A Survey on Network Technologies in Car-Infotainment Systems

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ABSTRACT

In-car entertainment (ICE), or in-vehicle infotainment (IVI), is a collection of hardware and software in automobiles that provides audio or video entertainment. The infotainment sector in cars has developed rapidly within the last few years. Where an AM/FM tuner was initially sufficient, many vehicles are now equipped with high-grade sound and navigation systems. This also increases the number of devices involved – radio, cell phone, CD changer, navigation system, voice operation and an additional multi-channel amplifier supplement the primary systems. These devices must interact in concert with each other and can only be controlled via a central operating surface to ensure drivers are not unnecessarily distracted. This paper presents a comprensive overview of network architecture used in car-infotainment.

Keywords *MOST; AVB; Ethernet; HMI; Traffic.*

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I. INTRODUCTION

The automotive industry can look back on nearly 20 years of experience using in-car communication systems. The development started with the CAN-Bus, which has been used in production vehicles since the 1990s. MOST, Media Oriented Systems Transport, a communication system with a new, flexible architecture, used by many different manufacturers, was developed to meet these demands. It can transmit audio signals synchronously, as in telephones, and is
the most widely used multimedia system in cars today[3]. Ethernet is emerging as the network of choice for infotainment and advanced driver assistance systems that include cameras, telematics, rear-seat entertainment systems and mobile phones. Audio-Video Bridging (AVB) over Ethernet is a collection of extensions to the IEEE802.1 specifications that enables local Ethernet networks to stream time synchronised, loss sensitive A/V data[2]. Within an Ethernet network, the AVB extensions help differentiate AVB traffic from the non-AVB traffic that can also flow through the network. In this survey it discribes breifly about the MOST(Media Oriented Systems Transport) and Ethernet Audio-Video Bridging (AVB).

1. MOST

MOST Technology is the result of the collaboration of car makers and suppliers, working to establish and refine a common standard within the MOST Cooperation. The founding fathers of the MOST Cooperation constitute the steering committee,the managing body. All companies interested in the system can, however, collaborate in working groups.The MOST system not only comprises all layers of the Open System Interconnect(OSI) Reference Model for communication and computer network design, but also standardizes the interfaces with the applications (e.g. an AM/FM tuner), which are defined as function blocks. Their implementation is described by example interaction models. In addition, the encoding of the audio and video signals is part of the specification [1]. The system designer is thus able to design multimedia systems on a relatively high abstraction level.

MOST Technology not only provides the synchronous transmission of audio and video data, but also provides for an application framework defining interfaces and functions of infotainment systems with a high abstraction level in order to cope with the complexity. MOST combines the various multimedia components in one ring

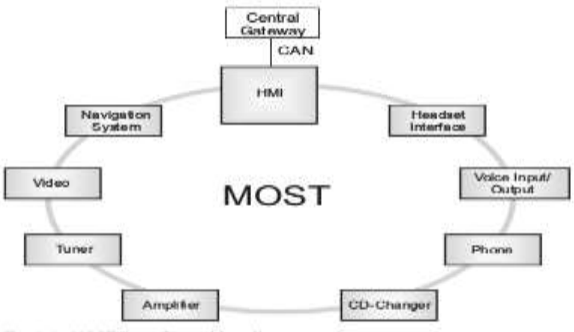

Fig : MOST Ring

Bluetooth is used for the wireless implementation of a headset or cell phone into the multimedia functions of a car. In the future, Bluetooth could also be used for a wireless diagnostic interface.

1.2. MOST Layer Model

When the MOST system was developed, vehicle manufacturers had two basic demands with regard to the functionality of an infotainment bus system:

1. A simple system design based on a function-orientated point of view.
2. the transmission of streaming and packet data, as well as control information.

The first demand resulted in the development of the MOST framework with function blocks being the essential part. Function blocks incorporate all properties and methods of a MOST device (e.g. a CD changer), which are necessary to control the device. Communication with these function blocks takes place over the application protocol, which consists of a self-explanatory mnemonic and does not require an address of the MOST device [1]. A simple and fast system design of the infotainment domain is thus possible with a high abstraction level.

The second demand was met by way of the frame structure. It synchronously transports multimedia data, can transmit great amount of data in a second area asynchronously without influencing the synchronous transmission and offers a Control Channel for control commands and status messages, such as the application protocol.

The Data Link Layer is based, according to the above mentioned second demand, on a synchronous transmission of data frames. It is realized by the MOST Network Interface Controller[1]. Besides the more common optical bit transmission layer, there is also an electrical one available for the physical layer.

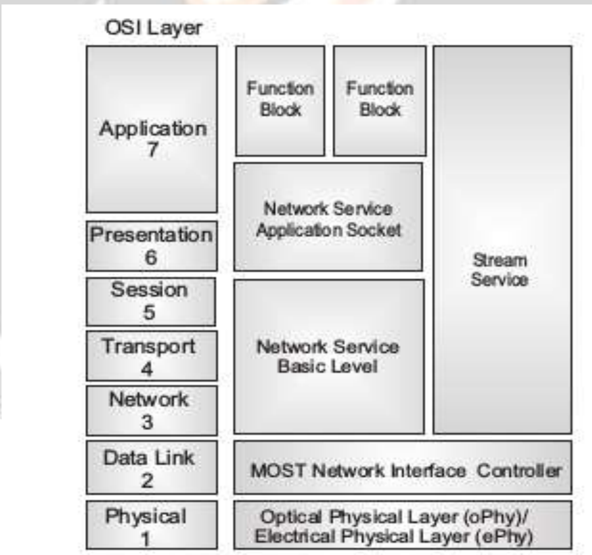

Fig : Most Layered Model

1.3. MOST Device

The basic architecture of a MOST device, as it is shown in figure 3.10, can be deduced from figure 3.1. It shows a device with an optical Physical Layer (oPhy). The Fiber Optic Receiver (FOR) transforms the light signal into an electrical signal, which is transmitted to the Rx input of the Interface Controller. The Tx signal from the controller is retransformed into a light signal by the

Fiber Optic Transmitter (FOX). The specification specifies receiver and transmitter uniformly as Fiber Optic Transceivers (FOT) or the physical interface.

The Data Link Layer is realized in the MOST Network Interface Controller, which controls the access to the three different areas [1]. The Network Services and the function blocks are implemented on a microcontroller, which is also referred to as External Host Controller (EHC). The access from the EHC to the asynchronous area and the Control Channel is effected via the Control Port (CP) of the MOST Network Interface Controller.

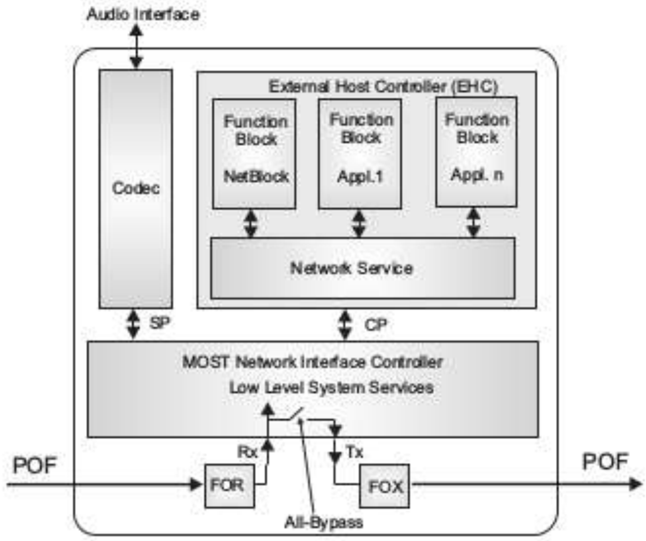

Fig: Most Device

1.4 Network Management

In addition to function blocks for application functions (such as CD changer or tuner), there are also a number of function blocks for network management functions, such as the Net Block, Power Master, Network Master and the Connection Master.

The Net Block must be implemented in every device. The other function blocks for network management are found only once in the system[1]. The specification does not specify, on which device these functions are implemented. They may be distributed in the system, but are usually found together in the HMI.

1.4. Transmission of Multimedia Data

For transmitting content on a synchronous channel, coding procedures have to be defined and the copy protection is to be ensured, particularly for the transmission of content protected by copyright [1]. MOST uses current coding procedures, such as PCM and MPEG, the implementations of which are to be found in the specification MOST Specification for Stream Transmission, MOST applies the DTCP (Digital Transmission Content Protection) standard for transmitting content protected by copyright.

2. Ethernet AVB

Ethernet is emerging as the network of choice for infotainment and advanced driver assistance systems that include cameras, telematics, rear-seat entertainment systems and mobile phones. But standard Ethernet protocols can't assure timely and continuous audio/video (A/V) content delivery for bandwidth intensive and latency sensitive applications without buffering, jitter, lags or other performance hits.

Audio-Video Bridging (AVB) over Ethernet is a collection of extensions to the IEEE802.1 specifications that enables local Ethernet networks to stream time synchronised, loss sensitive A/V data[4]. Within an Ethernet network, the AVB extensions help differentiate

AVB traffic from the non-AVB traffic that can also flow through the network. This is done using an industry standard approach that allows for plug and play communication between systems from multiple vendors.

The standard stipulates that AVB data can reserve only 75% of total available bandwidth, so for a 100Mbit/s link, the maximum AVB data is 75Mbit/s. The remaining bandwidth can be used for all other Ethernet protocols. In automotive systems, the streams may be preconfigured and bandwidth can be reserved statically at system startup to reduce the time needed to bring the network into a fully operational state. This supports safety functions, such as driver alerts and the reversing camera, that must be displayed within seconds.

The AVB standard can support up to eight traffic classes, which are used to determine quality of service. Typically, nodes support at least two traffic classes – Class A, the highest priority, and Class B. Microcontroller features help manage receive and transmit data with multiple priority queues to support AVB and 'best effort class' non AVB data.

The requirement to transfer high volumes of time sensitive audio and video content inside vehicles requires developers to understand and apply the Ethernet AVB extensions. AVB standardisation results in interoperable end-devices from multiple vendors that can deliver audio and video streams to distributed devices on the network with micro-second accuracy or better. While the standard brings complexities, new MCUs are designed with advanced features to simplify automotive A/V design

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