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DVB-SH Technology – An Overview

Abhilasha P[1], Dr. Rajini V Honnungar[2]

1. PG Student, RNSIT, Bangalore, abhilashahyr@gmail.com

2. Associate Professor, RNSIT, Bangalore, rajinivh@gmail.com

Abstract: In this paper, we will discuss the Digital Video Broadcasting Satellite Services to Handheld (DVB-SH) standard which provide an efficient way of carrying multimedia services over hybrid satellite and terrestrial. The key feature of DVB-SH is that it's a hybrid satellite/terrestrial system that allows the use of a satellite to achieve coverage of large regions or even a whole country. In areas where direct reception of the satellite signal is not possible, terrestrial gap filler can be used seamlessly to provide coverage. It is designed to use frequencies below 3GHz, typically around 2.2GHz.networks and applications of Positioning Using Mobile TV Based on the DVB-SH Standard and Satellite based Mobile TV Services.

Keywords: DVB-SH, DVB-H, MPE, MPE-FEC, Turbo Codes.

I. INTRODUCTION

DVB-SH (Digital Video Broadcasting Satellite Services to Handled) is the name of a mobile broadcast standard designed to deliver video, audio and data services to small handheld devices such as mobile telephones, and to vehicle-mounted devices. The key feature of DVB-SH is the fact that it is a hybrid satellite/terrestrial system that will allow the use of a satellite to achieve coverage of large regions or even a whole country. In areas where direct reception of the satellite signal is impaired, and for indoor reception, terrestrial repeaters are used to improve service availability. It is planned to use frequencies below 3 GHz, typically S-Band frequencies around 2.2 GHz adjacent to the 3G terrestrial frequencies. DVB began work on the DVB-SH specification in 2006. The system and waveform specifications have recently been released in the form of DVB Bluebooks, and sent to ETSI for publication as formal standards.

The DVB-SH standard provides an efficient way of carrying multimedia services over hybrid satellite and terrestrial networks, at frequencies below 3 GHz, to a variety of mobile and fixed terminals having compact antennas with very limited directivity. Target terminals include handheld (PDAs, mobile phones), vehicle-mounted, nomadic (laptops, palmtops…) and stationary terminals. The DVB-SH standard provides a universal coverage by combining a Satellite Component (SC) and a Complementary Ground Component (CGC): in a cooperative mode, the SC ensures geographical global coverage while the CGC provides cellular-type coverage. All types of environment (outdoor, indoor) can then be served, either using the SC from its first day of service, and/or the CCG that is to be progressively deployed, building on the success of DVB-H[1].

II. DVB-SH STANDARD

The ETSI formulated Digital Video Broadcasting Satellite Services to Handheld (DVB-SH) standard which provide an efficient way of carrying multimedia services over hybrid satellite and terrestrial networks. This operates at frequencies below 3 GHz to a variety of mobile and fixed terminals having compact antennas with very limited directivity. All types of mobile terminals including handheld (PDAs, mobile phones, etc.), vehicle-mounted, nomadic (laptops, palmtops, etc.) and stationary terminals are targeted in this standard. The specialty of the DVB-SH standard is that it provides a universal coverage by combining Satellite Component (SC), which caters a huge service area, and a Complementary Ground Component (CGC). The satellite component and the complementary ground component work in a cooperative mode. The standard envisages serving both outdoor and indoor environments. The satellite component can provide service directly after launch and the complementary ground infrastructure can be progressively realized mainly depending on the success of DVB-H .The DVB-SH standard envisages three types of terrestrial repeaters providing the complementary ground service. First are broadcast infrastructure transmitters, which complement reception in areas where satellite reception is difficult, especially in urban areas. They may be collocated with mobile cell site or standalone. Using these repeaters local content insertion at that level is possible with adequate radio frequency planning and/or waveform optimizations.

A. DVB-SH Architecture

A typical DVB-SH system is based on a hybrid architecture combining a Satellite Component and, where necessary, a CGC consisting of terrestrial repeaters fed by a broadcast distribution network (DVB-S2, fiber, xDSL…). The repeaters may be of three kinds:

1. Terrestrial Transmitters: are broadcast infrastructure transmitters, which complement reception in areas where satellite reception is difficult, especially in urban areas; they may be co-located with mobile cell sites or standalone. Local content insertion at that level is possible, relying on adequate radio-frequency planning and/or waveform optimizations.
2. Personal Gap-fillers: have limited coverage, providing local on-frequency re-transmission and/ or frequency conversion; a typical application is indoor

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enhancement of satellite coverage; no local content insertion is possible.

3. Mobile transmitters: are mobile broadcast infrastructure transmitters creating a "moving complementary infrastructure".

Typical use is for trains, commercial ships or other environments where continuity of satellite and terrestrial reception is not guaranteed by the fixed infrastructure. Depending on the waveform configuration and radio frequency planning, local content insertion may be possible.

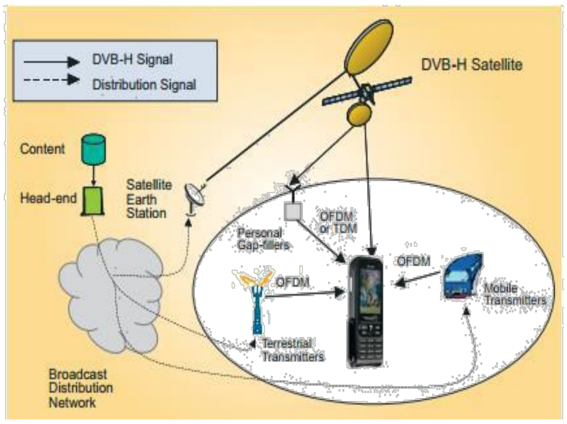

Fig 1. DVB-SH Architecture

OFDM (Orthogonal Frequency Division Multiplexing) is the natural choice for terrestrial modulation and is the basis of both the DVB-H and DVB-T systems. DVB-SH introduces a second scheme, a Time Division Multiplex (TDM), leading to two reference architectures termed SH-A and SH-B:

- SH-A uses OFDM both on the satellite and the terrestrial link
- SH-B uses TDM on the satellite link and OFDM for the terrestrial link

The S-Band is very demanding in terms of signal coverage. Its short wavelength (approx. 13 cm) requires a quite dense terrestrial repeater network in towns and cities. Naturally the cost of this network can be reduced if the signal-to-noise ratio (SNR) required for stable reception is low. When operating in S-band, the burden placed on DVB-SH by the high frequency is compensated for by a selection of tools that enhance the signal robustness. For example a state-of-the-art forward error correction (FEC) scheme, 3GPP2 Turbocode, is used. In addition, DVB-SH uses a highly flexible channel interleaver that offers time diversity from about one hundred milliseconds to several seconds depending on the targeted service level and corresponding capabilities (essentially memory size) of terminal class.

DVB-SH does not define transport protocols, Electronic Service Guide (ESG) etc. As in all other DVB transmission systems such "higher layer" issues are defined elsewhere. The DVB-IPDC specifications were originally defined with the DVB-H transmission system in mind and work is now continuing to ensure that they can also act as the "higher layer" of DVB-SH. The combination of a satellite footprint and a terrestrial complement delivers nationwide coverage to terminals which implement the TDM and OFDM modes of SH, a combination of SH and DVB-H, or simply the OFDM mode of DVB-SH operating in SFN. Key to deployment will be DVB-SH's interface with the existing

DVB-IPDC layer and the services based on it [2].

B. DVB-SH IP Encapsulator

The DVB-SH IP Encapsulator is compliant to the ETSI DVBSH international open standard. The DVB-SH IP Encapsulator is a critical network infrastructure element needed for the delivery of digital TV to mobile devices. In order to cost effectively and reliably deliver content such as live television to a large number of mobile devices, service providers must address the issues of scalability and mobility. At the same time, device power consumption, as well as mobile and indoor reception issues are genuine concerns. The DVB-SH IP Encapsulator addresses these issues in a shared infrastructure environment.

The DVB-SH IP Encapsulator will generate the full DVB-SH complaint Forward Link. DVB-SH type of network is totally based on IP and in this type of network video, audio and data are communicated as IP packets. The audio video programs are sent in the payload of IP packets. DVB-SH network carries the IP packets in the form of DVB MPEG2 TS packets and uses the ETSI Specified Multi-Protocol Encapsulation (MPE)[6] recommended technique (ETSI TS 101202) for converting IP packets into IP-MPE and transferring it over DVB based networks.

The DVB-SH IP Encapsulator consisting of the DVB-SH Forward Link Generation software consists of DVB-SH Service Information Tables Generation as specified in ETSI Standard Document (A079 IP Datacast over DVB-SH). The Forward Link also includes the generation of DVB-SH Descriptors [4], which convey specific information to the receivers as specified in ETSI DVB-SH Standards. The Forward Link also includes the generation of SHIP packets (SH Initialization Packets) and MPE-FEC packets. All generated data including IP-MPE packets, SI Tables, Descriptors, SHIP packets have to be multiplexed using PID based multiplexing to generate the MPEG2 Transport Stream. This MPEG2 TS is transferred to the DVB-SH Modulator using a PCI based ASI (Asynchronous Serial Interface) Card using the interface modules of the DVB-SH Forward Link Generator. The DVB-SH IP Encapsulator takes input via LAN (Ethernet) and outputs using an ASI Card. The modulated signal is up-converted and up-linked to the satellite.

C. Class of Receivers

One of the design considerations of a DVB-SH network is the choice between physical layer or link layer techniques to combat long interruptions of the line of

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sight which is typical of satellite reception with mobile terminals, and resulting for instance from the shading by buildings, bridges and trees. This decision is influenced by the cost and required footprint of the memory to implement long interleaver at physical layer.

A combination of a short physical interleaver with a long link layer interleaver could be advantageous in the short term mainly considering handheld terminals. When targeting vehicular-mounted devices where there are no restrictions with battery-life, the long interleaver at physical layer might be preferable in difficult reception conditions [3].

The specific satellite channel impairments are addressed by DVB-SH through long time diversity protection. This temporary service disruption is handled in two approaches. The interleaver may be in the physical layer or in the data link layer. Depending on the type of interleaver, two types of receivers are defined.

The Class 1 receivers support short physical layer protection of the order of one burst. The link layer interleaver is long which complements this physical interleaver. The Class 2 receivers support long physical layer protection (in the order of 10 seconds) which is possible with the use of large on receiver memory chips. This protection managed at channel level can be complemented by same link layer protection as class 1 receivers. It is up to the service and network operators to allocate the protection between the different layers, depending on the targeted quality of service, service categories and commercialized classes of receivers. The combination of different receiver types and system architecture makes four types of receiver configuration to be possible as shown in Table 1 below.

Terminal Configuration	**System Architecture**	**Receiver Class**
A-1	SH-A	Class 1
A-2	SH-A	Class 2
B-1	SH-B	Class 1
B-2	SH-B	Class 2

Fig 2. Receiver Configuration

D. Type of Modulation Supported

DVB-SH proposes OFDM modulation for the CGC, and either OFDM or TDM modulations for SC. The choice of a particular standard is dependent on the flexibility of network providers to choose according to satellite characteristics and regulatory considerations between SH-A and SH-B. The TDM transmission mode provides the choice of QPSK, 8PSK, 16APSK for power and spectral efficient modulation format in TDM transmission mode with a variety of roll-off factors (0.15, 0.25, and 0.35). QPSK, 16QAM and non-uniform 16QAM for OFDM transmission mode with support of hierarchical modulation on the other hand. Flexibility for network providers to choose, according to their transmission band (below 3 GHz), various channel bandwidths among 8 MHz, 7 MHz, 6 MHz, 5 MHz, 1,7 MHz, FFT length among existing 8k, 4k, 2k and an additional 1k directly scaled from the 2k mode.

E. Single Frequency Networks

Seamless reception of satellite and terrestrial signals using signal diversity either via single frequency network (SFN, SH-A only), maximal ratio combining (MRC, both SH-A and SH-B) or code diversity (complementary puncturing, SH-B only) techniques, the latter being possible via a common frame structure shared between TDM and OFDM modes. From the allocated spectrum for DVB-SH, the SH-B configuration needs a separate channel to be used in the complementary ground component than the frequency allocated for satellite broadcast. In SH-A the same frequency is used by the satellite as well as the complementary ground component as the time and frequency of the transmitted signal are highly synchronized. In SH-A SFN case, not only the OFDM modulation type is re-used between satellite and terrestrial links, but also the sub-carriers modulation and coding are strictly identical to allow a repetition at the same carrier frequency in an SFN mode. This is the concept of SFN networks, which is good in terms of bandwidth usage. In SHB, the physical layer parameters used in the satellite and complementary ground component differs only the content remains same in both the satellite and ground component creating the MFN concept.

F. DVB-SH physical layer outline

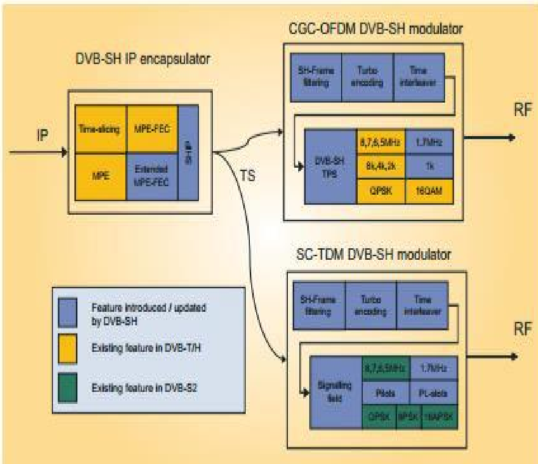

Fig 3. DVB-SH physical layer outline

3G networks have raised market expectations for indoor coverage to a level that needs to be matched. Good indoor coverage with an infrastructure that is lighter than 3G networks entails a selection of new tools for enhancing the signal robustness. For example, a state-of-the-art forward error correction (FEC) scheme, 3GPP2 Turbo code over 12 Kbits blocks, is used. In addition, DVB-SH uses a highly flexible channel interleaver that offers time diversity from about one hundred milliseconds to several seconds, depending on the targeted service level and corresponding capabilities (essentially memory size) of the terminal class.

A functional description of the components required on the transmitter side, in the case of an SH-B system. It can be seen that there is a common part including forward error correction and interleaving, which could be called “Outer Physical Layer” (OPL). Then there are two different “Inner Physical Layers” (IPLs):

- IPL-OFDM: Inner Physical Layer with multi-carrier modulation (OFDM) The multi-carrier modulation concept is derived from DVB-T;
- IPL-TDM: Inner Physical Layer with single-carrier modulation (TDM) The single-carrier modulation concept is adapted from DVB-S2 technology. For the OFDM part, the possible choices are QPSK, 16-QAM and non-uniform 16-QAM with support for hierarchical modulation. A 1K mode is proposed – in addition to the usual 2K, 4K and 8K mode – which does not exist in either DVB-T or DVB-H. The 1K mode targets mainly L-Band where the planned channel bandwidth is 1.75 MHz for the TDM part, the choices are QPSK, 8-PSK, 16- APSK for power and spectral-efficient modulation formats, with a variety of roll-off factors (0.15, 0.25, 0.35).

G. *DVB-SH Upper Layer outline*

DVB-SH is essentially a transmission system. It does not aim at defining transport protocols, audio and video coding solutions, an Electronic Service Guide (ESG)[3] etc. As with all other DVB transmission systems, such “upper layer” issues are defined elsewhere. More specifically, the following link layer features are inherited from DVB-H support of MPEG2-TS packets at the input, although the specification allows for the introduction of a Generic Stream at a later date;

- MPE encapsulation as defined in DVB-DATA and support of MPE Time Slicing (power saving) and handover between frequencies/coverage beams;
- Compatibility with MPE-FEC (intra-burst FEC);
- GSE ready.

III. APPLICATIONS

A. *Positioning Using Mobile TV Based on the DVB-SH Standard*

Positioning in urban or indoor environment is a hot topic, either due to regulations such as the E911 requiring US mobile telecommunication operators to be able to locate their subscribers in case of emergency, or due to the market development, with the extension of location-based services targeting the mass market concentrated in metropolitan areas. In deep urban or indoor areas, it is generally recognized that satellite-based positioning systems are not suitable (alone) to provide a continuous, reliable and accurate position to the user. Therefore, alternative positioning techniques may be useful to complement or replace satellite positioning in these environments. The possibility of using a mobile TV system based on the DVB-SH standard as system of opportunity for positioning [5].

A system level modification is used in order to make emitter discrimination possible in the synchronized emitter network. Then, the signal processing steps required for pseudo-range estimation are detailed. The proposed method is simulated using realistic channel sounding measurements and provides a mean positioning error around 40m.

B. *Satellite based Mobile TV Services*

The DVB-SH standard and address the need for mobile TV reception via satellite. The advantage of a satellite based mobile TV service compared to terrestrial based mobile TV service. The technical challenges of a satellite based mobile television reception technology are addressed. The salient features of the DVB-SH standard which makes the standard appropriate for mobile satellite networks. Mobile Satellite Network requirements and how well DVB-SH handles [6].

IV. CONCLUSION

In this paper, an overview has been provided about DVB-SH. A detailed description has been provided for the DVBSH standard along with the factors, which makes it so suitable for Mobile TV. It has been seen that DVB-SH provides a number of facility over its traditional counterparts. Applications of Mobile TV reception via satellite. The advantages of a satellite based mobile TV reception along with the associated challenges the technology and Positioning using a DVB-SH systems presents some advantages: the high expected received signal power should provide a good positioning service coverage in metropolitan centers or even indoor, and the emitter network is synchronized thus permitting to use time of arrival timing measurements for pseudo-range measurements.

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