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PERFORMANCE COMPARISON OF ROUTING PROTOCOLS IN WMNS

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Abstract: Wireless meshing has been envisioned as the economically viable networking paradigm to build up broadband and large-scale wireless commodity networks. Wireless mesh networks (WMNs) have emerged as a key technology for next-generation wireless networking. Because of their advantages over other wireless networks, WMNs are undergoing rapid progress and inspiring numerous applications. The main objective of this paper is to find out the performance comparison of three routing protocol by throughput performance and end-to-end delay and Zitter .

Keywords: Wireless mesh networks (WMNs), Qualnet 5.02 Developer, AODV, ZRP, OLSR.

1. INTRODUCTION

Wireless mesh networks (WMNs) are dynamically self-organized and self-configured, with the nodes in the network automatically establishing an ad hoc network and maintaining the mesh connectivity. WMNs are comprised of two types of nodes: mesh routers and mesh clients. .mesh routers form the wireless backbone; mesh clients access the network through mesh routers as well as directly meshing with each other. Mesh routers form an infrastructure for clients. The WMN infrastructure/backbone can be built using various types of radio technologies. The mesh routers form a mesh of self-configuring, self-healing links among themselves. The mesh routers form a mesh of self-configuring, self-healing links among themselves. Mesh networks is the multi-hop forwarding or relaying of packets over the wireless links for communication between the component nodes.

1.1 The Characteristics of WMNs

WMNs support ad-hoc networking, and have the capability of self-forming, self-healing, and self-organization.

- WMNs are multi-hop wireless networks, but with a wireless infrastructure/backbone provided by mesh routers.
- Mesh routers have minimal mobility and perform dedicated
- Mobility of end nodes is supported easily through the wireless infrastructure.
- Mesh routers integrate heterogeneous networks, including both wired and wireless. Thus, multiple types of network access exist in WMNs.

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1.2 Classification of Routing Protocols for WMN

There are three types of routing protocols in WMN such as Proactive, Reactive, and Hybrid. on these types of routing protocols over Ad Hoc On-Demand Distance Vector (AODV), and (OLSR) Optimized Link State Routing protocol (OLSR) (proactive) and Zone Routing Protocol (ZRP) is (hybrid).

Reactive Routing Protocols: The reactive routing protocols are based on some sort of query-reply dialog. Reactive protocols proceed for establishing route(s) to the destination only when the need arises. They do not need periodic transmission of topological information of the network.

Proactive Routing Protocols: Proactive protocols continuously learn the topology of the network by exchanging topological information among the network nodes. Thus, when there is a need for a route to a destination, such route information is available immediately. If the network topology changes too frequently, the cost of maintaining the network might be very high. If the network activity is low, the information about actual topology might even not be used.

Hybrid Routing Protocols: Often reactive or proactive feature of a particular routing protocol might not be enough; instead a mixture might yield better solution. Hence, in the recent days, several hybrid protocols are also proposed.

End-to-end delay refers to the time taken for a packet to be transmitted across a network from source to destination.

2. DESCRIPTION OF PROTOCOLS

2.1 OLSR

Optimized Link State Routing protocol (OLSR) [3] is based on link state algorithm and it is proactive in nature. This protocol performs hop-by-hop routing; that is, each node in the network uses its most recent information to route a packet. OLSR is an optimization over a pure link state protocol [3] as it squeezes the size of information send in the messages, and reduces the number of retransmissions.. OLSR is particularly suitable for large and dense networks [3]. In OLSR, each node uses the most recent information to route a packet. Each node in the network selects a set of nodes in its neighborhood, which retransmits its packets.. In OLSR, a HELLO message is broadcasted to all of its neighbors containing information about its neighbors and their link status and received by the nodes which are one hop away but they are not relayed to further nodes. On reception of HELLO messages, each node would construct its MPR Selector table. Multipoint relays of a given node are declared in the subsequent HELLO messages transmitted by this node.

2.2 AODV

Ad-hoc On-demand distance vector (AODV) [9] is another variant of classical distance vector routing algorithm. Like DSDV, AODV provides loop free routes in case of link breakage but unlike DSDV, it doesn't require global periodic routing advertisement. In AODV, each host maintains a traditional routing table, one entry per destination. AODV is capable of operating on both wired and wireless media AODV uses a simple request-reply mechanism for the discovery of routes. AODV protocol mainly involves 3 packets. They are [9]

1. Route Request (RREQ)
2. Route Reply (RREP)
3. Route Error (RERR)

When a source wants to send a message to designation and if it does not have a valid route to designation, it initiates a path discovery process to locate the other node.

AODV uses a broadcast route discovery mechanism where source node initiate route discovery method by broadcasting a route request (RREQ) packet to its neighbor. The RREQ packet contains a sequence number and a broadcast id. Sequence numbers are used by AODV to ensure the Freshness of route. Each neighbor satisfied with the RREQ replies with the route reply (RREP) packet adding one in the hop count field. AODV is capable of both unicast and multicast Routing. (RERR) used to monitor the link status of Next hop in active Routes. When link Breakage in an active route is detected, a RERR message is used to notify other nodes of the loss of the link. Route to the source and the destination sequence number specifies how fresh a route to the destination must be before it can be accepted by the source.. The route error (RERR) is sent by intermediate node or destination in 2 conditions

(*i*) When there is no path to the destination

(*ii*) When the link breaks in the valid path to the destination

2.3 ZRP

The Zone Routing Protocol (ZRP) combines the advantages of the proactive and reactive approaches by maintaining an up-to-date topological map of a zone centered on each node. The Zone Routing Protocol, as its name implies, is based on the concept of zones. A node that has a packet to send first checks whether the destination is within its local zone using information provided by IARP. In that case, the packet can be routed proactively. Reactive routing is used if the destination is outside the zone. [11] The reactive routing process is divided into two phases: the *route request* phase and the *route reply* phase.

In ZRP, each node maintains the routing information of all nodes within its routing zone referred as an Intra-zone Routing Protocol (IARP).. The Inter-zone Routing Protocol (IERP) is responsible for reactively discovering routes to the destination beyond a node's routing zone. This is used if the destination is not found within the routing zone. The route request packets are transmitted to all border nodes, which in turn forward the request if the destination node is not found within their routing zone]. For detecting link failure and new neighbor nodes, ZRP relies on a protocol provided by the Media Access Control (MAC) layer. ZRP control traffic under different query control mechanisms was measured in [11]. The zone routing protocol is targeted for large networks.

3. SIMULATION ENVIRONMENT

The overall goal of this simulation study is to analyze the performance of reactive, proactive and hybrid routing protocols. The simulation has been performed using QualNet version 5.02 .A software that provides scalable simulations of. Only 512 byte data packets are used.

Table 1
Simulation Parameters

Protocol	AODV ,OLSR , ZRP
Simulation Time	1200sec (20 Min)
Varying No of Nodes	8 -49
Size of Packet	512 bytes
Simulation Area	800X1200 m
Simulation Time	1200sec (20 Min)
Type of Traffic	CBR
Mac Protocol	802.11
Starting time	10 sec
End time	290sec
Network area	1500*1500
Simulation Time	300sec

Simulation Environment

A two-ray propagation path loss model is used in our experiments with shadow constant model. The MAC 802.11 is chosen as the medium access control protocol. To evaluate the performance of routing protocols, we use four different quantitative metrics to compare the performance of the selected protocols. They are Packet Delivery Fraction: The 512 bytes packets sent by the applications that are received by the receivers [13].

Average End-to-end delay: End-to-end delay indicates how long it took for a packet to travel from the source to the application layer of the destination [15].

Jitter: Jitter is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes.

Throughput: The throughput is defined as the total amount of data a receiver receives from the sender divided by the time it takes for the receiver to get the last packet [16].

4. SIMULATION RESULT AND DISCUSSION

In this section simulation results for the selected protocols in term of packet delivery fraction, average end-to-end delay, jitter and throughput are elaborated.

4.1 Simulation Result for Delay

Table 2
End to End Delay at 11 MBPS

Node\ protocol	*AODV*	*OLSR*	*ZRP*
8	0.00446695	0.0151112	0.00330969
16	0.00603183	0.0426766	0.0297049
25	0.00700949	0.0460231	0.160608
36	0.0495337	0.0939732	0.0392409
49	0.0162116	0.00924988	0.0113175

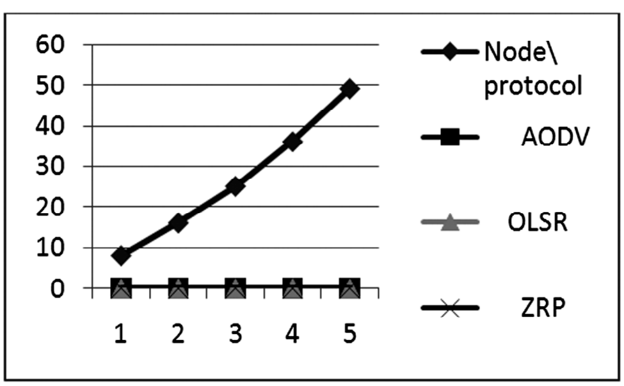

Figure 1: End to End Delay at 11 MBPS

Table 3
End to End Delay at 5.5 MBPS

Node\ protocol	*AODV*	*OLSR*	*ZRP*
8	0.01133	0.00878816	0.00843874
16	0.00531743	0.0152553	0.0278603
25	0.00979344	0.0165304	0.0148429
36	0.00888495	0.0218346	0.0168547
49	0.010235	0.0104263	0.0430628

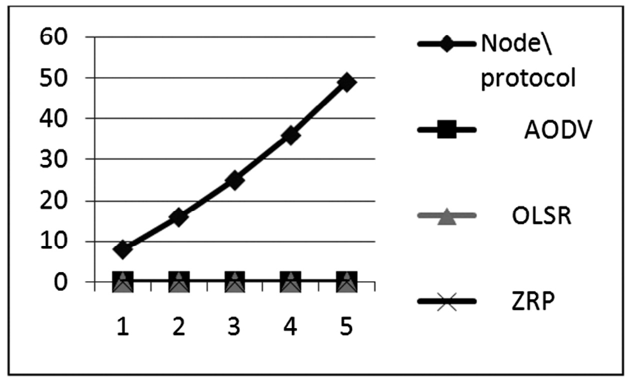

Figure 2: End to End Delay at 5.5 MBPS

As shown in figure 2 and 3, In case of delay predictions, it has been observed that AODV performs well at lower node densities while OLSR performs well at higher node densities. There is no big difference for delay variations by changing the speed from 5.5. to 11 Mbps.

4.2 Simulation Result for Jitter

Figure 4 and 5 shows value of pause time verses jitter.. AODV shows average good performance in terms of jitter though it is still higher than ZRP and OLSR protocols. AODV uses a broadcast route discovery mechanism where source node initiate route discovery method by broadcasting a route request (RREQ) packet to its neighbors so there is more scope for jitter. OLSR is proactive in nature and it provides optimal routes in terms of number of hops. For this purpose, the protocol uses multipoint relaying technique to efficiently flood its control messages. So that OLSR has less jittering than other protocol. ZRP is Hybrid type protocol that also shows better performance in terms of jitter due to reduced message flooding.

TABLE 4
Jitter at 11 MBPS

Node\ protocol	*AODV*	*OLSR*	*ZRP*
8	0.00138119	0.00621583	0.000101789

Table Cont'd

Table 4 Cont'd

16	0.00148273	0.0130145	0.00841321
25	0.000766119	0.0166394	---------------
36	0.0582152	0.0198154	0.0100124
49	0.00839131	0.00235661	0.000563443

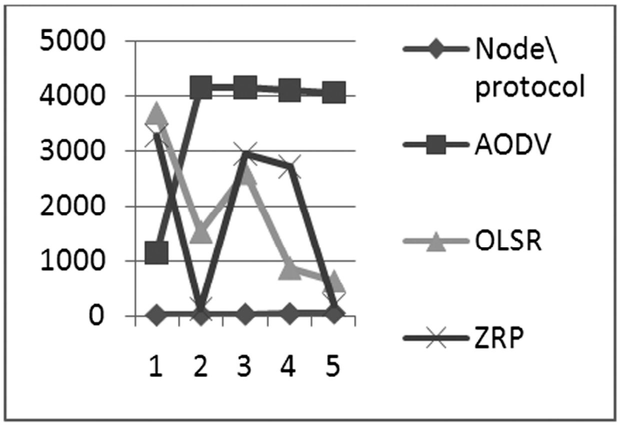

Figure 3: Jitter at 11 MBPS

Table 5
Jitter at 5.5 MBPS

Node\ protocol	*AODV*	*OLSR*	*ZRP*
8	0.0124287	0.00870483	0.00761163
16	0.00136503	0.0044731	0.00416496
25	0.00388996	0.0116241	0.00996902
36	0.00257109	0.0151501	0.0107314
49	0.00458547	0.00305458	0.0119408

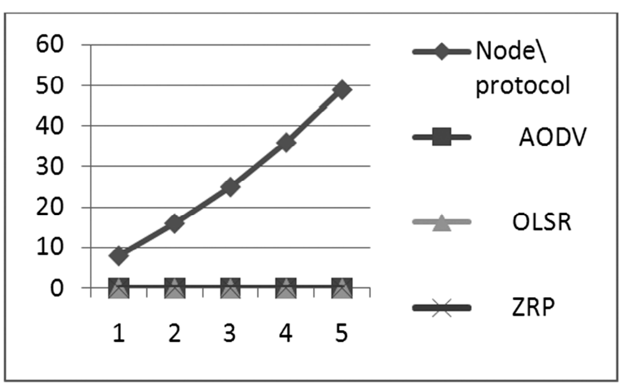

Figure 4: Jitter at 5.5 MBPS

In jitter calculations, it has found that ZRP does well at higher nodes, while AODV performs well at lower nodes at speed rate of 11 Mbps. For the speed rate of 5.5 Mbps, OLSR performs well at higher nodes while AODV predicts good results at lower nodes.

4.3 Simulation Result Throughput

In figure 5 and 6, the throughput result for 30 source nodes are shown. The graph shows ZRP has highest throughput value than other protocols. ZRP delivers data packets at higher rate because of proactive and reactive characteristics. In ZRP, while sending in INTRA zone routing protocol if it fails to send data or link breakdown occurs then INTER zone routing protocol will be activated. Henceforth data transfer will continue. OLSR has worst performance in throughput than other protocols because most of the nodes can not participate in data transfer. Another reason is link breakage since OLSR cannot repair route of breakage path. AODV shows good throughput performance.

Table 6
Throughput at 11 MBPS

Node\ protocol	*AODV*	*OLSR*	*ZRP*
8	4142	522	141
16	4142	1169	210
25	4140	228	212
36	3182	176	218
49	4169	2565	464

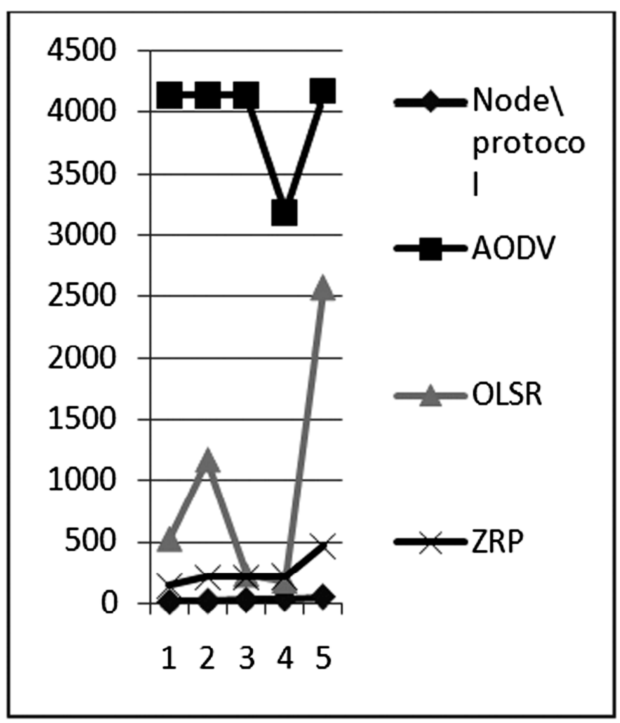

Figure 5: Throughput at 11 MBPS

Table 7
Throughput At 5.5 MBPS

Node\ protocol	*AODV*	*OLSR*	*ZRP*
8	1144	3682	3268
16	4147	1526	127
25	4152	2592	2939
36	4102	861	2716
49	4059	621	213

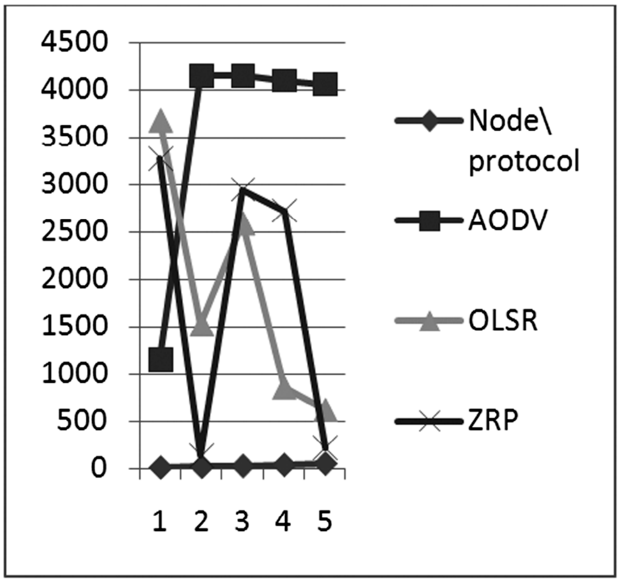

Figure 6: Throughput at 5.5 MBPS

So, In case of throughput, AODV works best, OLSR performs average and ZRP is in worst state at the speed of 11 Mbps. For the speed 5.5. Mbps, AODV again performs best while ZRP shows average results and worst performance is given by OLSR.

5. CONCLUSION

In this paper, the performance of OLSR, AODV and ZRP is compared with respect to three performance metrics.

In case of delay predictions, it has been observed that AODV performs well at lower node densities while OLSR performs well at higher node densities. There is no big difference for delay variations by changing the speed from 5.5. to 11 Mbps.

In jitter calculations, it has found that ZRP does well at higher nodes, while AODV performs well at lower nodes at speed rate of 11 Mbps. For the speed rate of 5.5 Mbps, OLSR performs well at higher nodes while AODV predicts good results at lower nodes.

In case of throughput, AODV works best, OLSR performs average and ZRP is in worst state at the speed of 11 Mbps. For the speed 5.5. Mbps, AODV again performs best while ZRP shows average results and worst performance is given by OLSR.

Finally we can conclude that in the range of 5-50 node densities, AODV is best in overall, ZRP predicts average results and OLSR is quite unsuitable for small networks with stated densities. Still the overall performance may also included with considering the other routing metrics like packet delivery ratio, packet sent, packet received and many more.

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