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Analysis of Digital Video Broadcast Second Generation Satellite (DVB-S2) for Simultaneous Voice Communication & TV Broadcast

Niamat Ullah Shah [a], Hamayoun Shahwani [a], Syed Attique Shah [a], Mohammad Imran [a], Muhammad Ashraf [a], Muhammad Akram [a], Muhammad Qasim [a], Zahid Rauf [a], Bakhtiar Khan Kasi [a]

[a] Faculty of Information and Communication Technology, Balochistan University of IT, Engineering and Management Sciences, Quetta, Pakistan
*Corresponding author: hamayoun.yousaf@buitms.edu.pk

***Abstract*-- The growing rivalry mainly in search of the audience in today's TV broadcasting industry has made the real-time gathering of latest national and international developments through contribution link, the most critical part. The communication among field staff/reporter and head office is through the cellular system. In areas with no mobile coverage, it is almost impossible to stay in touch and very difficult to share the latest updates. In this paper, a detailed study of Digital Video Broadcast- second generation Satellite (DVB-S2) standard used in Digital Satellite News Gathering (DSNG) link is carried out for the feasibility of two ways communication with the digital television broadcast. We have used communication system toolbox in MATLAB Simulink to implement our model. We created the system according to the DVB-S2 standard and also used RF Satellite channel instead of Adaptive White Gaussian Noise (AWGN) channel. Simulation results show that communication signal can be transmitted with digital video television broadcast in DVB-S2 baseband frame.**

***Keywords*- Digital Video Broadcast, Voice Communication, TV Broadcast**

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I. Introduction

In the digital television industry about 200 principle companies in technology, software development, and manufacturing, in co-ordination with broadcasters, network operators and regulators formed an association which is dedicated to produce open and flexible specifications standards through international standard bodies like European Committee for Electrotechnical Standardization (CENELEC) or European Telecommunication Standard Institute (ETSI) [1]. Digital Video Broadcast (DVB) project has developed different standards, like DVB-S for broadcasting digital media through satellite, for cable TV system DVB-C, for broadcasting digital television content through terrestrial standard is DVB-T and DVB-H a new prevailing TV format for mobile/Hand held devices and many more standards.

Digital Video Broadcasting-Satellite (DVB-S) standard define the parameters for the transmission of digital television broadcast signal through satellite. It outlines the modulation schemes and error correction systems for satellite television services. This standard uses quadrature phase shift keying (QPSK) modulation with Reed-Solomon convolutional code as error protection strategy and has compatibility with Moving Picture Experts Group-2 (MPEG-2) coded TV services. DVB-S (herein after refer as System) defines the Forward Error Correction (FEC), Modulation, Channel Coding and roll off factor for Broadcast Service via Satellite also known as BSS and fixed satellite [2] services bands. This standard is premeditated to deliver TV broadcast to headend stations, Direct to Home (DTH) signal, and Satellite Master Antenna Television-SMATV. Digital Video Broadcast-Second Generation Satellite (DVB-S2) can be used for different application by satellite due to its flexibility of standard. It is currently being used in almost all Satellite digital television channels. DVB-S2 [3] can accept multiple input transport streams (TS) of various formats. Higher data rates can be transmitted in the same satellite bandwidth with new standard. Spectral efficiency in digital communication is a measurement of bit rate that a given RF bandwidth can convey. With DVB-S2 a performance improvement of 30 % is achieved as compared with DVB-S while maintaining the same power and satellite bandwidth.

Abbreviations and Acronyms

DSNG	Digital Satellite News Gathering
DVB	Digital Video Broadcast
DVB-S	DVB-Satellite
DVB-S2	DVB-Second Generation Satellite

MPEG	Moving Picture Expert Group
FEC	Forward Error Correction
LDPC	Low-Density Parity Check
AWGN	Adaptive White Gaussian Noise
QPSK	Quadrature Phase Shift Keying
VCM	Variable Coding and Modulation
CNR	Central News Room
TS	Transport Stream
VSAT	Very Small Aperture Terminal
TDM	Time Division Multiplex
FDM	Frequency Division Multiplex
PSD	Power Spectral Density

Figure. 1 demonstrates the simplified diagram of a digital television channel. News from different sources like Digital Satellite News Gathering (DSNG) via satellite & Electronic News Gathering (ENG) are collected at Central News Room (CNR) which coordinates with different departments, within the news channel, and filed reporters. As soon as a story or news comes in, CNR department forwards that to the production department to get it ready to be on-air. The production department is responsible for getting the studio, production control room (PCR), news anchor and reporter from the field to be ready in coordination with CNR and technical department so that latest news can be broadcasted live for the viewers. Ingest department records the entire incoming news and archive department provides any supporting material for the news from the highly efficient media library. Multiple television broadcast services including sound and date can be incorporated within the same transmission capacity by exploiting the multiplexer flexibility. To multiplex these components on a single Satellite digital carrier it uses Time Division Multiplexing (TDM) [4].

Constant communication between field staff and News Room staff is mandatory in any news channel to get the latest updates without delay is of utmost importance. The communication among field staff and head office is through cellular phone service.

There are situations when filed staff, with DSNG Van, has to cover an event in such an area where mobile coverage is not available, like remote location and along the boarders or where mobile jammers are installed. In such circumstances it is not possible for the DSNG staff and news room to stay in contact with one another and provide the news about latest happenings to their viewers. In this paper we will study DVB-S2 standard in perspective to find the possibility of transmitting communication signal along with digital video broadcast signal. So that two way communications between CNR in head office and field reporter with DSNG can be take place even in the absence of other communication means.

Rest of the paper is organized as follows. In Section II, details of satellite connectivity i.e., DSNG is given. In Section III, DVB-S2 implementation in MATLAB is discussed using digital video broadcast signal. Results are shown in Section IV. Finally, the paper is concluded in Section V.

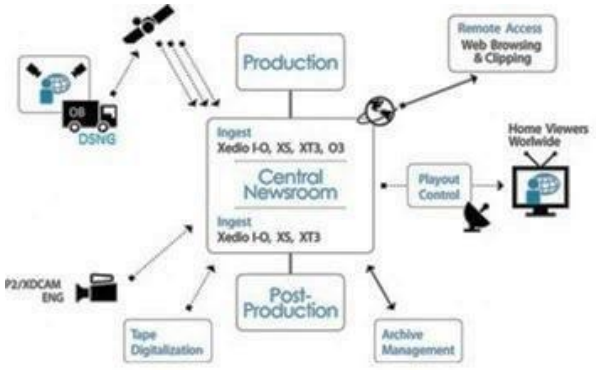

Figure 1: Block Diagram of Operational Department in a Digital Television Channel

II. SATELLITE CONNECTIVITY

Satellite Television has become the foremost and vital means for distributing information globally. The DVB-S2 is defined as operational block of apparatus which receives the input baseband digital signals encoded with the source codes specified in [5], [6], [7] and [8]. Figure. 2 shows the connectivity of different components via satellite that are involved in news channels broadcasting. Satellite links in any news channel are divided into two categories i.e., contribution links and distribution links

A. Contribution Link

These are the links through which filed staff and remote offices (called Bureau) sends feed and live audio/video to the head office to be incorporated with on-air programs/news bulletin. Contribution links include satellite links via DSNG vans/Satellite Fix Links and streaming links. Satellite links through DSNG are the main source to get the real-time live video coverage from any remote location in the field. [9], [10] The Ku band frequency spectrum is used for the contribution links between DSNGs and head office.

DSNG is defined as "transportable earth station which is capable of transmitting video or audio signal to single head office or multiple bureau offices so that it can be broadcasted to the viewers' [11]. This up-linking of signal to the satellite is for short periods and with very little setup time. Audio/video packets are carried in MPEG Transport Stream format. The symbol rate is matched to given transponder characteristics, and the frequency plan adopted. News channels rent the Ku band frequencies bandwidth and sliced that into a number of frequencies to facilitate a predefined set of satellite contribution links from DSNGs and Fix Links.

B. Distribution Link

All the latest stories from different sources including contribution link are gathered at Central News Room in head

office. After the post-production, final output audio/video signal goes to the uplink section which transmits the signal to broadcast satellite on distribution link on C band frequency spectrum to reach to the viewers. To communication with field staff from Central News Room and News Studio cellular service is used. There are occasions when field staff has to report an event from such a location where there is no cellular coverage or mobile jammers are installed and in such situations communication between field reporter and news studio is not possible. In such a situation, field staff can use satellite contribution links to send audio/video signal to the central newsroom and studio but news anchor in the studio cannot communicate back to the reporter.

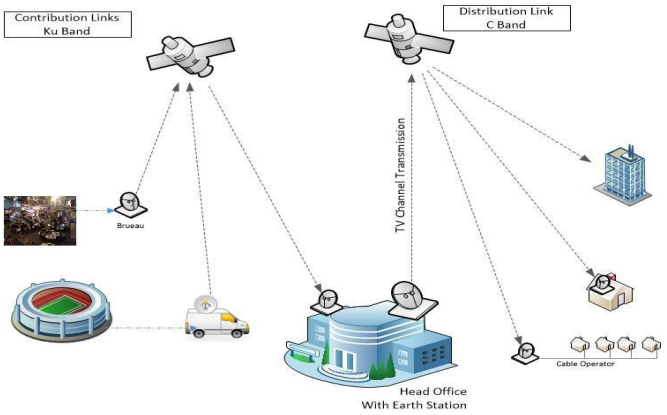

Figure 2: Satellite Connectivity in News Channel

III. DVB-S2 IMPLEMENTATION USING DIGITAL VIDEO BROADCAST SIGNAL IN MATLAB

In this section, we explained our design modelled in Matlab using communication's toolbox by utilizing in-built DVB-S2 Simulink. Implementation of LDPC decoder in DVB-S2 using Min-Sum algorithm is also explained in [12]. DVB-S2 model with our proposed model is shown in figure 3 which is implemented in Matlab. The foremost and important part of our system is the baseband signal generation. For incorporating audio communication channel, parameters and properties of baseband signal for the DVB-S2 system are studied. At the transmitter side the signal is transmitted on Ku band uplink frequency of 14.175 GHz and after passing through satellite and going through frequency translation signal is received by the receiver on Ku band downlink frequency of 11.125 GHz. A quaternary section Following assumptions and simplifications are considered for our simulation model.

- Transmitter and receivers are perfectly synchronized
- Each input stream has packet identifiers for the decoding and demultiplexing.
- Bernoulli binary sequence generator is used to model data field & baseband header of baseband frame for both video and communication signal.
- Implementation of normal FEC Frame (LDPC Block Length = 64800)
- One LDPC code word is processed in one unit of Simulink time

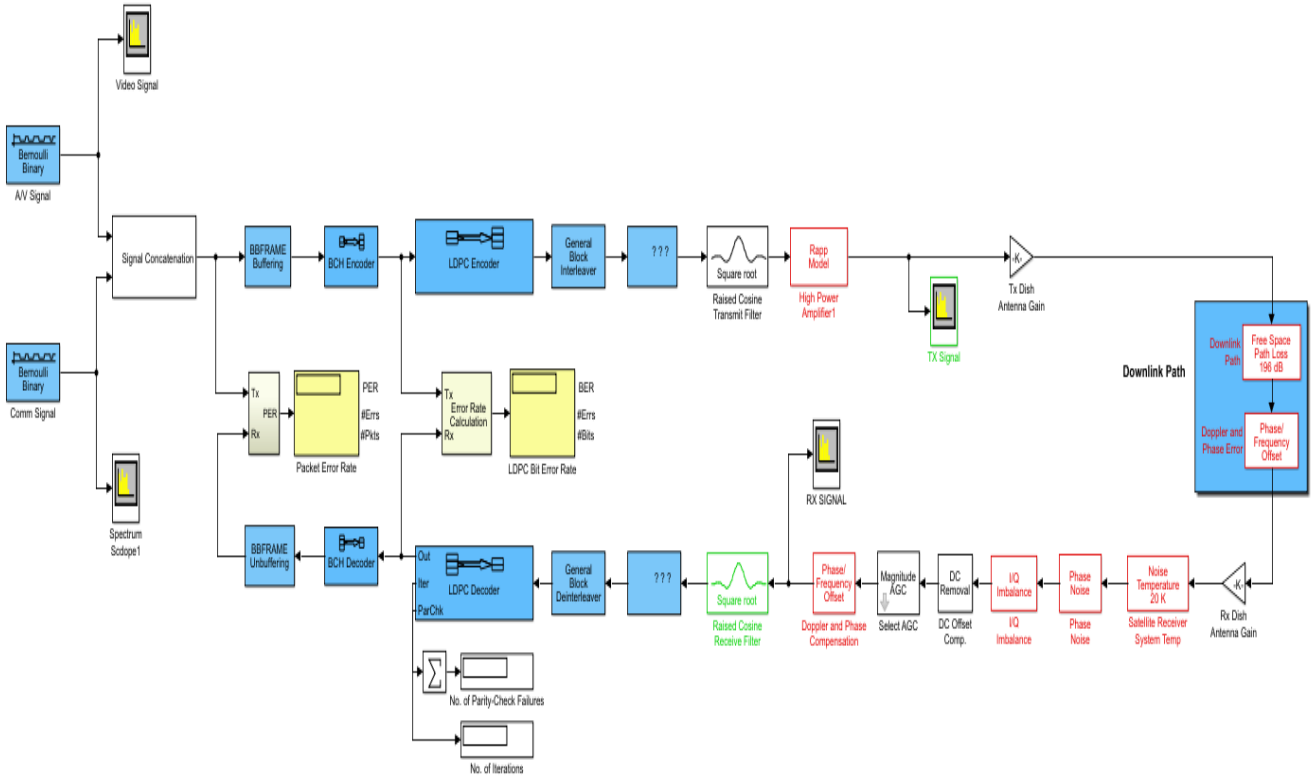

Figure 3: DVB-S2 Broadcast System with a communication channel

- For LDPC decoding it uses Es/No given by the user in input argument.
- Uses an RF satellite channel

IV. Simulation Results

In our simulation, we used Bernoulli random sequence generator to generate a balanced random binary sequence which acts as a source of video and communication signal packets. The output of Bernoulli generator is frame-based with length equal to MPEG packet which contains 188 bytes /1504 bits. In our model, we set the samples per frame to 752 for video signal source and 752 for communication signal source. If we divide the number of samples unequally then we encounter the sample time error in Matlab. In this way, we have embedded the communication channel bits into the basic source frame structure of DVB-S2.

The model was run for a number of simulations and results include BER, PER after encoding and Power Spectral Density of the signals at different stages are shown in figure 4, 5, 6, 7, 8, 9 and 10 respectively.

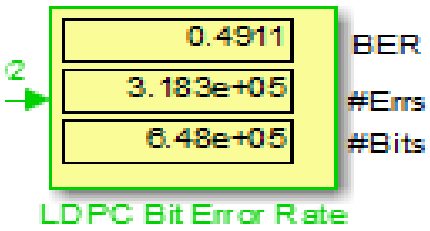

Figure 4: Bit Error Rate (BER)

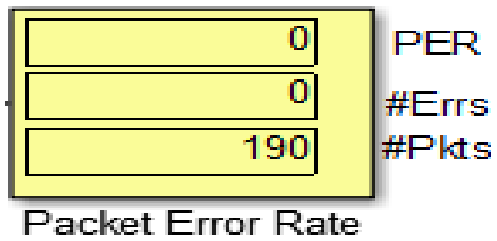

Figure 5: Packet Error Rate (PER)

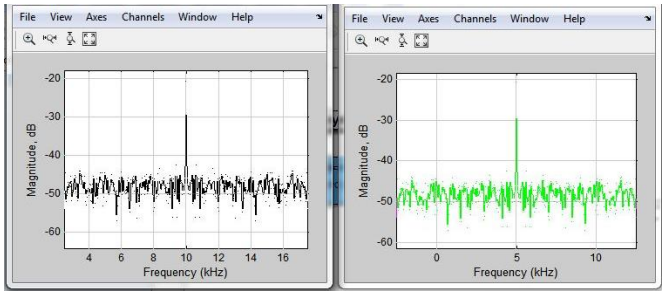

Figure 6: Input Video and Communication Signal Power Spectrum

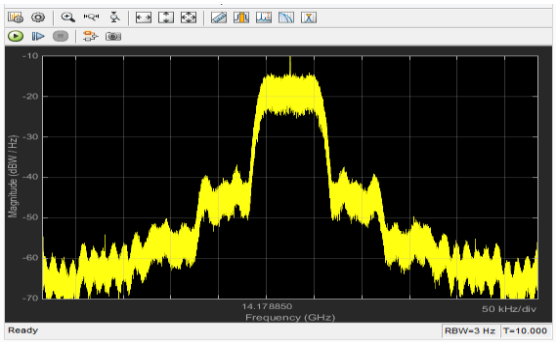

Figure 7: Transmitted Signal Power Spectral Density (PSD)

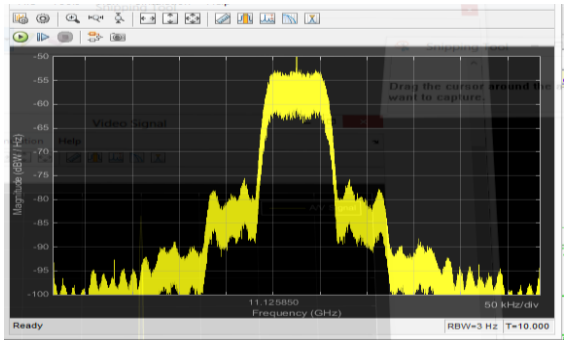

Figure 8: Received Signal Power Spectral Density (PSD)

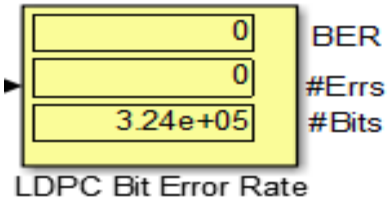

Figure 9: Bit Error Rate (BER) - DVB - S2

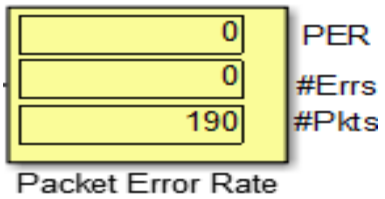

Figure 10: Packet Error Rate (PER) - DVB - S2

V. Conclusion

Primarily we acquired an in-depth understanding of the Digital Video Broadcast-Satellite (DVB-S) standards and the workflow of digital satellite television broadcast from the field. We have inspected the input Mode Adaptation, Baseband frame generation to incorporate the communication signal. Mathematical calculation and formation of Baseband Frame (BBFRAME) and FEC Frame (FECFRAME) in DVB-S2 system is incorporated for communication signal along with digital television broadcast signal. We have added the communication signal during the generation of Base Band Frame BBFRAME, by dividing the total bits in a frame between the two signals. Matlab Simulink is used to model our design and the system under the satellite link is checked. It is indicated form the simulation results that the communication signal can be integrated and transmitted with the digital video signal.

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