Chapter 2

Literature Review

2.1 INTRODUCTION

VANET (Vehicular Ad hoc Network) is a special sub class of MANET, where the vehicles are act as nodes. Unlike MANET the topology of VANET is highly dynamic and each node is acting as a router and node for sending and receiving messages within its range. Also vehicles are communicating with other fixed network infrastructure called RSU (Road Side Units).

The dynamic behaviour of vehicles makes routing and other services more challengeable. There are many routing protocols to obtain the route information in wireless Ad hoc networks. These are broadly classified into two categories; proactive and reactive. Of the two different categories, proactive maintains complete information about nodes and is table driven. Reactive protocols are known as on-demand routing protocols, which calculates routes for destination and takes more time to find a route.

This section attempts on investigations the different routing protocols such as AODV, Fish Eye State routing and DYMO. Also, the QoS constraints on VANET middleware, Handoff issues and media streaming metrics are discussed.

2.2 QOS ROUTING IN VANET

2.2.1 AD HOC ON DEMAND DISTANCE VECTOR ROUTING

Ad hoc On Demand Distance Vector routing protocol (AODV) (Paul et.al, 2012) is a reactive protocol used for -establishing route between nodes as on-demand basis. It supports both unicast and multicast routing. The special characteristic of AODV protocol is maintaining a Destination Sequence Number to provide up-to-date path. Also, avoids route redundancy and consumes only less usage of memory. The disadvantage of AODV is initial time taken for establishing route and multipath reply.
2.2.2 FISH EYE STATE ROUTING (FSR)

Fish Eye State Routing (Paul et.al, 2012) is a proactive routing protocol where the node information’s are maintained in a table. It exchanges only the partial routing information with its neighbours which reduces routing overhead. On node failure the information will not be reflected in the routing table.

2.2.3 DYNAMIC MANET ON DEMAND ROUTING (DYMO)

Dynamic MANET On-demand (DYMO) (Sommer, C., & Dressler, F 2007) is both proactive and reactive routing protocol which is built upon AODV.

![Routing information in AODV and DYMO](image)

DYMO discover path information about target node as well as all intermediate nodes of the path. The source node broadcasts special route request to and each request keeps an ordered list of all intermediate nodes and used for sending the reply message as show in Fig. 2.1.

2.2.4 ISSUES IN VANET ROUTING

As the medium access control layer of DSRC is highly dependent on IEEE 802.11 distributed coordination function (DCF) (Bianchi, 2000), the random channel access based MAC cannot provide guaranteed QoS. Hence it is much vital to understand the quantitative performance of DSRC, in order to design or incorporate decisions on adoption, control, adaptation, and improvement. This chapter proposes an analytical model to evaluate the DSRC-based inter vehicle communication. The investigation had much impact on the channel access parameters associated with the different services such as arbitration inter-frame space (AIFS), contention window (CW) (Bianchi, 2000). The proposed model AQVA, suggests successful message
delivery ratio and minimal channel service delay for broadcast messages while supports multi route messaging method for conference, media streaming services. The system works as an adaptive mechanism to inspect and provide support for the suitability of DSRC with respect to QoS over AODV (Jaap, Bechler, & Wolf, 2005; Perkins & Royer, 1999) in inter-vehicle and road safety applications.

VANET classifies routing protocols in five different (Garbinato, Miranda, & Rodrigues, 2009): Topology, Position, Cluster, Geocast, and Broadcast methods. Each method has its own advantages and disadvantages, which is the primary in discussion this section. Advantage of proactive routing protocols is that it does not adopt any route discovery mechanism since destination route is stored in the background, while its disadvantage is that it provides low latency for real time service applications, as well leads to maintenance of unused data paths, which uses the available bandwidth. FSR (Fisheye State Routing) (Pei, Gerla, & Chen, 2000), TORA (Park & Corson, 1997) belong to this category.

Several studies have been published comparing the performance of routing protocols using different mobility models or performance metrics (Table 2.1). One of the first comprehensive studies was done within the framework of the City Urban scenario (Jaap et al., 2005). Work by (S. R. Das, Belding-Royer, & Perkins, 2003) compared a larger number of VANET protocols. However, link level details and MAC interference are not modelled. Study by (Mahajan, Potnis, Gopalan, & Wang, 2006) compared the same protocols as the work by (Haerri, Filali, & Bonnet, 2006) yet for specific scenarios as the authors understood that random mobility would not correctly model realistic network behaviours, and consequently the performance of the protocols tested.

The interest in realistic mobility models for VANETs had induced large number of survey studies to be carried out to understand and evaluate the performance of VANETs in urban traffic or highway traffic conditions (Niu, Yao, Ni, & Song, 2007; Park & Corson, 1997). The performance results show that these models generate urban specific spatial and temporal dependencies, where the real mobility parameters differ from the initial and controlled ones. Performance comparison had become unfair and arguable.
<table>
<thead>
<tr>
<th>Routing methods</th>
<th>Protocol</th>
<th>Issues</th>
<th>Advantages</th>
<th>Application/ Service</th>
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</thead>
<tbody>
<tr>
<td>Proactive</td>
<td>FishEye (Pei et al., 2000) TORA (Park &amp; Corson, 1997)</td>
<td>[a] As the mobility increases route to remote destination become less accurate. [b] If the target node lies out of scope of source node then route discovery fails. [c] It gives a route to all the nodes in the network, but the maintenance of all these routes is difficult in VANET.</td>
<td>Routing table entries for a given destination are updated frequently</td>
<td>[a] safety messages and video/audio signals</td>
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<tr>
<td>Geocast</td>
<td>DG-CASTOR (Kohli, Kaur, &amp; Bindra, 2010), DRG (Mohapatra &amp; Krishnamurthy, 2005)</td>
<td>[a] Network partitioning and also unfavourable [b] Neighbours, which may hinder the proper forwarding of messages.</td>
<td>Defines a forwarding zone to control flooding of packets to reduce message overhead and network congestion caused by flooding packets everywhere.</td>
<td>[a] Road Side information Vehicle-to vehicle message transfer.</td>
</tr>
<tr>
<td>Position based/ Geocast</td>
<td>GS (Mohapatra &amp; Krishnamurthy, 2005), GPSR (Kumar, Narayan, &amp; Kumar, 2011)</td>
<td>[a] since GPSR does not consider vehicle density of streets it is not efficient for VANET. [b] Introduce long delays due to greater no. of hop counts. [c] routing loops causes Dissemination of messages to long path.</td>
<td>Success at higher packet loads and vehicle traffic densities.</td>
<td>[a] can be applied in static street map [b] location information about each node</td>
</tr>
<tr>
<td>Broadcast</td>
<td>BROADCOMM UMB (Jaap et al., 2005), V-TRADE (Niu et al., 2007)</td>
<td>Flooding packets within domain leads to congestion, packet loss and latency.</td>
<td>Overcome interference, packet collision and hidden node problems during message distribution in multi hop broadcast in UMB. Routing overheads are associated with selecting the next forwarding node in every hop</td>
<td>[a] traffic, weather, emergency, road conditions among vehicles [b] Advertisements, announcements.</td>
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Table 2.1. Routing scheme survey and analysis
In general, the survey summarizes that routing protocols of VANET needs improvement in (a) routing traffic load, (b) overall throughput, (c) end-to-end delay (d) control overhead (e) handoff and (f) session connectivity time.

2.3 MIDDLEWARE SUPPORT FOR MEDIA STREAMING IN VANET

2.3.1 NEED FOR MIDDLEWARE

Multiple technical challenges do exist to support VANET communication for providing safety and non-safety services. According to (Torrent Moreno et.al 2005) the main challenges are summarized as: (i) Due to high mobility of vehicles and traffic situations, node selection to forward a message is difficult (ii) Higher number of nodes creates channel congestion (iii) Fading issues when multiple nodes degrade the strength and quality of receiving signal.

(Boban, Misek, & Tonguz, 2008) pointed out the packet delivery ratio, end-to-end delay, and jitter and connection duration as challenging Quality of Service (QoS) parameters for communication. The main contributions of the authors are: (i) detailed analysis of QoS parameters for vehicular Ad hoc network (VANET) in both highway and urban environments. (ii) Analysing the connection duration of VANET scenarios and (iii) analysing the unnecessary delay and overhead in routing and applications.

2.3.2 VANET MIDDLEWARE

The various issues of VANET middleware (Senart, Bouroche, Cahill, & Weber, 2009) can be summarized as follows: integration of raw data, complexity in reasoning, dynamic sharing of data, communication delay constraints and other QoS issues. In this section, some of the VANET middleware approaches are discussed.

(Meier et.al 2005) proposed a real-time event based middleware for vehicular Ad hoc network called RT-STEAM. This is not relying on centralized server or lookup service for event handling. Proximity filters are introduced to handle events which belong to their geographical coverage. For traffic control application at junction, a V2I communication occurs where a vehicle can inform to the traffic controller about the arrival. So, traffic lights adapt with the situation at junctions to allow the vehicle depending on the passing vehicles. VMTL (Weiss, Gehlen, Lukas,
& Rokitansky, 2006) is a web service based middleware for vehicular applications. To achieve the high interoperability web services used as middleware framework and SOAP protocol is used for messaging purpose. For reasoning purpose RuleML language syntax have been defined. J2ME supported mobile devices are used for implementation and testing the vehicular application. Location tracking and tour data are considered as case study for realizing the performance of the middleware. The run time cost of middleware is greatly reduced and seems to be easy to use the application.

SCUDEWARE (Z. Wu et al., 2007) is a semantic and adaptive middleware for smart vehicles which contains three main components: virtual agents, semantic context management and adaptive service. The context data is built with ontology languages like Ontology Web Language (OWL). First order predicate is used for context reasoning with OWL-Lite semantics.

(Festag et al., 2008) proposed hybrid architecture that combines V2V and V2I communication for VANET applications. On Board Unit with direct sensors are used to collect the environmental information, process, interpret the situation and trigger warning messages. The driver’s behaviour with respect to road conditions at the time of accident are stored and authorized users can access this data for forensic analysis.

Publish subscribe middleware for VANET applications is proposed by (Caviglione, Ciaccio, & Gianuzzi, 2011), in which all the data and messages are represented in XML format and for data retrieval XQuery language is used. This middleware comprises with three main components: positioning, repository and notification services. The position of the vehicle and other related data are periodically sent to other vehicles with the help of stateful subscriptions.

**2.3.3 QOS MEDIA STREAMING IN VANET**

Various media streaming approaches for VANETs are classified (Hsieh & Wang, 2012) as shown in Figure 2.2. The authors reviewed these literatures and discussed their feasibility of media streaming to a group of nodes in urban VANETs. Based on the requirement of the thesis work, only hop by hop forwarding approaches are considered.
In SMUG (Streaming Media Urban Grid) a media stream is generated from a certain point (e.g. a roadside access point) and the stream is fed to SMUG-capable nodes and is distributed across a VANET (Soldo, Casetti, Chiasserini, & Chaparro, 2008). Here nodes are selected for forwarding and transmission and is done by TDMA scheme.

V3 (M. Guo, Ammar, & Zegura, 2005) provides a scheme to retrieve the scene of a certain area to an interested vehicle. And also the authors describes that the application scenario of V3 is that for a certain region on the road, the scene can be captured by one or more video sources, such as pre-deployed stations or vehicles passing by. Since each receiver has to establish a path, this may not be suitable for group communication.

2.4 HANDOFF IN VANET

To provide quality of service (QoS) with adaptable end-to-end delay, a middleware approach is proposed with support for handoff mechanisms. On analysis it has been identified that the current generation of commercial-off-the-shelf routing protocols lack in providing adequate QoS support and handoff brokerage in any changing, dynamic environments.
2.4.1 TIBCRPH

Traffic Infrastructure Based Cluster Routing Protocol with Handoff in VANET (TIBCRPH) (T. Wang & Wang, 2010) had proposed that it adopts the network traffic infrastructure and clusters the node in network with support over routing with Handoff capabilities. This approach adopts the vehicular density with its speed (mobility), distance between vehicles and time taken to cross between vehicles. Even though cluster analysis provides support in QoS but pro-active support to handoff does not exist as handoff metric analysis is not effective in implementation.

2.4.2 SIP

SIP (Roach, 2010) is a Session Initiation Protocol supported as a standard by IETF for invoking multiple sessions over a communication scenario. SIP had been implemented over VANET (Zhu, Niyato, Wang, Hossain, & In Kim, 2011) for maintaining a robust handoff over multiple intermediate nodes but this protocol does not claim to provide an efficient QoS mechanism.

(Musolesi & Mascolo, 2009) formulated on Context aware Adaptive Routing (CAR), which is a prediction based routing protocol with support over delay tolerant ad-hoc networks. A source node willing to send a message to a destination adopts Kalman Filter prediction with multi-criteria decision making theory to select next hop for message forwarding. Any node with high mobility is considered a good carrier of data since it follows multiple nodes during its transmission. Similarly the existing colocation pattern indicates that the node will meet the recipient again during next transmit.

2.4.3 ABSRP

The proposed set of services discussed in, a Service Discovery Approach for Vehicular Ad hoc networks (ABSRP) by (Mohandas, Nayak, Naik, & Goel, 2008) consider the policies for sharing network resources such as bandwidth, route capacity management along with service profile preferences, thus allowing to tailor the network services. Resource awareness services are layered under a set of communication services in a middleware architecture enabling communications among nodes belonging to distinct Ad hoc networks.
2.5 SUMMARY

The Literature study in this thesis provides investigations related to QoS in VANET which could address on the following: routing, middleware, media streaming and handoff. The different QoS parameters to support high mobility and communication constraints over VANET were discussed in terms of routing protocols, middleware, handoff and media streaming. Especially, in routing AODV, FSR and DYMO protocols have been analysed and identified the need of enhancement over these protocols for reliable communication. The study of different VANET middleware explores the issues in dynamic sharing of data and delay constraints.

Hence, it is observed that applying QoS metrics over VANET middleware greatly improve the quality in vehicular node communication. As the main objective of the thesis work focused on VANET communication over urban scenarios, hop by hop forwarding approaches have been studied to address the delay constraints in media streaming services. To address the handoff QoS issues in VANET, end-to-end delay metrics is studied with different protocols namely TIBCRPH, SIP and ABSRP.