SAMSUNG

INSIGHT OF AN AUDIO DRIVER BASED ON ALSA

Chandrasekar R

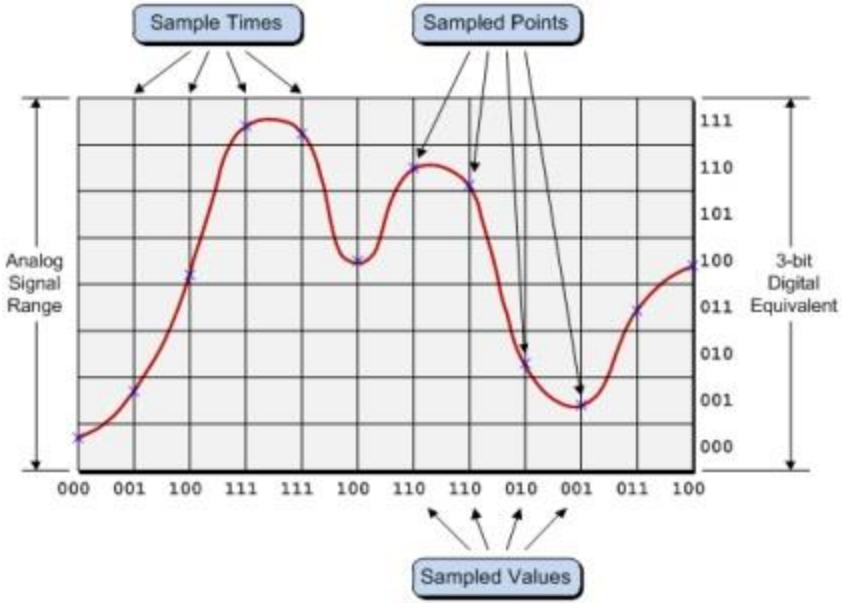
Samsung Semiconductor India R&D Center

Agenda

- Basics of Audio
- Audio Subsystem Overview
- Audio software architecture
- Android Audio System

Basics of Audio

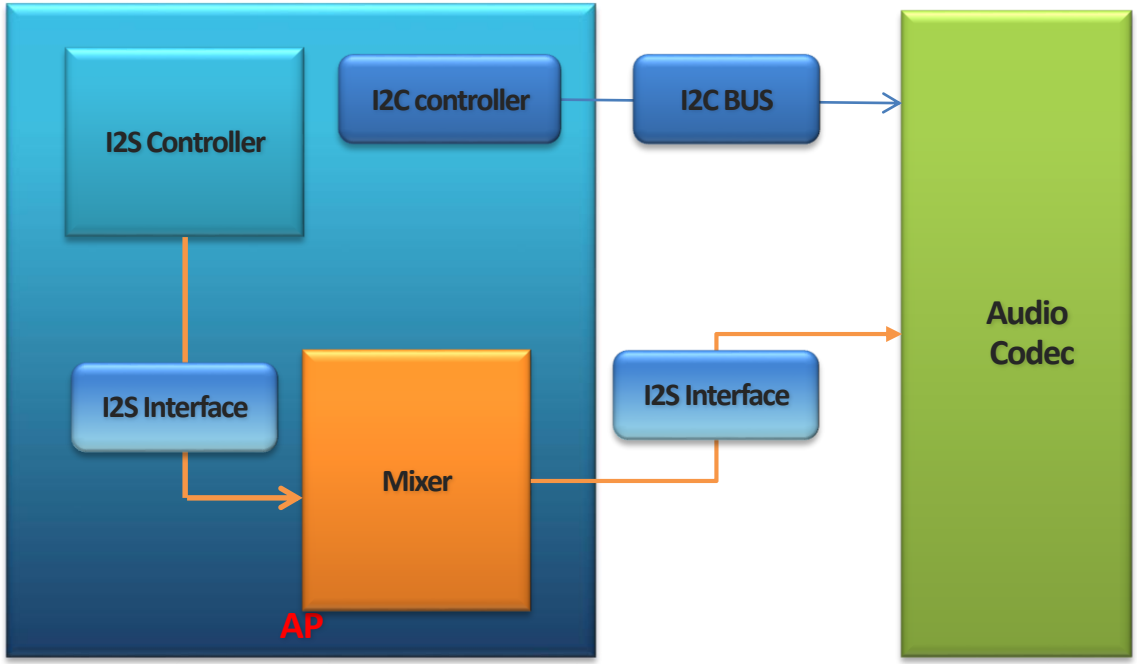
- Analog Audio Data vs Digital Audio Data
- Conversion from Analog Audio Data to Digital Audio Data
  - Data at each discrete time is called Sample.
  - Number of samples per second
    - Sampling Rate, Frame rate (FS)
  - Number of bits per sample
    - Bit-Length Count (BLC)
- Channels
  - Mono, stereo, 5.1 channel etc



Audio Subsystem comprises of following blocks

- I2S Interface
- Audio Subsystem Clock
- DMA
- I2C
- Codec (Analog to digital and Digital to analog converter)

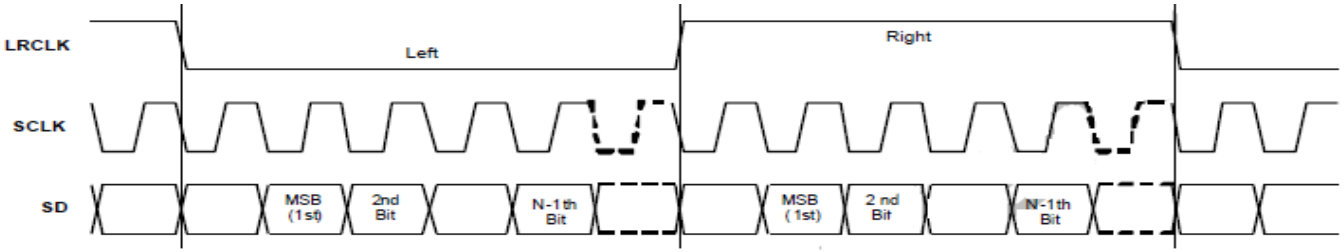
Audio Block


I2S Controller
I2C controller
I2C BUS
Audio Codec
I2S Interface
Mixer
I2S Interface
AP

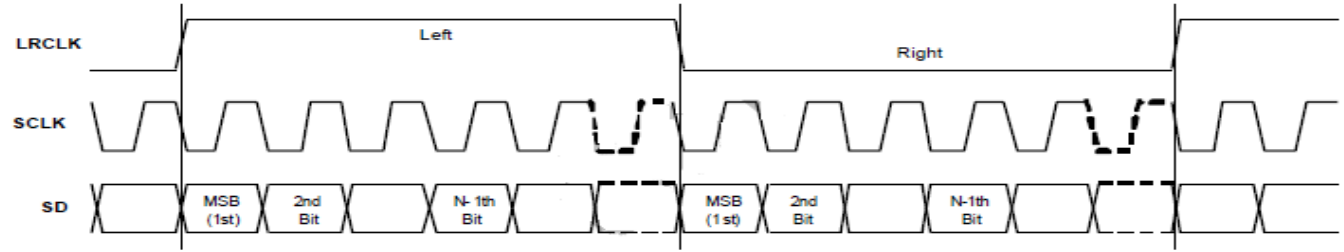
- I2S is a 3-line serial bus-interface
  - Word select line – LRCLK line
  - Clock line – SCLK line, bit-clock line
  - Data line – One line for two time-multiplexed channels

- 8/16/24 bits per sample
- Master/slave mode

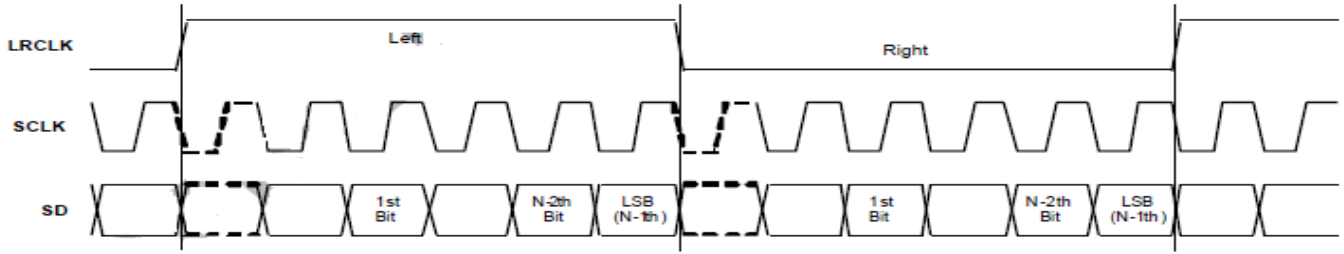
I2S Data Formats



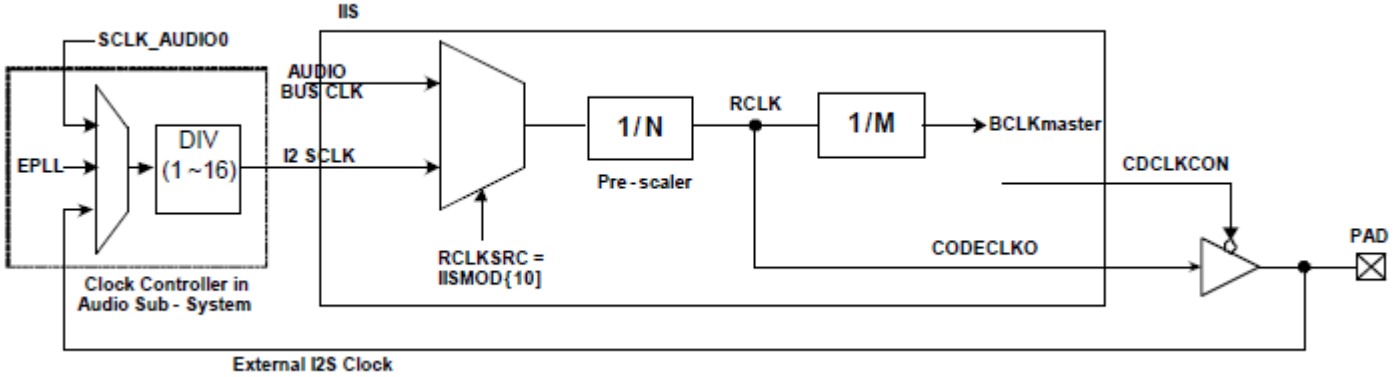
I2S Format (N = 8 or 16)



MSB - Justified (Left - Justified) Format (N = 8 or 16)



LSB - Justified (Right - Justified) Format (N = 8 or 16)



- Clock configuration is the impartment element in audio
- Based on the sampling rate appropriate root clock need to be configured
- The same clock need to be passed on to the codec if it takes from the external source
- Some codec generates the clock, in that case i2s block will take the root clock from the external audio codec

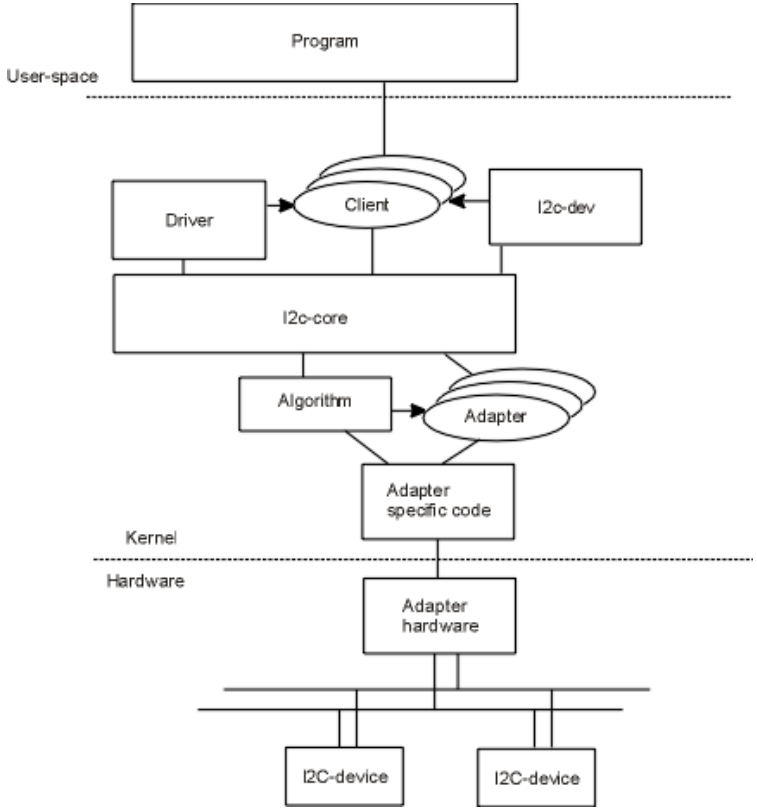
3 DMA channels normally used for mobile SoC

- TX Primary DMA
- RX DMA
- TX-Secondary DMA

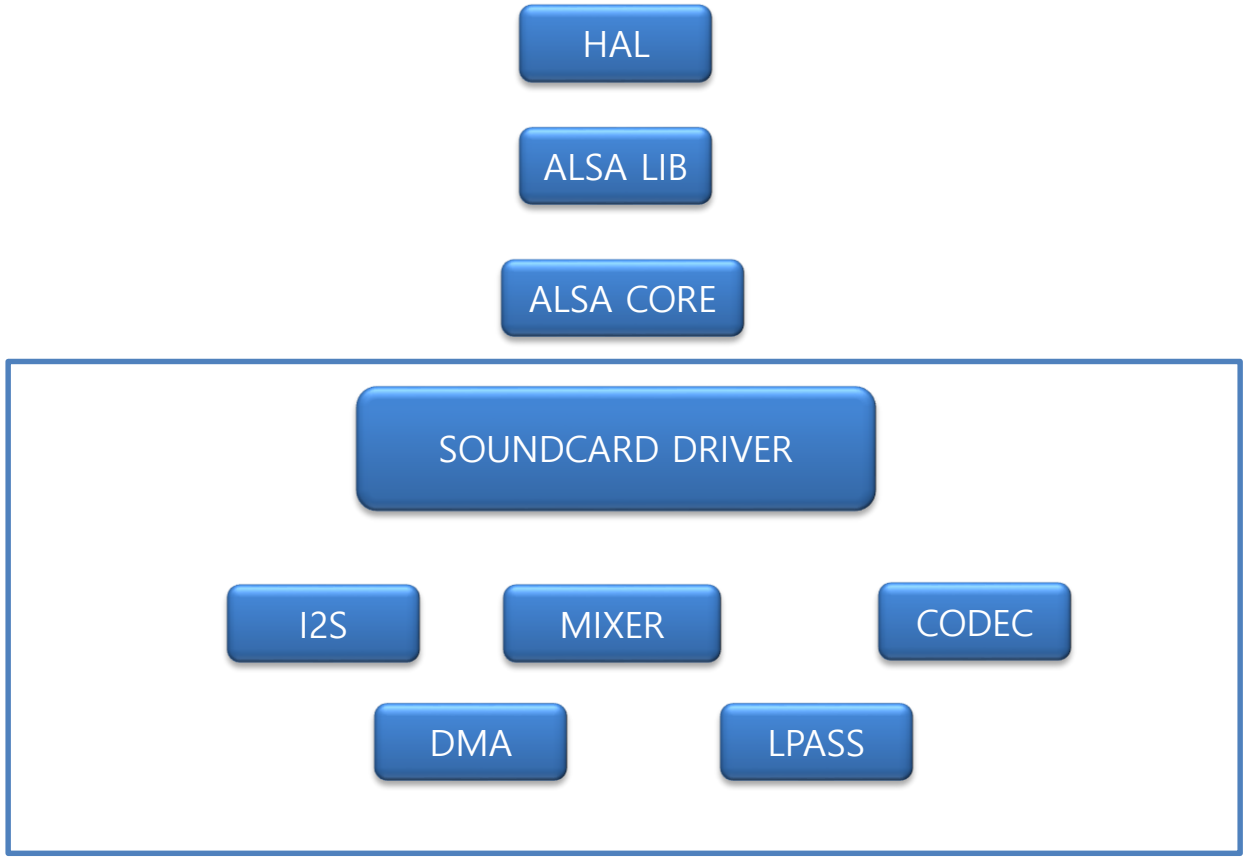
I2C Interface for codec

- Audio codec chip is controlled through I2C interface
- Audio codec driver registers itself as a client device to the I2C
- Codec driver used regmap to access the code registers through I2C

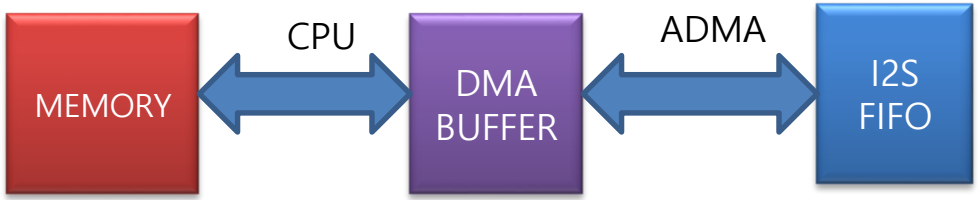
I2C Layers


Program
User-space
Driver
Client
I2c-dev
I2c-core
Algorithm
Adapter
Adapter specific code
Kernel
Hardware
Adapter hardware
I2C-device
I2C-device

S/W architecture

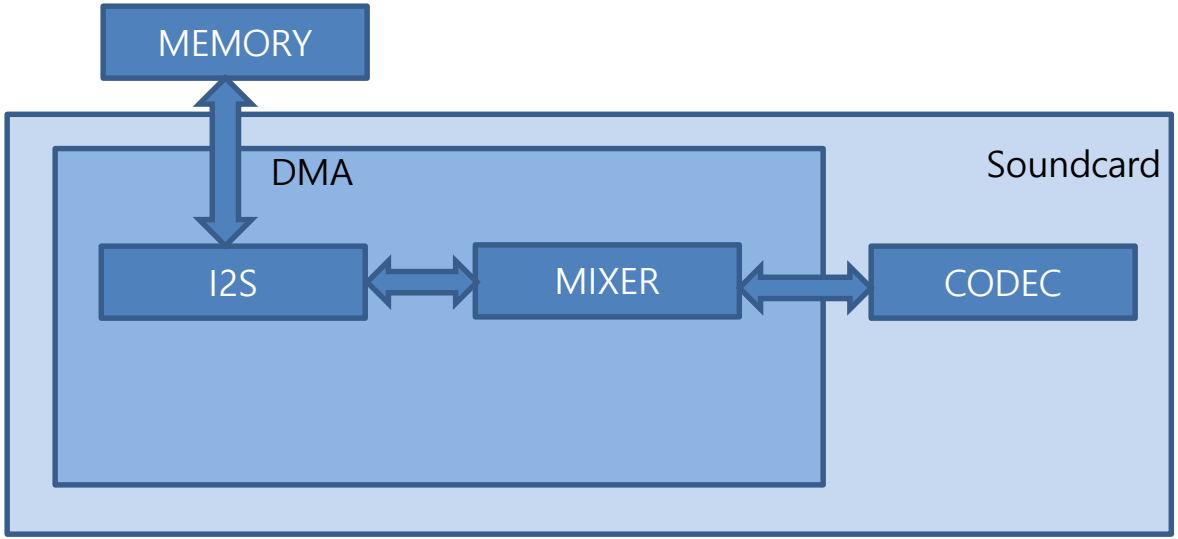


Data Flow in Audio Sub-System



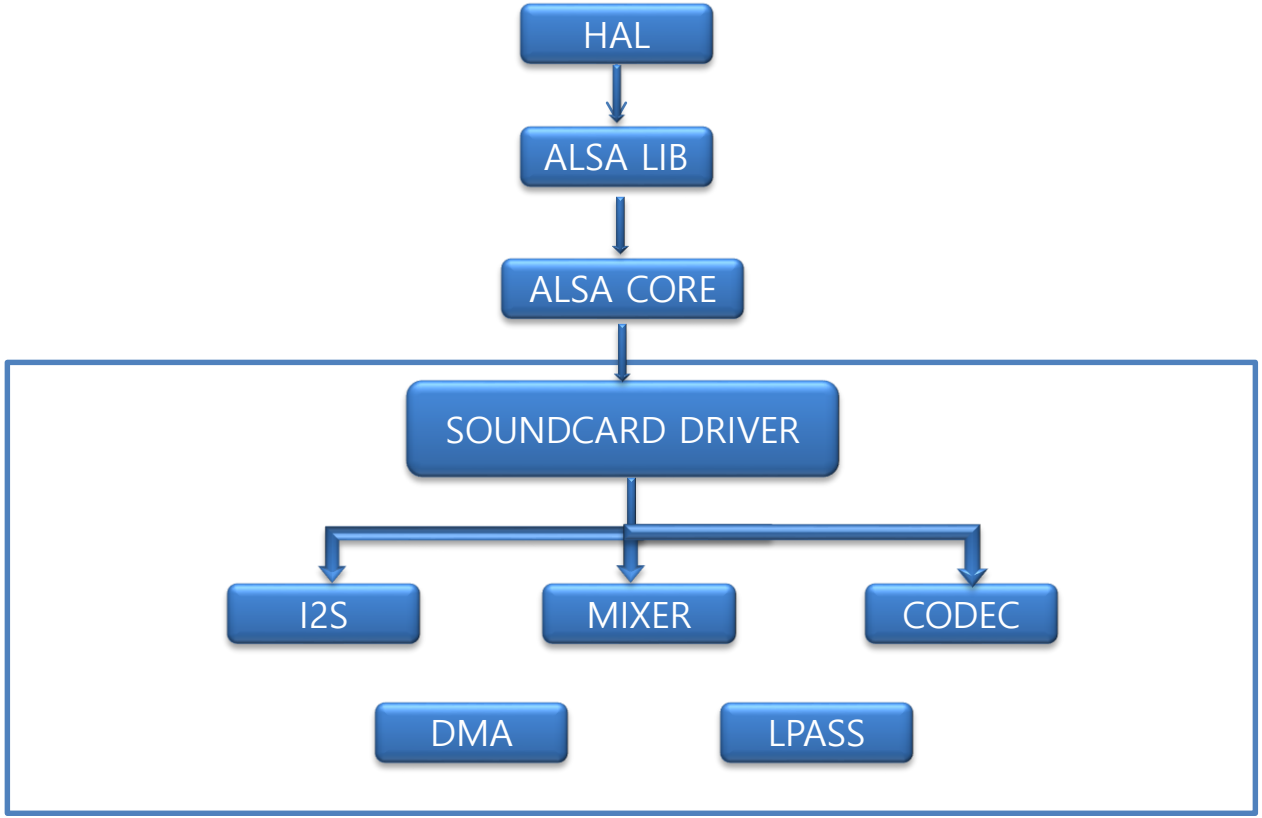
- CPU copies PCM data from memory in user space to DMA buffers
- ADMA channels copy from DMA buffer to I2S FIFO
- From I2S FIFO data is on I2S BUS

Data Flow in Audio Sub-System



Data flow from memory to CODEC

Control Flow in Audio Driver



S/W Implementation view of Audio Driver

- Each Interface functionality uses H/W as separate entity
- A separate device for each functionality is created

For Example:

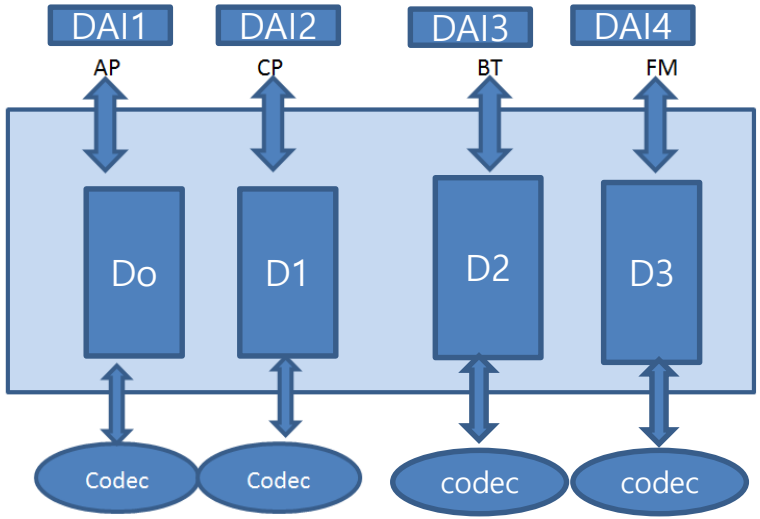
Like pcmC0D0c and pcmc0d0p –

c0 –card0

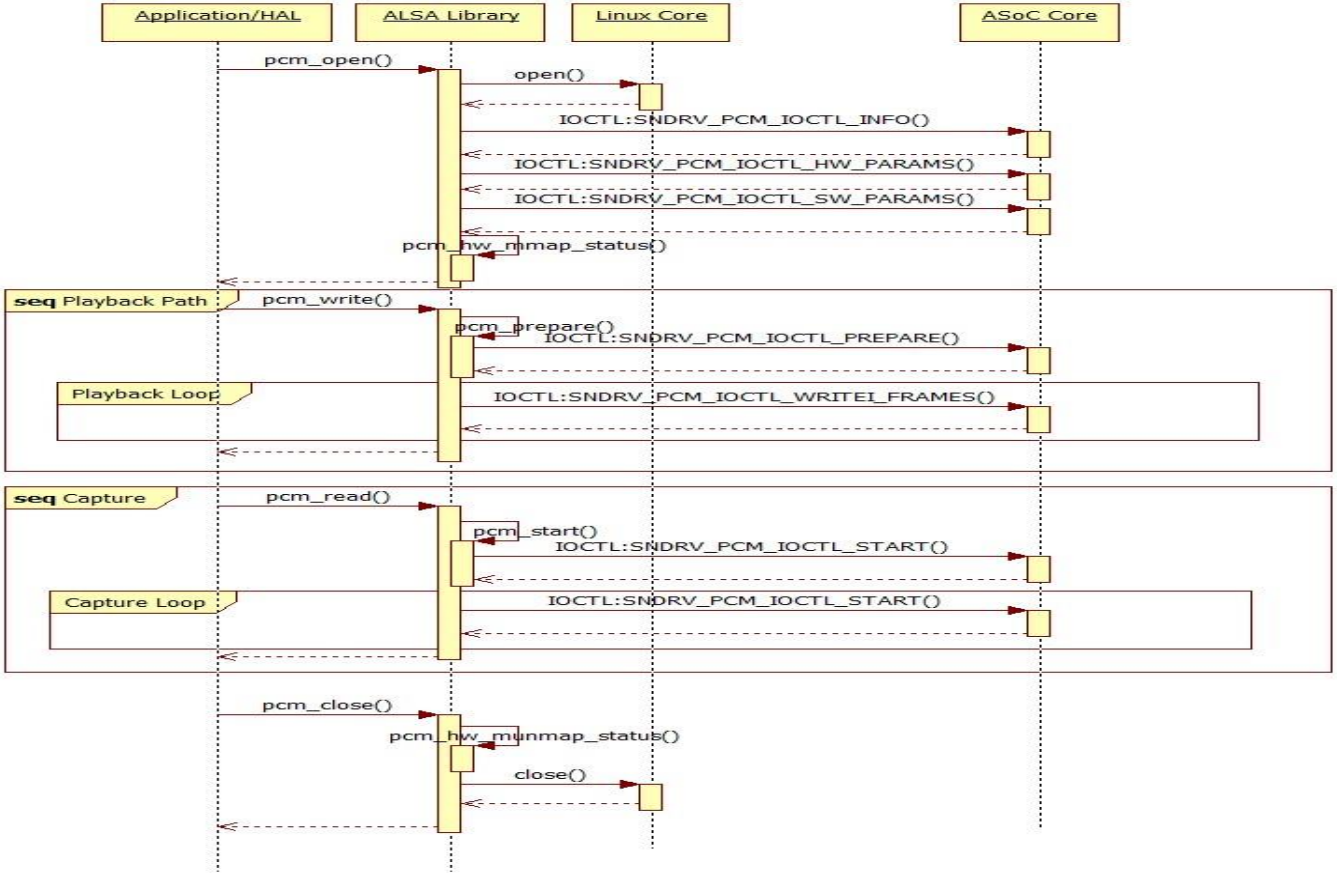
D0- device 0

P for playback and c for capture

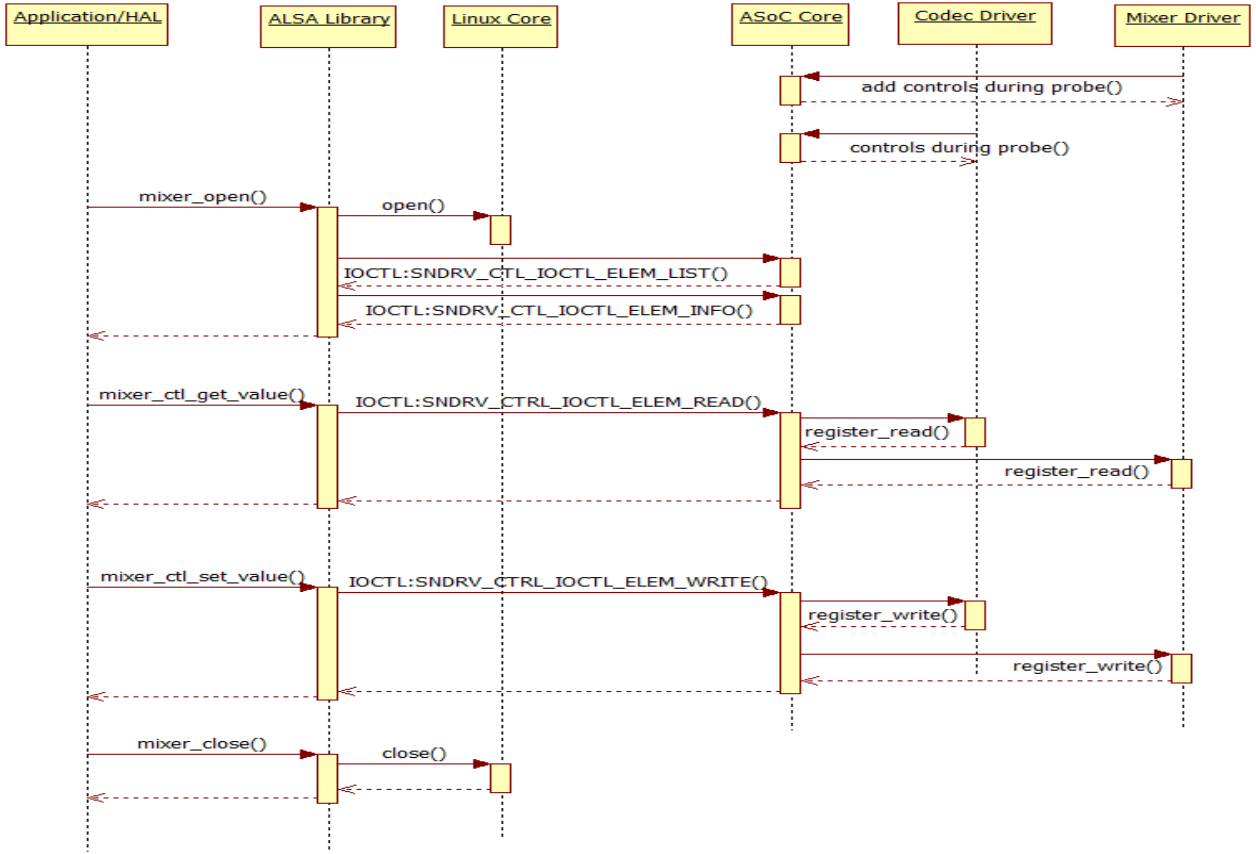
- After probe separate PCM DEVICES registered for each DAI-LINK



Sequence Diagram – Playback/Capture

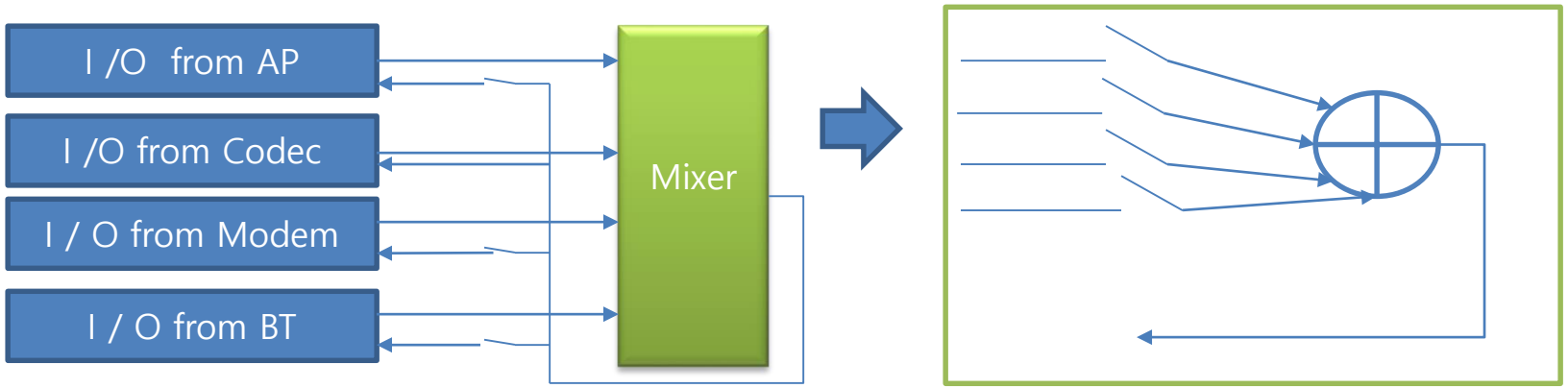


Sequence Diagrams – Mixer OPs



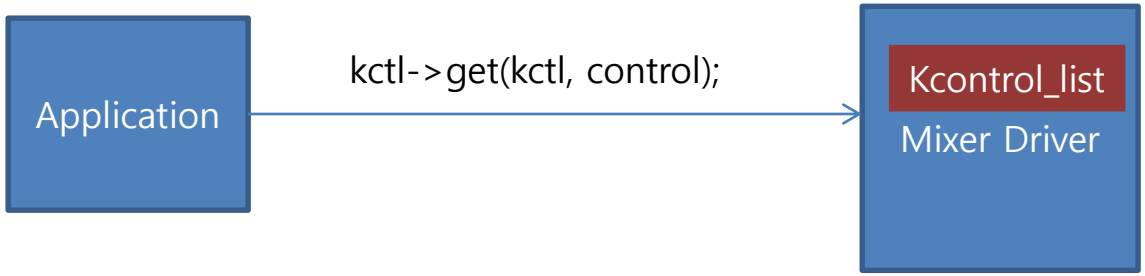
Block Diagram of Mixer

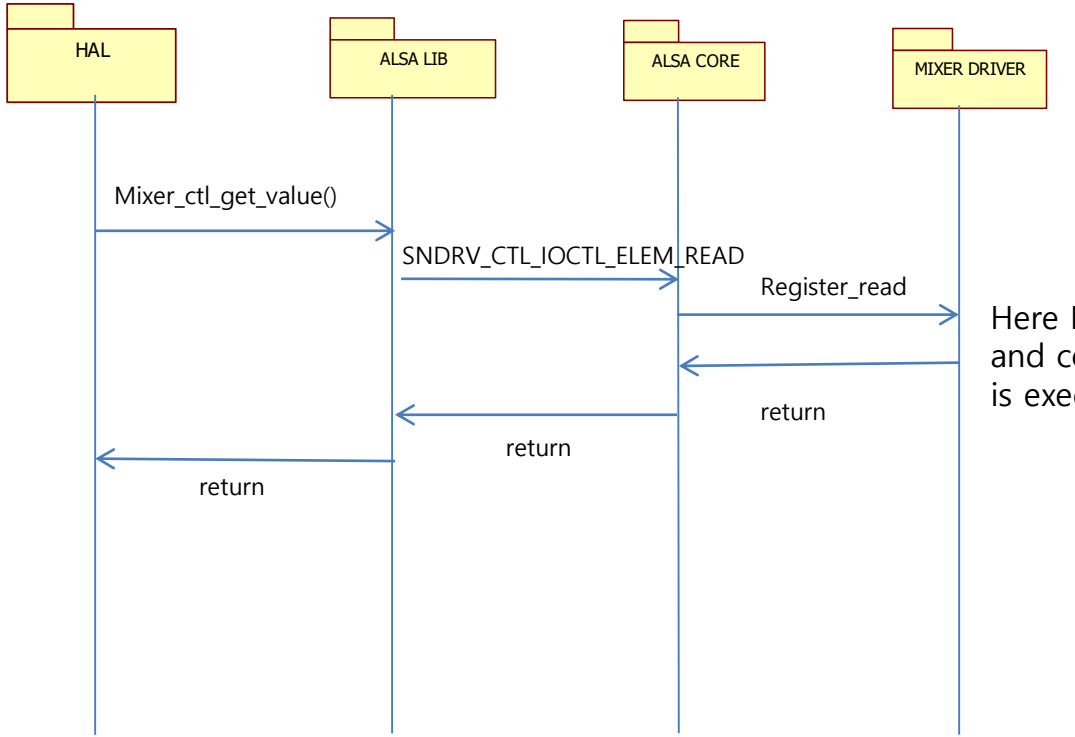
- Mixer is a hardware device mixes the digital audio data from different sources and send backs to them based on the selection



Kcontrols in Mixer

- Mixer driver exposes some controls for upper application layer though Kcontrols
- These controls are used to change SFRs of mixer which is done through regmap





Here Kcontrol list is checked and corresponding function is executed (get/put) .

Kcontrol Flow

DAPM controls

Power ON/ OFF sequence of respective paths gets when playback or capture stream opened

- Playback Paths

  Speaker On /Off

  Headphone On /Off

  Earpiece(receiver) On /Off

- Capture paths

  MIC1 On /Off

  MIC2 On /Off

- Gain controls

  DAC, ADC Digital gain control

  MIC1, MIC2, analog gain control

  SPK,EP, HP analog gain controls

- Mixer path selection

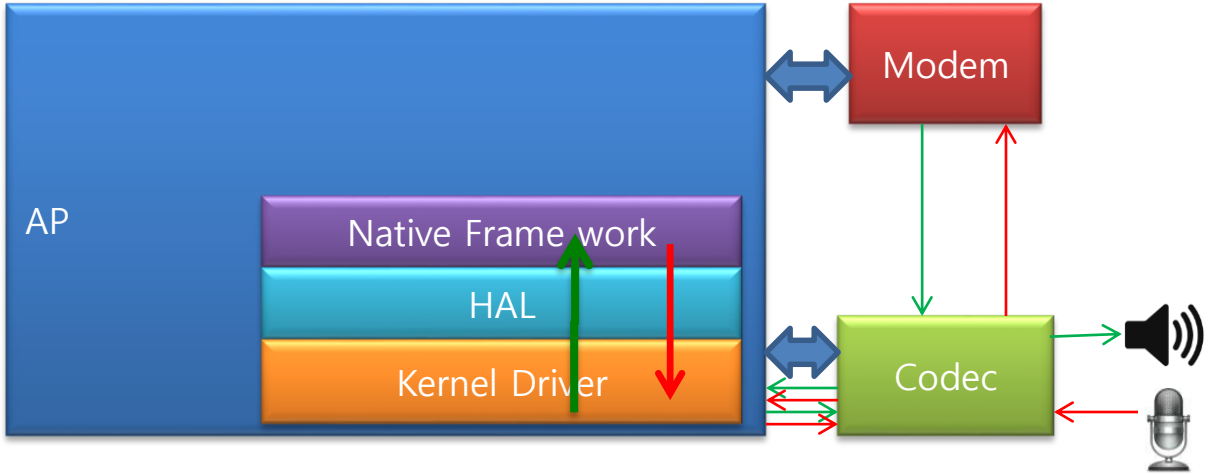
  MIC input data mixing can be selected through ADC mixer Controls

Use case Example

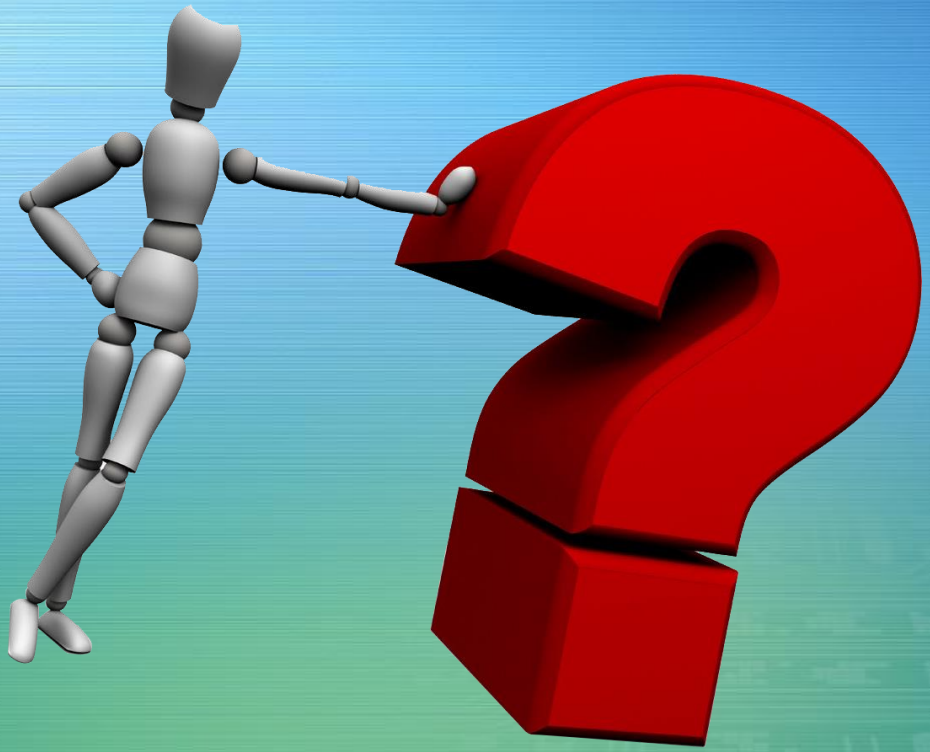
MOBILE USECASE of AUDIO DRIVER

Android Audio System

Voice Call Path



Any Questions ?



THANK YOU