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Research Article

QoS for Energy Efficient Routing Protocols in IEEE 802.11 Wireless Mobile Adhoc Network using Qualnet Simulator 6.1

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Abstract

In the current era of wireless network, popularity of MANET is increasing at a very fast pace. Reason for this increased attention is the wide range of multimedia applications running in an infrastructure less environment. Because of the infrastructure less environment, limited power and dynamic topology is used. It becomes difficult to provide an energy efficient environment in MANET. This type of network, operating as a stand-alone network or with one or multiple points of attachment to cellular networks or the Internet, paves the way for numerous new and exciting applications. In multi-hop wireless ad-hoc networks, designing energy efficient routing protocols is critical since nodes are power-constrained. Many routing protocols have been proposed so far. QoS of these protocols has been tested under CBR traffic with varying network condition. In this paper we proposed number of simulation in order to evaluate the quality of service of three routing protocols OLSR, DSR, ZRP under CBR traffic in terms of throughput, end-to-delay, jitter, total data received and packet delivery ratio in network scenarios. The network scenarios are considered effect of varying node and effect of constant pause time. The simulations are carried out in Qualnet simulator 6.1.

Keywords: *MANET, OLSR, DSR, ZRP, Qualnet Simulator 6.1.*

1. Introduction

The 1990s have seen a rapid growth of research interests in mobile ad hoc networking. The infrastructure less and the dynamic nature of these networks demands new set of networking strategies to be implemented in order to provide efficient end-to-end communication. These, along with the diverse application of these networks in many different scenarios such as battlefield and disaster recovery, have seen MANETs being researched by many different organisations and institutes. MANETs have become very popular due to growing popularity of mobile device. A MANET (Basagni, *et al*, 2003) is a collection of wireless mobile nodes that communicate with each other using multi-hop wireless links (Qayyum, *et al*, 2000) without predetermined topology or central control. MANETs employ the traditional TCP/IP structure to provide end-to-end communication between nodes. However, due to their mobility and the limited resource in wireless networks, each layer in the TCP/IP model requires redefinition or modifications to function efficiently in MANETs. MANET can be characterized as having dynamic topologies; bandwidth constrained, variable capacity links, energy constrained and limited security. In MANET each and every mobile node is assumed to be moving with more or less relative speed in arbitrary direction. So routing in MANET has become one of the challenging issues. Routing in the MANET (Royer, *et al*, 1999) is a challenging task (Corson, *et al*, 1999) and has received a tremendous amount of attention from researches. This has led to development of many different routing protocols for MANETs, and each author of each proposed protocol argues that the strategy proposed provides an improvement over a number of different strategies considered in the literature for a given network scenario. Therefore, it is quite difficult to determine which protocols may perform best under a number of different network scenarios, such as increasing node density and traffic. Other challenging task is supporting mobility in MANETs. The mobility of nodes in MANETs increases the complexity of routing protocols and flexible connections. Therefore, it is quite difficult to determine which protocols may perform better under a number of different scenarios such as increasing node density and mobility. This network works in situation where ordinary wired network is feasible like rural areas, third world war countries or disaster areas. Performance of MANET depends on the routing protocol, battery consumption by the nodes. There are various Qualities of service parameters which affect the performance like bandwidth delay, jitter, throughput etc.

In this paper, we have analysed the quality of service of three popular routing protocols: one proactive (OLSR), one reactive (DSR) and one hybrid (ZRP), when transmitting multimedia data in a multi-hop network. The

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Table 1 Comparison of routing protocols

Parameters	Proactive protocol	Hybrid protocol	Reactive protocol
Routing Philosophy	Flat/Hierarchical	Hierarchical	Flat
Routing Scheme	Table driven	Combination of both	On demand
Latency	Low due to routing tables	Inside zone low outside similar to Reactive protocols	High due to flooding
Routing Overhead	High	Medium	Low
Storage Capacity	High ,due to the routing tables	Depends on the size of zone, inside the zone sometimes high as proactive protocol	Low generally depends upon the number of routes
Mobility Support	Periodical updates	Combination of both	Route maintenance

paper is organized as follows: In section 2, we provide an overview of a wide range of routing protocols (Royer, *et al*, 1999) proposed. Section 3, comparison among the different types of routing protocols is shown in Table1.Section 4, performance evaluation metrics of all routing protocols. Section 5 presents simulation environment including scenario specifications Table 2. Section 5 presents analysis & result and discussion. Finally we conclude the paper and suggest which protocols may perform best in variable node and networks in second last section.

2. MANET Routing Protocols

2.1 OLSR Protocol

The Optimized Link State Routing (OLSR) protocol is an optimization of the classical link state algorithm, adapted to the requirements of a MANET. Because of their quick convergence, link state algorithms are somewhat less prone to routing loops than distance vector algorithms, but they require more CPU power and memory. They can be more expensive to implement and support and are generally more scalable. OLSR (Floriano, *et al,* 2008) is a proactive routing protocol optimized for mobile ad-hoc network. It has the advantage of having routes immediately available when needed. It inherits the stability of link state algorithm adapted to the requirement of MANET. The key concept used in OLSR is that of multipoint relays (MPRs). MPRs are selected nodes which forward broadcast messages during the flooding process. This technique substantially reduces the message overhead as compared to a classical flooding mechanism (where every node retransmits each message received). This way a mobile host can reduce battery consumption. Secondly, OLSR minimizes flooding of this control traffic by using only the selected nodes, called MPRs, to retransmit control message. This technique significantly reduces the message overhead where every node retransmits each message received. Each node selects its MPRs from the set of its neighbours saved in the neighbour list. OLSR may optimize the reactivity to topological changes by reducing the maximum time interval for periodic control message transmission. The protocol is particularly suited for large and dense network, as optimization is done by using MPRs which work well in this context and does not depend on any central entity.

The protocol does not require reliable transmission of control message. Each node sends its control messages periodically. Each control message contains a sequence number which is incremented for each message. Thus the recipient of a control message can if required, easily identify which information is more recent even if messages have been re-ordered while in transmission

2.2 DSR Protocol

Dynamic Source Routing (DSR) (Sheltami, *et al*, *2003*) is designed specifically for use in multihop wireless ad hoc network. This protocol is composed of two mechanisms of route discovery and Route maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the adhoc network. Route discovery takes place when source already does not know route to destination. Route cache is also maintained where all learned routes to any given node in the network exist. When a source sends a packet to destination, it obtains a route from route cache of previously learned routes. If no route is found then route REQUEST message is broadcasted to initiate route discovery protocol. When a node receives a route REQUEST message it returns route REPLY message to the initiator, if it is the target of the request. Simply when a node receives a route request it searches the route cache where all routes are stored. If not found then route REQUEST is broadcasted and flooded over the network until the destination node is found. In fact there is a aggressive use of source routing and caching in DSR. No special mechanism is needed to detect the routing loops. Each route REQUEST message contains a hop limit that may be used to limit the number of intermediate nodes allowed to forward that copy of the route REQUEST. As the REQUEST is forwarded limit is decremented and packet is discarded if limit reaches to zero. Another mechanism of expanding ring search for the target where a node can initiate another route REQUEST with hop limit of one. For each route REQUEST no route REPLY is received. Nodes can double the hop limit as previously attempted.

2.3 ZRP Protocol

Zone routing protocol (Haas, *et al*, 2002) is a hybrid of proactive and reactive protocol. By using it we can take advantage of both table driven and on demand driven protocol according to the application. The nodes of a zone are divided into peripheral nodes and interior nodes. Every node in the network has a zone associated to it. The zone of a node is defined as the collection of nodes whose minimum distance from the node is not greater than the radius of the node. The minimum distance is defined in terms of number of hops from that node.ZRP reduces the proactive scope to a zone cantered on each node. It uses proactive protocols for finding zone neighbours (instantly sending hello messages) as well as reactive protocols for routing purposes between different zones (a route is only established if needed). ZRP has a flat view over the network. In this way, the organizational overhead related to hierarchical protocols can be avoided. ZRP can be categorized as a flat Protocol because the zones overlap. Hence, optimal routes can be detected and network congestion can be reduced. ZRP consists of three parts: IARP (Haas, *et al,* 2002) proactive part, IERP (Haas, *et al,* 2002) reactive part, BRP (Haas, *et al,* 2002) used with IERP to reduce the query traffic.

3. Comparison of Protocols

The comparison among the different types of routing protocols (Jameli, *et al,* 1999) is shown in Table 1.

4. Performance Evaluation Metrics

Evaluating the performance of any routing protocol is one of the challenging issues and is related to the metrics that are used for evaluation. In this work, we based our evaluation on quantitative metrics. Quantitative metrics include statistical data, which provide the tools to assess the performance of the routing protocols.
The following five performance metrics have been chosen to compare the four routing protocols.

4.1 Throughput

This is the parameter related to the channel capacity. It is defined as the maximum possible delivery of the messages over the channel. It is usually measured in bits per second.

4.2 Average End-to-End Delay

It can be defined as average delay a data packet takes to travel from source to destination.

4.3 Jitter

It is defined as the difference in end-to-end delay between selected packets in a single connection. Any lost packets are ignored from this metric.

4.4 Total Data Received

TDR performance is the total data received at the destination in bytes.

4.5 Packet Delivery Ratio (PDR)

It is defined as the ratio of incoming data packets to the received data packets.

5. Simulation Environment and Analysis

The objective of the simulation is to evaluate the performance of four routing protocols (DSR, OLSR, ZRP) based on various performance metrics for MANET. Simulations were carried out using Qualnet Simulator 6.1 In simulation we generate scenario files considering the area of $1500 \times 1500\text{m}^2$ and keeping constant pause time (30sec).

Table 2 Scenario Specifications

Simulation Area	$1500 \times 1500m^2$
Node movement model	Random waypoint mobility
Traffic Types	CBR source
Number of nodes	20,40,60,820,100
Simulation Time	105sec
Maximum speed	110mps
Pause Time	30sec
Protocols Studied	DSR.OLSR,ZRP
Rate of packet generation	1packets/sec
Mobility of nodes	Min speed=1m/sec, Max speed=110m/sec
MAC Protocol	IEEE 802.11
Size	512 bytes

6. Result and discussion

6.1Throughput

With the varying no. of nodes (with constant mobility) the throughput is analysed. It is observed that DSR performs better than OLSR and ZRP. OLSR performs better than ZRP. Here the performance of ZRP protocol is weaker in case of throughput with varying nodes.

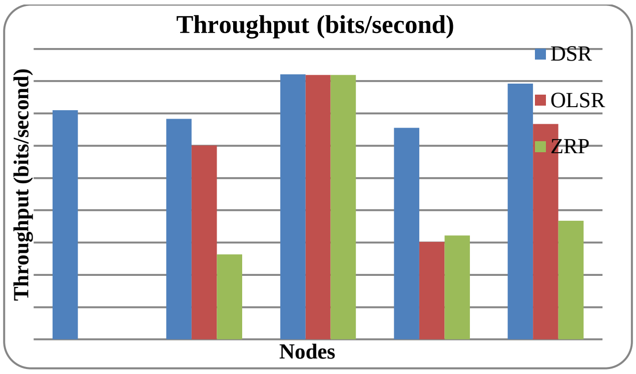

Fig. 1 Average Throughput in bits/sec with varying nodes.

6.2 End to End Delay

When a packet is transmitted from source to destination it takes time to reach. This time includes different delays as described in its definition above. In this analysis it is observed as expected the delays are increasing as the traffic load and no. of nodes are increasing. The average end to end delay very high in DSR than OLSR and ZRP. The OLSR has least end to end delay.

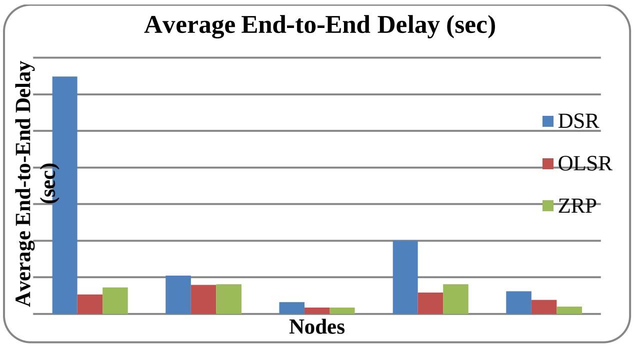

Fig. 2 Average End-To-End Delay in sec with varying nodes

6.3 Jitter

Jitter, the variation of packet arrival time, is an important metrics for any routing protocol. In this analysis with varying number of nodes it is observed DSR has largest jitter and least for ZRP. The performance shown in figure:

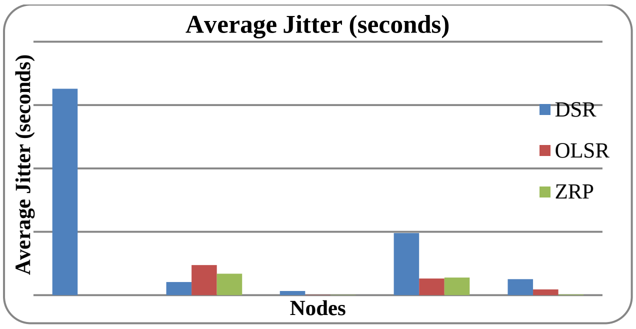

Fig.4 Average Jitter in sec with varying nodes

6.4 Total Data Received

TDR performance is analysed. It is observed that DSR routing protocol performs better than OLSR and ZRP when no. of nodes increases.

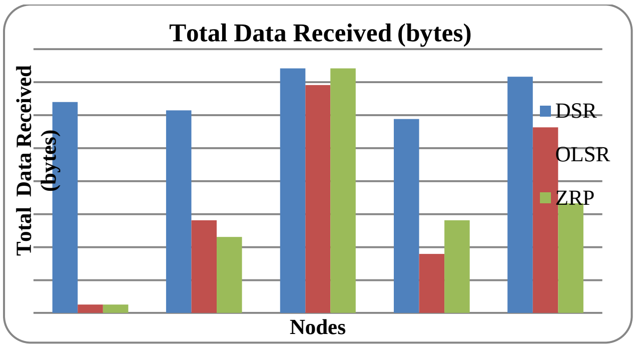

Fig. 5 Total Data Received with varying nodes

6.5 Packet Delivery Ratio

PDR performance is analysed. It is observed that, DSR routing protocol performs better than OLSR and ZRP when no. of nodes increases.

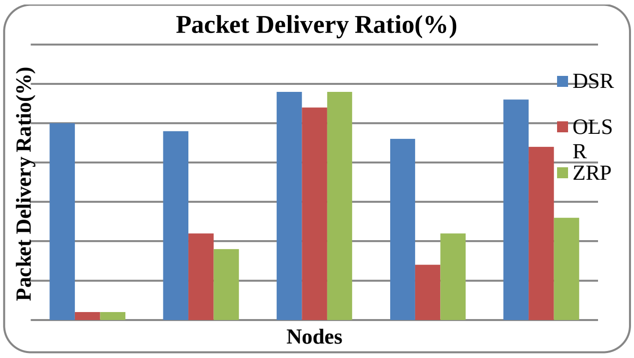

Fig. 5 Packet Delivery Ratio with varying nodes.

Conclusion

In this paper, we studied and analysed the performance of different routing protocol in realistic condition. The focus was put on the QoS of metrics with constant pause time, varying node density and mobility values.
1) DSR performs better than OLSR and ZRP in terms of throughput, total data received and packet delivery ratio.
2) OLSR performs better than ZRP in terms of throughput, end to end delay.
3) ZRP shows better in jitter than both. Almost ZRP is minimum in all cases.
4) Overall the performance of DSR protocol is better than OLSR and ZRP with varying nodes.

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