WHITEPAPER

AUTOMOTIVE PIXEL BASED COMMUNICATION IN INSTRUMENT CLUSTER

Varun S

September 2015

L&T Technology Services

Table of Contents

Abstract

The need to transport real-time, high resolution digital video from various media or camera sources to Instrument-cluster-displays throughout the vehicle is a growing demand for automotive developers. This white paper proposes the benefits of Automotive Pixel Link (APIX) based communication protocol in automobiles defined by Inova Semiconductors which will open up new avenues for designers to create new concepts with graphics systems.

Keywords: Automotive, APIX, HeadUpDisplay, Head Unit, Graphic processors

1. Introduction

APIX is a high speed serial link for transferring audio or video data in Gigabit/s, providing point-to-point connectivity designed for minimal electro-magnetic interference (EMI) and maximum transmission distances. Many next-generation driver assistance and infotainment systems have multiple video sources (CAM) and are displayed as shown in Figure 1. With the APIX technology, automotive developers can integrate, transmit and receive multiple APIX links with minimal engineering overhead.

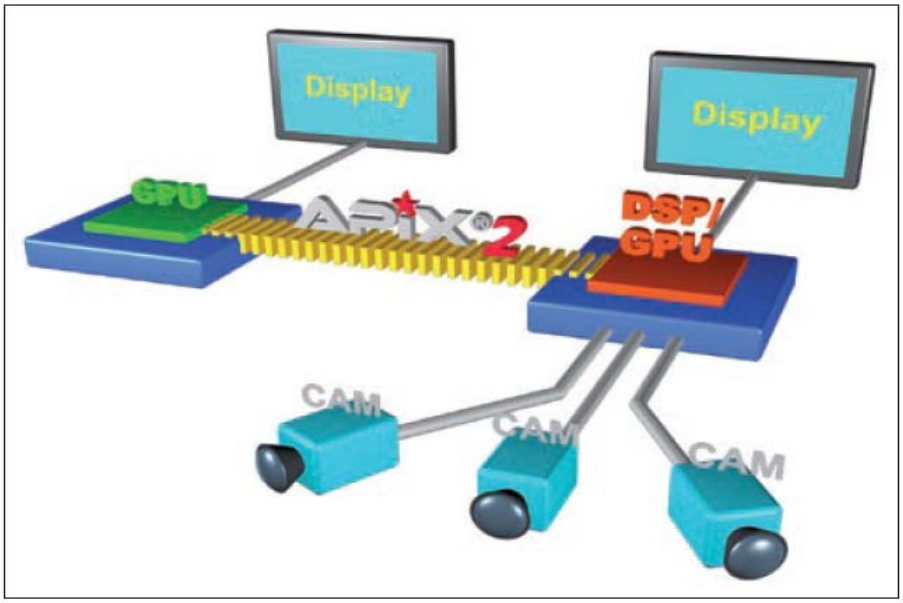

Figure 1: Concept of connecting multiple video source to display
(Source: BMW group)

2. How Automotive Pixel Link Communication works?

The APIX link transmits uncompressed pixel data at a data rate of 1Gbit/s and sideband control data at a data rate of 62.5Mbit/s over a single pair of copper wire as shown in Figure 1. The high speed downstream channel acts as a transparent gateway for the parallel video interface, providing the data sampled at the interface of the graphics processor on the same clock of the display. As an option, the APIX devices can be configured to carry the sideband control data over a separate pair of copper wire called upstream channel. The power supply is realized by using either one or both existing wire pairs.

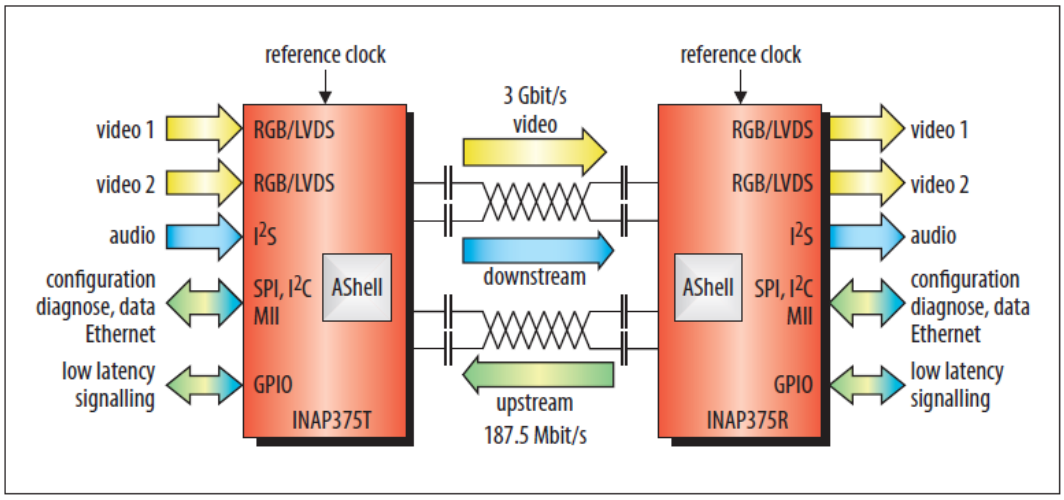

Figure 2: Block circuit diagram of the transmitter and receiver modules in APIX

The first microcontroller with embedded APIX transmitter is Fujitsu's MB91F467S- it is the first MCU with embedded APIX. This MCU along with Fujitsu's Indigo graphics controller MB88F332 can be used to build a modular hybrid instrument cluster as shown in Figure 3, with separated control (control subsystem) and display units (Graphics Subsystem).

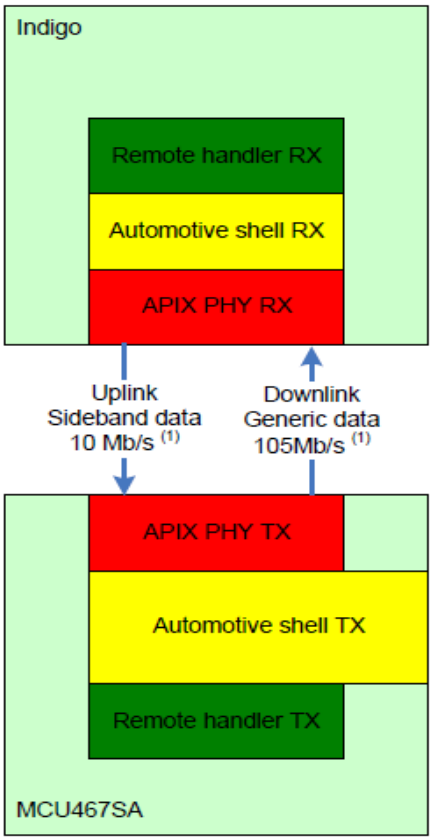

Figure 3: Modular concept of Instrument cluster

3. Challenges in the Market

i. Instrument cluster in future will not feature mechanical pointers inside and instead the entire display will be changed to graphics displaying in a high resolution display. Alongside the car instrument cluster displays used today are 10.25 inch, with 1,280x480 pixel resolution and of 18 bit color. To carry this huge volume of data ensuring high quality and less cost, Instrument cluster developers are intensely working to develop a Giga bit network with low cost and high quality.

ii. Increasing trend among buyers to connect smart phones and other High definition electronic devices to the car display system. About 1 billion smart phones have already been sold worldwide. The demand for in-vehicle display system which can interface the smart phones and iPad with high quality performance is currently increasing.

iii. For new vehicles, features like 'Video telephony' or 'baby watch'- image data needs to be transmitted from the head Unit to Display and

at the same time images needs to be transferred back to the head unit from cameras. This demands high volume of data transfer between devices inside car.

iv. The need for rear cameras and sensors to provide visual aid to the driver is increasing in automobile say Night Vision System, Navigation Graphics with 3D effect, High quality rain sensors etc. These sensors in vehicles are not very close to the vehicle display system as these are intended to work remotely. This needs expensive special cabling with less Electro Magnetic Interference.

4. L&T Technology Services' Approach to the Concept

At L&T Technology Services, we have Instrument cluster experts working on following projects:

i. Instrument Cluster and Head-Up-Display
ii. HMI and Display priorities
iii. Functional safety verification and validation activities
iv. ASIL Related Software Services

We have come up with an approach to realize the APIX based communication between Instrument cluster and Head-up-Display instead of Low Voltage Differential Signaling (LVDS) based communication in the existing software development life cycle process. The LVDS cannot run at very high speed as the effect of capacitance and inductance filter out the high frequency signals which can reduce only by reducing the operating voltage. This in turn makes it difficult to separate environmental noise with actual data signal.

The Head-up-Display (HUD) is a display that projects a picture in the windshield in front of the driver as shown in Figure 3. This allows the driver to have some important information in focus without leaving the attention to the street. All information to be displayed on HUD display is generated in Instrument Cluster. The interface between Instrument cluster and Head-up-Display (HUD) can be realized using APIX link which reliably transmits images and controls data over a distance of 20m. Before the introduction of APIX technology the communication between Instrument Cluster and HUD was via LVDS (Low voltage Differential Signaling) technology. But the main disadvantage of LVDS is the requirement of

high power to keep the devices at their saturation. Also the need for separate MCU inside HUD is no longer required with APIX based communication as display can be controlled remotely from Instrument cluster which reduces the cost considerably.

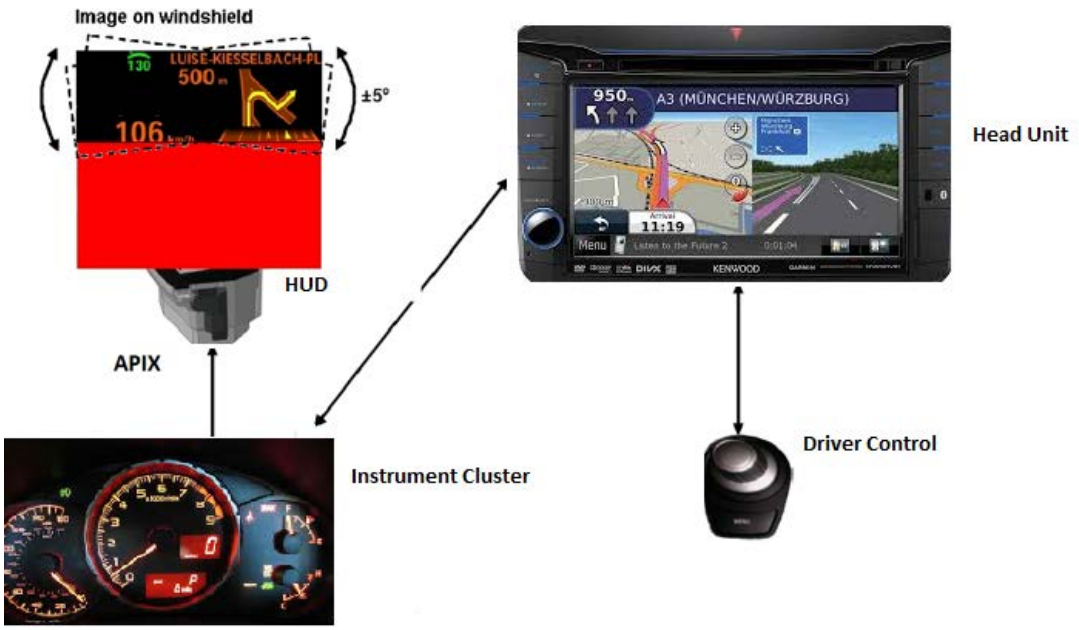

Figure 4: APIX communication between Instrument cluster and HUD

4.1. Challenges on Migrating from LVDS to APIX HUD

The LVDS HUD means there was a separate HUD IC to process and generate the Graphical data being sent from the Vehicle controller (Example MB91F467S) before being sent to HUD ECU for display. The design of APIX HUD is made to omit the need of separate HUD IC as APIX link is capable of sending Pixel data along with control data from Instrument cluster. Below are the critical design points considered to replace LVDS with APIX HUD.

i. The Instrument cluster MCU should support APIX feature. We have used the Fujitsu MB91F467S MCU which supports the APIX.

ii. The HUD driver code modification was required to send non-volatile profiling data like temperature and brightness profile of the HUD, stepper motor flags and serial number of HUD generated by the HUD driver software and is to be stored in the NVM when IC goes into sleep mode.

iii. With the introduction of the APIX sideband architecture HUD, many control algorithms have been shifted from the HUD into the IC.

iv. Since HUD is not a separate IC in APIX HUD architecture, the trouble shooting via vehicle diagnostics is no longer supported in HUD and instead it will be handled by Instrument cluster Diagnostics.

Other applications of APIX inside vehicle are as below:

- Central Infotainment Displays (CID)
- Automotive Dashboards
- Rear-Seat Entertainment Systems
- Automotive Driver Assistance
- Diagnostic Systems
- Camera Systems
- Medical Equipment

5. Benefits of L&T Technology Services' Proposed Solution

i. **Cost Effective**: The APIX link communication can replace the use of Optical fibre cable (MOST, IDB-1394) with pair of twisted copper wires. This reduces the cost considerably. Devices such as cameras can be provided with power supply via the same STP data cable. This reduces the cost, as well as its complexity in wiring.

ii. **Flexibility**: The APIX downstream link can be used to send uncompressed high quality video and audio data, but the sideband channel makes APIX very flexible and variety of buses and protocols can be sent over those channels. The sideband channels can be used to send I2C bus bi-directionally to control camera functions.

iii. **Scalability:** This is a point-to-point communication and hence any number of cameras or image sensors can be used to connect to Head Unit or a control Unit. But the CPU or Graphic processor should be capable of processing or accommodating these high speed information at a faster rate. In short the scalability of APIX communication is high.

iv. **Bandwidth:** Besides IDB-1394 (under certain conditions) this link is the only possibility in the automotive area to transmit uncompressed, low-delay video signals. Furthermore it is the only solution presented in this report which provides enough bandwidth for future high-resolution 1280x480 pixel TFTs which will probably replace the traditional analogue gauges.

6. Conclusion

Multimedia networks for automobile application are a promising and evolving domain. Researchers from various industries are keenly monitoring the developments in automotive industry to introduce their electronic devices and applications to automotive industry. The introduction of high speed in-vehicle network demands the production of efficient and high speed graphic processors and sensors which in turn demand the need for a high definition display in vehicle.

MOST and CAN protocols were considered standard technologies by automobile manufacturers till now. But the demand for higher bandwidth (cameras and entertainment resources consume more bandwidth) is a big challenge to the devices using MOST topology and CAN protocol as they are not compatible to support the devices in future (scalability and feature expansion is lesser). This is the reason APIX link is considered to be the future network topology among vehicle manufactures.

Currently Inova and other semiconductor companies offer a wide range of products based on the APIX and APIX2 technology. With APIX2, it is possible to introduce HD (High Definition) display resolutions into the car. The next step – the introduction of APIX NEXT technology - to support even UHD (Ultra High Definition) type of displays and other cable media is in development. Products will be introduced soon into the market, featuring advanced video, audio and data communication interfaces in line with advancements in imager, display and SoC technologies of Inova Semiconductor partners.

7. References

[i]. http://files.vogel.de/vogelonline/vogelonline/files/2572.pdf

[ii]. http://www.fujitsu.com

[iii]. http://link.springer.com/article/10.1365/s40111-008-0103-9#page-1IEC 61508.

[iv]. www.inova-semiconductors.de/en/technology

8. About the Author

Varun S, Project Lead, L&T Technology Services

Varun has expertise in Vehicle Communication Protocol (MOST, CAN, SPI, APIX) and application software development for Instrument Cluster and Head-up-Displays.

About L&T Technology Services

L&T Technology Services is a wholly-owned subsidiary of Larsen & Toubro with a focus on the Engineering Services space, partnering with a large number of Fortune 500 companies globally. We offer design and development solutions throughout the entire product development chain across various industries such as Industrial Products, Medical Devices, Automotive, Aerospace, Railways, Off-Highway & Polymer, Commercial Vehicles, Telecom & Hi-Tech, and the Process Industry. The company also offers solutions in the areas of Mechanical Engineering Services, Embedded Systems & Engineering Application Software, Product Lifecycle Management, Engineering Analytics, Power Electronics, and M2M and the Internet-of-Things (IoT).

With a multi-disciplinary and multi-domain presence, we challenge ourselves every day to help clients achieve a sustainable competitive advantage through value-creating products, processes and services. Headquartered in India, with over 10,000 highly skilled professionals, 12 global delivery centers and operations in 35 locations around the world, we constantly find flexible ways of working, tailored to our assignments and customer needs.

For more information, visit us at www.lnttechservices.com