

# Quality of Service based Routing in Mobile Ad Hoc Network- A Review

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**Abstract-**An ad hoc network contains a group of wireless mobile nodes which together forms a momentary network having infrastructure less or decentralized administration. It basically works on the principle of multi-hop relaying. A Quality of Service(QoS) is the set of a services which is offered by the network to the client. Provisioning of QoS aims at attaining a network behavior which is more deterministic so that information carried by the network can be delivered and network resources can be efficiently utilized. The ad hoc network has limited bandwidth, therefore an efficient use of network bandwidth is very essential. Achieving guaranteed quality of service(QoS) in MANET is an issue than in wired networks because of mobility of nodes, multihop transmission, contention for accessing the channel, and a lack of centralized coordination. This paper presents current state-of-the-art of various QoS routing protocols proposed by eminent researchers to support QoS routing in MANETs.

**Keywords-** Ad hoc Network, AODV, MANET, Quality of Service, QoS Metrics, QoS Routing, QoS Provisioning, QoS based Routing Protocols.

## 1. INTRODUCTION

The research in 1990s focussed mainly on design of dynamic and distributed communication protocols that shared the wireless channel and discovered the routes between the mobile devices. The goal of these protocols was to provide a best-effort level of service to ensure network operation with an unpredictable and shared wireless communication medium and to maintain a network topology view and routes with the failing links and mobile devices[1].

In order to realize the real potential of MANETs, they must be able to provide the type of network services, which best-effort protocols cannot provide. For example, the real time applications such as the multimedia services. Moreover, therefore, quality based service in ad hoc networks is more essential for the real time applications. It can be defined as a set of requirements of the service that the network should meet while sending a packet from source to destination. Further the variability in network parameters and limited resources add to the requirement of QoS provisioning in such type of networks.

Therefore, in the recent years, there is a shift from best-effort services to the higher and better-defined QoS in MANET research. The routing protocols based on QoS play a major role in a QoS mechanism, since their task is to find mobile nodes, if any, which can serve an application's requirements[1].

## 2. ROUTING IN MANET

Routing is the process of selecting best paths in a network i.e. finding the best path from source node to destination node in a Network. The routing protocols in ad hoc network are divided into three main categories i.e. proactive, reactive and hybrid routing protocols.

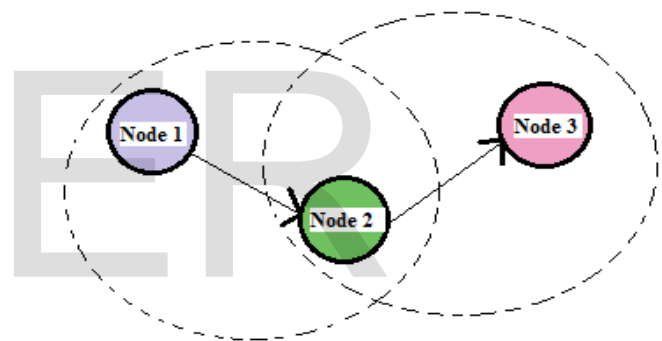


Fig: 1. MANET[2]

The Proactive routing protocol upholds the routing information, which is updated periodically. The routing information is usually maintained in tables, therefore they are also known as table-driven protocols e.g. DSDV.

The Reactive routing protocols build the route to the destination only if it is needed, hence they are also known as On Demand routing protocols e.g. AODV, DSR, TORA. When a source wants to send the message to a destination, it utilizes the mechanism for the route discovery to search the path to the destinations by route request initialization. When a route is established, the validity remains till the destination is reachable or when it is expired.

The Hybrid routing protocols are the combination of both proactive and reactive routing protocols e.g. ZRP. The route is established with the help of proactive routes and utilizes the reactive flooding for new mobile nodes. These routing protocols are designed to minimize the data traffic in the network and also to minimize the average hops for delivering a packet.

All these routing protocols are designed without QoS considerations. And if QoS is considered, some protocols may be unsatisfactory or impractical due to the lack of resources and the excessive computation overhead[3].

### 3. QoS IN MANET

Quality of Service(QoS) is the set of services offered by the network to the user. The objective of QoS provisioning is to achieve a network behavior which is more deterministic so that information carried by the network can be delivered and network resources can be utilized efficiently. A Service can be considered as a set of measurable predefined service requirements such as maximum bandwidth, minimum delay, minimum delay variance(jitter) and minimum packet loss rate.

After the acceptance of a request from the user, the network has to ensure that the requirements of the service of the user are met throughout the duration of flow. Hence the first job is to find a suitable path which is loop-free from the source to the destination.

After searching a suitable path, a resource reservation protocol is employed to reserve necessary resources along the path. The guarantee for quality of service can be provided only with appropriate resource reservation techniques. QoS provisioning often ask for negotiation between host and network, resource reservation and priority of packets. QoS can be rendered in ad hoc wireless networks through several ways viz per link, per node or per flow basis. In ad hoc wireless networks, the boundary between the network and the host is not described clearly, which makes it important to have better coordination among the hosts in order to achieve QoS.

The following are some of the metrics commonly used by applications to specify QoS requirement of the routing protocol-

- Throughput or Capacity: It is the data packets transmission rate in a unit time in the ad hoc network[4].
- Normalized Routing Load(NRL): The transmission of routing packets from the source node to the data packet delivered at the destination node[4].
- End-to-End delay: It is the data packet's average time delay from the source node to the destination node. When packet end-to-end delay is low, the performance of the network is better[5].
- Packet Loss Ratio(PLR)(percent): It is the ratio of the packets that dropped before reaching to the destination node to the packets originated by the source node[5].

The issues and challenges in providing QoS Support in MANETs are[6]:

- Dynamic network topology- Topology varies with time in ad hoc network which leads to imprecise network state information at the mobile nodes.

- Bandwidth Sharing: Since bandwidth in ad hoc network is limited, sharing with other mobile nodes lead to difficulty in allocation of the resources.
- Resource Constraints: Resources like battery power, if used blindly can leads to failure of mobile nodes and hence will affect the network availability and functionality.
- Lack of Centralised Control: The absence of centralised control demands a protocol to be self creative, self organised and distributed in nature.

### 4. LITERATURE SURVEY

The research have yield several ideas to provide solutions for QoS routing issue in MANET.

- In 2002, Dmitri D.Perkins and Herman D.Huges introduced the unique features of mobile ad hoc networks, which differed this network from the existing wired and wireless networks with infrastructure. They also discussed the affect of these features on QoS provisioning and described the first QoS model for mobile ad hoc networks. Then presented a summary of the algorithms which were proposed for each QoS component[7].
- In 2004, Al-Karaki and Kamal published his views about the state and the development trends in the field of QoS routing[8]. They highlighted the following areas-
  - Accommodation of multiple classes of traffic, particularly ensures the low class traffic which do not starve of network resources.
  - Preserve QoS guarantees under failure conditions.
  - To aid QoS routing, the position-determination systems such as GPS are used.
  - Prioritize the control packets over data packets in QoS based routing.
- In the year 2005, Baoxian Zhang and Hussein T.Mouftah, University of Ottawa have discussed some important design considerations to provide support for QoS routing. They presented an overview and addressed the issues of route selection with respect to constraints of QoS. They then devised an on demand an on demand and delay constrained unicast routing protocol[9].
- Lajos Hanzo II and Rahim Tafazolli in the year 2007 gave overview of QoS routing based metrics, resources, and factors that are affecting the network performance. They also done the classification of the protocols with the MAC(Medium Access Control) protocol[10].
- In 2011, Sanjeev Gangwar and Dr. Krishan Kumar gave a detailed outline of QoS routing based metrics, resources and factors affecting the routine of QoS routing protocols. The active QoS based routing protocols validity, strength and weakness were also studied and comparison was performed. QoS routing

protocols were also differentiated with respect to the QoS metrics[11].

### 5. QOS ROUTING PROTOCOLS

The objective of QoS routing is to establish a path from a source to the destination that fulfils the need of the desired QoS. The QoS-aware path is established within the constraints of bandwidth, minimal search, distance and traffic conditions. As the path selection is based on the desired QoS, the routing protocols can be termed QoS-aware.

The need for QoS aware routing protocols are:

- The existing protocols(e.g. AODV, DSR) do not take into consideration QoS metrics such as bandwidth, total delay, jitter and energy constraints.
- Moreover, to truly realize the potential of MANETs, the protocols must be able to deliver services in the field of entertainment or multimedia services which existing protocols or 'best-effort' protocols cannot provide as they have stringent time and reliability sensitive service requirements.
- Further, the applications like in military environment or the emergency operations like search and rescue, policing, fire fighting; there is a requirement of service which is time sensitive, quick and reliable.

Therefore, numerous QoS based routing protocols have been proposed:

- **Ad hoc QoS on demand routing protocol(AQOR)[12]** provides end to end QoS in terms of bandwidth and delay in MANET. In order to provide QoS, AQOR integrates:
  - On demand route discovery between the source and destination,
  - Signaling functions for resource reservation and maintenance,
  - And hop-by-hop routing.

The responsibilities of AQOR include Neighbourhood maintenance, Route discovery(with the help of Route Exploration, Route Registration and Loop Free Routing), Admission Control, Bandwidth Reservation and QoS Violation Detection.

- **QoS-aware routing protocol based on AODV** named QAODV[13] reduces invalid transmission of RREQ and saves the overhead in the establishment of the routing process. It considers bandwidth, delay, the number of hops and congestion of nodes in selected route, so it is more useful to on-time services than AODV.
- In **QoS based Optimised Link State routing protocol** QOLSR[14], the problems in OLSR viz the OLSR checks the control overhead which is involved in flooding routing information with the help of multipoint relays(MPRs) or subset of nodes and rebroadcasts it. As a result only MPRs are found during discovery of the routes and thus they are used as intermediate nodes on routes. Moreover, while calculating the optimal MPR set to reach all 2-hop

neighbors is an NP-complete problem and therefore heuristics are applied. Since the subset of nodes are MPRs, therefore the best links may not be efficiently used for routing; are been resolved by the new heuristics for building the set of MPRs in order to enable the QoS routing. The variation on the MAC delay metric and also the achievable throughput are employed by QOLSR for the QoS routing.

- In a **location aware QoS routing protocol** PLBQR[15], a location-delay prediction scheme which is based on a location-resource update protocol. The location updates consists of resource information involving the node for sending the update. The resource information and the location prediction mechanism for all nodes in the network are used in the QoS routing decisions. Moreover, there are dynamic changes in topology and resource availability due to nodes mobility in the ad hoc network. Due to these changes, the topological and routing information used by the network protocols get out dated very quickly. The advantage of this system is the prediction of new location(which is based on previous location) is made when there is geographical location variations.
- **A Genetic Algorithm-based source routing** GAMAN[15] is proposed that takes into the account end-to-end delay and transmission success rate for QoS metrics. Genetic Algorithms(GAs) may be employed for heuristic approximation of an optimal solution to a problem. In the first stage of the process, there is an involvement of encoding of the routes so that routes so that a genetic algorithm can be applied; it is known as Gene Coding. This is done by discovering the on demand paths and after that a network topology is constructed(in a logical tree-like structure). In the next stage, there is a calculation of fitness for each path. Further the values of fitness are utilized in selecting the paths for mutation operations and cross-over breeding.

The following table summarizes the QoS routing protocols studied:

Table 1. QoS Routing Protocols

S N o	QoS Routing Protocols	Route Discovery	Type of QoS Guarantee	QoS metrics	Routing Overhead	Limitations
1	AQOR [12]	Reactive	Soft	Bandwidth Delay	Full flooding of RREQ	For delay violation detection, the estimated time offset between the system clocks of source and destination node has to be known.

2	QAODV [13]	Reactive	Soft	Bandwidth Delay	Node traversal delay	Performance in larger network is not good.
3	QOLSR [14]	Proactive	Soft	Throughput Delay	Minimum flooding of RREQ	Since it does not rely on the use of lower layer information directly, the achievable QoS estimations are inherently not as accurate as with MAC layer idle-time estimation
4	PLBQR [15]	Proactive/ Reactive	Soft	Delay Bandwidth	Route recomputation in anticipation of link.	The accurate prediction on velocity and direction is not made when there are dynamic changes in the direction. The transmission is made only in linear pattern.
5	GAMAN [15]	Reactive	Soft	Bounded delay, packet loss rate	Node traversal delay	This protocol is not suitable for large networks.

## 6. CONCLUSION

In this review paper, an effort has been done to develop a comparative study of different QoS routing protocols. The analysis of QoS and its issues is done which makes QoS very challenging in MANET. Moreover, the comparative study of the work done by the researchers has been performed in order to provide QoS routing solutions in MANET.

The MANET will expand its applications in the future communication environments. The support of QoS will thus be an important and desirable component of MANET. Many important research issues and open questions need to be addressed to facilitate QoS support in MANETs. Further we can say that due to decentralized characteristics, dynamically changing topology, it is very difficult to achieve quality of service in MANETs. In the

future, an effort will be made to discover an efficient quality of service based routing scheme which can support both real and non real time traffic in MANET.

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