ISSN:0975-9646

K Himantha Rao et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (6) , 2015, 5256-5260

Reliable Routing in Vehicular Adhoc Network Using Maximum Reliable Threshold Construction(MRTC)

K Himantha Rao and Nagarjuna Karyemsetty

Department of Information Technology
VIGNAN'S Institute of Information Technology::Visakhapatnam

***Abstract*— The important property of vehicular ad hoc network (VANET) is high dynamic mobility. This characteristic leads the unstable connection of its links among vehicle node. In this scenario achieving high reliability message delivery service is a big challenge in VANET. There are many routing protocols existing to solve about the challenge but they are not up to the mark for achieving reliability. Here we improved as new reliable routing protocol to increase reliability which keep the overall network performance by using reconstruction method with alternative path, the performance and reliability of our protocol achieved is accepted result.**

***Keywords*— VANET, OBU, RSU, GPS, Reconstruction method.**

I. INTRODUCTION

Vehicular ad hoc network (VANET) is a specific case of mobile ad hoc network (MANET) to provide communication between vehicles, among nearby vehicles and roadside unit (RSU). This communication system consists of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) and infrastructure-to-infrastructure (I2I) network. Although a VANET is a special case of MANET and it share similar properties with respect to dynamic changing topology information, and other capabilities like available paths, available resources, distance information, signal problems. Actually MANET protocols are not suitable for VANET i.e. it can't be applied to the VANET topology, this can't give reliability, high throughput when communication is performed, many on demands or reactive routing protocols have been offered to be used in vehicular ad hoc networks, these routing protocols have better performance over proactive routing protocols.

In reactive routing protocols if a route is required, it is established a route so that decrease the routing overhead when performing communication in a network. Studies done by Jaap et al., show AODV performance on demand through routing protocols of VANET [1]. AODV routing protocol is one of the developed routing protocol in mobile ad hoc network as well as vehicular ad hoc network by using gateway communication. It acts as a bridge between VANET and MANET so that we can communicate via internet for sharing Global Positioning System information, safety and non-safety alert messages. The main aim of this network is user interface and communication with other users or neighbouring place for safety are non-safety applications.

II. INTRODUCTION VEHICULAR COMMUNICATION AND NETWORK

The VANET provides road safety information to decrease accidents and improve the driver safety among the vehicles, here all data is collected from onboard unit (OBU). It contains senders to observe information and this information is sent to road side unit(RSU) or sent to neighbouring vehicle nodes. It depends on the following requirements[2]

A. The architecture of vanet communication and network

It contains three main categories as shown in fig-a

- Inter-vehicle communication- It is vehicle-to-vehicle (V2V) communication in this type of category, vehicle can communicate with all its neighbouring vehicles without the use of any infrastructure support. If any alert messages are collected from sensors on board unit(OBU)of a vehicle, those messages are sent to its neighbouring vehicles such as on board unit(OBU)s
- Vehicle-to-road side communication- It vehicle-to-infrastructure (V2I) communication. In this case, The vehicles will use cellular gate ways and wireless local area networks are access points for internet connectivity. It provides different types of vehicles applications[3]
- Inter-road side communication-It is nothing but infrastructure to infrastructure (I2I) communication. We can mention this as hybrid vehicles -to- road side unit communication. Vehicles share the information received from infrastructure units with other neighbouring vehicles by depending upon network range and their position. It communicates with infrastructure either by single hope or multi hope way. It provides most flexible content sharing in vehicle-to-vehicle(V2V)communication.

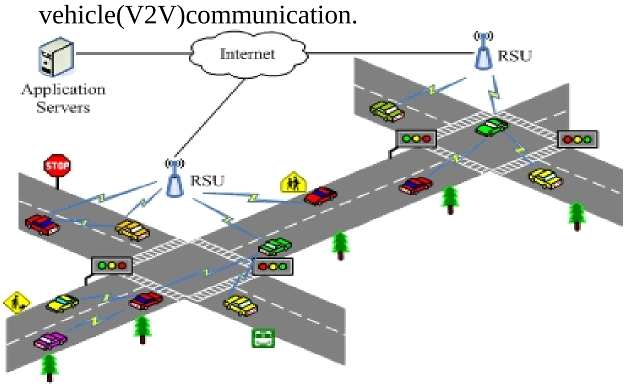

Fig. 1 Architecture of VANET

B. *The characteristics of VANETs*

Vehicle ad hoc network (VANET) nodes are self organized and have self maintained information without any centralized infrastructure authority or any centralized data of servers[3] i.e. here vehicle node only acts as client and servers at the same time these vehicle nodes can exchange information with one to other. Moreover, one of the unique attractive functions of VANET is as follows[2] then MANET. The difference between VANET an d MANET are as follows.

1) *Higher transmission power and storage*: The network nodes (vehicles) in VANETs are usually equipped with higher power and storage than those in MANETs

2) Higher computational capability: Operating vehicles can afford higher computing, communication and sensing capabilities than MANETs.

3) *Predictable mobility:* Unlike MANETs, the movement of the network nodes in a VANET can be predicted because they move on a road network. If the current velocity and road trajectory information are known, then the future position of the vehicle can be predicted.

III. CHALLENGING ROUTING REQUIREMENTS OF VANETS

From the special features of VANETs, one of the important issues is the routing process that needs to be addressed before these networks can be established effectively. Data is sent by packets these packets, are forwarded from the source to the destination using the available vehicles as broadcast. However, large number of vehicles, high dynamics and frequent changing nature of vehicles densities raise real challenges for the routing process in VANET. Crossing areas, traffic lights, similar traffic network conditions lead to frequent partitions in VANETs that make the routing process is very hard. On the other side, routing protocol design in VANETs can benefit from features like the mobility constraints and also some of the predictable mobility constraints on roads. Furthermore, the availability of other information such as GPS information and city maps can be used. Here we use global positioning system (GPS) location coordinates to find the distance of vehicles closer to the destination.

A. *Traffic Flow Models in VANETs*

The two major types to describe the spatiotemporal propagation of traffic flow models [4], they are macroscopic and microscopic traffic flow models. The macroscopic approach pictures the traffic flow as a physical flow of a continuous fluid. It describes the traffic dynamics in terms of aggregated macroscopic quantities such as traffic density p(x, t), Traffic flow q(x, t), and average velocity v(x, t) as functions of space x and time t corresponding to partial differential equations. These parameters can be related together through their average values using the following relations [5]:

$$d_m = \frac{1000}{\rho_{vet}} - l_m \qquad (1)$$

$$\tau_m = \frac{d_m}{v_m} = \frac{1}{v_m}\left(\frac{1000}{\rho_{vet}} - l_m\right) \qquad (2)$$

$$q_m = \frac{1}{\tau_m} = v_m \left(\frac{1}{\frac{1000}{\rho_{vet}} - l_m}\right) \qquad (3)$$

here d_m is the average distance between vehicles in meters, ρ_{vet} is the traffic density on the freeway section, i.e in vehicles per kilometer, l_m is the average length of vehicles in meters, τ_m is the average time gap between vehicles in seconds, v_m is the average velocity of vehicles on the road in kilometers per hour, and q_m is the average traffic flow in vehicles per hour. On the other hand, the microscopic approach describes the motion of each individual vehicle. It models actions such as accelerations, decelerations, and lane changes of each driver in vehicle as response to the surrounding traffic. It is known that the macroscopic approach can be used to describe both general traffic flow status and individual vehicles [6]. Hence, we use the macroscopic traffic flow model to describe the vehicular traffic flow and utilize the average velocity quantity to consider the mathematical distribution of vehicular movements over the traffic network. Moreover, the connection availability is determined based on the position, direction and velocity of each individual vehicle. So the involvement of microscopic traffic flow model can improve the accuracy of the modeling. Thus, we propose a hybrid approach combining both macroscopic and microscopic traffic flow models as an improvement. Here we utilize the velocity of vehicles' parameter from the macroscopic viewpoint to develop our *link reliability* model. We consider the velocity distribution over the vehicular traffic flow to determine the network connectivity status. The velocity of vehicles is one of main parameters to determines the network topology dynamics. It plays an important role in determining the expected communication duration between two vehicles.

B. *The Link reliability Models in VANETs*

We can define it as link between two vehicles that stay continuously over a specified time period [7]. Given a prediction interval T_p for the continuous availability of a specific link *l* between two vehicles at t, the link reliability value $r(l)$ is defined as follows:

$$r(l) = P\{\text{To continue to be available until } t + t_p \mid \text{available at } t\}. \qquad (4)$$

To calculate the link reliability $r(l)$, we utilize the vehicle's velocity parameter, normal distribution of vehicular velocity.[7][8], i.e. if the velocities of two adjacent vehicles are unchanged or changed between t and t + Tp, the resulting relative velocity is a normal distribution. Let $g(v)$ denote the probability density function of the velocity of vehicle v, and $G(v)$ be the corresponding probability distribution function:

$$g(v) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(v-\mu)^2}{2\sigma^2}} \quad (5)$$

$$G(v \le V_0) = \frac{1}{\sigma\sqrt{2\pi}} \int_0^{V_0} e^{-\frac{(v-\mu)^2}{2\sigma^2}} dv \quad (6)$$

where μ and σ^2 denote the average value(mean) and the variance of velocity v, respectively[9]. The distance d between two vehicles can be calculated using the function of the relative Δ_v and time duration T, i.e., $d = \Delta_v \times T$, where $\Delta_v = |v_2 - v_1|$. Since v_2 and v_1 are normally distributed random variables, Δ_v is also a normally distributed random variable and we can write $\Delta_v = \frac{d}{T}$. Let H denote the radio communication range of each vehicle. The maximum distance where communication between any two vehicles can be determined as 2H, i.e. when the relative distance between the two vehicles changes from H to $|H$. Let $f(T)$ denote the probability density function of the communication duration T. We can calculate f(T) as follows:

$$f(T) = \frac{4H}{\sigma_{\Delta v}\sqrt{2\pi}} \frac{1}{T^2} e^{-\frac{\left(\frac{2H}{T} - \mu_{\Delta v}\right)^2}{2\sigma^2_{\Delta v}}} \quad for\ T \ge 0, \quad (7)$$

Where $\mu_{\Delta v} = |\mu_{\Delta 1} - \mu_{\Delta 2}|$ and $\sigma^2\Delta_v = \sigma^2 v_1 + \sigma^2 v_2$ denote the mean and the variance of relative velocity Δ_v, respectively. We suppose that each vehicle is equipped with a Global Position System device to identify its location, velocity and direction information. T_p is defined as the prediction interval for the continuous availability of a specific link l between two vehicles i and j. It can be determined as:

$$L_{ij} = \sqrt{(y_i - y_j)^2 + (x_i - x_j)^2} \quad (8)$$

Where L_{ij} is the Euclidean distance between vehicles $i\ and\ j$ and v_{ij} is the relative velocity between vehicles $i\ and\ j$; and L_{ij} is calculated as above and T_p is defined as the continuous availability of a specific link *l* between two vehicles *i* and *j*. It can be determined as:

$$T_p = \frac{H - L_{ij}}{v_{ij}} = \frac{H - \sqrt{(y_i - y_j)^2 + (x_i - x_j)^2}}{|v_i - v_j|} \quad (9)$$

where L_{ij} is the Euclidean distance between vehicles i and *j*, and v_{ij} is the relative velocity between vehicles i and *j*. We can integrate $f(T)$ in (7) from t to $t + T_p$ to get the probability that, at time *t*, the link will be available for a duration *Tp*. Thus, the link reliability value $r_t(l)$ at time *t* is calculated as follows:

$$r_t(l) = \begin{cases} \int_t^{t+T_p} f(T)\,dT, & if\ T_p > 0 \\ 0, & otherwise. \end{cases} \quad (10)$$

The integral can be derived using the Gauss error Function Erf [10]. It can be obtained as

$$r_t(l) = Erf\left[\frac{\left(\frac{2H}{t} - \mu_{\Delta v}\right)}{\sigma_{\Delta v}\sqrt{2}}\right]$$

$$Erf\left[\frac{\left(\frac{2H}{t+T_p} - \mu_{\Delta v}\right)}{\sigma_{\Delta v}\sqrt{2}}\right] \quad when\ T_p > 0 \quad (11)$$

Here Erf is defined as follows:

$$Erf(\omega) = \frac{2}{\sqrt{\pi}} \int_0^{\omega} e^{-t^2} dt \quad -\infty < \omega < +\infty. \quad (12)$$

C. *Route reliability Models in VANETs*

In vehicular networks, more number of potential routes could exist between the source vehicle node s_n to destination vehicle node d_n, here each route is consist of a set of links (hops) or edges between the source node and the destination node. Without loss of generality, for any given route, let us denote R(P(sn,dn)), the number of its links as k: $l_1 = (s_n, n_1), l_2 = (n_1, n_2) \ldots\ldots l_k = (n_k, d_n)$. For each link $l_w (w = 1,2,3, \ldots \ldots, k)$, we denote by $r_t(l_w)$ the value of its link reliability as calculated in Equation (10)(11). The route reliability for a route P, which is denoted by $R(P(s_n, d_n))$, is defined as follows:

$$R(P(s_n, d_n)) = \prod_{w=1}^{k} r_t(l_w), \quad where\ l_w \in (s_n, d_n) \quad (13)$$

Suppose there are N number of potential multiple routes from the source node s_n to the destination node d_n, if M(s_n, d_n) = {P1, P2,…,PN} is the set of all those possible routes, then the optimal route will be chosen at the source node s_n based on the our reconstruction method it improves the first reliability of route, later reliability of total system or network is defined in reconstruction network model.

IV. Reliable Construction Network Model

A. *Challenge*

The present evolving network theory we cannot be directly applied to VANETs, the evolving topological properties of the VANET communication network are not scheduled in advance. And moreover, the present evolving network model cannot examine the reliability of communication links among nodes. For fulfillment of VANETs requirements, we extend/modify the present evolving network model. The modified version of the evolving network model is evolve based on the first two or three minimum cost spanning trees of vehicular traffic. These minimum cost spanning trees are predicted based on the underlying road network and topology of vehicular network. In addition, this method considers the reliability of communication links among vehicles. In the following paper, we briefly introduce the basics of the evolving network theory and then modifications to the present evolving network model to propose the reconstruction network model.

B. *Evolving Network Theoretical Model*

The evolving network theory [11] is offer as a formal generalization for dynamic networks. The evolving network is an indexed sequence of n sub networks of a given network, where the sub network at a given index corresponds to the network connectivity at the time interval indicated by the index number, as shown in Fig. 1. It can be observed from Fig. 1 that links are labeled with corresponding presence time intervals. Note that here *{A,D,C}* is not a valid journey so that link *{D,C}* exists only in the past Fig. 1. Basic evolving network model . with respect to link *{A,D}*. Thus, the journey in the evolving network is the route in the underlying network where its link time is labels are increasing order. In Fig. 1, it is very easy to find that *{A,B,E,G}* and *{D,C,E,G}* are valid journeys and *{D,C,E,G,F}* is not a valid path. By take basic evolving graph model or network [12]

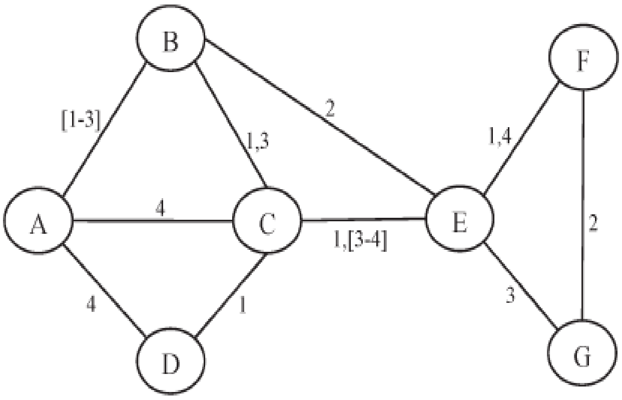

Fig. 2. Basic evolving graph model

Let us take fig:2 for this assign the wait for each links by link reliability model (10)(11). In the current evolving network theory, three *journey metrics* are defined [12]: the *foremost*, *shortest*, and *fastest* journey. Here we use link reliability as a metric to find minimum cost spanning of a network.

From Fig:3(a) and Fig3(b) select most reliable spanning trees we can draw more number of spanning trees but here we select most reliable spanning tree By this we achieve more reliable path. Here relabel spanning tree is shows Fig.4 with same time intervals as Fig.3(a) and Fig.3(b) we drawn initially it is as Fig:3(a),Fig4(a) later second time interval the spanning tree are show in Fig:3(b),Fig4(b)

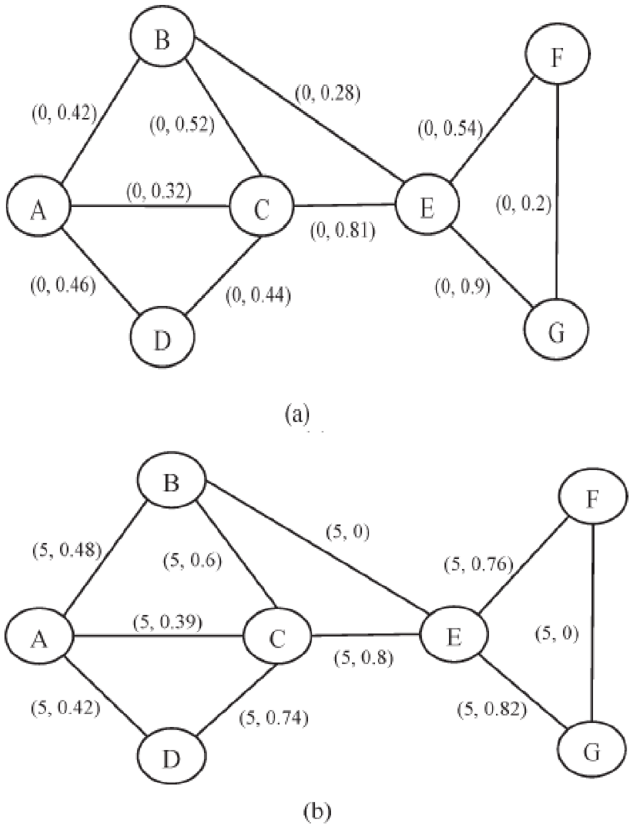

Fig.3 Proposed Reconstruction model (a) t=0s and (b) t=5s.

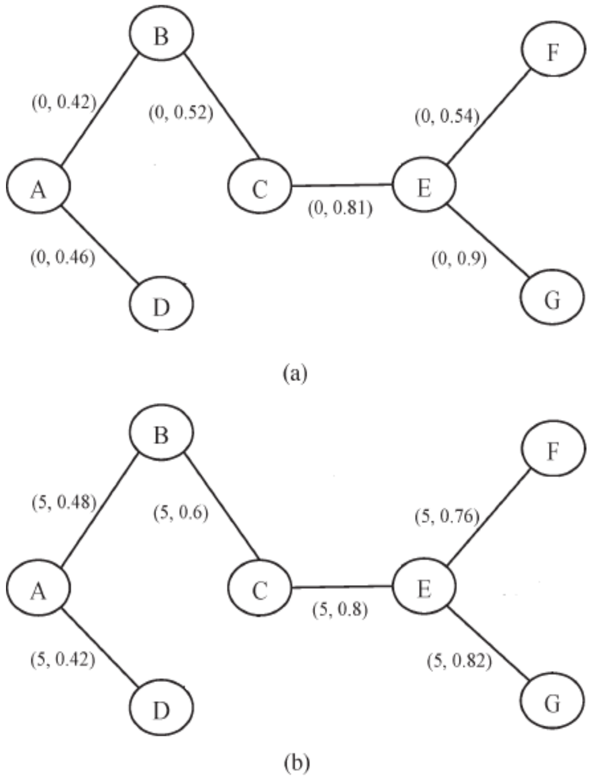

Fig.4 Spanning tree of Reconstruction model (a) t=0s and (b) t=5s.

Here reliability of spanning tree is calculated by(14) one more special case in here is parallel system [13]. The spanning tree path reliability is equal to addition of reliability values. and the reliability at initial time is 0.0395 and at time t=5 is 0.0603 Here initial time of spanning tree reliability is maintain and increase even though time increases.

V. CONCLUSIONS

In this paper we extend the evolving network theory and propose our Reconstruction network model. Link reliability and spanning tree and kruskal or prims algorithms are used to find minimum cost spanning trees. The reliability is vehicular network increases when even time period increases and also some of the links will fail with respect time increasing. Future scope of research can be done with the issue of time period increasing and control of link failure with high reliability.

.

REFERENCES

[1] S. Jaap, M. Bechler, and L. Wolf, "Evaluation of routing protocols for vehicular ad hoc networks in city traffic scenarios," *Proc. 5th International Conference on Intelligent Transportation Systems Telecommunications (ITST)*, June 2005. *Signal Processor (MC68175/D)*, Motorola, 1996.

[2] M Nekovee, Sensor networks on the road: the promises and challenges of vehicular ad hoc networks and vehicular grids (Paper presented at the workshop on ubiquitous computing and e-research, Edinburgh, UK, 2005)

[3] KC Lee, U Lee, M Gerla, Survey of routing protocols of vehicular ad hoc networks, in Advances in Vehicular Ad-hoc Networks: Developments and Challenges, ed. by M Watfa (Information Science Reference, Hershey, PA, 2009), pp. 149–170

[4] S. Olariu and M. C.Weigle, *Vehicular Networks From Theory to Practice*.New York, NY, USA: Taylor & Francis, 2009, pp. 344–346.

[5] M. Rudack, M. Meincke, K. Jobmann, and M. Lott, "On the dynamics of ad hoc networks for inter vehicle communication (IVC)," presented at the ICWN, Las Vegas, NV, USA, 2002

[6] B. S. Kerner, *Introduction to Modern Traffic Flow Theory and Control*.Berlin, Germany: Springer-Verlag, 2009.

[7] Z. Niu, W. Yao, Q. Ni, and Y. Song, "Link reliability model for vehicle ad hoc networks," in *Proc. London Commun. Symp.*, London, U.K., 2006, pp. 1–4.

[8] W. Schnabel and D. Lohse, *Grundlagen der Straßenverkehrstechnikund der Verkehrsplanung*. Berlin, Germany: Aufl Verlag für Bauwesen,1997.

[9] M. Rudack, M. Meincke, K. Jobmann, and M. Lott, "On traffic dynamical aspects of inter vehicle communications (IVC)," in *Proc. IEEE Veh. Technol. Conf.*, 2003, pp. 3368–3372.

[10] L. C. Andrews, *Special Functions of Mathematics for Engineers,* 2nd ed. New York, NY, USA: McGraw-Hill, 1992, pp. 110–112.

[11] A. Ferreira, "On models and algorithms for dynamic communication networks: The case for evolving graphs," presented at the 4e rencontres francophones sur les ALGOTEL, Mèze, France, 2002.

[12] J. Monteiro, "The use of evolving graph combinatorial model in routing protocols for dynamic networks," in *Proc. XV Concurso Latinoamericano de Tesis de Maestrìa*, 2008, pp. 1–17.

[13] I.J.Engineering and Manufacturing, 20 12,2, 79-85Published Online April2012inMECS(http://www.mecs-press.net)DOI: 10.5815/ijem.2012.02.12