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RESEARCH ARTICLE

Coexistence of DVB-T2 and 5G in The Low-Band Frequency: Performance Analysis Using SEAMCAT Simulator

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Abstract: The development of telecommunications technology in Indonesia is increasing the need for high-speed data services, one of which is the implementation of 5G. The government has designated the use of the 700 MHz band, which is adjacent to the DVB-T2 band (478–694 MHz), which could cause interference. This study analyzes the probability of interference between 5G and DVB-T2 using SEAMCAT based on the Monte Carlo (MC) method with the Okumura-Hata propagation model. The analysis was conducted by varying the distance between the 5G receiver, the transmission power of DVB-T2, and interference parameters such as dRSS, iRSS and Carrier-to-Interference Ratio (C/I). The simulation results show that as the distance between the two systems increases, the C/I value increases, thus decreasing the probability of interference. At a transmission power of 30 dBm, a minimum distance of approximately 10 km is required to reduce the probability of interference to approximately 1%. Additionally, increasing the transmission power results in higher iRSS values and causes a decrease in C/I, thus increasing the risk of interference, especially at close distances. Therefore, appropriate frequency management and power control strategies are needed to optimize the implementation of 5G without interference from DVB-T2 services, especially in areas with a high transmitter density.

Keywords: 5G networks, DVB-T2, spectrum sharing, interference probability, SEAMCAT simulation, low-band frequency (700 MHz), coexistence analysis

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1 Introduction

The rapid advancement of technology continues to occur globally each year, including in Indonesia [1]. According to a survey by the Indonesian Internet Service Providers Association (APJII), internet penetration reached 79.50% between 2023 and 2024. In 2023, a total of 221,563,479 individuals from the Indonesian population of 278,696,200 were actively using telecommunication services, and this number is projected to continue to increase [2]. This growing demand drives the need for high-speed data services and greater mobility. Such needs have encouraged the emergence of fifth-generation (5G) mobile communication technology, which offers higher data rates, lower latency, and the ability to connect a large number of devices simultaneously [3]. 5G networks are capable of delivering speeds of up to 20 Gbps with latency around 1 ms, although they also present challenges, particularly the requirement for wider frequency resources [4].

Meanwhile, the deployment of 5G networks in Indonesia remains uneven and is still in the development stage [5]. To accelerate the 5G rollout, the Ministry of Communication and Informatics (Kominfo) in 2022 designated several frequency bands for 5G implementation, including the 700 MHz low band, the 3.5 GHz and 2.6 GHz mid bands, and the 26 GHz and 28 GHz high bands. According to 3GPP TR 21.195 (Release 15), the frequency range 1 (FR1) for 5G spans 450–7125 MHz [6], while the frequency range 2 (FR2) covers 23–53 GHz [7].

To optimize 5G performance, additional spectrum resources are required. However, the use of adjacent frequency bands raises potential interference issues. The 700 MHz low band allocated for 5G is adjacent to the frequency band used by DVB-T2. In Indonesia, DVB-T2 operates within the 478–694 MHz range, which was previously utilized by analog television broadcast before the digital migration mandated by Kominfo in 2022 [8]. This condition may lead to interference from DVB-T2 signals in 5G services, especially because the transmission power of DVB-T2 transmitters is generally higher than that of 5G base stations, especially in areas with dense TV broadcasting infrastructure [9].

As shown in [10] differences in transmission power between adjacent-band systems can be a major factor contributing to interference, thus requiring appropriate spectrum management and technical parameters to ensure that both services can operate without disruption. Existing studies have predominantly focused on coexistence issues among digital broadcasting services or earlier generations of cellular technologies. To date, there remains a lack of research specifically examining interference between 5G and DVB-T2, particularly within the 700 MHz low-band spectrum currently being prepared for 5G deployment in Indonesia. Furthermore, most previous studies rely on international standard parameters without considering device characteristics, national spectrum arrangements, or the diverse geographical conditions in Indonesia, where transmitter density and environmental variations differ significantly. These limitations underscore a research gap that must be addressed to support accurate and context-specific spectrum planning in the country.

To address this gap, the present study analyzes the interference probability between 5G and DVB-T2 in adjacent channels based on the actual early-stage implementation conditions of 5G equipment in Indonesia, particularly within the 700 MHz band. This research employs the Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT) to perform a quantitative assessment of potential interference and evaluate the feasibility of adjacent-channel spectrum usage in the Indonesian context. In addition, the study proposes spectrum-mitigation strategies that can be recommended as technical measures to support the accelerated deployment of 5G networks in the 700 MHz band, ensuring that limited spectrum resources are utilized optimally and efficiently.

The novelty of this research lies in the interference analysis between 5G and DVB-T2 systems based on the actual conditions of the early deployment of 5G devices in Indonesia, particularly within the 700 MHz low-band spectrum that is currently being rolled out. Unlike previous studies, this work quantitatively examines interference probability using SEAMCAT by incorporating technical parameters, geographical conditions, and the regulatory framework specific to Indonesia to assess the feasibility of adjacent-channel operation. Moreover, this study proposes spectrum-mitigation solutions that can serve as technical recommendations to support the accelerated development of 5G networks in the 700 MHz band, enabling more optimal and efficient utilization of limited spectrum resources.

This study has limitations because all analyzes were conducted using SEAMCAT simulations with the Okumura–Hata propagation model, without direct field validation. In addition, the study acknowledges constraints related to geographical conditions and environmental variations, which cannot be fully represented through simulation. Specifically, this research utilized only the suburban environment type in the propagation modeling, and consequently, the resulting analysis only covers suburban conditions. The propagation characteristics in urban and rural environments were thus not included in the scope of the evaluation.

Nevertheless, the study remains focused on analyzing the interference probability between 5G and DVB-T2 to ensure that the limited spectrum can be utilized effectively and efficiently. Specifically, this research aims to evaluate the potential interference under adjacent-channel operation and to identify the mitigation strategies required to support the implementation of 5G in Indonesia. Simulations were carried out using the Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT) to obtain quantitative results regarding the potential interference between the two systems.

2 Research Method

SEAMCAT has two important parameters in the simulation: Victim Link and Interfering Link. Victim Link is the active working area between the transmitter side (wanted transmitter) and the receiver side (victim receiver). Whereas the Interfering Link is the active working area of interference between the interfering transmitter and the wanted receiver [11].

Figure 1 it is an Interference Scheme that models a victim receiver (vr) connected to a wanted transmitter (wt) modeled as a 5G victim link and operating among a population of DVBT-2 transmitters that have the potential to interfere (Interferer Transmitters - It) with the 5G victim receiver. The study utilizes a simulation approach because SEAMCAT, integrated with the Okumura–Hata propagation model, is capable of accurately representing real-world environmental conditions through the modeling of relevant technical parameters. Direct field measurements were not conducted because the research focus is on analyzing potential interference in a pre-defined frequency scenario for 5G deployment in Indonesia; thus, simulation is deemed sufficient to provide a quantitative overview as a basis for technical and policy recommendations.

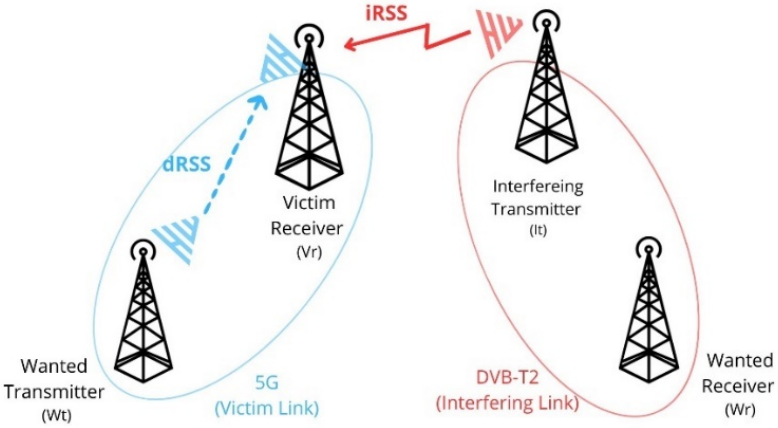

Figure 1: Interference scheme [12].

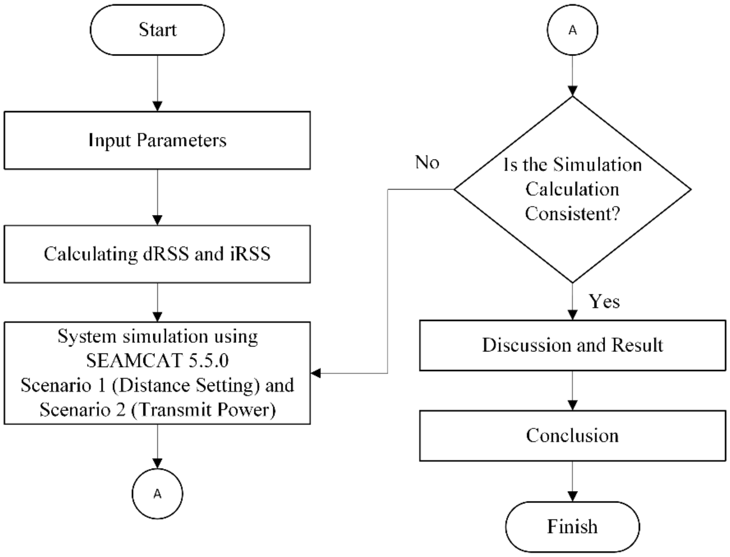

Figure 2: Flowchart.

2.1 Flowchart

Based on Figure 2 this research begins with inputting the 5G and DVB-T2 parameters. Then, the next step is to calculate the dRSS and iRSS values using the predetermined formulas. The next step is to conduct a simulation using the Calculation Engine (ICE) with SEAMCAT 5.5.0. This simulation will use two scenarios, namely distance adjustment and transmit power, with the simulation results being dRSS, iRSS, and C/I values. The first scenario is conducted by adjusting the distance between the 5G device and the DVB-T2.

The second scenario uses variations in transmit power values on the DVB-T2 device.If the calculation and simulation results are consistent, proceed to the analysis and discussion phase. However, if the calculation and simulation results are inconsistent. A recalculation of the dRSS and iRSS values is needed.

2.2 Propagation Model

This research applies to the Okumura-Hata model, which is used to predict signal propagation in various environments, whether urban, suburban, or rural. Okumura-Hata is one of the propagation models used to estimate path loss or signal attenuation based on frequency, distance, and the height of the transmitter and receiver antennas [13]. The general equation for path loss in equation (1) [14]. Indonesia has diverse topography, high population density in urban areas, and cellular frequency usage within the range covered by the Okumura-Hata model (150–1500 MHz). However, this only applies to certain frequencies.

$$PL = A + B\log(d) + CPL = A + B\log d + C \tag{1}$$

Where PL is the path loss, A, B, and C, are factors that depend on the frequency and height of the antenna. Factors A, B, and C, in Equation 2, Equation 3, and Equation 4:

$$A = 69.55 + 26.16\log(f) - 13.82\log(h_{tx}) - a(h_{rx}) \tag{2}$$

$$A = 69.55 + 26.16\log f - 13.82\log h_{tx} - a(h_{rx}) \tag{3}$$

$$B = 44.9 - 6.55\log(h_{tx})B = 44.9 - 6.55\log h_{tx} \tag{4}$$

h_{tx} is the height of the transmitter antenna while h_{rx} is the height of the receiver antenna in meters. f is the frequency in MHz and d is the distance in km. The function $a(h_{rx})$ and the coefficient C for sub urban areas as in Equation 5 and Equation 6.

$$a(h_{rx}) = (1.1\log(f) - 0.7)h_{tx} - (1.5\log(f) - 0.8) \tag{5}$$

$$C = -2\log(f/28)^2 - 5.4 \tag{6}$$

This study, to understand how interference between 5G signals and DVB-T2 can affect the performance of each technology, a simulation approach using SEAMCAT was employed. SEAMCAT is software developed by the European Communications Office (ECO). Its function is to analyze spectrum interference between communication systems through simulation using the MC method. This analysis involves Interfering Received Signal Strength (iRSS) and Desired Received Signal Strength (dRSS). iRSS is a measurement of the strength of the undesired signal. Whereas dRSS is the strength of the desired signal [15]. SEAMCAT calculates the interference probability (P_I) of the receiver based on the distribution of Carrier to Interference (C/I) values. C/I is a characteristic value of a technology that utilizes a carrier signal in the data exchange process [16]. The C/I ratio is used to determine the extent of interference from the interference signal on the main signal. SEAMCAT calculates the probability of interference (P_I) from the recipient [17]:

$$P_I = 1 - P_{NI} \tag{7}$$

with P_{NI} being the non-interference probability, P_{NI} is defined as follows [17]:

$$P_{NI} = P\left(\frac{dRSS}{iRSS}\,\middle|\,\frac{C}{I}\,dRSS > sens\right) \tag{8}$$

Where:

$$iRSS_{\text{comp}} = \sum_{i=1}^{p} iRRS_j \tag{9}$$

The equation for the probability of non-interference P_{NI} is the probability of no interference. P is the transmission power at the transmitter antenna. $dRSS$ is the received signal strength (dBm). $iRSS$ is the strength of the received interference signal (dBm). C/I is the ratio between the carrier signal and interference (dB). Receiver Sensitivity $(sens)$ is the sensitivity at the minimum signal level (dBm). To determine the interference occurring between the 5G network and DVB-T2, it can be calculated using the C/I value with the equation 10 [18]:

$$\frac{C}{I}(dB) = 10\log\left(\frac{10^{dRSS/10}}{10^{iRSS_{\text{composite}}/10}}\right) \tag{10}$$

Where $iRSS_{compossite}$ is the total of all signals that interfere with the 5G network receiver.

2.3 Parameter

Before conducting the simulation. Determining parameters that include the victim link and the interfering link that play a role in the interference analysis between 5G networks and DVB-T2. The DVB-T2 parameters follow the configuration presented by study [19], which analyzed coexistence within the 700 MHz band. The operating frequency of 686–694 MHz and the 8 MHz bandwidth were selected in accordance with ETSI [20] and the UHF allocation defined by ITU-R. The transmit power of 33 dBm, an antenna gain of 9 dBi, an antenna height of 150 m, as well as the sensitivity and noise figure values were directly adopted from the referenced study. The Okumura–Hatta propagation model is employed as it aligns with ITU recommendations for UHF frequencies and urban environments. Table 1 contains the parameter values of the interfering link, namely DVB-T2:

The 5G NR parameters follow the configuration presented in the study [21] and comply with the 3GPP TS 38.104 and 38.101 specifications. The operating frequency of 704 MHz lies within band n28, while the 20 MHz bandwidth represents the maximum value permitted for this band. The transmit power of 23 dBm, antenna gain of 0 dBi, noise figure of 7 dB, and receiver sensitivity of –119 dBm are adopted from standard UE specifications. The same propagation model is employed to maintain analytical consistency. Table 2 presents the parameters used for the victim link (5G network), where each value has been adjusted to ensure that the simulation results more accurately reflect real operational conditions.

2.4 Simulation Design

This simulation varies distance and power output to evaluate their impact on C/I and potential interference in 5G and DVB-T2 networks. The results show how changes in these

Table 1: Parameters of the DVB-T2 interfering link [19]

No	Parameter	Tx	Rx
1	Frequency band (n28)	686–694 MHz	
2	Bandwidth (MHz)	8	
3	Tx power (dBm)	33	0
4	TX antenna gain (dBi)	0	9
5	Tx antenna height (m)	150	10
6	Sensitivity (dBm)	-79.09	
7	Cell radius (Km)	15	-
8	Noise figure	6	6
9	Antenna patterns	Horizontal: omnidirectional BT.419 (Transmit)	
10	Propagation model	Okumura-Hatta	

Table 2: Parameters of the 5G victim link [21]

No	Parameter	Tx	Rx
1	Frequency band (n28)	704 MHz	
2	Bandwidth (MHz)	20	
3	Tx power (dBm)	23	46
4	TX antenna gain (dBi)	0	15
5	Tx antenna height (m)	1.5	30
6	Sensitivity (dBm)	-119	
7	Cell radius (Km)	5	5
8	Noise figure	7	7
9	Antenna patterns	3GPP tri-sector (60 deg) Beamforming 8x8	
10	Propagation model	Okumura-Hatta	
11	Emission mask	5G NR 10 MHz below 1 GHz	

two parameters affect signal quality, communication stability, and the risk of interference between systems.

Figure 3 it is a simulation design aimed at analyzing the impact of interference caused by DVB-T2 transmitters on 5G receivers. In this scenario. The DVB-T2 transmitter operates as a source of interference. The 5G receiver acts as the victim receiver that experiences interference due to the signal from the DVB-T2 transmitter. To evaluate the level of interference. A simulation was conducted by varying two main parameters. Namely, the distance between the transmitter and receiver, as well as the transmit power of the DVB-T2 transmitter.

2.4.1 Distance Variation

The distance between the DVB-T2 transmitter and the 5G receiver is the main factor determining the level of interference received by the 5G system. The closer the distance between the DVB-T2 transmitter and the 5G receiver, the higher the $iRSS$ value received by the 5G device, thereby increasing the likelihood of interference. On the other hand, if the distance

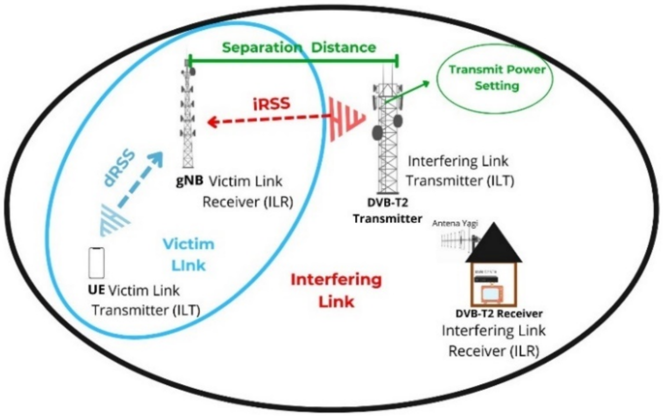

Figure 3: Simulation design.

between the two is increased, the interference power received by the 5G system will decrease. In this study, an analysis was conducted using variations in distance between the DVB-T2 transmitter and the 5G receiver, ranging from 1 km to 10 km to observe the effect of distance on the level of interference that occurs.

2.4.2 Transmit Power Variation

The power of the DVB-T2 transmitter is another factor that affects the level of interference received by the 5G receiver. The higher the transmission power used, the stronger the emitted signal, which can increase interference on the 5G system, especially at adjacent frequencies. On the other hand, if the transmission power is reduced, interference can be minimized. But the coverage of the DVB-T2 broadcast can also be affected. In this study, a variation in transmission power between 30 to 33 dBm is used to analyze the impact on the C/I value and determine the optimal transmission power level that allows both systems to operate efficiently. This simulation was conducted using SEAMCAT to analyze the probability of interference based on predetermined parameters.

3 Results

3.1 Analysis of Simulation Results

This research involves four simulation trials that will be tested. The first experiment is conducted at a DVB-T2 transmission power of 33 dBm with a device distance variation of 1-10 km. The second experiment was conducted at a DVB-T2 transmission power of 32 dBm with a device distance variation of 1-10 km. Then the third experiment was conducted under conditions where the DVB-T2 transmission power was 31 dBm with 1-10 km. Meanwhile, the fourth experiment was conducted when the DVB-T2 transmission power was 30 dBm with the same distance variation of 1-10 km for 5G and DVB-T2 devices.

The comparison of the simulation results and the dRSS and iRSS calculations is shown in Table 3. Based on the table, the calculated dRSS value is -66.02 dBm, and the simulation

Table 3: Comparison of $dRSS$ and $iRSS$ Values Obtained from Calculation and simulation Of DVB-T2 leak to 5G interference

Tx Power (dBm)	dRSS (dBm)		iRSS (dBm)	
	Calculation	Simulation	Calculation	Simulation
33	-66.02	-86.48	-101.964	-123.69
32	-66.02	-86.36	-102.964	-123.91
31	-66.02	-85.16	-103.964	-125.772
30	-66.02	-85.51	-104.964	-125.77

result is -86.48, meaning the difference in values occurs due to the difference in the number of samples taken and other factors such as the direction of the antenna. Meanwhile, the iRSS value obtained in the simulation is higher due to the large number of samples and the direction of the antenna used. Calculations typically use homogeneous properties (high antenna, no complex multipath), while simulations use multipath, diffraction, and scattering. Therefore, the values between calculations and simulations differ slightly.

3.1.1 Simulation with an output power of 33 dBm

Table 4: Simulation result of DVB-T2 and 5G interference probability with 33 dBm transmit power

Device Distance (km)	**dRSS (dBm)**	**iRSS (dBm)**	**C/I (dB)**	**Interference Probability (%)**
1	-86.48	-123.69	37.21	13.4
2	-86.36	-124.62	38.26	12.1
3	-86.26	-127.98	41.71	7.4
4	-85.96	-129.88	43.92	6.7
5	-86.41	-131.97	45.57	5.3
6	-85.69	-132.95	47.26	3.5
7	-86.27	-134.43	48.16	4.1
8	-85.16	-136.68	49.58	2.4
9	-85.69	-136.96	51.27	2.0
10	-85.51	-137.54	52.03	1.5

Table 4 is the simulation result under the condition of DVB-T2 transmit power of 33 dBm with a distance variation of 1-10 km. Based on the simulation results, with a distance variation of 1-10 km, the resulting dRSS values tend to be stable, whereas the iRSS values will increase as the distance used in the simulation increases. However, based on the results, the $dRSS$ and $iRSS$ values have met the standard criteria previously explained, which is $dRSS > iRSS$. Then the simulation results show that the C/I value produced will also increase as the distance between devices increases. The highest C/I value is obtained when the distance between devices is 10 km. The lowest interference probability will be achieved. When the distance used is 10 km with an interference probability of 1.5%, while the highest interference probability occurs when the distance used is 1 km.

3.1.2 Simulation with an output power of 32 dBm

Table 5: Simulation result of DVB-T2 and 5G interference probability with 32 dBm transmit power

Device Distance (km)	dRSS (dBm)	iRSS (dBm)	C/I (dB)	Interference Probability (%)
1	-85.94	-123.91	37.96	11.9
2	-85.67	-125.61	39.94	9.9
3	-86.42	-128.51	42.09	6.4
4	-85.44	-131.02	45.58	4.3
5	-86.41	-132.52	46.11	4.0
6	-85.91	-133.60	47.69	3.4
7	-85.88	-135.00	49.16	3.1
8	-86.18	-136.81	50.64	2.5
9	-86.35	-137.44	51.09	2.1
10	-85.85	-138.38	52.52	1.4

Based on Table 5, it shows the simulation results for the second experiment under the condition of DVB-T2 transmission power of 32 dBm, with a distance variation between the 5G device and DVB-T2 ranging from 1-8 km. The $dRSS$ value produced at a distance of 1 km is -85.94 dBm, while at the farthest distance of 10 km, the $dRSS$ value is -85.85 dBm.This indicates that distance does not significantly affect the generated dRSS value. The simulation results for the iRSS value show that the farther the distance between the 5G device and DVB-T2, the smaller the iRSS value will be. At 1 km, the $iRSS$ value is 123.91 dBm, whereas at 10 km, the $iRSS$ value is -138.38. Then, the C/I value will increase as the distance increases. The highest C/I value is at 10 km, which is 52.52 dB, and the lowest C/I value is at 1 km, which is 37.96 dB. The lowest interference probability is achieved at 1.4% at 10 km.

3.1.3 Simulation with a power output of 31 dBm

Table 6: Simulation result of DVB-T2 and 5G interference probability with 31 dBm transmit power

Device Distance (km)	dRSS (dBm)	iRSS (dBm)	C/I (dB)	Interference Probability (%)
1	-85.83	-125.77	39.94	9.6
2	-86.07	-125.85	39.78	9.4
3	-85.55	-129.68	44.14	6.0
4	-85.28	-132.35	46.07	5.5
5	-85.66	-133.75	48.09	3.4
6	-85.43	-135.32	49.89	2.9
7	-86.17	-136.31	50.15	2.8
8	-86.39	-137.47	51.08	2.7
9	-85.52	-139.02	53.50	1.9
10	-86.06	-139.06	53.00	1.6

Table 6 Shows the simulation results for the third experiment under the condition of a 31 dBm DVB-T2 transmitter with a distance variation of 1-10 km. The simulation results show that the $dRSS$ values produced are quite stable, ranging from 85 to 86 dBm. Meanwhile, the $iRSS$ results show that distance affects the simulation values produced. Where the $iRSS$ value will decrease as the distance between devices increases. The $iRSS$ value is -125.77 dBm at 1 km, while at the farthest distance of 10 km, the IRSS value reaches -139.06 dBm. Then, the smallest C/I value at 1 km is 39.94 dB. At 10 km, the C/I increases to 53 dB. The smallest interference probability is 1.6% at 10 km.

3.1.4 Simulation with a power output of 30 dBm

Table 7: Simulation result of DVB-T2 and 5G interference probability with 30 dBm transmit power

Device Distance (km)	dRSS (dBm)	iRSS (dBm)	C/I (dB)	Interference Probability (%)
1	-85.96	-125.88	39.92	9.0
2	-85.80	-128.40	42.60	6.3
3	-86.18	-130.61	44.44	5.9
4	-86.18	-133.02	46.84	4.7
5	-86.53	-134.54	48.01	3.6
6	-86.55	-136.67	50.12	3.4
7	-86.43	-137.75	51.31	2.2
8	-85.71	-138.41	52.70	1.7
9	-85.89	-139.80	53.91	1.5
10	-86.79	-140.54	53.75	1.0

Table 7 Shows the simulation results for the fourth experiment when the DVB-T2 transmission power is 30 dBm with a distance variation of 1-10 km. Based on the simulation results, the distance of the device does not significantly affect the resulting $dRSS$ value. This is evidenced by the fact that the $dRSS$ value tends to be around 85-86 dBm. Meanwhile, the $iRSS$ value will decrease as the distance from the device increases. The highest C/I value is 53.75 at 10 km, and the lowest C/I value is 39.92 dB. The probability of interference will decrease as the distance between devices increases. The smallest interference probability is at 10 km, which is 1%.

4 Discussion

Figure 4 illustrates the relationship between distance (km) and interference probability (%) for various transmission power levels, namely 30 dBm, 31 dBm, 32 dBm, and 33 dBm. Based on the graph, it can be observed that as the distance between the transmitter and receiver increases, the probability of interference tends to decrease. At relatively close distances (1–3 km), the probability of interference is still quite high, especially for higher transmission power. However, after reaching about 5 km, the probability of interference begins to decrease significantly until it approaches zero at distances greater than 8–10 km.

Furthermore, transmission power affects the level of interference, where higher transmission power tends to increase the probability of interference, especially at closer dis-

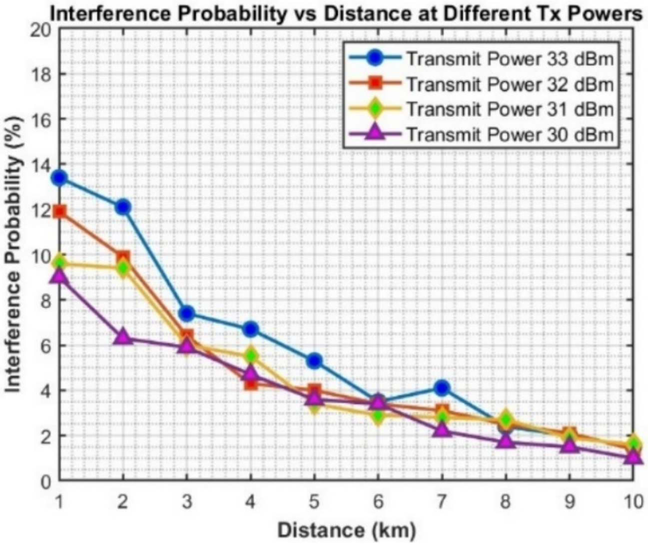

Figure 4: Interference probability vs distance graph.

tances. This can be seen from the 33 dBm transmission power, which has the highest interference probability compared to lower transmission powers. On the other hand, a transmission power of 30 dBm shows the lowest probability of interference at every distance. Interestingly, after reaching about 6–10 km, the influence of transmission power on interference becomes increasingly smaller due to natural signal attenuation.

5 Conclusion

Based on the analysis and discussion of the simulation results, it is known that the interference power level can reach -140.54 dBm at a transmission power of 30 dBm. The conversion distance required is 10 km to prevent interference between the DVB-T2 system and the 5G system. At this distance, the probability of interference occurring is 1%. The greater the distance between devices, the lower the risk of interference. The probability of interference is inversely proportional to the C/I value. Therefore, in managing DVB-T2 networks, the selection of an appropriate transmission power needs to be considered to reduce the possibility of signal interference, especially in areas with high transmitter density. To reduce interference, using lower transmission power or increasing the distance between transmitters can be effective strategies. Distance regulations aim to provide guidance in gNB construction planning to prevent interference. A distance regulation of 10 km can reduce interference, so a distance of more than 10 km would be better. Therefore, the relationship between distance and transmission power cannot be separated from each other to create an interference-free system. Future research is expected to determine 5G parameters in accordance with those set by the Indonesian government. In addition, the use of varying environmental conditions, such as urban and rural, can be utilized.

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