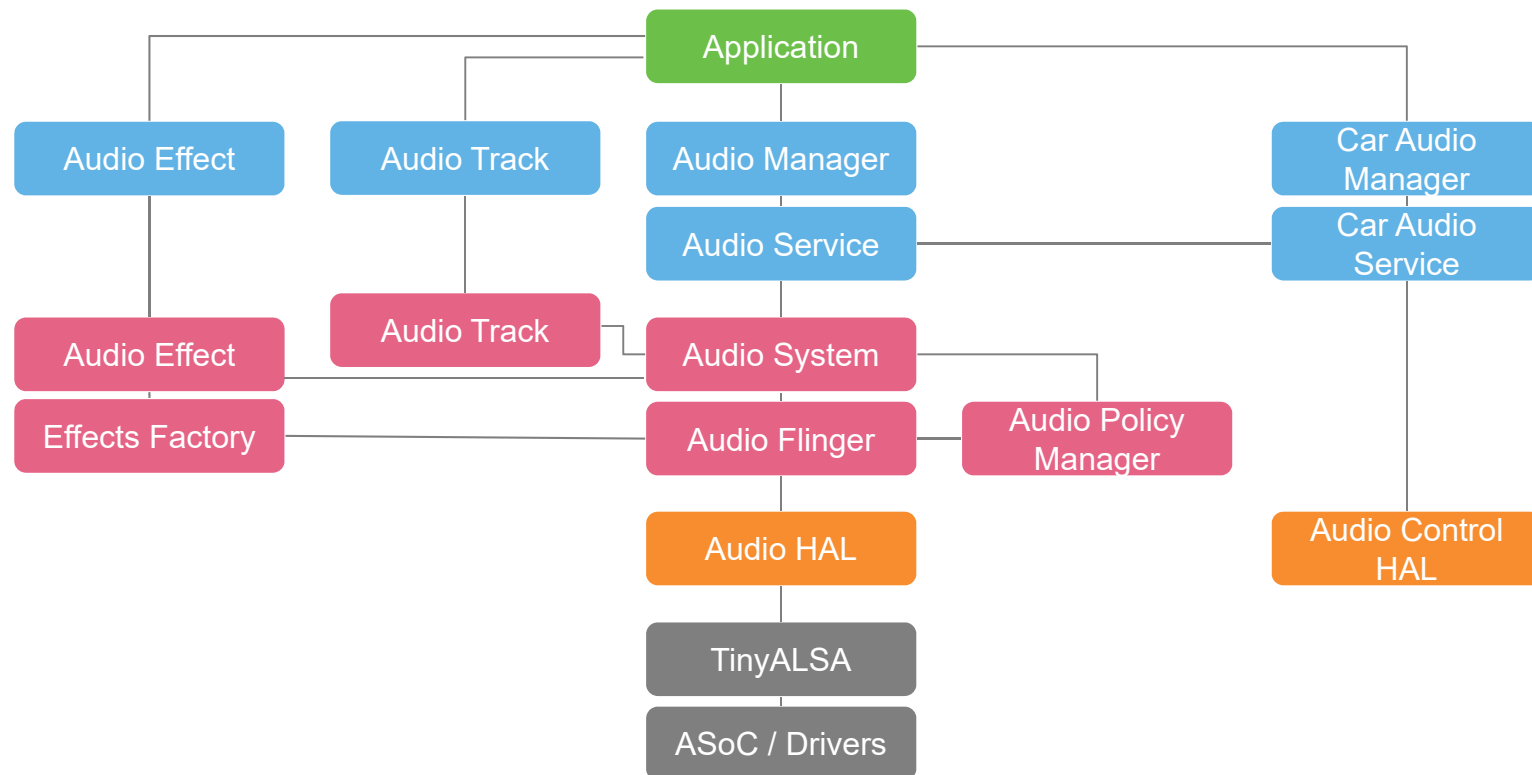Architecture overview

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Android Automotive Architecture

Applications	
Android Framework API	Car API
Android System Services	Car Services
HAL	Automotive HAL
Linux Kernel	

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Audio Framework

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Android sounds and streams (1/2)

Audio sources

Music Player   Voice Assistant   Navigation   Calendar

Audio Flinger

Mixer 0   Mixer 1   Mixer 2

Audio devices

Bus 0   Bus 1   Bus 2

Audio HAL

Chime Unit   →   External Mixer

Tuner   →

Car Amplifier(s)

Audio contexts
MUSIC
NAVIGATION
VOICE_COMMAND
CALL_RING
CALL
ALARM
NOTIFICATION
SYSTEM_SOUND

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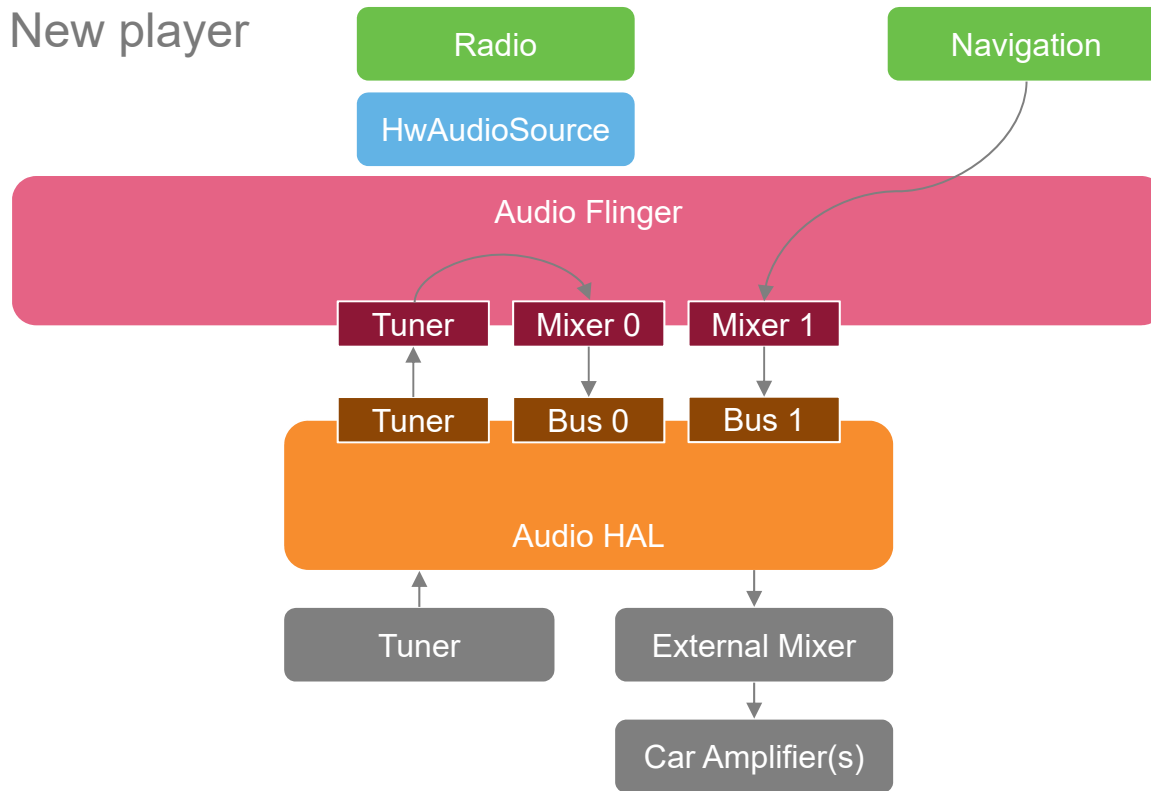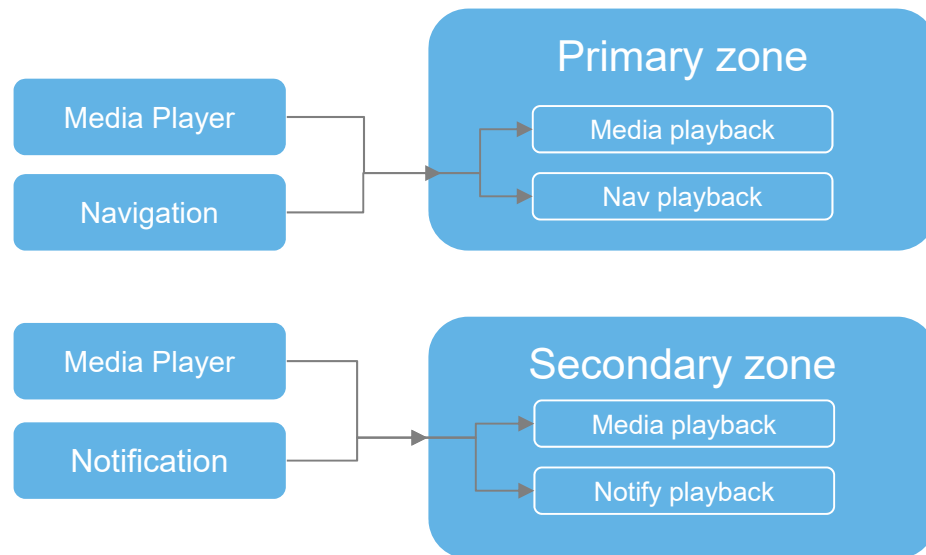
Android sounds and streams (2/2)

Android 10: New player

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Multi-Zone Audio (Android 10)

- Application can be played in zone
- Zone contains audio devices
- Zones have separate volume
- Zone can be requested by app
- No app auto-assignment to zone based on display yet
- HW volume keys controls primary zone only

Primary zone
- Media playback
- Nav playback

Media Player
Navigation

Secondary zone
- Media playback
- Notify playback

Media Player
Notification

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Audio Signal Arbitration (1/2)

- Pre-Android 10: AudioFocus
  - Not enforced

- Android 10: CarAudioFocus
  - Internal interaction matrix (currently fixed)
  - Supports multi-zone audio (maintains focus per zone)

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Audio Signal Arbitration (2/2)
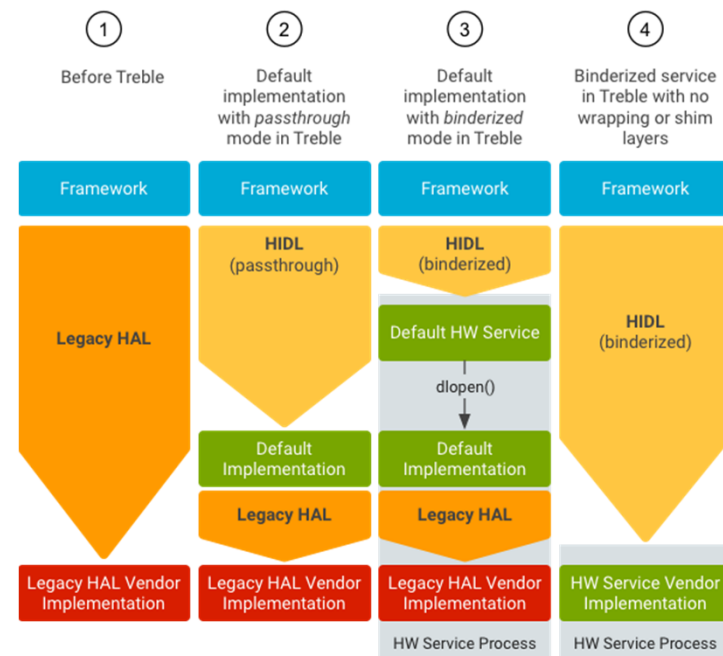
CarAudioFocus
interaction matrix

- Row selected by playing sound (labels along the right)
- Column selected by incoming request (labels along the top)

R – reject
E – exclusive
C – concurrent

	Music	Nav	Voice	Ring	Call	Alarm	Notification	System
Music	E	C	E	E	E	E	C	E
Nav	C	C	E	C	E	C	C	C
Voice	C	R	C	E	E	R	R	R
Ring	R	C	C	C	C	R	R	C
Context	R	C	R	C	C	C	C	R
Alarm	C	C	E	E	E	C	C	C
Notification	C	C	E	E	E	C	C	C
System	C	C	E	E	E	C	C	C

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Audio HAL interfaces

- HAL interface:
  hardware/libhardware/include/
  hardware/audio.h
- HIDL interface:
  hardware/interfaces/audio/

① Before Treble	② Default implementation with *passthrough* mode in Treble	③ Default implementation with *binderized* mode in Treble	④ Binderized service in Treble with no wrapping or shim layers
Framework	Framework	Framework	Framework
	HIDL (passthrough)	HIDL (binderized)	HIDL (binderized)
Legacy HAL		Default HW Service	
		dlopen()	
	Default Implementation	Default Implementation	
	Legacy HAL	Legacy HAL	
Legacy HAL Vendor Implementation	Legacy HAL Vendor Implementation	Legacy HAL Vendor Implementation	HW Service Vendor Implementation
		HW Service Process	HW Service Process

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Audio HIDL

- **IDevice** – represents Audio HW module (e.g. primary, USB, A2DP);
- **IDevicesFactory** – connect to one of the Audio HW modules;
- **IPrimaryDevice** – interface for primary Audio HW module, extends IDevice;
- **IStream** – controls audio streams;
- **IStreamIn** – specialization for input streams;
- **IStreamOut** – specialization for output streams;
- **IAudioControl** - interacts with the car's audio subsystem to manage audio sources and volumes.

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Audio Effects HIDL

Control effect lifecycle:

- **IEffectsFactory**

Generic effect interface:

- **IEffect**

Effect specializations (defined by Google):

- **IAcousticEchoCancelerEffect**
- **IAutomaticGainControlEffect**
- **IBassBoostEffect**
- **IDownmixEffect**
- **IEffectBufferProviderCallback**
- **IEnvironmentalReverbEffect**
- **IEqualizerEffect**
- **ILoudnessEnhancerEffect**
- **INoiseSuppressionEffect**
- **IPresetReverbEffect**
- **IVirtualizerEffect**
- **IVisualizerEffect**

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Configuration challenge

Configurable:

- attached audio output/input devices,
- audio effects,
- audio codecs configuration,
- audio hardware paths,
- audio features (CDD),
- default sounds.

Methods:

- global settings (for all processes),
- user / profile settings,
- car variant specific,
- static vs dynamic.

Related files:

- audio_policy_configuration.xml (bus address definition),
- AudioControl.cpp (sContextToBusMap),
- car_volume_groups.xml (mapping of buses to volume groups),
- config.xml (audioUseDynamicRouting),
- audio_effects.[xml|conf],
- media_profiles_*.xml,
- media_codecs_*.xml,
- other.

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Bartosz Bialek

Senior Software Engineer
Tieto, PDS BU Automotive & Smart Devices
bartosz.bialek@tieto.com