# QoS Parameters Analysis to Improve QoS in MANETS Routing Protocol

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***Abstract:*** **MANET is a self organized and self configurable network where the mobile nodes move arbitrarily. The mobile nodes can receive and forward packets as a router. Routing is a critical issue in MANET and hence the focus of this paper along with the performance analysis of routing protocols. We compared three types of routing protocols i.e. proactive, reactive and hybrid. All the MANETs routing protocols are explained in a deep way with QoS metrics. The performance of these routing protocols is analyzed by Q0S metrics to improve QoS in MANETs routing protocol. The comparison analysis will be carrying out about these protocols and in the last the conclusion will be presented for mobile ad hoc networks routing protocols. We compared two routing protocols (i.e. DSDV and AODV) for QoS parameter analysis using Packet delivery fractions (PDF), Average end-to-end delay of data packets, and Normalized routing load as parameters and show the simulation result using Network Simulation Tool (NS-2).**

***Index Terms:*** **MANET, NS-2, Performance, Q0S, Routing, Routing protocols, Simulation.**

## Introduction

A mobile ad hoc network (MANET), sometimes called a wireless ad hoc network or a mobile mesh network is a wireless network, comprised of mobile computing devices (nodes) that use wireless transmission for communication, without the aid of any established infrastructure or centralized administration such as a base station in cellular network or an access point in wireless local area network . The nodes are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet. Mobile nodes that are within each other's radio range communicate directly via wireless links, while those far apart rely on other nodes to relay messages as routers [1]. In ad hoc network each node acts both as a host and a router which forwards the data intended for some other node. Hence it is appropriate to call such networks as "multi-hop wireless ad hoc networks".

**Routing Approaches in Mobile Ad Hoc Network**

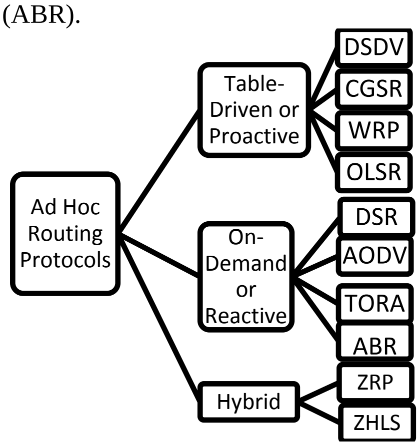
- In ad hoc mobile networks, routes are mainly multi hop because of the limited radio propagation range and topology changes frequently and unpredictably since each network host moves randomly. Therefore, routing is an integral part of ad hoc communications.
- Routing is to find and maintain routes between nodes in a dynamic topology with possibly uni-directional links, using minimum resources.

**Taxonomy for Routing Protocols in MANET**

***1. Table-driven or Proactive Protocols:*** Proactive routing protocols attempt to maintain consistent, up-to-date routing information between every pair of nodes in the network by propagating, proactively, route updates at fixed intervals. Representative proactive protocols include: Destination-Sequenced Distance- Vector (DSDV) routing, Clustered Gateway Switch Routing (CGSR), Wireless Routing Protocol (WRP), and Optimized Link State Routing (OLSR).

***2. On-demand or Reactive Protocols:***

A different approach from table-driven routing is reactive or on-demand routing. Reactive protocols, unlike table-driven ones, establish a route to a destination when there is a demand for it, usually initiated by the source node through discovery process within the network. Representative reactive routing protocols include: Dynamic Source Routing (DSR), Ad hoc On Demand Distance Vector (AODV) routing, Temporally Ordered Routing Algorithm (TORA) and Associativity Based Routing (ABR).




(Classifications of Ad Hoc Routing Protocols)

***3. Hybrid Routing Protocols:***
Purely proactive or purely reactive protocols perform well in a limited region of network setting. However, the diverse applications of ad hoc networks across a wide range of operational conditions and network configuration pose a challenge for a single protocol to operate efficiently. For example, reactive routing protocols are well suited for networks where the call-to-mobility ratio is relatively low. Proactive routing protocols, on the other hand, are well suited for networks where this ratio is relatively high. Researchers advocate that the issue of efficient operation over a wide range of conditions can be addressed by a ***hybrid*** routing approach, where the proactive and the reactive behavior is mixed in the amounts that best match these operational conditions. Representative hybrid routing protocols include: Zone Routing Protocol (ZRP) and Zone-based Hierarchal Link state routing protocol (ZHLS) [3, 4].

## Quality of Service

QoS is usually defined as a set of service requirements that needs to be met by the network while transporting a packet stream from a source to its destination. The network is expected to guarantee a set of measurable pre-specified service attributes to the users in terms of end-to-end performance, such as time, bandwidth requirement, probability of packet loss, the variation in latency (jitter), Route acquisition Delay, Communication Overhead, Scalability etc [11]. Quality of services for a network is measured in terms of guaranteed amount of data which a network transfers from one place to another in a given time slot. The size of the ad-hoc network is directly related to the quality of service of the network. If the size of the mobile ad-hoc network is large, it might make the problem of network control extremely difficult. Not all routes are capable of providing the same level of quality of service that can meet the requirements of mobile users. Quality of service (QoS) is the performance level of a service offered by the network to the user. The goal of QoS provisioning is to achieve a more deterministic network behavior, so that information carried by the network can be better delivered and network resources can be better utilized.

### *QoS parameters in Mobile Ad -hoc Networks*

As different applications have different requirements, the services required by them and the associated QoS parameters differ from application to application. For example, in case of multimedia applications time, bandwidth requirement, power requirement, probability of packet loss, the variation in latency (jitter), Route acquisition Delay, Communication Overhead, Scalability are the key QoS parameters, whereas military applications have stringent security requirements. For applications such as emergency search and rescue operations, availability of network is the key QoS parameter. Applications such as group communication in a conference hall require that the transmissions among nodes consume as minimum energy as possible [16]. In WNs the QoS requirements are more influenced by the resource constraints of the nodes. Some of the resource constraints are battery charge, processing power, and buffer space.

- **Throughpu**t is the effective number of data flow transported within a certain period of time, also specified as bandwidth in some situations.
- **Delay** is the time elapsed from the departure of a data packet from the source node to the arrival at the destination node, including queuing delay, switching delay, propagation delay, etc.
- **Jitter** is generally referred to as variations in delay. It is often caused by the difference in queuing delays experienced by consecutive packets.
- **Packet loss rate** is the percentage of data packets that are lost during the process of transmission.
- **Time complexity** is defined as the Time complexity is the time required to complete the forwarding nodes calculations.
- **Scalability**: It is the ability of a computer application or product (hardware or software) to continue to function well when it (or its context) is changed in size or volume in order to meet a user need.

There are three different ways to evaluate and compare the performance of MANET protocols.

- **1.** The first one is based on analysis and uses parameters such as time complexity, communication complexity for performance evaluation.
- **2.** In the second method, routing performance is compared based to simulation results using some simulator (e.g. Network Simulator, MAT LAB, OPNET, and so on.
- **3.** The last method is based on the implementation of the routing protocols and analyzes their performance using data from real-world implementation.

## Comparison of routing protocols in mobile ad hoc networks

***1. Proactive versus Reactive Approaches***
Ad hoc routing protocols can be classified as into two types; proactive or On Demand (reactive) base on each own strategy. On-demand (reactive) protocols will build the routes when required by the source node, in order for the network topology to be detected as needed (on-demand). When a node needs to send packets to several

destinations but has no routes to the destination, it will start a route detection process within the network [9]. When a route is recognized, it will be sustained by a route maintenance procedure until the destination becomes unreachable or till the route is not wanted anymore. Instances include "ad hoc on-demand distance vector routing" (AODV), "dynamic source routing" (DSR) and "Cluster Based Routing protocol" (CBRP).

Proactive protocols comprise the benefit that new communications with arbitrary destinations experience minimal delay, but experience the disadvantage of the extra control overhead to update routing information at all nodes. To overcome with this limitation, reactive protocols take on the opposite method by tracking down route to a destination only when required. Reactive protocols regularly utilize less bandwidth compared to proactive protocols, however it is a time consuming process for any route tracking activity to a destination proceeding to the authentic communication. Whenever reactive routing protocols must relay route requests, it will create unnecessary traffic if route discovery is required regularly.

### *2 .Clustering and Hierarchical Routing*

Scalability is one of the major tribulations in ad hoc networking. The term scalability in ad hoc networks can be defined as the network's capability to provide an acceptable level of service to packets even in the presence of a great number of nodes in the network. If the number of nodes in the network multiply for proactive routing protocols, the number of topology control messages will increases nonlinearly and it will use up a large fraction of the available bandwidth. While in reactive routing protocols, if there are a large numbers of route requests propagated to the entire network, it may eventually become packet broadcast storms. Normally, whenever the network size expands beyond certain thresholds, the computation and storage requirements become infeasible. At a time whenever mobility is being taken into consideration, the regularity of routing information updates may be extensively enhanced, and will deteriorate the scalability issues.

In order to overcome these obstacles and to generate scalable and resourceful solutions, the solution is to use **hierarchical routing**. Wireless hierarchical routing is based on the idea of systematizing nodes in groups and then assigns the nodes with different task within and outside a group. Both the routing table size and update packet size are decreased by comprising only a fraction of the network. For reactive protocols, restricting the scope of route request broadcasts can assists in improving the competency. The best method of building hierarchy is to gather all nodes geographically near to each other into groups. Every cluster has a principal node (cluster head) that corresponds with other nodes. Instances of hierarchical ad hoc routing protocols include "zone routing protocol" (ZRP).

And now we will shows the comparison between Table Driven, Demand Driven and Hybrid in Table 1, and then we show in Table 2 the protocols and comparison between their QoS parameters, Demand Driven (On-Demand) with six types of protocols such as TORA, DSR, AODV and ABR and comparison between them shows in table 3. Table 4 shows the Table Driven for four kinds of protocols such as WRP, CGSR, DSDV, OLSR and comparison between them.

| **Protocol** | **Type** | **Time Complexity** |
|---|---|---|
| **DSDV** | Table Driven (Proactive) | O (d) |
| **CGSR** | Table Driven (Proactive) | O (d) |
| **WRP** | Table Driven (Proactive) | O (h) |
| **OLSR** | Table Driven (Proactive) | O (d) |
| **DSR** | Demand Driven(Reactive) | O (2d) |
| **AODV** | Demand Driven(Reactive) | O (2d) |
| **TORA** | Demand Driven(Reactive) | O (2d) |
| **ABR** | Demand Driven(Reactive) | O(d+z) |
| **ZRP** | Hybrid | O (2d) |

Table-1: Time complexity of MANET Routing protocol

Where d is the network diameter and h is the height of the routing tree.

*z* = Diameter of the directed path where the REPLY Packet transits

It is extremely important that these networks should be able to provide efficient quality of service (QoS) that can meet the vendor requirements. The time delay is the main concern for QoS of routing protocols demanding that real time data be transmitted within a definite time interval. QoS support is essential for supporting time critical traffic sessions. Here we have comparison of proactive and reactive and hybrid routing protocols based on significant QoS parameter like throughput, bandwidth, time complexity, Communication Overhead, Scalability etc.

Table 2: Shows the protocols and comparison between their QoS parameter

| Parameter | Table Driven (Proactive) | Demand Driven(Reactive) | Hybrid |
|---|---|---|---|
| **Routing Structure** | Flat and hierarchical structure | Mostly Flat | Hierarchical |
| **Bandwidth requirement** | High | Low | Medium |
| **Power requirement** | High | Low | Medium |
| **Route acquisition delay** | Lower | Higher | Lower for Intra-zone; Higher for Inter-zone |
| **Control Overhead** | High | Low | Medium |
| **Communication Overhead** | High | Low | Medium |
| **Scalability** | Up to hundred nodes | Up to few hundred nodes, depend on (traffic level, number of hops) | Designed for up to 1000 or more nodes |
| **Topology dissemination** | Periodical | On-Demand | Both |

Table 3: Shows the Demand Driven (On-Demand) with four types of protocols and comparison between them

We selected two routing protocols (i.e. **DSDV** and **AODV**)

| On-Demand | TORA | DSR | AODV | ABR |
|---|---|---|---|---|
| **Routing Structure** | Flat | Flat | Flat | Flat |
| **Overall complexity** | High | Medium | Medium | High |
| **Frequency of update transmissions** | Event driven | Event driven | Event driven | Periodicall y |
| **Updates transmitted to** | Neighbors | Source | Source | Source |
| **Overhead** | Medium | Medium | Low | High |
| **Loop Free** | Yes | Yes | Yes | Yes |
| **Utilize hello messages** | No | No | Yes | Yes |
| **Multiple route support** | Yes | Yes | No | No |
| **Routing metric** | Shortest path | Shortest path | Freshest & shortest path | Associativ ely & shortest path & others |

Table 4: Shows the Table-Driven four kinds of protocols and comparison between them

| Table Driven | CGSR | WRP | DSDV | OLSR |
|---|---|---|---|---|
| **Routing Structure** | Hierarchical | Flat | Flat | Flat |
| **Overall complexity** | High | Low | High | Low |
| **Frequency of update transmissions** | Periodically | Periodical ly and as needed | Periodical ly and as needed | Periodically |
| **Updates transmitted to** | Neighbors and cluster Head | Neighbors | Neighbors | Neighbors |
| **Scalable** | No | Yes | Yes | Yes |
| **Loop Free** | Yes | Yes but non instantane ously | Yes | Yes |
| **Utilize hello messages** | NO | YES | YES | YES |
| **Critical nodes** | Cluster head | NO | NO | MPRs |
| **Multiple route support** | NO | NO | NO | NO |
| **Routing metric** | Shortest path | Shortest path | Shortest path | Shortest path |

## Simulation

for comparison using Packet delivery fractions (PDF), Average end-to-end delay of data packets, and Normalized routing load as parameters. In this paper, we considered two routing protocols. One of these is reactive: AODV and one is proactive: DSDV [17]. The simulations were performed using Network Simulator2 (NS-2.34) particularly popular in the ad hoc networking community.

### *Performance Evaluation and Design Simulation Model*

Here we choices Network Simulation Tool (NS-2). NS (version 2) is an object-oriented, discrete event driven network simulator developed at UC Berkely written in C++ and Tcl. NS-2 is primarily useful for simulating local and wide area networks.

### *Performance Metrics*

The paper focuses on 3 performance metrics which are important to measure the performance and activities that are running in NS-2 simulation.

In this scenario some parameters with a specific value are considered. Those are as shown in table 4 and 5.

The performance metrics are:-

***A. Packet delivery fractions (PDF):*** — The PDF shows how successful a protocol performs delivering packets from source to destination. This metric characterizes both the completeness and correctness of the routing protocol also reliability of routing protocol by giving its effectiveness.

***B. Average end-to-end delay of data packets:*** — There are possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC and propagation and transfer times. The time difference between every CBR packet sent and received was recorded, dividing the total time difference over the total number of CBR packets received gave the average end-to-end delay for the received packets. The lower the end-to-end delay the better the application performance.

***C. Data Packet Loss (Packet Loss) —***
When a packet arrives at the network layer the routing protocol forwards the packet if a valid route to the destination is known. Otherwise, the packet is buffered until a route is available. A packet is dropped in two cases: the buffer is full when the packet needs to be buffered and the time that the packet has been buffered exceeds the limit.

***D. Throughput*** -The ratio of the total amount of data that reaches a receiver from a sender to the time it takes for the receiver to get the last packet is referred to as throughput. It is expressed in bits per second or packets per second.

Table-6 SIMULATION METRIC

| ID | Metrics | Definition | Formula | Example value |
|---|---|---|---|---|
| **PS** | Packet Sent | Total no. of packet sent by the source node | Computed from trace file | 2000 |
| **PR** | Packet Received | Total no. of packet received by the Destination node | Computed from trace file | 600 |
| **PDF** | Packet delivery fraction | Ratio of packets received to packets sent | PDF=(PR/PS) *100% | 88.5% |
| **TD** | Total Delivery Time | Time spent to deliver packets(PR) | Computed from trace file | 1567.2 |
| **AD** | Average end to end delay | Delay spent to deliver each data packet | AD=TD/PR | 6.235 |
| **RF** | Routing packets | No. of routing packets sent or forwarded | Computed from trace file | 44 |
| **NRL** | Normalized routing load | No. of routing packets per data packets | NRL=RF/PR | 2.5 |

Table 5.Scenario for implementation of AODV and DSDV

| Parameter | Value |
|---|---|
| **Simulator** | Ns 2.34 |
| **Studied Protocol** | AODV and DSDV |
| **Simulation Time** | 100 sec |
| **Pause time** | 0-100s in steps of 20s |
| **Simulation Area** | 800 m X 800 m |
| **Packet size** | 512 Bytes |
| **Traffic Type** | CBR |
| **Bandwidth** | 2Mb/s |
| **Speed** | 0-25m/s in steps of 5 m/s |

## SIMULATION RESULTS

The simulation results are shown in the following section in the form of line graphs. Graphs show comparison between the two protocols AODV and DSDV on the basis of the above-mentioned metrics as a function of pause time.

***A. Packet Delivery Fraction (PDF)***
Figure 1 shows a comparison between both the routing protocols on the basis of packet delivery fraction as a function of pause time.

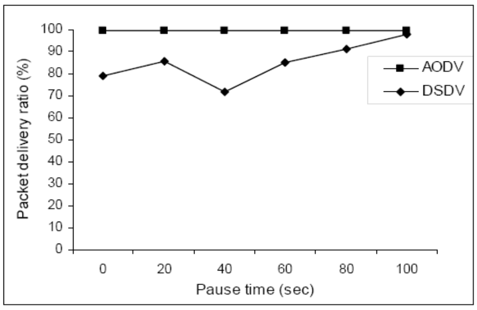



Fig.1: Packet delivery fraction vs. Pause time for 6- node model

Both of the protocols deliver a greater percentage of the originated data packets when there is little node mobility, converging to 100% delivery ration when there is no node motion. The On-demand protocol, AODV performed particularly well, delivering almost 100% of the data packets regardless of the mobility rate. DSDV performance is worst when mobility is high.

***B. Average End to End Delay***
Figure 2 shows comparison between both the routing protocols on the basis of average end-to-end delay as a function of pause time. DSDV performed pretty stable and the delay kept about 0.04 seconds when pause time increased from 0 seconds to 100 second. The reason is that it is a table driven protocol, so a node does not need to find a route before transmitting packets. So the delay is quite

stable. For AODV the delay is much more then the DSDV. AODV takes more time during the route discovery process.

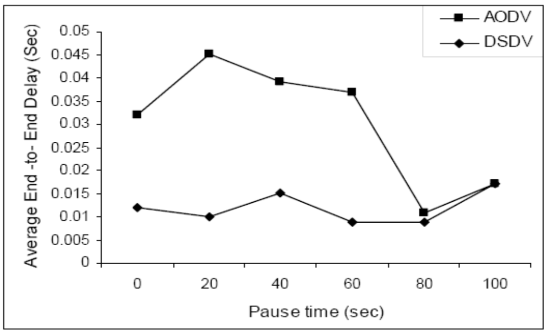



Fig.2 Average End-to-End Delay vs. Pause time for the 6-node model

### *C. Normalized Routing Load*

Figure 3 shows a comparison between both the routing protocols on the basis of normalized routing load as a function of pause time.

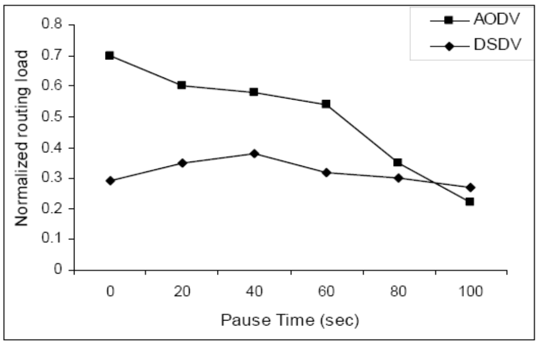



Fig. 3 Normalized routing load vs. Pause time for the 6-node model

As DSDV is a table driven routing protocol its overhead is almost the same with respect to node mobility. In cases of AODV, as the pause time increases, route stability increases, resulting in a decreased number of routing packet routing packet transmissions, and therefore a decrease in the routing overhead. A relatively stable normalized routing load is a desirable property for scalability of the protocols.

## CONCLUSION

This paper compared the two ad hoc routing protocols. AODV an On – Demand routing protocol, and DSDV a table driven protocol. Simulation results show that both of the protocols deliver a greater percentage of the originated data packets when there is little node mobility, converging to 100% delivery ration when there is no node motion. The packet delivery of AODV is almost independent of the number of sources. DSDV generates less routing load then AODV. AODV suffers from end to end delays. DSDV packet delivery fraction is very low for high mobility scenarios. AODV has less average end-to-end delay when compared to DSDV. The normalized routing load for AODV increases drastically as the number of nodes increases.

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