STATISTICAL MODEL OF RAIN FADING IN SURABAYA

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Abstract

An overviews statistic models of rain fading in Surabaya, it describes of fade slope statistic and fades duration, it's could from rain attenuation with synthetic storm method. From the attenuation value with synthetic storm method should make calculation to found fade slope in every rainfall event, total of fade slope could get fade slope statistic of conditional. To calculate time duration in every time at every threshold value in every rainfall event. And after that statistic fade duration was found. Rain fading duration influences the particular wind and the link, area, year, and the long of communication link.

1. Introduction

Kind of propagations problems in this communication system of millimeter is attenuation, it caused of rainfall, which is in communication system of millimeter, rainfall attenuation give a huge influences and also disturb the communication system strengthens [1] The communication system of millimeters in tropic country like Indonesia, the rainfall attenuation it could give an urgent problems, that knows the tropic country have a high rainfall intensity, and also effect of attenuation feel more. Fading caused of rainfall attenuation. So that needs a good planning in power supply from the station, it followed the fade variation as long as the rainfall comes to make balances with rainfall attenuation. This research find distribution fade dynamic models from the rainfall calculation in Surabaya that are fade slope and also fade duration. Fade slope used to calculate power control that can followed attenuation variation and fade duration used to plan interleaver on coding canals. This models would be applied to evaluate fade mitigation techniques (FMT) based on Indonesian weather.

2. Search Method

2.1 Rainfall Measurement

The measurement of rain fall which is done in ITS campus of Surabaya, which used disdrometer optic for the parameter, and it put on roof of mechanical engineering building From this calculation, it could found the rain fall value on the ASDO software since on January 22, 2007 until March 30, 2007.

2.2 Synthetic Storm Method

The synthetic storm method describe the value of rain fall as function from the long of line (km) where that rain fall moved on the line because of wind with particular speed (4). The 1st point is dividing the long of line (ΔL) from the length of effective line (L). The 2nd point is rain fall attenuation with synthetic storm method and the 3rd point is limitation of line dividing

$$\Delta L = v_r \times T \quad \text{(Km)} \tag{1}$$

$$A_m = \sum_{j=0}^{n-1} aR_{m-j}^{b} \times \Delta L_j \quad \text{(dB)} \tag{2}$$

With (v_r) is wind speed on a line, T sampling time 10s, R is the value of rainfall, k and α coefficient that is followed radio wave frequency, wave radio polarization and canting angle from rainfall, and it could be dividing of line $n = \left| L / \Delta L \right|$ that coefficient based on ITU-R P.838 recommendations on the 30 GHz frequency with horizontal

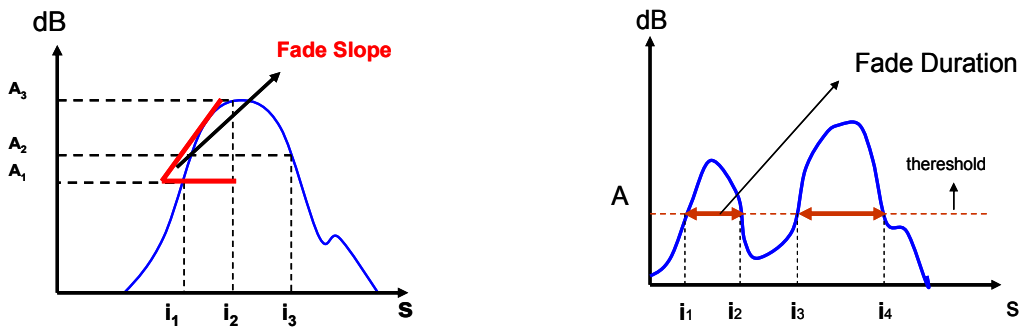
polarization. The calculation attenuation with SST method it do by two particular orientation, that are West - East and also South – North., so that found the influences wind if link

2.3 The Calculate of Fade Slope and Fade Duration

Fade slope indicates the rate of change of rain attenuation dB/s [4]. Fade slope could from the impact of rainfall attenuation or the other event that caused mitigation technique. 1a picture show fade slope in the rainfall attenuation. Based on van de kamp models, fade slope could written by formula 3 :

$$\varsigma(i) = \frac{A(i) - A(i-1)}{\Delta t} \quad \text{(dB/s)} \tag{3}$$

where A is attenuation (dB), Δt is a time interval (s) and i is index sample . After that,it can found CCDF fade slope of conditional. Fade duration indicates the time length how long the attenuation will exceed a certain threshold value [6]. To get fade duration statistic, the first found thereshold value, as 5, 10, 15, 20, 25, and 30 dB. For every threshold could calculate fade duration for every rain event. Then could found CCDF conditional of fade duration . 1b pictures could found fade duration, $i_2 - i_1$ and i_4-i_3.



(a) (b)

Figure 1 Fade Parameters: (a) Slope (b) Duration

3. Analysis and Working Through

On these research the first in done rainfall measurements and then could calculate rain attenuation with synthetic storm method. Rain attenuation which is done for 1, 2, 3 and 4 Km link distance. Then, could calculate fade slope and CCDF of fade slope for probability ($|\varsigma| > 0$) for all ς . Figure 2a is a CCDF of fade slope for West-East orientation and figure 2b for South-North orientation at probability ($|\varsigma| > 0$) for all ς.

For West-East (figure 2a), to design power control at probability 0.0001, the transmitter must to follow variety signal, for 1 Km = 0.3756 dB/s, 2 Km = 0.5476 dB/s, 3 Km = 0.8215 dB/s and 4 Km = 1.0953 dB/s. Beside for South-North orientation (figure 2b) at probability 0.0001, the transmitter must follow variety signal for 1 Km = 0.3756 dB/s, 2 Km = 0.5476 dB/s, 3 Km = 0.8215 dB/s and 4 Km = 1.0953 dB/s. From these analysis, that when length link designed progressively far hence transmitter have to be designed to able to follow the ever greater change sinyal every second.

Fade duration statistic can be gave attention by figure 3 and 4 to each orientation link, by threshold 5, 10, 15, 20, 25, 30 dB at length link (a) 1 Km, (b) 4 Km. For the design interleaver, fade duration at link with West-East orientation for threshold 5, 10, 15, 20 dB, interleaver unable to fade duration compensation for 1 and 4 Km because its fade duration > 500 second at probability 0.1. For the threshold of 25 and 30 dB interleaver able to fade duration compensation until 1 Km because its fade duration < 500 seconds at probability 0.1. For link with South-North orientation for threshold of 5, 10, 15, 20, 25 and 30 dB, interleaver able to fade duration compensation until 4 Km at probability 0.1 because its duration fade < 500 seconds. For at probability 0.2, interleaver only able to compensation the fade duration at 1 Km for the threshold 20, 25, and 30 dB.

4. Conclusion

Based on analysis result could take a conclusion. Wind direction have an effect on rain attenuation at synthetic storm method. Thereby for the application of synthetic storm method besides wind speed is also needed a wind direction wind.

Fading statistic very influenced by regional variation, year, wind direction and instruct the long link communication and distance of link communication, so that to design communication system have attention it. For design power control if path length wanted long progressivel, hence equalizer also have to be designed to be able to follow the signal variation which faster and also to attention link orientation. At these research for link of orientation the West-East, interleaver only able to compensation of fade until 1 Km with threshold 25 and 30 dB at probability 0.1 and for link orientation the South-North, interleaver able to compensation of fade until 4 Km at threshold 5, 10, 15, 20, 25, 30 dB at probability 0.1 and for the probability of 0.2 only able to compensation of fade duration untol 1 Km by threshold 20, 25, 30 dB.

5. Acknowledgments

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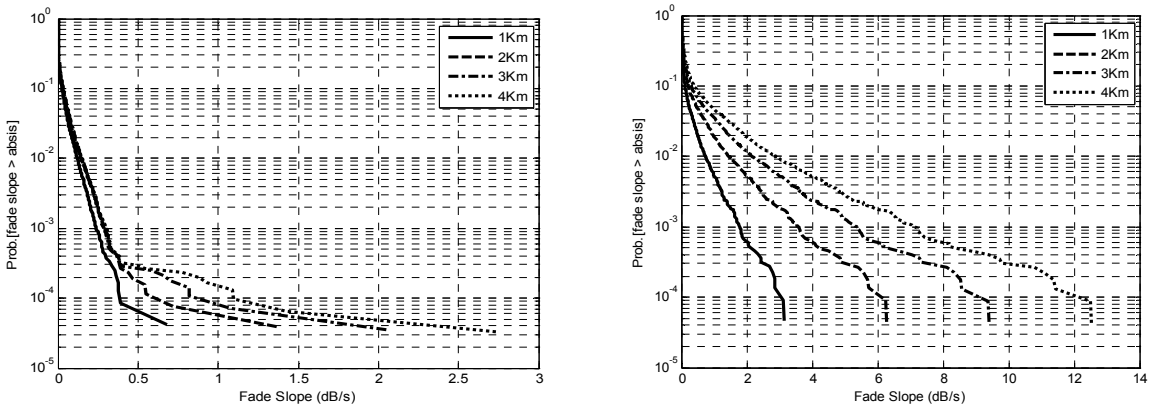
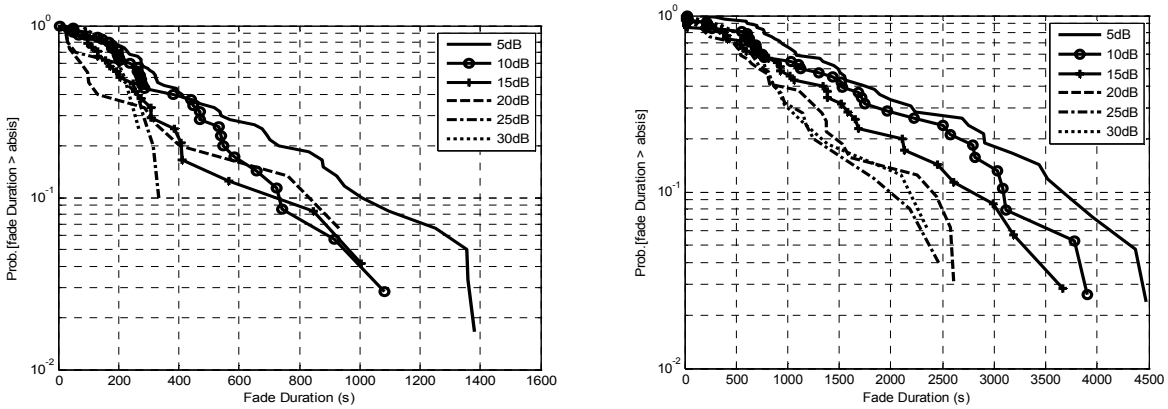


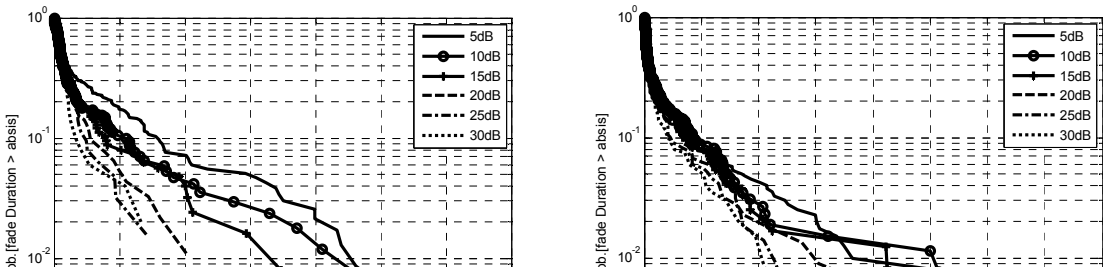
(a) (b)

Figure 2 Probability (| ς | > 0) for all ς,(a) E-W ,(b) S-N



(a) (b)

Figure 3 CCDF of fade duration at link (a) 1 Km, (b) 4Km. E-W.



6. References

1. Indrabayu, *The EvaluaMacro Diversity and Adaptive Modulation on Fixed Wireless Communication System in Millimeter-Wave under Rainy Condition,* Master's Thesis, ITS 2005.

2. R. Singliar, J.. Din, L.Csurgai, A.R. Tharek, P. Horvath dan J. Biot, "*Comparison of 38 GHz Rain Fade Dynamics between Malaysia and Hungary"*, hal 1-5, URL:http://www.telenor.no/broadwan/BROADWAN_CD/Publications/Singliar_ISTmobilewirelesssummit2006_38GHzfadedynamics.pdf

3. D.G.Sweeney and C.W. Bostian, "The Dynamics of Rain Induced Fades", *IEEE transactions on Antennas and Propagation,* March 1992, hal: 275-278.

4. M.M.J.L.van de Kamp, dan L.Castanet., "Fade Dynamics Review," *cost action 280, International workshop July 2002*, hal 1-20.

5. L. Castanet dan Max van de Kamp, "*Modeling The Dynamic Properties of the Propagation Channel"*, URL:http://www.cost280.rl.ac.uk/documents/WS2%20Proceedings/ws2.htm

6. S. Robert, B. Heder dan J. Bito, "Rain Fade Slope Analysis," *BroadBand Europe, Bordeaux, France*, 12 – 14 Desember 2005, hal 1-5.