Digital Video Broadcasting-Satellite to Handheld Services

Bharti Gupta
Department of Electronics and Communication Engineering
Swami Keshvanand Inst. of Tech, Manag. & Gramothan, Jaipur, India.

Narinder Kaur
Department of Electronics and Communication Engineering
Mata Raj Kaur Institute of Engg & Tech, Rewari, Haryana, India.

Raj Kumar
Department of Electronics and Communication Engineering
Mata Raj Kaur Institute of Engg & Tech, Rewari, Haryana, India.

Abstract - Universal education is the dream of India and more so with the passing of 'Right to Education bill' in the country. Looking to the diverse culture and vividity in the country it is not possible to take education to the last mile in the country with prevailing chalk-blackboard technique. An attempt has been made to probe various digital video broadcast (DVB) techniques for spatial and temporal distribution of contents as per stake holder needs Concept of time, space, energy and beam angle varying strategy has been explored. It is found that this technique would be very effective for remote and hilly areas with scanty population in India. This solution comes out from existing transmissions techniques which will be best one for long life, Reliable anywhere & at any time. DVB-SH 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.

DVB-SH system provides an efficient and flexible mean of carrying broadcast services over a hybrid satellite and terrestrial infrastructure operating at frequencies below 3 GHz to a variety of portable, mobile and fixed terminals having compact antennas with very limited or no directivity. Target terminals include handheld defined as light-weight and battery-powered apparatus (e.g. PDAs, mobile phones), vehicle-mounted, nomadic (e.g. laptops, palmtops…) and stationary terminals. The DVB-SH system coverage is obtained by combining a Satellite Component (SC) and, where necessary, a Complementary Ground Component (CGC) to ensure service continuity in areas where the satellite alone cannot provide the required Q.O.S.

Key words: Broadcasting, DVB-SH, Satellite Component (SC), Complementary Ground Component (CGC)

I. INTRODUCTION

DVB Project has drawn the attention of people of worldwide compatibility and standardization of codec terminals. DVB is an open system, allow the subscribers to choose different content providers and integration of PCs and Televisions. 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. The DVB-SH system coverage is obtained by combining a Satellite Component (SC) and, where necessary, a Complementary Ground Component (CGC) to ensure service continuity in areas where the satellite alone cannot provide the required Q.O.S. The SC ensures wide area coverage while the CGC provides cellular-type coverage. All types of environment (outdoor, indoor, urban, sub-urban and rural) can then be served. It should be noted that the area served by a beam of currently planned multi beam satellites is in the order of 600000 $Km^{2.}$

Two main different physical layer configurations are supported by the DVB-SH waveform standard:

A. SH- A exploiting OFDM transmission mode for both SC and CGC. SH-A allows (but does not impose) a Single Frequency Network (SFN) between the SC signal and the CGC signal carrying the same content. If SFN is implemented then FEC, Channel Interleave, modulation and Guard Interval cannot be optimized separately for the SC and CGC (by definition of SFN). If it is desirable to optimize these parameters separately for the SC and the CGC, a distinct frequency channel for the SC and the CGC can also be used in SH-A, leading to reduced spectrum efficiency and some handover complications for receivers having only one RF front-end. If the receiver has two RF-front-ends, soft combining and easier handover can also be implemented with SH-A.

B. SH-B exploiting TDM transmission mode for the SC and OFDM transmission mode for the CGC. SH-B requires a distinct frequency band for the SC and the CGC since they transmit signals based on two different physical layers. The impacts on the system frequency plan for this physical layer configuration are discussed in the next section. Each component of the transmission system can be optimized separately to its respective transmission path.

The OFDM waveform is known to exhibit a larger peak-to-average signal envelope fluctuation compared to the TDM waveform. Therefore, SH-A is recommended for spectrum limited systems while SH-B is of interest in power limited satellite systems.

II. RECEIVER CHARACTERISTICS

This section discusses, in general terms, the architectures of DVB-SH receivers. Two different receiver architectures can be distinguished according to the DVB-SH waveform options, respectively the OFDM/OFDM and the TDM/OFDM system architectures. The SH-B architecture encompasses the SH-A architecture in the sense that SH-B receivers can be used in an SH-A configuration. The converse is obviously not true. Receivers designed for the SH-A architecture are in general intended to be used with SFN between satellite and CGC. However, it is recommended that they should be also compatible with an MFN configuration (transmissions of the OFDM satellite signal and its OFDM CGC counterpart on two different sub-bands).

III. VEHICULAR RECEPTION CONSTRAINTS

Vehicular receivers must work at high moving speeds and stay longer in a satellite-only reception mode. However, vehicular receivers can exploit the following features not generally possible for receivers used in a handset:

- The terminal has adequate power supply able to support more complex receiver processing.
- The terminal allows better antenna diversity (order 2 or more) implementation (form factor and antenna spacing).
- One antenna can be optimized for satellite reception (directivity and matching polarization).
- Low Noise Amplifiers (LNAs) can be integrated with the antenna(s) to reduce sensitivity loss (the underlying assumption is that the vehicular receiver does not coexist with embedded Telecom modems in the same electronic equipment and therefore the RF filtering protection for the LNA is removed or relaxed, therefore improving noise factor).
- Larger memory can be embedded in the receiver so that longer Physical Layer interleaving can be supported.
- The higher speed of the terminal allows a better exploitation of time diversity (either at Physical Layer or at upper Layers), at equal memory resource.

IV. REFERENCE TERMINALS

4.1. Top-level design considerations

Terminal categories

To address a wide range of market sectors, DVB-SH allows a large freedom in terminal implementations. Three main categories can be identified and are considered here after:

Category 1: Car-mounted terminals (also called “vehicular”)

Category 2: portable TV devices with 2 sub-categories

- Large screen (= 10’’) portable devices, battery or mains powered
- Pocket able (handheld) TV devices, mainly battery powered.

Category 3: Handheld terminal with embedded cellular telecom modem (or “convergence” terminal).

Car-mounted terminals can especially benefit from the nation-wide coverage and allows designers to include many of the advanced features of DVB-SH (Seamless complementary satellite/CGC coverage, SH-B configuration, high-order modulations, long time interleave). Portable TV devices have large screen and are mainly stationary during reception. They could have attached antenna but also detachable antenna accessories. This latter case allows high reception performances thanks to optimization of the antenna position by the user (i.e. find a LOS reception from satellite or optimized position for good reception from CGC). Handheld terminals can especially benefit from the outdoor and indoor coverage’s in buildup areas (similar to 3G coverage) but are more challenging due to their small form factor, the large number of functions to be integrated, limited battery power and coexistence with other active radio functions. Category 2b has common characteristics with handset. Most often, pocket able terminals embed a large number of multimedia features without necessitating coexistence with radio modems.

Other features which are at the discretion of the manufacturers/markets include:

- Antenna dedicated and/or optimized to satellite link
- Number of antennas and branches for diversity gain

For terminal category 1, according to vehicular reception constraints, antenna with optimized diagram pattern and polarization will be used.

Additional Low Noise Amplifier will be connected directly to antenna to optimize noise figure and sensitivity.

- Power of processor embedded in terminal
- Embedded memory for physical layer processing
- Host memory for PVR functions

V. MEMORY REQUIREMENTS FOR DVB-SH PROCESSING

The DVB-SH receive baseband processing may follow a similar architecture as that of the DVB-H counterpart, namely analog-to-digital converter, OFDM demodulator, de-interleave, Forward Error Correction (FEC), de-multiplexing, multi-protocol de-capsulation, MPE-FEC, IP filter and terminal host interfacing. New modified functions are mainly the Turbo decoder and the physical layer time de-interleave

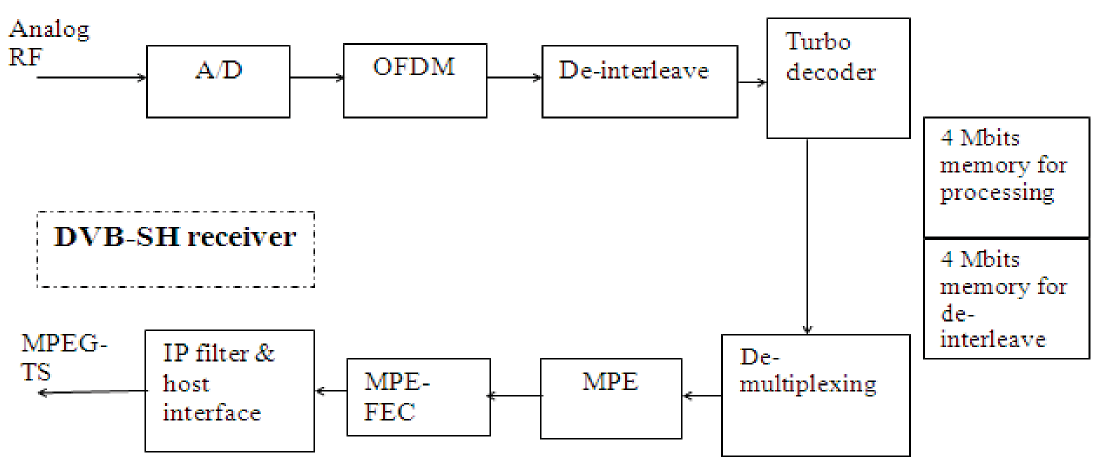

Figure1. Memory requirement for DVB-SH processing

VI. RECEIVER FOR VEHICULAR TERMINALS

Depending on terminal categories, various antenna and front-end solutions will be embedded in receiver

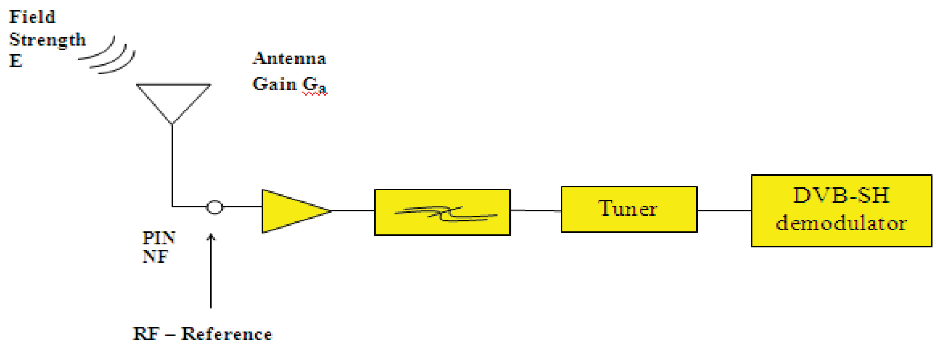

Figure 2 - Radio receiver architecture for Terminal category 1

The Turbo decoder needs extra hardware which is available as an off-the-shelf building block from 3G technology development. The main challenge from the Physical Layer Interleave is its memory requirement which is dependent to the DVB-SH Receiver Class:

Class 1

Receivers Class 1 are required to handle an interleave profile comprising one full SH-frame with 816 CU. Using the convolution interleave approach which typically halves the amount of memory needed, this transforms to:

- Interleave lengths of up to 240 ms (QPSK, uniform) and 120 ms (16QAM, uniform)
- Capability to store and process up to 408 CU or 6528 IU (can be handled with approx. 4 Mbits of memory)

Since support of DVB-H is likely for DVB-SH receivers, the memory dedicated to the DVB-H MPE-FEC could be allocated to the de-interleave. In this case, the DVB-H MPE-FEC, if ever transmitted, is not processed. The choice between MPE-FEC processing or interleaving processing should be managed at system level. Therefore, DVB-SH Class 1 receivers could be realized with the same amount of memory than previous DVB-H receivers.

Class 2

Receivers Class 2 are required to handle an interleave profile comprising 64 full SH-frames with 52224 CU. Using the convolution interleave approach which typically halves the amount of memory needed, this transforms to:

- Interleave lengths of up to 30 sec (QPSK, non-uniform) and 15 sec (16QAM, non-uniform)
- Capability to store and process up to 26112 CU or 417792 IU (can be handled with 256 Mbits memory)

VII. DVB-SH REFERENCE RECEIVER MODEL

The receiver performance is defined according to the reference model shown in figure 1.

Reference points are defined for:

- RF
- transport stream
- frame errors before MPE-FEC
- frame errors after MPE-FEC and extended MPE-FEC
- IP-stream

All the RF receiver performance figures are specified at the RF-reference point, which is the input of the receiver.

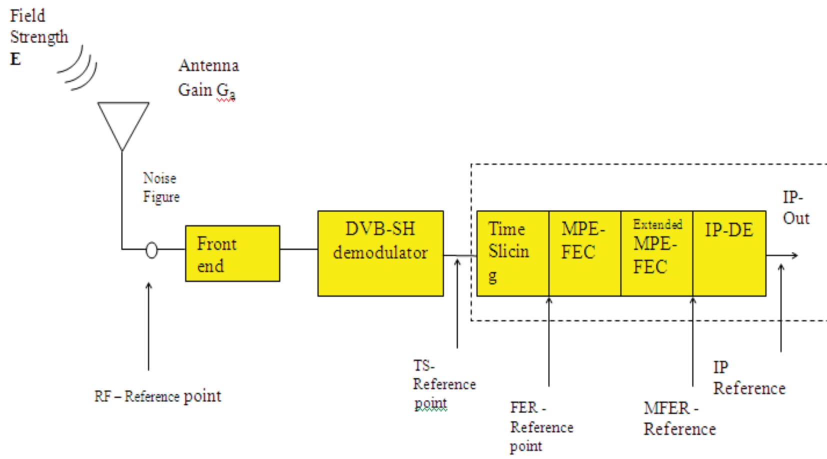

Figure4. Reference Model

VIII. RECEIVER FOR VEHICULAR TERMINALS

Depending on terminal categories, various antenna and front-end solutions will be embedded in receiver. For terminal category 1, according to vehicular reception constraints, antenna with optimized diagram pattern and polarization will be used. Additional Low Noise Amplifier will be connected directly to antenna to optimize noise figure and sensitivity.

IX. CONCLUSION

As a consequence of the above, DVB-SH services are a mix of Common services and Local services. Common services are services that are available in the SC and MUST be transmitted in the CGC (although possibly with different attributes) below for more details). Local services are services that are available in the CGC only. Common services are usually those with very large audience while Local services have more fragmented audiences, possibly with geographical dependencies. A Local service package for one city/town may differ from the package for another city/town. There are challenges for DVB-SH due to higher mobility, satellite specific propagation channels, and, in some cases, higher frequency bands. Some of these constraints are addressed somewhat differently by SH-A and SH-B architectures.

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