Performance Comparison and Analysis of AD-Hoc Routing Protocols (DSR, DSDV) in MANET.

Md. Ashek Raihan Mahmud, A k m Wahed Juberi, Md. Shariful Islam

Abstract— A Mobile Ad hoc Network (MANET) is a kind of wireless ad-hoc network, and is a self-configuring network of mobile nodes (routers) and associated hosts connected by wireless links – the union of which forms an arbitrary topology. The nodes (routers) are free to move randomly and organize themselves arbitrarily, thus the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet. There are various routing protocols available for MANETs. The most popular ones are DSR and DSDV. In this work, an attempt has been made to compare these two protocols on the basis of performance basis under different environments. The comparison has been done under the UDP, TCP payload. The tools used for the simulation are NS2 which is the main simulator, NAM (Network Animator) and Tracegraph which is used for preparing the graphs from the trace files. The results presented in this project work clearly indicate that the different protocols behave differently under different environments. The results also illustrate the important characteristics of different protocols based on their performance and thus suggest some improvements in the respective protocols.

Index Terms—MANET, DSDV, DSR, NS2, EED, PDF, Ad-Hoc

1 Introduction

Wireless networks have become increasingly popular in the network industry. They can provide mobile users with ubiquitous communication capability and information access regardless of locations. Conventional wireless networks are often connected to a wired network so that the ATM (Asynchronous Transfer Mode) or Internet connections can be extended to mobile users. This kind of wireless network requires a fixed wireline backbone infrastructure. All mobile hosts in a communication cell can reach a base station on the wireline network in one-hop radio transmission. In parallel with the conventional wireless networks, another type of model, based on radio to radiomulti-hopping, has neither fixed base stations nor a wired backbone infrastructure. In some application environments, such as battlefield communications, disaster recovery etc., the wired network is not available and multi-hop wireless networks provide the only feasible means for communication and information access. This kind of network is called Mobile Ad hoc NETwork (MANET). In general, Mobile Ad-hoc Networks are formed dynamically by an autonomous system of mobile nodes that are connected via wireless links without using an existing network infrastructure or centralized administration [6].

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Almost all previous work are based on simulation and have looked at the performance of TCP payload over IEEE 802.11 ad hoc networks. Less attention has been devoted to UDP payload. Since UDP is fast and less complex protocol used in internet for real time transmission, its performance in MANETs is still an interesting and active area of research. Although various authors in there research have provided a performance based comparative analysis between the two traffic scenarios namely, TCP/FTP traffic and UDP/CBR traffic, a great deal of concatenation is still required on UDP/CBR traffic to provide some more specific results.

This paper introduce two routing protocol techniques and a comparison between them and identified the strength and weakness.

2 Protocols Under Consideration

2.1 DSDV Routing Protocol

The destination sequenced distance-vector routing protocol (DSDV) [2] is one of the first protocols proposed for ad hoc wireless networks. It is an enhanced version of the distributed Bellman-Ford algorithm where each node maintains a table that contains the shortest distance and the first node on the shortest path to every other node in the network. It incorporates table updates with increasing sequence number tags to prevent loops, to counter the count-to-infinity problem, and for faster convergence [3].

As it is a table-driven routing protocol, routes to all destinations are readily available at every node at all times. The tables are exchanged between neighbors at regular intervals to keep an up-to-date view of the network topology. The tables are also forwarded if a node observes a significant change in local topology. The table updates are of two types: incremental updates and full dumps. An incremental update takes a single network data packet unit (NDPU), while a full dump may take multiple NDPUs. Incremental updates are used when a node does not observe significant changes in the local topology. A full dump is done either when the local topology changes significantly or when an incremental update requires more than a single NDPU. Table updates are initiated by a destination with a new sequence number which is always greater than the previous one. Upon receiving an updated table, a node either updates its tables based onthe received information or holds it for some time to select the best metric(which may be the lowest number of hops) received from multiple versions of the same update table from different neighboring nodes. Based on the sequence number of the table update, it may forward or reject the table.

2.2 DSR Routing Protocol

Dynamic source routing protocol (DSR) [2] is an on-demand protocol designed to restrict the bandwidth consumed by control packets in ad hoc wireless networks by eliminating the periodic table-update messages required in the table-driven approach. The basic approach of this protocol (and all other on-demand routing protocols) during the route construction phase is to establish a route by flooding Route Request packets in the network. The destination node, on receiving a Route Request packet, responds by sending a Route Reply packet back to the source, which carries the route traversed by the Route Request packet received. Consider a source node that does not have a route to the destination. When it has data packets to be sent to that destination, it initiates a Route Request packet. This Route Request is flooded throughout the network. Each node, upon receiving a Route Request packet, rebroadcasts the packet to its neighbors if it has not forwarded already or if the node is not the destination node, provided the packet's time to live (TTL) counter has not exceeded. Each Route Request carries a sequence number generated by the source node and the path is has traversed. A node, upon receiving a Route Request packet, checks the sequence number on the packet before forwarding it. The sequence number on the packet is used to prevent loop formations and to avoid multiple transmissions of the same Route Request by an intermediate node that receives it through multiple paths. Thus, all nodes except the destination forward a Route Request packet during the route construction phase. A destination node after receiving the first Route Request packet, replies to the source node through the reverse path the Route Request packet had traversed.

3 Simulation and Performance Evolution

3.1 Simulation Environment

The simulator used to simulate the ad hoc routing protocols is the Network simulator2 (Ns2) [1] that is developed by the CMU Monarch project at Carnegie Mellon University. Ns2 is an event driven, object oriented network simulator enabling the simulation of a variety of local and wide area networks. It implements different network protocols (TCP, UDP), traffic sources (FTP, web, CBR, Exponential on/off), queue management mechanisms (RED, Drop Tail), routing protocols etc. Ns2 is written in C++ and a script language called Otcl. Ns2 uses an Otcl interpreter towards the user. This means that the user writes an Otcl script that defines the network (sources, destination, and types of traffic) and which protocols it will use. This script is then used by Ns2 during the protocols (TCP, UDP), traffic sources (FTP, web, CBR, Exponential on/off), queue management mechanisms (RED, Drop Tail), routing protocols etc. Ns2 is written in C++ and a script language called Otcl. Ns2 uses an Otcl interpreter towards the user. This means that the user writes an Otcl script that defines the network (sources, destination, and types of traffic) and which protocols it will use. This script is then used by Ns2 during the simulations. The input files can be generated by OTcl script and these files are then used for the simulation and as a result from this, a trace file is generated as output prior to the simulation, the parameters that are going to be trace during the simulation must be selected. The trace file can then be scanned analyzed for the various parameters that we want to measure. This can be used as data for plot with for instance Xgraph.

3.2 Simulation Setup

We have considered two routing protocols for our simulations which are DSDV and DSR. For analyzing the performance of UDP and TCP traffic over considered protocols we used NS-2 with CMU wireless extension. The MAC protocol and Physical layer radio type used are respectively IEEE802.11 and IEEE802.11b. The network simulations carried out for the study are based on 1000 x 1000 meter flat grid topography. The square topography seemed to a right choice for simulations which provides a more rigorous environment for performance comparison.
We have done our simulations in three phases:

Phase 1: In this Phase, we considered the network scenario of 30 nodes in which source node, destination node and all other neighboring nodes are mobile with varying speed of 5, 10, 15, 20, 25 and 30m/s. Each simulation tasted for a period of 200s with a pause time of 50 seconds. In Table1, we have summarized the model parameters that have been used for phase 1.

Table1: Simulation Setup for Phase1

Simulator	NS-2.29
Simulation Area	1000m X 1000m
Mac protocol	IEEE 802.11
Antenna type	Omni-antenna
Packet size	512 byte
Routing protocol	DSDV & DSR
Traffic Source	UDP,TCP
Simulation time	200 s
Mobility model	Random way point
Number of Node	30
Speed	5,10,15,20,25,30m/s

Phase 2: In this Phase, we considered fixed mobility speed of 5 m/s and fixed pause Time of 50s and measured the performance only by varying the number of nodes. Each simulation lasted for a period of 200s with 10, 20, 30, 60, 90 and 120 nodes. In Table 2, we have summarized the model parameters that have been used for phase 2.

Table2: Simulation Setup for Phase2

Simulator	NS-2.29
Simulation Area	1000m X 1000m
Mac protocol	IEEE 802.11
Antenna type	Omni-antenna
Packet size	512 byte
Routing protocol	DSDV&DSR
Traffic Source	TCP,UDP
Simulation time	200 s
Mobility model	Random way point
Number of Node	10,20,30,60,90,120
Speed	5m/s

Phase 3: In this Phase, we considered fixed mobility speed of 5 m/s and fixed node 30 and measured the performance only by varying the pause time. Each simulation lasted for a period of 200s with 50s, 100s, 150s, 200s, 250s and 300s pause time .In Table 3, we have summarized the model parameters that have been used for phase 3.

Table3: Simulation Setup for Phase3

Simulator	NS-2.29
Simulation Area	1000m X 1000m
Mac protocol	IEEE 802.11
Antenna type	Omni-antenna
Packet size	512 byte
Routing protocol	DSDV&DSR
Traffic Source	TCP,UDP
Simulation time	200 s
Mobility model	Random way point
Number of Node	30
Speed	5m/s
Pause time	50s,100s,150s,200s,250s,300s

3.3 Performance Evolution Matrix

There are two main performance parameters that are considered Packet delivery fraction and Average End to End delay. Packet delivery fraction accounts to the percentage of packets delivered when the network is subjected to different traffic conditions. These two parameters are evaluated through the three phases of the research to make the performance analysis of the ad-hoc routing protocols.

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Packet Delivery Fraction (PDF): It is the ratio of data packets received to packets sent. It tells us about the fraction of the packets delivered from source to destination.

PDF = Number of packets Received/ Number of packets sent

End to End Delay (EED): A networks end-to-end delay is defined as the average time interval between the generation and successful delivery of data packets for all nodes in the network, during a given period of time. Packets that are discarded or lost are not included in the calculation of this metric.

Average End-to-End Delay = ∑tPR - ∑tPS

Where,
tPR – Packet Receive Time,
tPS – Packet Send Time.

3.4 Performance analysis by varying mobility speed (Phase1)

This is the first phase of the simulation environment where performance of the routing protocols is evaluated by varying the mobility speed .In this phase ,the performance parameters Packet delivery fraction and Average End-to-end delay are analyzed by changing the mobility speed. Performance metrics are calculated from trace file, with the help of AWK program. The simulation results of phase1 are shown in the following section in the form of Scatter graph.

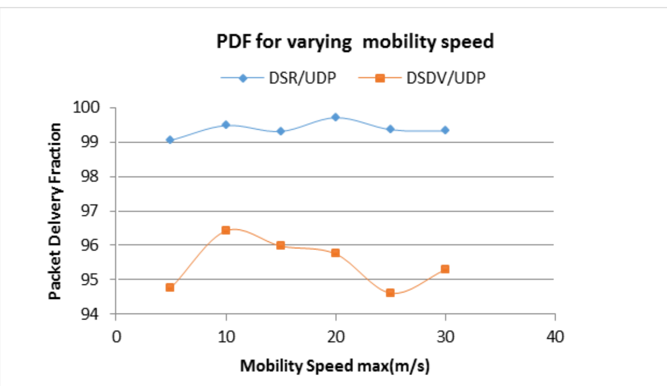

Figure 3.1: PDF for varying mobility Speed

In the figure 3.1 shows that DSR offers higher PDF when UDP traffic is transmitted. Increment in node mobility speed does not affect the UDP traffic over DSR that much. This is because, DSR include the feature of route caching which saves packet dropping at the time of route discovery.PDF is almost about 100% for DSR . Although PDF is reduced a little over DSDV increase in mobility speed_does not reduce the packet delivery fraction for UDP Because UDP does not use any flow control mechanism. PDF of UDP is almost about 95% for DSDV.

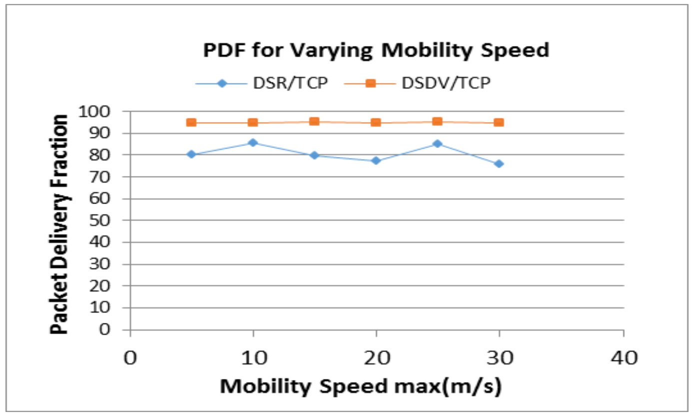

Figure 3.2: PDF for varying mobility Speed

In figure 3.2_shows that DSR offers lower PDF than DSDV when TCP traffic is transmitted. This is because DSR drops a few data packets while route discovery. Moreover TCP has it own transport control mechanism. It is observed that when mobility speed increases, PDF fluctuates a little over DSR. This is due to the flow control and congestion control mechanism of TCP. Over DSDV, a constant PDF is observed. Because of being proactive protocol, DSDV does not drop packets during the route discovery. PDF is almost about 95% for DSDV.

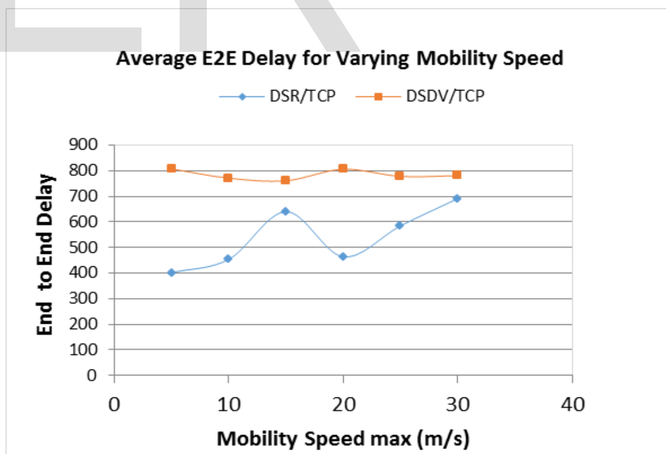

Figure 3.3: EED for varying Mobility Speed

In Figure 3.3 shows that DSR_experiences least delay for TCP traffic . This is due to the source routing used by DSR, which implies that a destination node does not need to discover a new route to the source node in order to send the acknowledgement. DSDV experiences more delay for TCP traffic. This is because, TCP's congestion control and flow control mechanism restricts the source from sending packets over the network when it is already overloaded with the control overhead of DSDV. With increase in mobility the delay experiences non-linear variation for TCP traffic for DSR. This is because when the nodes move

speedily the routes between the source and destinations become shorter and longer more frequently.

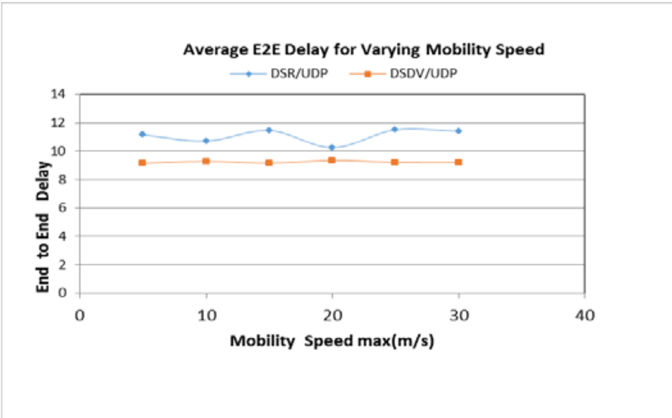

Figure 3.4: EED for varying Mobility Speed

Figure 3.4 shows that, end-to-end delay for DSDV protocol is less than DSR protocol when UDP packets are transmitted . This is due to the fact that, in case of proactive protocol like DSDV routes are available the moment they are needed. UDP traffic suffers more delay over DSR. For UDP traffic End-to-End delay over DSR does not suffer much as the node mobility is increased. But UDP packets experiences an constant end-to-end delay performance in DSDV protocol. This is because UDP does not use any flow control mechanism

3.5 Performance analysis by varying Network Node (phase2):

This is the Second phase of the simulation environment where performance of the routing protocols is evaluated by varying the network load. In this phase, the same performance parameters- Packet delivery Fraction and Average End-to-end delay are analyzed by changing the load of the network. This phase is required to measure the scalability of the routing protocols in small, medium and large networks. As such, the number of nodes has been varied from 10 nodes to 120 nodes so that a small, medium and a large network can be simulated. The simulation results of phase2 are shown in the following section in the form of Scatter graph.

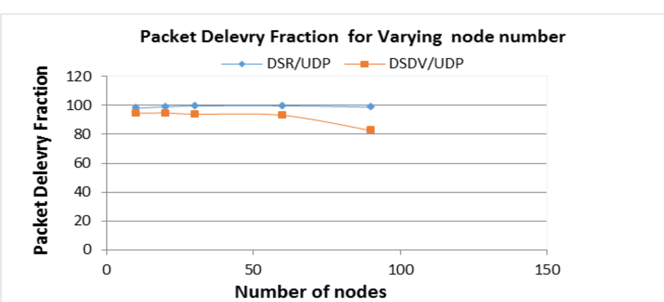

Figure 3.5 PDF by varying network load

Figure 3.5 shows that DSR offers more PDF when UDP traffic is transmitted.. Increment in node number does not affect the UDP traffic over DSR. This is because, DSR include the feature of route caching which saves packet dropping at the time of route discovery. PDF over DSDV is slightly lower and UDP traffic also suffers little fluctuations when node number increases. PDF is almost about 99% for DSR and almost about 90% for DSDV.

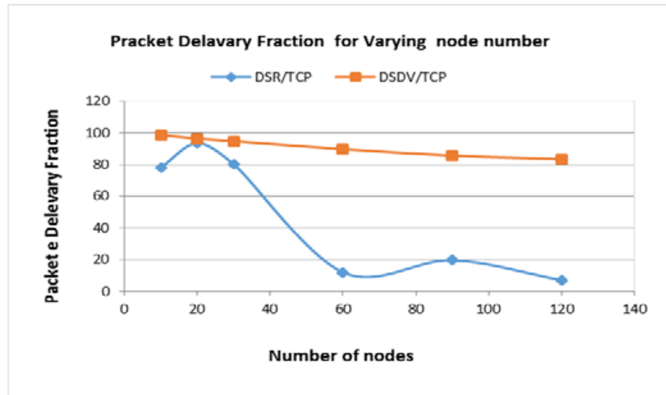

Figure 3.6 PDF by varying network load

Figure 3.6 shows that, PDF over DSDV protocol is more than DSR. This is because DSDV protocols have the routing tables are available at the moment they are needed. But when node number increases, PDF of TCP traffic experiences an average decrease over both DSR and DSDV because control overhead can be significant in large networks or in networks with rapidly moving nodes.

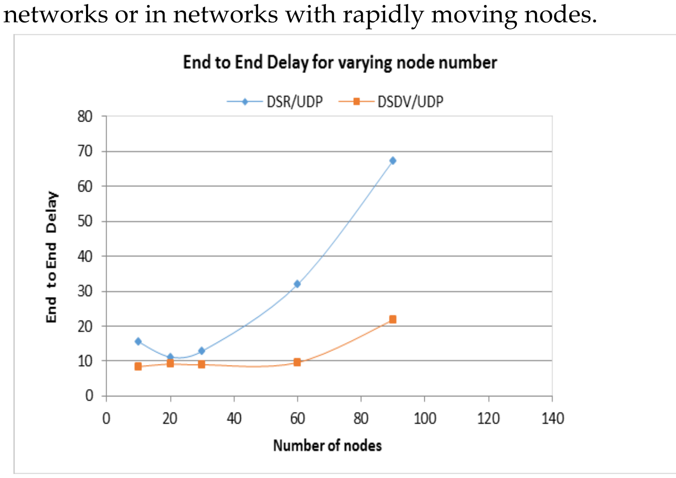

Figure 3.7 EED by varying network load

Figure 3.7 shows that , end-to-end delay for DSDV protocol is less than DSR protocol when UDP packets are transmitted . This is due to the fact that, in case of proactive

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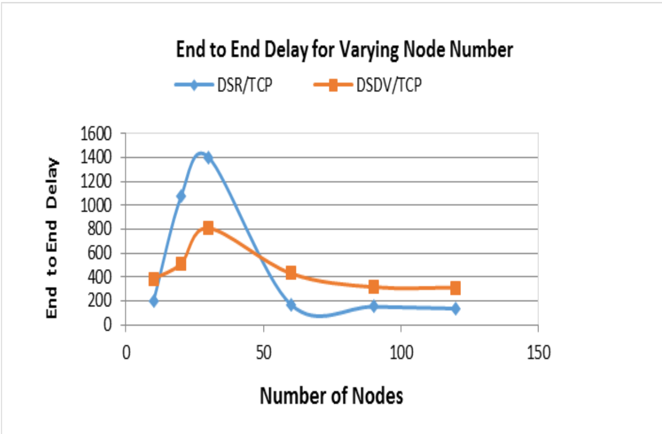
protocol like DSDV routes are available at the moment they are needed. End-to-End delay of UDP traffic over DSR does not suffer much as the node numbers is increased. UDP



packets experiences better and constant end-to-end delay performance over DSDV protocol. This is because UDP does not use any flow control mechanism.

Figure 3.8 EED by varying network load

Figure 3.8 shows that, end-to-end delay of TCP packets over DSDV protocol is much higher than delay over DSR protocol. This is because, TCP's congestion control and flow control mechanism restricts the source from sending packets over the network when it is already overloaded with the control overhead of DSDV.TCP traffic does not suffer more rise and fall with increasing node numbers in DSR and DSDV protocols

3.6 Performance analysis by varying Pause time (phase3):

This is the third phase of the simulation environment where performance of the routing protocols is evaluated by varying the pause time. In this phase, the same performance parameters- Packet delivery Fraction and Average End-to-end delay are analyzed by changing the pause time. This phase is required to measure the scalability of the routing protocols in small, medium and large networks. As such, the number of pause time has been varied from 50s nodes to 300s . The simulation results of phase3 are shown in the following section in the form of Scatter graph.

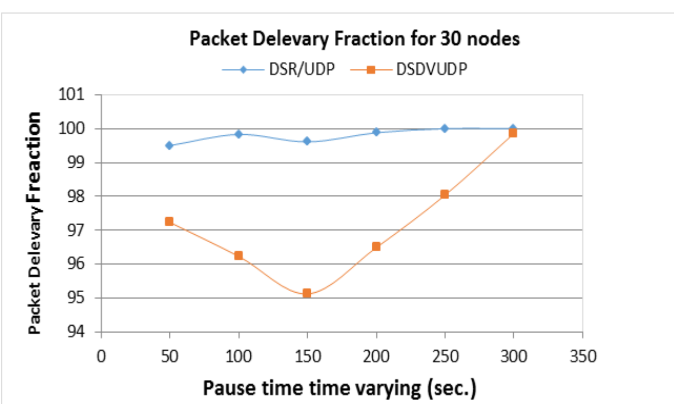


Figure 3.9 PDF by varying pause time

Figure 3.9 shows that DSR offers higher PDF when UDP traffic is transmitted. Increment in Pause Time does not affect the UDP traffic over DSR. This is because, DSR include the feature of route caching which saves packet dropping at the time of route discovery. While increasing Pause Time_with exceptions near 150 second the PDF increases gradually. Because in proactive protocols like DSDV, routes are available at the moment they are needed. PDF of UDP is almost about 100% for DSR. of UDP is almost about 96% for DSDV.

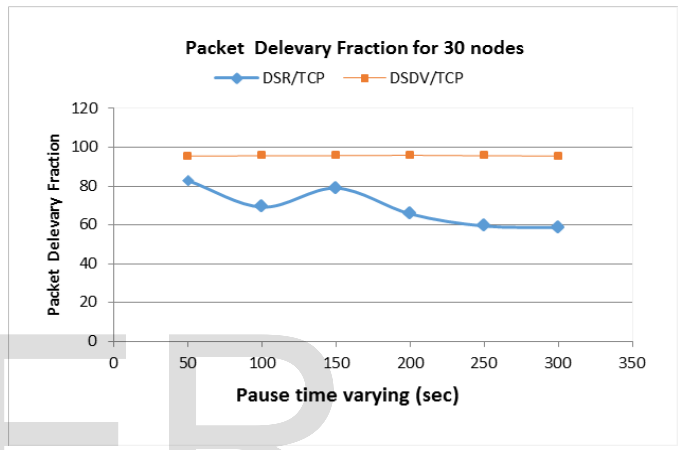


Figure 3.9 PDF by varying pause time

Figure 3.9 shows that PDF over DSR for TCP traffic is much less than that over DSDV. This is because DSR drops a few packets while route discovery. But when Pause Time increases, the TCP traffic observes an average fall down of PDF. The congestion control mechanism might be the cause for this because at a certain time several nodes gather at a certain area. PDF over DSDV is about 96% and remain almost constant while increasing pause time. This is because in DSDV protocol routes are already available when necessary which reduces the packet drops.

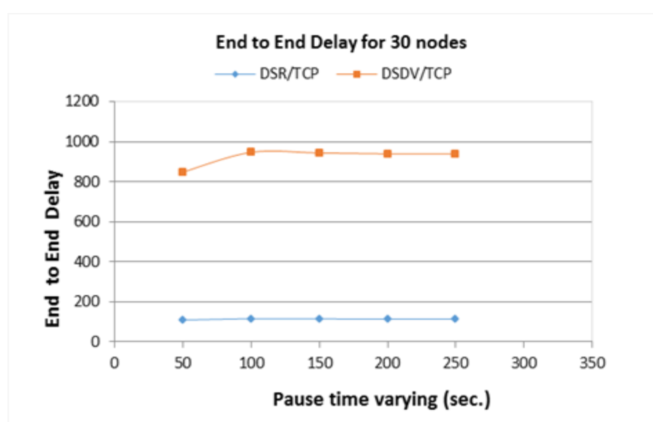


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Figure 3.10 EED by varying pause time

Figure 3.10 shows_ that, end-to-end delay of TCP packets over DSDV protocol is much higher than delay over DSR protocol. This is because, TCP's congestion control and flow control mechanism restricts the source from sending packets over the network when it is already overloaded with the control overhead of DSDV.TCP traffic does not suffer more rise and fall with increasing Pause Time in DSR and DSDV protocols

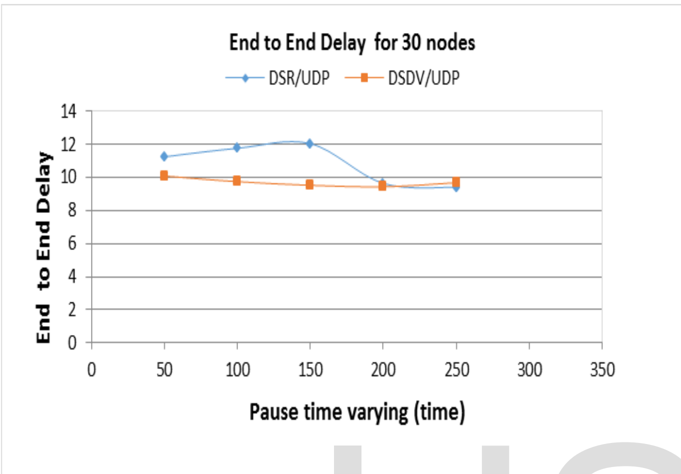

Figure 4 EED by varying pause time

Figure 4. Shows that, end-to-end delay for DSDV protocol is less than DSR protocol when UDP packets are transmitted . This is due to the fact that, in case of proactive protocol like DSDV routes are available at the moment they are needed. End-to-End delay of UDP traffic over DSR does not suffer much as the node numbers is increased. UDP packets experiences better and constant end-to-end delay performance over DSDV protocol. This is because UDP does not use any flow control mechanism.

4. CONCLUSION

After detailed analysis based on the three phases comparison between the two routing protocols namely DSDV and DSR is depicted in the above table. In short, for UDP traffic, DSR is better considering these two metrics since offering the highest PDF and moderate lower end-to-end delay. For TCP traffic, DSDV is better considering only PDF.

However, we see that different protocols performs differently in different environments so that selection of the protocols should be solely based on the condition and there cannot be a specified common protocol for all different mobile environment . The results obtained in the simulation are expected to give a solid ground for all future ventures in developing a new protocol which might be accepted as a standard on which is robust and performs equally well in ranges of mobile environment for real time transmission.

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