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ANALYSIS OF BEHAVIORS OF ADAPTIVE MODULATION RADIO WITH RAIN INTENSITIES

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ABSTRACT

Adaptive modulation techniques have the potential to substantially increase the spectrum efficiency and bit error performance efficiency. Adaptive Modulation Radio (AMR) functionality enables link capacity to be optimized in accordance with the weather conditions. In the AMR scheme, the most efficient modulation is good weather conditions, while less efficient modulation is used during bad weather conditions. In this study, behaviors of the AMR has analyzed with the rain intensity data collected by the Department of Meteorology. Analysis data was collected from the eight commercial microwave links for 13GHz and 18GHz frequency bands of iPasolinks. In this paper outcomes feasibility prediction of function of AMR feasibility of throughout December month in Rathnapura district for both 13GHz and 18GHz. This shows highly percentage of hours in Rathnapura AMR operate in most efficient modulation level. These results will contributes to the telecommunication service providers in Sri Lanka.

Keywords: AMR, adaptive modulation, BER, QAM

1. INTRODUCTION

When considering the modern demand for multimedia services, the ability to provide spectrally efficient and flexible data rate access is one of the important design considerations of future wireless systems. One approach to satisfy both of these requirements is to adapt the modulation and transmission power according to the instantaneous propagation conditions, interference scenarios, and traffic or data rate requirements. This technique is called adaptive modulation [1, 2]. Adaptive modulation techniques have recently been proposed for two-way data transmission over cable [3]. For instance, variable-rate QAM has been proposed for several third-generation wireless communications systems. It has been shown in [1, 2] that adaptive modulation effectively improves the Bit Error Rate (BER) performance on radio channels which suffer

shadowing and fading. AMR is the commercially available technology to perform adaptive modulation in commercial microwave. There are several vendors provide this technology. Purpose of this study is to analyses of behaviors of the AMR with rain intensities. The modulation switching is done by SNR level measurements of the present link condition. This means, BER at receiver level can be good enough to decide switching scheme. Figure 1 is shown the modulation variable process of adaptive modulation radio.

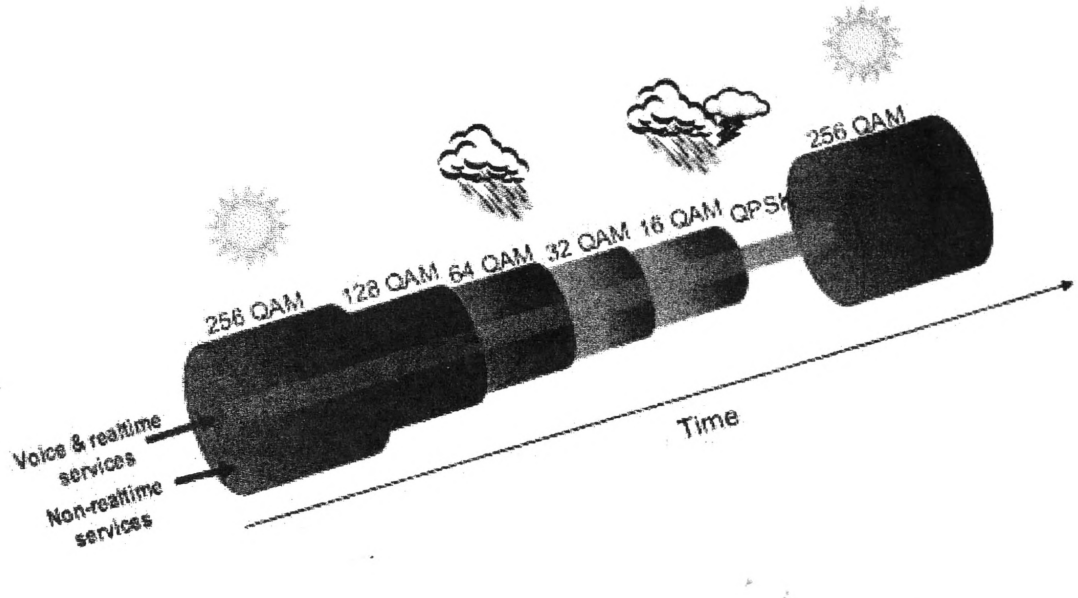

Figure 1: the modulation switching process of adaptive modulation radio.

2. METHODOLOGY

For this study, method was selected from the several methods by considering theoretical background deeply and data availability. The analysis has been done based on the error alarms generated and adaptive modulation level changing notifications to different modulation level generated history data. One of vendor was selected from vendors who provide AMRs by considering several factors for the study. The NEC ipasolink 200 AMR was selected for this study. Errors counted history data were collected from exporting to the excel sheet. Rain fall data were collected from the Department of Meteorology and analysis has done based on the requirements. There are lots of error alarms generated in the rainy periods, according requirement, High Bit Error and Low Bit Error alarms occurred counts in faded minutes were analyzed with respect to rain intensities (mm/minutes). According to the iPasolink specifications , High Bit Error alarm generated in threshold BER are vary between 10^{-6}, 10^{-7}, 10^{-8}, 10^{-9} and Low Bit Error alarm generated in threshold BER are vary between 10^{-6}, 10^{-7}, 10^{-8}, 10^{-9} [3,4].When considering collected alarms counted history with rain intensities for 18GHz links, analysis graphs are summarized as follows

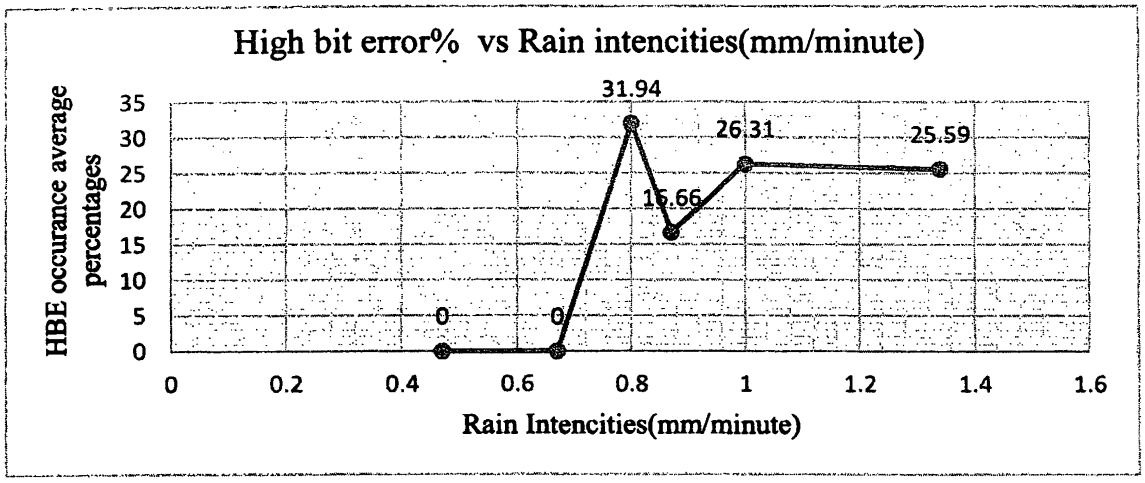

Figure 2: High Bit Error Average Percentages relationship with Rain intensities

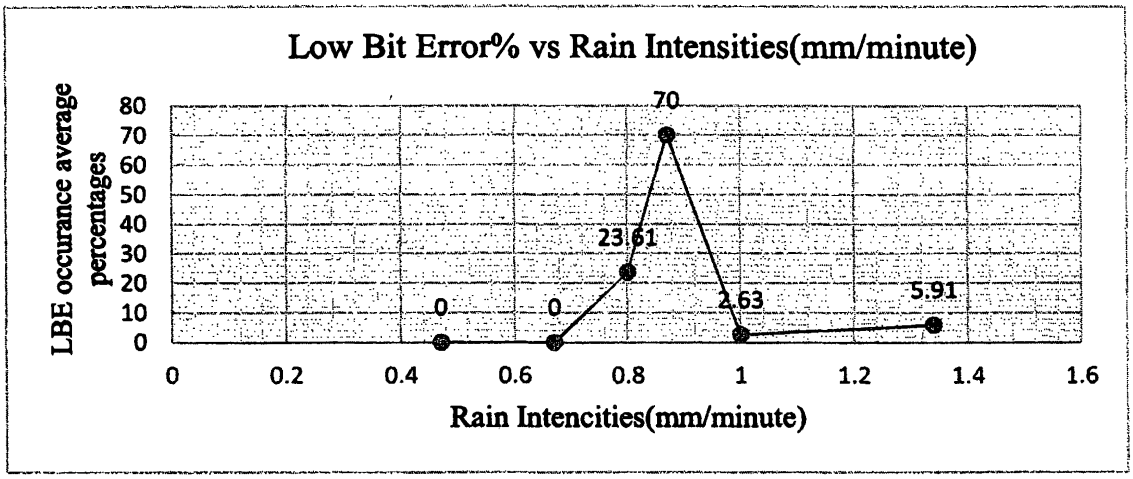

Figure 3: Low Bit Error Average Percentages relationship with Rain intensities

Figure 2 shows average percentage High Bit Error alarms fluctuations with the rain intensities (mm/minute). When considering fluctuation pattern, when rain intensities increases, Bit Error Rates also increases. But it's coming to higher rain rates there is degradation of Bit Error Rate occurrence average percentages in both HBR and LBR.

It can be concluded that in middle of rain intensities very high bit error rates occurrence percentages. Further it can be seen, with high rain intensities, there is more High Bit Error alarm occurrence average percentages than Low Bit Error and threshold bit error rate vary between 10^{-3}, $10^{-4,}$ and 10^{-5}.There is an inversely proportional relationship between the SNR and BER. Then SNR fluctuation can be predict by above conclusion.

Analysis based on the collected modulation level varies in minutes time periods, transmit modulation analysis for different rain intensities are details in charts. As a example one chart has described as follows.

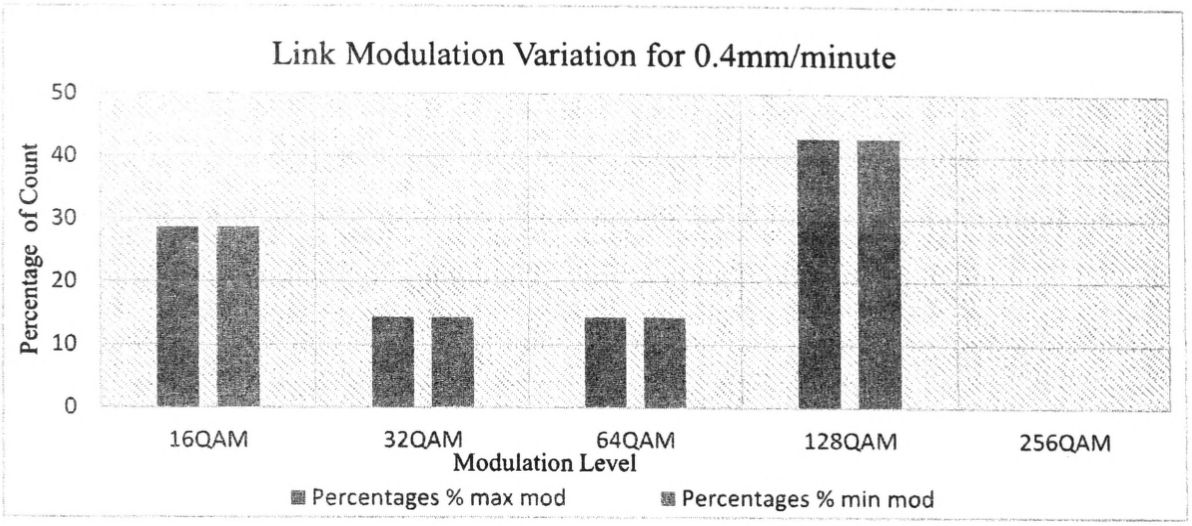

Figure 4: Link Modulation variation for 0.4 mm/minute

The bar chart is reperesents the maximimum minimum modulation levels with count percentages for all 0.4 mm/ minute rain intensity operate minutes. According to chart outline, it can be seen that percentage of maximum modulation count and minimimum modulation count is 128QAM. When it consider about the range, there is no range minimum to maximum modulation level. Link operate more 128QAM level in whole minute which operate under 0.4mm/minute.

3. RESULTS AND DISCUSSION

The results of the summery of analysis are show in below tables by using similar analysis method for each rain intensities for 13GHz and 18GHz frequency bands links

Table 1: Modulation vary ranges regards to rain intensities for 18GHz links

Rain Intensity (mm/minutes)	Link modulation vary ranges
0.4	128QAM
0.5	64QAM
0.67	64QAM - 32QAM
0.8	32QAM
0.87	32QAM- 64QAM
1	16QAM- 32QAM
1.34	16QAM - 32QAM

Table 2: Modulation vary ranges regards to rain intensities for 13GHz links

Rain Intensities (mm/minutes)	Link modulation vary ranges
0.04	128QAM
0.08	128QAM
0.14	64 QAM - 16QAM
0.34	32QAM
0.47	32QAM - 16QAM
1.14	16QAM
1.54	16QAM

By using this modulation level values, further study was done regarding modulation level availability for specific time period for specific region. For this, a district was selected from Sri Lanka by considering the historical rainy data of each district. Rathnapura district was selected for this study. Rain fall fluctuations of recent three year is shown in following figure 3.

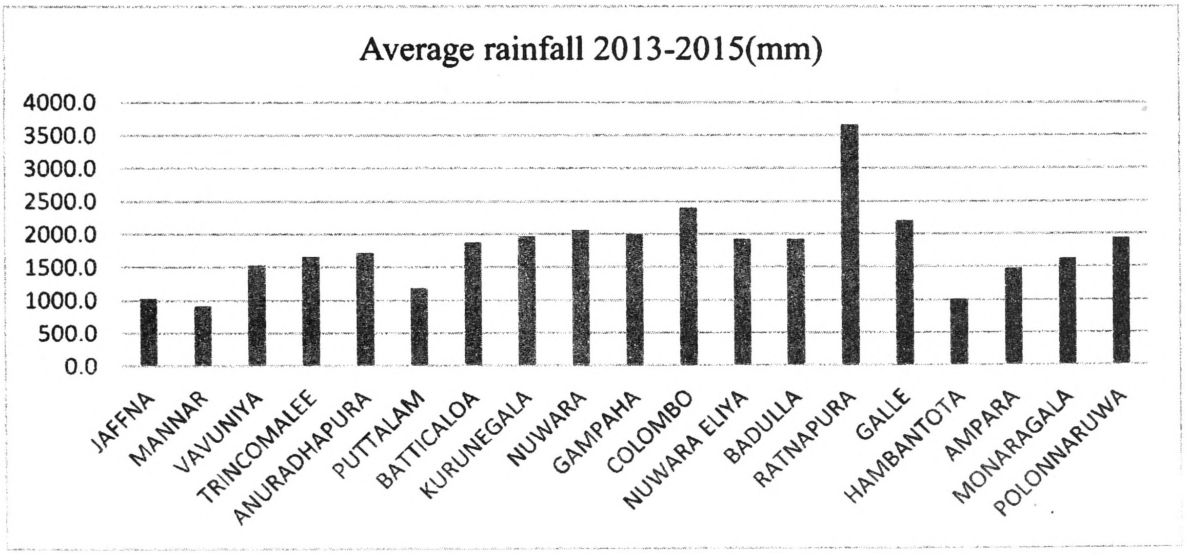

Figure 3: Average Rainfall in Sri Lanka 2013 – 2015 (mm)

Rain intensity data were collected for every 15 minutes for December month to Rathnapura district and mapped predicted modulation level regarding for every 15 minutes time period Modulation availability for December moth predicted for both 18GHz links and 13GHz links The following figures shows the results of the analysis

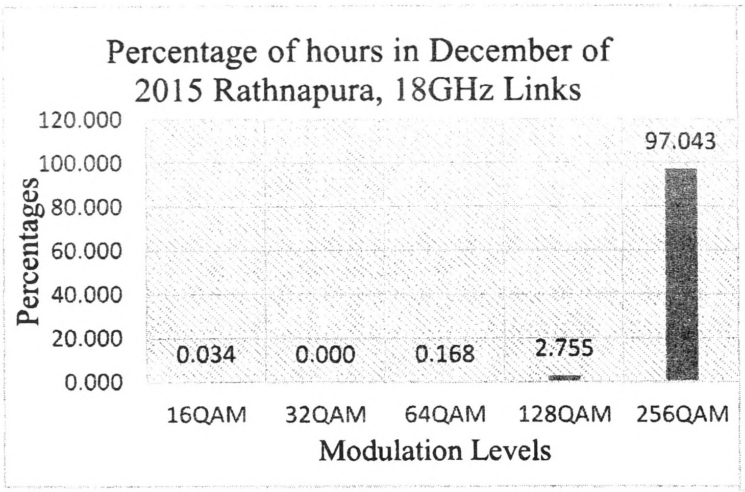

Figure 4: Percentage of hours for Rathnapura for 18GHz links

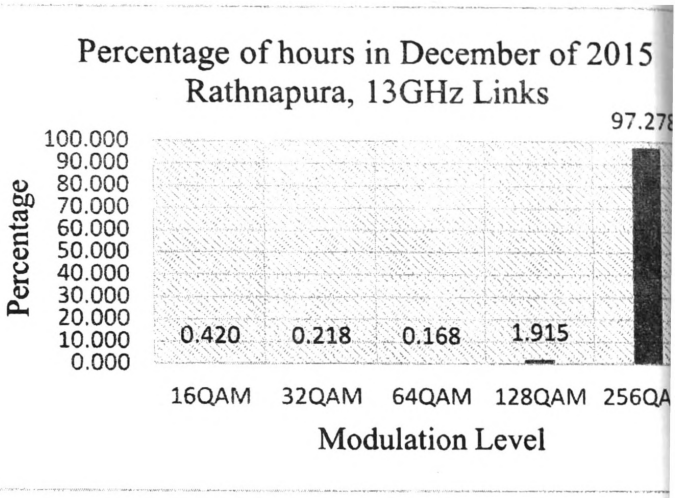

Figure 5: Percentage of hours for Rathnapura for 13GHz links

According to the analysis result, as shown in above figures, most of the percentage of hours are operating under the most efficient modulation it is 256QAM. It means there is AMR feasibility with the rain fluctuation.

4. CONCLUSION

The final outcome of this study is an analysis of behaviors of Adaptive Modulation Radio with rain intensities. In this study, AMR function feasibility was analyzed for the Rathnapura District. This shows highly percentage of hours in Rathnapura AMR functions in most efficient modulation level. These results of this study will contributes to the telecommunication service providers in Sri Lanka.

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REFERENCES

[1]. G. J. Pottie, System design choices in personal communications, 1995.

[2]. H. Matsuoka, S. Sampei, N. Morinaga, and Y. Kamio, Adaptive Modulation system with variable coding rate concatenated code for high quality Multi-media communication systems.

[3]. Cable Television Laboratories, 1998, [Online] http://www.cablemodem.com/

[4]. iPasolink 200 datasheet.