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Performance Analysis of AODV Protocol with TCP/FTP Traffic and Improved AODV Protocol with UDP/CBR Traffic for Optimizing Routing and QoSin MANET

Amandeep Kaur and Kuldeep Singh
Department of Computer Science and Engineering[1],
Department of Electronics and Communication Engineering[2]
Guru Nanak Dev University Regional Campus
Fattu Dhinga (Sultanpur Lodhi)
Punjab, India-144606Punjab, India-144606

Abstract**:** The transmission and reception of information between sourceand destination in a MANET relies on the performance of the traffic scenario (application traffic agent and data traffic) used in a mobile ad-hoc network. The traffic scenario basically defines the reliability and capability of information transmission, which formulates its performance analysis. The objective of this paper is to compare the performance of TCP/FTP on Normal AODV and UDP/CBR traffic on Improved AODV routing protocol generally implemented in a mobile ad hoc environment. An empirical study has been done using NS-2. Exhaustive simulations have been done to analyze the results, which are evaluated for performance metrics, such as throughput, packet delivery ratio and average end to end delay. The effect of variations in, number of nodes, on the network performance is analyzed over a wide range of their values. It is observed that the UDP/CBR on IMPROVED AODV offers a far better performance for throughput than TCP/FTP on Normal AODV; in case of PDR, it offers great PDR for CBR traffic on Improved AODV than TCP on NORMAL AODV.The results follow these trends over a wide range of simulation parameters.

Keywords**:** AODV, Average End To End Delay MANET, NS-2, Packet Delivery Ratio, Routing Protocol TCP/FTP, Throughput, UDP/CBR

INTRODUCTION

A Mobile Ad Hoc Network (MANET) is a wireless network which basically consists of various wireless mobile nodes communicating with one another for some ad-hoc purpose. Mobile ad-hoc networks (MANETs) are infrastructure-free networks of mobile nodes that communicate with each other in wireless mode. There are several routing schemes that have been proposed for sending and receiving data and several of these have been already extensively simulated or implemented as well [2]. In such networks, there is no fixed infrastructure available, therefore, they are well suited for the infrastructure less environments such as earthquake prone areas, battlefield applications, virtual classrooms, and many emergency services [6, 17]. In such scenarios, MANET's features like mobile nodes, abruptly changing topology, no physical network boundary, communication with the nodes within wireless range, support the need of communication. The MANET imposes several challenges for communication, out of which one of the important challenges is to provide secure and efficient routing of data in the network [11, 12, 6, 7, and 8]. So, there is a great need to develop dynamic and efficient routing protocols, which can ensure efficient and secure routes for communication.

The main objective of this paper is to carry out the performance evaluation of an Ad hoc On demand Distance Vector (AODV) routing protocol for Transmission Control Protocol/File Transmission Protocol (TCP/FTP) and User Datagram Protocol/Constant Bit Rate (UDP/CBR) traffic types, subjected to three varying parameters; number or density of node. These scenarios are tested .by exhaustive simulations performed on Network Simulator- Version 2 (NS-2) and the conclusions are drawn based on performance metrics, such as, throughput, packet delivery ratio, and average end to end delay, to evaluate the performance.

I. RELATED WORK

It is very challenging issue in highly mobile network to finding a stable route between source and destination. Various approaches have been proposed to deal with node mobility.

A. Energy Supported AODV (En-AODV.) For Qos Routing In MANET

In this paper the author provided the energy supported AODV (EN-AODV) for quality of service routing in MANET.Routing protocols should incorporate QoS metrics in route finding and maintenance, to support end-to-end QoS. The QoS parameters like throughput, PDR and delay are affected directly [13].

The Energy based AODV protocol (EN-AODV) announces energy and based on nodes sending and receiving rates and the sizes of the data to be transmitted it justifies whether its energy level is maintained or decreased. It calculates the energy levels of the nodes before they are selected for routing path. A threshold value is defined and nodes are considered for routing only if its energy level is above this threshold value.

B. Entropy-Based Long-Life Multipath Routing Algorithm in MANET

In this research work the author provided the Entropy-Based Long-life Multipath Routing Algorithm in MANET. So far, much of the effort of multipath routing has been focused on using the predefined alternate path when a relay on the primary path has failed regardless of the availability of the alternate path. This reactive route handoff can increase the overhead for frequent route discoveries. This paper gives a technique of Entropy-based Long-life Multipath Routing algorithm in MANET (ELMR). The key idea of ELMR algorithm is to construct the new metric-entropy and select the stability multipath with the help of entropy metric to reduce the number of route reconstruction so as to provide QoS guarantee in MANET [4].

C. Reliable Route Selection Algorithm Using Global Positioning Systems in Mobile Ad-Hoc Networks.

In this research paper provided the integrated approach for A Reliable Route Selection Algorithm Using Global Positioning Systems in Mobile Ad-hoc Networks The technique of this paper is to select the most reliable route that is impervious to failures by topological changes by mobile nodes' mobility. To select a reliable route, we introduce the concept of *stable zone* and *caution zone*, and then apply it to the route discovery procedure of the existing on-demand routing protocol (i.e., AODV).

The concept of the *stable zone* and *caution zone* which are located in a mobile node's transmission range is based on a mobile node's location and mobility information received by Global Positioning System (GPS) [17].

D. M-MAC: Mobility-BASED Link Management Protocol for Mobile Sensor Networks.

In this paper [3] every node maintains the RSSI table ,RSSI table contain the signal strength value of node's all neighbor, with the help of this RSSI table, when changes is occur in node table RSSI value node predict that his neighbor node is moving away from us, after predicting the link failure it performs following steps:

- *Dropping***:** If quality of link is broken or we can say that signal strength is not good then packet may be drop and retransmission may occur.
- *Relaying***:** In this technique, a node can become a forwarding node when either sender or receiver are in its neighbor table and forward the data between source and destination, if the link between source and destination is fail.
- *Selective forwarding***:** we can say that if intermediate node come from bad link then it will drops the packets.

II. AODV ROUTING PROTOCOL

The following sections focus on the basic features and functionality of AODV routing protocol thatemploys to service in a MANET. This may help to provide a clear understanding of the routing scheme, which indirectly governs the transmission capability of a network [2, 4, 5, 10, 12, and 15].

A. BASIC FEATURES

The basic features are mentioned below:

- AODV routing protocol belongs to the category of reactive or on demand routing protocols. In such protocols, the nodes do not update their routing tables periodically, unless new routes are demanded by any network node.
- Stimulated by the above feature, such protocols are not suitable for the networks that are highly dynamic, prone to frequent and unpredictable changes.
- AODV routing protocol does not start route discovery of its own, unless it is requested by some other node that is willing to transmit any data.
- In AODV, the lifetime of the routes in routing table of the nodes is until the routes are no longer needed in the network, i.e. the routes are discarded, if they are not used for a specified period of time.
- AODV routing protocol provides route to the destination "on-demand".
- Here any of the source nodes willing to communicate with the destination node of the network to which it has no route information, so it has to make route discovery before making any transmission.
- The route discovery and route maintenance which are the two main responsibilities of AODV routing protocol are done by the use of three types of control messages; Route Request (RREQ), Route Reply (RREP), Route Error (RERR) messages.
- From the available choices of route, the sender selects the one offering the shortest path to the destination. If one or more routes are of equal length, then it selects the one offering minimum traffic.
- AODV employs destination number as the requested node identity to find routes to the destination. This number is mentioned in the RREQ control message.
- Bandwidth in AODV is mainly consumed during the starting of any transmission, but not during the entire transmission.

B. FUNCTIONALITY

The basic functionality of the AODV that needs to be understood is the route discovery mechanism employed in AODV. The routes to the destination are traced by using three control messages namely RREQ or query message, RREP and RERR message. These three are explained as follows:

- *RREQ Control Message*: AODV starts discovering routes with the RREQ messages. The source node in the network broadcasts or floods these RREQ messages to its neighboring nodes. The RREQ messages will be propagated in the network in the aforementioned manner at every node, until the destination node in the network is found. The destination will be checked for matching the destination identity or destination sequence number attached in the RREQ message.

- *RREP Control Message*: Once a node matches the destination sequence number, the destination node generates a RREP message and replies the source with the same, through the same route by which the destination was traced.
- *RERR Control Message*: These messages are generated and propagated through the network in the event of link failures occurring in two possibly encountered scenarios; first, link failure during the transmission of RREP messages and second, link failure in the active route during the course of data transmission. In both the cases the RERR message is generated by a node encountering link failure.

C. IMPROVED AODV

When the route is needed, the source sends the RREQ packet to his entire neighbor after that node check if RREQ retry is less than Retry threshold (RET) then it select the route on the basis of signal strength of the RREQ packet means it compare the signal strength of RREQ packet of the sender's node if it is greater than signal threshold value then intermediate node receive this packet otherwise it discard this packet with the help of this approach routing protocol search the stable path to the destination, on the basis of signal strength if there is no route to the destination so node again send the RREQ packet to the neighbor node and RREQ retry is also increase by one, if it greater than Retry Threshold value then it switch to normal AODV and find the route on the basis of minimum hop count so we can always find the best path among available path even in the distant node as shown in Figure1

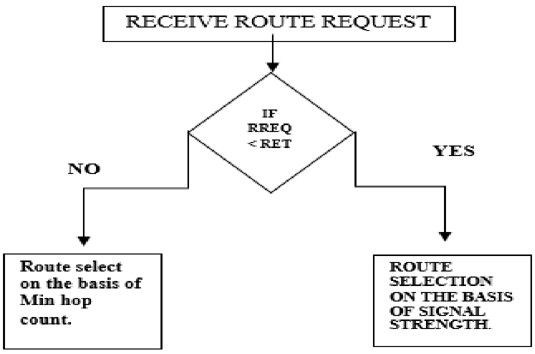

Figure 1. Route selection in IMPROVED AODV

III. PERFORMANCE METRICS

The performance of any system needs to be evaluated on certain criteria, these criteria then decide the basis of performance of any system. Such parameters are known as performance metrics [1, 2, 13, 14, and 15]. The three types of performance metrics used to evaluate performance of TCP/FTP and UDP/CBR in this paper are described below:

A. THROUGHPUT

The throughput is the measure of how fast we can actually send data through the network. It is the measurement of number of packets that are transmitted through the network in a unit of time. It is desirable to have a network with high throughput

$$\text{Throughput} = \frac{\sum PR}{\sum t_{st} - \sum t_{sp}} \quad (1)$$

Where, PR – Received Packet Size,

t_{st}-Start Time,

t_{sp}- Stop Time.

Unit – Kbps (Kilobits per second)

B. PACKETDELIVERYRATIO *(*PDR*)*

It is the ratio of number of packets received at the destination to the number of packets generated at the source. A network should work to attain high PDR in order to have a better performance. PDR shows the amount of reliability offered by the network.

$$PDR = \left\{ \frac{\sum NR \times 100}{\sum NG} \right\} \quad (2)$$

Where, NR – Number of Received Packets, NG – Number of Generated Packets

Unit – Percentage ratio (%).

C. AVERAGE END – TO – END DELAY

This is the average time delay consumed by data packets to propagate from source to destination. This delay includes the total time of transmission i.e. propagation time, queuing time, route establishment time etc. A network with minimum average end to end delay offers better speed of communication.

$$\text{AverageEnd-to-EndDelay} = \sum t_{PR} - \sum t_{PS} \quad (3)$$

Where, t_{PR} – Packet Receive Time,

t_{PS} – Packet Send Time

Unit – Milli Seconds (ms).

IV. DATA TRAFFIC /APPLICATION TRAFFIC TYPES

Data and traffic agent that takes the responsibility to transport the data in the network are of different types and offer different characteristics in the network [2, 14, 16, and 17]. It is necessary to understand the characteristics and therefore the performance to find the suitability of each type in a network. The two types of data/traffic agent types used in the network are as follows:

A. TCP/FTP

In such a traffic scenario, TCP represents the data type and FTP represents the application traffic agent of any application which transports TCP data. Here TCP is a transport layer protocol and FTP is an application layer protocol. This scenario offers oriented transmission environment, where communication occurs in phases, namely, connection establishment, data transmission, connection termination. The three basic characteristics offered are:

- *Reliable:* TCP/FTP offers reliable communication, as it provides guaranteed delivery of data by employing the acknowledgements which guarantees the delivery of data at a destination. In case acknowledgements are not received till the timeout period, retransmissions are made to ensure the delivery of data at the receiver. We can say that positive acknowledgements, timeouts, and retransmissions are required to guarantee the delivery of data in a network.
- *Bi-directional*: Here in TCP/FTP, in one direction i.e. the forward direction, the sender transmits the data and in the other direction i.e. the reverse direction, the receiver acknowledges the sender by transmitting acknowledgements. So, in this way bi-directional communication occurs.
- *Conforming*: The network while working with TCP/FTP, offers conforming nature. The network is conforming in the context of transmissions as it offers both flow and congestion control. Flow control by preventing overflow of recipient buffer, and congestion control by keeping the track of acknowledgements, time outs, and retransmissions.

B. UDP/CBR

This type of traffic implies data of UDP type and application traffic agent is CBR. Here, the former is a transport layer protocol and latter is application layer protocol. It offers transmission of data at constant bit rate and does not communicate in phases, and traffic moves in one direction from source to destination without any feedback from destination. It offers three basic characteristics mentioned below:

- *Unreliable:* The network is quiet unreliable as it does not set up communication in phases and does not rely on acknowledgements to recover the lost messages. The sender node does not take the responsibility of the successful delivery of data.
- *Unidirectional*: As no acknowledgements are transmitted from receiver, only one way communication is done i.e. on the forward link. The destination does not send any data packet to the receiver, therefore it offers unidirectional traffic.
- *Predictable*: The UDP/CBR has predictable nature of transmission, as it offers constant bit rate, fixed and known packet size, fixed and known packet interval, and fixed and known packet stream duration.

V. SIMULATION ENVIRONMENT

The operating system that is used to support the simulation described in this paper is Linux (Fedora 20). The simulation tool is Network Simulator-2 (NS-2.35), which is a discrete event simulator. This simulator needs operating system that supports g++ system files, that is offered by Linux or UNIX and not by windows which on the other side supports .exe system file. Linux is used; as it offers both graphical user interfaces (GUI) and command line interface (CLI), whereas UNIX offers only CLI. The simulation of a MANET is done for AODV routing protocol, and the impact of variation in the parameters like, simulation time, number of nodes, are observed on the network.

A. Parameters Evaluation

The simulation parameter has shown in Table1. Here, we designed and implemented our test bed using Network Simulator (NS-2.35) to test the performance of both Routing algorithms. The data transmission rate is 4 packets/sec. The total simulation timeis100seconds.

Table I.: Parameters Evaluation for Normal and Improved AODV

Parameter	**Values For Normal AODV**	**Values For Improved AODV**
Simulation duration	100s	100s
Number of nodes	100	100
Mobility speed	Stationary nodes	2 to 16 m/s
Mobility model	Randomly arranged	Random way point
Transmission range	250 m	250 m
Packet rate	4 packets/s	4 packets/s
Packet size	512 b	512 b
Traffic type	TCP	CBR

B. Simulation Results

In this section different simulation results are calculated for NORMAL AODV with TCP traffic and IMPROVED AODV with CBR traffic and comparison is made on basis of different parameters.

Table II:. Performance Evaluation Results for Different Nodes

Parameters	**Evaluation for normal AODV**	**Evaluation for improved AODV**
Average throughput	75.85 kbps	136.5 kbps
Average end to end delay	43.28 ms	33.2 ms
Packet Delivery ratio	96.54.%	99.6%

Figure 2 shows the comparison of AODV and Improved AODV protocols in terms of packet delivery ratio (PDR) w.r.t. number of nodes. This figure and table 2 clearly reveal that Improved AODV outperforms in terms of PDRof 99.6% than that of AODV having PDR value of 96.54%.

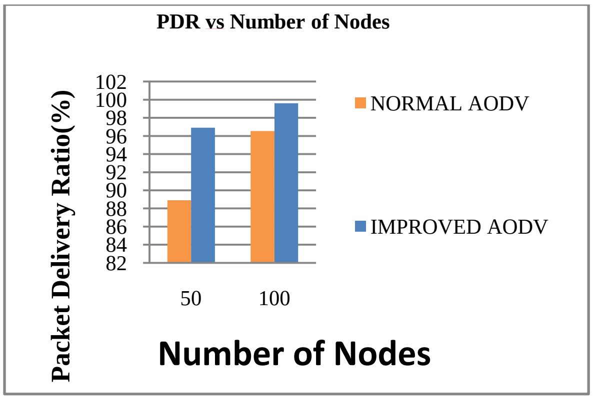

Figure 2. Comparison of normal and improved AODV on the basis of packet delivery ratio

Figure 3 gives the comparison of throughput for AODV and Improved AODV w.r.t number of nodes. It is evident from this figure and table 2 that the average throughput value for AODV is 75.85 kbps and throughput value for Improved AODV is 136.5 kbps.

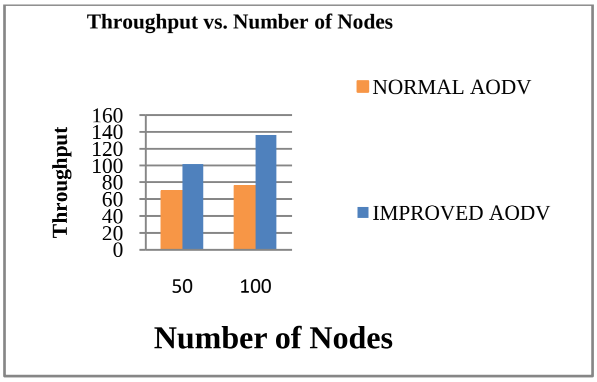

Figure 3. Comparison of normal and improved AODV on the basis of Throughput

Figure 4 gives the value of average end to end delay for AODC and Improved AODV. It is again evident from this figure and table 2 that the average end to end delay for AODV and Improved AODV are 43.28 ms and 33.2 ms respectively. Thus improved AODV protocol leads to lesser delay for data delivery in MANETs.

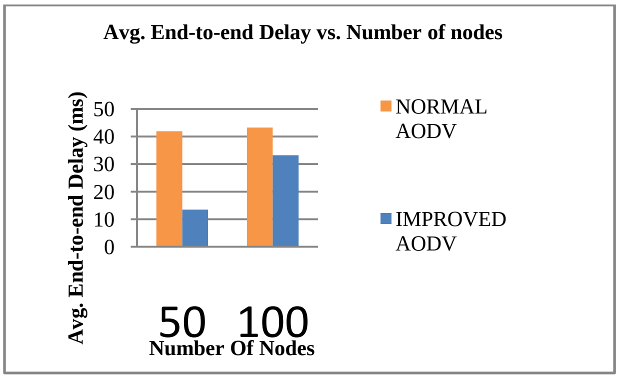

Figure 4. Comparison of normal and improved AODV on the basis of Average end to end delay

Thus it clear from this discussion that improved AODV algorithm with CBR traffic performs exceptionally well as compared to normal AODV protocol with TCP traffic in terms of packet delivery ratio, end to end delay and throughput of MANETS.

VI. CONCLUSION

For CBR traffic, IMPROVED-AODV is more beneficial at highly mobile and dense network. As the number of node increases IMPROVED-AODV gives high throughput value, lesseraverage end to end delay and high packet delivery ratio than NORMAL-AODV with TCP traffic. Thus, IMPROVED-AODV not only enhance the network performance but also more reliable in data transmission as it reduces the network partition and packet loss in the networks.

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