

The Evolution of “Media Oriented Systems Transport” Protocol

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Summary. The communication protocols applied in vehicles have gone through long lasting development. Their initial purpose was to support the communication functions in systems supporting conventional point – to – point connections and simultaneously to control the motor operation with regard to emissions. They have made it possible to test vehicle subassemblies in central diagnostic mode. The throughput of communication network required for the solutions in the scope of vehicle control and diagnostics are limited (≤ 10 Mbps). They are unsuitable for smooth multimedia transmission from several sources.

The article contains consistent summary of Media Oriented Systems Transport (MOST) communication protocol features. MOST bus underwent three principal development phases. In its present specification it comes close to the standard enabling easy transmission of digital data in the widely applied Ethernet networks format. The text contains also the consideration of diagnostic testers making it possible to eliminate the defects of MOST bus.

Key words: MOST, Vehicle Information Network.

INTRODUCTION

The first multimedia installation based on MOST bus and protocol was introduced in the year 2001. In the same year, MOST bus was applied in the next ten vehicle models. In the year 2013, MOST Cooperation consortium could report MOST introduction into 140 vehicle models including new models i.e. Audi A3 and Mercedes class S. MOST bus and protocol have been present in popular medium segment vehicles e.g. Volkswagen Golf and Opel Insignia as well as the models: Rolls Royce Ghost, Phantom and Wraith.

The functioning of majority of wire communication buses in motor vehicles is based on linear bus topology [4, 12, 21, 28, 29]. Therefore MOST bus is a unique solution because it is based on ring topology (Fig. 1). The application of fibre optic solution is another specific feature. The communication via cable connections is possible after

transceivers replacement. One of devices (master) contains the complete database for devices in the ring (Fig. 1b).

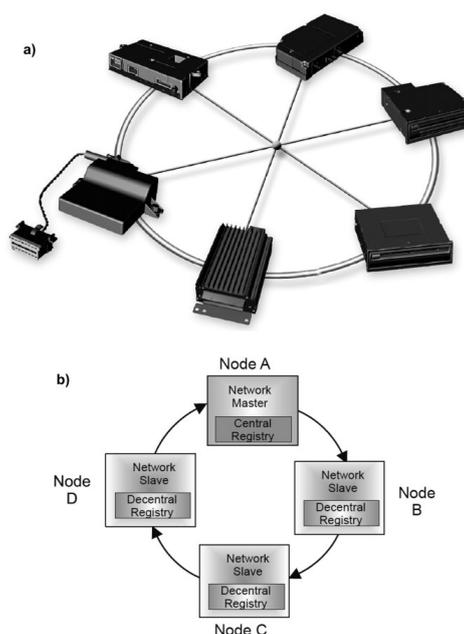


Fig. 1. The communication bus in ring topology: a) view of real devices, b) communication mechanism diagram [19, 21]

MOST bus operation is typical for ring topology. The data block received from preceding node is used as information and commands source. The block received from preceding node is regenerated and forwarded. Turned off devices transmit optical signal without its analysis. The data transfer is finished when the block is received by its sender. The ring contains some special nodes responsible for the ring management i.e. commands generation on the basis of user activity and for the ring synchronization (Fig. 1b). MOST protocol and bus are dedicated to multi-

media networks which are sometimes called Infotainment networks [1, 4, 5, 7, 26]. High throughput levels are required for data stream in such networks. Despite MOST150 standard functioning since several years, this fact has been not mentioned in many publications. Most often the graphical presentations inform about the throughput of about 25 Mbps (Fig. 2) which is underestimated by three times. The throughput of 150 Mbps will be probably exceeded soon. The manufacturers of Plastic Optical Fibers (POF) indicate the throughputs of 500 Mbps along the section of 20 m or 170 Mbps along the section of 115 m [3, 6]. The transceiving equipment is prepared for operation with throughput of 5 Gbps [2, 13]. The current throughput is sufficient to use MOST as an element in the network supporting images received from security camera or from the games network [5, 18, 25].

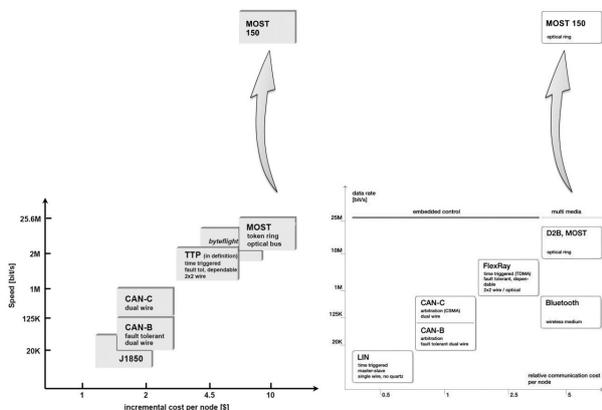


Fig. 2. Lack of information on the throughput of MOST 150 bus in data summaries for communication protocols [19, 27]

The communications based on Function Blocks is the common feature of all MOST versions. Because MOST is a “new” communication method, it is possible to find references for its individual elements in layer type ISO-OSI model. Application layer commands are the key MOST Function Blocks as the standardized commands used to control the behaviour of devices installed in the ring and enabling the data transfer. It is assumed that each device installed in the ring and conforming with MOST specification will support the Function Block commands. Built-in support for Function Block is necessary in order to manage such devices. The functional addresses are assigned to the devices after their introduction into the ring. By means of said addresses the devices performing the role of controllers can read and declare the operation parameters of the devices performing the role of saves. The devices and accessible software can be divided into three (3) groups: Human Machine Interface – the software making it possible for the user to communicate with MOST bus devices, program user’s interface; Controllers – the devices functioning as the controllers for other devices (change of sound intensity, change of GPS system map on the screen), they manage the information about the Function Block commands for controlled systems; Slaves – the actuators which do not contain any information about the system structure but respond to the Function Block com-

mands associated with them. Due to their passive role in the system, the slave devices can be added to and removed from the system without changing the configuration of the whole bus. The communication method based on Function Blocks is common for all versions of MOST protocol: 25, 50 and 150.

MOST25

The numbers contained in the MOST protocol version refer to approximated maximum communication speed expressed in Mb s⁻¹. Detailed data are contained in the Table 1.

The frame is the basic communication unit in the second layer of ISO-OSI communication model. In MOST25 the data are transformed in the form of blocks consisting of 16 frames. Each of 16 frames contains a part of message controlling the nodes. The control message is subdivided into the group of frames in order to reduce the utility data loading with control data.

The utility data within a single frame occur in the form of stream data (e.g. sound) transferred in synchronous mode and in the form of package data (e.g. GPS system). The length of parts of frame associated with synchronous and asynchronous may vary. This length is preliminary determined by means of boundary descriptor. Therefore it is possible that package section does not exist or its length is equal to 9 four – bit words (Fig. 3). The initial bits of the preamble are used for slave nodes time synchronization. Two bits of control data are the part of larger message controlling the network and subdivided into frames in the whole block. The purpose of parity bit is to increase the transmission security [8, 23].

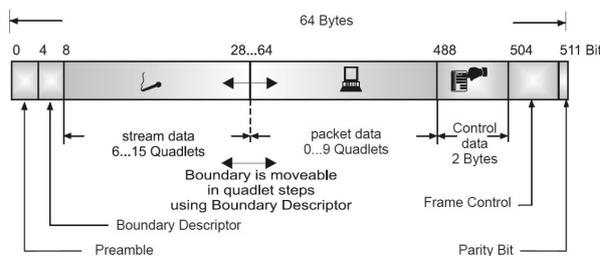


Fig. 3. MOST25 protocol frame [8, 9]

MOST50

As can be seen from the name of protocol in MOST50 version, its communication speed should be two times higher than in case of MOST25. Except of increased speed of transceivers, the length and structure of the frame have been changed in physical layer. MOST50 frame is two times longer than in case of MOST25 and contains 128 bytes. MOST25 contains 4 bytes of control data arranged in two locations of the frame (Fig. 3). MOST50 contains 11 control bytes located in the header only on the beginning of the frame (Fig. 4).

It should be emphasized that the frame structure is more simple and more flexible in MOST50 version (control data

located in one header area). In case of lack of stream or package data it is possible to remove the area dedicated for such types of data.

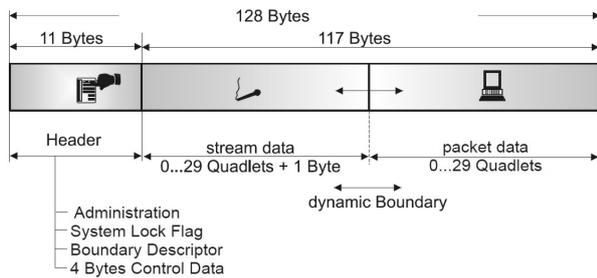


Fig. 4. MOST50 protocol frame [8, 9]

MOST150

In case of the transmission in the framework of MOST150 protocol, it is required to increase the transceivers speed three times in comparison with MOST50 version. The frame is also three times longer and equals to 384 bytes. Its internal structure is not changed. The length of stream and package part can be adjusted in this part of data. The protocol is more efficient than in the case of version 50 because the area to be used for data has been increased from 117 to 372 bytes and accompanying control part has been increased from 11 to 12 bytes only [9, 23].

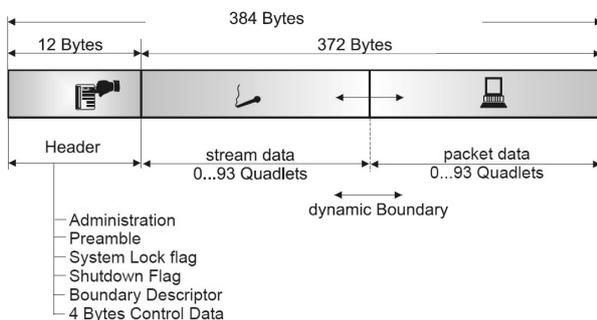


Fig. 5. MOST150 protocol frame [9]

From the structures of MOST25, 50 and 150 frames illustrated in Figures 3-5 it appears that there are no key changes introduced in MOST150. The previous synchronous communication and the support of new data called isochronous is actually possible in the stream communication part. An example for isochronous data is the data with sampling frequency different than basic frequency of the bus operation. The synchronous mode is simulated regardless of asynchronous data transfer. There are three types of isochronous channel support: Audio/Video packages streaming, discrete frames streaming and QoS (Quality of Service) isochronous mode.

Audio/Video packages streaming in isochronous mode consists in asynchronous data packages transfer depending on bus loading and on task load of MOST150 interface package support. Therefore the video support application is not required to provide band reservation or to establish the connection any more.

The discrete frames streaming is used when data sampling (e.g. audio) is other than bus speed. In such case audio data are transferred by the bus with sampling data in order to make it possible for the receiving node to transmit the data with sampling speed conforming with streaming speed.

QoS (Quality of Service) isochronous mode makes it possible to transmit the streaming data with specified quality. In typical situation, an available band is shared by the applications. The quality assurance consists in reservation of required throughput for specified application [9, 23].

The asynchronous channel is often called package and Ethernet channel sharing the band with the synchronous channel. This channel makes it possible to send 93 four-bit words in a frame. MAMAC (MOST Asynchronous Medium Access Control) layer is responsible for TCP/IP protocol transmission via asynchronous channel in MOST25 and MOST50 versions. MOST150 contains MHP (MOST High Protocol) layer. Actually it is possible to address in asynchronous channel by means of 16-bit package addresses (conventional MOST addressing) and 48-bit Ethernet addresses (addressing by means of MAC addresses) [9, 23].

Table 1. Bandwidth of MOST 25, 50 and 150 frame [9]

Parameter	MOST25	MOST50	MOST150
Streaming data			
Minimum bandwidth [Mbps]	8.48	0.38	0
Maximum bandwidth [Mbps]	21.17	44.93	142.85
Packet data			
Minimum bandwidth [Mbps]	0	0	0
Maximum bandwidth [Mbps]	10.84	44.54	142.85
Control data			
Minimum bandwidth [kbps]	405.84	448.00	512.00
Maximum bandwidth [kbps]	405.84	810.62	1130.00

DIAGNOSTIC TOOLS

High throughput of MOST bus combined with fault tolerance is possible as a result of fibre optic transmission medium. The fibre optic communication makes the diagnostics and bus faults elimination more difficult [22]. However it is possible to gather information from typical diagnostic testers communicating with motor vehicle via standard OBD connection. It is impossible to establish any connection with the bus ring by means of typical multimeters. The transmitting – receiving diodes and bus socket are shown in Fig. 6.

The diagnostic workshops are unable to perform the repairs by means of actually possessed measuring and testing equipment. There are two methods used to detect a failure in fibre optic ring circuit. The first method is based on error message generated by master module in the bus. The master module contains the database for bus elements configuration. On the basis of times of response to the test signal introduced from the module into fibre optic conductor, the master module is able to determine, with high probability, the defective module or the fibre optic section with problematic communication. In order to verify the diagnosis it is necessary to carry out the tests by means of special testers.

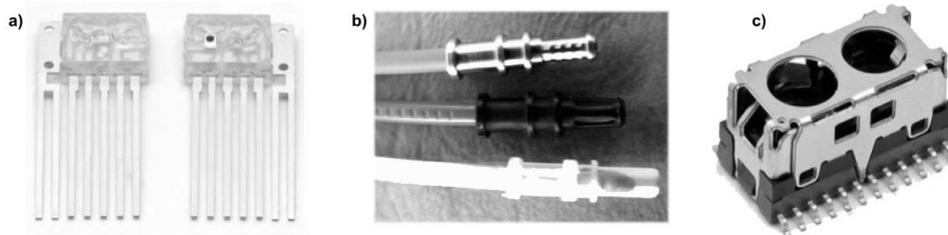


Fig. 6. Elements of fibre optic ring of MOST bus: a) transmitting – receiving diodes; b) fibre optic cables plugs; c) socket of MOST node [2, 8, 9, 10, 13]

The tests consist in the replacement of defective module by the tester and in checking whether the ring is closed in this manner. Another method consists in fibre optic conductor continuity check performed by means of two testers, i.e. one tester used as the source of optical signal and another as the receiver thereof. Except stream travel continuity it also possible to measure light stream attenuation. An example of such tester for D2D bus is illustrated in Fig. 7. Fig. 7b illustrates how to connect two testers in order to check the fibre optic section.

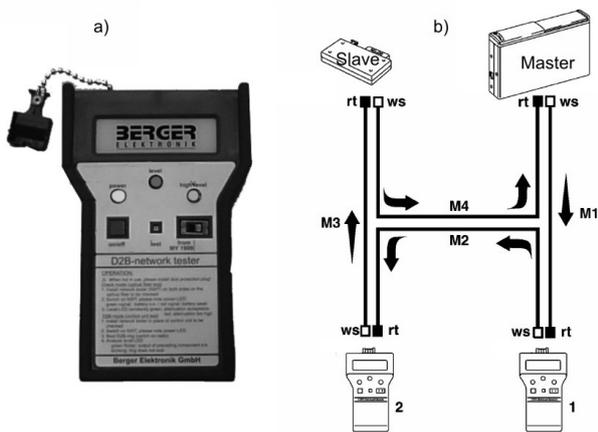


Fig. 7. Diagnostics of optic ring on the example of D2B bus: a) tester; b) connection method [14]

The examples of motor vehicles with multimedia system based on MOST bus are the new models of BMW vehicles. The diagnostic system for such vehicle consists of a measuring head and software running on personal computer.

The measuring head is connected with an Ethernet interface on one end and to OBD diagnostics socket of the vehicle on another end. Therefore it is possible to gather standard information about vehicle condition or to reprogram the modules. Since several years the optical interface connector enabling direct tester connection to the optical ring is the mandatory equipment of such tester. Fig. 8 contains two photos of such devices – GT1 measuring head and OPS Di-CAN MOST tester. Thanks to comprehensive testers functions and accompanying software it is possible to read the error codes, to cancel the codes to carry out programming, data decoding, to locate the components and to display the connection diagrams.

Although the testers systems described above are sufficient for fails detection and elimination in workshops, their capabilities are rather limited in case of preparation of the new solutions of MOST bus. In case of nonstandard problems or in case of necessity to determine the technical boundaries of the project, it is necessary to use laboratory equipment dedicated to MOST protocol. Such specialized solutions are available for research tasks, e.g. „MOST150 Controller 6161” measuring card manufactured by GOEPEL electronic (Fig. 9a). Using this card it is possible to perform typical bus tests i.e. ring continuity check and to configure MOST bus systems collaborating with CAN or LIN networks. Ready to use sets of tests are available for elements checking for their compliance with MOST protocol requirements. An example of dialog window of such software delivered by LeCroy is illustrated in Fig. 9b [11, 24]. The physical tests are carried out by means of oscilloscopes supplied by the same company. Similar solutions are proposed by Agilent. Its N6466A MOST Compliance

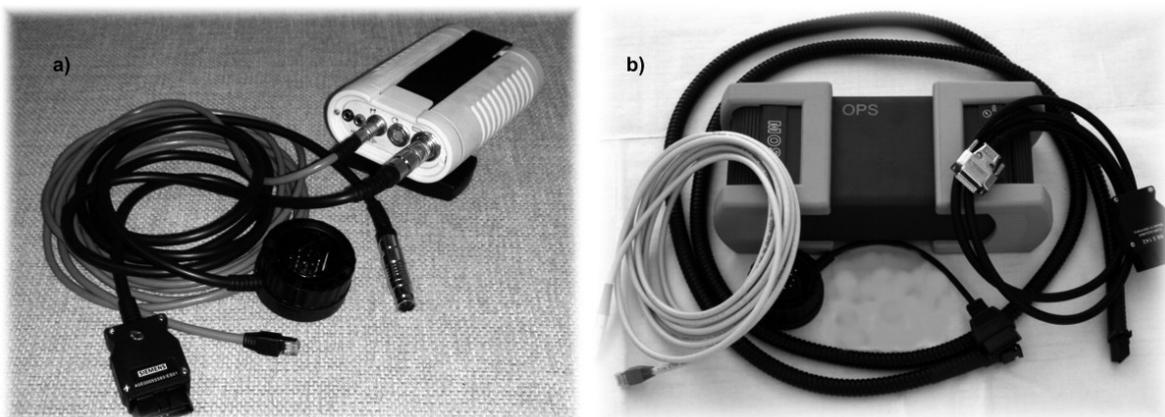


Fig. 8. Testers heads dedicated for BMW vehicles: a) GT1; b) OPS [16, 20]

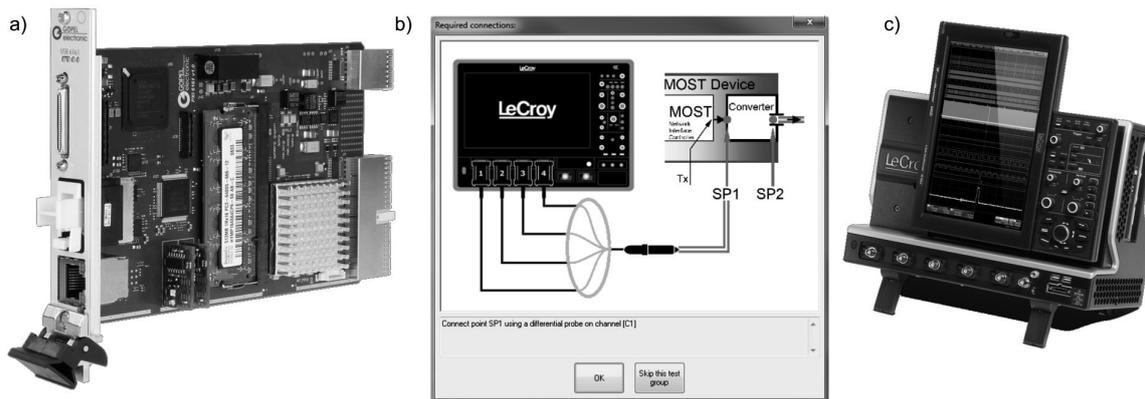


Fig. 9. Advanced tools for analysis of MOST protocol MOST bus devices: a) measuring card; b) LeCroy testing package; c) oscilloscope for LeCroy package [24]

Application running on Infiniium oscilloscopes makes it possible to verify the compliance of hardware layer with requirements established by MOST standard.

CONCLUSIONS

The multimedia systems installed in vehicles have come a long way from the first lamp type receivers used in the thirties of the 20th century. The first fibre optic multimedia bus Domestic Digital Bus designed in early nineties of 20th century was the initial phase of MOST bus. The evolution of protocol used in Media Oriented Systems Transport bus makes it possible to make the following conclusions:

- at the moment, the MOST bus is the fastest multimedia bus dedicated to motor vehicles;
- MOST protocol in MOST150 version is characterized by high flexibility in the scope of band allocation for synchronous and asynchronous data;
- MOST150 version is characterized by facilitated transmission of data based on IP protocol and by introduced Quality of Service support;
- MOST bus makes it necessary to use specialized diagnostic tools for elimination of errors in fibre optic ring;
- there are automated tools available for verification process automation for devices compliance with MOST standard;
- there is such a rich variety of currently available elements, devices and descriptions that the special databases are created to contain the information about MOST bus elements [17].

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EWOLUCJA PROTOKOŁU
„MEDIA ORIENTED SYSTEMS TRANSPORT”

Streszczenie. Protokoły komunikacyjne stosowane w pojazdach przeszły długą drogę rozwoju. Początkowo miały tylko obsługiwać komunikację w systemach zastępujących tradycyjne połączenia typu punkt-punkt. Jednocześnie kontrolowały pracę silnika pod kątem emisji zanieczyszczeń. Pozwalały i pozwalają na centralną diagnostykę podzespołów samochodowych. Rozwiązania sterowania podzespołami pojazdu oraz diagnostyki wymagają niewielkich przepustowości sieci komunikacyjnej (≤ 10 Mbps). Nie nadają się do płynnego przesyłania multimediów z kilku źródeł. Artykuł zawiera spójne zestawienie cech protokołu komunikacyjnego Media Oriented Systems Transport (MOST). Magistrala MOST przeszła trzy główne etapy rozwoju. W aktualnej specyfikacji zbliża się do standardu pozwalającego na łatwe przesyłanie danych cyfrowych w postaci zgodnej ze szeroko stosowaną w sieci Ethernet. W tekście zamieszczono także rozważania na temat testerów diagnostycznych pozwalających na usuwanie usterek magistrali MOST.

Słowa kluczowe: MOST, Vehicle Information Network.