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Geographical Forwarding Methods in Vehicular Ad hoc Networks

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ABSTRACT

Vehicular ad hoc networks are new and emerging technology and special class of mobile ad hoc networks that provide wireless communication between vehicles without any fixed infrastructure. Geographical routing has appeared as one of the most scalable and competent routing schemes for vehicular networks. A number of strategies have been proposed for forwarding the packets in geographical direction of the destination, where information of direct neighbors is gained through navigational services. Due to dynamically changing topologies and high mobility neighbor information become outdated. To address these common issues in network different types of forwarding strategies have been proposed. In this review paper, we concentrate on beaconless forwarding methods and their forwarding methods in detail.

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1. INTRODUCTION

The vehicular Ad hoc network is a self-organized, distributed and highly mobile network that facilitates ubiquitous connectivity between vehicles. The applications of vehicular Ad hoc networks are classifying into two basic types; safety and general data routing applications. The general routing applications provide one-to-one and one-to-all data broadcasting for different services such as for route planning, entertainment and for simple communication. In safety applications, the data is broadcasting in one-to-all manners and in predefined region such as for lane changing assistance, electronic brake light and road condition applications. These applications need priority and delivery in a short time especially for urgent situations like vehicle collision, accident detection, etc. [1].

The wireless communication between vehicles performed by means of DSRC (Dedicated Short-Range Communication) standard protocol at MAC (medium access control) layer and operates on 5.9 GHz. The vehicles are disseminating the packets periodically after every 300 ms with geographical location information via global positioning system (GPS). GPS is broadly available and consider as essential automotive equipment installed in vehicles. In network, the vehicle nodes select a suitable candidate for forwarding the packets and accomplish the multiple data deliveries. Because of VANET unique features, the network has been suffered from different issues related to routing, channel congestion and in data forwarding strategies, etc. Vehicular communication channels suffered from signal scattering and reflections, which mortify signal quality and strength. Also, the high mobility patterns are more dynamic with high fading conditions and cause of joint correlated shadow fading effects. In congested areas, the vehicles can temporary disconnected with near neighbors vehicles because of dynamic changing and frequent static and dense configuration. To handle these issues in vehicular ad hoc networks different type of routing protocols have been proposed such as topology based, cluster, geocast and geographical based. However, geographical based routing protocols are predominant and feasible because these protocols obtain information from a street map and from navigational services. These protocols are used to avoid the broadcast storm problems in network. Each vehicle node is aware of its own position through GPS devices and with a multihop manner the farthest vehicle select as a forwarder in broadcast range [2].

The functionality of geographic based routing protocols divided into three main categories: path selection, forwarding and recovery. The path selection is not mandatory but if any protocol use this method so it is count as an advantage. If protocol fail to find road path then select forwarding strategy and select neighbor node to forward data packet [3], [4]. Commonly for path selection two strategies used, the first one is based on Dijkstra algorithm [5] and the second one is based on next junction or intersection [6]. The first strategy has some problems in term of overhead and reduced availability. Next junction selection is better option for control network overhead but because of traffic density metric, the road select with high traffic density instead of less vehicle road. The second strategy is forwarding as a significant phase for every geographical based routing protocol, which is discussed in detail in next sections. The last strategy is recovery mode, it is used when other forwarding strategies into a local maximum or local optimum situations, where the source vehicle node is closer to destination node and neighbors nodes and destination node is not reachable by one hop. One of most used strategy is right hand rule traverse graphs [3]. For neighbor node discovery, the nodes periodically broadcast beacon messages, but due to vehicular network properties the neighbor list is outdated and the selection of next candidate node is difficult. To solve this issue many beaconless approaches have been proposed and show better performance in vehicular network. The main objective of this review is to highlight these approaches and discuss their operation and features.

This review is based on forwarding strategies used in vehicular ad hoc networks. The section 2 describes the component and architecture and popular applications of vehicular ad hoc networks. The section 3 presents the existing forwarding approaches. The last section illustrates the discussion and conclusion.

2. COMPONENTS AND ARCHITECTURE OF VANETS

The network has some components for communication and establish the connection between infrastructure and vehicle nodes. There are three main components in VANETs architecture: AUs (Application units), OBUs (On board units) and RSUs (Road side units) [7]. The AUs and OBUs are used for consumer services and installed in vehicles. The RSUs act as a router to provide these services to moving vehicle nodes in network through IEEE 802.11p standard. On board units have capability to communicate with other vehicles as well as with road side unit and application unit. On board units are used for IP mobility management, processing and data collections. Applications units are separate devices or may be integrated with on board unit used to communicate with road side unit. The road side units are installed and deployed on road side with radio communication coverage for vehicles. The dedicated short range communication (DSRC) is used to provide communication between vehicles and IEEE 802.11p is used among other road side units and on board units. Figure 1 shows the various components of generalized architecture of VANETs.

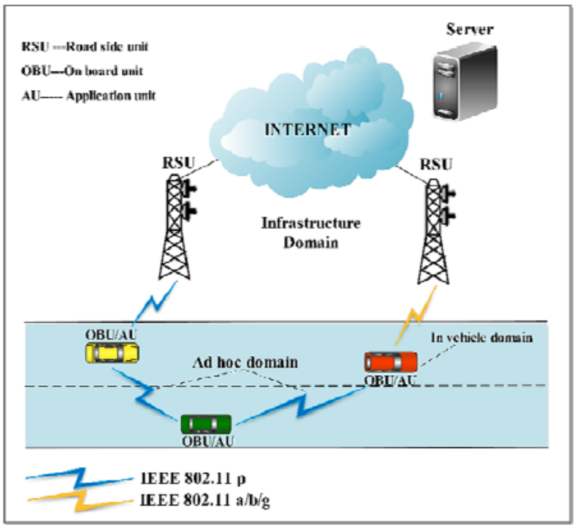

Figure 1. VANET Architecture

The applications of vehicular networks can be broadly categorized into two types namely infotainment and safety applications. Under infotainment applications category major applications are broadcasting information about near petrol pump information, restaurant seat availability, movies timings, food and sale offers, etc. The second category is safety applications, where vehicles disseminate the information about collision avoidance, accident detection and other safety related information. The below Table 1 shows some important applications with description.

Table 1. Vehicular applications

S/No	Applications	Description
1	Alert Applications	In these types of applications, RSU generates alert messages such as warning about violating the traffic signal, stop sign movement assistance and blind merge detection, etc.
2	Vehicle Maintenance Applications	These applications are related with vehicle diagnostic and maintenance such as safety recall notice and just in time repair notification.
3	Safety Services	In these applications, the driver received information about emergency vehicle warning, signal preemption and post-crash warnings.
4	Sign Extension	Different types of signs involved in this category such as curve speed warning, low bridge warning, wrong way alert and amber alert.

3. RELATED WORK

The geographical or position-based routing protocols were developed for wireless mobile ad hoc, sensor and for packet radio networks in 1980s [8], [9]. The first position based protocol was proposed by Takagi and Klennrock in 1984 with the concept of progress to the destination [10]. In 1987 the improved version proposed by Finn, which is based on geographical distance to the destination node. There are some strategies proposed based on direction angular deviation, which is refer to line between destination and forwarder node [11]. There are some hybrid approaches proposed and used both methods DREAM (Distance Routing Effect Algorithm for Mobility), and DHGR (Dynamic Hybrid Geographic Routing)[12]. These types of methods are based on position information for route finding and select the next hop to forward the packet toward the destination by geographical direction. There are four main strategies for forwarding the packet in geographical based routing protocols shows in Figure 2.

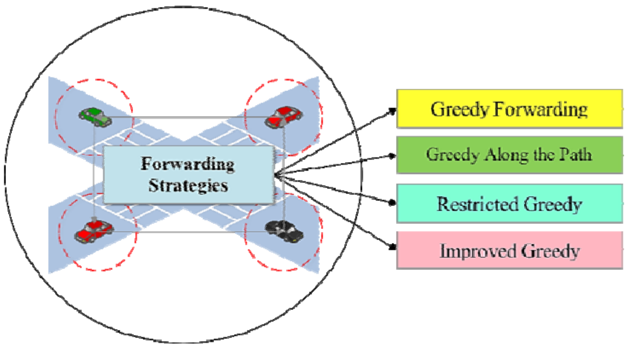

Figure 2. Forwarding Strategies

The one of the effective way of forwarding the packet is greedy approach [13], where source node select the neighbor node which is near with destination node. Hello message carry the source node current position and destination position and forward the packet but it is not mean that always position based protocol select an adequate vehicle node. The selection of closer node with the destination not mean it is a best route or successfully reaches destination. If the path is used in this strategy, normally it refers to greedy along the path [6], where node selection is based on road to next junction and selected path. But still this enhanced method suffered from insufficient selection of forwarding node due to propagation and node high mobility issues in network. There are some other greedy approaches proposed with some restrictions to addressed and overcome these issues. Some of them solved the propagation problems in junctions and based on priority node exist in center of a junction. Although there are some issues related to restricted greedy approach such as communication bottleneck. The bottleneck means if priority junction node is a neighbor of sending node or vehicle node moving slow and stop and become a priority junction node and receive all the incoming traffic. Another limitation is selection of neighbor for forwarding the packet, which is moving to the destination or priority junction node. This restriction also suffered from some errors in network such as selecting a next junction when other adjacent roads are without vehicles and packet will travel back on the same road and less frequency problem arose. This approach is called improved greedy. The improved greedy approach overcomes the issue of greedy approach when vehicles stop to follow red signals and might be in tendency to send the packet to opposite direction nodes. Because improved greedy approach is only routes the packets via traveling vehicles toward the destination and solved this issue. To address these issues, researchers proposed different types of solutions for forwarding the packet to the destination. In below section, we discuss popular geographical forwarding methods.

3.1. Geographical Forwarding Methods

The geographical forwarding methods does not perform well if it cannot find the next hop because of taking wrong decision at intersections, due to high velocity and longer delay in networks. The selection of next hop, which is near with destination vehicle node may select a longer path that does not go towards the destination. In this situation, the recovery strategy proposed by [3] and [13] based on planner graph, but these strategies are not efficient in preventive vehicular environment, where large obstacles (buildings, trees, etc.) obstruct the transmission signals. Various approaches proposed to overcome these problems, where a vehicle node broadcast beacon message to decide the location of its direct neighbors. Each node stores and maintains direct neighbor information in a table, while the vehicles are in speeds so the information is outdated and cause of packets dropping. Also the saving information in tables and maintainence lead to network overhead and consume resources as well as disturb the sleeping cycles and effect the VANET communication. Some other proposed schemes [14]-[16] based on receiver-side relay election and use one or more than one criteria for forwarding for choosing next best hop. These schemes do not consider low connection time among vehicles, error-prone wireless channels, and optimal wireless range. Some issues still existing in these approaches such as sub-optimality of packet forwarding, overhead in network, packet dropping, route failure, and repair notification. To address these issues in vehicular network, researchers proposed different approaches for packet forwarding such as beacon and beaconless based strategies. To take the properties of vehicular network the beaconless approaches are consider most appropriate and suitable for vehicular network. These approaches do not send the beacon or Hello messages to find the neighbor and forwarder node in network.

The main objective of this review is to discuss the beaconless geographical forwarding approaches, which are mostly used for forwarding the data with Hello messages.

3.2. Beaconless Data Forwarding Schemes

For Neighbor discovery, geographical routing protocols send periodic beacon or hello messages to update its own and neighbor information in the network. Through these beacon periodic messages, the vehicle nodes update and maintain its list of neighbors. If the neighbor list is outdated the vehicle node faced problem into select optimal node as a next candidate or may select a node which is near with radio range and will move out from radio range. To solve this issue the beaconless approached have been proposed. In below section the most effective and efficient beaconless routing strategies are discuss.

3.2.1. Contention-based Beaconless Packet Forwarding Algorithm (CBBPF)

This is another geographical based beaconless forwarding algorithm [17] with contention-based next hop selection. CBBPF contains three types of packets: request, reply, and data. First the protocol holds the data packet and only broadcast request control packet and wait for the reply, this packet contain position of forwarding and destination node. When neighbor nodes receive request packet then they check the closer node with the destination and if any neighbor find this so it will become a forwarding node. The success node broadcast reply control packet with reply destination field, then source node forward the data. If the neighbor node does not find the node then after a set time it drop the request packet and go to its initial state. In the case of local maximum CBBPF used store and carry strategy based on the contention next-hop selection. In this strategy, the timer values of all candidates nodes are adjusted with distance of two nodes and positions of current forwarder and destination neighbor. Author evaluated the proposed protocol in sparse and dense environment and analyzed the performance in terms of end-to-end delay, packet delivery ratio and average store and carry time.

3.2.2. Geographic Random Forwarding (GeRaF)

Michele Zorzi, et al., [18] proposed a scheme, which is similar with CBF, where the RTS (request-to-send and CTS (clear-to-send) MAC handshake method is used to control duplicate forwarding issue with beaconless approach instead of full message. The scheme is based on geographical location and randomly selection of the nodes and rely on nodes by contention between receivers. The author assumed some parameters to evaluate the scheme with existing approaches such as every node know its own position and sink node position. The node initially broadcast the own address with location of the projected destination. All neighbor nodes are receiving the message, assess the packet and check own position with destination and trying to behave as a relay. This packet is RTS frame and waits for receive a reply with CTS frame. The selection of the relay node is based on dividing the coverage area into relay region and non-relay region and non-relay nodes are not selected for relay. In a case of high reply, the optimal forwarding node is selected for forwarding the data packet to the neighbors. The packet contains broadcast address, transmitter location and final destination location. Author evaluated this scheme in terms of average number of hops and available neighbors to reach the destination. However, this scheme avoids some important parameters such as packet delivery ratio and end-to-end delay. Another weakness of this scheme is duplicate message retransmission at the same time and cause of enhancing the data packet delivery at the destination node.

3.2.3. Guaranteed Delivery Beaconless Forwarding (GDBF)

Chawla et al., [14] proposed beaconless scheme based on RTS/CTS handshake mechanism and biased timeout to select best next hop. The proposed scheme is working with two modes greedy and recovery, through greedy mode closer node with destination respond first and in recovery mode the node selected with shorted timeout and near with source node, and other nighbours node cancel CTS packets automatically, if the connection with source node is not part of the Gabriel graph. When another neighbor node receives data packets from the source node then they cancel messages. GDBF scheme showed better performance using IEEE 802.11 MAC layer in terms of low overhead and guaranteed delivery. However, this scheme used single criteria to measure the waiting time-out, which is not enough for high- performance vehicular networks.

3.2.4. Priority-based Receiver-Side Relay Election Scheme

Egoh et al., [21] proposed a scheme based on priority criteria with least remaining distance and generalized mapping function for geographical forwarding. The scheme considering relative priority between the eligible relay node and take the least remaining distance from destination. The relative priority of eligible nodes are controlled by mapping shape parameters and suitable for achieving the best relay election performance. The scheme only uses distance from the transmitter to receiver as a single criteria and calculate the waiting time. Distance is determined by the potential next hops and the destination node. Author analyzed the protocol performance through probabilistic analysis and showed better achievements in the delay of one election attempt, election failure probability and effective delay for successful relay election process.

3.2.5. Multi-Criteria Receiver-Side Relay Election Scheme

Egoh et al., [15] proposed two criteria, which are based on forwarding node selections: hop progress (greediness) and reachability (link quality) to decide waiting time for selection the best next hop. The scheme uses multi parameters mapping function to merge the all decision process into a single virtual criterion to categorize the predictable relay candidates. However, proposed approach is feasible for radio transmission range follows a fixed circular radius and not appropriate for VANET obstacles environment. Some other schemes [22] proposed with multi-criteria receiver-side self-election to reduce the traffic overhead generated by periodic beacon messages and influence the IEEE 802.11 RTS/CTS frame exchange instead of sender election scheme. The receiver self-election scheme is used to select best next hop, and keep away from the implicit broadcast of the beacon message in geographical forwarding in congested networks. The scheme uses three key parameters for waiting function: forward progress, optimal transmission range, and received power. However, these static weights are not suitable for rapidly and dynamically changing vehicular environment.

3.2.6. Implicit Geographical Forwarding

This scheme proposed by Son et al., [21] and based on the integration of beaconless routing with IEEE 802.11 MAC layer. In this scheme, the node holds the packet with known destination and broadcast the data packet and not aware of its neighbors nodes. Before forwarding the packet, every neighbor node computes a small transmission time-out and depends on its position relative with destination and last node. If the node is situated at best position then it introduce the short delay and retransmit the packet first. The residual node cancels the scheduled packet after perceiving this transmission. Though, if some neighbors with forward progress may not hear the message they can retransmit.

3.2.7. Select and Protest Based Beaconless Forwarding

In this scheme author, [22] proposed a select and protest beaconless forwarding scheme that enables reactive face routing with guaranteed delivery. The forwarder node triggers the contention process, where the probable neighbors of planner graph might be answer. Then the protest messages are used to accurate wrong decisions. The scheme has two potentials to deal with beaconless recovery issues: select and protest approaches. The select approach is based on beaconless forwarder planarization (BFP) and protests approach is based on Angular relaying. The select approach construct a local planner subgraph, and use for afterwards by face routing protocol, as shown in Figure 3(a), where node F sends an RTS packet and contention between candidate nodes begin. It is opposite from greedy forwarding, where all node within transmission range are likely contenders and the timeout is based on the distance of forwarder not the destination. Then candidate C is suppressed, such as it has to cancel the scheduled reply if another candidate C1 situated at Gabriel edges. This is due to suppressed nodes are witness in contradiction of other candidates. Consequently, through protest messages the resulting graph obtain more edges compared to Gabriel subgraph and incorrect decisions might be corrected. These messages are essential even if another subgraph constructed, planner and connected proximity graph can be constructed without protests.

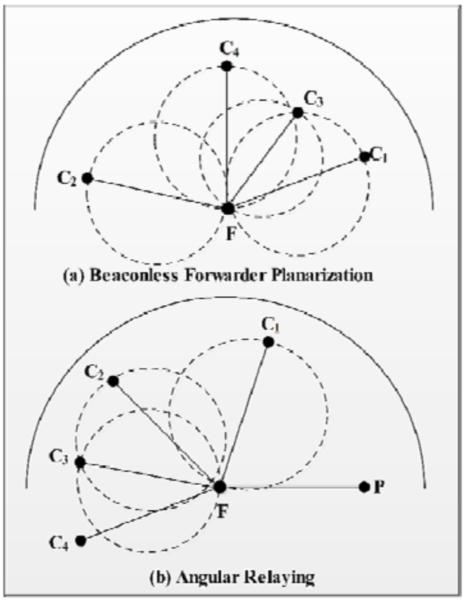

Figure 3. Select-and-Protest based beaconless forwarding scheme

The Angular Relaying is starting from RTS packets, which are transmit through forwarder node F and contain the forwarder and previous hop position and recovery direction. The candidate node answer is based on angel between previous hop, delay function, and position of candidate and forwarder nodes. The first node C replies counter-clockwise without final candidate and other candidates are located within the Garbriel circle over (F, C) with larger delay. Such a candidate node may be send a protest against the first decision and automatically select for candidate node. If needed this decision again corrected through more protest messages until no protest issued for further process. Then the last candidate select for next hop and gets the message from the forwarder, as shown in Figure 3(b).

3.2.8. Next Hop Forwarding Method

In this proposed [23] forwarding method every node broadcast beacon messages with its own ID and own position information. After receiving this hello message from neighbor nodes, each vehicle node corrects the location information of its neighbor nodes. Author compared proposed scheme with greedy forwarding method where a sender node selects node for forwarding the packet which is near with destination, but the number of hop from source node will be minimized and forwarding distance of one hop is large. Author analyzed that if the distance of one hop is larger than propagation loss or increases, then transmission quality in the form of packet error rate degraded. To address these problems, author suggested that selection is based on by selecting that neighbor node which is within a predefined maximum forwarding distance as shown in below Figure 4(b). The scheme also consider transmission quality of the wireless link, because the path losses depend on the forwarding distance. For transmission quality, the term ETT (expected transmission time) [24] is used to assess the quality. Basically the ETT is a function of bandwidth of the link and the loss rate. If the packet error rate is high the ETT increased. Then the next hop will be selected using link metric denoted by EPD and contain transmission quality and forwarding distance. It relates with progress distance d per unit time. From the information of the destination neighbor, and sender nodes, d is calculated for every next-hop candidate node. Every node corrects the neighbor information periodically through hello messages and packet error rate measured and reported. The packet contains node ID, ETT, and EPD, where ID is come from hello messages and progress distance is calculated by location information of the sender node. Author evaluated the proposed scheme performance and showed that the scheme is better in high throughput and in packet delivery ratio.

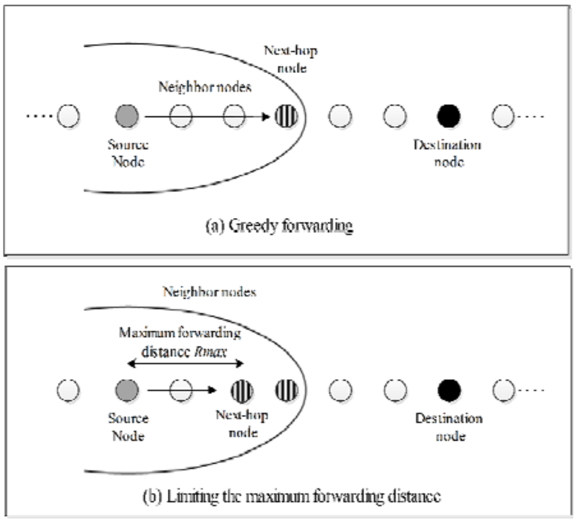

Figure 4. Next-hop forwarding method

3.2.9. Intelligent Beaconless Routing

In [25], an intelligent beaconless (IB) geographical routing algorithm to enable the vehicles to forward packet along the city street efficiently. The protocol is based on reformed 802.11 request-to-send/clear-to-send (RTS/CTS) frames with source and destination distance, signal strength and direction metrics. For stable and reliable packet forwarding candidate node consider relative direction and power signal to elect itself intelligently. The simulation results show the IB protocol positive response in terms of average delay, packet delivery ratio in urban vehicular scenario.

3.2.10. Beaconless on Demand Strategy (BOSS)

Another effort of beaconless routing protocol taken by Sanchez et al., [26], where the author proposed beaconless on demand strategy for wireless sensor network (BOSS). The protocol uses three way handshake scheme RTS/CTS and DDFD as a discrete timer-assignment function. This function divided the neighbor area into sub areas according to progress toward destination. The DDFD is used to decrease collisions among answers during selection phases. The main contribution of protocol is the addition of full data packet and consider active and passive acknowledgment mechanisms. However, protocol achieved high packet delivery and ratio while having low bandwidth consumption.

3.2.11. LIAITHON

Authors in [27] proposed a location aware multipath video streaming scheme (LIAITHON) for urban vehicular network based on location information for discover the optimal route. It is a multipath receiver based protocol for minimize the collision, congestion through the packets reduction in length compared to single path protocol. The degree of closeness and selection of forwarding zone are used for relay node for transmitting the packets for the interval of reservation time toward the destination. The forwarding node selection is based on geographical advance, link stability and degree of closeness. The degree of closeness is responsible for discovering two relatively short paths with minimal route coupling effect. The protocol does not address the impact of distributing multiple video flows in network, in the presence of more flow traversing in same communication range the coupling effects occur.

3.2.12. VIRTUS
Cristiano et al., [28] proposed a resilient location aware video unicast scheme (VIRTUS) reactive unicast receiving based protocol for selection policy of relaying nodes. Protocol uses the current and future location with the help of three factors forwarding zone definition, reservation time estimation and waiting time calculation with the help of Bayesian state estimation. The limitation of this protocol is constant value of forwarding zone directed toward the destination and not suitable for urban environment because vehicle nodes are moving along the road.

3.2.13. Beaconless Opportunistic Routing
Denis et al., [29] proposed a beaconless opportunistic routing (LinGo) protocol based on link quality and beaconless approach for mobile multimedia internet of things. The protocol working on multiple metrics such as link quality, geographical location and energy. Author proposed a cross layer approach include MAC and forwarding functionalities and assume the CSMA/CA mechanism relies on beaconless method with two operational modes: contention and back bone based forwarding. For forwarding protocol used DFD function including link quality, geographical information and remaining energy. The energy is not an issue in vehicular networks and LinGo is designed for mobile applications.

3.2.14. Beaconless Routing for Vehicular Environment
Pedro et al., [30] proposed beaconless routing protocol for vehicular environment (BRAVE) based on spatial awareness and beaconless geographic forwarding. The spatial awareness refers to allowing intermediate nodes change initial plan based on view of street map and local information. The trajectory of the packet compute at every forwarding node and next junction selection is based on Dijkstra shortest path algorithm. Protocol use four types of messages date, response, select and ack. The protocol use store and forward strategy instead of recovery mode. The protocol performance is better in terms of packet delivery ratio and packet dropping in case of high density. On the other hand the less density situation has high end to end delay and network overhead.

3.2.15. Beaconless Geographic Multiple Routing
Ping et al., [31] proposed a beaconless geographic multipath routing protocol (BGM) to construct maximum node disjoint multiple paths. In this protocol each node select multiple paths for forward the data packets within disjoint subzone divided through a division algorithm. Before sending the packet source node calculate distance toward destination and calculate sub zones based on number of acquired paths and coefficient of each curve for zone division. Then, source node record the location information of itself, destination and coefficient of curves into a packet head and forward the data packet to next node. Forwarding strategy find node-disjoint multiple paths in network with high node density and maximize node-disjoint multiple paths in networks without beaconing.

4. DISCUSSION
Different types of routing protocols have been proposed to handle vehicular ad hoc network environment such as topology based [32], cluster, geocast and geographical based [33] routing protocols. As discussed in the introduction, that geographical routing protocols offer a suitable solution to handle frequent route breaks and higher delay in vehicular ad hoc network. However, if these protocols do not find the next hop because of wrong decision in urban environment, where various different type of obstacles exists, dead-end roads exist and due to high mobility the longer delay in congested network noticed. Sometime closer node with destination may select that does not go toward the destination. Different types of recovery approaches proposed, which are based on planner graph but due to obstacles these are still suffered and not effective in restrictive vehicular networks. Various types of geographical forwarding approaches are proposed to tackle these problems with periodically broadcast beacon messages and beaconless approaches. From the beacon hello messages consumes resources and disturb sleeping cycles. The discussed forwarding approaches have shortcoming due to sup-optimally and leads to packet dropping and cause of network overhead [34]. To address these challenges beaconless approaches have been proposed and discussed in above sections. These approaches are efficient to control the vehicular properties and work well in network. These beaconless approaches working with link quality, transmission range, and direction properties for find the optimal forwarder node in network. These methods are working on MAC layer where they use RTS/CTS packets with some metrics to check the best neighbor node, which has good link quality and within transmission range and direction toward the destination. These metrics are more practical to find the best route and relay node in vehicular network. Through these data forwarding approaches the applications of intelligent transportation system will be more efficient and provide convenience to travelers [35].

5. CONCLUSION

In this paper, we describe the most important geographical forwarding methods for vehicular ad hoc networks and their operation. Due to dynamic changing topology and high mobility of vehicles the network still faced different network related issues. Every protocol has own strategy for forwarding the packet in the network. In this paper, we discussed most important forwarding methods applied in different geographical routing protocols. This study is a first step for the researcher to improve the forwarding methods and network efficiency for vehicular ad hoc network.

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REFERENCES

[1] Kavitha K, Bagubali A, Shalini L, editors. *V2V wireless communication protocol for rear-end collision avoidance on highways with stringent propagation delay*. Advances in Recent Technologies in Communication and Computing, 2009 ARTCom'09 International Conference on; 2009: IEEE.
[2] Huang J, Huang Y, Wang J, “Vehicle Density based Forwarding Protocol for Safety Message Broadcast in VANET”.
[3] Karp B, Kung H-T, editors. *GPSR: Greedy perimeter stateless routing for wireless networks*. Proceedings of the 6th annual international conference on Mobile computing and networking; 2000: ACM.
[4] Rao S. A., Pai M., Boussedjra M., Mouzna J., “GPSR-L: Greedy perimeter stateless routing with lifetime for VANETS”, *ITS Telecommunications, 2008 ITST 2008 8th International Conference on,* 2008.
[5] Lochert C., Hartenstein H., Tian J., Fussler H., Hermann D., and Mauve M., “A routing strategy for vehicular ad hoc networks in city environments”, *Intelligent Vehicles Symposium, 2003 Proceedings IEEE,* 2003.
[6] Jerbi M., Senouci S. M., Meraihi R., Ghamri-Doudane Y., “An improved vehicular ad hoc routing protocol for city environments”, *Communications, 2007 ICC'07 IEEE International Conference on,* 2007.
[7] Al-Sultan S., Al-Doori M. M., Al-Bayatti A. H., Zedan H., “A comprehensive survey on vehicular Ad Hoc network”, *Journal of network and computer applications*, Vol. 37, pp. 380-92, 2014.
[8] Finn G. G., “Routing and addressing problems in large metropolitan-scale internetworks”, *DTIC Document*, 1987.
[9] Basagni S., Chlamtac I., Syrotiuk V. R., Woodward B. A., “A distance routing effect algorithm for mobility (DREAM)”, *Proceedings of the 4th annual ACM/IEEE international conference on Mobile computing and networking,* 1998.
[10] Takagi H., Kleinrock L., “Optimal transmission ranges for randomly distributed packet radio terminals. Communications”, *IEEE Transactions on,* Vol. 32, No. 3, pp. 246-257, 1984.
[11] Kranakis E., Singh H., Urrutia J., “Compass routing on geometric networks”, *In Proc 11 th Canadian Conference on Computational Geometry,* Citeseer, 1999.
[12] Chen M., Leung V. C., Mao S., Xiao Y., and Chlamtac I., “Hybrid geographic routing for flexible energy—delay tradeoff”, *Vehicular Technology, IEEE Transactions on*. Vol. 58, No. 9, pp. 4976-4988, 2009.
[13] Lochert C., Mauve M., Füßler H., and Hartenstein H., “Geographic routing in city scenarios”, *ACM SIGMOBILE Mobile Computing and Communications Review*, Vol. 9, No. 1, pp. 69-72, 2005.
[14] Chawla M., Goel N., Kalaichelvan K., Nayak A., and Stojmenovic I., “Beaconless position based routing with guaranteed delivery for wireless ad-hoc and sensor networks,” *Ad-Hoc Networking: Springer*, pp. 61-70, 2006.
[15] Egoh K. and De S., “A multi-criteria receiver-side relay election approach in wireless ad hoc networks”, *Military Communications Conference, 2006 MILCOM 2006 IEEE,* 2006.
[16] Füßler H., Mauve M., Hartenstein H., Käsemann M., and Vollmer D., “Mobicom poster: location-based routing for vehicular ad-hoc networks”, *ACM SIGMOBILE Mobile Computing and Communications Review,* Vol. 7, No. 1, 47-49, 2003.
[17] Asgari M., Ismail M., and Alsaqour R., Reliable Contention-based Beaconless Packet Forwarding Algorithm for VANET Streets”, *Procedia Technology*. Vol. 11, pp. 1011-1017, 2013.
[18] Zorzi M. and Rao R. R., “Geographic random forwarding (GeRaF) for ad hoc and sensor networks: multihop performance”, *Mobile Computing, IEEE Transactions on*, Vol. 2, No. 4, pp.337-348, 2003.
[19] Egoh K. and De S., “Priority-based receiver-side relay election in wireless ad hoc sensor networks”, *Proceedings of the 2006 international conference on Wireless communications and mobile computing*, 2006.
[20] Nzouonta J., Rajgure N., Wang G., and Borcea C., “VANET routing on city roads using real-time vehicular traffic information”, *Vehicular Technology, IEEE Transactions on*, Vol. 58, No. 7, pp. 3609-3626, 2009.
[21] Son S., Blum B., He T., and Stankovic J., “IGF: A state-free robust communication protocol for wireless sensor networks”, *Tec Report Depart Comput Sci Univ Virginia*, 2003.
[22] Kalosha H., Nayak A., Ruhrup S., and Stojmenovic I., “Select-and-protest-based beaconless georouting with guaranteed delivery in wireless sensor networks”, *INFOCOM 2008 The 27th Conference on Computer Communications IEEE,* 2008.

[23] Okada H., Takano A., Mase K., "A proposal of link metric for next-hop forwarding methods in vehicular ad hoc networks", *Consumer Communications and Networking Conference, 2009 CCNC 2009 6th IEEE,* 2009.
[24] Draves R., Padhye J., Zill B., "Routing in multi-radio, multi-hop wireless mesh networks", *Proceedings of the 10th annual international conference on Mobile computing and networking,* 2004.
[25] Ghafoor K. Z, Abu Bakar K., Lloret J., Khokhar R. H., Lee K. C., "Intelligent beaconless geographical forwarding for urban vehicular environments," *Wireless networks,*Vol. 19, No. 3, pp. 345-362, 2013.
[26] Sanchez J.A., Marin-Perez R., Ruiz P. M., "BOSS: Beacon-less on demand strategy for geographic routing inwireless sensor networks", *Mobile Adhoc and Sensor Systems, 2007 MASS 2007 IEEE Internatonal Conference on,* 2007.
[27] Wang R., Rezende C., Ramos H. S., Pazzi R. W., Boukerche A., Loureiro A. A. F., "LIAITHON: A location-aware multipath video streaming scheme for urban vehicular networks", *Computers and Communications (ISCC), 2012 IEEE Symposium on,* 2012.
[28] Rezende C., Ramos H. S., Pazzi R.W., Boukerche A., Frery A. C., Loureiro A. A. F., "Virtus: A resilient location-aware video unicast scheme for vehicular networks", *Communications (ICC), 2012 IEEE International Conference on,* 2012.
[29] Rosário D., Zhao Z., Santos A., Braun T., Cerqueira E., "A beaconless Opportunistic Routing based on a cross-layer approach for efficient video dissemination in mobile multimedia IoT applications", *Computer Communications*, Vol. 45, pp. 21-31, 2014.
[30] Ruiz P. M., Cabrera V., Martinez J.A., and Ros F. J., "*Brave*: Beacon-less routing algorithm for vehicular environments", *Mobile Adhoc and Sensor Systems (MASS), 2010 IEEE 7th International Conference on,* 2010.
[31] Dong P., Qian H., Wei X., Lan S., Pu C., "A Beacon-Less Geographic Multipath Routing Protocol for Ad Hoc Networks", *Mobile Networks and Applications,* Vol. 18, No. 4, pp. 500-512, 2013.
[32] Qureshi K. N., Abdullah H., "TOPOLOGY BASED ROUTING PROTOCOLS FOR VANET AND THEIR COMPARISON WITH MANET", *Journal of Theoretical and Applied Information Technology,* Vol. 58, No. 3, 2013.
[33] Qureshi K. N., Abdullah A. H., and Yusof R., "Position-based Routing Protocols of Vehicular Ad Hoc Networks & Applicability in Typical Road Situation", *Life Science Journal,* Vol. 10, No. 4, 2013.
[34] Qureshi K. N. and Abdullah A.H., "Localization-Based System Challenges in Vehicular Ad Hoc Networks: Survey", *Smart Computing Review,* Vol. 4, No. 6, pp. 515-528, 2014.
[35] Qureshi K. N. andAbdullah A. H., "A survey on intelligent transportation systems", *Middle-East Journal of Scientific Research,* Vol. 15, No. 5, pp. 629-642, 2013.

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