

AGL Reference Hardware Specification Document

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Change History

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1. AGL Reference Hardware overview

1.1. Goals of AGL Reference Hardware

This document defines the specification of the Automotive Grade Linux (AGL) Reference Hardware.

The goals of the AGL Reference Hardware are :

- Defining the scope of peripherals which should be supported by AGL.
- Building Reference Hardware, System Architecture to deal with various requirements from OEMs.
- Reducing the gap of AGL community hardware and product hardware.

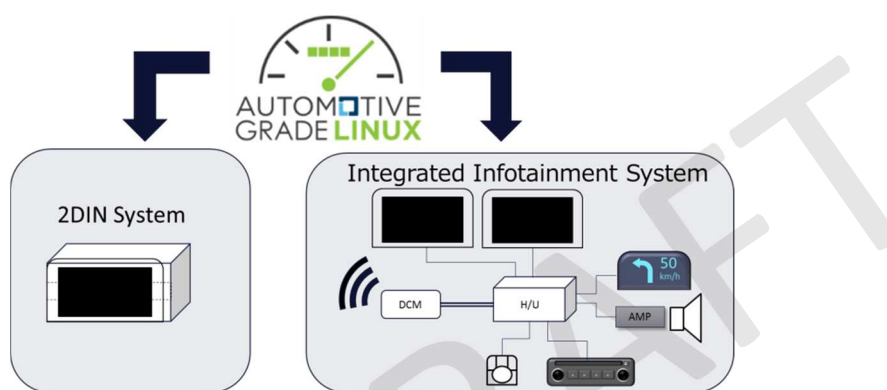
1.2. Glossary of Terms

Term	Definition
AGL	Automotive Grade Linux
BD	Blu-ray Disc
DCM	Data Communication Module
HAL	Hardware Abstraction Layer
HMI	Human Machine Interface
HU	Head Unit
HUD	Head-Up Display
IVI	In-Vehicle Infotainment
NFC	Near Field Communication
RSE	Rear Seat Entertainment
SoC	System on a Chip
TCU	Telematics Communication Unit

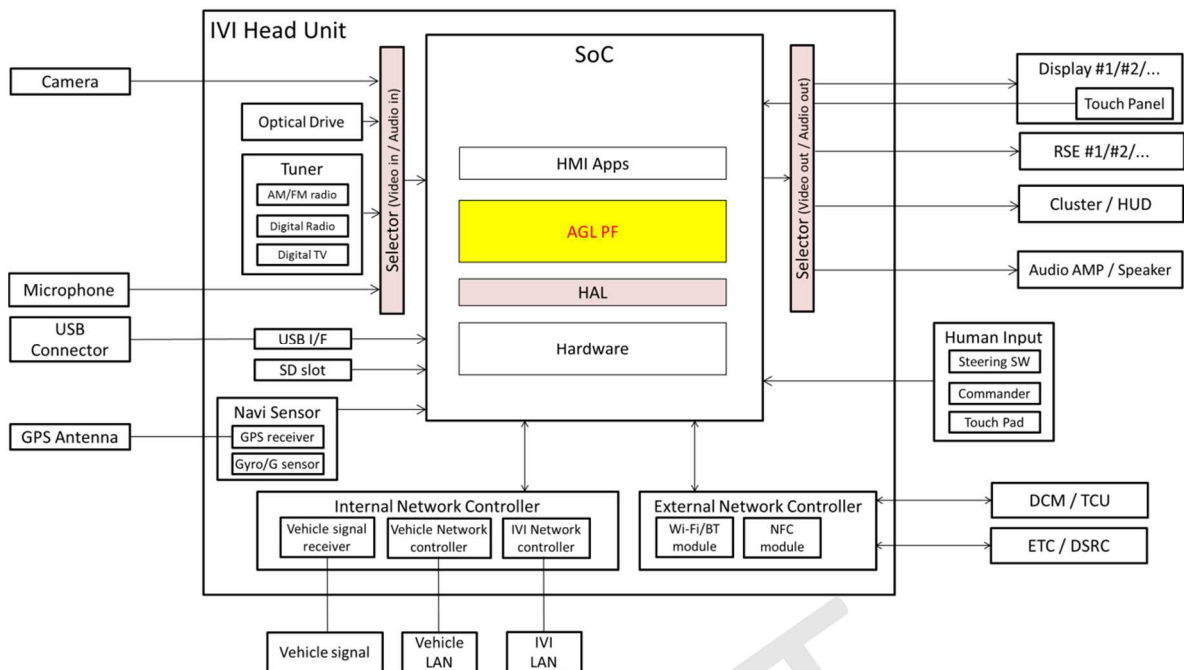
2. System Architecture

2.1. Overview

There are multiple OEMs with each having a variety of cars. This creates a wide variety of types and combinations of peripheral devices connecting to the head unit. AGL UCB needs to be able to operate on multiple IVI system configurations. For example, AGL should support the various In-Vehicle Infotainment (IVI) systems, such as two different systems are shown in the figure below.



The figure below shows an overview of AGL System Architecture from the perspective of the Reference Hardware. This System Architecture is designed to deal with various requirements from multiple OEMs and types of cars.



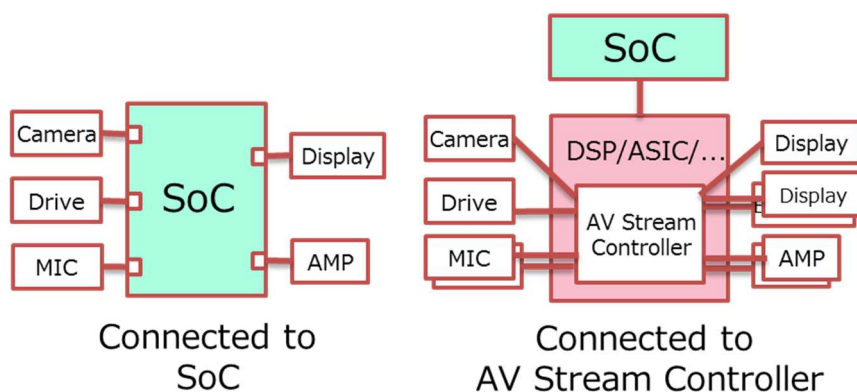
In order to realize it, AGL System Architecture should have a number of mechanisms to absorb the difference of the system configurations. The later sections describe them.

2.2. Selector

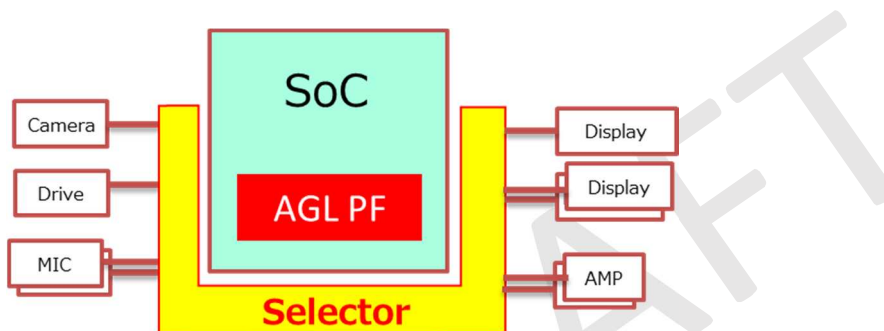
2.2.1. AV control device

An IVI Head Unit (HU) is connected with many peripheral devices which send or receive Audio / Video signals. However the number of Audio / Video signals is limited by the capability of System on a Chip (SoC). Therefore some IVI-HUs have a specific module which controls Audio / Video signals in order to mediate the signals and SoC capability. The specific module is called AV Stream Controller whose entity may be Audio DSP, Video ASIC or any other device.

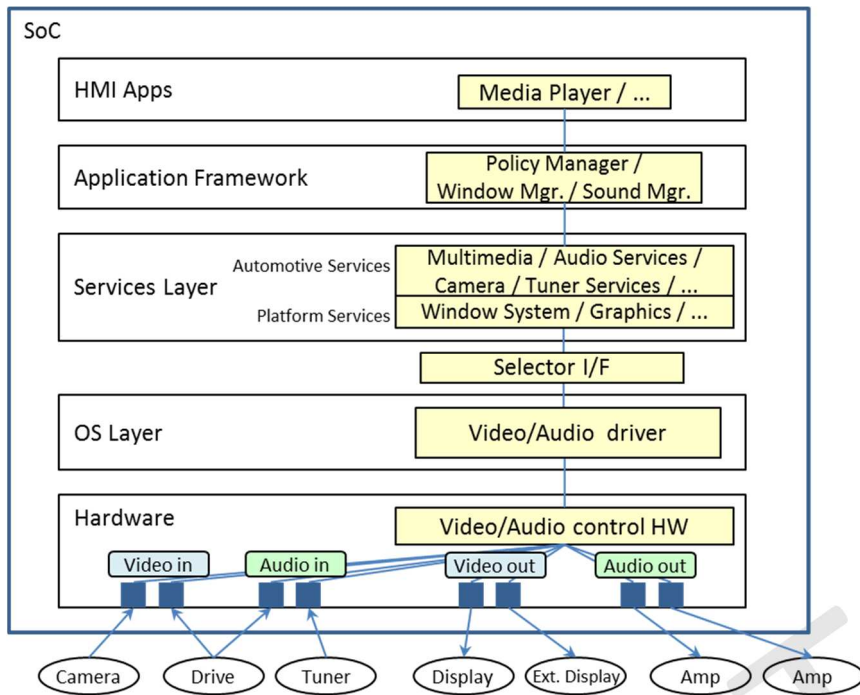
On the other hand, there are IVI-HUs that these peripheral devices are connected to SoC directly.



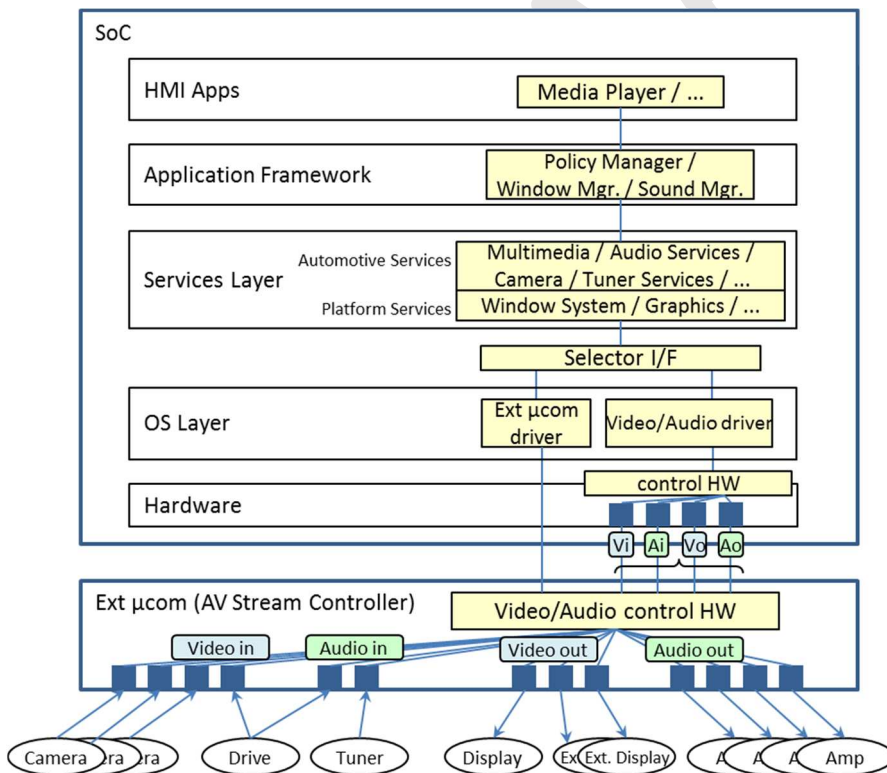
In order to realize this, some kind of abstraction mechanism is required. Hereafter we call the mechanism "Selector".



The block diagrams below describe images of Selector implementation as reference. This topic is still under discussion, but Selector might be realized by the combination of Application Framework, Service Layer, and Hardware Abstraction Layer.



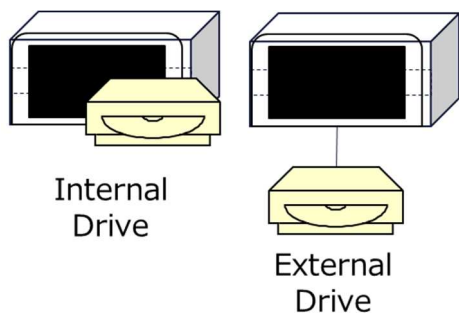
<T.B.D> An image of Selector implementation (Connected to SoC)



<T.B.D> An image of Selector implementation (Connected to AV Stream Controller)

2.2.2. Location of peripheral devices

Generally several peripheral devices are included in IVI system. And some of them (e.g. optical drive, tuner, display, etc.) may be integrated into IVI-HU or separated from IVI-HU. Thus AGL must support both compositions equivalently.



In order to realize it, Selector must have hardware abstraction mechanism. The mechanism may be realized in device drivers (Linux kernel layer) or Hardware Abstraction Layer (HAL).

3. Peripheral devices and functional requirements

3.1. Video / Audio input peripherals

IVI-HU receives video streams and/or audio streams from the peripherals. For the peripherals, the concept of Selector is required.

3.1.1. Camera

Use Case :

Surround view camera, rear view camera, surround view image recognition, etc.

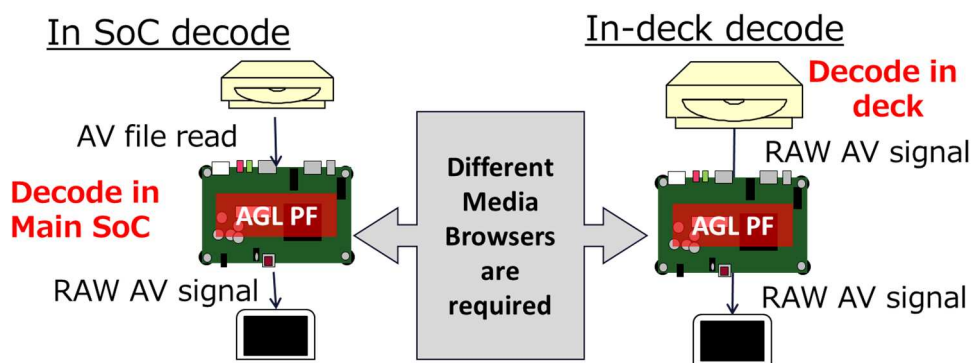
- The function of image processing (distortion correction, multi-viewpoint image composition, etc.) is out of scope in this EG. Other ECUs exterior to IVI-HU will take responsibility for such processes.

3.1.2. Optical drive

Use Case :

Media Player (CD / DVD / BD)

- The difference of internal HU and external ECU should be absorbed by device driver layer / HAL.
- It is possible to have two types of allocations of decoding function. So AGL PF should consider both of them as follows.



3.1.3. Tuner

Use Case :

AM / FM radio, digital radio, digital TV, etc.

- The difference of internal HU and external ECU should be absorbed by device driver layer / HAL.
- In the case of supporting digital TV, not only audio stream but also video stream needs to be processed.

3.1.4. Microphone

Use Case :

Voice recognition, hands-free communication

- The difference of internal HU and external ECU should be absorbed by device driver layer / HAL.

3.2. Video / Audio output peripherals

IVI-HU sends video streams and/or audio streams to the peripherals. For the peripherals, the concept of Selector is required.

3.2.1. Display

Use Case :

Center information display (main / sub)

- Multiple display support is required.
- In the case of the touch panel displays, IVI-HU needs to receive the touch input signals from them.
- The difference of internal HU and external ECU should be absorbed by device driver layer / HAL.

3.2.2. RSE

Use Case :

Rear Seat Entertainment (RSE) System

- In regard to function allocation, two patterns of RSE should be considered.
 - (a) Accepts simple commands such as volume change. Fully controlled from IVI-HU at front seat. Similar to multiple displays from the IVI-HU's point of view.
 - (b) Has individual GUI and provides all the functions but Video / Audio source. Equivalent to tablet devices.
- Unlike display / cluster / Head-Up Display (HUD), IVI-HU must provide not only Video output but also Audio output.
- Multiple RSE support is required.
So multiple Video / Audio output streams support is required.

3.2.3. Cluster / HUD

Use Case :

Instrumental cluster, HUD, AR HUD

- In the current scope of Reference Hardware System Architecture Expert Group, Linux is not assumed as OS for cluster or HUD. So Virtualization (Hypervisor) is out of scope in this version of specification while more discussion about the topic is needed.
- The function to send images and contents from IVI-HU to cluster / HUD is needed. As an example, surface sharing of window system inter ECUs may be included into the scope.

3.2.4. AMP / Speaker

Use Case :

Audio amplifier, speaker

- The support for multiple channels or multiple audio sink is required.

- The difference of internal HU and external ECU should be absorbed by device driver layer / HAL.

3.3. Data communication peripherals

3.3.1. Vehicle External Network devices

The devices mentioned in this section treat the data communication with the outside vehicle such as mobile communication network, smartphone connection.

3.3.1.1. DCM / TCU

Use Case :

Communication with a network outside the car (e.g. mobile communication network)

- In regard to emergency call, both compositions below are assumed.
 - (a) IVI-HU takes responsibility for calling (audio input / output).
 - (b) It works in DCM (Data Communication Module) / TCU (Telematics Communication Unit).

3.3.1.2. Wi-Fi / Bluetooth®

Use Case :

Communication with the smartphone via wireless connection or communication with a network outside the car (Wi-Fi spot, etc.)

3.3.1.3. USB

Use Case :

Communication with the smartphone via USB

- In this connection, Video / Audio streams are also processed as the data communication.

3.3.1.4. ETC / DSRC

Use Case :

V2X Communication

3.3.1.5. NFC

Use Case :

Driver identification with a smartphone, etc.

3.3.2. Vehicle Internal Network devices

The devices mentioned in this section treat the information inside the vehicle except for the IVI-HU. There are various function allocations and various types of networks. For example, vehicle velocity signal may be analog signal of speed pulse or may be CAN signal through vehicle network. So vehicle data abstraction is required.

3.3.2.1. Vehicle Network

Use Case :

Getting vehicle data from the vehicle networks

- CAN is a major vehicle bus and other networks have been used. (CAN, CAN FD, LIN, etc.)

3.3.2.2. IVI Network

Use Case :

Getting vehicle data from the vehicle networks

- In some vehicles, vehicle network and IVI network are separated because of security, workload, and so on.
- Various networks have been used. (CAN, Ethernet, etc.)

3.3.2.3. Vehicle signal

Use Case :

Getting vehicle data from the vehicle networks

- Directly connected lines such as analog signal, serial connection, and so on.

3.4. Other peripherals

3.4.1. Human Input devices

Use Case :

User input of HMI (touch panel, touch pad, commander, steering switch, etc.)

- Some signals from these devices may be transmitted through vehicle internal network. (CAN, etc.)

3.4.2. Navigation sensor

Use Case :

Vehicle positioning

- GPS / G / Gyro sensors

3.4.3. USB / SD (Media Storage)

Use Case :

Media Player (USB memory, SD card)

- In these cases, Video / Audio streams are always decoded in SoC.

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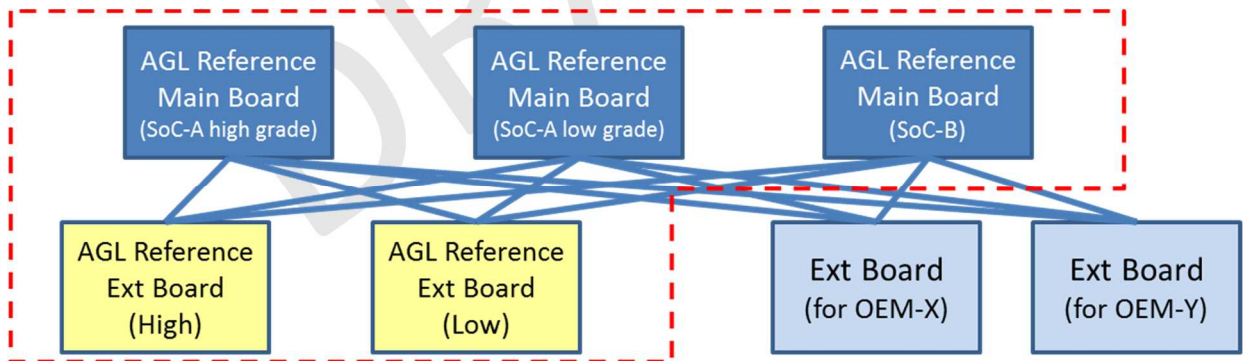
4. AGL Reference Hardware requirements

4.1. Major policy

As was mentioned before, the diversification of IVI system configuration is inevitable. So there are many variations on the requirements to main SoC, specifically various kind of SoC and various range of CPU performance. On the other hand, there are many variations on the peripherals of IVI-HU, too.

With this in mind, AGL Reference Hardware should meet the following three major policies.

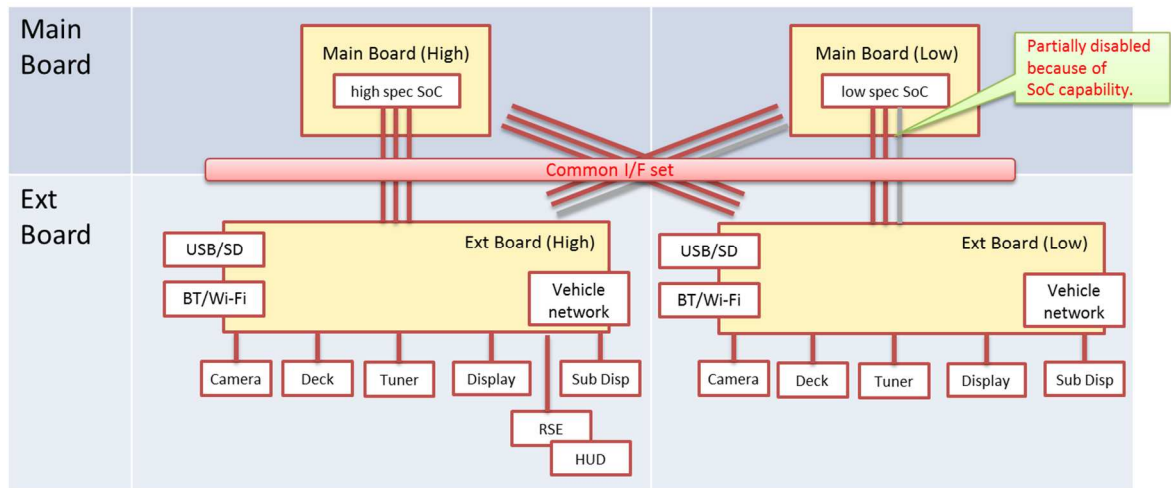
- (1) Two boards constitution
Composed of main board and extension board
- (2) Interchangeable main boards
Covering various SoC grades and various SoC vendors
- (3) Interchangeable extension boards
Covering various types of cars and various OEMs and replaceable with OEM original boards



4.2. Hardware Specification

4.2.1. Common I/F Set

In order to realize all the major policies, “Common I/F Set” between AGL Reference Main Boards and AGL Reference Extension Boards must be defined. By using Common I/F Set, one main board can be connected with different type of extension boards. In the same way, one extension board can be connected with different type of main boards.



Major I/F such as HDMI, I²S will be chosen as the Common I/F Set.

The table below is just tentative.

<T.B.D>

Type of signal	I/F candidate	Max. # of connections
Audio input	I ² S	3
Audio output	I ² S	3
Video input	CSI	3
Video output	HDMI	2
Data communication	USB	
Device control		
Power management		

4.2.2. Main Board

AGL Reference Main Boards are main SoC boards mounting Common I/F set. AGL Main Reference Boards should be supported by at least two SoC vendors.

4.2.2.1. Hardware Block Diagram

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4.2.2.2. Specification of External Interface

<T.B.D>

4.2.2.3. Specification of Internal Interface

<T.B.D>

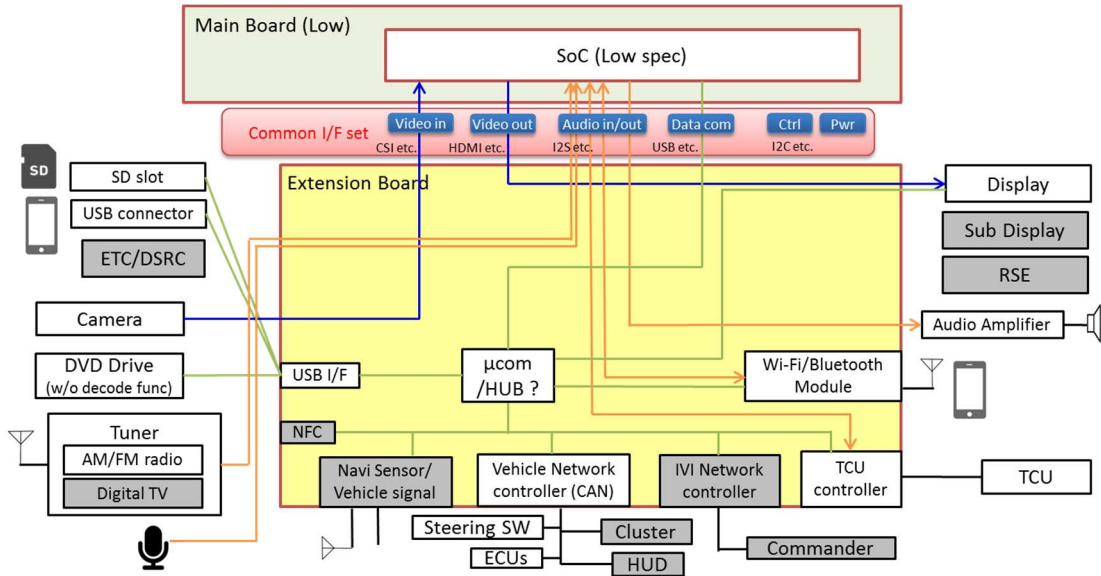
4.2.3. Extension Board

As the first step of development for AGL Reference Extension Board, one extension board should be built, which can be connected with at least two different main boards. And if required, one more extension board may need to be developed to support luxury system.

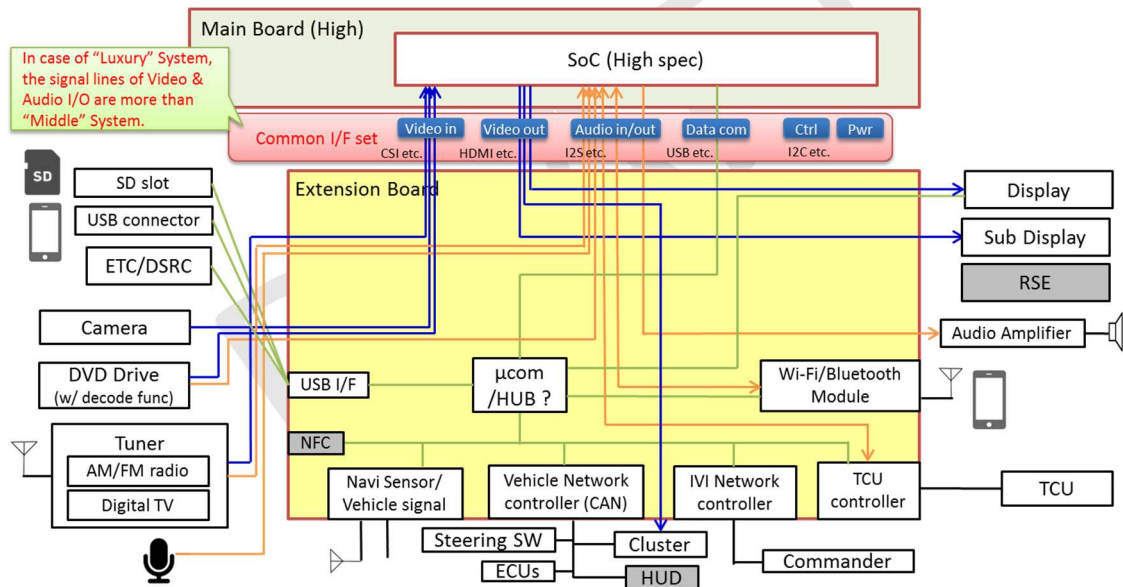
4.2.3.1. Hardware Block Diagram

Show the candidates of extension board configurations below.

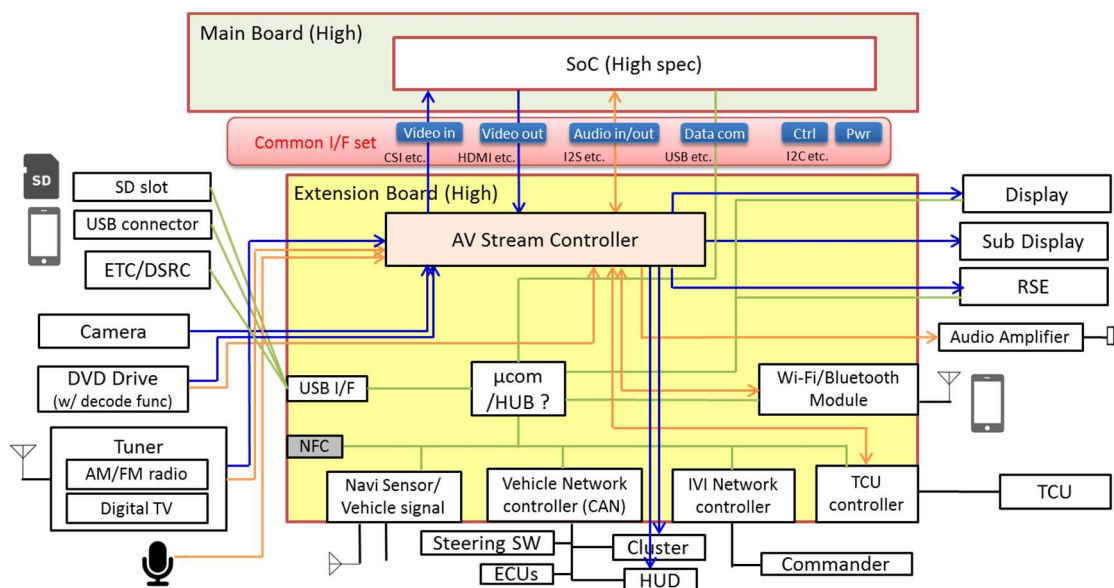
<T.B.D>



Configuration of extension board (Low) connected with main board (Low)



Configuration of extension board (Low) connected with main board (High)



Configuration of extension board (High) connected with main board (High)

4.2.3.2. Specification of External Interface

<T.B.D>

4.2.3.3. Specification of Internal Interface

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5. AGL software requirements

<T.B.D>

5.1. Selector Support

- Selector mentioned in the section 2.2 should be supported.
- Collaborate with the User Interface and Graphics Expert Group. (Related to Audio routing, etc.)

5.2. Vehicle Data Abstraction

- As mentioned in the section 3.3.2, the mechanism of vehicle data abstraction is required to absorb the variation of OEMs.
- Collaborate with the Connectivity Expert Group. (Related to vehicle data)

5.3. Cluster / HUD Support

- To support cluster / HUD, the function of sending images and contents from IVI-HU to them is required.
- Collaborate with the User Interface and Graphics Expert Group. (Related to multiple ECUs)

6. Notices

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