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Vehicular Ad-Hoc Networks: A Comprehensive Survey on Routing schemes

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Abstract
This paper describes the concept of Vehicle Ad-Hoc networks which has been made viable by the convergence of wireless communications and digital electronics in transportation models. A Vehicle Ad-hoc Networks (VANETs) consists of Road side unit (RSU) and vehicular system - a path to maximum connectivity. They provide access to multiple systems and utilize transportations system for communication. VANET's are undergoing rapid changes due to the modernize usage of technology in safer, efficient transportation and used for numerous applications. In order to provide the detailed study and better understanding about the technical issues of VANETs, this paper presents a detailed study on recent advances and open research issues in VANETs. First, the state-of-the-art of various routing protocols and algorithms are explored, a review of factors influencing the design of VANETs is provided and analyzed to identify a better solutions for communications. Then, the routing model for vehicular system is outlined, and the algorithms and protocols developed for each layer in the literature are explored. Finally, wide research issues in the industrial standards and current application of the VANETs is discussed, with an objective to spark new research interests in this field.

Keywords
VANETs, Connectivity, Transportation, Research, Routing Protocols, Security

I. Introduction

Currently, road traffic activities are one of the foremost significant periodical routines globally. Passenger and cargo transportation are important for human growth. Therefore, novel betterments like improved safety mechanisms, greener fuels, etc., on this field are attained daily.

Driving is one among the most incident factors of traffic safety, thus there's a clear require to do it securer. Despite in part automating this job, trusted driver data provisioning is crucial to reach this objective. An exact weather report or earlier alertness of forthcoming risks (e.g. bottlenecks, accidents) will be extremely utilizable for drivers. For this reason, a novel form of information technology named VANET (Vehicular Ad-hoc NETwork) is being produced.

VANETs are a subset of MANETs (Mobile Ad-hoc NETworks) in which communication nodes are chiefly vehicles. Since, this type of network must handle with a large number of highly mobile nodes, finally spread in several roads. In VANETs, vehicles will communicate one another (V2V, Vehicle-to-Vehicle communications). Furthermore, they can link to an infrastructure (V2I, Vehicle-to-Infrastructure) to obtain several services. This infrastructure is supposed to be placed on the roads.

Data exchanged through VANETs frequently do an essential function in traffic safety. For instance, in the eCall plan, an emergency call is established when in-vehicle sensors find that an accident has taken place (eSafetySupport - 2007). Such information should be exact and honest, as lives may rely on this application. In this manner, very strict security necessities are to be reached. Furthermore, privacy of drivers must be preserved, i.e., a vehicle shouldn't be easily chased by unauthorized persons. Fulfilling all these security demands have result in a large amount of investigate parts, every one handling several views of data security and privacy.

This chapter provides an outline of the present condition of routing problems through VANETs. For this reason, several routing protocol for communication use are distinguished and studied. Furthermore, routing necessities and possible threat in routing are examined.

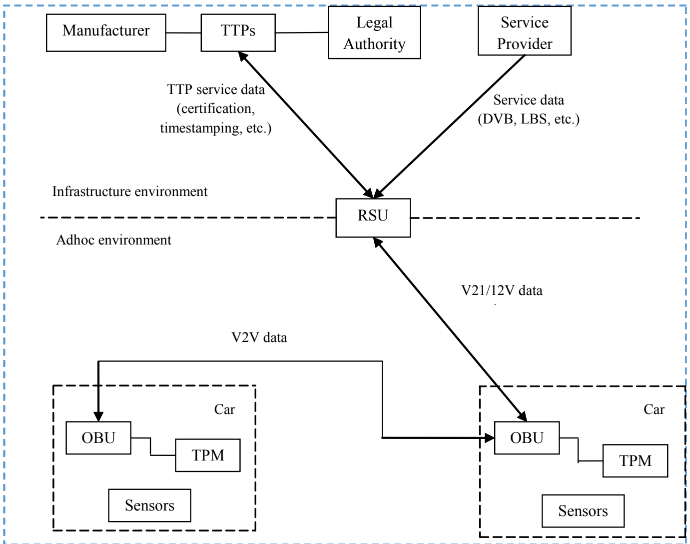

Fig. 1: Simplified VANET Model

At last, the routing alterations to attain improved performance and some other needs would be studied. In this manner, the reader can recognize the present developments in data routing suggested to clear not solely traditional troubles (e.g. data confidentiality) however additionally several context-specific ones (e.g. eviction of misbehaving vehicles from the VANET).

Chapter organization: In section II, a typical VANET model is described, addressing the present entities and their relationships. Various communication forms are distinguished additionally. Section III demonstrates the several related works on routing necessities that have to be attained in VANETs and especially in every communication model. Section IV examines the essential design factors to attain the routing necessities earlier presented whereas Section V delineates the basic problems of VANETs. At last, section VI summarizes the major conclusions and lessons acquired from this study and shows future investigate directions on VANET routing.

II. Vanet Model Overview

There are numerous entities included in a VANET resolution and exploitation. Although the wide bulk of VANET nodes are vehicles, there're further entities which do fundamental processes in these networks. Furthermore, they may communicate with one another in numerous different ways. In this section, the most general entities which seem in VANETs are described first. In the second part, the several VANET settings which could be seen among vehicles, and among vehicles and the remaining entities are analysed.

Common VANET entities

Various other entities are normally supposed to be in VANETs. To realize the internals and corresponding security problems of these networks, it's essential to study such entities and their relationships. Figure 1 presents the regular VANET strategy.

As given in figure 1, two different environments are usually taken in VANETs:

- **Infrastructure environment:** In this part of the network, entities may be enduringly interlinked. It's chiefly composed by those entities that handle the traffic or provide an outside servicing. In one side, producers are typically taken inside the VANET model. Since a part of the constructing procedure, they distinguish individually every vehicle. In opposite side, the legal authority usually exists in VANET models. Despite the various rules on every country, it's normally referred to two important duties such as, vehicle registration and offence reporting. Each vehicle in an administrative area must get recorded when constructed. The result of this process is, the authority releases a license plate. Alternatively, it too processes traffic reports and fines. Trusted Third Parties (TTP) are additionally there in this environment. They provide several functions such as credential management or time-stamping. Both producers and the authority are corresponding to TTPs since they finally require their functions (for instance, for releasing electronic credentials). Service providers are too taken in VANETs. They provide services which could be acquired over the VANET. Location-Based Services (LBS) or Digital Video Broadcasting (DVB) are the two examples of this services.
- **Ad-hoc environment:** In this part of the network, sporadic (ad-hoc) communications are made from vehicles. From the VANET viewpoint, they're provided with three different devices. First Of All, they're provided with a communication unit (OBU, On-Board Unit) that permits Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I, I2V) communications. Alternatively, they include a set of sensors to evaluate their individual position (e.g. fuel consumption) and its environment (e.g. slippery road, safety distance). These sensorial data may be distributed with other vehicles to raise their consciousness and better road safety. At last, a Trusted Platform Module (TPM) is frequently raised on vehicles. These devices are particularly concerning for security reasons, as they provide trusted storage and calculation. They commonly contain a honest internal clock and are assumed to be tamper-resistant or at least tamper-evident (Papadimitratos et al. - 2007). In this manner, sensitive information (e.g. user credentials or pre-crash information) could be faithfully stored.

As referred earlier, VANETs as communications network enforce various specific necessities. Vehicles travel at a comparatively higher speed and, then again, the higher amount of vehicles existing in a road may result in a huge network. Therefore, a specified communication standard, named as Dedicated Short Range Communications (DSRC) is produced to handle with such necessities (Armstrong Consulting Inc. - 2009). This standard delineates that there would be some communications devices placed by the roads, known as Road-Side Units (RSU). In this manner, RSUs turn into gateways between the infrastructure and vehicles and contrariwise.

VANET settings

Various applications are permitted by VANETs, chiefly hitting road safety. In this kind of application, messages exchanged through VANETs have various nature and reason. By considering this, four different communication models are distinguished:

V2V warning propagation: There're situations in which it's essential to transmit a message to a particular vehicle or a group of them. For instance, when an accident is found, a cautionary message must be broadcast to incoming vehicles to enhance traffic safety. Then again, if an emergency public vehicle is coming, a message must be transmitted for leading vehicles. In this manner, it will be better for the emergency vehicle to get a clear way. In all these cases, a routing protocol is then required to forward that message to the destination.

V2V group communication: In this pattern, solely vehicles having some characteristics may take part in the communication. These characteristics could be static (e.g. vehicles of the identical enterprise) or dynamic (e.g. vehicles on the identical region in a time interval).

V2V beaconing: Beacon messages are transmitted sporadically to nearby vehicles. They comprise the current speed, heading, braking use, etc. of the sender vehicle. These messages are utilizable to raise neighbor consciousness. Beacons are just transmitted to 1-hop communicating vehicles, i.e. they aren't forwarded. Actually, they're helpful for routing protocols, as they permit vehicles to find the easiest neighbor to route a message.

I2V/V2I warning: These messages are transmitted either by the infrastructure (over RSUs) or a vehicle when a possible danger is noticed. They are usable for raising road safety. For instance, a warning should be transmitted by the infrastructure to vehicles approaches to an intersection when a possible collision may occur.

III. Related Works

Naumov and Gross [7] offer a position-based routing scheme that is designed specifically for inter-vehicle communication in a city and/or highway environment. They introduce a framework called Connectivity-Aware Routing (CAR). The CAR protocol comprises of four main parts, namely, destination location and path discovery, data packet forwarding along the found path, path maintenance with the help of guards and error recovery. It employs an adaptive beaconing mechanism where the beaconing interval is modified corresponding to the number of the registered nearby neighbors. When a node forwards a data packet, it resets the timer for transmitting the next beacon, whereas data packets carry beacon-equivalent reports. Guard concept is introduced to catch key components of a path. There are two kinds of guards,

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standing guards and traveling guards.

A standing guard symbolizes temporary state information that is united to a geographical area, instead of to a specific node. A traveling guard contains also a velocity vector, additionally to the guarded position and radius. Each node that receives a traveling guard, records the time when the guard was received. Traveling guards permit the information carried by the guard to travel with a certain speed along the road. To find a destination and a path to it, CAR utilizes Preferred Group Broadcasting (PGB) in data dissemination mode. PGB optimizes broadcasts specifically for VANETs and shrinks control messages overhead by rejecting redundant transmissions.

Data packets are forwarded in a greedy manner toward the destination throughout the set of anchor points employing the Advanced Greedy Forwarding (AGF) algorithm. AGF is utilized to forward the route reply back to the source via the recorded anchor points. Timeout algorithm with packet buffering and an active waiting cycle is used to tackle temporary gaps. A long-term disconnection recovery algorithm ought to be invoked when a simple timeout approach failed. To prevent several simultaneous answers from more than one new neighbor, jitter is introduced before replying back. CAR is suitable to find connected paths between source and destination pairs. It maximizes the possibility of successful delivery. It does not involve expensive computations and successfully improves protocol performance. The limitation is overhead is created by path discovery phase.

Lochert et al. [5] introduce an approach that deal with the challenges of city scenarios where obstacles often block radio signals. They introduce Greedy Perimeter Coordinator Routing (GPCR) that is a position-based routing protocol. The main idea of GPCR is to require advantage of the fact that streets and junctions form a natural planar graph, while not using any global or external information like a static street map. GPCR comprises of two parts, namely, a restricted greedy forwarding procedure that accustomed to forward a data packet towards the destination and a repair strategy that avoids utilizing graph planarization by making routing decision according to streets and junctions rather than individual nodes and their connectivity. The repair strategy includes two steps: first, on every junction it has to be determined which street the packet ought to follow next and secondly, in between junctions greedy routing to the next junction, is utilized.

Two alternative approaches are used to find a node on a junction. i) every node regularly transmits beacon messages including the position of the node that is sending the beacon also the position of all of its neighbors. By observing the beacon messages, for every neighbor, a node has the information like its position and the position and presence of the neighbor's neighbors. ii) doesn't need special beacon messages and every node calculates the correlation coefficient with regard to the position of its neighbors. This method doesn't require external information like a static street map for routing. The problem occurs in greedy approach is the packet gets stuck in a local optimum.

Jerbi et al. [3] urge a scheme that finds robust and optimal routes within urban environments. A novel geographic routing protocol, GyTAR (improved Greedy Traffic Aware Routing) is presented here. GyTAR strategy is structured into three methods: a completely decentralized scheme for the estimation of the vehicular traffic density in city-roads, a mechanism for the dynamic selection of the intersections through which packets are forwarded to reach their destination and an improved greedy forwarding mechanism between two intersections. GyTAR includes a completely decentralized mechanism for the estimation of vehicular traffic density in city-roads. The decentralized approach relies on the traffic information exchanged, updated and preserved among vehicles in the roads and rotates around the core idea of information relaying between groups of vehicles instead of individual vehicles. The vehicles are arranged into location-based groups. Local density information is calculated by each group leader and relayed between groups employing Cell Density Packet (CDP).

GyTAR adopts an anchor-based routing approach with street awareness. Hence, data packets are routed between vehicles, following the street map topology. A recovery strategy based on carry- and-forward is needed aside from the improved greedy routing strategy to find the risk that remains when a packet gets stuck in a local optimum. GyTAR efficiently relay data in the network and well-suited for on-vehicle chat or gaming. The longer delays might cause more errors while estimating the number of vehicles within some cells.

Zhao and Cao [15] make a proposal to forward the packet to the best road with the lowest data-delivery delay. They present several vehicle-assisted data delivery (VADD) protocols. VADD relies on the idea of carry and forward where nodes carry the packet when routes don't exist and forward the packet to the new receiver that moves into its vicinity. VADD has three packet modes based on the location of the packet carrier, namely, Intersection, StraightWay and Destination. By switching between these packet modes, the packet carrier selects the best packet-forwarding path. Zhao and Cao propose a stochastic model to calculate the data-delivery delay, which is utilized to choose the next road (intersection). In intersection mode, two different forwarding protocols Location First Probe (L-VADD) and Direction First Probe (D-VADD) are introduced. L-VADD tries to find the closest contact toward that direction as the next hop in the preferred forwarding direction of a packet. D-VADD ensures that everyone agrees on the priority order by letting the vehicle moving toward the desired packet-forwarding direction carry the packet.

Hybrid Probe (H-VADD) is designed to defeat the limitations of L-VADD and D-VADD. H-VADD inherits the advantage of using the shortest forwarding path in L-VADD when there's no routing loop and employs D-VADD to handle the routing loop problem of L-VADD. But in data forwarding in the StraightWay mode, a packet switches to the Destination mode when its distance to the destination is below a predefined threshold. The location of the destination becomes the target location and GPSR is used to deliver the packet to the final destination. This offers better performance and packet-delivery ratio. This has increased query delay and computational complexity. Also space limitation occurs.

Yang et al. [14] introduce a framework for adaptively selecting routes based on statistical and real-time data to avoid the influence of inaccurate statistical density data. They propose adaptive connectivity aware routing (ACAR) protocol. First, assume every vehicle can get its current location and they are established with a pre-loaded digital map, such as the commercial map offered by MapMechanics, which not only describes the land attributes like road topology and traffic light period but also is accompanied by traffic statistics like traffic density and average velocity at a certain time of the day. It propose the cell-based connectivity model for vehicles moving within road segments and also the cluster-based connectivity model for vehicles clustered around intersections. Then, it mixes those two models and presents the connectivity model for a road segment. To model the path loss between two nodes, two cases have to be taken into account, the line-of-sight

(LOS) and non-line-of-sight (NLOS).
The ACAR protocol includes two important elements, correctly choosing an optimal route consisting of road segments with the better estimated transmission quality and efficiently forwarding packets hop-by-hop through each road segment in the chosen route. To reject the impact of inaccurate statistical density data, it developed an adaptive route selection algorithm that gathers real-time density information on-the-fly whereas forwarding packets. In each road segment in the chosen route, the next hop is selected utilizing a metric that minimizes the packet error rate (PER) of the whole route based on measured PERs at each node. Additionally, carry-and-forward mechanism is adopted to deal frequent network partitions in VANETs. Through GPS, each vehicle can get its real-time location and velocity. This information is then broadcasted periodically along with its id to neighbors. Each node preserves a table of its neighbors information including locations, velocities and ids. To avoid out-of-date neighbors, it implements the neighbor location prediction (NLP) algorithm. It has higher data delivery ratio, throughput and lower networking delay. The drawback is lower performance and quality.
Menouar et al. [6] propose a concept for VANETs to improve its performances by exploiting vehicles movements patterns. They present a new design of the Movement Prediction based Routing (MOPR) concept. Optimized Link State Routing (OLSR) is selected as the proactive routing protocol for the MOPR implementation. OLSR for mobile ad-hoc networks has the feature to build a subgraph connecting all nodes in the network in order to cut back the overhead of broadcast control message while reaching all nodes in the network. The route discovery is done through the exchanging of control messages named Topology Control (TC) messages that permit each node in the network to have a global view on the whole network topology, then to build its routing table. OLSR works in two steps: MultiPoint Relay (MPR) nodes selection and routing routes construction. In the first step, each node in the network chooses as MPRs the shortest set of one-hop neighbors that covers all its two-hop neighbors. In the second step, each node communicates through the TC messages the list of its one-hop neighbor nodes. MOPR-based MPRs selection is done by two ways, namely, MPRs are taken based on one-hop LS information and MPRs are selected based on both one-hop and two-hop Link State (LS) information. The advantage is, it has a better stability and ensures a long connection lifetime. However it has routing overhead caused by the routing protocol.
Lee et al. [4] introduce a framework that improves the packet delivery ratio with minimum modification for routing in Vehicular Ad Hoc Networks (VANET). They propose GpsrJ+ which is a position-based routing protocol. It comprises of two modes, recovery mode and greedy mode. As obstacles block radio signals, packets may only be greedily forwarded along road segments as close to the destination as possible. So, the major directional decisions are made at junctions. In the recovery mode, packets are greedily backtracked along the perimeter of roads. GpsrJ+ lets nodes that have junction nodes as their neighbors calculate on which road segment its junction nodes would forward packets onto and thus may safely overpass them if not needed. The prediction relies on the fact that the forwarding node is aware of all road segments on which its junction neighbors have neighbors. The road segment, on which neighbor nodes are, is extracted from the urban map utilizing the neighbor's location. At Last, nodes incorporate this information in the modified beacon and broadcast it to the forwarding node that carries out the prediction. It only forwards packets to nodes in road junctions if the forwarding decision changes with regard to the general forwarding direction of the recovery mode; or else, packets are permitted to progress across the intersection with the maximum progress, preserving the protocol many hops.
GpsrJ+ uses the fact that a node can define whether it should forward to its furthest neighbor or junction neighbor by finding the road segment. This method betters the recovery strategy and delivery ratio. Still this must be optimized by considering junction nodes over more than one road segment. This isn't sufficient to define a road segment. There is increase in failed hops when compared to Greedy Perimeter Coordinator Routing (GPCR).
Nzouonta et al. [8] urges a method to create road-based paths consisting of successions of road intersections that have high probability, network connectivity among them. They propose a class of routing protocols called road-based utilizing vehicular traffic (RBVT) routing. Then it present two RBVT protocols, a reactive protocol RBVT-R and a proactive protocol RBVT-P. RBVT-R discovers routes on require and reports them back to the source that includes them in the packet headers. RBVT-P generates periodical connectivity packets (CPs) that visit connected road segments and store the graph that they form. This graph is then spread to all nodes in the network and is employed to calculate the shortest paths to destinations. The RBVT protocols assume that each vehicle is equipped with a GPS receiver, digital maps and a navigation system that maps GPS positions on roads. Vehicles exchange packets utilizing short-range wireless interfaces like IEEE 802.11 and dedicated short-range communication (DSRC). To reduce the effects of the broadcast storm problem, RBVT-R uses an improved flooding mechanism. It employs a dynamic route updating technique at the source to maintain the route consistent with the current road segment positions of the source and the destination nodes..
Tian et al. [13] urges a framework that develops a versatile communication platform for inter-vehicle communications based on self organizing, MANETs. They propose a spatially aware packet routing approach to predict permanent topology holes made by spatial constraints and avoid them fully. A spatial model delineates the spatial environment where mobile hosts are located in. The purpose of a spatial model is to offer common high-level abstractions of spatial objects and their relationships. To construct a spatial model, the relevant spatial information has to be extracted form available Geographic Information Systems (GIS), like digital road maps used in vehicle navigation systems. It develops a parser for the Geographic Data Files (GDF), the European standard that is utilized to describe and transfer road networks and road related data. Employing this parser, road topology information can be extracted from a digital road map in GDF format. This spatial model is constructed based on the extracted topology information. An appropriate partition and level of detail can be selected to reduce the storage capacity requirements of the spatial model.
Then it describes the Spatially Aware Routing (SAR) algorithms, which consists of Geographic Source Routes (GSR) and the GSR-based packet forwarding. The weight function dependent on the application, such as geographic length or the average travel time. Rather than forwarding packets to the neighbor that is geographically closest to the destination, in SAR each forwarding vehicle maps the positions of its neighbors into the graph form and selects the neighbor with the shortest path along the GSR to the destination as the next hop. With this method, a packet will move successively closer to the destination along the GSR from

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one vertex to the next vertex. SAR can effectively improve routing performance. But the drawback is storage and communication overhead occurs. It'll not guarantee that forwarding vehicles can always find a suitable neighbor on the GSR.

Rondinone and Gozalvez [10] present an approach to estimate the multi-hop connectivity of road segments. They introduce DiRCoD, a novel Distributed and Real Time Communications Road Connectivity Discovery mechanism designed to better the operation of routing protocols by dynamically estimating the multi-hop forwarding capabilities of road segments. DiRCoD has been designed to help routing protocols in choosing the next forwarding road segment by directly determining its multi-hop connectivity. A road segment is considered to be connected if a set of vehicles offers the capability to transmit packets from one end to the other through multi-hop communications. A direct estimation of multi-hop connectivity in road segments can be attained with lower signaling overhead compared to methods utilizing road traffic density assessments.

To help routing decisions, DiRCoD offers a measure of the multi-hop connectivity or the availableness of vehicles capable to forward the packet through multi-hop communications. DiRCoD mechanism exploits the broadcast beacon message also referred as Cooperative Awareness Message (CAM) to estimate the multi-hop connectivity of every road segment. To calculate the multi-hop connectivity of a road segment, DIRCoD assumes the use of GPS systems to recover vehicles' positions and of digital maps to map them on a given road network. It also divides the segment into different sections of length equal to the vehicles' communications range on Service Channel 1 (SCH1). To estimate the multi-hop connectivity or virtual distance to a certain intersection, DiRCoD introduces a connectivity field that is added to the CAM transmitted by vehicles. The connectivity field initially shows the road section the transmitting vehicle is placed at. If a vehicle is alert to the presence of vehicles that are located at sections closer to the multi-hop target intersection or in the intersection itself, the connectivity field will point those road sections or the target intersection zone. DIRCoD's performance increases and implementation cost is reduced. Still it has communication overhead.

Seet et al. [12] offer a method that promising routing strategy for inter-vehicular communication systems (IVCS). They propose A-STAR, a new position-based routing scheme called Anchor-based Street and Traffic Aware Routing, designed specifically for IVCS in a city environment. A-STAR adopts the anchor-based routing approach with street awareness to delineate more exactly the use of street map information in the routing scheme for anchor path computation. It calculates the anchor paths with traffic awareness that refers to vehicular traffic, including cars, buses and other roadway vehicles. The street map in use by the vehicle is supposed to be loaded with bus route information. An anchor path can be calculated using Dijkstra's least-weight path algorithm. For the map with pre-configured information, is named as statistically rated map. A better weight assignment scheme is dynamically monitors and assigns weight to a street based on its latest traffic condition, which can offer higher quality of anchor computation. This information could then be utilized to re-compute the weight of every street on the map, (eg.) more vehicles, less weight assigned and vice-versa. Such a map with re-configurable information is called a dynamically rated map.

A more efficient recovery strategy is proposed for A-STAR, i.e., a new anchor path is calculated from the local maximum to which the packet is routed. The packet is salvaged by traversing the new anchor path. To prevent other packets from traversing through the same void area and also the street at which local maximum occurred is marked as 'out of service' temporarily and this information is distributed to the network by piggybacking them onto the packets to be recovered. Nodes getting these packets update their local map with the 'out of service' information prior to making their forwarding decision. The 'out of service' streets aren't utilized for anchor computation or re-computation during the 'out of service' duration and they resume 'operational' after the time out duration. A maximum threshold value is also determined to limit the number of times a packet can be recovered to avoid the perpetual sending of outdated data and bandwidth wastage. M-Grid mobility model is used to delineate the movement of vehicular nodes in a city area. M-Grid is a variant of the Manhattan model that models the vehicular movement in a typical metropolis where streets are set out on a grid pattern. The benefit of this method is improvement in packet delivery. The disadvantage is it has higher delay when compared to GSR and there is a need for improved performance with vehicular nodes.

Ros et al. [11] urges a framework suitable for a wide range of vehicular scenarios. They present the Acknowledged Broadcast from Static to highly Mobile (ABSM) protocol, a fully-distributed adaptive algorithm. ABSM is localized also based on applying the connected dominating set (CDS) and neighbor elimination scheme (NES) concepts on the currently obtainable neighborhood information. ABSM assumes ideal communication radios to calculate the network connectivity and therefore apply the CDS/NES techniques. Since real communication links are far from ideal, the protocol makes use of broadcast acknowledgments to ensure the reception of the message or retransmit it. A message is acknowledged during its whole lifetime. At termination, it's removed from the vehicle's buffer and no more acknowledgments are issued. Vehicles are assumed to be equipped with GPS receivers. Periodic beacon messages are exchanged to update the vehicles' local topology knowledge that comprises sender's position to compute a CDS backbone after each beacon message round. ABSM saves the redundant transmissions because the beacons contain the acknowledgment of the message and therefore the newly discovered neighbors are not covered again.

In order to minimize the number of message transmissions while preserving reliability, ABSM creates a broadcast delivery backbone based on a CDS heuristic. Vehicles in the CDS select a shorter timeout, to give them higher priority to retransmit. In addition, NES is employed to further decrease the number of redundant transmissions. This method is appropriate for vehicular scenarios like urban layouts with intersections. This guarantees ultimate scalability. The flaws due to unexpected situations still appear. Also has lower performance due to the higher fading. Sometime the reliability of ABSM algorithms drops.

IV. Important Design Factors

The crucial factors that affect the design Vehicular Ad-Hoc Networks is discussed below as:

Radio Techniques

The improvements of communications model and also the introduction MIMO (multi input and multi output) system is taken as important problem for the design of VANETs. To enhance capability and flexibleness of wireless systems in modern years, various communication measures are delineated.

Mobility

The improvements of wireless communications lead to the design of mobile computing. Mobile communication is important partner and a crucial factor for the design of VANETs based network. As ad hoc network permits communication routing employing the end-user devices, the network topology and connectivity rely on the movement of users. This enforces severe difficulty for the VANETs based network communication. But Ad-hoc network may be related with the VANETs network and therefore permit a compatible communication.

Scalability

Scalability is a crucial necessity for the design of compact VANETs. Without the usage of this characteristic, the network performance degrades considerably as the network size enlarges. For instance, routing protocols can't be allotted independency to obtain a trusted routing path, transport protocols might drop connections and MAC protocols might get considerable throughput and output reduction with maximum packet loss. To guarantee the scalability in VANETs, all protocols from the MAC layer to the application layer require being scalable.

Dedicated routing and configuration

VANETs are chiefly attained popularity because of its backbone based designed. Therefore the structure must be effective to permit connectivity between several networks and must offer suitable routing configuration for the connected system. It must be effective track any failure if happened during the communication process. VANETs include mesh routers for the functionalities related with dedicated routing. Therefore, the load on end-user devices is considerably reduced that may be utilized for lower energy utilization and high-end application capableness among mobile end-users. Furthermore, the end-user necessities are restricted that reduces the cost of devices that might employed in VANETs.

Security

Though numerous security strategies are suggested for wireless LANs in previous years, however almost of them can't be used directly applicable for VANETs. For example, there's no centralized reliable authority that could be delineated to propagate a public key in VANETs because of the distributed system architecture. The present security strategies suggested for ad hoc networks may be taken for VANETs. But, most of the security resolutions for ad hoc networks are even not developed sufficient to be implemented practically. Furthermore, the various network architectures between VANETs and ad hoc networks commonly provide an answer for ad hoc networks inefficient in WMNs.

V. Fundamental Research Issues

VANETs is suffered by numerous components like network architecture, network topology, network node density, traffic pattern, number of channels utilized for every node, trans-mission power level and node mobility that puts down the performance based quality of the system. An appropriate relationship between network capability and also the above components offers delineate steps to design protocol for effective communication.

A. Guideline to improve the capacity

A node must solely communicate with nearby nodes. To implement this thought, two main strategies are offered in:

- Throughput capacity can be raised by deploying relaying nodes.
- Nodes require to be classified into clusters.
- Communications of a node with other node that isn't close should be conducted over relaying nodes or clusters.
- Traffic in all nodes is transmitted to a single gate-way that isn't the case in VANETs. Therefore bettering the performance of the system.

B. Routing

Based on present MAC and transport protocols, network performance isn't scalable with the design of effective routing protocol which takes the available number of efficient nodes or the number of hops in a network. This difficulty might be noted chiefly throughout the network capacity improvement through utilizing multiple channels/radios per node or expanding wireless radios with higher transmission speed. But, these approaches don't really offer improved routing protocol that might guarantee the scalability of VANETs, since resource usage isn't truly bettered. Thus, for efficient communication, it's important to produce new routing and transport protocols for VANETs.

C. Security

VANETs are general to security attacks in different protocol layers. Existing security approaches can be efficient to a specific attack in a particular protocol layer. But, there still presents a require for an optimized mechanism which may avoid or counter attacks in all protocol layers. Optimization could be utilized for self-organization and self-configuration capacity as a preferred characteristic in VANETs. Still, current VANETs may just partly recognize this purpose. Moreover, existing VANETs even have extremely restricted capacities of mixing heterogeneous wireless networks, because of the trouble in constructing multiple wireless interfaces and also the related gateway/bridge functions within the same mesh router. Efficient security measure is to be designed to deal multi framework difficulty.

VI. Conclusion

Thus VANETs can be designed based on existing technologies, field trials but existing VANETSs is still proven to be far below expectations in consideration to performance. VANETs can be considered as a promising solution for wireless environments in order to transfer information among the vehicles with the best solutions. Road side units have minimal mobility and form the VANET backbone for Mobile vehicles/clients. In order to further improve the flexibility of VANETs networking, a back bone aware network is usually equipped with multiple wireless interfaces built on either the same or different wireless access technologies. As explained throughout this article, there exist research problems. However the most important and urgent ones are the Routing Protocols and the security. In future, identification of better routing protocol with reduced time delay can be considered for higher scalability and performance. In efficient road side unit some time reduces the overall performance of the system. In spite of above discussed open research problems, we believe that VANETs will be one of the most promising technologies for next-generation wireless networking.

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