MODELS OF TRANSMISSION CHANNELS FOR DIGITAL TV DVB-H AND DVB-SH BROADCASTING

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ABSTRACT

This paper introduces two standards of digital television broadcasting to handheld devices of DVB-H and DVB-SH standards and models of theirs transmission channels. Since DVB-SH system is going to work as a hybrid of satellite and terrestrial broadcasting system, satellite and terrestrial propagation characteristics and channel models are mentioned. Reference transmission system architectures of DVB-H, DVB-SHA and DVB-SHB are depicted.

1. INTRODUCTION

The DVB-H (Digital Video Broadcasting – Handheld) is the ETSI EN 302 304 standard [1] [2] of European digital television for the transmission to handheld receivers. It is a physical and link layer specification which goal is to provide an efficient way to deliver multimedia services into the handheld devices by terrestrial networks. The system includes features which will reduce battery consumption. DVB-H services can use more efficient video compression systems such as MPEG-4 AVC (Advanced Video Coding). DVB-H is closely related to DVB-T [3] and can be transmitted via slightly modified DVB-T transmitters on UHF bands (TV band IV and V) [4].

The DVB-SH (Digital Video Broadcasting – Satellite Handheld) is the ETSI EN 302 583 standard [5] [6] of an advanced transmission system designed to deliver video, audio and data services to handheld receivers. DVB-SH is a hybrid of satellite and terrestrial system that will use satellite SC (Satellite Component) coverage of large regions and terrestrial CGC (Complementary Ground Component) gap fillers in regions where direct reception of satellite signal is not possible. The standard considers transmission at frequencies below 3 GHz, typically around 2.2 GHz [6] [7].

2. DVB-H AND DVB-SH TRANSMITTER BLOCK DIAGRAMS

Since DVB-H is closely related to DVB-T [3] the transmission is executed via modified DVB-T transmitters. DVB-H transmitting system [1] is shown in the Figure. 1.

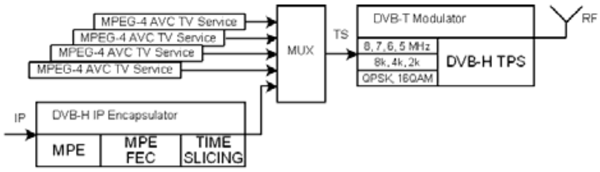

Figure 1: DVB-H transmitting system block diagram.

In DVB-SH there are two possibilities for channel modulations, DVB-SH-A mode with OFDM modulations for both SC and CGC transmissions and DVB-SH-B mode with OFDM modulation for CGC and TDM modulation for SC transmission exist. Both modes have common and separate parts for processing for each mode. DVB-SH transmitting system [6] is shown in the Figure. 2.

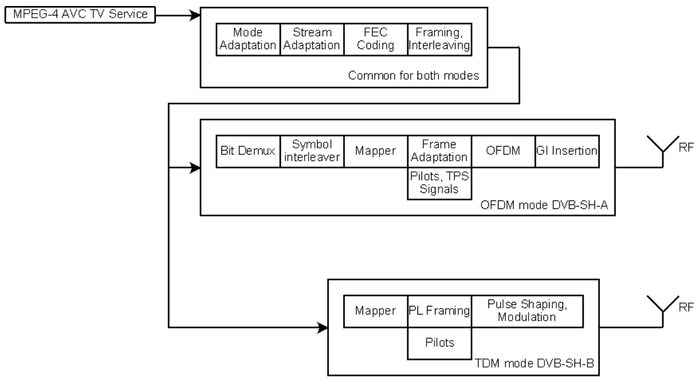

Figure 2: DVB-SH-A and DVB-SH-B transmitting system block diagram

3. TERRESTRIAL AND SATELLITE DIGITAL TV BROADCASTING CHANNELS

Only significant influences to signal propagation are those caused by the environment close to the user terminal, at frequencies below 3GHz. Atmospheric effects are negligible. For DVB handheld terminals, three main mobile environments may be considered [6] [8]:

RURAL ENVIRONMENT

The propagation in rural environment is mainly affected by the vegetation. The coverage is provided by the SC.

URBAN ENVIRONMENT

The propagation in urban environment is mostly affected by dense buildings or other constructions with height of 4 storeys or higher. The coverage is provided by the CGC.

SUBURBAN ENVIRONMENT

Suburban environment represents an intermediate case with medium density of buildings, lower structures (2-3 storeys) and roads which are wider than in an urban environment. The SC and the CGC both contribute to the desired coverage. Small villages may be treated as suburban areas where, if the population density is low, satellite may be the only source for service provision.

3.1. CHANNEL INFLUENCES CONSIDERING THE DISTANCES SCALE

For both LMS (Land Mobile Satellite) and terrestrial mobile channels, the effects are conventionally divided into three types based on the scale of distances to be considered [8]:

PATH LOSS AT LARGE SCALE

The signal suffers variations (very slow fluctuations) due to modifications in the geometry of the propagation path. This loss is usually proportional to distance from the transmitter to the user terminal, powered by an empirical exponent, based on theory and measurements.

SHADOWING AT MID-SCALE

The signal suffers amplitude variations due to nearby obstacles on the ground (slow fluctuations), e.g. obstructions caused by buildings, trees etc., the scale here being similar to the dimensions of these obstacles.

MULTIPATH FADING AT SMALL SCALE

The scale of the variations of the signal is about one wavelength (fast fluctuations), as a result of the constructive or destructive addition of multiple paths. For wideband systems, it is necessary to consider the multipath fading as frequency selective.

The satellite propagation channel is generally non-frequency selective. This assumption is very accurate for 1.5 MHz, pretty correct for 5 MHz and fairly correct for 8 MHz channel in DVB-SH. It means that the satellite propagation channel can be considered as a single complex multiplicative process. Link margins are not as large as for terrestrial networks. More specifically, the satellite distance from the user is basically constant within the beam and the satellite power limitations make the link margin bounded to a value typically ranging from 5 to 15 dB [6].

The terrestrial propagation channel is considered to be frequency selective because of their respective coherence bandwidths. A frequency selective fading is classically characterized through a Power Delay Profile (PDP) which gives the relative time of arrival, the relative power and the type (Ricean or Rayleigh distribution and spectrum) of each group of unresolved echoes (also called tap). These PDP are then used to parameterize Tapped Delay Line (TDL) models. For SFN operation between satellite and terrestrial OFDM (SH-A, SFN), all contributions have to be taken into account.

3.2. SATELLITE CHANNEL MODELS

The basic classification of LMS channel models are into three classes [8].

Empirical models are obtained from experimental data. They are very close to reality for the environment type in which the measurements have been done but are difficult to generalize to other environment types.

Statistical models are based on the use of canonical statistical distributions. Like empirical models, statistical models are applied to environment classes (rural, suburban, urban, etc). The subsequent classification problem is not straightforward, since an environment classified as urban in some countries may look a little more like small town elsewhere. Therefore statistical models are also difficult to generalize.

Physical models rely on a deterministic modeling of the propagation phenomena (reflection, diffraction, refraction), but also of the considered environment. These models have been efficiently used for planning purposes in terrestrial radio-communication or broadcast networks.

STATISTICAL MODELS FOR NARROW–BAND SIGNALS

The most suitable models for DVB-SH satellite channels are statistical models. The statistical LMS propagation model is characterized by parameters that have been derived through synthetic time series matching with experimental data obtained in different LMS propagation environments [6] [8]. Statistical models for satellite channels assume that the received signal is composed of two parts - a coherent part associated with the LOS (Line of Sight) path, a diffuse part arising from multipath components. Statistical models can be divided into categories in order to their complexity [8]:

Single – state model, which does not consider channel time variances and are inadequate for modeling of propagation in different mobile environments.

Two – state (Lutz) model is a statistical model which represents the channel by a two states. The “good” state occurs when a dominant LOS component is received. In that state, the channel can be considered as a Ricean channel. The “bad” state occurs when no LOS component is received. This model allows the generation of time series representing different environments; in spite of it two-state channels were considered not enough to represent the variety of propagation conditions experienced in the different environments.

Three – state (Fontan) model is a further refinement of the Lutz model which includes three states. State 1 - LOS, State 2 - moderate shadowing, State 3 - deep shadowing. This model is the most accurate statistical LMS channel model available today.

Quasi – static channel model corresponds to the LOS state of Fontan model. Since the terminal is quasi static, the resulting channel can be described by a very low Ricean fading process.

3.3. TERRESTRIAL CHANNEL MODELS

Gausian and Rayleigh channel models for DVB-H are defined [7]. These models could be used for the effective simulation in DVB-SH as well.

Mobile channel TU-6 was used previously. This profile reproduces the terrestrial propagation in an urban area. It has been defined by COST 207 [4] as a typical urban (TU6) profile and is made of 6 paths having wide dispersion in delay and relatively strong power. TU6 channel profile leads to some difficulties. At low speeds (i.e. pedestrian situations), TU6 is not well adapted, creating strange behaviors. Moreover TU6 channel profile seems to be more demanding than the real condition [9].

A set of new channel models have been developed by the Wing-TV project [9]. These are Pedestrian Indoor (PI), Pedestrian Outdoor (PO), Vehicle Urban (VU) and Motorway Rural (MR). These new models were created especially for describing the slowly moving hand held reception indoors and outdoors. Models are based on real measurements in DVB-H Single Frequency Networks and have paths from two different transmitter locations. Parameters such as total excess delay, RMS delay spread, number of taps, power delay profiles, K-factors and Doppler spread were obtained [9].

4. CONCLUSION

Digital TV for handheld devices DVB-H is currently on the air in many countries. Satellite Digital TV for handhelds with the CGC is a perspective near future system which is still developed. Presented paper is initial part of the study focused on DVB-H and DVB-SH channel modeling. Next steps are modeling of transmitting and receiver blocks of DVB-H and DVB-SH systems with adjustable parameters, selection of appropriate channel models and MATLAB simulations of transmitter and channel parameters influences.

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