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Performance analysis of routing protocols in MANET

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ABSTRACT

Popularity of Mobile ad hoc network in research is due to their ad hoc nature and effectiveness at the time of disaster management when no infrastructure support is available. Due to the limited transmission range of wireless network interfaces, multiple network hops may be needed for nodes to exchange data across the network. In such a network, each mobile node operates as a router, forwarding packets for other mobile nodes in the network that may not be within the direct reach. Routing protocols developed for wired networks such as the distance vector or link state protocols are inadequate here as they not only assume mostly fixed topology but also have high overheads. This has lead to several routing algorithms specifically targeted for ad hoc networks. In this paper, we include the MANET supported routing protocols and their performance analysis over different performance parameters such as packet delivery ratio, delay, throughput, control overhead and energy etc.

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1. INTRODUCTION

Wireless network is one of the types of data communication network that utilizes wireless connections for connecting devices for exchanging information [1, 2]. Wireless network technology avoids the expensive method of the installations of cables for the data connection between devices within various locations. Radio networks and Wi-Fi local networks are two of the examples of wireless networks. There exists two main classification of wireless networks; infrastructure and infrastructure less wireless networks. In the former, the data communications are created and maintained through access points or routers. An example of this type of network is cellular networks. The latter type is basically known as Ad hoc networks. In such a network where stations are capable of created by themselves and exchanging information between them in a multi-hop style without the fixed infrastructure. Such an infrastructure less property of the network can be easily adapt in a given location.

The highly dynamic nature of a mobile ad hoc network results in frequent and unpredictable changes of network topology, adding difficulty and complexity to routing among the mobile nodes. The challenges and complexities, coupled with the critical importance of routing protocol in establishing communications among mobile nodes, make routing area the most active research area within the MANET domain [3].

2. PROPOSED MODEL

MANET has routable networking environment to process the exchange of information or packet from one node to other node. Different protocols are simulated for measuring the packet drop rate, the overhead introduced by the routing protocol, end-to-end delay of packet, network throughput, energy efficiency etc [4]. MANET Routing Protocols are typically subdivided into two main categories: Proactive Routing Protocols [5] and Reactive Routing Protocols [6]. Proactive protocols constantly analyze the network topology and gather information from it by the exchange of information among the various nodes. This means that when any route from a source to a destination is required it is available immediately. Proactive protocols essentially store routing information in one or more tables and hence they are known as table driven routing protocols [7]. Proactive protocols are Destination Sequenced Distance vector (DSDV) [8, 9], Optimum Link State Routing Protocol (OLSR), Wireless Routing Protocols (WRP). Reactive routing protocols also known as on-demand protocols [10, 11] mainly minimize traffic overhead in a network. It is based on "query reply" dialog. It is not continuous but when it is needed it creates a procedure for finding one route from source to the destination. Reactive routing protocols are Dynamic Source Routing (DSR), Ad Hoc On Demand Distance Vector (AODV) [12, 13], Ad Hoc On Demand Multipath Distance Vector (AOMDV).

Hybrid Routing Protocols-Hybrid Routing is the combination of Proactive and Reactive protocols. This protocol is used mainly in hierarchical routing. As it is hierarchical, so the high-level nodes consume more power and memory to maintain more information of routing. Zone-Based Hierarchical Link-State Routing Protocol (ZRP) is the example of hybrid protocol.

DSDV is one of the earliest protocols developed for ad hoc networks. The main idea in DSDV [14] is the use of destination sequence numbers to achieve loop freedom without any inter-nodal coordination. DSDV also uses triggered incremental routing updates between periodic full updates to quickly propagate information about route changes. DSDV maintains route entries only when required. Optimized Link State Routing (OLSR) [15] is based on link state routing where the link state information is exchanged among all other nodes in the network. The Dynamic Source Routing Protocol (DSR) [16] is characterized by the use of source routing. That is, the sender knows the complete hop-by-hop route to the destination. These routes are stored in a route cache. Ad Hoc on Demand Distance Vector Routing (AODV) is pure on-demand routing protocol. AODV uses traditional routing tables, one entry per destination [17]. AOMDV is multi path protocol which is basically extension of AODV protocol [18]. AODMV contains multiple route entries in routing tables which efficiently selects another path when required.

In performance comparision, mobility model also plays vital role. Frequently used mobility model is Random Waypoint Mobility Model (RWMM) in which nodes movement are independent towards random destination and with different velocity. To simulate the desired work, network simulator 2.34 is used. NS2 is discrete event simulator, uses C++ and OTcl languages [19, 20]. In desired simulation environment, the MANET nodes use constant bit rate (CBR) traffic sources when they send data to the Internet domain. In the simulation environment, the mobile nodes move according to our selected random waypoint mobility model. We have generated the movement scenario files using the setdest program and traffic is generated using cbrgen utility. The total duration of each simulation run is 200 seconds. Thus for simulation network parameters listed below in Table 1 are used.

Table 1. Simulation Parameters Used for Analysis

Parameter	Value
Number of nodes	10 to 100 nodes
Mobility model	Random Way Point Mobility Model
Simulation time	200 s
Topology Size	1000 m × 1000 m
Routing protocols analysed	DSDV, DSR, AODV, AOMDV, OLSR
Packet size	512 bytes

3. RESULTS AND DISCUSSION

The different performance metrics used for analysis of routing protocols for MANET are packet delivery ratio, end to end delay, routing overhead, throughput and energy consumed [21] etc. Packet delivery ratio is the ratio of the number of delivered data packet to the destination. A greater value of the packet delivery ratio means a better performance of the protocol [22-24]. AODV and DSR protocols provides highest packet delivery ratio. It is found that DSDV provides very low packet delivery ratio due to the frequent route failures and its proactive nature. Figure 1 shows a graph of the packet delivery ratio for 50 nodes MANET with random mobility by varying interval. Table 2 specifies packet delivery ratio values for different intervals.

End-to-end delay is the average time taken by a data packet to arrive at the destination [25, 26]. Only the data packets that are successfully delivered to the destinations are counted. A lower value of end-to-end delay means a better performance of the protocol. DSDV routing protocol provide very low delivery time in less traffic network. AODV is worst in case of delivery time. Figure 2 shows a graph of the delay for 50 nodes MANET with random mobility by varying interval. Table 3 specifies delay values for different intervals.

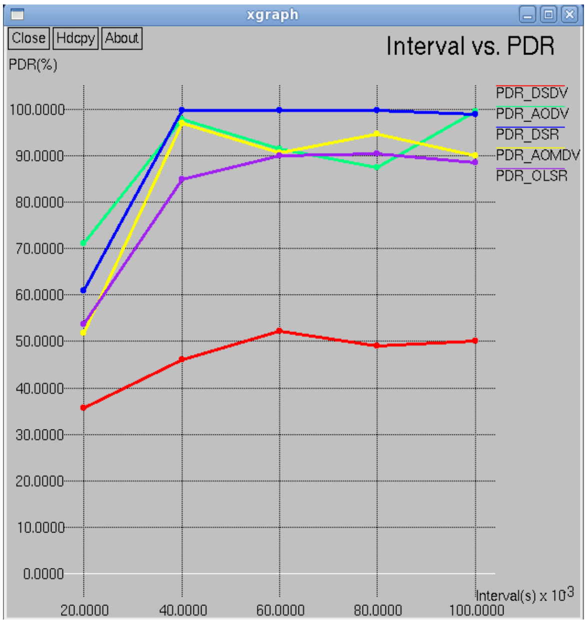

Figure 1. Interval vs. PDR

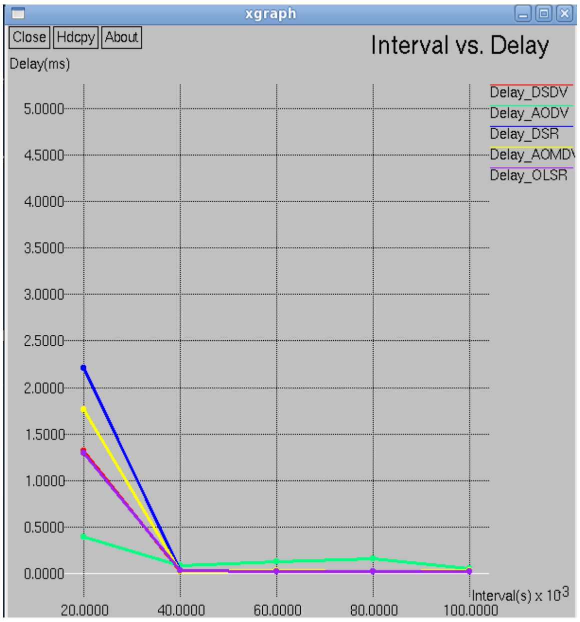

Figure 2. Interval vs. delay

Table 2. Interval vs. PDR for 50 Nodes Mobile ad Hoc Network with Random Mobility

Interval	0.02	0.04	0.06	0.08	0.10
AODV	72.36	99.75	99.12	99.07	90.00
DSDV	24.26	31.99	41.87	38.06	24.51
DSR	57.85	99.81	98.61	99.63	99.74
OLSR	53.66	84.92	90.02	90.39	88.49
AOMDV	51.84	96.92	90.50	94.61	89.95

Table 3. Interval vs. Delay for 50 Nodes Mobile ad hoc Network with Random Mobility

Interval	0.02	0.04	0.06	0.08	0.10
AODV	0.34	0.10	0.07	0.04	0.09
DSDV	1.41	0.03	0.02	0.02	0.02
DSR	2.48	0.03	0.03	0.03	0.03
OLSR	1.29	0.03	0.02	0.02	0.02
AOMDV	1.76	0.02	0.03	0.03	0.03

For successful reception of data packets to the destination, control packets are required. Control packets do not carry any useful data; In addition, they consume the bandwidth. Hence, the control overhead should be minimum. DSDV provides largest control overhead due to its proactive nature. AOMDV is multi-path routing protocol, which generates large overhead whereas, OLSR provides large control overhead because of link state updates. Figure 3 shows a graph of the control overheads for 50 nodes MANET with random mobility by varying interval. Table 4 specifies packet delivery ratio values for different intervals.

Throughput is the rate at which the data is traversing a link. As we go on increasing the interval, throughput starts decreasing[27]. DSDV provides the lowest throughput while AODV provides the highest throughput. Figure 4 shows a graph of throughput for 50 nodes MANET with random mobility by varying interval. Table 5 specifies throughput values for different intervals.

Nodes in MANET have restricted energy and computing resources. The nodes low in energy level will not be in a position to complete the routing. The routing protocols have to route the packets depending on the MANET constraints such as limited battery power in addition to the optimum path. The limited battery supply to mobile node in MANET, forces the routing protocols to minimize the energy consumption and maximize the network life time. Hence energy efficiency is one of the main problems in a MANET, especially in designing a routing protocol. Figure 5 shows a graph of the average energy consumption for 50 nodes MANET with random mobility by varying interval. Table 6 specifies average energy consumption values for different intervals.

Figure 6 shows a graph of the residual energy for 50 nodes MANET with random mobility by varying interval. Table 4 specifies residual energy values for different intervals.

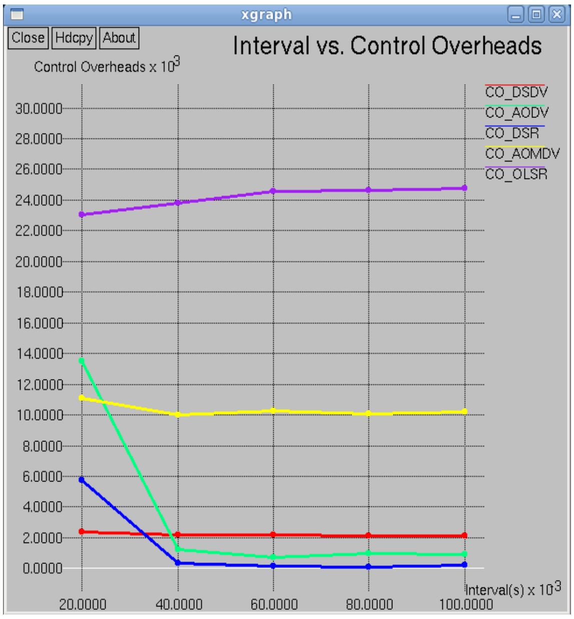

Figure 3. Interval vs. control overheads

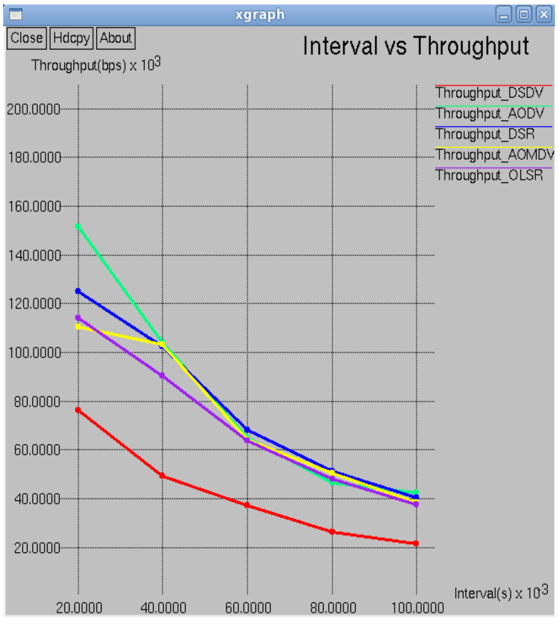

Figure 4. Interval vs. throughput

Table 4. Interval vs. Control Overheads for 50 Nodes Mobile ad hoc Network with Random Mobility

Interval	0.02	0.04	0.06	0.08	0.10
AODV	14578	1409	1147	654	750
DSDV	2457	2159	2170	2098	2085
DSR	5333	180	278	92	102
OLSR	23036	23828	24574	24659	24763
AOMDV	11093	10036	10238	10104	10195

Table 5. Interval vs. Throughput for 50 Nodes Mobile ad hoc Network with Random Mobility

Interval	0.02	0.04	0.06	0.08	0.10
AODV	154001	101909	70334	52729	38325
DSDV	51633	34052	29713	20257	10437
DSR	118726	102244	67347	51043	40890
OLSR	114218	90381	63874	48108	37683
AOMDV	110346	103149	64216	50355	38304

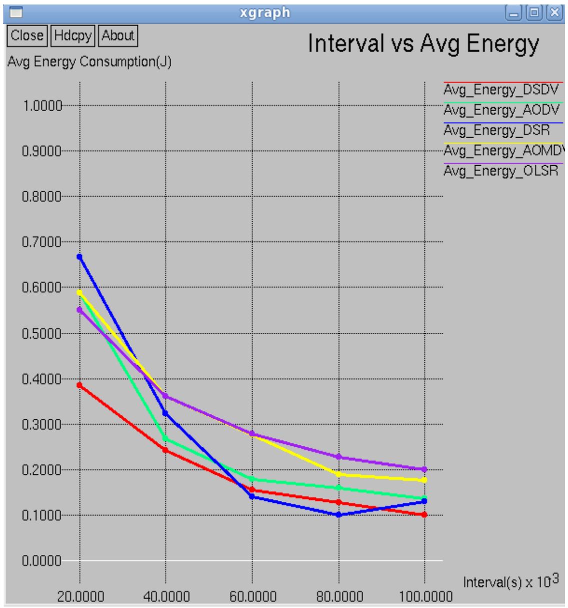

Figure 5. Interval vs. Avg. energy

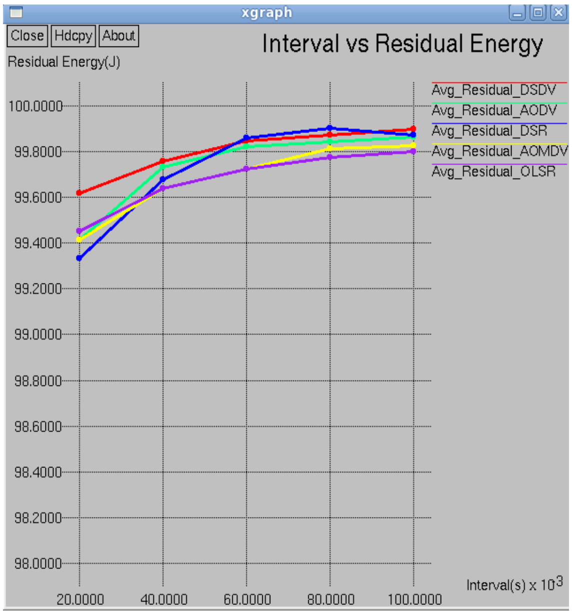

Figure 6. Interval vs. residual energy

Table 6. Interval vs. Avg. Energy for 50 Nodes Mobile ad hoc Network with Random Mobility

Interval	0.02	0.04	0.06	0.08	0.10
AODV	0.590	0.250	0.221	0.118	0.128
DSDV	0.362	0.198	0.144	0.112	0.090
DSR	0.728	0.282	0.263	0.171	0.122
OLSR	0.550	0.361	0.278	0.226	0.200
AOMDV	0.588	0.361	0.276	0.190	0.176

Table 7. Interval vs. Residual Energy for 50 Nodes Mobile ad hoc Network with Random Mobility

Interval	0.02	0.04	0.06	0.08	0.10
AODV	99.40	99.74	99.77	99.88	99.87
DSDV	99.63	99.80	99.85	99.88	99.90
DSR	99.27	99.71	99.73	99.82	99.87
OLSR	99.44	99.63	99.72	99.77	99.79
AOMDV	99.41	99.63	99.72	99.81	99.82

4. CONCLUSION

In this paper, performance analysis of existing routing protocols such as DSDV, OLSR, AODV, AOMDV and DSR is implemented. Various performance metrics such as packet delivery ratio, delay, throughput, control overhead and energy are used. The results obtained from analysis of various proactive and on-demand routing protocols shows, for low loads and low mobility, proactive protocols DSDV gives better results. End-to-end delay is less in DSDV protocols. Packet delivery ratio is highest in case of AODV and DSR Protocols. For high traffic, AODV and DSR protocols are more suitable as they generate less control overhead due to their reactive nature. AODV, AOMDV and DSR protocols provides high throughput while DSDV protocol provides less throughput irrespective of the traffic present on the network. Average energy consumption is less in DSDV protocols as compared with AODV and DSR. Thus DSDV protocol minimizes the energy consumption and maximizes the network life time.

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