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Simulation of Digital Radio Mondiale (DRM) Coverage Prediction – A study case with Radio Republik Indonesia (RRI)

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***Abstract*— In this paper, DRM is applied for simulating coverage prediction in Radio Republik Indonesia (RRI). The proposed method is developed by simulating high frequency propagation from RRI Pro 3 transmitter with VOACAP online software. The simulation is undertaken in some different conditions. The variation of antenna type and transmitter power are observed in the simulation. The time of propagation also discussed to predict the coverage. The result shows that the variation of parameter influences the coverage result of DRM propagation in HF band. Changing the antenna type and time of propagation will make impact in the range of coverage while adding power transmitter gives insignificantly effect to the range of coverage.**

Keywords—DRM, Prediction Coverage, VOACAP

I. INTRODUCTION

Countries around the world are now in the process for migrating from analogue to digital radio broadcasting. Digitalization provides advantages such as allows such features as automatic tuning, offers credible single frequency network and uses more efficient spectrum [1]. DRM is a digital radio standard designed by DRM Consortium for Low Frequency (LF), Medium Frequency (MF), and High Frequency (HF) bands [2][3]. DRM system is designed to provides a high quality digital replacement for current analogue radio system. It can be used both in Analogue Modulation and Frequency Modulation bands. DRM standard developed by an international consortium consist of broadcaster, network providers, manufactures, broadcasting unions and research institute. It specifically designed to allow new digital transmission to co-exist with the current analogue systems [4]. It also provides many advantages such as excellent audio quality, wide coverage, and significant energy cost saving.

Average radio today can only receive some 35-40 local FM stations. DRM itself has the potential to bring every radio a vast selection of new content because it is ideally suited to long range broadcasting so everyone can stay tuned to the same station as they cross regional and national boundaries and move from one country to another [4]. DRM is very portable and mobile. It can be taking anyplace to listen to what we want, when we want and where we want. Innovation in DRM brings short wave and medium wave broadcast can be heard in FM-like sound quality with excellent reception.

Radio Republik Indonesia (RRI), as state-owned radio of Indonesia joined DRM consortium in 2015. It possibly made Indonesia as the next county to apply DRM. Therefore, in this paper, DRM coverage simulation is investigated with HF propagation prediction model using VOACAP software. The coverage result variation as a response of changing simulation's parameters such as antenna type and transmitter power are analyzed. The propagation time also discussed to see the consequence on the coverage result.

II. DRM STANDARD

A. Frequency Bands

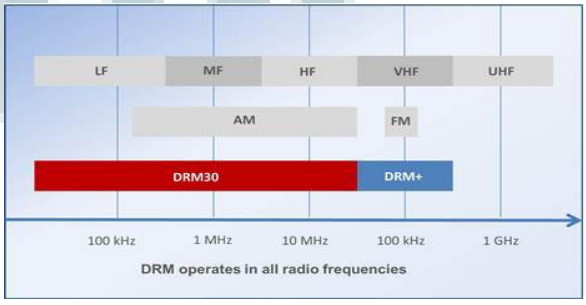

Fig. 1 DRM modes [3].

DRM system is a flexible digital sound broadcasting which available in frequency below 30 MHz [5]. Frequency bands for both DRM30 and DRM+ modes can be seen in Fig. 1. DRM standard describes several different operating modes which can be divided into two groups as follows [3]:

- DRM30 modes, designed for utilizing AM bands below 30 MHz
- DRM+ modes, designed for utilizing FM broadcast band from 30 MHz to 300 MHz

B. *Coverage Concepts for DRM*

Planning for DRM coverage is build based on two concepts [5]:

- Minimum usable field strength

Minimum usable field strength describes the requirement field strength for the receiver to a given level of performance. In DRM, it can be defined as bit error rate (BER). The BER is used as parameter whether the DRM signal can be reconstructing or not.

- Protection ratio

Protection ratio is the minimum values that the wanted signal levels must exceed unwanted interfering signal level.

The frequency bands for DRM is lay on LF until VHF bands, however in Indonesia most of AM radio use HF frequency bands [6]. Therefore, in this work we use HF propagation to calculate the coverage for DRM system in RRI station.

C. *HF Propagation Model*

HF Bands are ideal for providing coverage of large areas ranging from few hundred kilometers to several thousand kilometers from the transmitting site via sky-wave propagation. In addition, it can also propagate via groundwave but the range is only limited to few tens kilometers [7]. There are some methods to calculate HF prediction model which can be divided as follows:

- ICEPAC: IONCAP with ICED profile model developed by NTIA / ITS (Institute for Telecommunication Science)
- VOACAP: IONCAP modified by USIA/VOA for broadcasting
- REC 533: ITU R PI.533 model for international HF planning.

In this work, VOACAP is used as a model for understanding HF propagation for DRM coverage prediction.

III. Simulation and Result

Simulation is based on VOACAP freeware, a free online HF propagation prediction software developed by Jari Perkiomaki, James Watson, and Juho Juopperi. VOACAP is an engine which has the most accurate propagation prediction with radio propagation experience built in. This freeware can be found at http://www.voacap.com/coverage.html. The appearance for simulating HF propagation coverage in VOACAP online can be seen in Fig. 2.

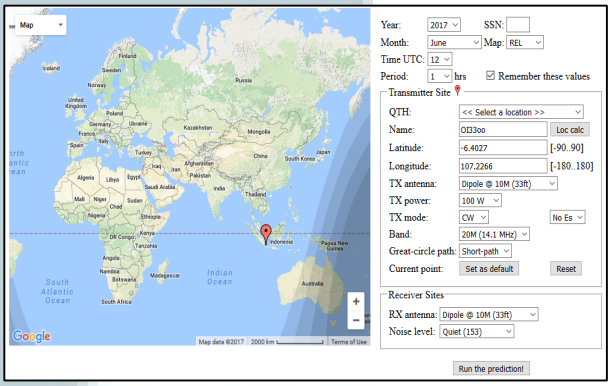

Fig. 2 Appearance of VOACAP coverage map.

A. *Parameter of Simulation*

There are some parameters that should be include for calculating HF coverage as follows:

- Date

This contain year, month and time which used for simulation. It can be flexible, depends on the requirement. In this work, the month and year is set as June 2017. The time itself is changed from 8 A.M, 12 A.M, 5 P.M, 9 P.M. and 12 P.M.

- Transmitter Site

Transmitter site is an important parameter for predicting HF coverage. It contains the location of Tx (with its longitude and latitude), antenna, Tx power, Tx modulation, band frequency, and great circle path. RRI

station PRO 3 is chosen as a Tx location with -6.1729000 latitudes and 106.822353 longitude. Frequency band applied for this simulation is 30 M Band with 10.1 MHz frequency.

There are many types of antenna which can be chosen in this simulation. Two widely used antennas are omnidirectional antenna and directional antenna. Based on commonly used antenna in Indonesia for AM/FM broadcasting and recommendation antenna for conduct HF propagation from [8], omnidirectional antenna that selected in the simulation are ¼ λ ground plane antenna, 5/8 λ antenna, and dipole antenna with length of 10 m. Meanwhile, from prior research in [9], the directional antenna that applied in this simulation is 3 element Yagi antenna with length of 15 m. The length of dipole and 3 element Yagi antennas are calculated with formula from [10]. The maximum transmitter power to be permitted in AM broadcasting in Indonesia is 2000 Watt [11] and mostly it ranged from 100 Watt, 500 Watt and 1000 Watt. Therefore, the transmitter power applied in this simulation are 100 Watt, 500 Watt, and 1000 Watt.

- Receiver Sites

The receiver in this simulation is static reception. The parameter only contains antenna used in receiver site. It is set to be the same as the antenna used in transmitter site.

The simulation is divided into three parts. In each part, some parameter is adjusted to obtain optimum specification for DRM coverage prediction with HF propagation approach. In the first simulation, the antenna type is adjusted into 4 types as mentioned before. In the second simulation, the transmitter power is added from the prior condition to see the effect on coverage result while in the third simulation, the time of propagation is changed into several variations. The coverage result is presented in graph which represent signal power received in that area (in percent) or the circuit reliability to conduct broadcasting communication in that area.

B. Simulation 1: Adjusting antenna type

In this first simulation, the time is set as 12 P.M with 250 Watt of transmitter power. From the results in Figs. 3-6 we can see that each type of antenna gives different result for predict the coverage. Three elements Yagi antenna gives the most intense reliability DRM coverage compared to 1/4 λ ground plane antenna, 5/8 λ antenna, and dipole antenna. Full coverage (100% coverage of DRM) can be reached until another Asia country like India and China. Some states in Australia also can hear RRI PRO 3 broadcast with 80%-100% reliability.

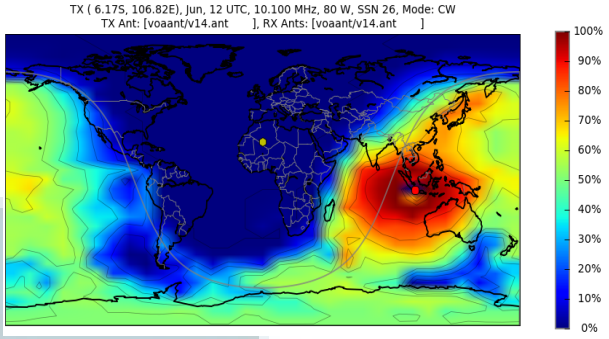

Fig. 3 Coverage Prediction for 1/4 λ ground plane antenna

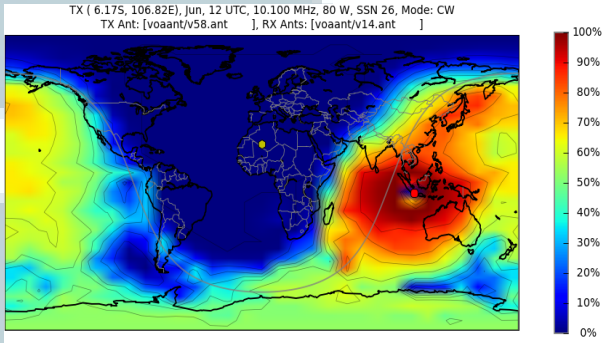

Fig. 4 Coverage Prediction for 5/8 λ antenna

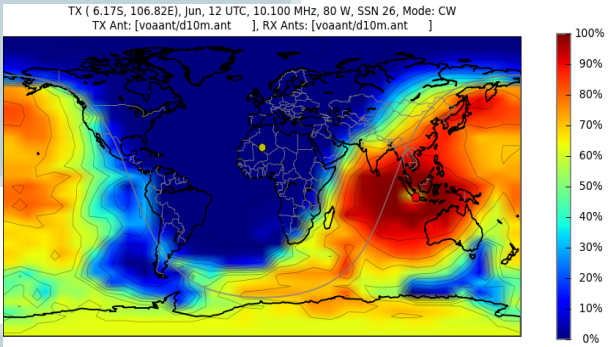

Fig. 5 Coverage Prediction for dipole antenna with length of 10 m

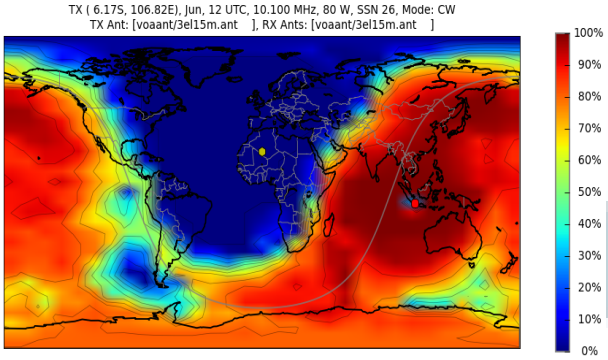

Fig. 6 Coverage Prediction for 3 antenna element Yagi antenna.

C. *Simulation 2: Adjusting Tx Power*

In the second simulation, the Tx power is tuned into 500 Watt and 1000 Watt. Because the result in the first simulation shows that Yagi antenna gives most intense DRM coverage, the transmitter antenna in the second and third simulation is set as three element Yagi antenna with length of 15 m. The result given in Figs.7-8 shows that adding power to transmitter will insignificantly increase the range of coverage for DRM, moreover, it just does addition to the intensity of reliability in 70%-100%.

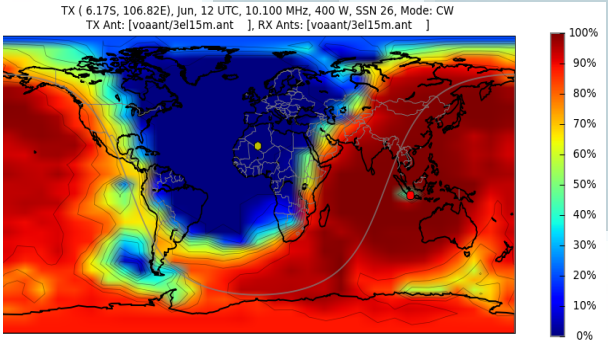

Fig. 7 Coverage Prediction for 500 W Tx Power

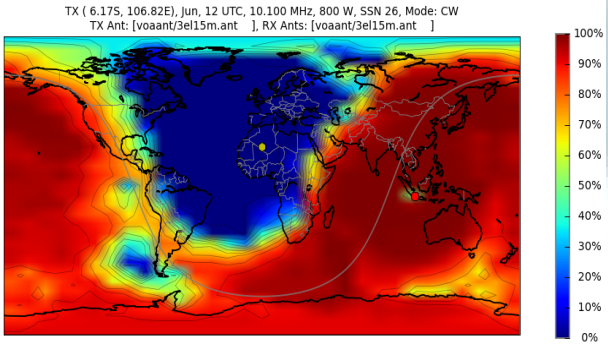

Fig. 8 Coverage Prediction for 1000 W Tx Power

Fig. 7 shows that added transmitter power into 500 W will not really contribute to the range of coverage but only increase the intensity for 80%-90% coverage. While from Fig.8, changed the power to 1000 W gives almost the same result as Fig.7, it only increases the intensity for 80%-90% coverage.

D. *Simulation 3: Adjusting the time*

In this third simulation, the time parameter is changed into four conditions as mentioned before. Another parameter remained the same with the first simulation with three element Yagi antenna and 500 Watt transmitter power.

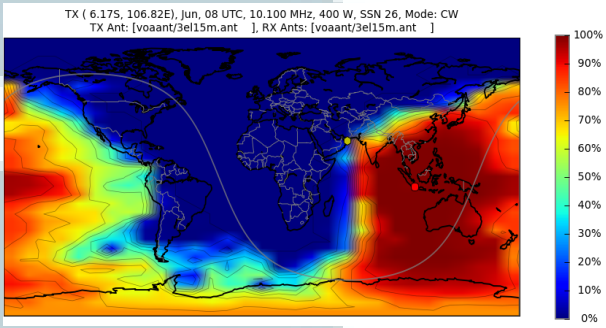

Fig. 9 Coverage Prediction at 8 A.M

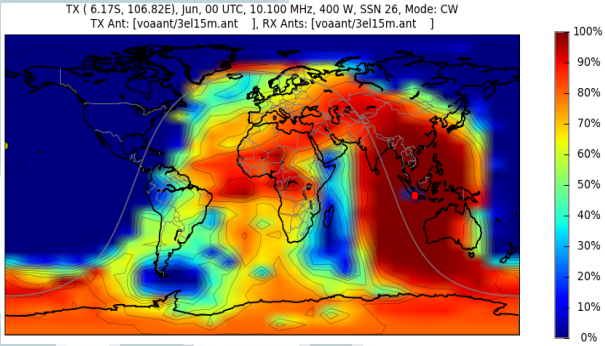

Fig. 10 Coverage Prediction at 12 A.M

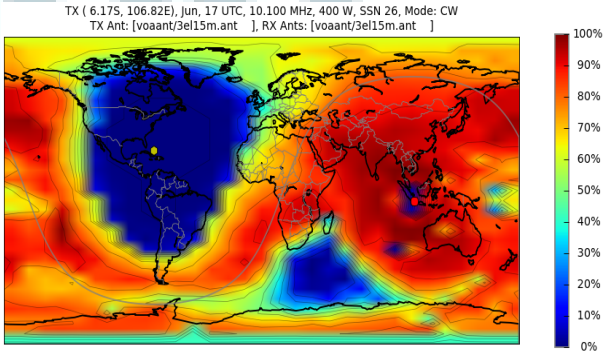

Fig. 11 Coverage Prediction at 5 P.M

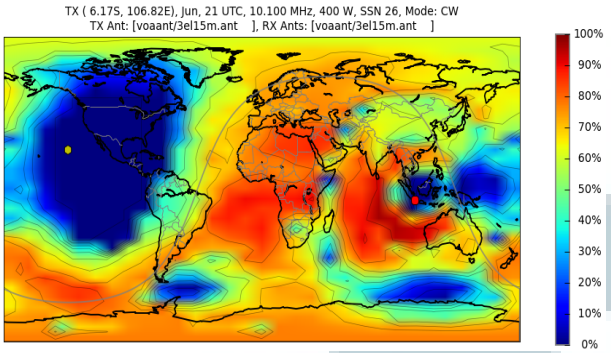

Fig. 12 Coverage Prediction at 9 P.M

HF propagation is affected with ionosphere condition. It can be seen from the simulation result in Figs. 9-12 that the time of propagation affected the coverage result. At 12 A.M and 5 P.M the DRM coverage can reach more country with larger reliability. At 8 A.M the DRM only can deliver the broadcasting content in ASEAN country while at 9 PM it gives wider coverage but decrease the reliability. The difference in the range of DRM coverage is caused by the ionosphere variation that change by the time of the day. The ionosphere condition will affect the HF propagation and its coverage.

IV. CONCLUSION

As mentioned in the earlier of this paper, the DRM standard has a large coverage ranging from few hundred kilometers until thousand kilometers. This is proven from the simulation that all the results in the pictures show the reliability to conduct radio communication from RRI Pro 3 to worldwide. Changing some parameters will affect the coverage result. The transmitter antenna will broaden or limit the result of coverage prediction depend on the type of antenna. Three element of Yagi antenna gives widest coverage compared with dipole antenna, ¼ λ antenna ground plane, and 5/8 λ antenna. Adding the transmitter power insignificantly affect the coverage, however it increases the intensity for 80%-90% coverage. The time of simulation also give impact to the range and reliability of coverage because the HF propagation is effected by the variations in the ionosphere.

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