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Modeling of VANET Technology & Ad-Hoc Routin Protocols Based on High Performance Random Waypoint Models

Ruhbakhsh Yahoo*
*Department of Electrical Engineering, Mahabad Branch, Islamic Azad University, Mahabad, Iran

Abstract-***Today, one of the new technologies in the modern era is Vehicular Ad-hoc Network which has taken enormous attention in the recent years. Because of rapid topology changing and frequent disconnection makes it difficult to design an efficient routing protocol for routing data between vehicles, called V2V or vehicle to vehicle communication and vehicle to roadside infrastructure, called V2I. Designing an efficient routing protocol has taken significant attention because existing routing protocols for VANET are not efficient to meet every traffic scenario. For this reason it is very necessary to identify the pros and cons of routing protocols as well as simulation of protocols is essential to understand existing routing protocols behavior. In this research paper, we focus on VANET topology based routing protocols and also measure the performance of two on-demand routing protocols AODV & DSR in the random waypoint scenario.***

Keywords: ***Vehicular ad-hoc network, AODV, DSR, Packet Delivery Ratio, Loss Packet Ratio,Average End-to-End Delay***

I.INTRODUCTION

VANET (Vehicular ad-hoc network) is special form of MANET which is an autonomous & self-organizing wireless communication network, where nodes in VANET involve themselves as servers and/or clients for exchanging & sharing information. Due to new technology government has taken huge attention on it. There are many research projects around the world which are related with VANET such as COMCAR, DRIVE ,FLEENET and NOW (Network on Wheels) , CARTALK, CARNET [1-4]. There are several VANET applications such as Vehicle collision warning, Security distance warning, Driver assistance, Cooperative driving, Cooperative information, Internet access, Map location, Automatic parking, and Driverless vehicles[5-7]. In this paper, we mainly focus on VANET topology based routing protocols and we alsohave evaluated the performance of AODV and DSR based on random waypoint model. The remainder of the paper is organized as follows: Section 2 describes the VANET characteristics. Section 3 describes shortly about VANET topology based routing protocols pros & cons. Section 4 discusses briefly about two ondemand routing protocols AODV and DSR procedure.

In this paper, some existing radio wave propagation loss models for the forested environments are briefly reviewed. As a continuation of the research progress on radio propagation characteristics through forested channels, the experimental measurements carried out on the radio wave propagation loss at VHF (92.1MHz as a case study) through long (~64km) forested communication channels are reported. The experimental measurement results obtained are compared with some existing propagation loss models: Free Space Attenuation (FSA), Ground Reflection (GR) and Canopy Ground Reflection (CGR) models, and integration of foliage-induced effect and reflection effect models: CGR plus ITU-R or SUM(CGR, ITU-R) and CGR plus Weissberger or SUM(CGR, Weissberger). Using the method of least square fit to the experimental measured data, CGR model gives the best fit for the radio wave propagation loss at VHF (92.1MHz) through long tropical forested channel. This paper is organized as follows: Section I gives the introduction of the behaviour of the propagation of radio wave through forest channels. Section II briefly review some related work on the radio wave propagation in the forest. Section III explains the experimental method used to carry out the study. Section IV explains the results obtained and gives the implications. The last section V concludes the paper and followed by references and author biography.

II. DESCRIPTION OF OBJECTIVE FUNCTIONS

Service restoration of a distribution system is a complex and urgent task that must be performed rapidly by system operators. In this paper, we focus the objectives of the restoration plan on the following concerns:

1) Restore as much load within the outof-service area as possible
2) Operate a minimal number of switches
3) Devices should not overload too much, and if they must
4) Keep the load balanced as much as possible.

Other issues such as maintaining the radial system Structure and voltage drop are considered as system constraints. The definitions below are the fuzzy objectives and their associated membership function.

Where, f = resonant frequency in MHz, d = distance covered by the radio waves in km, P_T = transmitter power output in dBm, P_R = received power, G_T and G_R = transmit and receive antennas gain in dBi respectively, L_T = Transmission line loss between transmitter and transmit antenna in dB, L_R = transmission line loss between receiver input and receive antenna in dB. The free space attenuation (FSA), A is then determined from the expression given as:

$$A = 10\log_{10}\left(\frac{PR}{PT}\right), \quad \text{dB} \quad (2)$$

Also, Alade, 2012 [15] presented the standardized free space attenuation, FSA (or Free Space Loss, FSL) of radio wave propagation in free space (LOS) as:

$$A = 147.5571 - 20\log10\ f - 20\log10\ d \quad \text{dB}, \quad (3)$$

Where, f = resonant frequency in Hz, d = distance covered by the radio waves in meters (m).

On the radio wave propagation characteristics in the forest environments (non LOS), some fairly reliable analytical and empirical propagation loss models available are based on the earlier laboratory experimental results, and not really on physical measurements in the real physical forest environments. Some of well known empirical radio wave propagation loss models for forest environment reviewed by previous authors are listed as follows [3], [4], [6], [8]: The Weissberger's modified exponential decay model which is applicable, where a ray path is blocked by dense, dry, in-leaf trees found in temperate climates and where the propagation is likely to occur through a groove of trees rather than the canopy top is given as:

$$L_W = \begin{cases} 1.33 f^{0.284} d_f^{0.588}, & 14\text{m} < d_f \le 400\text{m} \\ 0.45 f^{0.284} d_f, & 0\text{m} \le d_f < 14\text{m} \end{cases} \quad \text{dB}, \quad (4)$$

re, f is the resonant frequency in GHz and d_f is the forest depth in meters (m). The ITU recommendation (ITU-R) model which was developed from measurement carried out mainly at UHF band, and was proposed for the cases where either the transmitting or receiving antenna is near to a small (d_f < 400m) groove of trees so that the majority of the signal propagates through the trees. It is given as:

$$L_{ITU-R} = f^{0.3} d_f \quad \text{dB}, \quad (5)$$

Where, f is a resonant frequency in MHz and d_f is forest depth (distance) in meter.

As extension of research on modeling of radio wave propagation in the forest environments, a new method to model ground short-range propagation loss in forested areas with tree-canopy effect at the VHF and UHF bands using integration of the existing empirical foliage loss model (Weissberger and ITU-R or COST 235) and ray tracing model (as shown in the figure 1) to include the loss effect from ground and tree canopy reflections was developed by [6].

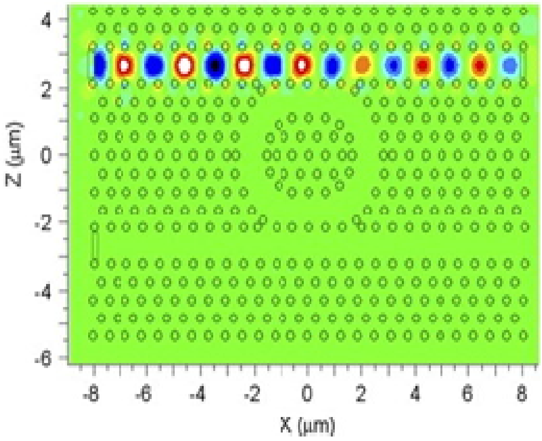

Figure 1: Showing the Ray tracing model of the direct (1), ground-reflected (2), and tree-canopy reflected (3), waves [6].

The ray tracing model of the path loss $L_{1\text{-reflected}}$ due to the ground - reflection only is given by:

$$L_{1\cdot reflected} \cdot FSL \cdot 20\log 10(\cdot\ \cdot)\ \text{dB}, \quad (6)$$

Where the tree-canopy reflection is present, the ray tracing model of the path loss $L_{2\text{-reflected}}$ due to the tree canopy reflection only (or both reflections) is given by:

$$L_{2\cdot reflected} \cdot FSL \cdot 20\log_{10}(1 \cdot 2 \cdot \cdot_1 \cdot \cdot_2)\ \text{dB}, \quad (7)$$

Where, $\cdot\ \cdot$ is the phase different between the direct and reflected rays, and it is given by:

$$\cdot\ \cdot\ \cdot \frac{4 \cdot h_T h_R}{\cdot\, d_f}, \quad (8)$$

Where, h_T and h_R are the transmitting and receiving antenna heights over the ground in meters respectively. It is assumed that d_f is larger then h_T and h_R,. $\cdot\ \cdot_1$ and $\cdot\ \cdot_2$ are the phase differences between the direct and ground-reflected rays and the direct and tree-canopy reflected rays respectively. For $\cdot\ \cdot_1$, $h_T = h_R = h_2$; and for $\cdot\ \cdot_2$, $h_T = h_R = h_1$ (see figure 1).

By incorporating the foliage-induced excess loss for the radio-wave propagation through the forest medium, the following models were obtained [6]: The path loss (PL) model due to the tree-canopy reflections (or tree-canopy and ground reflections) is given by:

$$PL_{forest} \cdot L_{foliage} \cdot L_{2\cdot reflected}\ \text{dB}, \quad (9)$$

The path loss (PL) model due to the ground reflection only is given by:

$$PL_{forest} \cdot L_{foliage} \cdot L_{1\cdot reflected}\ \text{dB}, \quad (10)$$

Where, $L_{foliage}$ can be L_W, or $L_{ITU\text{-}R}$, etc.

III. MEASUREMENTS CAMPAING AND COMPUTATIONS

The tropical forest where the experiment took place is located between Ogbomoso (LAT 8° 29'N, LONG 4° 29'E) and Oyo (LAT 7° 50'N, LONG 3° 56'E), Nigeria. The forest can be classified as medium dense to dense vegetations with mixed different types of plants. Figure 2a, b shows some parts of the forest. The forest consists of types of plants like Thick, Mahogany, Iroko, Mango and palm trees etc. Dense canopies are formed by the leaves of the trees. The average thickness (trunk diameter) and height of the trees range between 0.76m to 2.56m and 5.07m to 15.3m respectively. The spacing between the trees is irregular and ranges between 3m to 7m. The forest ground is covered with scrubs. The 92.1MHz, 3.5kW transmitter is employed in the experiment and located within the forest environment of interest. It consists of the transmitting antenna of 130m high, and the actual power radiated from the antenna after transmitter and cable losses are deducted is 2.5kW. The experimental measurement set up is as shown in the figure 2c. The experimental measurements were carried out by moving a low gain standard receiving dipole antenna (~0.5m from the ground surface) well matched to the receiver system (GSP810-Spectrum Analyser) set up inside a vehicle to measure the received signal power in dBm at 1km interval from the transmitting antenna up to 64km along the forest channel. The computations and statistical analyses were achieved with aid of Microsoftexcel2007. The graphical analyses were done with the aid of Matlab2007R.

IV. RESULTS AND DISCUSSION

In this paper, the radio wave propagation characteristics through long forested channel at VHF (92.1MHz as a case study) were investigated experimentally. The measurements were carried out in the months of October, November and December, 2011, under no wind, and no rain weather conditions with daily average ambient temperature ranges between 29°C and 34°C. Having measured the signal power received at every 1km interval to cover 64km through the desired forested channel, the measured attenuation in dB was deduced using Equation 2. Figure 3 is the plot of attenuation versus forest distance for the measurements, FSA, GR, and CGR models. Figure 4 is the plot of attenuation versus forest distance for the measurements, SUM(CGR, ITU-R) and SUM(CGR, Weissberger) models. All the existing analytical and empirical models were compared with the measurements. For all the cases, the attenuation decreases with distances, d_f along the forest channel.

The table 1 shows the statistical data for all the data plotted in Figures 3 and 4. The CGR model provides the best fit to the experimental measurements data, and closely followed by GR model. The FSA model of radio wave propagation loss, since it is based on free space communication links (LOS), does not include the additional loss on the propagation components such as direct wave and reflected, refracted, diffracted waves etc through the complex communication channels like forest, and therefore, it does not have ability to model forest links accurately. Also, based on the results obtained, SUM(CGR, ITU-R) and SUM(CGR, Weissberger) models which incorporated the foliage-induced excess loss for the radio-wave propagation through the forest medium have failed to adequately handle the radio waves propagation loss at VHF band through long forest depth.

V. CONCLUSION

When a fault occurs, the blackout area and the number of customers affected heavily depend on the effectiveness of the service restoration algorithm. Generally, the TPC operators tend to restore the electricity power based on of their existing knowledge and heuristic rules. However, owing to the multitude of feeders, laterals, and switches in a typical distribution system, it is not easy to restore an out-of-service area solely depending on the past experiences of human operators. In this paper, the radio wave propagation characteristics through long forested channel at VHF (92.1MHz as a case study) were investigated experimentally.
The measurements were carried out in the months of October, November and December, 2011, under no wind, and no rain weather conditions with daily average ambient temperature ranges between 29°C and 34°C. Having measured the signal power received at every 1km interval to cover 64km through the desired forested channel. one of the new technologies in the modern era is Vehicular Ad-hoc Network which has taken enormous attention in the recent years. Because of rapid topology changing and frequent disconnection makes it difficult to design an efficient routing protocol for routing data between vehicles, called V2V or vehicle to vehicle communication and vehicle to roadside infrastructure, called V2I. Designing an efficient routing protocol has taken significant attention because existing routing protocols for VANET are not efficient to meet every traffic scenario. For this reason it is very necessary to identify the pros and cons of routing protocols as well as simulation of protocols is essential to understand existing routing protocols behavior. In this research paper, we focus on VANET topology based routing protocols and also measure the performance of two on-demand routing protocols AODV & DSR in the random waypoint scenario.

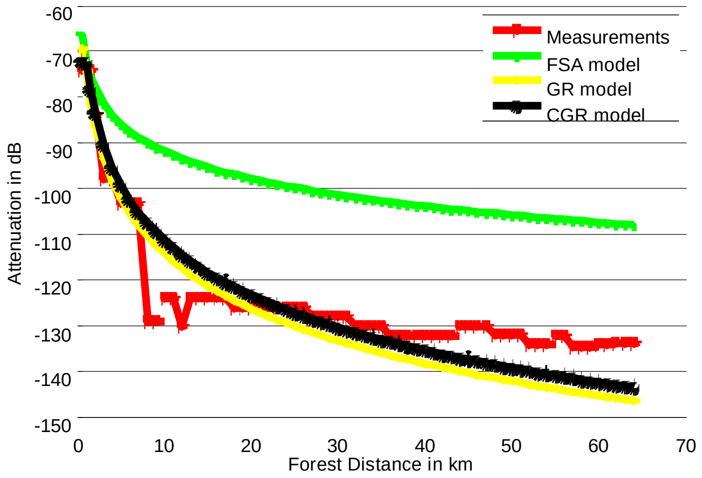

Figure 3: Showing the measured propagation loss compared with the FSA, GR and CGR models.

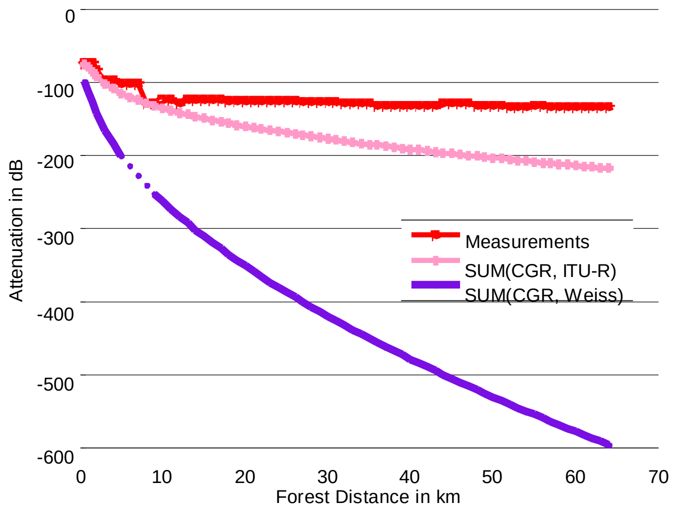

Figure 4: Showing the measured propagation loss compared with the SUM(CGR, ITU-R) and SUM(CGR,Weiss)models.

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