ISSN No. 0976-5697
Volume 5, No. 7, September-October 2014
International Journal of Advanced Research in Computer Science
REVIEW ARTICLE
Available Online at www.ijarcs.info

A Review on Quality of Service (QoS) in Vehicular Ad Hoc Networks (VANETs)

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Abstract: When mobility of nodes further increases in a Mobile Ad Hoc Network (MANET) it gives rise to the concept of Vehicular Ad Hoc Network (VANET) which is an emerging new technology that integrates ad hoc network, wireless LAN (WLAN) and cellular technology to achieve intelligent inter-vehicle communications and improve road traffic safety and efficiency. In this paper we present a detail study of various QoS parameters of existing technologies for further improvements**.**

Keywords: QoS, MANET, VANET, Address Autoconfiguration, Dropped packets.

I. INTRODUCTION

The Quality of Service (QoS) refers to several related aspects of Telephony and Computer Networks that allow the transport of traffic with special requirements. In particular, much technology has been developed to allow computer networks to become as useful as telephone networks for audio conversations, as well as supporting new applications with even stricter service demands. Quality of service in the field of Telephony was first defined in 1994 in the ITU-T Recommendation E.800. This definition is very broad, listing six primary components: Support, Operability, Accessibility, Retainability, Integrity and Security.[1] A 1995 recommendation X.902 included a definition is the reference mode[2]. In 1998 the ITU published a document discussing QoS in the field of data networking. X.641 offers a means of developing or enhancing standards related to QoS and provide concepts and terminology that will assist in maintaining the consistency of related standards.[3]

Mobility adds complication to the QoS mechanisms. In Packet-Switched Networks the service quality is affected by several factors: stability of service, availability of service , delays, reliability, scalability, maintainability, etc.[4]

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Many things can happen to packets as they travel from origin to destination, resulting in the following problems as seen from the point of view of the sender and receiver:

Low throughput: Due to varying load from other users sharing the same network resources, the bit rate (the maximum throughput) that can be provided to a certain data stream may be too low for real time services if all data streams get the same scheduling priority.

Dropped packets: The routers might fail to deliver some packets if their data is corrupted or they arrive when their buffers are already full. The receiving application may ask for this information to be retransmitted, possibly causing severe delays in the overall transmission.

Errors: Sometimes packets are corrupted due to bit errors caused by noise and interference, especially in wireless communications. The receiver has to detect this and, just as if the packet was dropped, may ask for this information to be retransmitted.

Latency: It might take a long time for each packet to reach its destination, because it gets held up in long queues, or takes a less direct route to avoid congestion. This is different from throughput, as the delay can build up over time, even if the throughput is almost normal. In some cases, excessive latency can render an application unusable.

Jitter: Packets from the source will reach the destination with different delays. A packet's delay varies with its position in the queues of the routers along the path between source and destination and this position can vary unpredictably. This variation in delay is known as jitter and can seriously affect the quality of signals audio and/or video.

A Mobile Ad-hoc Network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless Technology. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. MANETs are a kind of wireless ad hoc networks that usually has a routable networking environment on top of a Link Layer ad hoc network. When mobility of nodes further increases in a Mobile Ad Hoc Network (MANET) it gives rise to the concept of Vehicular Ad Hoc Network (VANET) which is an emerging new technology that integrates ad hoc network, wireless LAN (WLAN) and cellular technology to achieve intelligent inter-vehicle communications and improve road traffic safety and efficiency[5]. IEEE is working on a variation of 802.11 standard that would be applied to support communication between vehicles and roadside infrastructure, or, alternatively, among vehicles themselves. The first milestone of standardization process was the allocation of 75 MHz of DSRC (Dedicated Short Range Communications) spectrum to accommodate Vehicle-to-Vehicle(V2V) and Vehicle-to-Infrastructure (V2I) communication for safety related application by US Federal Communications Commission(1999) [6]. IEEE standards IEEE P1609.1, P1609.2, P1609.3 and P1609.4 were prepared for vehicular networks [7] for uniformity and improving Quality of Service(QoS) in VANETs.

II. A REVIEW OF LITERATURE SURVEY

We are living in the age of Information Technology where data or information is exchanged over network of networks i.e Internet based on Internet Protocol(IP)[8][9]. With the continuous advancement in Wireless Technology , As mentioned above Mobility & Quality of Service are the two very much demanded features over Internet.

The set of applications for VANETs is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks. The design of network protocols for these networks is a complex issue. Regardless of the application, VANETs need efficient distributed algorithms to determine network organization, link scheduling, and routing. However, determining viable routing paths and delivering messages in a decentralized environment where network topology fluctuates is not a well-defined problem. While the shortest path (based on a given cost function) from a source to a destination in a static network is usually the optimal route, this idea is not easily extended to VANETs. Factors such as variable wireless link quality, propagation path loss, fading, multiuser interference, power expended, and topological changes, become relevant issues. The network should be able to adaptively alter the routing paths to alleviate any of these effects. Moreover, in a military environment, preservation of security, latency, reliability, intentional jamming, and recovery from failure are significant concerns. Military networks are designed to maintain a low probability of intercept and/or a low probability of detection. Hence, nodes prefer to radiate as little power as necessary and transmit as infrequently as possible, thus decreasing the probability of detection or interception. A lapse in any of these requirements may degrade the performance and dependability of the network. The auto configuration of VANETs is also a very challenging area.

The Mobility to fixed IP Based network is provided by using Mobile IP protocol[10][11]. There is lot off research is going on to extend the concept of Mobile IP protocol to provide mobility solutions to Mobile Network viz Mobile Ad Hoc Networks (MANETS) and Vehicular Ad Hoc Networks (VANETs).

Vehicular Ad Hoc Networks (VANETs) [21][45][55] are expected to become the unavoidable part of the network computing environment in coming future. With the proliferation of wireless devices in every sphere of life & community , the need of such devices to communicate in a seamless manner is becoming essential. As VANETs are gaining popularity, the Quality of Service (QoS) requirements of a traffic added extra burden on the network. The parameters of QoS are jitter, bandwidth, and delay. It means ensuring quality of application will provide more reliable communication, less jitter time, more bandwidth utilization and less delivery time.

The IntServ model provides QoS on a flow basis. It means IntServ architecture [14] allows sources to communicate their QoS requirements to router and destination on the data path by means of a Resource Reservation Protocol (RSVP) [15][16] signaling protocol .DiffServ model [17] [18] overcomes the difficulty in implementing and deploying IntSer model. In DiffServ model flows are classified into a limited number of service classes. This solves the scalability problem in the IntServ model, but it does not guarantee services on per hop basis .

This section summaries the literature survey on of Mobile IP & its Integration with VANETs [33][34][35][36][37] , QoS aspects in VANETs [38][39][40][41][42][43][44], Congestion Control & Congestion Avoidance mechanisms[27][28][29] and Auto Configuration of VANETs [46][47][48][49][50][51][52][53][54].

Nadjia Kara [19] discuss various Mobility Management Approaches Viz Hierarichical MIP (HMIP) , Dynamic HMIP (DHMIP) , Multicast HMIP (MHMIP) . All these strategies are used to reduce the signaling traffic related to Mobile Terminal (MT) registration with Home Agent (HA) whenever their Care-of-Address (CoA) changes but she doest not discuss any thing about the QoS.

Rami Langar , Nizar Bouabdallah , Raouf Boutaba and Bruno Sericola [20] proposed Adaptive Micro Mobility Management scheme designed to track efficiently the mobility of a node so as to minimize both the handoff latency & signaling cost while ensuring the Mobile Node (MN) QOS requirement by introducing the concept of residing area. Micro Mobility Domain is divided into virtual residing area (residing area is constructed by considering the current network position & required QoS) where the Mobile Node (MN) limits its signaling exchanges within this local region instead of communicating with the relatively far away root of the Domain at each handoff occurrence. They tested their scheme in MPLS access area not in IntServ or DiffServ Domain.

Ulf Jonsson, Fredik Alriksson et. al. [22] proposed a solution MIPMANET (Mobile IP for Mobile Ad Hoc Networks) for connecting the ad hoc network to a internet using on demand routing protocol. It provides Internet access by using Mobile IP with foreign agent care-of-address and reverse tunneling. This allows nodes to enjoy the mobility services of Mobile IP while at the same time the requirements on the adhoc routing protocol are kept minimum. They have used AODV as routing protocol & have not considered the size of MANET a Foreign Agent (FA) will serve .

Yu-Chee Tseng , Chia-Ching Shen & Wen-Tsuen Chen [23] proposed extension in Mobile IP to integrate mobility in mobile networks using standard IP routing to relay Mobile Ip messages & data packets instead of Adhoc routing protocols by utilizing host specific routes & default route.

Khaleel Ur Rahman Khan , Rafi U Zaman , A Venu gopal Reddy [24] [25] [26] Proposed a Effective Destination Sequence Distance Vector (Eff-DSDV) protocol which can be used to Integrate Ad Hoc nodes to fixed IP based network . One of the ad hoc hosts is used as Mobile Gateway Node (MGN) acting as a bridge between the Mobile and the Wired network. The full duplex communication between VANET nodes and the wired node is through this MGN. The MGN accesses the switch in the wired network through an Acess Point. Their strategy does not take into account the visiting mobile node of the infrastructure network , to join the ad hoc network and access the wired resources.

Dongli Zhang and Dan Ionescu [27] suggested a mechanism which prevents congestion within the IP core system by applying dropping at the ingress outer router instead of dropping at egress routers to utilize thr IP core network optimally. Hence congestion will be avoided in the IP core network and assured QoS can be provided. They only suggested about controlling congestion (by dropping using RED/WRED) at ingress router not individual routers within the core.

Consolee Mbarushimana and Ali Shahrabi [28] proposed a cross layer Type of Service Aware (TSA) congestion avoidance protocol which uses both the Type of Service (ToS) field of a packet & traditional hop count as a route selection metric and avoid congestion by distributing the load over potentially greater area and therefore improving spatial reuse. They have compare the performance of TSA with AODV only in their work.

T Senthil Kumaran , Dr. V Sankaranarayanan [29] Proposed a early detection congestion and control routing protocol for MANETs called EDAODV which detects congestion at a node level by calculating queue status value and finding congestion status. Based on the congestion status EDAODV utilizes the non-congested predecessor and successor nodes of a congested node and initiates route finding process bi directionally to find alternate non-congested path between them for transmitting data. The process finds more non-congested alternate paths and choose a best single path for transmitting data. A key in EDAODV design is the bi-directional alternate path discover concept. This concept tries to find out non-congested alternate path thus creating extra congestion by exchanging Bi-Directional Route Request (BIRREQ) packets transmitted by Predecessor and Successor while finding alternate path.

S.Venkatasubramanian , Dr. N.P. Gopalan [30] proposed a QoS based, Robust Multipath Routing (QRMR) protocol for MANETs by assigning weights to individual links depending upon the metric link quality(Lq), channel quality(Cocc)(this depends upon channel occupancy & channel reliability) and end to end delay (Davg). For any intermediate node I with established transmission with several of its neighbours the weight metric W for the link from node i to a particular neighbouring node is given by

W=Lq + Cocc + Davg. They have show that by the use of QRMR Packet delivery ratio for QRMR increases when compared to AOMDV [31] and average end to end delay is less.

T. Calfate, M.P Malumbers [32] proposed a flexible architecture for mobile networks such as VANETs that is able to offer end to end QoS based upon IEEE 802.11e standard by adding a probe based admission control system . The proposed architecture includes cross layer optimization and does not rely on intermediate station (nodes) along end to end path for admission control or signaling purposes hence avoiding resource consuming tasks such as continuous channel measurements , traffic shaping , and resource reservation. Distributed Admission control for Manet Environment (DACME) is the main component it is a probe based admission control mechanism that performs end to end QoS measurements according to QoS requirements , by issuing probe packets. But the problem is what will be optimal size of probe packets. ? How many probe packets should be send before starting transmission. Since no reservation of resources in intermediate node is made QoS requirement may fail.

Bachar Wehbi [46] review the various address configuration approaches used in Mobile Networks. He categorized address configuration into three category viz Statefull Approaches (Agent Based Addressing , MANETconf, Buddy Protocol, Prophet), Stateless Approaches (Strong Duplicate Address Detection SDAD, Weak Duplicate address Detection WDAD, Passive Duplicate Address Detection PDAD, Ad Hoc IP Address Autoconfiguration) and Hybrid Approches.(Hybrid Centralized Query-based Autoconfiguration HCQA). He also discussed about the merits & demerits of approaches into various category.

III. CONCLUSION

In this review paper we observed that generally all the approaches used to integrate VANETs with fixed Internet via a gateway (FA) [20][22][23][24][25] which is used to connect the VANETs nodes to the Internet. It provides Internet connectivity for the VANETs nodes. The VANETs node should discover the gateway information and its route in order to access Internet. When VANET node moves inside the VANET with multiple gateways , it should be able to discover and select the gateway with optimal route. Hence Integartion approaches of VANETs be improved , modified or enhanced for gateway discovery with minimum delay , minimum overhead and optimal route .

Generally in wired networks, QoS parameters are characterized by the requirements of a multi media traffic. But in ad hoc networks QoS requires extra constraints due to highly dynamic network topology, low communication bandwidth , limited processing and power capacity of mobile station than infrastructure based fixed station . In review it is observed that QoS requirements in VANETs are generally implemented by finding and maintaining route from source to destination [29][30]31][32] in the network that can be able to support required level of QoS. Route selection strategies can be based on the link state , shortest path, power of node and maintenance of route describe how to make sure that when the network topology changes , new route that can support existing QoS obligation are available or can be quickly found. Another way to make VANET QoS aware is either by controlling or by avoiding congestion [27][28][29] in the network. Hence for providing efficient solution to QoS aware VANETs there is need to improve , enhanced or create new architecture and protocols for routing and congestion control in VANETs which can handle the Real Time and Multimedia applications efficiently and optimally with less packet loss , jitter and delay and thus increasing the throughput and reliability of VANETs.

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