Smart Home realization through Wireless communication system

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Abstract— Over the few decades, the Communication Technology has evolved surprisingly. The data rate, the reliability and multiple access supported by wireless digital communication are very interesting. Accessibility of worldwide information from a remote area via digital signals is not less than any boon for human beings. Receiving information from a far satellite at home at TV screen via STB gave a new dimension to the entertainment world. This success story is further leading to the next generation (G) Internet of Thing (IoT) services for Global communication and M2M (Machine to Machine) communication. With the recent innovation in satellite communication, our Homes are getting SMART. Homes will be blessed by satellite based IoT at very low cost. IoT services will be provided by Satellite, 5G mobile and other competitive technologies. These technologies will enable us to get live interaction via smart devices of our smart home, to control and access our home appliances from anywhere throughout the world with its ubiquitous features. Transmission and Reception of signals from Home to Satellite via DVB-S2 and Indoor distribution of signals via Wi-Fi n within rooms of the Smart Homes is the basic concept behind this idea. Uplink from home will be introduced soon with help of smart LNB using Millimeter wave RF carrier of 30 GHz. This paper presents a cloud centric vision for implementation of IOT services in Smart Homes. DVB-S2 Transmitter, DVB-S2 Receiver and Wi-Fi n with input signal is analyzed on Agilent SystemVue and then synchronized with Agilent Vector Signal Analyzer (VSA) to check and verify the Output Response of the designed Smart Home system.

Keywords- DVB-S2, M2M, IOT, STB

I. INTRODUCTION

Implementation of latest technologies in daily life in order to make tasks pretty easier and smart is on its peak. Providing home owners an assurance of security, comfort and convenience at low operating cost is the basic motive behind Smart Home. The different appliances (i.e. Air Conditioning, heating, television, AV systems, computer, camera and other security systems) of a smart home has capability to communicate with each other. And can be operated and control remotely from any location, inside or outside the room via web access facility. A Smart Home is such an implementation of technologies like DVB-S2 transmitter, DTH receiver, Wi-Fi hotspot and various Wi-Fi receiving devices. DVB-S2 (Digital Video Broadcast – Satellite - Second Generation) is the second generation digital satellite transmission technology for broadband satellite application, developed by Digital Video Broadcast (DVB) project on the success of the first generation DVB-S's specifications. To deliver the best performance, DVB-S2 uses the latest channel coding and modulation techniques that made it to achieve performances approachable to the theoretical limit. Parity check codes of low density, with QPSK (Quadrature Phase Shift Keying), 8PSK,16APSK (Amplitude and phase-shift keying), and 32APSK modulations are adopted to properly run the system on nonlinear satellite channel. DVB-S2 is basically designed to broadcast services for SDTV (Standard definition Television) and HDTV (High Definition Television). News Gathering, terrestrial

VHF (Very High Frequency) /UHF (Ultra High Frequency) TV distribution, Digital TV contribution, Internet Trunking and other professional applications are also some amazing features of DVB-S2 technology. A DVB-S2 standard is briefly specified in context of the three basic concepts: best transmission performance approaching Shannon limit, the total flexibility of system and reasonable receiver complexity. DVB-S2 has flexibility to cope with the characteristics of previously existing satellites, with associated C/N (Carrier-to-Noise ratio) requirements and spectrum efficiency. It is not limited to audio source coding and MPEG-2 (Moving Picture Expert Group- 2). It has capability to pace and handle with a lot of audio- video and many more data formats including numerous formats defined by DVB project, for future applications and uses, having enough good features to replace DVB-S and DVB-DSNG with much better spectral efficiency. More Bandwidth (up to 30% of bandwidth saving), more Margin (up to 2.5dB gain in margin), more flexibility, less amplifier cost, less satellite cost, and comparatively small antenna size in DVB-S2 made it more popular. It is so close to Shannon's limit that most probably it might be the last DVB Standard. And this DVB-S2 used for transmission and reception of data will further be introduced to Wi-Fi n (802.11n standard). After successful establishment of Wi-Fi standards 802.11a, 802.11b, and 802.11g, work commenced to achieve capacity of delivering extreme data for todays' user application and high demand. IEEE 802.11n standard achieved this raw data speed. Wi-Fi standard 802.11n, an addition to Wi-Fi family, is a specification for WLAN (Wireless Local Area Network). Increasing WLAN speed, extended wireless transmission range and improved reliability, it uses wider radio frequency channel and MIMO (multiple input/multiple output) technology. In order to decrease time between transmissions, it uses frame aggregation. Unlike the request to channel by sending station, then send one packet, releasing the channel and again request and repeated process in current WLAN, 802.11n standard can transmit a continuous series of frames. With frame aggregation, these continuous series of frames can be transmitted without any need to regain authority for each frame, once channel is requested by station and authority to transmit. The raw data throughput with 802.11n is expected to reach nearby 600Mbps, that is more than 10 times greater than throughput of 802.11g. Our motive is to use this short range transmission frequency with high volume over a room or a small home i.e. Smart Home. And here comes idea of a Smart Home with parallel application of DVB-S2 and IEEE 802.11 Wi-Fi technologies.

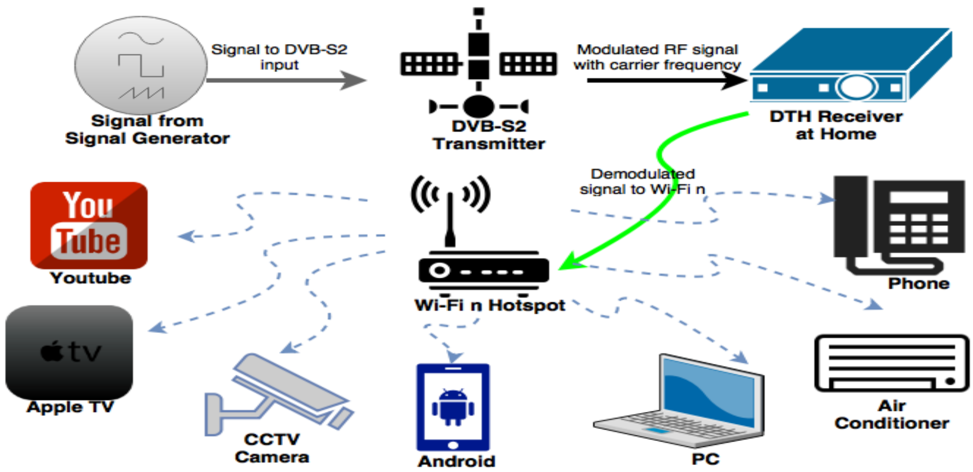

Figure 1. Basic idea behind Smart Home

As the figure above depicts it well that raw data input at DVB-S2 satellite transmitter transmitted over RF carrier frequency, is being received at home via DVB-S2 STB (Set Top Box). And the received data is being locally distributed over different devices in various rooms of home via Wi-Fi 802.11n.

II. LITERATURE SURVEY

Concept for SMART HOME and SMART LNB was first introduced by EUTELSAT at Europe. And as an Industrial partner, Ayecka is presently implementing such SMART HOME projects. Eutelsat enables and connected services with smart LNB and Machine to Machine (M2M) connectivity as its innovative applications via satellite connectivity. In this IoT era, things are getting smart with latest technology implementations. For user oriented Internet of Things applications, Smart Home concept can take benefit of being implement with satellite communication with help of DVB-S2 transmitter, receiver and 802.11n local transmission. This enables broadcasters, users and platform operator in expanding their limitations. This will help to enable an interactive user interface/infrastructure, can be use in audience or member's measurement inside, home automation from any location, applications in security parameters, controlling almost appliances with a gesture touch etc. The main objective of this paper is the implementation of DVB-S2 transmitter, receiver and Wi-Fi n distribution over Smart Home. Information or signal from signal generator is processed at input terminal of DVB-S2 transmitter via means of BBScrambler, Merger Slicer, BCH_Encoder, LDPC_Encoder, Bit_Interlever, CRC_Encoder, Mapper, PL_Framer, and PLScrambler etc to source element of transmitter part. Channel coding and different modulation applied in process, are based on recent development by deferent scientific communities: adaption of low density parity check codes (LDPC), being combined with QPSK, 8PSK, 16APSK, and 32APSK modulations for this system to properly work with the non-linear satellite channels. Receiver part of DVB-S2, in a similar way to DVB-S2 transmitter, has to perform the same process as demodulation technique to retrieve the originally transmitted signal. Receiver goes through the processes like PL_Descrambling, PLDemuxing, Demapping, LDPCDecoding, BCHDecoding etc. The received demodulates signal is then transmitted locally in rooms of Smart Home via IEEE 802.11n standard transmission. Wider channel bandwidth, OFDM implementation, MIMO and multiple input multiple output power saving are used to improve data throughput. Basically, utilization of MIMO in 802.11n is to carry high data rates. This provides maximum available bandwidth utilization. Previous system used bandwidth of 20 MHz, but newer improve in 802.11n standard have option for 40 MHz bandwidth too. The technologies associated with antenna has been significantly improved in Wi-Fi n by introducing diversity and beam forming etc. The IEEE 802.11n output process through the WLAN transmitter, OFDM (Orthogonal Frequency Division Multiplex) filter, SC (switched capacitor) Filter, Modulation, Demodulation and lastly WLAN transmitter via BER (Bit Error Ratio) measurement. OFDM is one among the important forms of modulation used in Wi-Fi n. This is a key factor among the entire modulations used in Wi-Fi n and generation of RF Signal formats. Orthogonal Frequency Division Multiplex provides capability of high data rate transmission. OFDM (Orthogonal Frequency Division Multiplex) is a transmission technique that avoids mutual interference of signals by making those signal orthogonal. And the signal carrying information, which is to be transmitted, splits across carrier supplying good resilience against selective fading multiple path effect. This paper describes the uses and applications of satellite based IoT (Internet of Things) for Smart Home considering a lot benefits, users' security and easy accessibility. The objective is to tackle the shortcoming of normal LNB, which is the basic limitation of interactive user experience. Simulation of all these steps are done by Agilent SystemVue, and Agilent VSA (Vector Signal Analyzer). Agilent 33250A Function / Arbitrary Waveform Generator is used to generate signal at DVB-S2 transmitter input. Sink data and spectrum analysis at different nodes are done in order to verify the proper functioning. Agilent MXG N5182A-503 Vector Signal Generator is used to transmit the simulated design's signal with help of signal downloader and Agilent Infiniivision DSO7032B Oscilloscope as receiver.

III. FEC ENCODING

Low Density Parity Check (LDPC) code, a simple block code with limited algebraic structure, is used by DVB-S2 technology in order to achieve the best performance. Having parallelizable and easy decoding algorithm, LDPC codes have various operational features like addition, comparison, table look-up and adjustable degree of parallelism. These features make it easy to complexities and trade-off throughput during processes. FEC (Forward Error Correction) is a widely used coding technology in communication system. It's a method to obtain the error control of transmission in which, the source (transmitter) transmits the redundant information data and receiver responses to the part of data containing no apparent error. Together with modulation, Forward Error Correction is the important part of system that helps in achieving excellent satellite performance, in presence of different interference and noises of high level. Being used in different communication applications, FEC is widely used in numerous optical communication systems as of its capability of lowering the BER (Bit Error Ratio). Using this, performance of a communication system can be improved in an efficient way. As per Shannon theorem, FEC can ensure that signal having information is transmitted over a channel (noisy channel) at Shannon limit (maximum rate) without any bit error.

A. Decision Methods

Basically two type of decision methods can be used by FEC coding: hard decision and soft decision. In hard decision, input of a FEC decoder consists single level binary bits, i.e. 0 and 1. High maturity and low complexity feature of hard decision makes it popularly used in wide scenarios. In soft decision, the FEC decoder input here, is a multilevel quantization signal. Although, the coding rate of hard decision and soft decision are same, coding gain in soft decision is higher in comparison to hard decision; though, processing complexity is greatly increased. Concatenated BCH (Bose, Chaudhuri, and Hocquenghem) outer codes having the same block length as of LDPC (Low Density Parity Check) code are introduced, to avoid possible errors. The BCH codes have 8 to 12 bits of correction capability, depending on configuration of inner LDPC code. Carrying concatenation of BCH outer code and LDPC inner code in FEC encoding, FEC coded blocks (frames) can have normal frame length of 64,800 bits or 16,200 bits for short frame length. Within a frame, FEC (Forward Error Correction) and modulation are constant when VCM (Variable Coding and Modulation) or ACM (Adaptive Coding and Modulation) are used. But might be change with different frame. There is chances of containing a mix of short and normal code blocks in transmitted signal. To separate these bits mapped at the same transmitted signal, bit interleaving is applied for 8PSK, 16APSK and 32APSK in FEC coded bits.

B. Mapping into Constellation

Satellite's digital transmission have limitations of power and bandwidth, as there is limited availability of these source. That's why, different transmission modes, Forward Error Correction coding and modulations are applied in DVB-S2, giving various trade-offs among power and spectrum efficiency. Depending upon system's requirement and selected modulation, different code rates of 1/2, 1/3, 1/4, 2/3, 2/5, 3/4, 3/5, 4/5, 5/6, 8/9 and 9/10 are available. In combination with Quadrature Phase Shift Keying (QPSK), 1/3, 1/4 and 2/5 coding rates were introduced with signal below noise level, which is exceptionally a poor link condition. Simulation demonstrates superiority of above discussed mode over BPSK (Binary phase-shift keying) modulation with combinational of code rates 1/2, 2/3 and 4/5.

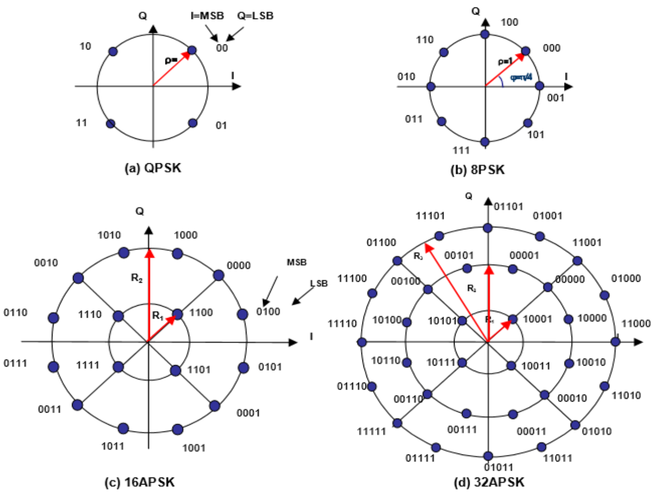

Figure 2. The four DVB-S2 constellations QPSK, 8PSK, 16APSK, and 32APSK before PLScrambling.

Depending upon the area of application, four modes of modulations: QPSK, 8PSK, 16APSK, and 32APSK (Shown in Fig. 2) can be selected for the transmitted payload. Spectrum efficiencies ranging from 0.5 to 4.5 bits per symbol are available and may be opted by selecting the code rates and modulation constellation depending upon the capability of satellite transponder being used.

QPSK (Quadrature Phase Shift Keying) and 8PSK (8 Phase Shift Keying) being virtually constant modulations and also applicable in non-linear satellite transponder, are considered for broadcast applications. If pre-distortion schemes are employed properly, 16APSK provides extra efficiency in spectrum for interactive applications with multi-beam satellites and specific broadcast applications like regional spot beams. 32APSK modes are mostly used in professional applications. 32APSK can be used for broadcasting purpose, but in this case, uplink station requires some adaptability in advanced pre-distortion method. In order to minimize the nonlinearity effect of transponder, this adaptability is required with a higher level of available C/N (Carrier-to-Noise ratio). Since these modes are less power efficient in comparison to other, the data throughput is comparatively much greater. By placing the points of the constellation on the circle, the 16APSK and 32APSK constellations have been optimized to make it operational over the non-linear transponder. Nonetheless, their linear channel performance is respectively comparable with the linear channel performance of 16QAM and 32QAM. Operation of all Theses modes discussed here, are also appropriate for use in quasi-linear satellite channels in multi-carrier FDM application.

***C.* Bit Mapping into QPSK Constellation**

Each FEC (Forward Error Correction) FRAME can have normal FECFRAME length of 64,800 bits, or 16,200 bits for short FECFRAME length. These each FECFRAME shall be converted Serial to Parallel with parallelism level = ηMOD (i.e. 2 for QPSK, 3 for 8PSK, 4 for 16APSK and 5 for 32APSK).

Generating variable length IQ sequence, depending on ηMOD (modulation efficiency), each FCFRAME are mapped into constellation with FECFRAME as input sequence and output sequence as complex FECFRAME (XFECFRAME). These sequences are composed of 16,200/ηMOD for short XFECFRAME or 64,800/ηMOD for normal XFECFRAME modulation symbols in complex vector IQ format. (where I is in-phase component and Q

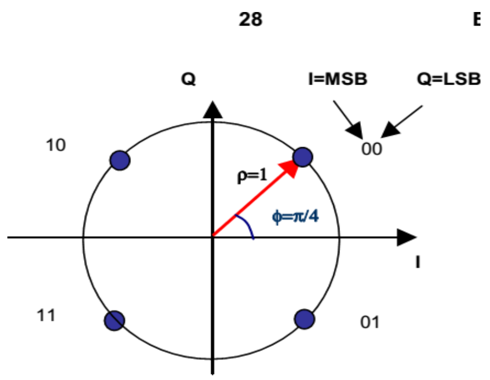

Figure 3. Bit mapping into QPSK constellation

is the quadrature component). Modulation symbols may be in equivalent format i.e. ρ exp(jφ) (where ρ is vector modulus and φ is phase).

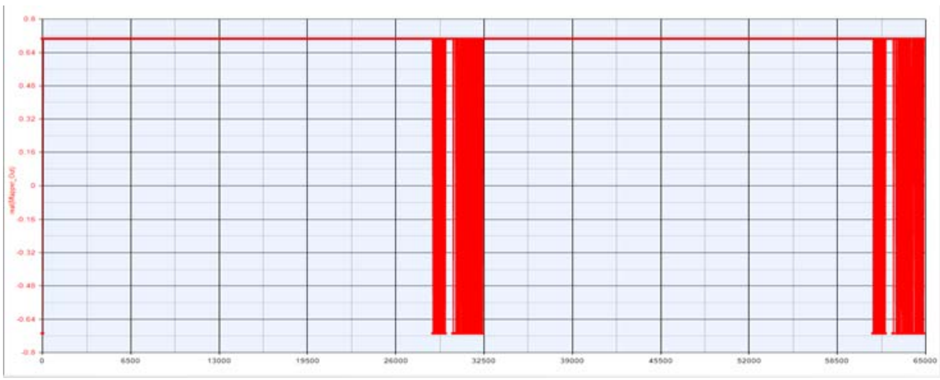

Figure 4. Waveform of PL Frame showing followings

i) the BB HEADER of 80 Bits
ii) with DFL part All 1
iii) BCH encoder Parity Bits
iv) LDPC encoder Parity Bits
v) PL Frame Length = ½ of BB Frame Length with ηMOD =2 for QPSK modulation

For better Clarity in understanding, all the three waveforms are shown in one graph.

Figure 5: Waveform compared for

i) BB Frame (RED)
ii) FEC FRAME (Blue) and
iii) PL Frame (Green)

IV. The Smart Home Constituents

A. DVB-S2 System

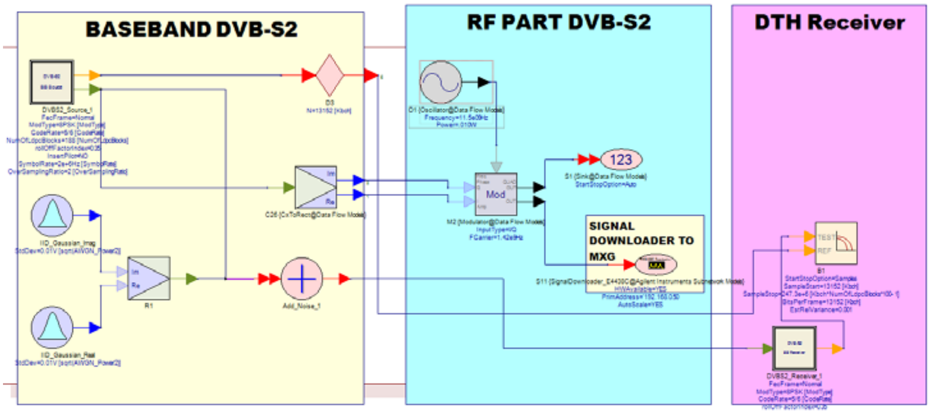

Figure 6. DVB-S2 Tx-Rx

DVB-S2 transmitter is the transmitting part of DVB-S2 system. It uses encoding techniques to encode the input signal and then transmit with help of 11.5e+09 Hz carrier frequency. The signal need to be transmitted, processed through various encoding techniques like CRC_Encoder, BCH_Encoder, LDPC_Encoder etc.

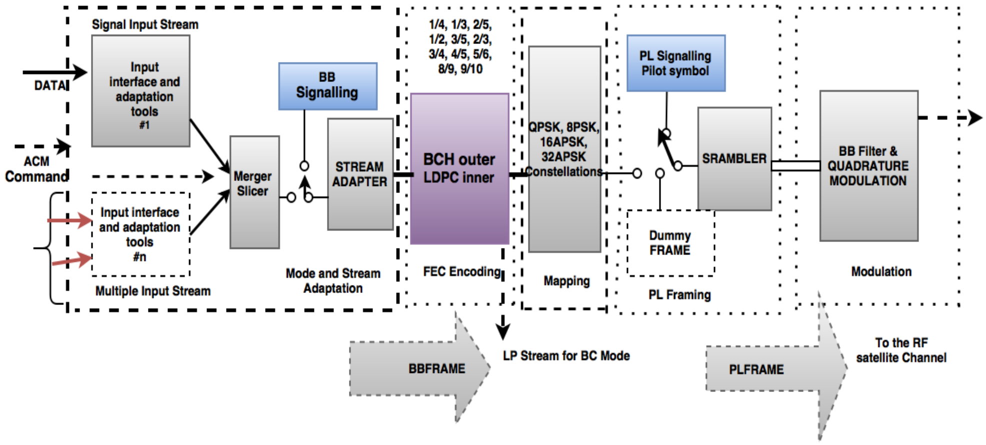

Figure 7. DVB-S2 Transmitter Block Diagram

The DVB-S2 transmitter block diagram above gives the basic idea of transmission. The flexibility of this new architecture makes it capable to cope with characteristics of other satellite transponders already existing. DVB-S2 transponder has spectrum efficiencies with a large variety in comparison to DVB-S technology. The schematic of the functional block of Digital Video Broadcasting - Satellite - Second Generation (DVB-S2) represented in fig.7 depicts different levels of signal generation. The two levels of framing structure: BBFRAME and PLFRAME are basically involved in the process.

At BB (Base-Band) level, BBFRAME carries a variety of signal bits, helps in flexible configuration of receiver as per the application scenario. The BBFRAME (Base-Band frame), has a more fulfilled signaling functionality, for configuration of the receiver as per the application scenarios. Constant Coding and Modulation or Adaptive Coding and Modulation (CCM or ACM), generic or transport stream, and single or multiple input streams are some example of receiver’s application scenarios. At PL (Physical-Layer) level, the PLFRAME has been deigned to carry signal bits that are a bit highly protected, providing signaling and the robust synchronization at the physical-layer. Thus a receiver can easily synchronize and detect the coding parameters and modulations before FEC decoding and demodulation. Here synchronization refers to phase and carrier recovery, and frame synchronization.

B. DVB-S2 Transmitter

The DVB-S2 transmitter encoded the input signal with different constituting encoders like BBScrambler, CRCEncoder, MergerSlicer, BCHEncoder, BitInterleaver, LDPCEncoder, Mapper, PLFramer, PLScrambler and then proceeds for transmission of the input signal. On carrying out the concatenation of Bose-Chaudhuri-Hoquenghem (BCH) outer codes and Low Density Parity Check (LDPC), inner codes for Forward Error Correction (FEC) can have the code rate 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10. And for normal frame length, the Forward Error Correction (FEC) coded block length is n ldpc = 64,800 bits or 16,200 bits for short frame length depending upon the application area.

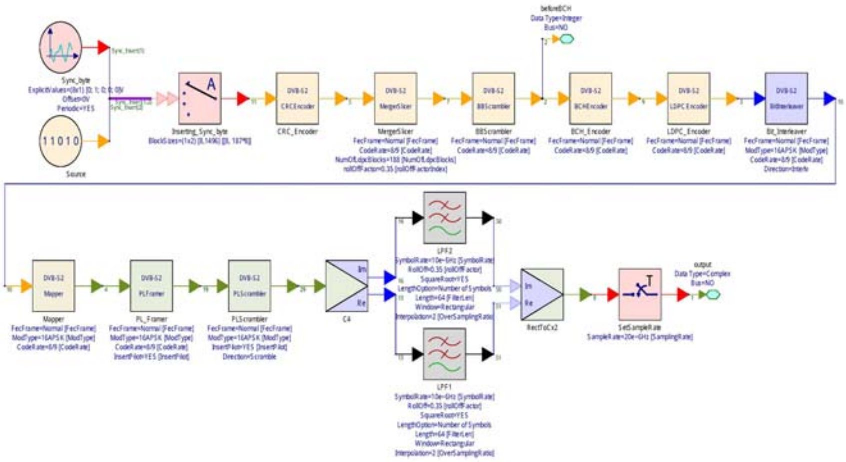

Figure 8. DVB-S2 Transmitter Simulation Design

In order to provide PLSignaling, PLFRAME insertion and PLScrambling for dispersal of energy, Physical Layer (PL) Framing is applied in a synchronous way with the Forward Error Correction frames. For generating the RF (Radio Frequency) signal and shaping of the signal spectrum (roll-off factor= 0.35 taken here) of input signal, Quadrature Modulation and Base-Band filtering is applied. The Arbitrary Waveform generator generates the arbitrary waveform constituting with the Random Bit Generator. The waveform might be repeated as the Periodic parameter of Waveform is set to YES. The random bit generator here generates a sequence of random bits and then signal passes to AsyncCommutator (Asynchronous Data Commutator). Input streams at AsyncCommutator is asynchronously combined to one output stream from N inputs. The CRC encoder is used for implementation of CRC-8 encoder. Each firing, 188*8 bits input tokens are consumed and same bits of output token generated. Proceeding by 8-bit CRC encoder, the generator polynomial follows g(X) = (X 5+X 4+X 3+X 2+1)(X 2+X+1)(X+1) = X 8+X 7+X 6+X 4+X 2+1. And then stream as Packetized Input Stream to DVBS2 MergerSlicer's input, where each firing, the input tokens consumed are NumOfLdpcBlocks*DFL bits and NumOfLdpcBlocks*K bch bits are generated as output tokens. Next block is the BBScrambler (baseband scrambler). The error protection comprises of baseband scrambler, a BCH (BoseChaudhuri-Hoquenghem) block encoder, and an LDPC (Low Density Parity Check) encoder which is further followed by the Bit-interlever. In DVB-S2 source, the BBFRAME including padding-block and BBHeader are first scrambled (i.e. BBScrambler). And then further supplied to the Forward Error Correction block where Bose-Chaudhuri-Hoquenghem code is first added. Next to that, another error protection, length to which depends on the selectable code rate appending to the Low Bit Parity Check encoder. The possible cade rates might be 1/2, 3/5, 2/3, 3/4, 4/5 or 5/6. The DVB-S2 Mapper is implement for constellation mapping which is connected with the PL_Framer (physical layer framing) for implementation of physical layer framer process. The SetSampleRate (Set Signal Sample Rate) associates the sample rate and creates timed signal at output with its input signal.

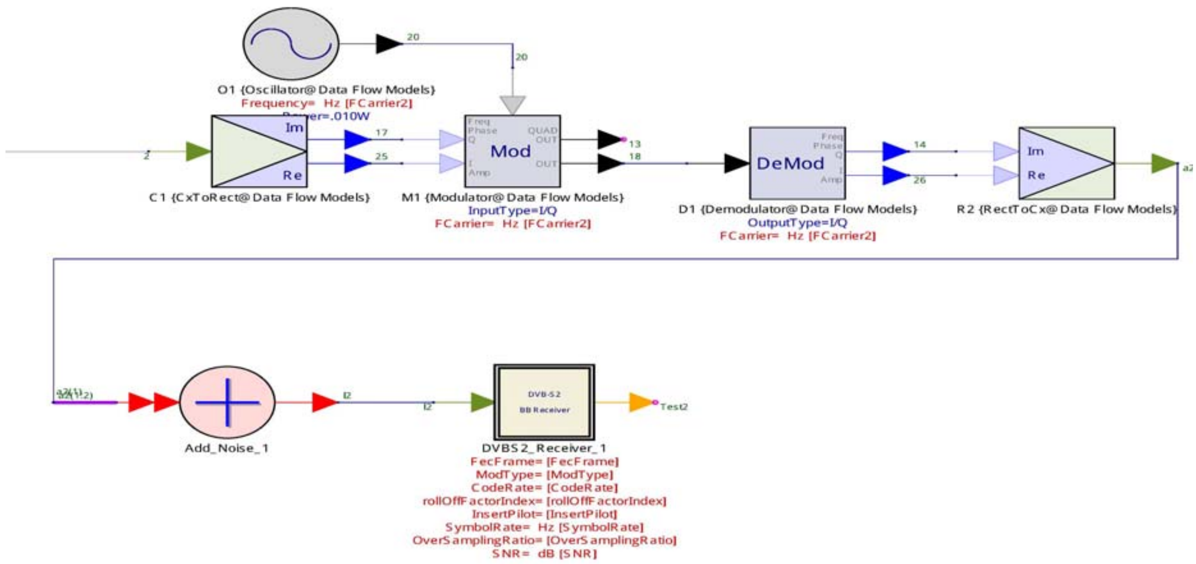

Figure 9. Implementation of Carrier Frequency Over Signal

Output to the DVB-S2 transmitter is further carried out via double CxToRect. It converts input complex values from SetSampleRate of transmitter to real and imaginary values at its output, attached to modulator. This modulator is capable to perform frequency, amplitude, phase, or I/Q modulation. It reads one input sample, modulate, and write one sample as output in addition to the oscillator with Carrier Frequency of 11.5 GHz and 0.01 W of power.

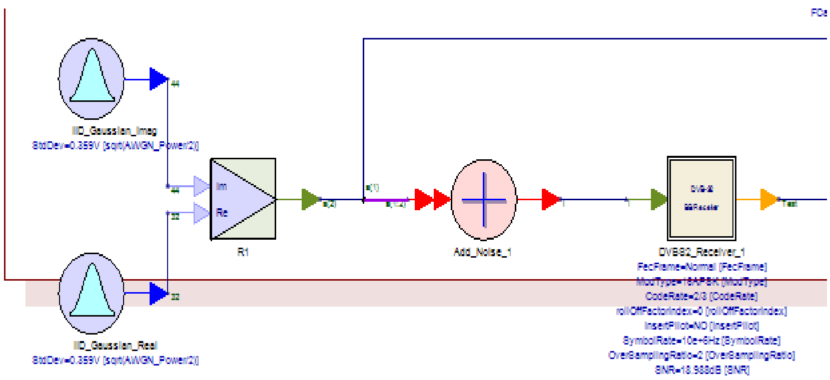

Figure 10. Addition of Noise Signal

Modulated signal is carried out by DeMod (Demodulator) and converted to a complex value via double RectToCx. The Multiple Input Adder reads 1 sample from all input signals and produces 1 sample as sum of the input signal at its output.

C. DVB-S2 Receiver

DVB-S2 receiver down-converts the transmitted signal after receiving. And further demodulate it to generate a meaningful message at output. The entire process is carried out with help of various components inbuilt inside i.e. Downconverter, DVBS2 Demapper, DVBS2 FrameSync, DVBS2 LDPCDecoder, DVBS2 PLDemuxFrame, BB Receiver etc. The received complex input signal is converted to real and imaginary values at output of CxToRect. LPF_RaisedCosine (Low-pass Raised Cosine Filter) consumes Decimation number of input samples and in every execution Interpolation number of samples are produced at output. The complex value is down-sampled by Data Block Chopper reads a block of nReads=2 samples producing nWrite=1 sample at output.

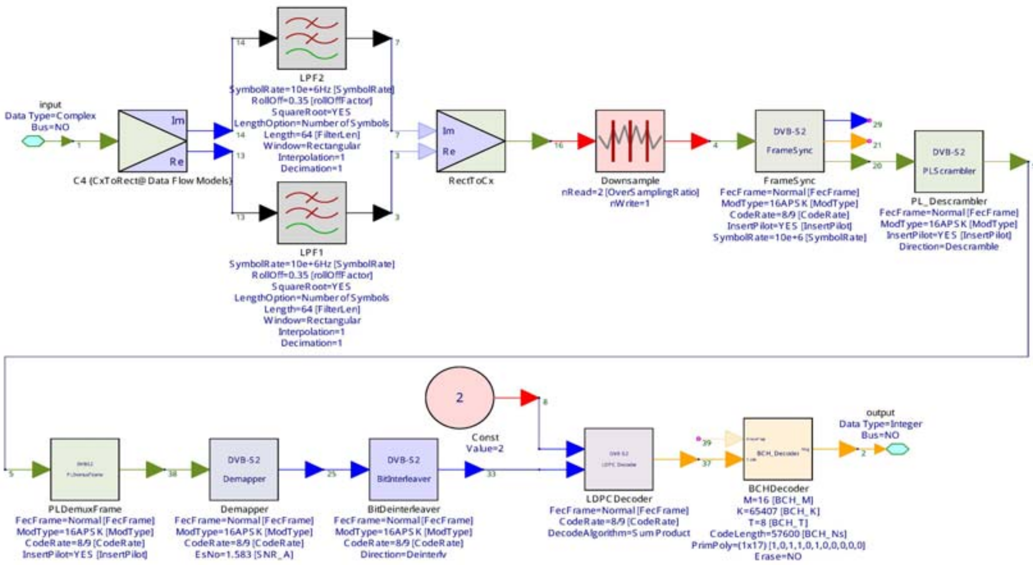

Figure 11. DVB-S2 Receiver Simulation Design

FrameSync block is for frame synchronization. At FrameSync, the input signal at correlator is sampled at rate of one sample per symbol with ModType= 16APSK, SymbolRate=10 MHz and CodeRate= 8/9. Firstly, it is decoded differentially and the resulting sample are further sequentially shifted with the final processing of peak search algorithm. PLScrambler (Physical Layer Scrambler) used in scramble direction having 16APSK ModType. The entire demodulation process goes with 16APSK ModType and CodeRate of 8/9 which is required, as were used in modulation. DVBS2_PLDemuxFrame carries out the reverse process of DVBS2_PLFramer, removing the PLHeader (Physical Level Header) and pilots. And the signal passes through constellation demapper for DVB-S2 (DVB-S2_Demapper) with Es versus noise density set at 1.583. The DVB-S2_Demapper performs soft demapping by transforming the received symbol values into log- likelihoods. BitInterlever in DVB-S2 receiver implements the bit level in Deinterlv (Deinterleaver) direction for 16APSK modulation formats. The inner channel decoding is done by Low Bit Parity Check (LDPC) Decoder with Sum Product algorithm. Each firing, the output generated are K ldpc(=N bch) bits concatenated to Const (Constant generator) with consumption of Nldpc bits tokens as input Constant Generator. The Const produces output with parameter value =2 finally being decoded by BCH_Decoder. Defined Root of generation polynomial (M), Primitive message length (K) and Error correction capability (T) for BCH_Decoder are 16; 65407 and 8 respectively with Code_Length of 57,600. It decodes the primitive binary systematic code of BCH (Bose-Chaudhuri-Hocquengham). And the final demodulated signal is further distributed locally over IEEE 802.11n. with carrier frequency of 2.4 GHz.

D. Wi-Fi n (IEEE 802.11n Standard)

IEEE 802.11n commonly known as Wi-Fi n wireless-networking standard, is used for local transmission of received signal via DVB-S2 receiver. Input signal at Wi-Fi n source processed through WLAN_11n_PSDU_generation, WLAN_11n_DataWrap, WLAN_11n_Scrambler, WLAN_11n_ChCoder, StreamParser, STBC, MuxOFDMSym, and FFT_Cx (Complex Fast Fourier Transform) etc. in order to generate WLAN 802.11n BaseBand signal. 40 MHz bandwidth parameter is taken with BCC coding type and zero windowing length. Each firing, a whole packet of WLAN 11n generated with consumption of HTlength × 8 information bits at each firing. Complex signal, generated at WLAN 11n source converted to real and imaginary values via complex to real and imaginary converter (double CxToRect). Further modulation is processed with dispersion of 104 MHz carrier frequency over signal. In order to provide a desired amount of amplification to the modulated Wi-Fi n RF converted signal, Nonlinear Amplifier with Noise Figure is required. It models a non-linearity of signal including noise figure in addition to use with complex envelope signals. Its nonlinearity is basically defined by different parameters like GCType, dBc1out, PSat, RappS, GCSat, TOIout, RefR and GComp.

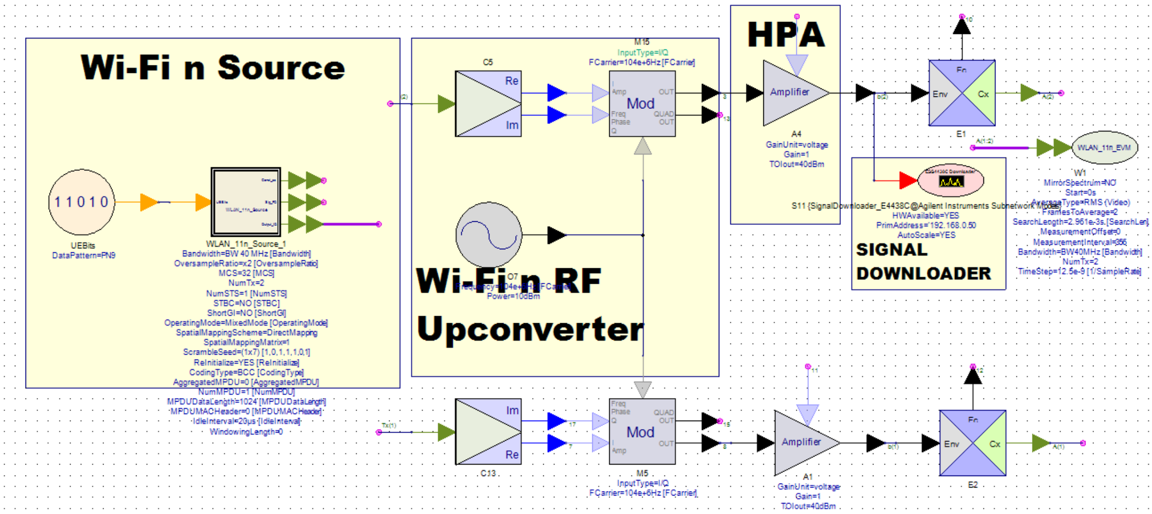

Figure 12. Wi-Fi n (IEEE 802.11N) Hotspot Design

One sample read and one sample write technique is followed here with gain =1 and 40dBm of TOIout. SignalDownloader_E4438C acts as the interface between the software and hardware to transmit the desired modulated RF signals providing a specified power level. The additional hardware instrument control is being command via the SCPICommand (Standard Commands for Programmable Instruments) parameters via Agilent SystemVue. The entered SCPICommands are executed just before the RF power turn on and the RF signal modulation.

V. RESULT

A stable waveform of 1KHz tone from Agilent 33250A Function / Arbitrary Waveform Generator connected at input of DVB-S2 Baseband is transmitted with RF carrier. The received signal at DTH receiver is linked to output of Wi-Fi n source.

Figure 13. Stable 1KHz signal waveform

The output to Wi-Fi n simulation designed on Agilent SystenVue is dumped in Agilent MXG N5182A-503 Vector Signal Generator from via SignalDownloader_E4438C (Signal Downloader for Agilent ESG E4438C and MXG N5182A RF Signal Synthesizers). 104.00 MHz carrier frequency is used for transmission of Wi-Fi n modulated signal providing specified power of 3.00 dBm. Since Wi-Fi n uses carrier frequency range of 2.42 GHz-2.47 GHz, but here carrier frequency is manually set to 104.00 GHz as Agilent Infiniivision DSO7032B Oscilloscope can receive signal within range of 350 MHz only.

Figure 14. Wi-Fi n signal dumped in Agilent MXG

The Agilent MXG N5182A RF Signal Synthesizer's Radio Frequency output is connected with antenna to transmit the Wi-Fi n signal for local distribution purpose. Reception of transmitted Wi-Fi n signal is analysed on

Agilent Infiniivision DSO7032B Oscilloscope in time and frequency domain applying different windowing like Hanning, Flat-top, Rectangle, and B-H (Blackman-Harris) windows.

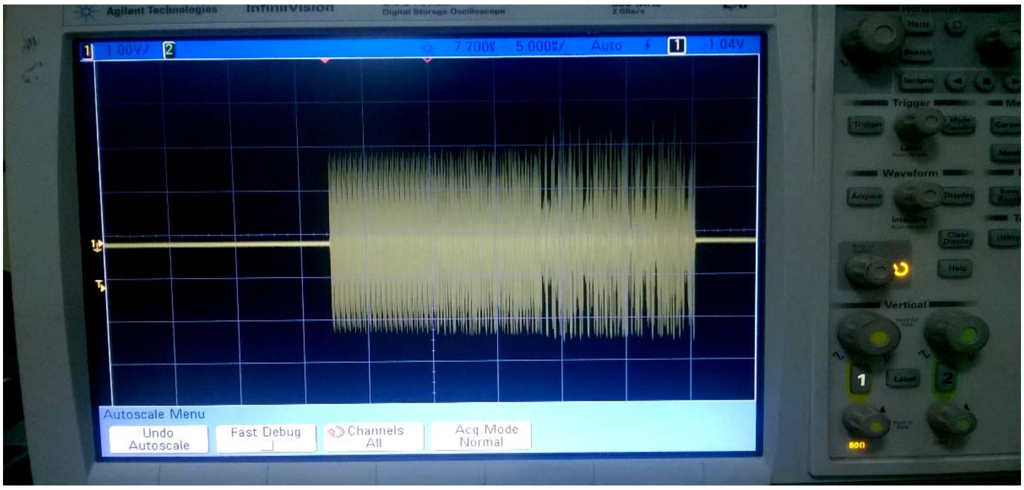

Figure 15. Received signal in time domain on DSO7032B

The stable waveform of 1KHz tone from Agilent 33250A Function / Arbitrary Waveform Generator is obtained on Agilent DSO7032B Oscilloscope in time domain after DVB-S2 transmission, receiving at home and local distribution through IEEE 802.11n. Window function (tapering function or apodization function) mathematical function is applied to make function zero outside spectrum bandwidth. It makes comparing and calculation easy over peak lobe and side lobes.

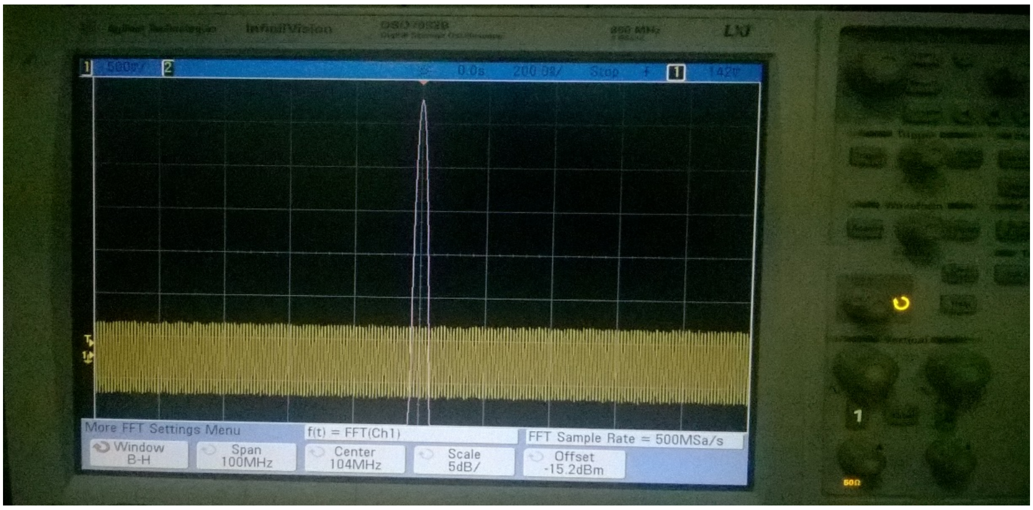

Figure 16. Peak line showing carrier frequency

Spectrum of carrier frequency dispersed over signal applying various windowing is received with certain parameters:

Window = B-H

Span = 100 MHz

Carrier frequency = 104 MHz

Scale = 5dB/division

Offset = -15.2 dBm

f(t) = FFT (Fast Fourier Transform)

FFT Sample rate = 500MSa/s

Voltage Scale = 500mv/division

Time Scale = 200ns/division

Spectrum of Wi-Fi n signal transmitted with carrier frequency of 104.00 MHz is received on Agilent DSO. The dispersed carrier frequency over signal is shown above applying Fast Fourier Transform over the function f(t).

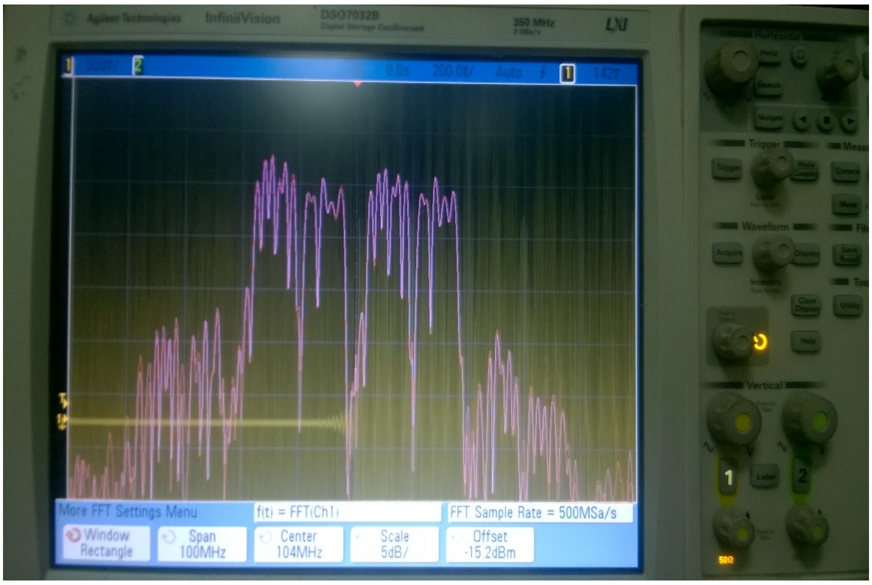

Figure 17. Signal spectrum in Rectangular Window

The simplest window, Rectangular (boxcar or Dirichlet window) window applied over spectrum. Rectangular window applied over spectrum makes it equivalent to replacing all but *N* values of a data sequence by zeros, making it appear as though the waveform suddenly turns on and off:

$$\omega(\eta) = 1$$

Figure 18. Signal spectrum in Blackman-Harris Window

Aadding more shifted sinc functions meant to minimize side-lobe level, Blackman-Harris window applied with FFT Sample rate of 500Msa/s.

Figure 19. Signal spectrum in Flat-Top Window

A partially negative values window having flat top in frequency domain (i.e. Flat-Top window) is applied for the measurement of amplitudes of sinusoidal frequency components. They have a low amplitude measurement error suitable for this purpose, achieved by the spreading of the energy of wave over multiple bins in the spectrum. Spectrum received on DSO is shown above applying Flat-Top window.

Figure 20. Signal spectrum in Hanning Window

Side lobes in Hanning window are comparatively below than other applied windows earlier providing more peak to side lobe ratio.

VI. RESULT

In this paper, satellite based IOT for smart home application is synthesized. The main characteristics of DVB-S2 system, describing the main modulation/demodulation algorithms for a signal transmission implementation, including receiver synchronization is explored. Signal transmitted over DVB-S2 is further received at DVB-S2 receiver (DTH Part) after demodulating the signal. DTH simulation output linked to Wi-Fi n input is transmitted locally with help of 802.11n simulation on Agilent SystemVue. And locally transmitted message signal via 802.11n with carrier frequency of 104.00 MHz (Since DSO has range limit of 350 MHz, but in hardware transmission and reception, 2.4 GHz range will be used) is received on Agilent Infiniivision DSO7032B Oscilloscope in time and frequency domain. Spectrum were analysed applying different windowing. Testing of signals at different levels of design and simulation like at Baseband level, Receiver level, 802.11n hotspot level and final phase are helpful in verification of final demodulated signal received at DSO. Thus, this paper will enlighten a better understanding of SMART HOME implementation using wireless communication and progress towards an IoT. And will be helpful by providing a comprehensive view for integration of DVB-S2, Wi-Fi n and similar functional elements which are operational over delivering IoT.

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