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Implementation of Generic Stream Encapsulation Protocol for IP Datagram Encapsulation over DVB-S2 Baseband Frames

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ABSTRACT
Digital Video Broadcasting over Satellite, the 2nd generation (DVB-S2) standard allows a direct transmission of IP datagram using the Generic Stream Encapsulation Protocol replacing the existing transport Stream (MPEG-TS).The paper gives the description of the GSE Protocol for the transmission of IPV4 datagram and other network layer packets directly over DVB-S2 Generic Stream. The protocol specifies the Encapsulation format; fragmentation over DVB-S2 Base-Band frames and the mechanism to send the encapsulated stream to its destination.

Keywords
GSE, DVB-S2, BBframe, MPEG-TS.

1. INTRODUCTION
The 1st generation of Digital Video Broadcasting for Satellite (DVB-S) standards adapts variable sized Audio-Visual (A/V) payload units and encapsulated Protocol Data Units (PDUs) to fixed-size 188 Bytes packets [1]. There are two Encapsulation Protocol used in DVB-S for IP data Encapsulation, Multiprotocol Encapsulation protocol and Unidirectional Lightweight Encapsulation Protocol. The on hand way to wrap IP datagrams over DVB-S could not fully take advantage of the new feature of the DVB-S2 standard, for which a unique encapsulation protocol is proposed. The Generic Stream Encapsulation is composed with the precise characteristics of DVB-S2 in mind that provides all the necessary ways to fully exploit its better reliability, Flexibility and capability [2].

The DVB-S2 standard used for IP datagram can be transmitted over DVB satellite links, introduced an IP-forth coming link layer that is continuous Generic Streams- and the adaptive combination of advanced error coding, modulation [2]. This paper focuses on GSE's design choices for perception of DVB-S2's novel features and possibilities.

The points covered in the other section of the paper are as follow. Section I explains Encapsulation format and fragmentation over DVB-S2 baseband frame. Section II emphasizes the implementation details with the observed results and last section describes the conclusion of the paper.

2. GENERIC STREAM ENCAPSULATION PROTOCOL SPECIFICATION
Generic Stream Encapsulation Protocol is a Data link Layer Protocol that encapsulates the incoming IP datagrams, Ethernet Frames, or other network layer packets [3][4]. GSE provides basic features such as Fragmentation, Integrity Check and PDU Encapsulation as explained below.

2.1 Encapsulation and Fragmentation
DVB-S2 is implemented with different encapsulation level. As shown in the fig. 2, the incoming network layer IP packets are encapsulated in multiple GSE packets in Data Link Layer. The process of encapsulation outlines start and end of each Protocol Data Unit (PDUs). It adds control information such as Address Label, Network Protocol Type and Integrity Check as and when needed [3] [6].

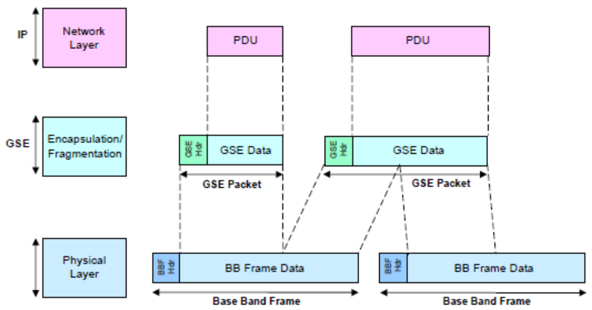

Fig.1. GSE Encapsulation within DVB-S2 Protocol Stack [7]

Each GSE packet comprises of GSE header followed by GSE payload in which the wrapped PDU is placed. The GSE header format is shown in fig 3. The first 2 bytes fields are always present while the rest of the fields may be excluded depending on the preceding control fields in the first 4 bits of GSE header.

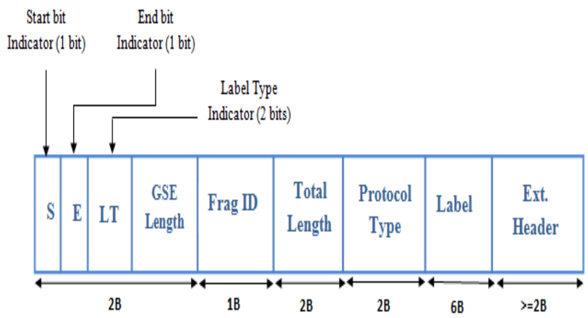

Fig.2. GSE Header Format

The maximum length of GSE packet is 4096 Bytes including GSE header. Thus, PDUs may be encapsulated or fragmented depending on the size of IP packet. The MTU of IP packet is 65535 bytes. IP packets are fragmented if its size is more than the size of GSE packet.

2.2 Base-Band Frame Overview

At Physical layer DVB-S2 Base-Band Frames are built. A fixed length base-band Header (BBHEADER) of 10 bytes shall be inserted in front of the DATA FIELD [5] that informs receiver about the input stream format: Single Input stream or Multiple Input Stream, Generic Stream or Transport Stream, Modulation Technique such as Constant Coded and Modulation (CCM) or Adaptive Coded and Modulation (ACM) with other configuration detail. Length of BBFRAMES is variable ranges from 384 bytes to 7264 bytes depending on the MODCOD selection. There are 28 combinations for modulation and error protection level labeled as MODCOD.ACM provide the mechanism to change the MODCOD on-the-fly according to the link quality informed by the receiver.

There are two modes of GSE packet encapsulation. First is padding mode and second is packing mode. In padding mode only one GSE packet is wrapped and leftover space is padded by padding bytes while, In case of packing multiple leftover space is filled by another GSE packet if the remaining space can encapsulated another it without fragmenting GSE packet. Thus, the only information required by the Fragmentation process from the physical layer is the Base Band frame Data Field Length.

2.3 Integrity Check

In GSE CRC-32 is computed at PDU level for every fragmented PDU to detect error occurred while reassembling the fragmented PDUs [6]. Each GSE Packet where the S-bit value is "0" and E-bit value is "1" shall carry a 32-bit CRC field in the last four bytes of the GSE Packet.CRC-32 calculation includes all bytes of the PDU payload, of the Total Length, of the Protocol Type, of the Label (when present) and possible Extension headers fields, and places this in the CRC Field. Similarly, In Base-Band Frames CRC-8 is computed on Base-Band header and placed in the CRC field in BBFRAME header.

2.4 Routing

Routing is the mechanism used in Generic Stream Encapsulation Protocol used to find the network path to another system. It enables the message to pass from one computer to another and reach to its destination. Multiple routes are configured before getting started with the Encapsulation process. The configured route can also be updated as and when required. The incoming packet check for availability of route if it is available sends the packet to its destination address.

3. IMPLEMENTATION DETAIL

The Block Diagram below depicts the Network Configuration to carry out the experiment of GSE protocol.

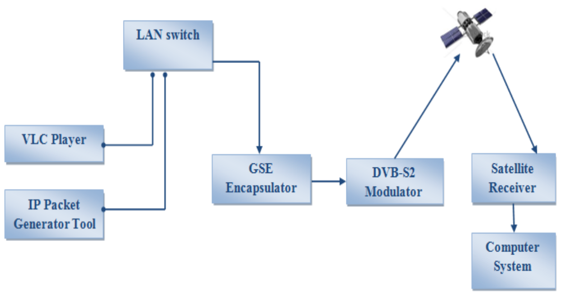

Fig .3. Experimental Block Diagram of GSE over DVB-S2

Transmitter can be any IP packet generator tool, or VLC media player for MPEG-TS stream which transmits the packets. The intermediate system will acts as a GSE Encapsulator with DVB-S2 Base-Band frames, which is being implemented in Linux platform using socket programming. Base-Band Frames generator with GSE Encapsulator sends Base-Band Frames to DVB-S2 modulator for uplink to the satellite receiver which is then transferred to another system. But to check the correctness of the frames we have used Wireshark Network Packet Analyzer software.

GSE Implementation is divided into set of Modules such as Receiving Module, Processing Module, Fragmentation Module, GSE Header append Module and BBframe Generation Module as shown in the below figure.

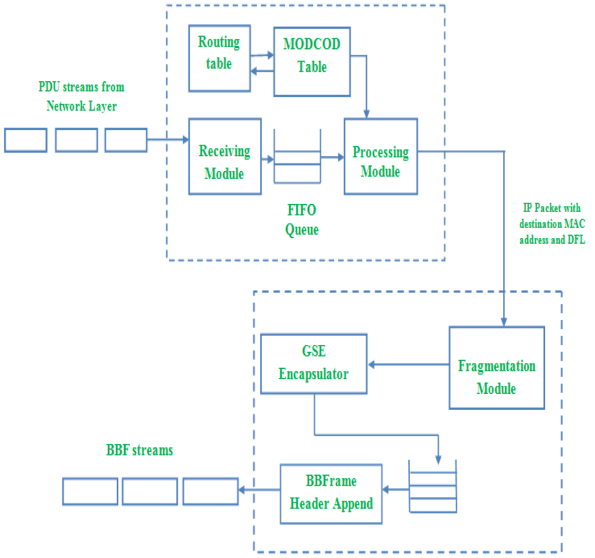

Fig.4. Implementation Flow of GSE Encapsulator

Receiving Module receives the incoming PDUs from the network layer, Find the upper layer protocol and store it in the FIFO Queue. Processing Module fetch the PDUs from Queue interact with the configured routing table and MODCOD table to Check for the availability of route defined for destination address, if route is available it finds the Datafield Length based on the MODCOD technique selected for the destined node.Datafield Length is the maximum length of the Base-Band Frame where GSE packet is encapsulated. If Datafield length less then the length of GSE packet it performs fragmentation, append GSE header according to the type of fragment i.e 13 byte GSE header for first fragment, 3 byte header for subsequent fragment, 3 byte header and 4 byte CRC for last fragment and at last, BBframe Generator append 10 Byte Base-Band header that forms Base-Band Frames. The Modulation Techniques selected in BBframe is responsible for Quality of Service in DVB-S2. After the formation of Base-Band Frame Mode Adaptation header is appended this is used to check the synchronization of packets as well as the Modulation and Coding Techniques such as QPSK, 8-PSK, 16-APSK and 32-APSK combined with Bose-Chaudhuri-Hocquenghem (BCH) and Low Density Parity Check (LDPC) codes. The LDPC code rate can be chosen among 11 values: 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9 and 9/10 for a resulting family of concatenated Forward Error Coding schemes (FEC) [2].

The Flow chart below depicts the implementation flow of Generic Stream Encapsulation with encapsulation mode such as padding and packing.

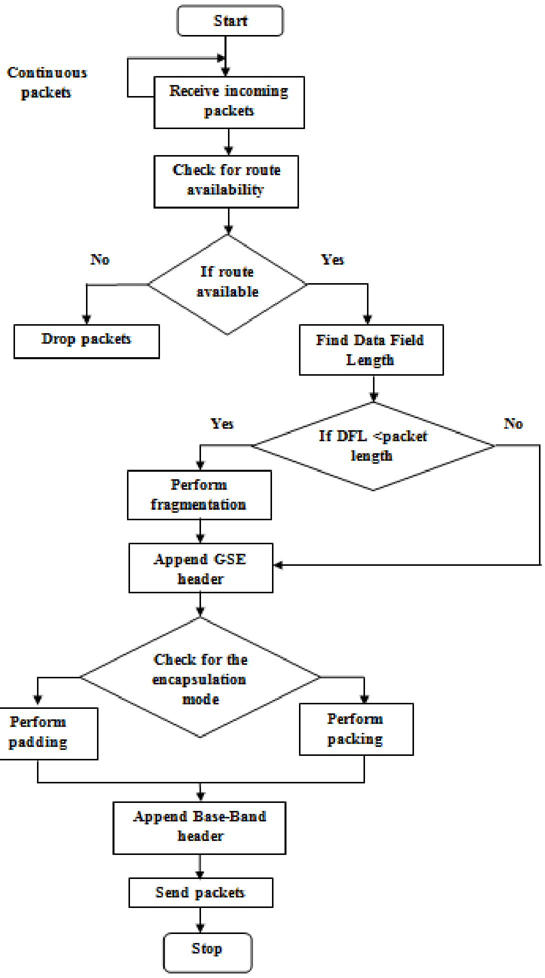

Fig.5. Flow chart of GSE Encapsulator

In this paper we present the results based on random packets as well as real traffic. The analysis is divided into two modes Fragmented packets and unfragmented packets with Padding and section packing. As GSE encapsulate IP and other network layer packets, we have also analyzed the results using different protocol.

4. EXPERIMENTAL RESULTS

The results obtained after implementing this software are described as follow.

4.1 Generic Stream Encapsulation with Fragmentation.

The results were observed in wireshark that shows Generic Stream Encapsulation over DVB-S2 using random packet and incoming IP packet. Packet generated tends to be large in size. Therefore it is being fragmented as shown below. If incoming packet is non-ip packet Wireshark will decode it as DVB-S2 BB as shown in figure 5.

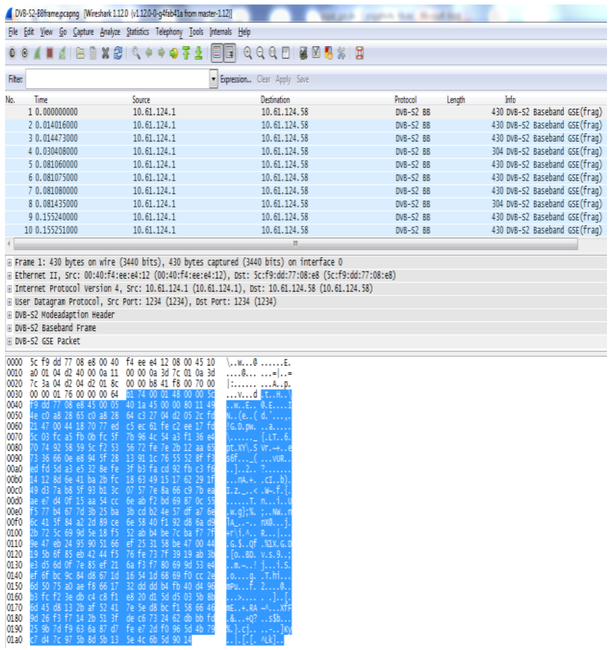

Fig.6. GSE over BBframe with fragmentation

4.2 Generic Stream Encapsulation without Fragmentation.

The Following Figure shows the encapsulation of IP packet by considering padding and packing mode. When IPV4 packet is encapsulated in GSE, the packet is being decoded with the transport layer protocol used. As shown in the figure UDP packet is decoded in GSE packet.

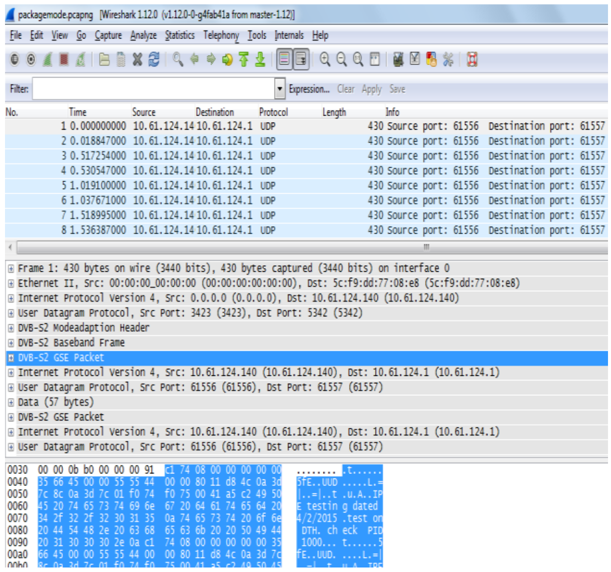

Fig.7. GSE over BBframe without fragmentation in package mode

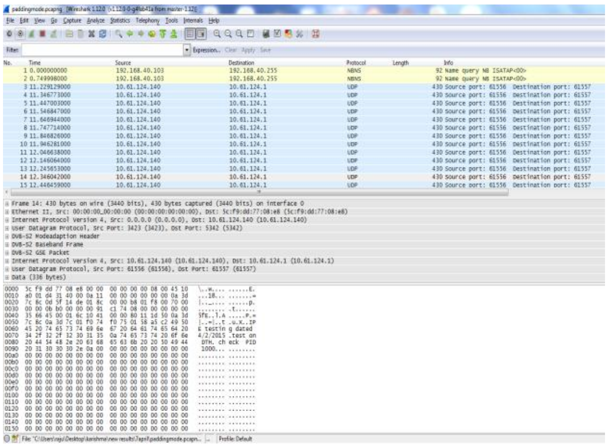

Fig.8. GSE over BBframe without fragmentation in padding mode

Generic Stream Encapsulation Protocol is also analyzed with various other Network layer protocol such as ICMP, IGMP, TCP and MPEG-TS within GSE.

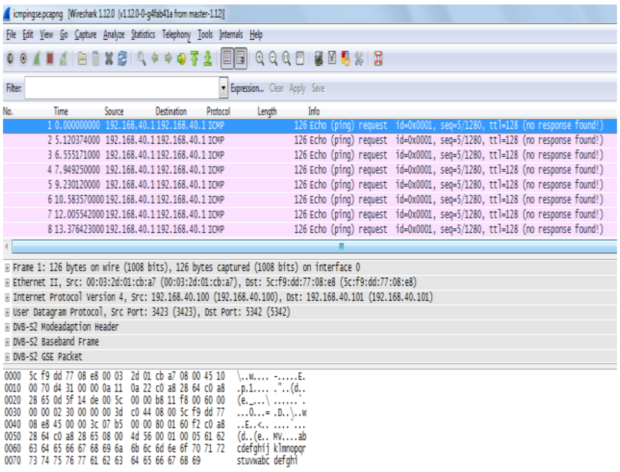

Fig.9. Encapsulation of ICMP in GSE

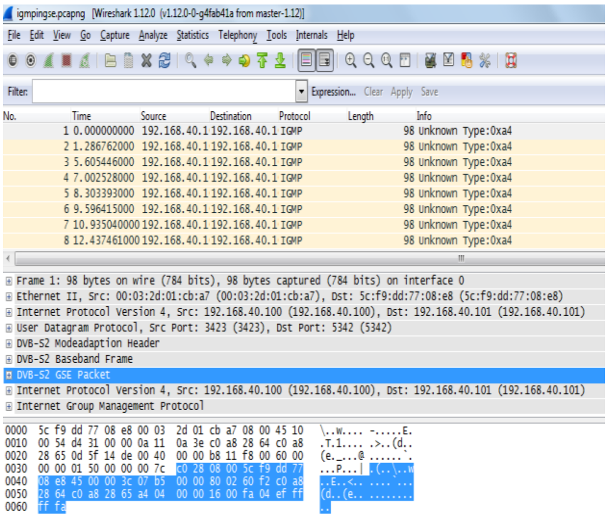

Fig.10. Encapsulation of IGMP in GSE

In case of MPEG-TS Encapsulation in GSE (Figure 10), MPEG-TS Packets are decoded only if Wireshark finds the same length of MPEG-TS packet (1316 bytes) as transmitted without using padding and packing.

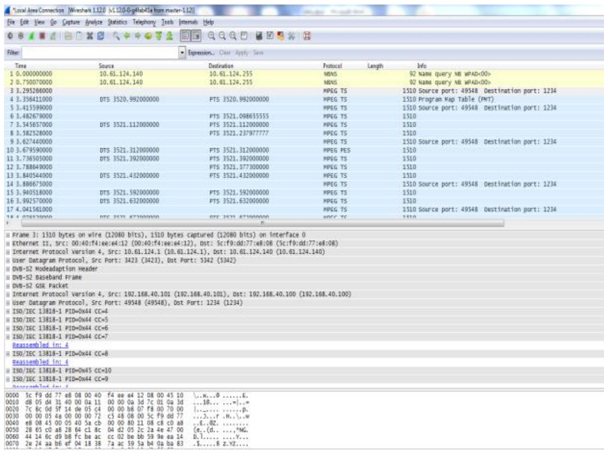

Fig.11. Encapsulation of MPEG-TS in GSE

5. CONCLUSION

In this paper we have presented the Implementation of Generic Stream Encapsulation Protocol over DVB-S2 in Linux Platform. It particularly focuses on the interests of this encapsulation protocol for IP services delivery. The set of features makes GSE a good entrant for the encapsulation protocol of DVB protocols. The Protocol is being analyzed by various other network layer protocol and MPEG-TS within GSE. We have also introduced the concept of routing, to send the packets to its destination.

6. REFERENCES

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