International Journal of Information Technology and Management

Vol. VI, Issue No. II, May-2014, ISSN 2249-4510

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AN INTERNATIONALLY INDEXED PEER REVIEWED & REFEREED JOURNAL

www.ignited.in

International Journal of Information Technology and Management
Vol. VI, Issue No. II, May-2014, ISSN 2249-4510

An Analysis of Parameters of Cable TV in Digitization Network in Area of Broadcasting

N. Govardhan[1] Dr. Syed Musthak Ahmed[2] Dr. B. K. Madhavi[3]

[1]Assistant Professor, Department of ECE, SR Engineering College, Warangal

[2]Professor, Department of ECE, SR Engineering College, Warangal

[3]Professor, Department of ECE, Keshav Memoral Institute of Technology, Hyderabad

Abstract – This paper is a survey of the transmission techniques used in digital television (TV) standards worldwide. With the increase in the demand for High-Definition (HD) TV, video on-demand and mobile TV services, there was a real need for more bandwidth-efficient, flawless and crisp video quality, which motivated the migration from analogue to digital broadcasting. In this paper we present a brief history of the development of TV and then we survey the transmission technology used in different digital terrestrial, satellite, cable and mobile TV standards in different parts of the world. First, we present the Digital Video Broadcasting standards developed in Europe for terrestrial (DVB-T/T2), for satellite (DVB-S/S2), for cable (DVB-C) and for hand-held transmission (DVB-H).We then describe the Advanced Television System Committee standards developed in the USA both for terrestrial (ATSC) and for hand-held transmission (ATSC-M/H). We continue by describing the Integrated Services Digital Broadcasting standards developed in Japan for Terrestrial (ISDB-T) and Satellite (ISDB-S) transmission and then present the International System for Digital Television (ISDTV), which was developed in Brazil by adopteding the ISDB-T physical layer architecture. Following the ISDTV, we describe the Digital Terrestrial television Multimedia Broadcast (DTMB) standard developed in China. Finally, as a design example, we highlight the physical layer implementation of the DVB-T2 standard.

Digitization of cable television in India is an important and necessary step for regulating cable television sector in India and to bring transparency in the system to benefit all stakeholders, including consumers and cable operators. The Cable Television Networks (Regulation) Amendment Bill, 2011 mandated that all Cable companies should convert their analogue systems to digital in four metros by 31 March 2012 and whole country should go digital by 31 December 2014. The Act also requires the cable operators to submit reports on the total number of subscribers, subscription rates, and the number of subscribers for free-to-air and pay channels.

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INTRODUCTION

Cable modem termination systems (CMTSs) can report a variety of operating parameters to the end user. For example, CMTSs that use Broadcom BCM3137, BCM3138, or BCM3140 or Texas Instruments TNETC4522 series upstream burst receivers can provide an “upstream SNR” estimate. This function is a very useful tool, but it has resulted in much confusion. It is not unusual for a cable company’s network operations center (NOC) staff to report an alarm condition when the reported upstream signal-to-noise ratio (SNR) of the CMTS drops below a defined threshold. A headend technician follows up by checking the upstream RF performance with a spectrum analyzer or similar test equipment, only to find that everything appears normal. Data personnel in the NOC insist there must be a problem, while outside plant technicians see nothing amiss on their test equipment. What is going on here?

The discrepancy occurs from a lack of understanding about just what the CMTS upstream SNR estimate is – and what it is not. Further confusion comes from the fact that cable modems and digital set-top boxes (STBs) can provide digitally modulated signal operating parameters such as RF signal level and SNR. These are downstream parameters at the customer premises, not upstream parameters as is sometimes incorrectly assumed. In addition, test equipment used by cable operators to characterize digitally modulated signals can measure downstream – and in some cases upstream – modulation error ratio (MER). Some of these instruments call this parameter SNR.

Digital Video Recorders have created a paradigm shift in consumer television viewing habits by allowing viewers to control what, when and how they watch television content. A DVR is a digital set-top box with a hard disk drive which enables viewers to record, store and ultimately personalize their viewing experience. Going beyond basic time-shifting of broadcast television, DVRs allow consumers to playback content using 'trick-mode' functions such as fast-forward, pause and fast-reverse. The popularity of DVRs is undisputed and they have become an integral part of cable and satellite TV offerings. Operators report a significant reduction in customer churn, increased ARPU (average revenue per user) through rental fees, and increased customer satisfaction when DVRs are deployed in the home. The table to the left illustrates the rapid and sustained growth of this market.

INTERNET VIDEO STREAMING

Today, visual media are used in a multitude of application scenarios. Understanding the different classes of video applications is important as they pose different sets of constraints and requirements and therefore, involve different choices for system design. This study first provides a brief overview of the diverse range of video communication applications. It then reviews the state of the art in digital video transmission, focusing on recent advances in Internet video and the associated areas of research. New challenges in video streaming are then introduced, namely the issue of video quality and its potential role in Internet video adaptation that this research addresses. A detailed review of work on video quality measurement techniques is presented, which serves as the foundations that the work of this research is based upon.

Specifically, digital video is now an important medium for communications and entertainment on the Internet. While video services are still predominantly carried over specialised networks, such as terrestrial digital TV (DTV), cable, satellite, or circuit-switched networks, the growth and popularity of the Internet has motivated video communication over best-effort packet networks. At first sight, the Internet seemed unsuitable to support video services since digital video is characterised by high bandwidth demands, error intolerance and requirements for low delay.

However, research and development in video compression, adaptive rate control, congestion control, error protection and other related areas, have proven that video can be efficiently and effectively transmitted over a network that does not offer any explicit quality of service (QoS) guarantees. The quality of a video application is usually difficult to measure or quantify in an unambiguous, universal manner. Quality is a multi-parameter property related to the nature of the application and the context of its use. In some cases, application quality is synonymous to the level of satisfaction or enjoyment of the human viewer. In others, to the degree that the application successfully completes its task (e.g., to enable visual communication or assist a cognitive task) and usually a combination of the two. A viewer's enjoyment when watching a video programme also depends on its content and material. Other factors, like the viewing distance, the size and quality of the display or its resolution and contrast, are also significant. Above all though, the quality of sound and video have the primary importance. Furthermore, it is well known that good sound quality tends to alleviate the viewer's ability to detect impairments of video.

Although quality is a rather difficult concept to grasp, two features of quality measurement are widely accepted. First, quality implies a comparison. This comparison may be direct ('better', 'worse'), or indirect ('good', 'bad'). Second, quality must be measured in some open ended scale . A direct comparison is taking place when both the original (or reference) and the impaired (or test) video sequences are available and shown to the viewer or passed to the measurement instrumentation. When the reference is not available, then comparison (in the case of subjective tests) is done using some 'internal' reference of quality of the individual viewer.

Figure: Impact of common video compression artifacts on the perceived quality of images

DIGITAL TELEVISION SYSTEMS

As shown in Table I, the idea of transmitting pictures over the ether dates back to the 19th century and it was followed by several important developments in the 20th century that led to the invention of the all-electronics color TV. At the same time, other forms of communications were progressing and the demand for a high-quality, immersive TV experience was growing, which led to the adoption of digital broadcasting for introducing flawless high-definition video and High-Fidelity (Hi-Fi) sound as well as introducing new interactive services and designing TV systems for people on the move – or mobile TV.

Digital TV systems are composed of several standardized concepts, including video coding, audio coding, transport stream formats, middle-ware and the transmission technology. In this section we will provide a quick overview of these concepts, while the rest of the paper will focus on the transmission technology used in the different DTV standards. Video and Audio Coding- At the time of writing, high definition video and audio transmission is becoming the norm in the TV industry, where the demand for high-definition video, video-on-demand and multimedia video and image services is increasing. Hence, it is essential that efficient digital compression techniques are used for encoding the video and audio signals. Considerable research efforts have been invested in the past few decades to efficiently represent video and audio signals.

Source encoding is the process of turning an analogue video/audio signal, captured by a camera for example, into a digital signal and appropriately compressing the digital signal for transmission at a reduced data rate. A source decoder carries out the reverse operations of the encoder and transforms a compressed video stream into its uncompressed format to be shown on a TV screen for example. In DTV, video and audio coding reduces the amount of bandwidth required for transmission of high-quality video and audio signals as well as for reducing the transmission power.

Data Stream Multiplexing Format- The set of DTV signals includes video, audio and other interactive services. Their transmission is supported by control signals including the channel coding code rate and modulation scheme identities invoked for the transmission of a specific frame. Video, audio, control information and other services are transmitted in specially designed description frames right before information transmission. The most popular stream structure is the MPEG-2 audio and video Transport Stream (TS) structure. The TS is formed of a sequence of TS packets, each having a length of 188 bytes with a 4-byte header containing a synchronisation byte (sync byte) and the Packet ID (PID). MPEG also defines Program-Specific Information (PSI) that includes information about the TS payload, which is then used by the receiver for decoding the appropriate data from the stream. There is a Program Association Table (PAT) associated with a PID of ‘0’, that includes information used by the receiver for decoding the PIDs of the Program Map Table (PMT). The PMT includes information about the PIDs for the elementary streams of each service.

IMPACT OF DIGITISATION

In CAS the FTA channels were downlinked by LCO and distributed whereas in DAS all channels, including FTA channels, are downlinked, encrypted and distributed by the MSO only. It is primarily the LCO that collects the subscription revenues from the subscribers and the MSO collect the subscription revenues from the LCO based on lump sum/fixed contracts. Invariably MSO ends up losing money, as the subscription money so collected from LCO for distribution of TV channels is far lesser than the amount demanded by the pay broadcasters.

The July 2010 Tariff Order of the TRAI provides that the revenue share between the MSO and LCO shall be based on mutual negotiations. Carriage fee, which broadcasters pay to MSOs and Local Cable Operators (LCOs) for taking their channels to the viewers, has been a bone of contention and has pitted broadcasters against MSOs and LCOs. In October 2012 broadcasters had entered into an agreement with MSOs that the carriage fee would range from 50 paisa to Re 1 per set top box subscriber per channel per year. The agreement was for an initial period of one year and included marketing fees and packaging fees. The TRAI suggested that a carriage fee of Rs 3-5 be set per set top box (STB) per annum. Digitisation will increase the broadband penetration in India, and will do so at a much lower cost. Analysts suggest a 10 per cent increase in broadband penetration will increase the GDP by 1.5 per cent.

CABLE TV FREQUENCY PLANS

The frequency plan of cable TV channels in the U.S. is specified by the FCC. FCC rules in Part 76 specify frequencies to in accordance with the channel allocation plan set forth by with the Electronics Industry Association (EIA) [16]. The nominal channel spacing is 6- MHz, except for the 4-MHz frequency gap between channels 4 and 5. Table 2.4 shows the standard (STD), incrementally related carrier (IRC), and harmonically related carrier (HRC) cable TV frequency plans in the U.S.

In the STD cable TV frequency plan, which is similar to the frequency plan of terrestrially broadcasted TV channels, all the visual carriers except channels 5 and 6 are located 1.25 MHz above the lower edge of the channel boundary in 6-MHz multiples (1.25 + 6N) MHz. The visual carriers for channels 5 and 6 are located 0.75 MHz below the 6-MHz multiples. Notice that the visual carrier in the following channel groups 14_15, 25_41, and 43_53 have a 12.5-kHz frequency offset relative to the rest of the channels. In the IRC frequency plan, all the visual carriers except for channels 42, 60, and 61 are located 1.2625 MHz above the lower edge of the channel boundary in 6-MHz multiples (1.2625 + 6N) MHz. Thus, the visual carrier in the IRC frequency plan has 12.5-kHz frequency offset compared with the STD frequency plan. This frequency offset was selected to minimize interference in the 25-kHz radio channels, which are used for communications by airport control towers and aircraft navigation equipment based on FCC rulings. In the HRC frequency plan, all the visual carriers except for channels 60 and 61 are located essentially at the lower channel boundary in 6.0003-MHz multiples. As with the IRC plan, the 300-Hz incremental band increase was selected to minimize the interference in the 25-kHz radio channels used for aviation. The cable TV channel numbers are often designated according to electronic industry association (EIA).

MARKET OPPORTUNITY

Cable subscribers currently represent the single largest group of pay-TV consumers with digital satellite subscribers ranking a close second. As illustrated by the chart below, S2 Data expects cable subscribers to exceed 386 million subscribers by 2011 with DBS subscribers exceeding 121 million during the forecast period. By 2011, more than 500 million households worldwide will have cable or satellite pay TV subscriptions, representing nearly 50 percent of total worldwide television households. The forecasted growth of cable and satellite subscribers, multiple HDTV households and DVR deployments is creating a powerful impetus for operator-installed home entertainment networks. Trials and early deployments will begin to accelerate over the next 12-18 months as operators deploy next generation set top boxes with integrated coaxial-based home networking technology.

The importance of operator-installed coaxial entertainment networks will increase considerably over the forecast period as operators develop additional revenue-generating services beyond whole-home DVR. In addition to delivering premium entertainment services to multiple locations within the home, operators are working to enable a fully integrated digital media experience allowing next generation set-top-boxes to act as media hubs allowing subscribers to access digital photos, music and videos normally stored on a home PC or other CE device. Because home computers are generally located in a home office or den, consuming digital content is generally limited to a fixed location. By allowing consumers to connect devices to the entertainment network, subscribers can enjoy their entire library of content in any room in the household where cable and satellite STBs reside.

CONCLUSIONS

DVB has provided specifications for a broad variety of digital transmission systems concerning communication via satellite, CATV, and terrestrial networks. These systems have been or are currently being standardized by ETSI. Table 10.7 provides an overview of the typical parameters of the DVB digital transmission systems. Satellite communication suffers from power limitations. For this reason, QPSK is used as a modulation method. The advantage of satellite communication is the rich availability of bandwidth, which in the end allows a high bit rate. After receiving the satellite signals, further trans-mission via a SMATV network is enabled by the DVB SMATV system.

It has been more than a century since broadcasting was invented. Television really took off in the 1950s, when TV sets became affordable and the programs more entertaining. The broadcasting industry is expected to evolve further amidst the tremendous range of innovations in the area of communications technology and it is also expected to continue as being an essential player in bringing information to people. Interleavers disperse the bursts of errors which would potentially overwhelm the channel decoder. This improves the attainable system performance. However, using longer interleavers requires more memory for storing the data and imposes an increased delay on the system. In contrast to terrestrial and mobile channels, cable and satellite channels typically do not experience fading. Hence, a single interleaver is used in the cable and satellite standards, while several interleavers are invoked in the transmission chain of the terrestrial and hand-held standards. The interleavers in the terrestrial and hand-held standards help improve the system performance at the cost of imposing an increased delay on the system, as well as increasing the cost and complexity of the receiver implementation by requiring more processing power and more memory.

Cable digitization will revolutionize the TV viewing experience; it has the potential to make TV viewing more personal, interactive and social. Also, a rise in the number of pay channels is expected, with substantial improvisation in the content. The industry will witness many mergers and consolidations because LCOs will tie up with triple play service providers or MSOs, to upgrade their infrastructure. Since the entire set up is to be changed for the new plan to be implemented, a standardized technological frame work is to be set up. An adequate supply of well-priced and upgraded technology is required for the success of such a futuristic project. A regulatory body needs to be set up to answer and rectify the grievances of both the consumer and the service providers.

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