Plug in – ready

UPnP as a proposal for a MOST/IP gateway

This paper proposes a smooth solution for the integration of consumer devices into the vehicle across a layer-3 network. It describes the signaling to establish an audio streaming between a consumer device, e.g. an iPhone, and the vehicle's infotainment system and finally presents a use case.

By Helge Zinner and Josef Noebauer

Todays vehicle networks are almost fully closed systems with limited, accurately defined interfaces to the outside environment and between the vehicle's domains. Vehicle networks are complex distributed systems and can not be compared to conventional computer networks with respect to innovation cycles and safety constraints. Specific networking solutions have been developed for the use in vehicles rather than applying well known information technology standards.

With OBD (On Board Diagnosis) the first common interface to the vehicle was introduced. By this standardization, starting in the early 1980s, a world wide uniform access to the vehicle network was established.

Another interface to the vehicle is the infotainment domain. People bring their mobile devices, e.g. iPhones and navigation systems into the vehicle. With respect to comfort and driver distraction it is a benefit to use the vehicles infrastructure, since vehicles are equipped with larger displays, controls and speaker systems.

Common approaches for the integration of entertainment media are restricted to certain automotive solutions. „Music Interface", „USB-Audio-Interface", „Media Interface", and „Universal Audio Interface" are the present answers of the OEMs. In consequence of the multiple consumer standards each solution will differ based on whether it supports a file system, analog/digital streaming or proprietary formats.

Integration problems for multimedia devices are familiar to the consumer industry, which is confronted with similar issues because of the variety of media interfaces like FireWire (IEEE 1394), USB and numerous vendor specific solutions. Several adapters are necessary to connect and control devices with common computer systems.

Microsoft and Intel were the main leaders in the standardization of an upper layer software solution to address this problem [1]. The idea of UPnP relies on the layers above and including the network layer (internet protocol; IP) of the OSI model without any relation to hardware. Any need for configuration is hidden for the user as services will take care of it. Specific device categories are specified by UPnP, e.g. the category UPnP AV (Audio/Video) for multimedia devices. UPnP AV is an expanding technology, since more and more mobile devices are compliant to this standard (e.g. Apple iPhone/iPod, Nokia N-Series).

UPnP AV can not be found in existing automotive networks yet. Therefore UPnP AV was chosen as methodology for consumer device integration.

Implementation of the MOST/IP gateway

A major constraint for applying UPnP AV for the in-vehicle infotainment network was to reuse MOST (Media Oriented Systems Transport [2]) devices without modifications. A further constraint was the need to comply

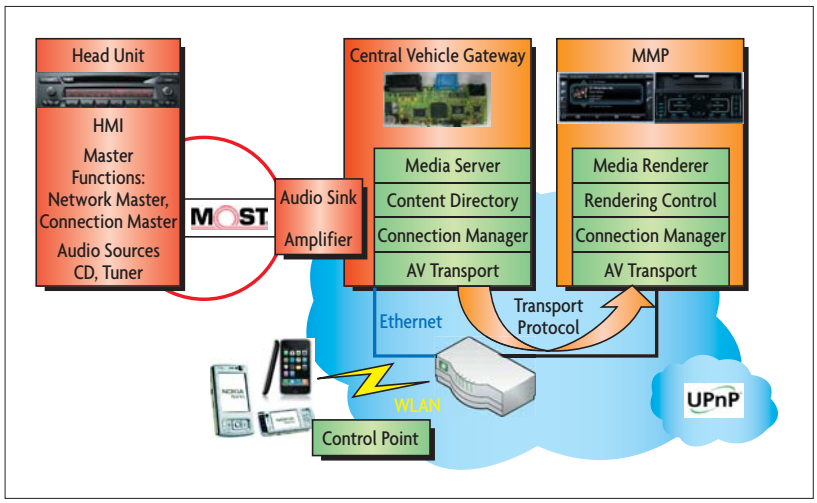
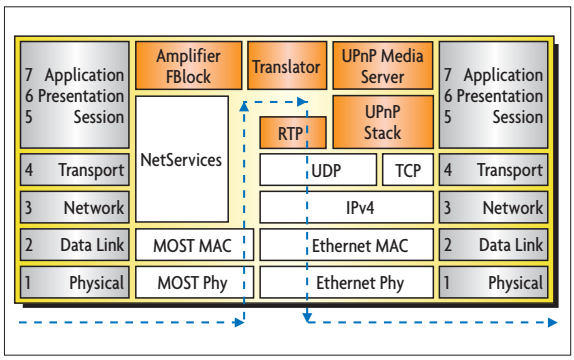


Figure 1. MOST/UPnP AV gateway setup.

with typical automotive software requirements, like not using dynamic memory allocation and not creating operating system objects like tasks, messages etc. during runtime. Additionally all fully qualified automotive components from Continental should bewere used for the implementation, in order to gain experience with IP based services and protocols in vehicle environments.



I Figure 2. Gateway software architecture.

Therefore an UPnP AV based streaming architecture as shown in **figure 1** was designed and implemented.

The central vehicle gateway, which already offers support for MOST and TCP/IP as shown in **figure 2**, has been selected for the integration of the UPnP AV services. The gateway has already been able to transform messages from MOST to ethernet and vice versa in a transparent way by meeting both protocol definitions. Due to the already existing capabilities of this ECU it addresses both streaming among different physical layers and interworking between MOST and IP based technologies.

Figure 2 shows the main function blocks required for achieving a streaming and logical interworking between MOST and IP.

Streaming to an IP network

In the current implementation a solution to stream audio from MOST to the IP network is offered. Accordingly, the gateway has to address the audio content delivery between both networks. Audio streaming requires support of a protocol not causing significant delays, so we decided to integrate the Real Time Protocol (RTP, RFC3550, [3]), since this supports real time streaming for audio data. The use of a standardized RTP stack allows being compatible to other applications.

The integration of the chosen stack had to be done in a way to fit to the above mentioned automotive constraints. Therefore the RTP stack was modified with respect to the usage of system resources. Performance tests have shown that the embedded environment has no adverse effects on the real time streaming.

The dashed line in figure 2 shows the flow of the synchronous audio stream captured directly from the MOST transceiver via DMA mechanisms and forwarded directly to the RTP stack. The stack is based on UDP services and forwards the stream into the IP network.

Interworking

UPnP AV requires providing the entities Media Server, Media Renderer and a Control Point as shown in figure 1. Consequently a Media Server [4] (including the respective protocol stack) was integrated into the central vehicle gateway. The integration of the chosen stack again had to be done in a way to fit to the above mentioned automotive constraints. Therefore the Media Server and stack was modified with respect to operating system resources.

The gateway acts as a Media Server, i.e. it offers content available at the MOST (Amplifier FBlock) to the IP side via the Translator shown in figure 2. The Control Point is represented by an iPhone, which initializes and configures the Media Server and Renderer to set up the streaming. The Microsoft Auto based infotainment system (Multimedia Platform; MMP [5]) from Continental acts as Media Renderer, i.e. as streaming sink. A commercially available Media Renderer application was integrated into the automotive version of Windows CE. In order to realize a network designed for the integration of consumer devices, a standard WLAN router was used to establish the connections.

In a next step, shown in **figure 3**, the MOST/IP gateway will be implemented based on the MMP. The UPnP AV Media Renderer will be adopted, to receive an audio stream from an external UPnP AV device and to stream it into MOST via the MOST FBlock AuxIN. Furthermore the commercial WLAN router will be replaced by the intelligent antenna module (advANTage from Continental) in order to cover the complete path from a consumer device to a MOST amplifier with automotive components

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Cost reduction seems possible

This software based solution will influence cost and overall weight of an infotainment system in a positive way. To confirm the operation of the automotive UPnP AV Media Server, a simple demonstration of IP streaming was shown. The communication with an iPhone, including an UPnP AV control point application shows that the automotive UPnP AV stack was implemented properly.

However, the integration of the UPnP AV stack into an AUTOSAR based ECU has also shown that several modifications to the stack had to be made. Therefore, integrating it into a system like Continental's MMP (Microsoft Auto) or AutoLinQ [6] (Android) is suggested.

The strict disjunction of hardware and software layers offers a smooth concept for unification when mobile devices meet infotainment systems.

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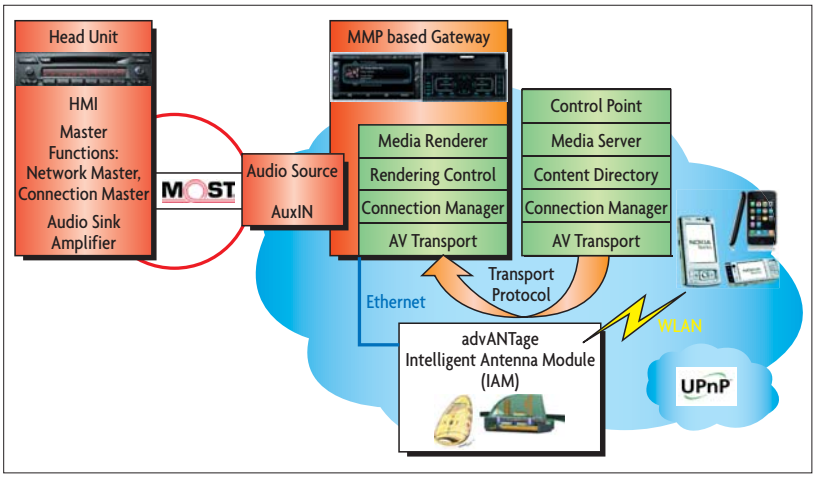

Figure 3. Smooth consumer device integration via UPnP AV.

Links

[1] www.UPnP.org
[2] www.mostcooperation.com
[3] www.ietf.org/rfc/rfc3550.txt
[4] http://ushare.geexbox.org
[5] www.conti-online.com/generator/www/de/de/continental/automotive/themes/passenger_cars/interior/multimedia/mmp/mmp_de.html
[6] www.conti-online.com/generator/www/de/de/continental/automotive/general/press_service/press_releases/hidden/interior/pr_2009_06_02_autolinq_de.html
[7] www.conti-online.com/generator/www/de/en/continental/automotive/general/press_service/press_releases/hidden/interior/pr_2009_09_15_always_on_en.html