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Extensive Review of Security and QoS Based MANET Routing Protocols

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Abstract – The Mobile Ad Hoc Network (MANET) is collection of wireless devices which communicate among each other without need of any physical infrastructure as well as centralize administrations. Each mobile node in MANET acts as peer node. The communication is MANET is based on routing methods and hence since from last 2 decade there are number of routing methods designed with objective of improving the Quality of Service (QoS) performance of MANET. There are number of reasons due to which the QoS performance is affected such as mobility and security attacks. As the mobile nodes in MANET are moving randomly with varying mobility speed, this can leads the challenging tasks to achieve the guaranteed QoS performance. Therefore it is required to have efficient routing protocol with load balancing and dynamic behaviour of mobile nodes handling in MANET. Also, due to the open nature of wireless communications, such networks are easily vulnerable to different security attacks. The goal of this paper is to present the study on recent QoS aware routing protocols and security aware routing protocols. Additionally, we are presenting the current research gap based on analysis of all recent methods of QoS improvement. The outcome of this paper is the current research problems and motivation for MANET QoS enhancement.

Keywords— Wireless Communication, MANET, Quality of Service, Routing Protocols, Data Rate, Security.

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I. INTRODUCTION

Basically, wireless networks are categorised into two main categories such as infrastructure based and without infrastructure based wireless networks. Mobile ad hoc networks are designed without any infrastructure. The second type is the Infrastructure less wireless network (ad hoc wireless networks), infrastructure-based wireless networks rely on an access point (AP),which is a device that communicate as a connection between the wired & wireless networks, Example of the infrastructure based wireless networks is the wireless networks set up into the offices ,airports , homes & hospitals , when a customer's connect to the internet with the help of AP the other type of wireless networks does not rely on to the fixed infrastructure, & it has been very generally known as the *ad hoc wireless network*. Wireless Ad hoc network consists of self-corporate devices & it can be implement without the infrastructure. In ad hoc mode there are number of real life example of MANET like vehicle-to-vehicle, building-to-building and ship-to-ship communications. They communicate with each other by using on peer-to-peer routing Mobile Ad hoc Networks (MANETs); it can be defined as autonomous system of mobile nodes connected with each other via wireless. Every node in MANETs woks as a router as well as a host and forwards packets to each other to active the communication between nodes not directly connected by wireless links. The main challenge on wireless MANETs is a development of dynamic protocols that can efficiently find routes between communication mobile nodes. This type of routing protocol should be able to keep up with high degree of the nodes mobility that is frequently changed into the network topology (Liqi Shi, et. al., 2009) (Calafate, et. al., 2009). The combination for the quality of the links differs with the use of broadcasting nature of the Wireless channels.

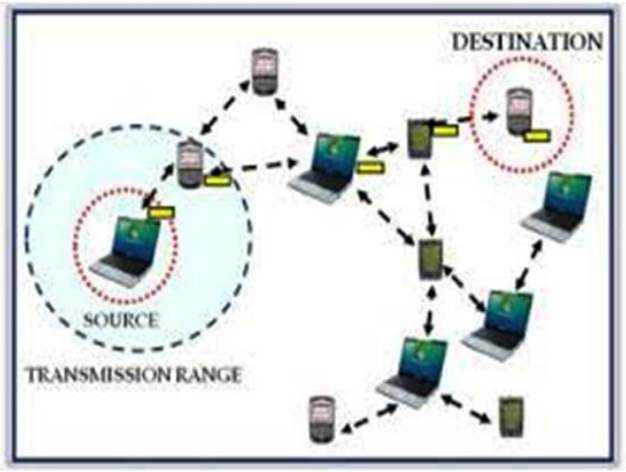

Fig.1. Example of MANET Communication among Source and Destination Node

Figure 1 is showing the example scenario of data communication between source node to destination node through the intermediate mobile nodes. The data transmission is possible using the routing protocol between mobile nodes. While working with the wireless networks, the network layer received the most of the researcher's attention. Due to this there are many routing protocols proposed by various authors for MANET with their different aims and objectives by targeting the specific application needs. At the network layer there are two major operations performed by network layer such as data forwarding and routing. These two are completely different methods (Mohamed, et. al., 2010). The concept of data forwarding is nothing but process of regulating how the packets taken from one link and added into another link. Whereas the routing determines the route on which the data packets are routed from source mobile node to sink mobile node. Here the latter method is essentially providing former method with control input. Although a large amount of efforts has been put in routing into the ad hoc networks, into the contrast, data sending follows very much the similar paradigm as into the IP forwarding in the Internet (Calafate, et. al., 2009). IP forwarding is basically multi-hip-hop wired network where a packet transmission only engage a single cable can be obtained by nodes, was designed for modern Ethernet case. IP packets are transmitted at one end of the Ethernet cable and the other. when a packet is transmitted on a physical channel however, Wireless network, this channel by all other nodes within the transmission range is checked for the most part of the research to get a packet node history as completely negative thoughts was not intended for overhearing, i.e., intervention (Pradeep & Soumya, 2010). Thus, the goal of research in wireless networking is to create the wireless links as well as wired ones. Unfortunately, this ignores the inherent nature of broadcasting of the wireless communication links. For the use of mobile ad hoc networks to originally successes beyond labs & test beds, we must tame & covering its broadcasting nature instead of fighting it. Cooperative interaction is an effective approach to achieving goal like this (Venkatasubramanian & Gopalan, 2013).

In recent times, these wireless ad hoc networks have come into eminence as they embrace the prospective to transfiguring numerous parts of our life, from daily communications, to military and ecological applications. Nevertheless, a number of technical barriers still stay behind and these all are must to be resolved and optimized before one can comprehend the filled potential of wireless ad hoc networks. It is argued that components in wireless ad hoc networks must be developed adaptive and responsive with respect to change in network topology, node connectivity, load situations, and end-to-end quality of service factors or conditions. Mobile Ad-hoc networks (MANETs) do possess a number of limitations that are must to be resolved so as to ensure higher quality of service (QoS) (Elayarasu & Saravanan, 2013) (Sanguankotchakorn, et. al., 2013). Few of the dominant problems and shortcomings of MANET are, node mobility, autonomous and infrastructure less, energy constrained operation, unreliable communication medium, hidden node problem, exposed node problem, congestion problem, MAC issues, routing issues, transport issues, security and QoS.

A mobile ad hoc network (MANET) could be visualised as a independent system or a multi-hop wireless addition to the web. As a independent system, Manet should available its own routing protocols and robust mechanism of network management. As a multi-hop wireless extension, it should additionally facilitate a supple, possible and perfect communication amongst the users or access to the services like web. Lately, due to increasing attractiveness of multimedia applications and in anticipation of commercial preparation of MANETs, the standard of service (QOS) prop in MANETs has become an imperative prerequisite. Though, the QoS support during a manet network is dissimilar to that of the wire line network or the cellular communication network as wireless bandwidth is collective and is shared amongst neighbouring nodes and therefore the network topology constantly variations with the mobility of comprising nodes.

This situation wants widespread association between the nodes, each to set up the route and to secure the resources needed for facilitating optimum quality of service (QoS) (Kumar & Kamalakkannan, 2013). The analysis groups defining the QoS as a group of service needs to be achieved by the communication network whilst performing transportation of a packet stream from source node to sink or to destination node. Inherent to the perception of QoS is conformity or an assurance by the network to endow with a group of quantitative pre-specified service attributes to the user in terms of performance parameters like delay, jitter, offered bandwidth, packet loss, etc. As just in case of the web, MANETs are developed for supporting the best-effort service with no guarantees of associated

QoS. Consequently, once a packet is lost during a manet network, the transmitter simply retransmits the lost data packet and it might be declared as a good approach for applications requiring no QoS, however easy end-to-end retransmission of data is ridiculous or not comfortable for real-time applications that are sensitive to those performance factors like packet loss, delay, bandwidth accessibility, etc. (Nikose & Salankar, 2014).

The quality of service (QoS) routing is dissimilar from the resource reservation and they possess two distinctive responsibilities that can be either together or individual in QoS architectures. The QoS routing protocol is employed for finding an alternate path that could facilitate the QoS requirements, but it is the QoS signalling that reserves, even maintains, and releases resources across the network elements. The QoS signalling would function better in case it coordinates with QoS routing but majority of QoS routing methods are either very complex or very costly and hence leads to substantial overhead in MANET. The QOS is the overall performance of the telephony or the computer network, particularly the performance seen by the users of the network are data rate, average throughput, bandwidth efficiency, end to end delay, jitter, packet delivery rate etc. These all parameters used to define the QoS performance of MANET. In this paper, our motive is QoS enhancement for MANETs. We are presenting the study on recent approaches presented by various researchers for improving the QoS performance of MANETs. In section II, we are presenting the study on recent methods of QoS improvement and data security. In section III, the comparative analysis of recent methods, finally in section IV the research gap is discussed.

II. LITERATURE REVIEW

A. QoS Aware Methods

Liqi Shi et.al (2009)

In [1], author introduced the approach for QoS routing methods with the feature of medium access control (MAC) layer as well as QoS metric collection schemes. They investigated the feasibility and effectiveness of voice support in multihop IEEE 802.11 MANETs using the QoS constrained ad hoc on demand distance vector (AODV) routing protocol. From this article, author noticed that using QoS constrained AODV routing into the multi-hop IEEE802.11 MANETs, voice communication is just supported in a very limited manner. Another outcome noticed by authors was from their OPNET simulations which was showing that IEEE 802.11 performing poorly in multi-hop MANETs because of the problem of hidden node, and hence this was the major obstacle of voice support. Therefore it was required to have improvement at MAC protocols or physical layer in order to support voice with QoS guarantee in MANETs. Additionally author noticed that QoS routing metrics play an important role in determining the performance of a QoS routing algorithm, which should be selected with caution.

C. T. Calafate et.al (2009)

In [2], another approach for MANET QoS support based on 802.11 MAC protocol is introduced by author. The novel approach proposed by author for QoS architecture which was able to support the applications with bandwidth, delay, and jitter requirements in MANET environments. The proposed architecture is modular, allowing the plugging in of different protocols, which offers great flexibility. Despite its modularity, they introduced the optimizations based on interactions among the media access control (MAC), routing, and admission control layers which offer important performance improvements. Author validated their proposed method under the different network loads, node mobility degrees, and routing algorithms were considered and tested in order to quantify the benefits offered by our QoS proposal. Figure 2 is showing the architecture of this QoS method.

Mohamed Tekaya et.al (2010)

In [3], author presented the multipath routing with load balancing and QoS in MANET. Author proposed the new routing protocol by coupling a multipath routing protocol with load balancing mechanism as per the QoS needs. The designed routing protocol was named as QLB-AOMDV (QoS and Load balancing AODMV). OLB-AOMDV is approach to achieve better load balancing with respect to the end-to-end QoS requirement. This was the first routing protocol based approach by considering the QoS requirements in MANET in recent times. The practical results of conducted by author showing that QoS performance improvement of QLB-AODM in terms of load balancing, delay and capacity.

Dr. B.S Pradeep et.al (2010)

In [4], another approach designed by author for load balancing and QoS improvement. Author modified the existing AODV routing protocol in order to achieve the QoS requirements and load balancing features with addition of extensions' in messages exchanged while route discovering process in MANET. They presented the detailed practical simulation model with MAC, physical and routing layers with both AODV and proposed QoS-AODV routing protocols and compared the performance in terms of average delay, normalized routing load and packet delivery rate.

S. Venkatasubramanian et. al (2013)

In [5], author proposed the multi-path routing for load balancing as it helps to minimize the maximum utilization and delivering the same traffic demands. With this approach, at first Route Discovery was initiated whenever the source nodes are attempts to discover routes to the destination by flooding request packets (RREQs). The RREP are sent on the basis of first come first served basis. Upon receiving the RREPs, intermediate nodes extracting the route path information and forwarding them according to the specified route. Afterwards balancing function as well as forwarding function for each path was calculated. For balancing function and forwarding function author used the threshold value. If the threshold values are satisfied then only the load distribution was processed, otherwise similar route was utilized for data transmission. At the time of load distribution, failure and success probabilities were calculated. At last, the algorithm of optimization was designed for finding the successful number of routes for the data transmission.

P. Elayarasu et.al (2013)

In [6], combined approach for QoS improvement and resource utilization were proposed by author for MANET as well as WIMAX networks. Author designed the resource utilization based load balancing method tailored for Mobile WiMAX was designed and three enhancement proposals were made. This was the first approach for automatically tuning the load balancing triggering threshold as well as to enable BS controlled load balancing for Best Effort Mobile Stations.

Teerapat Sanguankotchakorn et.al (2013)

In [7], another heuristic method designed based on the on cross layer design method in order to improve performance of OLSR by using Bit Error Rate (BER) explained from the physical layer along with the network layer parameter defined weighted Connectivity Index (CI) which was the combination among the link connectivity as well as capacity. The designed approach was presented to find the optimized path in terms of highest weighted CI as well as lowest BER in order to enhance the performance of Multipoint Relays (MPR) selection method and route computation. Author investigated the performance of designed method in terms of throughput, average delay, packet delivery ratio and overhead.

R. Senthil Kumar et.al (2013)

In [8], R. Senthil Kumar, In this paper, proposed a new cross layer scheme based algorithm to reduce the link break in MANETs. This present three schemes to reduce packet retransmission ratio by dividing signal information between the PHYSICAL LAYER & MAC LAYER, & to communicate the frequent route failures in MANET by identify shortly to be broken links instead of prediction of incoming signal power, To find out the optimized route maintenance by taking into the consideration of Bandwidth,

Mr.M.D.Nikose et.al (2014)

In [9], author introduced the cross layer based algorithm which was used to enhance the performance of TCP of the ad hoc network as well as to minimize the packet drop rate. However with this approach a repeated disconnection of mobile node can cause some packet losses and delays in some scenarios. The practical simulation results were shown in terms of throughput, jitter and packet delivery ratio.

Sandhya Onkar Ahire et. al (2015)

In [10], author proposed the routing protocol based QoS improvement method. Author presented the improved opportunistic MANET routing protocol in order to overcome the opportunistic data transfer problem while communication. Author first presented the CORMAN protocol, which was showing better performance against existing one; then they presented the limitations of CORMAN. Finally to address the limitations of CORMAN, address these limitations, algorithm of ECORMAN was designed with aim of improving the QoS performance against CORMAN protocol based on efficient channel reuse algorithm. ECORMAN was designed by modifying the CORMAN routing protocol.

Surendran. S et. al (2015)

In [11], the most recent QoS improvement method proposed by author. At first they did the extensive review of fault tolerant routing protocols and then proposed ant colony based algorithm for MANET routing. They proposed the QoS constrained fault tolerant ant look ahead routing method. This approach attempted to detect the valid path as well as look ahead path pairs which may be helps in selecting the alternate route in case of current route failure. The advantage of this method is that they are considering the secure data communication as well as in which they used the cryptography based algorithms for data security among source and destination node. Below figure 4 is showing the approach designed by author.

B. Security Methods

Below methods are reported recently for the secure data transmission for MANET.

Shakshuki, et. al., 2013

In [12], author Elhadi M. Shakshuki *et al.* EAACK is presented most recently to overcome the previous techniques discussed above. In this method author have proposed a novel IDS named EAACK protocol specially designed for MANETs and compared it against other popular mechanisms in different scenarios through simulations. Practically this method was outperforming all above three methods. Delay

performance is worst. For communication, this approach not used the efficient cryptography method.

Sheltami, et. al., 2009

In [13], proposed a new scheme called AACK based on TWOACK. Similar to TWOACK, AACK is an acknowledgment-based network layer scheme which can be considered as a combination of a scheme called TACK (identical to TWOACK) and an end-to-end acknowledgment scheme called ACKnowledge (ACK). Compared to TWOACK, AACK significantly reduced network overhead while still capable of maintaining or even surpassing the same network throughput. The concept of adopting a hybrid scheme in AACK greatly reduces the network overhead, but both TWOACK and AACK still suffer from the problem that they fail to detect malicious nodes with the presence of false misbehavior report and forged acknowledgment packets.

Balakrishnan, 2007

In [14], Liu *et al.* proposed a 2ACK scheme for the detection of routing misbehavior in MANETs. In this scheme, two-hop acknowledgement packets are sent in the opposite direction of the routing path to indicate that the data packets have been successfully received. A parameter acknowledgment ratio, i.e., *R*ack, is also used to control the ratio of the received data packets for which the acknowledgment is required. This scheme belongs to the class of proactive schemes and, hence, produces additional routing overhead regardless of the existence of malicious nodes.

Jian-Ming Chang, 2014

In [15], proposed the recent technique for defending against collaborative malicious attacks by using CBDS approach on DSR protocol. Author proposed new mechanism (called the CBDS) for detecting malicious nodes in MANETs under gray/collaborative blackhole attacks. The practical simulation results revealed that the CBDS outperforms the DSR, 2ACK, and BFTR schemes, chosen as benchmark schemes, in terms of routing overhead and packet delivery ratio. This method claimed the efficiency against the existing works. The limitation of this method is that poor delay performance; also end to end data security is not considered which may be addressed using efficient cryptography technique only.

Wei Liu & Ming Yu, 2014

In [16], another recent security method proposed based on onion routing. Author proposed the novel MANET routing protocol called AASR (authenticated anonymous secure routing) in order to achieve the security against the different types of attacks. This the recent method reported for MANET security based on onion routing. However, their simulation results revels that it leads to more delay for data transmission

III. COMPARATIVE ANALYSIS

Table 1 is showing the comparative study among different methods discussed in this paper with their drawbacks.

Table 1: Comparative Study of QoS Enhanced Methods

Ref. No.	QoS Methodology	Evaluated Metrics	Limitations
1	Routing Protocol	Packet Transmission Rate, Delay, Efficiency	Scalability and Reliability issues. Security is not addressed.
2	Cross Layer Design	Throughput, PSNR, Traffic Acceptance Rate	Time consuming and complex process of deployment. Security is not addressed.
3	Multipath Routing	Delay, Throughput, PDR	Secure communication and QoS improvement still to be done.
4	Routing Protocol	Delay, Packet Delivery Fraction, Normalized Routing Load.	This is complex method and will lead to routing overhead. Security is not addressed.
5	Multipath Routing	Delay, Packet Drops, Throughput, PDR.	Security is not addressed. Threshold needs to update according to type of communications.
7	Cross Layer Design	Throughput, PDR, Delay, Control Overhead.	Increasing Control overhead and processing overhead. Security is not addressed.
8	Cross Layer Design	PDR, Throughput.	Scalability and Reliability needs to evaluate, security is not addressed.
10	Cross Layer Design	PDR, Delay	More performance metrics should be considered. Security is not addressed.
11	Secure Routing Protocol	PDR, Throughput, Routing Overhead.	Basic ACO method used inefficient encryption and decryption algorithm.

IV. RESEARCH GAPS

In above section, we discussed the different approaches introduced for QoS improvement for MANETs based on different methodologies such as cross layers based, routing protocol based and MAC protocol based. Most of QoS enhanced methods do not supported the secure routing in MANET. This is the first research gap we identified from our study. It may be the reason that security is coming under separate domain, however presence of security method also having major impact of QoS of MANET. Apart from this, the current works are not fully evaluated under the diverse set of networks ranging from small to very large network size, mobility speed, traffic rate etc. Another problem that we identified from our study is still there is no optimized method designed for guaranteed QoS improvement for MANET. The recent ACO based approach is suffering from the limitations of ACO methods itself; hence there is chance of failure of such method.

V. CONCLUSION AND FUTURE WORK

In this paper, our goal of was to present the detailed study on QoS enhancement methods presented in last decade. We first introduced the MANET architecture and its communication patterns, and then discussed the importance of QoS for MANET applications. The methods discussed are from 2009 to very recent 2015 over QoS enhancement in MANETs. Most of QoS improvement methods are based on routing protocol based algorithms. After the study of all methods, we presented their comparative study in terms of performance metrics, QoS methodology and their limitations. The research gap presents the research problems associated with existing solutions for QoS Improvement in MANET. For future work, we suggest to design work to overcome the research gaps identified in this paper.

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