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Performance Analysis of MANET Routing Protocols with UDP and TCP under VBR traffic

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Abstract: Identifying network quality in Mobile Ad hoc Network (MANET) is very challenging issue because of its decentralization infrastructure and dynamic variation of users. It involves consideration of various parameters: such as transport layer protocol, packet size, number of users and selected routing protocol. In this work we carry out a number of simulations to evaluate the behavior of routing protocols (Proactive and Reactive) in relation of transport layer agents User datagram Protocol (UDP) and Transmission Control Protocol (TCP). The main attention of work is to analyze the behavior with variation of number of nodes. For the work we have selected AODV, DSDV and AOMDV routing protocols and traffic data rate is considered as variable Bit Rate (VBR). Simulations are done by NS2. For results the performance is analyzed with metrics such as throughput, packet delivery ratio and end-to-end delay.

Keywords: MANET, TCP, UDP, AODV, DSDV, AOMDV.

1. INTRODUCTION

Mobile Ad hoc Network (MANET) are considered as are very dynamic wireless networks without any specific infrastructural topology (Tuteja, *et al.,* 2010). MANETs comprises mobile nodes which can be added dynamically without any deployment of central or fixed infrastructure (Bagwari *et al.,* 2012), (Shaikh, *et al.,* 2013), where communication links between nodes are transparently established as the nodes enter in communication range of any node. In MANET the network quality involves multiple issues at every layer of network including MAC, network layer design and routing protocols (Mohapatra and Kanungo, 2011).

Unlike traditional system MANET constantly amend physical topologies and needs sensitive routing protocols involves dynamic and consistent change of topologies of nodes (Sharma, *et al.,* 2010), on the other side the performance of routing protocols diverge in contrast of used agent (Transport protocol) and network load (Chaudhary, 2012).

Focus of this work was to analyze the performance of routing protocols with the variation of transport agents (UDP and TCP) and number of nodes. Network performance was analyzed by Throughput, end to end delay and packet delivery ratio.

The paper organized as follows. Description of routing protocol is discussed in Section 2. Section 3 presents research review and in Section 4network model and parameter settings for simulation are presented. Results and discussions are highlighted in section 5 and we conclude the work in Section 6.

2. ROUTING PROTOCOLS IN MANET

Routing in MANET involves two functions; identify and establish the optimal path and transfer the data by that link (Agrawal, *et al.,* 2011). Broadly Routing protocols in MANETs are divided in three categories: Proactive, Reactive and Hybrid (Kaur *et al.,* 2013).

2.1 Proactive Routing Protocols

Proactive routing protocols are table-driven routing protocol (Jhaveri, Patel and Jinwala, 2012). In this approach a path between source and destination is predefined, in proactive routing protocols, the routes are updated randomly and dynamically, there is no requirement of route discovery. Concurrently packets move on those links which identified as high data rate routes. DSDV, DTDV, OLSR, LCA etc. are examples of proactive-routing protocols. In our work we selected Destination Sequenced Distance Vector (DSDV) protocol as one of a proactive routing protocol.

2.2 Reactive Routing Protocols

Reactive routing protocols are on-demand routing protocols. The routes are discovered when needed for communication (Bhat *et al.,* 2011), (Bilandi, 2012). Reactive routing protocols are more scalable under huge network traffic. AODV, ABR, DSR and AOMDV are some types of reactive routing protocols. For our work we considered AODV and AOMDV as the reactive routing protocols.

2.3 Hybrid Routing Protocols

Combination of Reactive and Proactive protocols is known as hybrid routing protocol. These protocols

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were planned to overcome the drawbacks of reactive and proactive routing protocols such as control overhead of proactive protocols and latency of reactive routing protocols (Tseng, *et al.,* 2011). ZRP (Zone Routing Protocol) and TORA (Temporally Ordered Routing Algorithm) are examples of hybrid routing protocols.

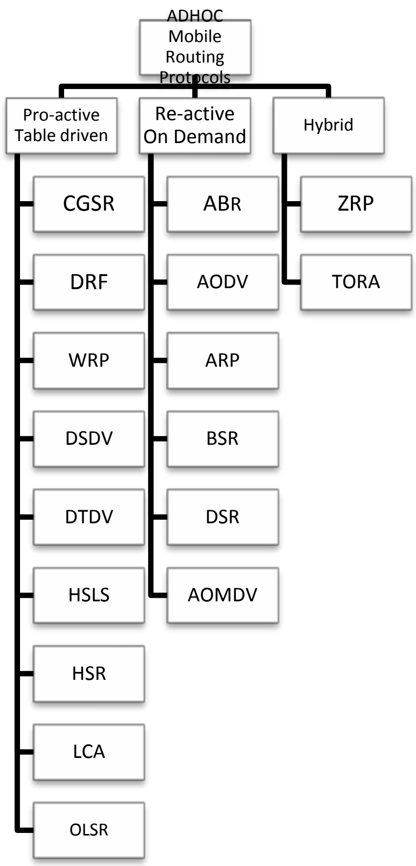

Fig. 1 : Taxonomy of Routing Protocols (Yasin, *et al.,* 2013)

3. RESEARCH REVIEW

Routing is key issue in MANETs, various routing protocols are available for MANETs in the categories of reactive, proactive and hybrid. In the support of routing protocol, network quality is depended on various other parameters such as data rate shaping, transport layer protocols and number of nodes. Lot of research material is available on the analysis of these routing protocols under selection of different routing protocols and network parameters. In the work of (Bhatt and Bhatt, 2015), the performance of four routing protocols i.e. AODV, TORA, DSR and OLSR is analyzed in terms of throughput and packet end to end delay. The work is limited to network application of FTP under TCP. The work of (Singh and Rozy, 2015), focused on comparative analysis of transport protocols for two routing protocols. They worked for transmission control protocol (TCP) and user datagram protocol (UDP). The analysis is based on the variation of routing protocols (OLSR and TORA) and mobility models (reference point group, random waypoint and Manhattan mobility). (Singh, *et al.,* 2015) selected three protocols AODV, OLSR and DSR to evaluate the performance of network with the consideration of mobility and scalability.

In (Mahajan, 2014) the authors focused the VBR traffic and TCP to analyze the performance of DSR protocol. (Kaur, *et al.,* 2013) studied the performance of OSLR, DSR and AODV routing protocols under two different applications i.e. HTTP and Data Base. They found that under heterogeneous applications OLSR offers stable results as compared to AODV and DSR. Their work was limited to number of nodes up to 50. The authors (Yasin, *et al.,* 2013) have focused on the behavior of proactive, reactive and hybrid protocols, they analyzed OSLR, DSR, AODV and TORA using video application, data rate of traffic is chosen as CBR, number of nodes to 50 and Transport protocol as UDP. They suggest the OSLR work better for multimedia applications. The performance of OSLR, DSR and AODV is evaluated in (Adam *et al.,* 2011) with background application of video transmission. The work is based on UDP.

In this work we analyzed the behavior of two categories of MANET routing protocols. We select Proactive (DSDV) and Reactive (AODV, AOMDV) Protocols.

Mostly researchers focused on any one of transport protocols TCP or UDP and their preferred data rate format is CBR which is associated to limited applications. In this work we use both transport protocols (TCP and UDP) while the traffic data rate is set as VBR traffic this is in support of multimedia application. This effort shows the support of routing protocol associated with TCP and UDP. The number of nodes is specified as 100 with the variation of 4 points 20, 40, 60 and 80 active nodes.

Following table highlight the significance of our work in relation of pervious research work.

Table 1 : Summary of research review

Publication	Protocols	Protocols Category	Network Data rate	Transport Protocol	No. of nodes
(Bhat, *et al.,* 2015)	AODV TORA DSR OLSR	Proactive Reactive Hybrid	CBR	TCP	50
(Singh, *et al.,* 2015)	OLSR TORA	Proactive Hybrid	CBR	TCP UDP	50
(Singh, *et al.,* 2015)	OLSR TORA	Proactive Reactive	CBR	TCP	100
(Mahajan, S. 2014)	AODV OLSR DSR	Reactive	VBR	TCP	50

(Kaur, *et al.*, 2013)	DSR	Proactive Reactive Hybrid	CBR	TCP	50
(Yasin, *et al.*, 2013)	OSLR DSR AODV TORA	Proactive Reactive	CBR	UDP	50
(Adam, *et al.*, 2011)	AODV DSR OLSR	Proactive Reactive	CBR	UDP	50
Proposed Work	DSDV AODV AOMDV	Proactive Reactive	VBR	TCP UDP	100

4. SIMULATION SETUP AND PERFORMANCE METRICS

In our work the NS2 tool was used to simulate the behavior of routing protocols (AODV, DSDV and AOMDV). For that each routing protocol (AODV/DSDV/AOMDV) was analyzed with variation of number of nodes and transport layer protocols with VBR. Network contains 100 nodes, for variation we select 20, 40, 60 and 80 active nodes in different scenarios. **(Fig. 2)** presents the simulation setup of the system.

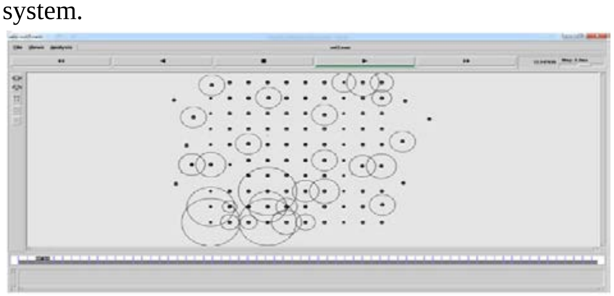

Fig. 2 : Simulation Setup for System Design (NS2)

Table 2 presents the used simulation parameters and their values. For signal propagation and mobility, the System is simulated with random walk model and Two Ray Ground Propagation.

Table 2 : Simulation Parameters and Settings

Simulation Parameters	Settings
# Nodes	100
Environment Area Size	2800 x 1500 sq.m.
Antenna type	Omni
Ch. Radio Propagation	Two Ray Ground
Agent	UDP, TCP
Mobility models	Random Walk movement
Sig. Propagation Model	Two Ray Ground Propag.
Routing protocols	AODV/DSDV/AOMDV
Simulation time	300 sec
Traffic source	VBR
Call duration time	150
Call gap time	150

Traffic parameters are highlighted in **Table 3**, traffic data rate is supposed to be Variable, where packets sizes and data rates have initial and maximum limits for variation.

Table 3 : VBR Parameters and settings

VBR Parameters	Settings
data rate	512 Kb
max rate	4 Mb
rat_dev	0.25
burst rate	1
rate time	2
time_dev	0.5
pkt size	8192 bytes
max pkt size	10000000
Constant	FALSE
No. of changes	4

5.

6. RESULTS

The performance of Routing protocols is expressed by three metrics, End to End Delay, Throughput and Packet delivery Ratio. Results and discussion of every metric is presented in following sections.

6.1 Delay Analysis

(Fig. 3), **(Fig. 4)**, and **(Fig. 5)** show the variation of end to end delay in association of AODV, DSDV and AOMDVprotocols under UDP and TCP with VBR traffic. These results are further explained by **Table 4**. From these results it's clear that in all routing protocols, overall TCP offer minimum delay as compared to UDP, that is because the system uses VBR, where TCP window sizes could vary according to data rate.

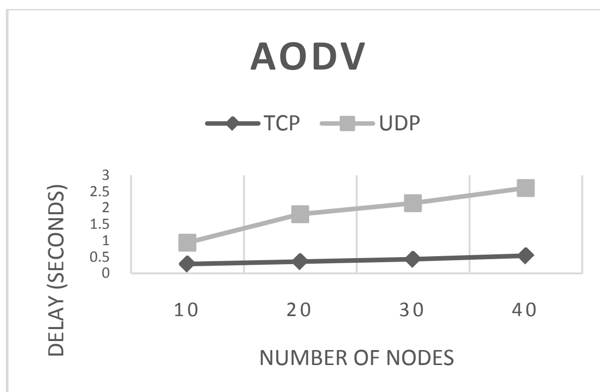

Fig. 3 : AODV - End to End Delay versus Number of Nodes

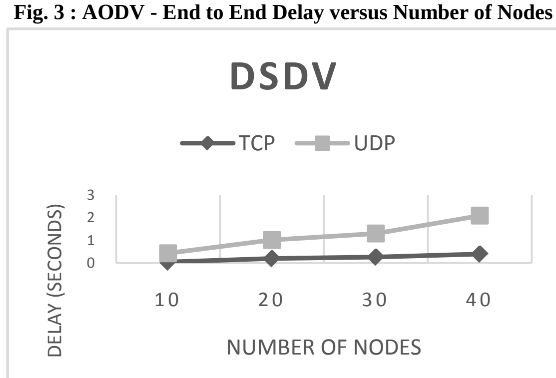

Fig. 4 : DSDV - End to End Delay versus Number of Nodes

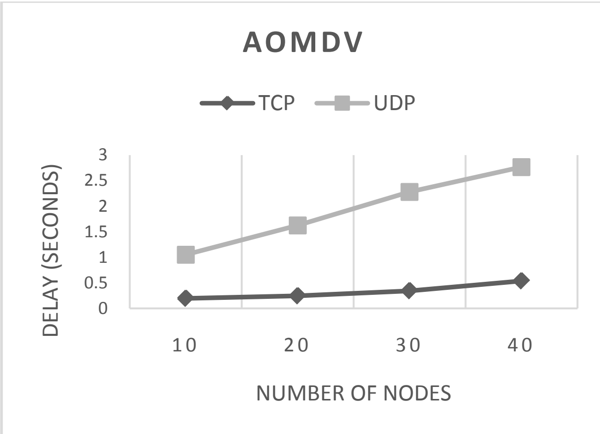

Fig. 5 :AOMDV - End to End Delay versus Number of Nodes

Table 4 : End to End Delay Analysis

Routing Protocol	Source Nodes	Dest. Nodes	Total Pkt Sent	Pkt Rec UDP	Pkt Rec TCP	E to E Delay (sec) UDP	E to E Delay (sec) TCP
AODV	10	10	110176	60527	45164	0.653	0.284
	20	20	218224	73518	55518	1.454	0.356
	30	30	292448	70384	52115	1.719	0.428
	40	40	405072	70044	49657	2.075	0.536
DSDV	10	10	110176	41344	38692	0.433	0.045
	20	20	218224	63626	67630	1.0154	0.197
	30	30	292448	71041	71550	1.304	0.261
	40	40	405072	71897	70457	2.091	0.395
AOMDV	10	10	110176	47466	42070	1.051	0.196
	20	20	218224	75388	66609	1.623	0.245
	30	30	292448	69158	62756	2.278	0.345
	40	40	405072	75086	60239	2.765	0.538

Table 4identify that AOMDV is more delay sensitive then other two protocols DSDV and AODV. DSDV was with minimum delay variation up to nodes 60, as nodes increased from 60, a rapid raise in delay was observed. Same variation is observed under TCP protocol.

6.2 Throughput Analysis

(Fig. 6), **(Fig. 7)**, **(Fig. 8)** are related to Throughput results. In the cases of AODV and AOMDV, UDP have higher throughput value then TCP, while DSDV have opposite results, **(Fig. 7)** shows that DSDV offered higher throughput with TCP.

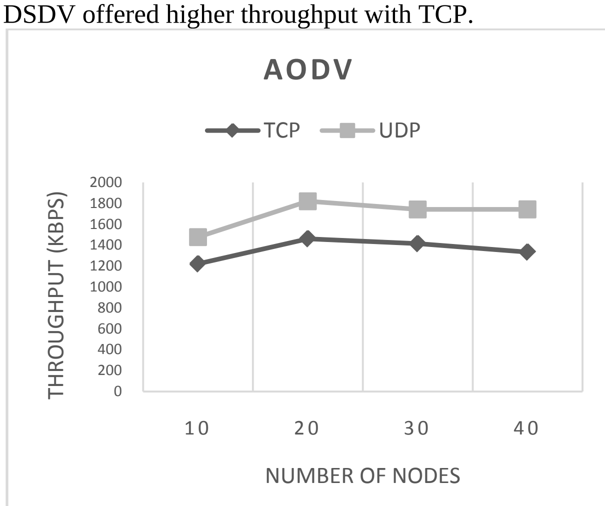

Fig. 6 : AODV – Throughput versus Number of Nodes

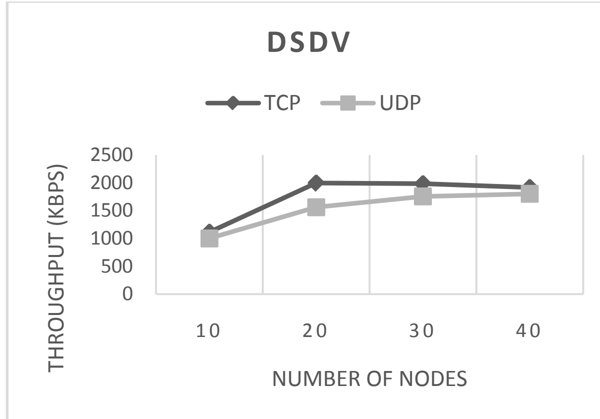

Fig. 7 : DSDV – Throughput versus Number of Nodes

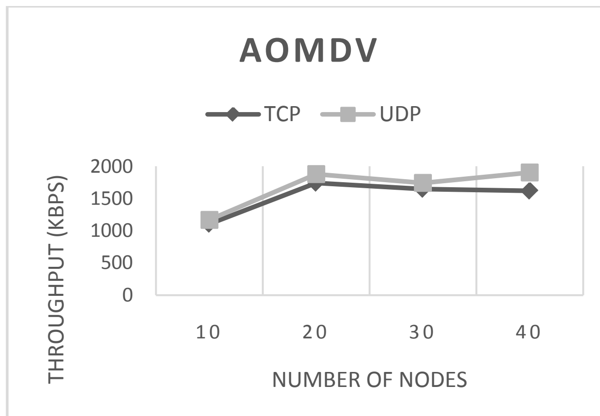

Fig. 8 : AOMDV – Throughput versus Number of Nodes

Itis obvious that in AOMDV the variation of throughput with UDP and TCP are closely related, averagely AODV have higher throughput with UDP than AOMDV, while AOMDV have sharp variation as number of nodes are varied. DSDV have maximum throughput with TCP and stay constant as the number of nodes are increased.UDP throughput is higher in **(Fig. 6)** and **(Fig. 8)** due to Reactive nature of AODV and AOMDV, while in **(Fig. 7)** DSDV have lower value of Throughput due to pro-active nature.

6.3 Packet Delivery Ratio Analysis

From **(Fig. 9)**, **(Fig. 10)**, **(Fig. 11)**, it's clear that variation of PDR for DSDV under UDP and TCP are almost same. While AOMDV have slightly higher variation then the case of AODV where PDR with UDP offer higher value than TCP.

Details results of PDR are highlighted in **Table 5**. AOMDV offers maximum PDR with UDP and minimum PDR with TCP, while it's decreased as number of nodes are increased. AODV have higher rate of PDR at start where number of node are 20 (10 source and 10 destination) then decreased for UDP and TCP. It's noticed that DSDV behave same for PDR results under UDP and TCP with variation of node.

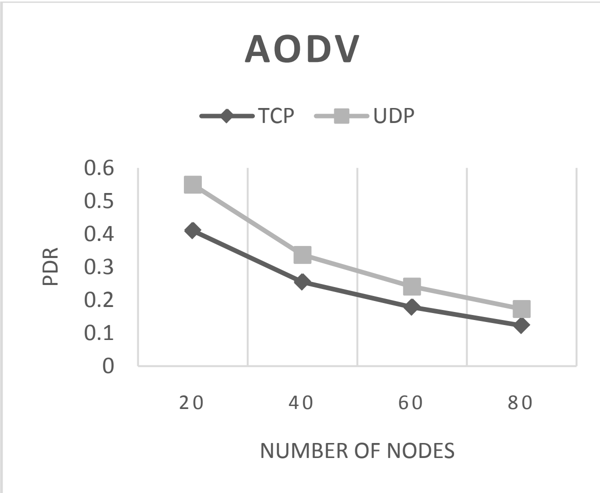

Fig. 9 : AODV – PDR versus Number of Nodes

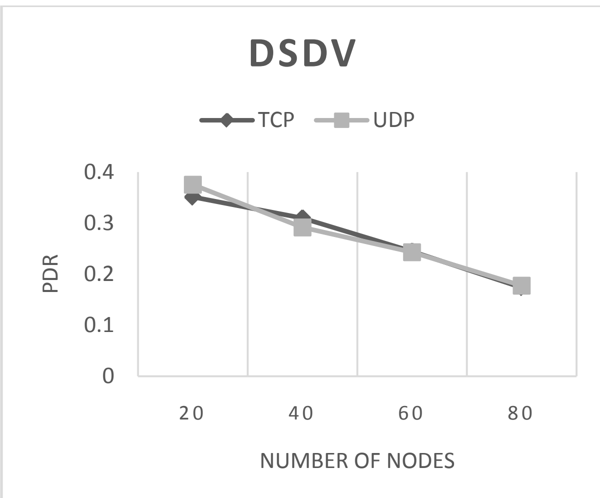

Fig. 10 : DSDV – PDR versus Number of Nodes

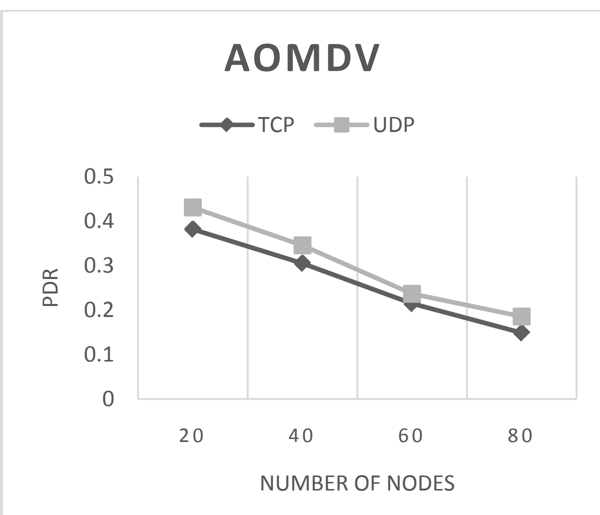

Fig. 11 : AOMDV – PDR versus Number of Nodes

Table 5 : Packet Delivery Ratio (PDR)

Routing Protocol	Source Nodes	Dest. Nodes	Total Pkt Sent	Pkt Rec UDP	Pkt Rec TCP	PDR UDP (%)	PDR TCP (%)
AODV	10	10	110176	60527	45164	54.94	40.99
	20	20	218224	73518	55518	33.69	25.44
	30	30	292448	70384	52115	24.07	17.82
	40	40	405072	70044	49657	17.29	12.26
DSDV	10	10	110176	41344	38692	37.53	35.12
	20	20	218224	63626	67630	29.16	30.99
	30	30	292448	71041	71550	24.29	24.47
	40	40	405072	71897	70457	17.75	17.39
AOMDV	10	10	110176	47466	42070	43.08	38.18
	20	20	218224	75388	66609	34.55	30.52
	30	30	292448	69158	62756	23.65	21.46
	40	40	405072	75086	60239	18.54	14.87

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8. CONCLUSION

In this paper the performance behavior of three mobile ad-hoc network protocols AODV, AOMDV and DSDV is analyzed with distinction of TCP and UDP agents and node density.

The results were highlighted in terms of end to end delay, Throughput and PDR. These quality metrics are identified with the variation of network nodes. Nodes having omnidirectional antenna and two way channel with VBR traffic. From results it's identified that re-active protocols AODV and AMODV have maximum delay, Throughput and PDR with UDP agents as compared to TCP. Also PDR at UDP reduce with increasing the number of nodes and come closer to intersect with PDR at TCP. Proactive protocol as DSDV offers rapid increase in delay in connection of UDP while with TCP a reduced amount of delay was observed. Throughput of DSDV through TCP is greater than the DSDV with UDP. PDR of DSDV with both agents almost recognized identical.

This shows that reactive nature of protocols response positively with association of UDP agents as compared to TCP while proactive nature encouraging results with TCP.

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