Study on Profiles of Indonesia Digital Television DVB-T2 Channel Model for Rural Areas

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Abstract. This paper proposed *Radio Frequency Profile (RF Profile)* of Indonesian digital Television (TV) with *Digital Video Broadcasting – Second Generation Terrestrial (DVB-T2)* standard for rural Indonesia. This paper used *Software New York University Simulator (NYUSIM)* with Indonesian environmental parameters to obtain the representative channel model to be evaluated under *Orthogonal Frequency Division Multiplexing (OFDM)* for better implementation in Indonesia with maximum performance. This RF Profile is also useful for industries for mass production of Indonesian digital TV devices. The results of this paper are RF DVB-T2 profiles to confirmed for rural Indonesia using outage and *Bit Error Rite (BER)* perfomances.

Keywords: digital TV, DVB-T2, OFDM.

1 Introduction

Nowdays, analog Television (TV) has also been developed into digital TV. The main advantage of digital TV is the signals resist from interference and distortion. Digital TV have some benefits for consumers, such as high resolution image and video, the ability to connect with personal computers, and clearer sounds. Some benefits are also obtained by distributors such as efficient bandwidth, advertising creations, as well as recording with multi-use hard drives[1].

Indonesia have a plan to make the transition from analog TV to digital TV in 2018. The Government of Indonesia, through Minister of Communication and Information Regulation No. 05 of 2012, will use the Digital Video Broadcast - Second-generation Terrestrial Broadcasting (DVB-T2) broadcasting standard which is the development of the DVB-T digital standard [2]. However, the DVB-T2 Standard has not been implemented in Indonesia yet, it has applied the RF Profile parameters to be applied to Orthogonal Frequency Division Multiplexing (OFDM) in rural Indonesia.

OFDM is widely used for wireless communications and digital transmission systems because its resistance from multipath fading which causes the increment of inter-symbol interference (ISI) and inter-carrier interference (ICI). The additional problem is implementation, the implementation of the OFDM concept in DVB-T2 is also still not well known for rural areas of Indonesia [3].

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In this paper, we proposes a solution of the problem of RF parameters of Indonesia's profile so that the implementation of Indonesian DVB-T2 can be maximized and have a great benefit for the community. This paper analyzes the RF DVB-T2 Profile parameters using the New York University Simulator (NYUSIM) Software. The obtained of RF profile with DVB-T2 standard will be use to RF DVB-T2 Profile of Indonesia so that Indonesia has parameters such as those in ASEAN countries which have previously had an RF Profile [4].

This paper aims to determine the results to design the DVB-T2 digital TV RF profile and find out the optimal parameters that are optimal in rural Indonesia. The expected results of this paper are RF profiles which consist of parameters and can be applied in rural areas of Indonesia [5].

2 System Model

We consider bandwidth of 10 MHz and frequency 694 MHz. The simulation starts with collecting data sources and bits of data using NYUSIM software. This paper uses Forward Error Correction (FEC) for the encoding and decoding process. The QAM design to map data bits into a Quadrature Amplitude Modulation (QAM) symbol. FFT with OFDM is added to the system model to find optimal parameters for rural Indonesia. After the system model is designed, we evaluate the DVB-T2 RF Profile channel to find out the potential parameters in the system that can be used for rural Indonesia. We also analyze RF Profile performance for rural Indonesia [6].

A. Channel Modeling

Climate parameters in rural areas can be used as representations of rural areas, barometric pressure, humidity and temperature in rural areas are used as climates to be inputted as parameters. This model can represent rural areas because of the focus of this paper is a rural area in Indonesia. The distance between the sensor and the receiver is 200 meters. The parameters for channel model are shown in Table I. Parameters input from the NYUSIM channel simulator to generate rural PDP [7].

B. Channel Capacity

The calculation of channel capacity is important to design communication system because it affects the calculation of outage probability. Channel capacity will change the position in environmental conditions. Channel capacity is influenced by the width of the transmission bandwidth and PDP. Calculation of channel capacity is also achieve with the Shannon Capacity theorem. Where C is the channel capacity, B is the bandwidth in Hertz, and gamma is the signal ratio power to noise (SNR) [8].

Table 1. Simulator Parameter NYUSIM.

Parameter NYUSIM	
Frequency	694 MHz
RF Bandwidth	10 MHz
Scenario	Rma
Environment	NLOS
T-R Separation Lower Bound	200
Upper Bound	200
TX Power	30 dBm
Number of RX	1000
Barometric Pressure	1010.1
Humidity	87 %
Temperature	26 C
Rain rate	120 mm/h
Polarization	Co – Pol
Foliage Loss	No
Follage Attenetion	No

Thus, if $R \leq C$ then transmission may be accomplished without error in the presence of noise. The negation of this theorem is also true: if $R > C$, then errors cannot be avoided regardless of the coding technique used [5].

3 The Proposed Rural RF Profile of DVB-T2

In this study using the OFDM system and using Binary Phase Shift Keying (BPSK) modulation. OFDM is a transmission technique that uses several frequencies (multicarrier) which are arranged orthogonally. Each sub-operator is modulated with a modulation technique with a low symbol ratio. Subcarriers in OFDM overlap as shown in Fig. 1, because the subcarrier units are orthogonal [9]. As a result, OFDM provides a lot of bandwidth using the Frequency Division Multiplexing (FDM) technique. The OFDM system is shown in Fig. 1. The information data line b is modulated by mapper M and then converted to parallel parallel. The orthogonal process is carried out by Reverse Fourier Transform (FFT), which is then added by Cyclic Prefix (CP) before being sent via the antenna. At the receiver, noise occurs then CP is removed by block CP remover. The last bit bˆis obtained from the FFT output [10]. in this study using BPSK to find out whether the results using uncoded BPSK are better or not.

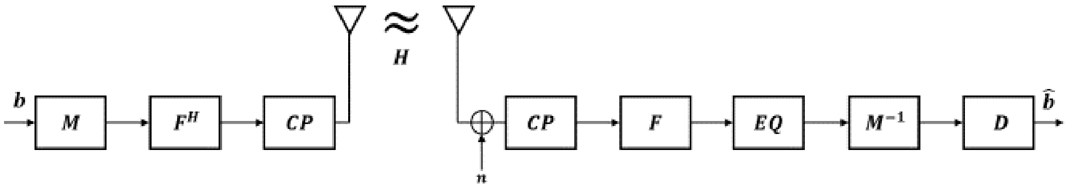

Figure 1 Structure of basic OFDM used for digital TV.

In this study besides using OFDM systems and using BPSK modulation, this study examined the results of probality outage in rural areas, and BER for rural areas in Pangalengan and Situbondo. the results of the research using the OFDM and BPSK systems will be analyzed whether it can be applied to the rural population in Pangalengan and in Situbondo.

4 Perfomances Evaluation

A. Power Delay Profile

In PDP plots, the Y axis represents the signal strength of each multipath, and the X axis represents the respective propagation delay. The transmitted signal is received by the receiver with different signal strength when moving through multipath channels [11]. In the NYUSIM channel simulator it produces a PDP with 1000 trials to get one PDP representative from the Rural area. Fig. 2 (a) indicates that the original PDP that has been run has 13 paths before mapping. Fig. 2 (b) shows the PDP that has been mapped into 8 mapped paths.

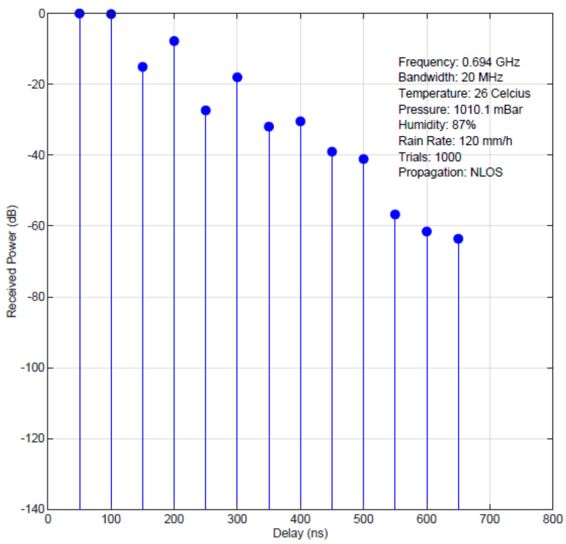

Figure 2 (a) Original PDP results for Rural Areas.

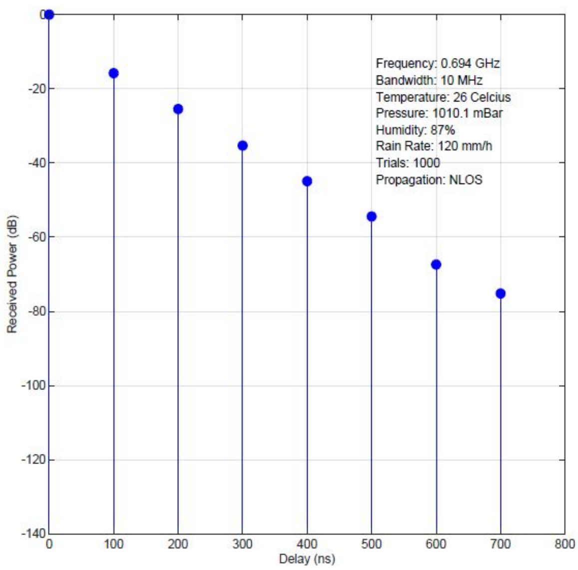

Figure 2. (b) Mapped PDP results for Rural Areas.

Fig. 2 The proposed representative PDP of Indonesia digital TV: (a) the original representative, (b) Scaled representative PDP suitable for small FFT size

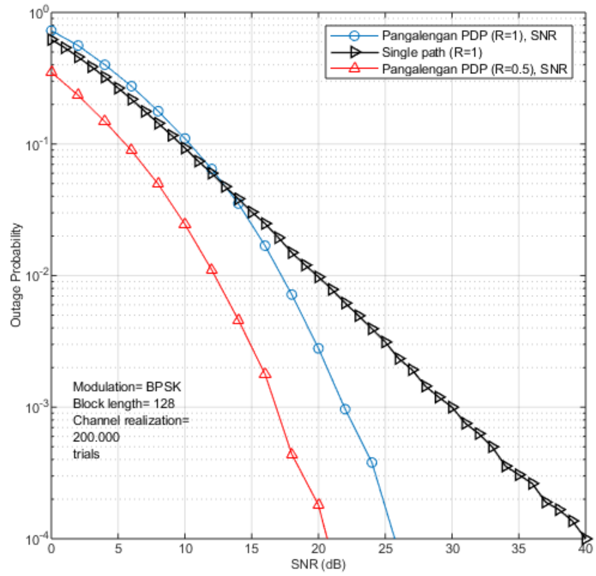

Figure 3 The outage perfomances for Indonesia DVB-T2 channel model of Pangalengan rural areas.

B. Outage Probability

Outage performance can be known by calculate the outage probability of the channel. Formula of outage probability with coding rate R is higher than capacity C describe as

$$P_{outage} = P_r(R > C) \quad (1).$$

The probability of outages is obtained from PDP which is processed based on information theory and the principle of signal processing, then determined its Shannon capacity (C), compared with the coding rate (R) to evaluate the probability of outages [12]. Fig. 3. DVB-T2 outage was examined in the rural area of Pangalengan. Outage probability results that can be R = 1 and R = 0.5 show results that are downward from the predetermined theorems. because of that, the results of outage prability for rural areas in Indonesia have good results because it is not the same as the established theory [13].

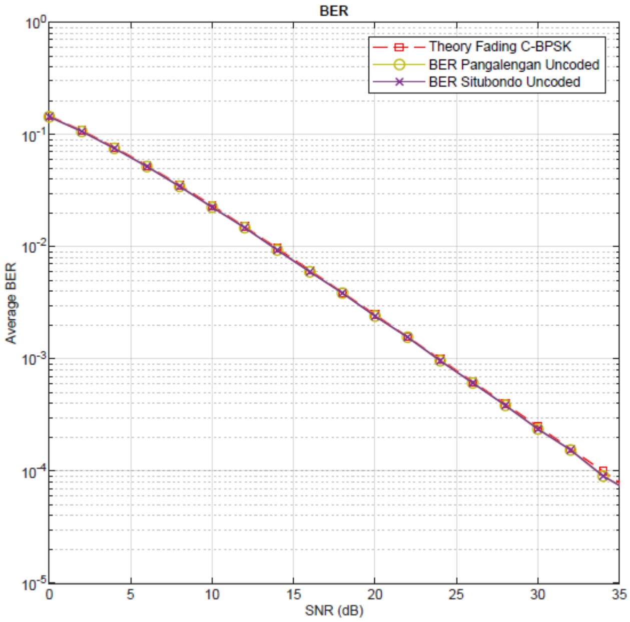

Figure 4. The BER perfomances of DVB-T2 at Pangalengan and Situbondo rural areas.

C. Bit Error Rate

Bit Error Ratio or Bit Error Rate (BER) is parameter to measure the performance of the system that has been designed. The measurement results of BER are not subjective so that data users need the good performance of BER. The smaller BER value means that the performance is getting better, because it shows the smaller error bits of data received [14]. BER values can be calculated by

$$BER = \frac{err}{N} \tag{2}$$

with err is the number of bits that error during the total transmission and N is the number of all bits sent. fig. 4 BER performances from DVB-T2 used a lowered channel model in the rural areas of Pangalengan and Situbondo. The BER produced in Fig. 4 shows that the Pangalengan and Situbondo regions are the same as theory fading C-BPSK because, in this study it did not use chennal coding, using BPSK modulation and using uncoded [15].

5 Conclusions

This paper has investigated channel model, channel capacity, PDP, and outage perfomances of DVB-T2 for Indonesia. Based on several mathematical reviews and computer simulations, this paper has investigated the theory and analysis of the DVB-T2 for rural areas of Indonesia, especially for Pangalengan and Situbondo. From the obtained representative

PDP, we have derived the outage perfomance, which is expected to be the theoretical references for DVB-T2 in rural areas. Outage perfomances has been derived for coding rates of R = 1 and R = 0.5. We have confirmed that the BER performances agree to the theoretical BER curve for the uncoded system. We expect that the use of channel coding can further confirm the validity of the proposed channel model for DVB-T2 in rural areas.

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