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Interference Analysis of Weather Radar at The Meteorological Station

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Abstract— This research aims to analyze the disturbances that occur at the Sultan Syarif Kasim II Meteorological Station Weather Radar and provide appropriate treatment to stop the source of the disturbance. For this reason, the following steps are arranged: Literature studies, preparation for mitigating interference, measurement, interference analysis, and interference resolution. After applying measurements, the following results were obtained: The interference location point is on the azimuth line (8.07° and 37.84°), Noise floor level -107.3 dBm at a frequency of 6500 MHz when SSID PermanaNET#02 5825 MHz is on, noise floor level -111.1 dBm at a frequency of 6500 MHz when SSID PermanaNET#02 5825 MHz is off, distance between BMKG Radar station to Point of Presence (PoP) ISP PT. Medianusa Permana is very close ±200 meters, antenna SSID PermanaNET#02 5825 MHz pointing to the BMKG Radar Station, and sensitivity of the EEC DWSR–2500C Radar Device is -113 dBm. Interference at the 6500 MHz radar frequency comes from the Out Of Band Emission frequency 5825 MHz (SSID PermanaNET#02). Following this, the interference is mitigated by the off-air method, which is deactivation of the PermanaNET SSID#02 device.

Keywords: Frequency Spectrum Interference, Noise Floor, Radio Frequency Spectrum, Telecommunications, Weather Radar.

INTRODUCTION

The Radio Frequency Spectrum is a limited natural resource that has strategic value in telecommunications operations. The telecommunications operator must have a permit to use the Radio Frequency Spectrum [1]. Licensing is carried out to minimize disruption. In ITU Radio Regulation no. 1.166 radio interference is defined as the effect of unwanted energy due to one or a combination of emission, radiation, or induction on reception in a radio communications system, manifested by performance degradation, misinterpretation or loss of information that could be extracted without the presence of such unwanted energy [2]. Radio frequency interference (RFI) occurs when unwanted energy enters or is present on the frequency channel occupied by a victim receiver, so that the receiver cannot receive the desired signal properly [3]. RFI can influence the interpretation process of raw data and image formation [4]. Interference can be sourced from other radio systems, mobile phones, and some devices such

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as RFID system [5]. The process for reducing disturbances is carried out if the reporting party has an Izin Stasiun Radio (ISR). ISR is a permit to use a radio frequency channel based on certain requirements [6]. In the Regulation of the Director General of Postal and Informatics Resources and Equipment number 6 of 2020 concerning Monitoring and Handling Radio Frequency Spectrum Disorders. In Chapter III, mitigation of radio frequency spectrum disturbances, part of Article 18 explains that handling of radio frequency spectrum disturbances is carried out based on a priority scale. The priority scale as intended in paragraph (1) can be grouped based on the nature of the disturbance, including interference with the radio communication system which endangers the safety of human life, state defense and security, or distress [7] [8]. One of the devices that falls into the category of radio communication systems that endanger the safety of human life, national defense and security, or is in danger if interference occurs is a meteorological station weather radar device. In this case, the allocation of the radar frequency spectrum has been regulated by the International Telecommunication Union (ITU). The radar allocation band is 5 Ghz in band. Where this frequency is close to device bands such as Wireless Fidelity (Wi-Fi), Wireless Local Area Network (WLAN), Radio Local Area Network (RLAN)[9].

Many case studies regarding radio frequency spectrum interference have been carried out by previous researchers. Research by Aziz, Azwar with the title "Study of the Effectiveness of Handling Radio Frequency Interference at the Radio Frequency Spectrum Monitoring Center, Evaluation of the Utilization of Radio Frequency Monitoring Tools in Padang in 2016" [6], uses quantitative research methodology, with purposive sampling and a sample size of 85 respondents in 5 locations research, namely Jakarta, Bandung, Surabaya, Yogyakarta and Batam with the analysis technique using the Structure Equation Modeling (SEM) analysis technique with Partial Least Square (PLS). Next research is by Reza Aditya Aziz with the title "Analysis of Co-channel Interference on the GSM 900 Network in the Karawang-West JavaRegion" [11]. The aims of the research are to instigate Co-Channel interference that occurs in the Karawang region on GSM 900 PT. INDOSAT between the eel/site Karang Seti and the large cellsite Serka Sukatani C/1 reaches O - 3 dB and the eel/site Sukatani Batujaya with the large cellsite Batu Jaya C/I reaches 3 - 6 dB. Research conducted by K. Ariansyah with the title "Interference analysis of T-DAB and Analog TV in the Very High Frequency (VHF) band" [12], aimed to obtain geographical separation between the T-DAB system and analog TV as an interference solution with the analysis carried out with the help of SEAMCAT. The latest research, conducted by M. Budiono et all, with the title "Study of Handling Radio Frequency Spectrum Disorders at the Gorontalo Monitoring Location"[13], use a field observation methodology study and with several related parties sequentially to collect the necessary field data. The tools and materials used in this research are: Garmin Montana 650s GPS, R&S PR 100, R&S HE300 Antenna, FieldFox N9918A, BWA 5 GHz TP-Link CPE 610 Antenna, Anritsu MS2720T Spectrum Analyzer, Steiner Binoculars, Inverter, Laptop, and Car Monitoring. From the spectrum analyzer it is known that interference can occur due to the presence of other signals that have the same frequency and strength of the interference signal.

Vaccarono et all has published the article with the tittle “Survey on Electromagnetic Interference in Weather Radars in Northwestern Italy” [14]. It investigated the sources of interference influencing of weather radars in Northwestern Italy which mostly caused by RLAN and WLAN. This work aims to introduce the RFI phenomena affecting both C-band and X-band weather radars in Piemonte region, Italy. The effect of electromagnetic interferences in weather radars leads to a biased hydrometeor classification and quantitative precipitation estimation. Furthermore, a case study of RFI characteristics and mitigation is evaluated by J. Yin et all [15]. The authors characterized the RFI using the real measurements from an operational C-band SHV radar and mitigated the effects of RFI. This article was written to analyze the types of interference and appropriate handling of Weather Radar interference at the Sultan Syarif Kasim II Meteorological Station, by the Pekanbaru Class I Radio Frequency Spectrum Monitoring Center. This article uses a methodology in the form of literature study, preparation,

engraving, interference sensitivity analysis, and interference resolution. It is hoped that this paper can contribute as a reference in resolving interference problems that occur on the BMKG weather radar. This paper consists of four sessions, namely introduction, methodology, results and discussion and conclusions.

METHODOLOGY

To achieve the aim of the research, there are some steps done as shown in Figure 1. The detail of these steps can be explained as follows:

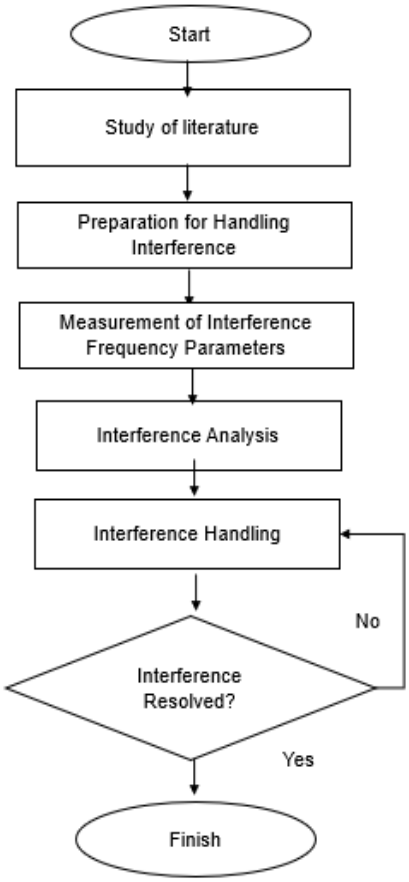

Figure 1. Research Flowchart

A. Literature Studies

Literature studies, as shown in Figure 1, are carried out as a first step before carrying out interference handling. Data collection is carried out by observing and identifying. The data referred to are rules or SOPs for handling radio frequency spectrum interference, references related to ISR data from the BMKG weather radar, SSK II meteorological station, data on the equipment used, and the process of handling radio frequency interference by the Pekanbaru Class I Radio Frequency Spectrum Monitoring Center Balmon.

B. Preparation for handling interference

This preparation includes preparing the legal basis for the activity, preparing the equipment used, and carrying out an inspection of the reporter's ISR weather radar station. ISR weather

radar station inspection is an activity to check whether the data in the field matches the data in ISR. During the inspection, it was found that there were differences between field data and the data in ISR. The inspection results table can be seen in the Table 1.

Table 1. Meteorological Station Weather Radar Inspection Results

No	Radio Station Inspection	Existing Data	ISR (Izin Stasuin Radio)	Inspection results
1.	Radio Frequency	Rx: 5600 MHz	Rx: 5650 MHz	Existing Tx and Rx frequencies “Do not comply with ISR”
2.	Location Coordinates	0°27’ 23” LU 101° 27’ 50.6” East longitude	0°27’ 23” LS 101° 27’ 50” East longitude	USR coordinates (especially South latitude) do not match existing ones. The truth is North latitude
3.	Power (ERP)	250000 W(250KW)	94W	Location Coordinates

C. Measurement

This measurement aims to identify the frequency and characteristics of the frequency that will be observed. The technical devices used in this activity are monitoring devices. The monitoring devices can be seen in the Table 2.

Table 2. Monitoring devices

No	Monitoring Devices	Devicesl Description
1.	R&S®DDF007	Portable direction finder (9 kHz to 7.5 GHz).
2.	R&S® HE400	Handheld Directional Antenna.
3.	R&S®PR100	Portable Receiver (9 kHz to 7.5 GHz).
4.	R&S® HE300	Handheld Directional Antenna.
5.	Ubiquiti WiFi Access Point.	Advanced Wi-Fi networking devices for reliable professional solutions.

D. Interfarance Analysis

This analysis is carried out by identifying the type of disturbance that occurs based on data obtained from measurements. What is done at this stage is to identify the location of the disturbance, detect the source of the disturbance, analyze the type of disturbance that occurs and overcome it by stopping the disturbance off air.

E. Interference termination

Actions to stop the source of interference are carried out based on the results of the analysis that has been carried out so that the appropriate way to stop the source of interference is known. In this case, the method used to eliminate this disturbance is by turning off the air of the interfering device.

RESULT AND DISCUSSION

The activities that have been carried out, the results that will be discussed include mapping results, measurement results and results of stopping interference.

A. Mapping results

The results of mapping the location of the interference from the azimuth line and coordinate points can be seen in Figure 2. It can be seen that the mapping of the disturbed azimuth lines (8.07° and 37.84°) and the disturbance location points using the GPS (Global Positioning System) application. Then identify maps, satellite images, photos of buildings/roads (street view), and plan locations suspected of being monitoring targets in that azimuth direction (tall buildings, multi-storey shophouses, or busy centers).

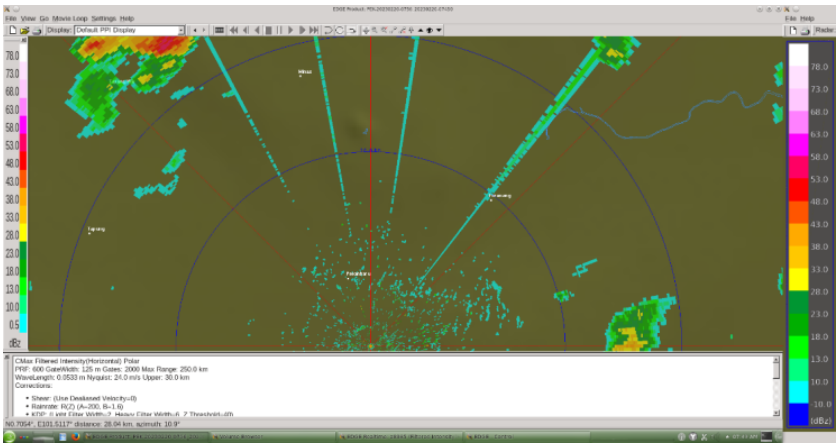

Figure 2. Mapping of Disturbed Azimuth Lines (8.07°and 37.84°) and Disturbance Location Points

B. Measurement Results

In this activity, monitoring and tracking of sources of interference was carried out using WiFi Access Point devices and portable monitoring stations (DDF007 and PR100). The measurement results found that the source of interference came from the use of one of PT's ISP Access Point devices.

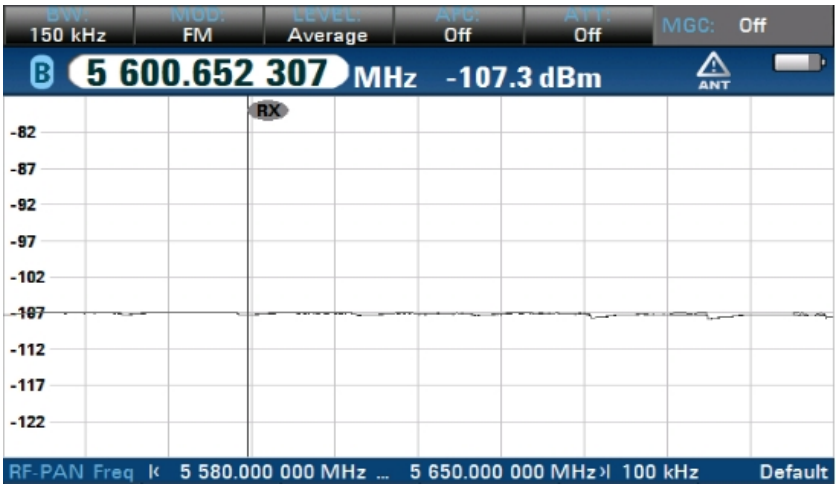

Figure 3. Noise Floor, Radar BMKG Off, SSID PermanaNET#02 5825 MHz On

Medianusa Permana with SSID PermanaNET#02, Ubiquiti Networks Rocket M5 brand and sectoral antenna that works at the 5825 MHz frequency. The results of the 5600 Mhz Noise

Floor measurement are shown in the figure 3. From Figure 3, it can be seen that the Noise Floor with a level of -107.3 dBm at a frequency of 6500 MHz when SSID PermanaNET#02 5825 MHz is On. Meanwhile, if SSID PermanaNET#02 5825 MHz is off, you can see it in the Figure 4.

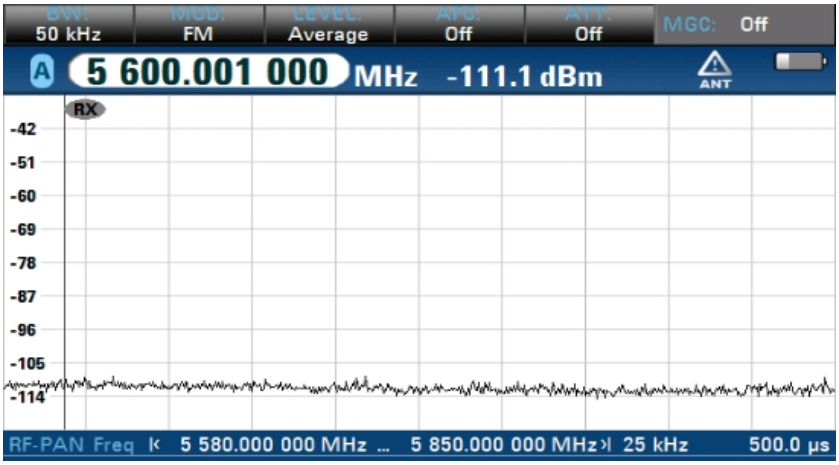

Figure 4. Noise Floor, Radar BMKG Off, SSID PermanaNET#02 5825 MHz Off

As can be seen in the Figure 4, when SSID PermanaNET#02 5825 MHz is Off, the Noise Floor level is -111.1 dBm at a frequency of 6500 MHz. Therefore, technically, interference can occur due to Out Of Band Emissions so that the Noise Floor in the area around the ISP WiFi Access Point antenna becomes raised. This is due to the close distance between the WiFi Access Point antenna and the BMKG Radar (around 200 m), the use of a sectoral WiFi antenna with a wider beamwidth than a parabolic antenna, and a sectoral antenna that faces west (the Pasir Putih direction) so that antenna emissions can affect the BMKG radar. The ideal radar signal sensitivity level is -110 dBm to -113 dBm, as shown in the Figure 5.

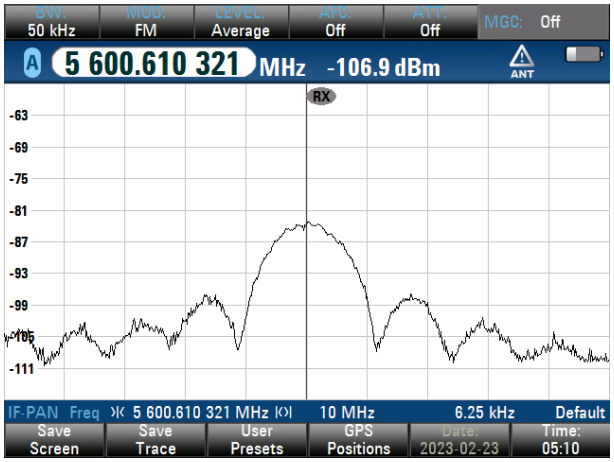

Figure 5. Ideal Radar Signal

Figure 5 show that the radar signal working at the 5.6 GHz frequency has scattered emissions (spurious emissions) around the main frequency with a level of -106.9 dBm. If the level is outside specifications, it can cause the radar to experience interference due to false

information entering the Rx radar. The receiver specifications on the radar is dispacthed in the table 3.

Table 3. Receiver Specificatios

Receiver Specifications		
Category	**Analog Receiver**	**EDRP-8 Digital Receiver**
Sensitivity @0.8 µsec @2.0 µsec	-110 dBm -113 dBm	-110 dBm -113 dBm

As shown in the Table 3, the sensitivity of the radar receiver is -110 dBm and -113 dBm. As for the recap of the identification of the source of the 5825 MHz frequency beam from ISP PT. Medianusa Permana interferes with the BMKG 5600 MHz Radar frequency because:

- Noise Floor level -107.3 dBm at a frequency of 6500 MHz when SSID PermanaNET#02 5825 MHz is On.
- Noise Floor level -111.1 dBm at a frequency of 6500 MHz when SSID PermanaNET#02 5825 MHz is Off.
- Distance between BMKG Radar Station to POP ISP PT. Medianusa Permana is very close ±200 meters.
- Antenna SSID PermanaNET#02 5825 MHz pointing to the BMKG Radar Station.
- Sensitivity of the EEC DWSR–2500C Radar Device -113 dBm.

C. Interference Mitigation

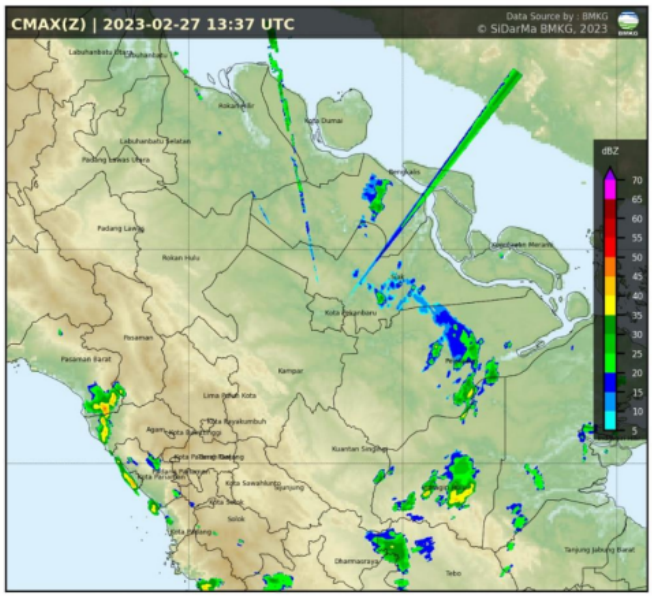

Figure 6. Interference with the Weather Radar of the Meteorological Station with an Azimuth Of 8.4° at an Elevation Of 0.5° has Disappeared (Clear)

Out of Band Emissions from the Permana NET#02 5825 MHz SSID frequency cause interference at the BMKG Radar Station because the sectoral antenna is pointing towards the BMKG Radar Station and its adjacent location. After finding the source of the disturbance, the process of stopping the source of the disturbance is carried out using the off-air method. Off air method is a method of stopping interference by deactivating the interference device and lowering it from the Base Transceiver Station (BTS). The following are the results of the BMKG

Radar Status after the source of interference was stopped. Figure 6 displays the interference with the Meteorological Station Weather Radar has disappeared. In this way, handling and stopping the disturbances that occur have been carried out properly.

CONCLUSION

The handling of Weather Radar Frequency Interference at the Sultan Syarif Kasim II Meteorological Station by the Pekanbaru Class I Radio Frequency Spectrum Monitoring Center is in accordance with the SOP which refers to the Regulation of the Director General of Postal and Informatics Resources and Equipment Number 6 of 2020 concerning Monitoring and Handling of Radio Frequency Spectrum Interference. Sectoral antenna direction and distance of POP ISP PT. Medianusa Permana, which is close to the BMKG SSK II Pekanbaru Radar Station, causes interference. Interference on the 6500 MHz radar frequency comes from Out Of Band Emission frequency 5825 MHz (SSID PermanaNET#02).

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