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IP Encapsulation using Multiprotocol Encapsulation over DVB-S

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***Abstract*- The trendy demand of DTV (Dish TV) services through the Satellite communications gave a major role to the standard Digital Video Broadcasting over Satellites (DVB-S), which comprises of providing standard and HDTV services over the Satellite. The DVB project supports the MPEG-TS transmission. Encapsulators are the important part of the Digital Video Broadcasting over satellites and are the core for transmission in the digital TV system, owning to all programs, data and different value-added services that are transmitted after packaged and multiplexed. However, the motivation is to make our own software based product. This article uses a simple algorithm following the standard Multiprotocol Encapsulation (MPE) defined in ISO 13818-6 DSM-CC standard. DVB standards are initially intended for digital audio video broadcasting using MPEG-2 Transport Stream (TS) and not optimized for IP packets. Therefore in this paper, we present IP packets encapsulation Multiprotocol Encapsulation method defined by DVB standards.**

***Index Terms*- MPE, MPEG-TS, DVB-S, DSM-CC.**

I. INTRODUCTION

The 1st generation of Digital Video Broadcasting for Satellite (DVB-S) standards adapts fickle sized A/V stream, payload units and encapsulated Protocol Data Units (PDUs) to fixed-size 188 Byte packets. Currently, the encapsulation method used in DVB-S called Multiprotocol Encapsulation is considered in the paper.

Multi Protocol Encapsulation (MPE) is widely used in current DVB-S systems for wrapping Internet Protocol (IP) datagrams over MPEG-TS, which is based on the Digital Storage Media Command and Control (DSM-CC). MPEG-TS is used in almost all existing digital broadcasting systems, including the DVB and the standards of Advanced Television Systems Committee (ATSC) family as the format of baseband data, organized in a statistically multiplexed sequence of fixed-size, 188-byte TS Packets. Initially intended to convey MPEG-2 encoded audio and video streams, the MPEG-2 TS was eventually used also for the transport of IP traffic. The analysis result is fundamental for research to enhance efficiency for Transporting IP traffic in satellite networks. The paper presents the flow of implementation of encapsulation protocol to output 188 byte Transport Streams. This paper is planned as follows. First part has brief about DVB-S and IP over MPEG. Second part includes introduction to Multi protocol Encapsulation method and its Format, next part comprises of fragmentation of MPE sections to TS and Route to propel the encapsulated packets. Finally, results are presented in last section.

II. IP OVER MPEG IN DVB-S

DVB-S is planned to provide DTH services for consumer integrated receiver decoders, as well as collective antenna system and cable television head end system. It is well-suited with MPEG 2 coded Television services. Flexibility defined with specification facilitates the transmission capacity to be used for variety of TV Service configuration, including sound and data service. While the actual DVB-S standard only specifies the physical link characteristics and framing, the superimposed transport stream delivered by DVB S is mandated as MPEG-2, known as MPEG Transport Stream. In order to support data service, the broad concept of DVB suggests the Multi-protocol encapsulation (MPE) based on “IP over everything”, i.e., IP over MPEG, to accommodate IP packet (network layer), i.e., Internet[2]. MPEG-2 Sections can be used to transmit datagram’s of variable size with a maximum length of 4 k bytes. MPEG-2 Sections are built in a way that MPEG-2 demultiplexers available on the market can filter out single sections which may reduce the required software processing power of the receiver. This is the main reason why the MPEG-2 Sections have been chosen as the mechanism for the transmission of encapsulated protocols and data carousels. MPE is preferred over carousals because the efficiency of carousals are dependent on the data retransmitted in fixed interval of time. For real time data, MPE comes in use. IP-based transmission is attractive to allow union with Internet and also to extend the reach of TV over home/commercial packet networks. It also accommodates multiplexing of other IP-based services.

III. MULTI-PROTOCOL ENCAPSULATION

Multi Protocol Encapsulation is used extensively in current DVB-S systems for encapsulating Internet Protocol (IP) datagrams over MPEG-TS, which is based on the Digital Storage Media Command and Control (DSM-CC). In almost all existing digital broadcasting systems, MPEG-TS is used, together with the DVB and the standards of Advanced Television Systems Committee (ATSC) family as the format for baseband data, structured in a statistically multiplexed sequence of preset-size, 188-byte TS Packets[4]. Initially proposed to convey MPEG-2

Encoded audio/video streams, the MPEG-2 TS were ultimately used for the transport of IP traffic with revision method [2] named as Multi-Protocol Encapsulation. The acceptance of MPE inflected the function of DTV platforms as admittance networks for multimedia services and IP-based broadband data[5].

The part of capacity of the broadcast channel is potentially used by the broadcasters for inclusion of Unicast/multicast IP traffic with audio visual streams. MPE is data link layer protocol and is likely to carry exclusively IP data and includes the provision of LLC/SNAP for other type of data to be carried.

The format of wrapping data over MPE/TS is shown in the figure. The payload are wrapped into MPE 12 Byte section header that is compliant to the DSM-CC section. The optional 8Byte LLC/SNAP is to be added for non-IP payload types, optional stuffing and a 4 Byte crc is added in the trailer.

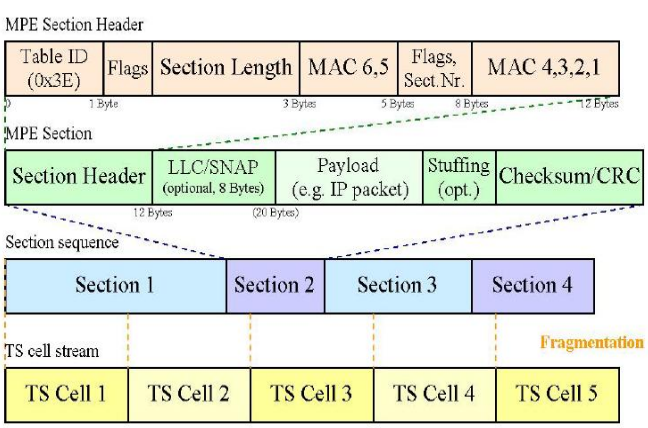

Figure1. Payload wrapped in TS cells.

This complete section is wrapped up to the TS cells of 188 Bytes. On the start of new section the (PUSI) payload unit start indicator bit gives the offset of the beginning of the new section.

The MPE encapsulation is performed in following ways: the stream is divided in SNDU (Sub Network Data Units) containing a header in bytes of 2 (length), 2 (type) and 4 (CRC). The SNDU is encapsulated into a series of MPEG-2 transport stream packets belonging to the same TS channel. The 184 bytes of the TS data are filled and a MPEG-2 TS standard header of 4 bytes is added having a packet identifier (PID) of 13 bits to identify the TS channel. If another SNDU is available, the encapsulator packs the empty room in the TS payload; to indicate that the packet carries the start of a SNDU the payload unit start indicator (PUSI) in the MPEG header is set to one.

The multiplexing of users can be performed in two different ways, either according to the destination address (PID) or to the physical layer requirements. In the first case, MPE protocol can be applied thus increasing MPEG efficiency. In the second case, MPE protocol could only be used in its current version by coordinating PID and physical layer.

IV. DETAILED MPE HEADER FORMAT

MPE has by this time been adopted in IP/MPEG-2 gateways and decapsulators or receivers; it is the only IP-to-MPEG-2 encapsulation protocol for almost a period. Using MPE, each IP packet arriving at an MPEG Encapsulation doorway has an MPE header attached to form a network layer packet named Protocol Data Unit (PDU). The complete PDU is then fragmented to form a series of MPEG-2 TS Packets. Since IP packets are of variable size, it is reasonable to expect most IP packets will be placed in a series of TS packets[5]. A one-bit Payload Unit Start Indicator in the TS packet header and one-byte PTR after the TS header indicate a specific TS packet carries the start of a new TS Packet payload.

The basic MPE header format carries a MAC destination address, but no payload type field. This leads to the assumption in most current Receiver driver software that the payload is IPv4. If the payload is other IPv4, such as IPv6 packet, the type field is required to de-multiplex the received packets. In MPE, this requires the inclusion of the optional Logical Link Control/Sub-Network Access Point header of 4 bytes.

In most cases, the end of an IP packet does not precisely align to the end of a TS packet payload, one or more bytes will typically be free and may be unused known to be as Padding or used to carry a subsequent packet as packaging.

Encapsulators and the corresponding receivers may use either mechanism, but must choose the same one. TS packet. Padding is the default mechanism within MPE.

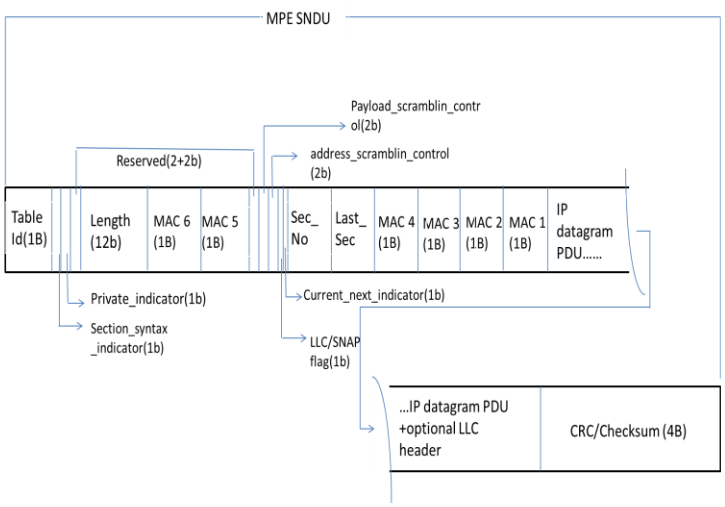

Figure 2. Header format for Multi-protocol Encapsulation

V. IMPLEMENTATION DETAIL AND RESULTS

The packets are captured from raw socket and are then processed for applying multi-protocol encapsulation format. The Ethernet header is excluded and the IP packet is wrapped up in 12 byte section header and a 4Byte trailer of crc/checksum. The section is packed up according to its maximum size given of 4080 bytes. The section formed includes 8 byte LLC/SNAP header for non IP payload. These sections are fragmented into TS packets and the TS header is summoned up to the MPE data. The use of threads and queue helps to achieve the proper synchronization and flow in implementation. For other payload types the additional header is used to specify the type of packet which is carried in MPE section.

Private data was encapsulated in MPE format and multiplexed with audio video streams. The mapping is done on the PMT table. The figure below shows packet captured in Wireshark and multiplexer showing private data and A/V streams multiplexed.

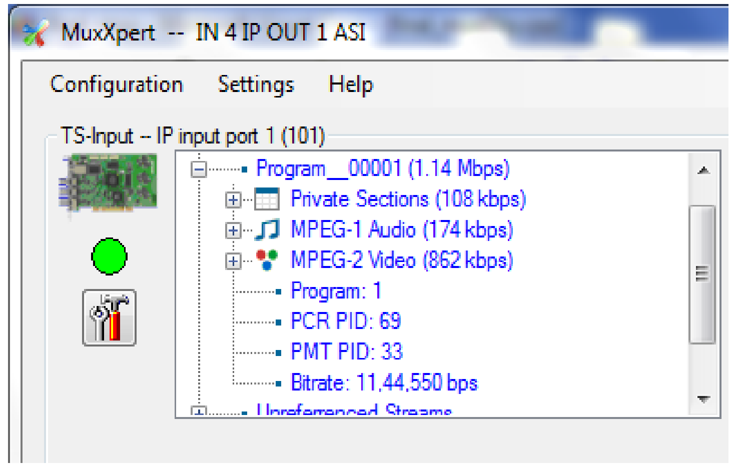

Figure3. MPE Private Packet multiplexed with Audio Video streams.

An experiment was done of inserting private data in MPE section, forward the 188 Byte TS output wrapping private data to the modulator. Results on MUX EXpert showed that private data is distinguished by modulator even from other A/V streams. A very simple implementation represented that using socket data can be received, processed to 188 Byte TS Output and propelled to the receiver, that can be a multiplexer, modulator, etc.

The use of Wireshark was done to test the packets that are received and transmitted to get the overview of the processing done on the data.

The next snapshot is of 188 byte data filtered by Setup Box which discards the Ethernet header of the 188 byte packets. The packet information is mapped to PMT tables.

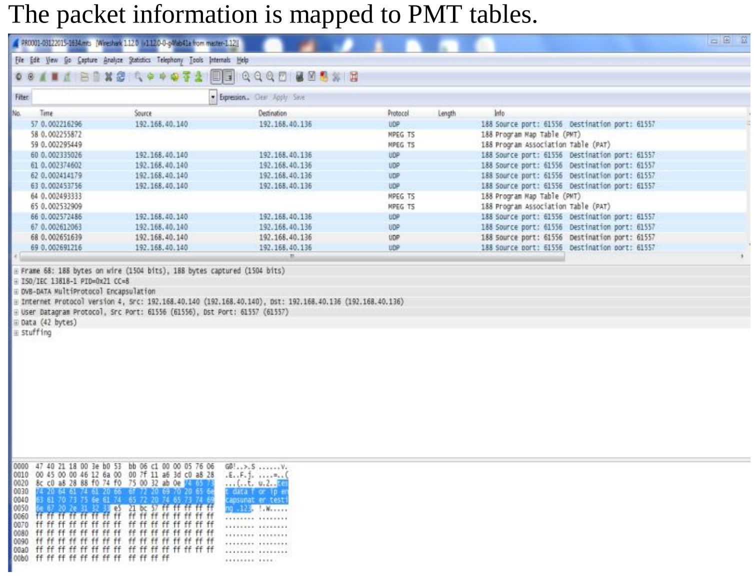

Figure 4. MPE Private packet at Setup Box.

The figure gives detailed byte by byte analysis of the DVB DATA MPE detected in Wireshark. The private packet encapsulated in MPE, Audio/ Video Streams are propelled to Setup Box. Setup Box distinguishes the private information.

VI. CONCLUSION

In this paper, Multi-protocol Encapsulation method of encapsulation is explained along with the implementation flow and results attained. A simple algorithm is presented to process the PDUs in order to output TS packets over DVB S networks. All the existing are hardware based so this paper gives an idea of Software implementation of Data Link Layer protocol, minimizing the costing and proceeding to the brevity and simplicity. Similar to the hardware based Encapsulators available this can help in achieving encapsulation.

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