(VVOF)Velocity Vector-based Opportunistic Forwarding in Vehicular Sensor Network

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I. INTRODUCTION

The emergence of ubiquitous communication helps make safer and unobstructed street. Sensor detection is a valid technology to collect and process traffic data (vehicular speed, vehicle density, images from street) with the help of equipped sensors under the road or installed along the street. Vehicular sensor network (VSN), developed from wireless sensor network (WSN), is characterized by unlimited energy resources and mobility. The removal of energy restriction offers various developments for vehicular network. However, VSN faces dynamic changeable topology and intermittent contacts. Therefore,traditional sensor network protocols can't fully be mapped to requirements of VSNs. The challenging points encourage the study of delay tolerant routing for VSN, presented in [1].

The concept behind that comes from the studies on delay-tolerant networks (DTNs), where message ferries (MFs) techniques[2] and opportunistic forwarding are adopted.In the later one, routes carry messages between source and destination. In [3], opportunistic routing and forwarding issues attract much attention, because looking for a path with shorter delay and less cost is always a challenging work.

In [4], Fastest-Ferry Routing in DTN-enabled Vehicular Ad Hoc Network (FFRDV) inlets message ferry technique to VANET and selects message ferries according to a velocity-based strategy. Xu[5] presented Packet-Oriented Routing protocol (POR), to emphasize neighbor selection basing on awareness of packets to be sent and in consideration of probability to complete transferring of these packets. In POR, each node tries to deliver its packets to a neighboring node with best parameter, such as average delay, delivery ratio,etc... However, the communication is thwarted if collisions occurs. When several nodes try to select neighbors within adjacent range, then the best applicant will always be requested and be blocked by collision. This paper will base on the characteristics of VSN and propose a novel scheme for opportunistic routing.

II. VELOCITY VECTORS' ANGLE COMPUTATION

We assume every vehicle is equipped with multi-sensor which can sense the requested messages from remote vehicle or user. In order to serve a request, the mobile node in the targeted area should sense the required messages and send a response back to the requesting user. We assume each sensor knows its current location information using Global position System (GPS). At the initialization of the network, each node creates and updates a neighbor report, which includes the node's currently position, i.e. cartesian coordinates x and y.

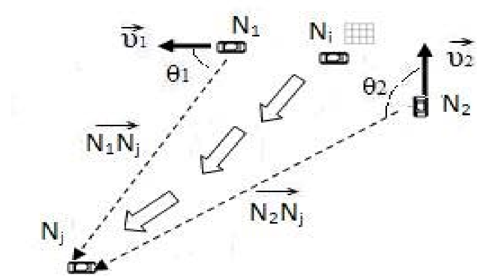

Fig. 1. Velocity vectors' angle computation

Velocity vector's angle computation is the key part of our protocol. Figure 1 shows a typical scenario for computing the vector's angle. Here N_k, v_k, and θ_k, (k=1,2,...,i,...,j...),represent vehicles, velocities, and vectors' angles, respectively. As an example, N_i senses data and becomes data source for a remote request from N_j. When N_i wants to send data to N_j, at first, N_i sends a location packet $Lt(i)$ to all the available neighbors, which contains destination of data. When N_1, N_2 receive $Lt(i)$, they compute their current-to-dest location vectors separately. As we define, that θ_1 presents the angle between $\overrightarrow{v}_1$ and $\overrightarrow{N_1N_j}$, that is, θ ($\overrightarrow{v}_1 \bigwedge \overrightarrow{N_1N_j}$). Node N_1 uses $\lceil cos\theta \rceil$ to confirm θ_1 range. For example, $\overrightarrow{v}_1$ and $\overrightarrow{N_1N_j}$ make an acute angle, so $\lceil \cos\theta \rceil$ = 1. And $\overrightarrow{v}_2$ and $\overrightarrow{N_2N_j}$ make an obtuse angle, so $\lceil \cos\theta \rceil$ = 0. If only node N_i receives an angle mark "1" from one neighbor, N_i sends data to it. Otherwise, once no satisfied neighbor exists, node N_i has to disseminate $Lt(i)$ periodically.

III. THE PROPOSED SCHEME

Our approach can be summarized into two steps: Request flooding phase and Angle-based data forwarding phase. A scenario that represent our idea for metropolitan area can be observed from fig. 2.Any user U_i may request data from any other remote location $(x_p+\delta, y_p+\delta)$ in the target area, where p (x_p, y_p) means a unique position and δ is a location correction factor. In VSN, this can be a traffic control center which always requires synchronized traffic conditions and traffic systems. Also this can be a driver who wonders traffic density somewhere to choose a un-congested path to his destination

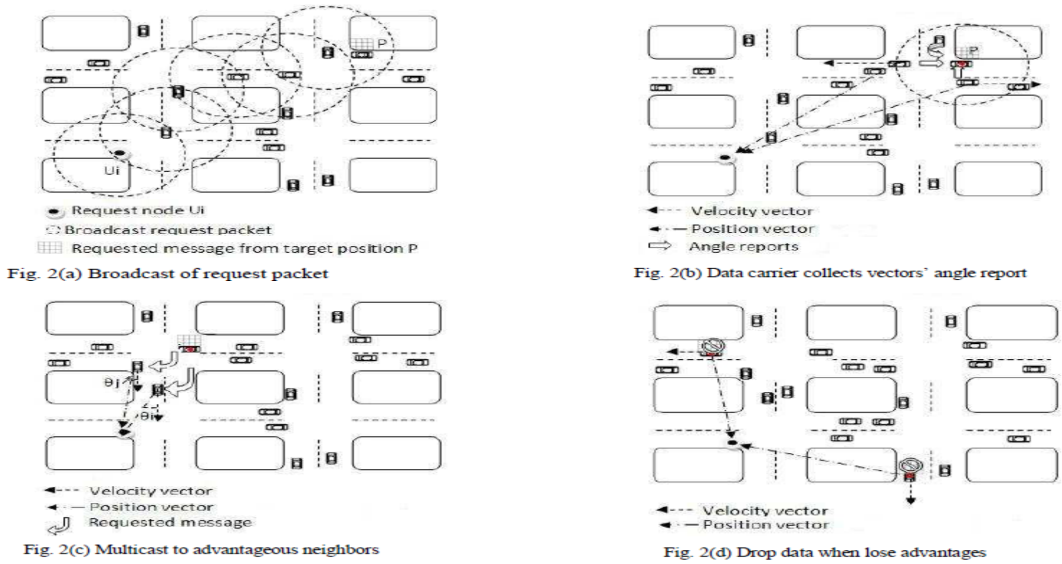

Fig. 2. Data request and reply

with less delay.So this user can be both static and mobile. We first explain our scheme with a static requesting user, and it's practical to develop this idea to a mobile one in the future.

After Ui starts a request for message from area $(x_p+\delta, y_p+\delta)$, a request packet γ_i is broadcasted to all the neighbors within maximum transmission range TR. (Fig. 2a) Packet γ_i contains ID of U_i, $(x_p+\delta, y_p+\delta)$ and data requirement. To reduce interference, only neighbors which are between 75%TR and TR are authorized to be the next relay. Furthur to minimize the interference, among N_i, if a node receiveds a repeated γ_i, it won't broadcast repeatedly and discards γ_i.

When γ_i reaches targeted area, nodes in area $(x_p+\delta, y_p+\delta)$ sense requested message. For instance, the marked node in Fig. 2b senses data and becomes source node. Source node will then select next hop following the Vectors' Angle Computation, as described in preview section. All other potential nodes send back angle mark $\lceil \cos\theta \rceil$ packed in angle reports. For every hop, advantageous neighbors are confirmed and carry data to requesting user. (Fig. 2c) To avoid network resources waste, once a data carrier loses advantages, it will discard the messages automatically. From Fig. 2d, if one node detects its own vector angle mark $\lceil \cos\theta \rceil$ is negative, it drops data. Finally, the requested data reaches U_i. Otherwise, regularly request should be initialized. Our scheme is designed to choose several advantageous neighbors to relay the messages for high successful transmission rate. Data is automatically dropped when carrier loses advantages for effective usage of buffer.

IV. CONCLUSION

The further evaluation will be continued in ns-2.31. The simulation environment is set on a 1500*1500 meters area with car-following model is set to 25km/h. The radio model is 2.4 GHz for IEEE 802.11b. The simulation is compared with the Packet-Oriented Routing protocol (POR). In our novel opportunistic routing scheme using DTN technique, data is stored and forwarded to all the neighbors if $\lceil \cos\theta \rceil$ between velocity vector and current-to-dest location vector is positive. The previous mathematical analysis indicates its better performance. The performance is expected like Fig. 3,[5]. Then more evaluation and analysis will be implemented.

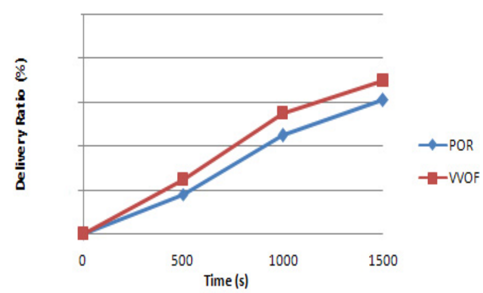

Fig. 3. Performance comparison

ACKNOWLEDGMENTS

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