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Performance Analysis of Reactive Routing Protocols AODV, DYMO, DSR, LAR in MANETs

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***Abstract*:-** MANETs are one the cutting-edgeevolving wireless technologies. The routing in mobile ad hoc networksplays a vital role and has been researchedwide-range in last decade. The routing protocols are classified as proactive,reactive and hybrid. Reactive routing protocols are considered for its advantages compared to others. In this paper, reactive routing protocols, Ad Hoc On-demand Distance Vector (AODV), Dynamic MANET On-demand (DYMO) protocol, Dynamic Source Routing protocol (DSR), Location Aided Routing protocol have been selected to analyze the performance and compare the routing protocols by varying Network size and Mobility speed to various levels. The performance metrics analyzed were Average Throughput, Average End-to-End Delay, Average Jitter, Energy Consumed in Transmit Mode, Energy Consumed in Receive Mode. The simulations were carried on Exata 5.4 simulator. The analysis of the routing protocols for the configuration setting is presented at the conclusion.

Keywords:*MANETs; EXATA; AODV; DYMO; DSR; LAR.*

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I. INTRODUCTION

Wireless networks are broadly divided as infrastructure-based network and infrastructure-less networks. Ininfrastructure-based networksi,e Cellular networks, nodes connect each other with an internet or an intranet through access point.At the other end, in infrastructure-lessnetwork, nodes communicate with each other through wireless links without any centralized administration. Such a network is called as an Ad hoc network.

MANETs are self-organizing and self-configuring multi-hop wireless networks where the structure of the network changes dynamically due to mobility of nodes. So routing in MANETs in a challenging task because of the route changes and link breaks between the path from source to the destination[1].

Routing protocols in MANETs are mainly classified into proactive, reactive and hybrid. Proactive routing protocols are alsocalled as table-driven routing protocols. In this type, every node maintains routing information to every other nodes in thenetwork even it is not required. Routing tables are updated periodically throughout the network. Reactiverouting protocol is also called as On-demand routing protocol. In this type, routing information is discovered onlywhen it is required. Route discovery and Route Maintenance are the two phases in routing. Reactiverouting protocols perform better compared to proactive routing protocols. Features of Proactive and reactive routing protocols combined toform as hybrid protocols [2].

AODV, AODV version 2 (DYMO) , DSR and LAR are some of the popular reactive routing protocols. DYMO is AODV version 2, a successor of AODV and is a new reactive routing protocol [3]. It functions similar to AODV. It addssome extra features to extend AODV protocol. It is an energy-efficient protocol compared to other reactive routing protocols [4]. The Dynamic Source Routing Protocol (DSR) is a source-routed on-demand routing protocol. A node maintains route caches containing the source routes that it is aware of. The node updates entries in the route cache as and when it learns about new routes.LAR [5] [6] is on demand routing protocol like AODV and DSR. It utilizes location information of mobile nodes to decrease the routing overhead.

The rest of the paper is organized as follows – section II presents the Literature survey of the related work, section III describes the Overview of Routing protocols, Section IV presentsExperimentation and SimulationEnvironment, Section V presents Performance Evaluation and Result Analysis, Section VI describes Conclusions and Future Scope of work.

II. LITERATURE REVIEW OF RELATED WORK

Maya C Aravind et al. [7] reviews comparison of DYMO routing protocol with AODV and DSR protocols.

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The performance of DYMO routing protocol compared to AODV and DSR with QoS metrics is analyzed. The author indicates the advantageous features i,e path accumulation and less routing overhead in DYMO.

MdARafatur et al. [8] compared the performance of proactive, reactive and hybrid routing protocols for MANET with Qualnet 4.5 simulator using dense network size and at realistic mobility speed. The performance is evaluated based on Throughput, Packet Delivery Ratio, Average End to End Delay and Jitter. Simulation resultsindicate that DYMO outperforms AODV, OLSR and ZRP in terms of Packet Delivery Ratio .OLSR and ZRP performs best with respect toEnd to End Delay and Jitter and ZRP showed best outcome in terms of Throughput compared to DYMO, AODV and OLSR.

Ha DuyenTrung et al. [9]compares the performance of four different protocols for ad hoc networks and proposes a location multipath routing-based approach by extension of LAR. The performance metrics are analyzed using varying network load andmobility. Simulations demonstrate proposed LAMR outperforms LAR and AODV in most mobility scenarios. This paper describes the performance evaluation and comparison of four routing protocols and also discusses the solutions for security in MANET.

Dong-Won Kum et al. [10] compares two reactive routing protocols - AODV and DYMO using an ns-2 simulator based on total throughput, routing overhead, and average packet size of the routing control packets. The simulation results reveal that with the path accumulation feature of DYMO routing overhead is reduced; the routing packet size is increased.

Ricardo de Oliveira Schmidt et al. [11] presents an evaluation of two routing protocols OLSR, DYMO for MANETs in a scenario with high mobility. The results indicate that DYMO outperforms OLSR in terms in delivery rates, low routing overhead.

III. OVERVIEW OF ROUTING PROTOCOLS

Routing protocols are classified as proactive, reactive and hybrid. Reactive routing protocols are discussed here.Most prominent protocols are AODV, DYMO, LAR and DSR. DYMO is a new reactive protocol.

AODV:

AODV expandedas Ad-hoc on demand distance vector routing protocol. It is aenhancementto the DSDV routing protocol. It performs Route Discovery and Route Maintenance process and incorporates hop-by-hop routing concept from DSDV [1].InAODV, routing information is delivered on-demand ie, routes will be discovered only as and when required. AODV solvesthe count toinfinity problem by including sequence numbers are used to trace the exact route information [12].

AODV periodically broadcasts HELLO messages to the neighboring nodes to know theconnection between the nodes. When the source node wants to establish a route to the destination node, it broadcasts an RREQ message. This RREQ message is sent by the sourceto its intermediate nodes, if the node receiving a RREQ does not have a route to the destination. It then rebroadcast theRREQ to its next immediate neighbors until it reaches the destination. If link break occurs then the node generates RERR message and forwards to the neighbouringnodes[13].

DSR:

DSR expanded as Dynamic Source Routing. It is a reactive routing protocol which has two main operations: routediscovery and route maintenance. It uses the route caching concept. Route discovery is used by a source node to establish a route to destination node. Source node broadcasts RREQmessage and intermediate node receives RREQmessage, it appends its address and forwards it again till it reaches the destination. When the destination node receives the RREQ, it initiates a RREPmessage and sends it back to the sourcealong the route in the RREQ message. When the source receives the RREPmessage from the destination, it caches the route in its route cache. In the route maintenance phase, this protocolrequires the next hop to acknowledge receiving the packet. If there is a breakage in the route, the source node will receive aRERR packet indicating the link is broken. The source node will use alternate route in the route cache or start newrouting discovery process [13].

DYMO

DYMO stands for Dynamic MANET On Demand Routing Protocol. It is a successor of AODVrouting protocol. DYMO is a purely reactive routing protocol in which routes are discovered on demand i,e as when needed. DYMO supports the feature of Path accumulation. DYMO does not support unnecessary HELLO messages and operation is purely based on sequence numbers allotted toall the packets.It incorporates sequence numbers to ensure loop freedom. The basic operations are route discovery and maintenance. Route discovery isperformed at source node to a destination for which it does not have a valid route. And route maintenance is performed toavoid the existing routes from the routing table [2].

LAR:

LAR is reactive routing protocol like AODV and DSR. It tries to reduce the routing overheads present in the traditional flooding algorithm by using location information. Thisprotocol assumes that each node knows its location

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througha Global Positioning System (GPS) [14]. Two different LARschemes were proposed, the first scheme computesa request zone which defines a boundary where the route request packets can travel to reach the required destination.The second method stores the coordinates of the destinationin the route request packets [14]. These packets can only travel inthe direction as the relative distance to the destination becomessmaller as they travel from one hop to another. Both methodslimit the control overhead transmitted through the networkand hence conserve bandwidth. They will also find theshortest path to the destination, since the routerequest packets reach from the source and toward thedestination. The limitation of this protocol is that eachnode should have GPS[14].

IV. EXPERIMENTATION AND SIMULATION ENVIRONMENT

Simulation Environment:

Simulation environment set for the experimentation is described as follows. The experimentation is carried out on Windows Operating System with Exata Simulator. Mobile ad hoc network is formedwith network size 20,40,60nodes at aterrainsize for the simulation environment of1000 x1000 sqmts. Propagation model used for the network is two-ray ground, traffic application type is CBR, Mobility model used is Random way point, mobility speeds chosen are 5,10,15, 20, 25 m/sec. Pause time is set to zero, which indicates all nodes are at highmobility speed and with packet size is 512 bytes. The routing protocols used for simulations are AODV, DYMO,DSR,LAR. Simulation time for the scenario execution is 900 sec. Energy Model is set to generic. Battery Model is set to Linear. The Performance metrics evaluated are Unicast Throughput Received (bps), Average End-to-End Delay,Average Jitter, Energy consumed in transmit mode and Energy consumed in receive mode.Simulation parameter settings are shown in the Table 1.

TABLE I. PARAMETER SETTING FOR SIMULATION PROCESS

Parameter	**Value**
Simulator	Exata 5.4
Routing Protocol	AODV, DYMO,DSR,LAR
Propagation Model	Two Ray Ground
Packet size	512 bytes
Network size	20,40,60
Mobility speed	5,10,15,20,25 m/sec
Pause Time	0 sec.
Data rate	2 Mbps
Node placement	Random
Radio Type	802.11b
Battery Model	Linear
MAC Layer	IEEE 802.11
Application Traffic	CBR
Antenna Type	Omni directional
Simulation Time	900 sec.
Terrain size	1000 x 1000 sq.mts
Mobility Model	Random way point

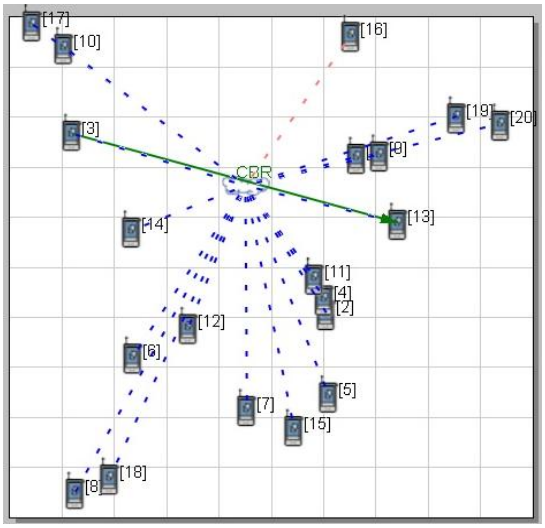

Figure 1. Simulation Scenario at the beginning

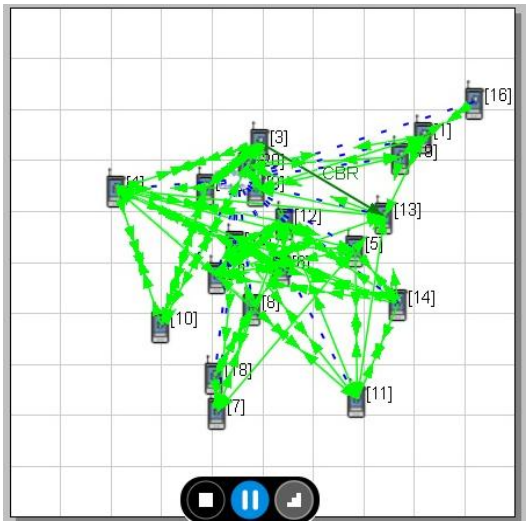

Figure 2. Simulation Scenario Execution

V. PERFORMANCE EVALUATION AND RESULT ANALYSIS:

The performance evaluation of the routing protocols is analyzed through various performance metrics as follows.

A. Average Throughput (TP): Average Throughput is the average number of packets successfully delivered per unit time i.e.bits delivered per second. Also refers to the amount of data transfer from source mode to destination in a simulatedamount of time [5].

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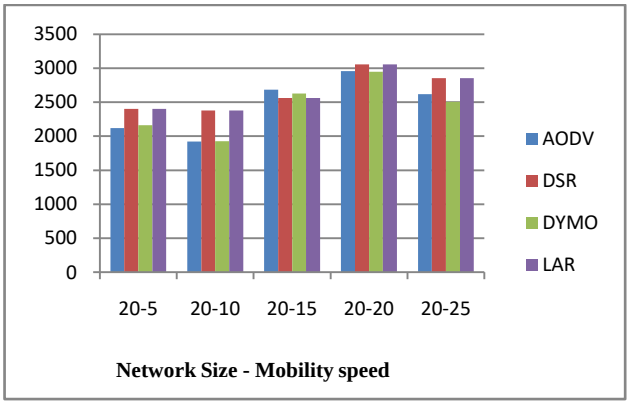
B. Average End-to-End Delay(ms): End-to-end delay indicateshow long it took for a packet to travel from the sourceto the application layer of the destination [3]

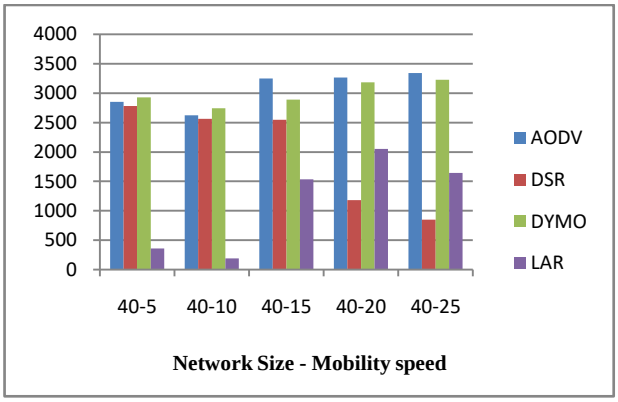
C. **Average Jitter(ms)**: Jitter is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes.

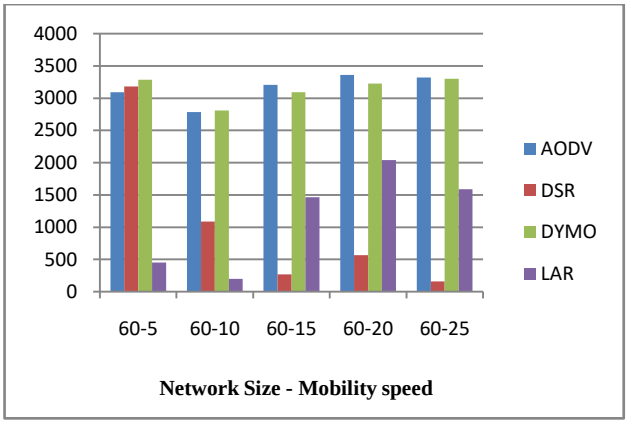
D. Energy Consumed in Transmit mode: Energy Consumed by all nodes during the transmission of the packets in the transmit mode.

E. **Energy Consumed in Receive mode:** Energy Consumed by all nodes during the reception of the packets in the receive mode.

A. Average Throughput(bps):

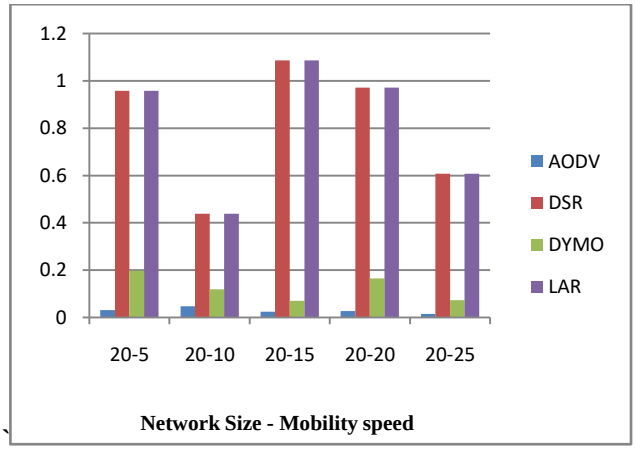


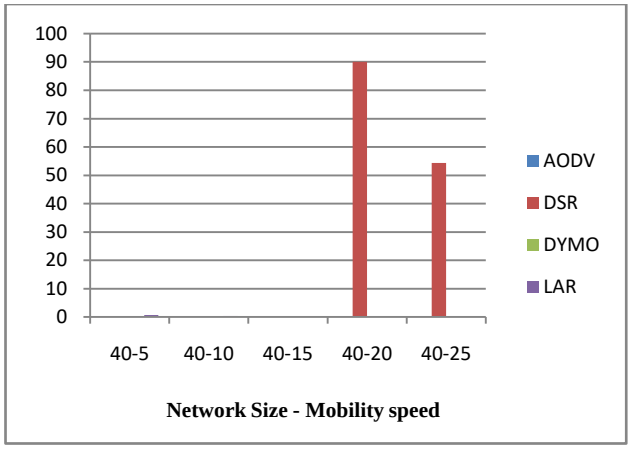




From the graphs, Average Throughput is analyzed. In all cases, we found that for lower network size at mobility speed 20 m/sec all protocols give optimum throughput. For medium network size except LAR at mobility 5 gives optimum values. LAR is not suitable for medium network size at all speeds. In case of DSR, as the mobility increases throughput decreases. For larger networks, DSR, LAR gives the minimum performance. In DSR, as the mobility increases throughput gradually decreases. In all cases AODV,DYMO gives steady state performance for all network sizes and mobility speeds also as the mobility increases DYMO performance increases in most cases of network sizes. LAR is not supported for medium and large networks.

B. Average Unicast End-to-End Delay (seconds) (AEED)





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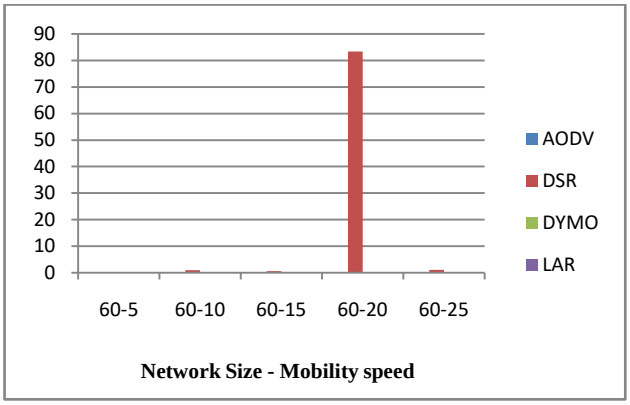
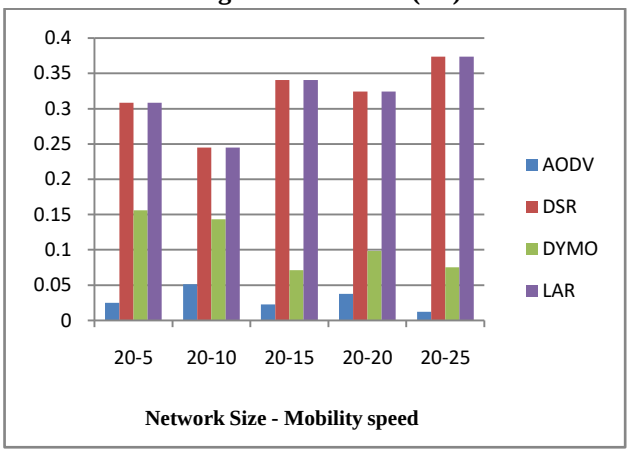
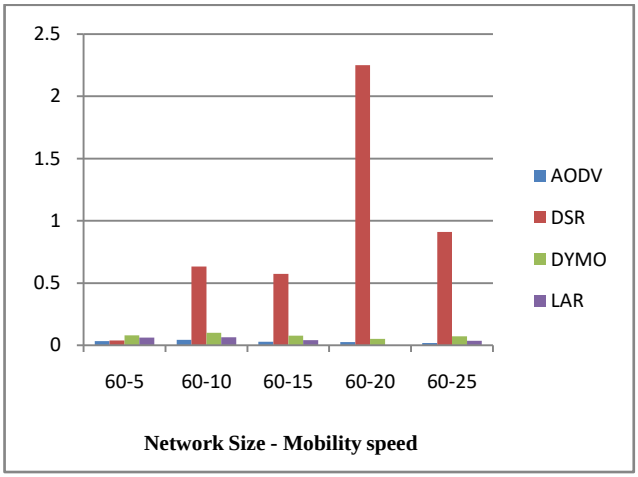
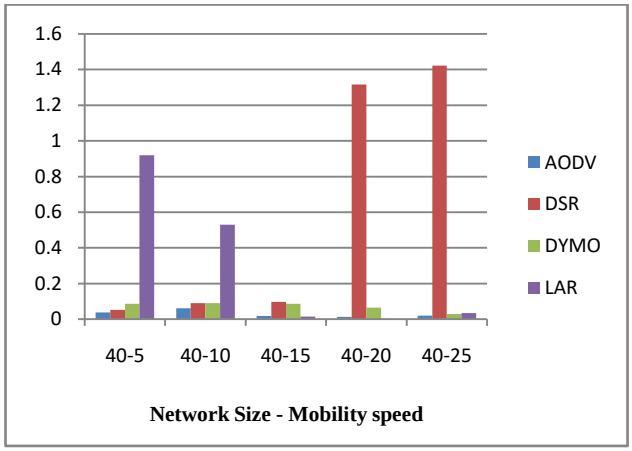


From the graphs, Average End-to-End Delay (AEED) is analyzed. It is observed that DSR,LAR has higher AEED at lower network size when compared to AODV and DYMO. DSR has high AEED athigher mobility speeds (20 and 25 m/sec) for medium network size and high AEED at 20 m/sec for large network size. From the above, DSR shows higher AEED when compared to other protocols in most cases. AODV, DYMO has minimum Average End to End Delay at all network sizes.

C. Average Unicast Jitter (ms)

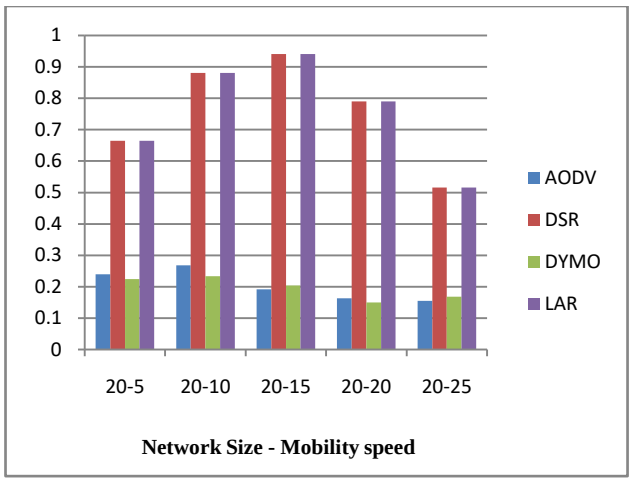


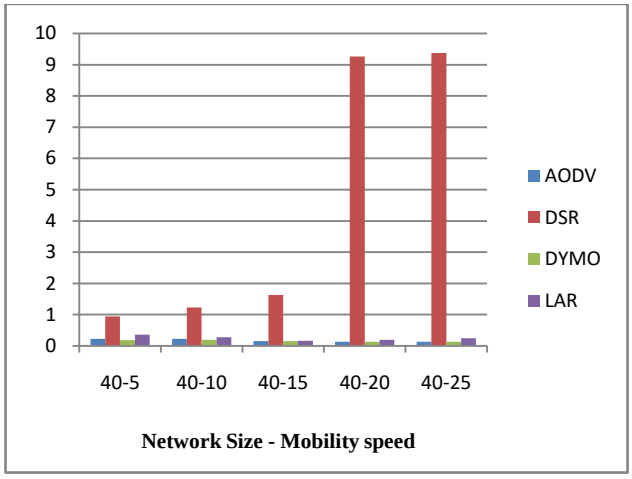




From the graphs, Average Jitter is analyzed. It is observed that DSR,LAR has higher Average Jitter at lower network size when compared to AODV and DYMO. DSR has high Average Jitter athigher mobility speeds (20 and 25 m/sec) and LAR has high Average Jitter at lower mobility speeds (5 and 10 m/sec) for medium network size and DSR indicates high Average Jitter for largenetwork size. From the above, DSR shows higher Average Jitter when compared to AODV, DYMO, LAR in most cases. AODV, DYMO has minimum Average Jitter at all network sizes.

D. Energy consumed (in mWh)in Transmit mode





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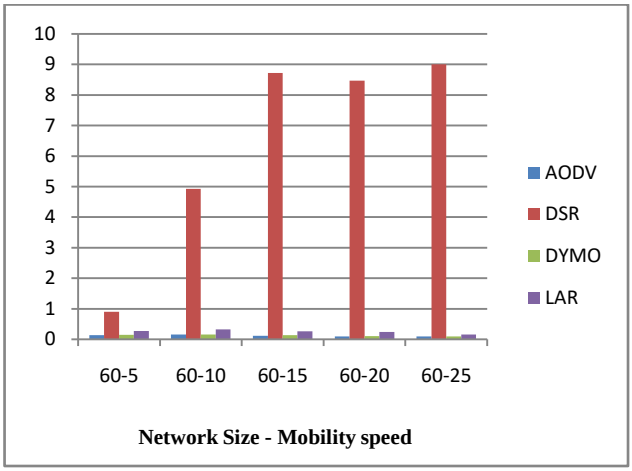
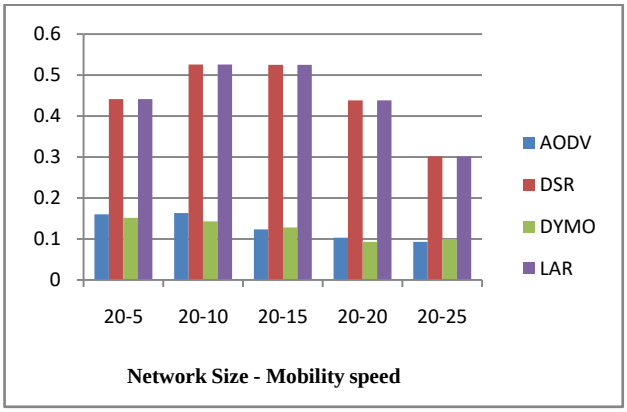
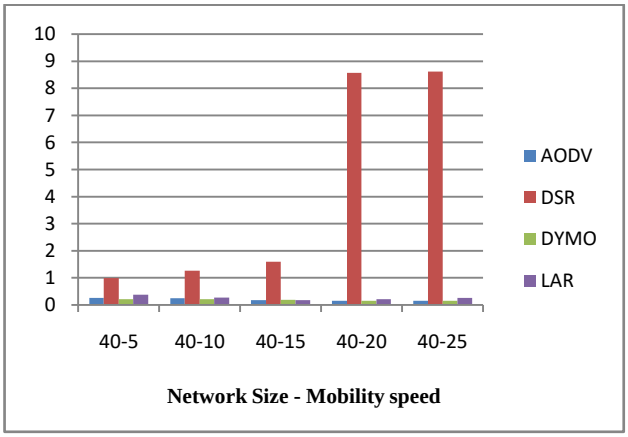
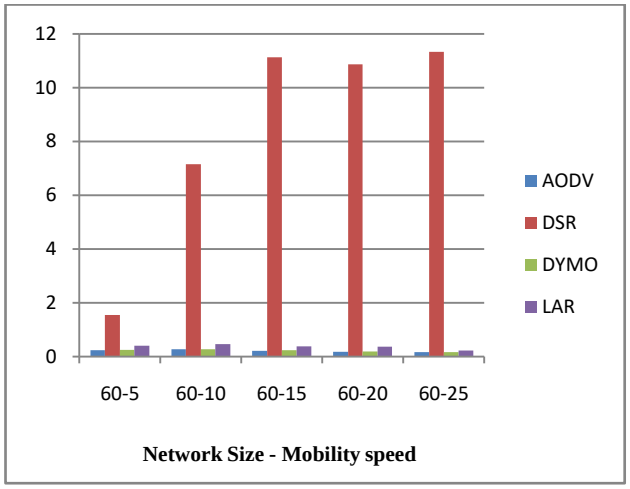


From the graphs, Energy consumed in Transmit mode is analyzed. It is observed that DSR, LAR has higher Energy consumption in Transmit mode at lower network size when compared to AODV and DYMO. DSR has high Energy consumption all mobility speeds for medium and largenetwork sizes when compared to AODV,DYMOand LAR. From the above, it shows that DSR has the higher Energy consumption in Transmit mode and AODV, DYMO has minimum at all network sizes.

E. Energy consumed (in mWh)in Receive mode







From the graphs, Energy consumed in Receive mode is analyzed. It is observed that DSR, LAR has higher Energy consumption in Receive mode at lower network size when compared to AODV and DYMO. DSR has high Energy consumption at all mobility speeds for medium and large networksizes when compared to AODV, DYMO and LAR. From the above, it shows that DSR has the higher Energy consumption in Receive mode and AODV, DYMO has minimum at all network sizes.

VI. CONCLUSIONS

The performance comparison of routing protocols AODV, DYMO, DSR, LAR is evaluated using Exata 5.4 Simulator. The comparison is carried out with various network sizes i,e 20,40,60 nodesi,e. low, medium and large network sizes respectively and mobility speeds 5, 10,15,20,25 m/sec for thorough analysis. The performance metrics considered for evaluation are Average Throughput,Average End to End Delay, Average Jitter, Energy Consumed in Transmit mode, Energy Consumed in Receive mode.

From the graphs, it is observed that Average Throughput for lower network size at mobility speed 20 m/sec all protocols give optimum throughput. For medium network size except LAR at mobility 5 gives optimum values. LAR is not suitable for medium network size at all speeds. In case of DSR, as the mobility increases throughput decreases. For larger networks, DSR, LAR gives the minimum performance. In all cases AODV, DYMO gives steady state performance for all network sizes and mobility speeds also as the mobility increases DYMO performance increases in most cases of network sizes.

Average End-to-End Delay (AEED) is observed that DSR, LAR has higher AEED at lower network size when compared to AODV and DYMO. DSR has high AEED at higher mobility speeds (20 and 25 m/sec) for medium

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network size and high AEED at 20 m/sec for large network size. DSR shows higher AEED when compared to other protocols in most cases. AODV, DYMO has minimum Average End to End Delay at all network sizes.

Average Jitter is observed that DSR, LAR has higher Average Jitter at lower network size when compared to AODV and DYMO. DSR shows higher Average Jitter when compared to AODV, DYMO and LAR in most cases. AODV, DYMO has minimum Average Jitter at all network sizes.

Energy Consumed in Transmit mode and Receive mode is observed that DSR, LAR has higher value at lower network size when compared to AODV and DYMO. DSR has high Energy Consumption all mobility speeds for medium and large networks when compared to AODV, DYMO and LAR. It clearly indicates that DSR has the higher Energy Consumption in Transmit and Receive mode AODV, DYMO has minimum at all network sizes.

The results clearly indicate that the DSR routing protocol is not suitable for network sizes and mobility speeds for the considered performance metrics when compared with AODV, DYMO, LAR protocols. AODV and DYMO show steady state performance for all network sizes and mobility speeds. The work may further extended considering various propagation models, pause times, mobility models on the routing protocols to understand the routing protocols performance in various aspects.

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