A Comparative Study and Analysis of three Routing Protocols (AODV,DSDV,DSR) in Mobile Ad hoc Network bearing CBR Traffic

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Abstract—Ad hoc Network is a collection of wireless mobile nodes dynamically forming a temporary network without the use ofany existing network infrastructure or centralized administration .The highly dynamic nature of mobile ad hoc networks results in frequent changes and unpredictability in network topologies, adding difficulty and complexity to routing among the mobile nodes within the network. There are different routing protocols proposed for MANETs which makes it quite difficult to determine which protocol is suitable for different network conditions as proposed by their Quality ofservice offerings.In this paper, an attempt has been made to compare threerouting protocols on the basis of performance under different environments. The comparison has been done under the UDP payload (CBR traffic). The tools used for the simulation are NS2 which is the main simulator, NAM (Network Animator) and trace-graph which is used for preparing the graphs from the trace files. The results presented in this paper clearly indicate that the different protocols behave differently under different environments.

Index Terms—MANET, AODV, DSDV, DSR, NS2, Throughput, 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. Inparallel 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 threerouting protocol techniquesand a comparison between them and identified the strengthand 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.

2.3 AODV Routing Protocol

Ad hoc on-demand distance vector (AODV) [4] routing protocol uses an on-demand approach for finding routes, that is, a route is established only when it is required by a source node for transmitting data packets. It employs destination sequence numbers to identify the most recent path. The major difference between AODV and DSR stems out from the fact that DSR uses source routing in which a data packet carries the complete path to be traversed. However, in AODV, the source node and the intermediate nodes store the next-hop information corresponding to each flow for data packet transmission. In an on-demand routing protocol, the source node floods the Route Request packet in the network when a route is not available for the desired destination. It may obtain multiple routes to different destinations from a single Route Request. The major difference between AODV and other on-demand routing protocols is that it uses a destination sequence number (DestSeqNum) to determine an up-to-date path to the destination. A node updates its path information only if the DestSeqNumof the current packet received is greater than the last DestSeqNum stored at the node. A Route Request carries the source identifier (SrcID), the destination identifier (DestID), the source sequence number (SrcSeqNum), the destination sequence number (DestSeqNum), the broadcast identifier (BcastID), and the time to live (TTL) field. DestSeqNum indicates the freshness of the route that is accepted by the source. When an intermediate node receives a Route Request, it either forwards it or prepares a Route Reply if it has a valid route to the destination. The validity of a route at the intermediate node is determined by comparing the sequence number at the intermediate node with the destination sequence number in the Route Request packet. If a route Request is received multiple times, which is indicated by the BcastID-SrcID pair, the duplicate copies are discarded. All intermediate nodes having valid routes to the destination, or the destination node itself, are allowed to send Route Reply packets to the source. Every intermediate node, while forwarding a Route Request, enters the previous node address and it'sBcastID. A timer is used to delete this entry in case a Route Reply is not received before the timer expires.

This helps in storing an active path at the intermediate node as AODV does not employ source routing of data packets. When a node receives a Route Reply packet, information about the previous node from which the packet was received is also stored in order to forward the data packet to this next node as the next hop toward the destination.

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 SimulationSetup

We have considered three routing protocols for our simulations which are DSDV, AODV, and DSR. For analyzing the performance of CBR traffic over considered protocols we used NS-2with 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 two 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	AODV,DSDV &DSR
Traffic Source	CBR (UDP)
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	AODV,ASDV &DSR
Traffic Source	CBR (UDP)
Simulation time	200 s
Mobility model	Random way point
Number of Node	10,20,30,60,90,120
Speed	5m/s
Pause time	50s

3.3 Performance Evolution Matrix

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

Throughput: It is a measure of the effectiveness of a routing protocol measured in bits/second.

Throughput = (nPS*PZ) / Simulation Time

Where,
nPS – Number of Packet Sent,
PZ – Packet Size.

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-Throughput, 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.

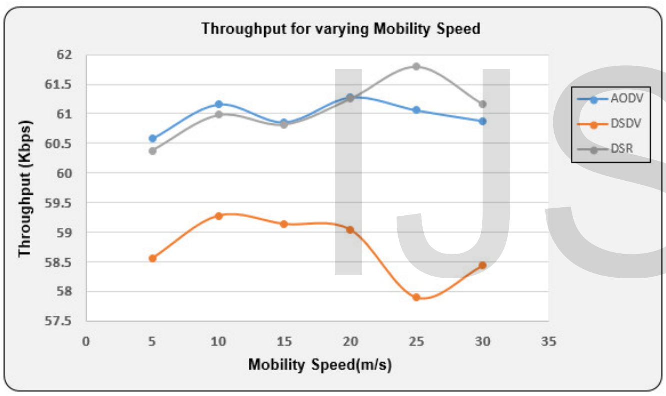


Figure 3.1: Throughput plot by varying mobility Speed

In the figure 3.1, the throughput are plotted at different speeds to see how the data speed varies for different network scenarios and observed that DSR shows Maximum and consistent throughput throughout all the speeds. It has an average speed of 61.06 kbps which is higher than AODV, 60.97 kbps and DSDV, 58.72 kbps. DSDV suffers decrease in throughput close to 57 kbps at maximum speed (20 meters/sec).This is because of frequent link changes and connection failures.

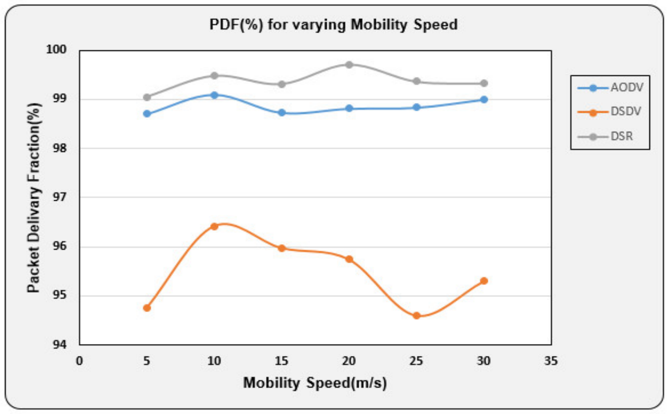


Figure 3.2:PDF plot by varying mobility Speed

When the packet delivery fraction is calculated against varying speed, it is observed from Figure 3.2 that DSR again outperforms all the protocols at all speeds maintaining a packet delivery fraction close to 100%. AODV's performance is comparable to DSR delivering almost 98% of the packets. DSDV delivers close to 96% of the packets at low speed but could not keep the same rate with the increase in speed because of its frequent link changes and connection failures. Packet delivery in DSDV drops to as low as 94% at speed 25m/s.

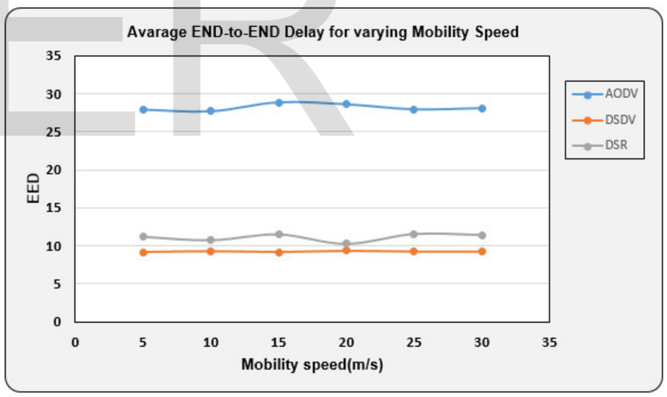
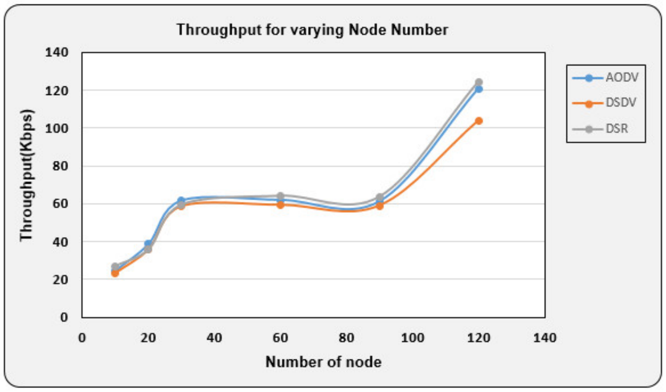


Figure 3.3:EED for varying Mobility Speed

In Figure 3.3, Average End-to-end Delay is plotted by varying speed. DSR once again shows optimum results with Average End-to-end Delay being significantly low. Even at high speed, DSR is able to maintain a low End-to-end Delay because of its efficiency in its dynamic routing algorithm. DSDV performed constant low delay at low as well as high speed but as the speed increased, the number of dropped packets also increased. AODV once again failed to perform well at high and low speed as the Average End-to-end delay well above 25ms.

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- Throughput, 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 3.4 shows the throughput of the ad-hoc routing protocols under varying network load. It is seen that AODV performs the better compared to the other protocols with a throughput of 65.5 kbps at small networks.

Figure 3.4 Throughput plot by varying network load

But DSR performs the best compared to the other protocols with a Peak throughput of 127.5 kbps at larger network load. DSDV significantly has lower performance because of frequent link changes and connection failures.

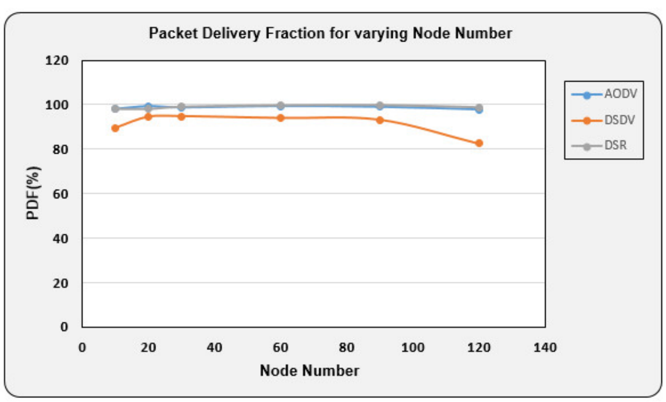


Figure 3.5:PDF plot by varying network load

Figure 3.5 gives the packet delivery fraction of all the protocols when the nodes are varied. Looking at the trend, it can observed when the network load is increased, the packet delivery fraction for all the protocols gets reduced. DSDV has a peak packet delivery fraction of close to 100% when it is a small network i.e. number of nodes is 20. But as the load is increased, the performance degrades. For a large network scenario (80 nodes), packet delivery fraction start to decrease which shows that DSR does not perform well when the network size is complex. AODV shows similar trend with AODV slightly showing better performance in small and large networks. DSR has a good packet delivery fraction throughout the different scale of networks and it has a certain kind of consistency. The packet delivery fraction (PDF) of DSR is consistent between 97% to 95% throughout the different scale of networks.

In Figure 3.6, it is observed that End-to-End delay of CBR traffic experiences least and constant delay over DSDV. This is due to the fact that, in case of proactive protocol like DSDV routes are available the moment they are needed.

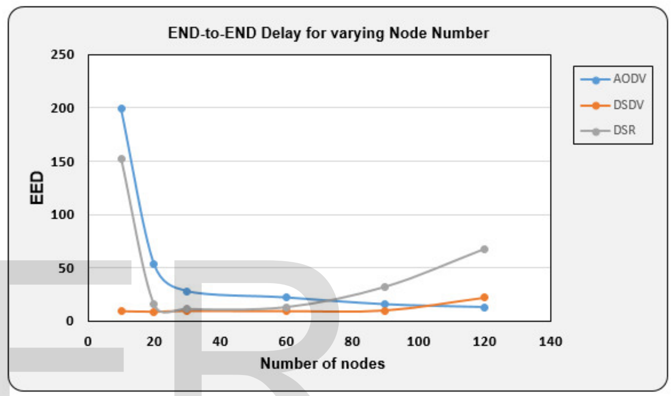


Figure 3.6: Average EED by varying network load

CBR traffic suffers more delay over AODV and DSR. This is because in reactive protocols there is some finite latency while the route is discovered. Among these two reactive protocols DSR has less delay because of its route caching feature.

4 Conclusion

This work is an attempt towards a comprehensive performance evaluation of three commonly used mobile ad hoc routing protocols (DSDV, AODV and DSR).It can be concluded for the both phases that throughput, packet delivery fraction over DSR perform better than DSDV and AODV for CBR traffic. Although for both phases, PDF increases a little while the node number, speed increases for CBR traffic. For CBR traffic DSDV performs the best with regards to delay and among the other two DSR offers lesser delay than AODV for both phases.

However, we see that different protocols perform differently in different environments. So the selection of the protocol should be solely based on the condition and there cannot be a specific common protocol for all different mobile environments.

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