Link Stability Increasing Between the Vehicles in VANETS Using Long Path Life Time

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Abstract - VEHICULAR Ad hoc Networks (VANETs) have recently gained much attention as an important means to enable the inter-vehicle communications. In particular, VANETs are a promising solution to improve the vehicular traffic safety (e.g., by warnings sent in case of accidents, low bridges, ice, or oil on road), reduce the impact of vehicles on environmental pollution (e.g., traffic light scheduling to help the driver to move in the green phase), or simply provide the on-board infotainment services such as Internet access.

The main disadvantage of VANETs is vehicle frequent failures in VANETs links due to high mobility. In this project, I focus on anypath routing to improve the reliability of multi-hop VANET communications .The main focus is on addressing the link stability issues and the method employed is called Long Lifetime Anypaths (LLA) providing stable communication paths. Comparison to the reference Shortest Anypath First (SAF) scheme, LLA routing algorithm provides.

Keywords - NS2, Path Life, Anypath.

I. INTRODUCTION

Vehicular Ad Hoc Networks (VANETs) have grown out of the need to support the growing number of wireless products that can now be used in vehicles. VEHICULAR Ad hoc Network’s (VANETs) have recently gained much attention an important means to enable the inter-vehicle communications. In particular, VANETs are a promising solution to improve the vehicular traffic safety (e.g., by warnings sent in case of accidents, low bridges, ice, or oil on road, reduce the impact of vehicles on environmental pollution (e.g., traffic light scheduling to help the driver to move in the green phase), or simply provide the on-board infotainment services such as Internet access [6] ,[7]. As proposed by the U.S. Federal Communications Com- mission (FCC) and defined in the 802.11p standard, VANETs utilize seven 10 MHz channels in the 5.880-5.925 GHz band (known as Dedicated Short Range Communications – DSRC) with the typical link length limited to about 300 m. However, high mobility of vehicles causes frequent failures of inter-vehicle links. Therefore, lifetime of a multi-hop path is often shorter than the time needed to install the path.

Several traditional routing protocol metrics are of interest to us: packet delivery ratio, packet delivery latency, energy consumption and throughput. First, we will compare the performance of LLR at different traffic loads between a pair of nodes. We will find out how these metrics vary when we choose LLRs with different route lifetimes and different route lengths. We look at a fully connected network by randomly placing 100 nodes inside a network with unit radius centered at (0,0). The transmission range of each node is 0.5. We place the source node at (-0.5,0) and the destination node at (0.5,0). Nodes move with a speed uniformly distributed from [0, Sm] in a random direction without stopping. As we mentioned earlier, the choice of Sm only scales the lifetime of LLRs and does not affect their relative performance. 802.11 is used as the MAC layer protocol and the wireless bandwidth is 2Mbps. There are three steps to design this project [1]. The longest route lifetime and its route length. The longest route lifetime of the shortest path. This is the best case among all the shortest paths. The shortest route lifetime of the shortest routes. This is the worst case for all the shortest paths.

II. LONG LIFETIME ANYPATHS (LLA) CONCEPT

In order to model the point-to characteristic to anypath routing (see Fig. 2), the network is represented here by a hyper graph G = (V , E), where V is the set of nodes(vehicles),and E is the set of hyperlinks, each hyperlink being an ordered pair (i, J), where i denotes a given vehicle connected with the forwarding set J of neighboring vehicles3. The cost of anypath from a given vehicle i to the destination vehicle d can be defind by the following Bellman equation.

$$C_{id} = C_{ij} + C_j \tag{1}$$

$$c_{ij} = 1/p_{ij} = \frac{1}{1 - \prod_{j \in J} (1 - p_{ij})} \tag{2}$$

Where is the probability of delivering the packet from node i to at least one node from J based on individual probabilities of packet delivery p_{ij} for links (i, j). c_{ij} Value thus represents the expected number of anypath transmissions (EATX metric from needed to successfully deliver the packet sent by node i to any node from J. The cost c_j of anypath from J to d can be defined as the weighted average of costs of all paths from J to d:

$$c_J = \sum_{j \in J} \omega_{ij} C_j \tag{3}$$

Where c_j is the cost of a path between vehicle j from J and the destination vehicle, while weight w_{ij} denotes probability of node j being the forwarding node of a packet received from vehicle i. In the simplified case of independent packet losses, w_{ij} values can be defined based on p_{ij} as:

$$w_{ij} = \frac{p_{ij}\prod_{k=1}^{j-1}(1-p_{ik})}{1-\prod_{j\in J}(1-p_{ij})}; \quad . \tag{4}$$

However, future values ofpij depend on mobility characteristics of vehicles, and, in particular, on their time-dependent movement vectors. Any two vehiclesi andjconnected att0 will remain connected afterΔt time, if distance rij between them does not exceed the max.

$$r_{ij}(t_0+\Delta t) = \left|\Phi_i(t_0+\Delta t) - \Phi_j(t_0+\Delta t)\right| \le r_{\max} \tag{5}$$

The communication range rmax movement vector of node i.To reduce changes of a transmission path for consecutivepackets, when establishing the anypath at timet0, we needplicate forwarding, under anypath routing only one of these neighboring nodes will next forward the packet towards the destination. For this purpose, relay priorities are assigned to neighboring nodes by a reliable anycast scheme . In general, higher priorities are given to relay nodes with lower costs to the destination. A certain lower-prioritynext hop will forward the packet only if all the respectivehigher-priority neighbors fail to receive it, e.g., if in a given timeslot, no MAC acknowledgement (ACKmessage) is sent by a higher-priority node upon receiving the packet. The packet is lost, only if none of neighbors receive it. The size of a forwarding set is a compromise between the forwarding cost (in general, this cost decreases with the increase of a number of forwarding relays and transmis-sion delay (too many nodes in the forwarding set may result in longer paths, or even create loops). Compared to unicast transmission, reliability of anypath forwarding is improved, since for each transit node, probability of delivering a packet to at least one neighboring node is greater than the probability of delivering it to a specified forwarding node only However, since there is no deterministic rule for selectingthe next hop, each packet may traverse a multitude of possiblepaths (forming anypath) to reach the destination (Fig. 1).Therefore, the negative outcome of this opportunistic forward-ing is route flapping due to choosing a particular route ina non-deterministic way on a per packet basis by link-andnetwork-layer protocol mechanisms. As a result, traversing different routes by consecutive packets may degrade the level of QoS perceived by end users (i.e., QoE).In this paper, we focus on link stability as an important fac-tor preventing from route flapping in anypath communications. This issue is very important for many real-time safety services with stringent QoS requirements, e.g., emergency warnings, or safe driving assistance including real-time video transmis-sion. Even though there are some proposals available in the literature concerning anypath routing in VANETs. This paper is the first one to introduce a method to remarkably improve the anypath stability.

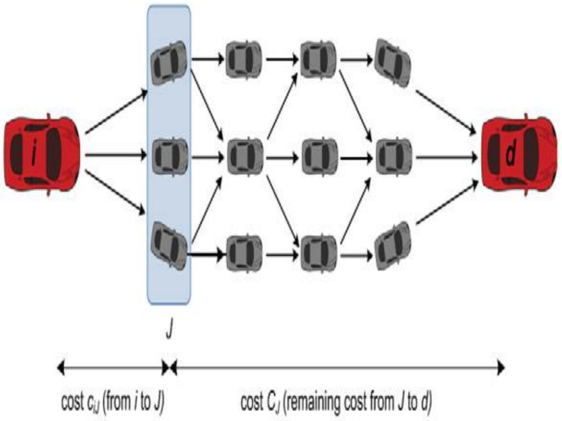

Fig.1: Example anypath between vehicles s and d marked with bold arrows

Forwarding set for node s towards node d is marked with a blue area to identify ”stable links”, i.e., links between vehicles moving in similar directions with similar speeds. For this purpose, we definethe stability index sij of link (i, j) at any timet0based on information on vehicles movement in the previous interval (t0-Δt, t0), as the normalized increase of distance between vehiclesi andjin the past (t0-Δt, t0)interval.

II. SIMULATION SCENARIOS AND PARAMETERS

The Communication between vehicles is frequently mentioned as a target for ad hoc routing protocols, there have previously been not many studies on how the specific movement patterns of vehicles may influence the protocol performance and applicability. Typically the behaviour of routing protocols for VANET is analyzed based on the assumption that the nodes in the network follow the random waypoint mobility model. In this model each node randomly selects a waypoint in the simulation and moves from its current location to the waypoint with a random but constant speed.

In this paper, we assume vehicular environments of urban area, in order to have an accurate evaluation of such condition; the mobility model is adapted to the road linear characteristics. Thus the performance of routing protocol is simulated reasonably and the conclusion has some value in the simulation and practical application of VANET. In this paper, we focus on link stability as an important factor preventingfrom route flapping in anypathcommunications. This issue is very important for many real-time safety services with stringent QoS requirements, e.g., emergency warnings, or safe driving assistance including real-time video transmission . Even though there are some proposals available in the literature concerning anypath routing in VANETs, this paper is the first one to introduce a method to remarkably improve the anypath stability.

Fig.2: Example scenario

III. SIMULATION AND RESULT ANALYSIS

Evaluation of our LLA approach characteristics was focused on analyzing the values of path cost, hop count, message transmission delay, minimal and average path link stability, as well as end-to-end transmission stability (all calculated for each anypath and next averaged over all considered anypaths). For each anypath, we analyzed these characteristics with respect to its primary path (i.e., path of the lowest cost). Evaluation was done for a 53-node network from Fig. 6. We investigated 50 scenarios. In each scenario: the set of transmission demands included all vehicle pairs, at the analyzed time t0, vehicles were allowed to move in directions compliant with the roadmap from Fig. 2,following municipal regulations, speeds at time t0 were uniformly distributed in range 0-16 m/s, with the change of inter-vehicle distance in Δt=1s set to r=16 m. Movement vectors Si of vehicles in future interval (t0, t0+Δt) were estimated based on the respective ones from the past interval (t0-Δt, t0), where Δt = 1 s. Since transmission delay times can be regarded as negligible ones [20], during path computations, network topology (including location of vehicles and their speeds) was assumed to be”frozen”, i.e., it did not change during path computations.

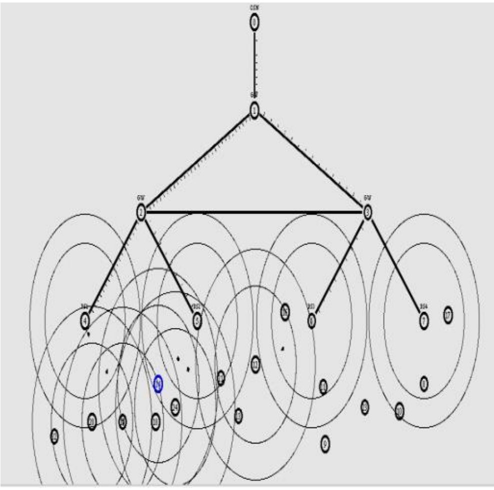

Fig.3: Nam file output

Results of LLA algorithm execution were compared to the respective ones of the reference SAF algorithm from [8]. Link delivery ratios p_{ij} were estimated based on link lengths using Eq. 1 from [10]. Path cost values were calculated according to the metric from Eq. 1 based on introduced formulas present the average values of analyzed characteristics together with the lengths of the respective 95% confidence intervals. Due to choosing links having both high values of packet delivery ratios and link stability indices in anypath computations, results referring to the average path cost obtained by our LLA algorithm were about 76% better than the respective ones for the reference SAF algorithm (36.60 against 150.20). Paths selected by LLA approach were also characterized by better ratios of minimal link stability (0.25 against 0.11) as well as the average link stability (0.55 against 0.33).

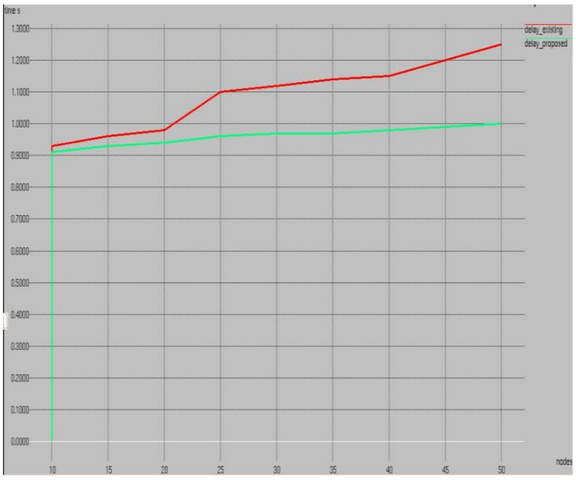

Fig.4: Delay Comparision

Our technique also achieved 50% better values of end-to-end stability. All these results showed that LLA is able to establish paths characterized by improved stability compared to the common SAF technique.

Fig.4: Through put

V.CONCLUSION

In this paper, we addressed the problem of stability of anypath communications in VANET networks in the presence of inter-vehicle link failures being result of vehicles mobility. In order to improve stability of anypaths, we introduced a special metric of link costs that, apart from being based on packet delivery ratios, also included information on the level of link stability. Simulations confirmed benefits of our approach in comparison to the reference SAF scheme. In particular, the average total path cost based on link delivery and link stability ratios was reduced by over 75%.

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