Outage Performances of 5G Channel Model Considering Humidity Effects

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***Abstract*—The fifth telecommunication generation (5G) is predicted to be deployed in 2020, where high frequencies of 1–100 GHz expected to be utilized are causing high attenuations. We consider communications under a 5G channel model for operating frequency of 3.3 GHz with bandwidth of 60 MHz based on 5G New Radio (NR) standard. In this paper we propose a 5G channel model based on Telkom University real-field environments under humidity effects derived using computer simulations for 5G NR implementation in Indonesia. The channel model is represented by the Power Delay Profile (PDP), which is confirmed by outage performance of Telkom University 5G channel model.**

***Index Terms*—Power Delay Profile, Outage Performance**

I. Introduction

Indonesia has different characteristics of channel from other countries [1] due to the uniqueness of the geographical position of Indonesia. Therefore, it is necessary to make a radio channel model of Indonesia. The main factor to be used to determine channel characteristics is the power delay profile (PDP) as a result of processing measurement data. The channel model describes the amount of the possible received signal power and the intersymbol interference (ISI) [2]. The benefit of channel model is to provide the expectd system performance based on the outage performances.

The similar model has been presented in [3] and [4], where the models do not assume humidiy effect. In this paper, consider the fifth telecommunication generation (5G) channel model operating at 3.3 GHz with 60 MHz bandwidth based on the specification of orthogonal frequency division multiplexing (OFDM) numerology one in 5G NR standard representing Telkom University under humidity effects. The 5G channel model is obtained from thousand trials for several areas in the Telkom University campus. This paper also compare the PDP and outage performance.

II. System Model

We set the maximum distance between transmitter and receiver to zoom following the maximum coverage radius of 5G system with receiver at 1000 position in urban micro (UMi) area as shown in Fig. 1. We use omnidirectional antenna, because the receiver is moving around with Non-Line Of Side (NLOS).

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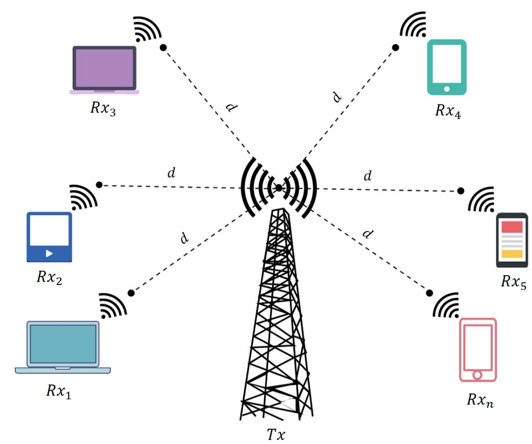

Fig. 1. Transmitter and receiver for channel model measurements.

III. The Proposed Framework

First, the data are processed using the averaging method to produce the average value of each environmental parameter. Second, we input the parameters to the New York University (NYU) simulator. Third, we create instataneous PDP into the representative PDP. The number of 1000 instataneous PDP are thresholded -150 dBm assuming to be Indonesian 5G sensitivity device. Fourth, we determines the power value for each path with cumulative distribution function (CDF). The process continues with calculation the outage performances.

There are several input column for channel parameters in NYU simulator, which are filled with the are obtained real-field parameters, as:

- Frequency: 3.3 GHz, (has a range between 0.5– 100 GHz)
- RF Bandwidth: 60 MHz, (has a range between 0–800 MHz)
- Scenario: Urban Micro, (has an options of Urban Micro, Urban Macro, Rural Macro)
- Environment: NLOS, (has an options of LOS, NLOS)
- T-R Separation Distance: 200 m, (has a range between 10 – 500 m)
- Tx Power: 30 dBm, (has a range between 0 – 30 dBm)
- Barometric Pressure: 1011 mbar (Telkom University)
- Humidity: 52% & 100% (Telkom University)

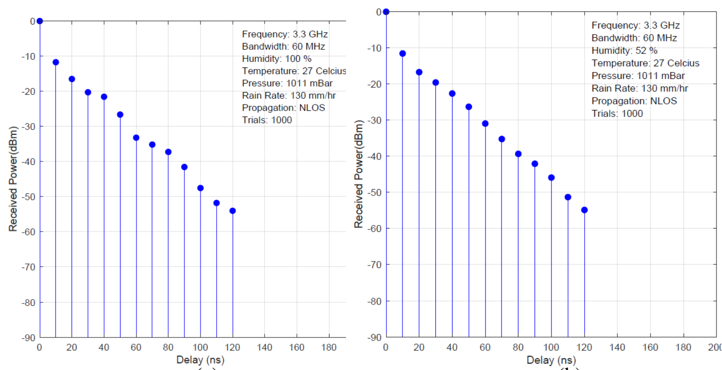

Fig. 2. Representative PDP with (a) maximum temperature and (b) minimum temperature effects of Telkom University.

- Temperature: 27^o C (Telkom University)
- Rain Rate: 130 mm/hr (Telkom University)
- Polarization: Circular, (has an option Circular, and Cross Polarization)

IV. Outage Performance

Representative PDP of Telkom University 5G channel models are shown in is Fig. 2 that using data from Badan Meteorologi, Klimatologi, dan Geofisika (BMKG) from January 2017 until January 2018. Bandung city has characteristic of average barometric pressure of 1011 mbar, temperature of 27^o C, maximum humidity of 100 %, and minimum humidity of 52 %. Representative PDP with minimum humidity Hmax of 100 % has 13 path, meanwhile the total path of representative PDP with maximum humidity Hmin of 52 % has 13 path.

The outage performance of communications using 5G Telkom University channel model is shown in Fig. 3. It is confirmed that the outage probability curve of 5G Telkom University channel model considering humidity effects has a better performance than single path, because multipath channel provides diversity effect. At the same channel coding rate R, outage probability for channel having maximum humidity $Hmax$ and minimum humidity $Hmin$ have performance curve with the same gradient. The outage probability at 10^{-4} from 5G system in Telkom University with humidity maximum can be achieved with Eb/N_0 of 17.7 dB at $R = 1$ and Eb/N_0 of 16.5 dB at $R = 1/2$. On the other hand, the outage probability at 10^{-4} with humidity minimum can be achieved at Eb/N_0 of 17.6 dB at $R = 1$ and Eb/N_0 of 16.6 dB at $R = 1/2$. These outage performance and $Eb = N_0$ values are expected to be a theoretical reference Eb/N_0 for 5G system implementation in Telkom University.

V. Conclusion

We have proposed the Telkom University 5G channel model represented by the PDP, which is confirmed by outage performance of Telkom University 5G channel model derived based on the Shannon limit capacity. Computer simulations based on NYUSIM are conducted to produce the representative PDP of the Telkom University 5G channel model considering the humidity effect, where the parameters are taken from real-field conditions of Telkom University. The results show that when the humidity is maximum, Telkom University 5G channel model has 13 paths. On the other hand, when the humidity is minimum, the Telkom University 5G channel model has 13 paths.

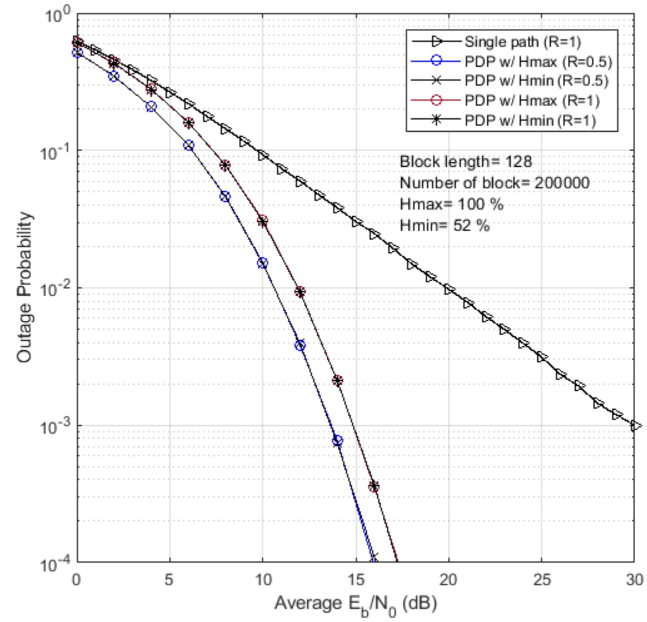

Fig. 3. Outage performances of communications 5G Telkom University channel model.

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