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SIMULATION OF VARIOUS QoS PARAMETERS IN A HIGH DENSITY MANET SET-UP USING AODV nthBR PROTOCOL FOR MULTIMEDIA TRANSMISSION, DATA TRANSMISSION AND UNDER CONGESTION SCENARIO

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Abstract

Mobile ad hoc networks (MANETs) are a setup of several independent nodes that are capable of transmitting any kind of data by themselves. In MANETs, the node themselves act as routers and the setup can either be single hop or multihop depending on the application. These devices have wide and varied applications; like in military deployment, for network set up in meetings, electronic classrooms etc. As the applications and use of MANETs has increased, it has also become imminent for MANETs to support multimedia transmission, high quality data transmission and also to work efficiently in a congestion scenario. To support these parameters it is necessary to have a robust routing protocol that provides good Quality of Service (QoS) parameters under different conditions. In this paper the authors simulate transmission of multimedia traffic with AODV nthBR routing protocol for a high density MANET setup. AODV nthBR routing protocol is also simulated for a congestion scenario and the results are then compared with the existing routing protocols.

Keywords:

MANETs, AODV, DSR, AODVBR, AODV nthBR, Multimedia, QoS

1. INTRODUCTION

Mobile Ad Hoc Networks (MANETs) are a collection of dynamic nodes and they can be set up independently without any infrastructural requirements. These devices have grown in popularity due to their ease of set up. With the tremendous increase in their popularity, MANETS need to support a host of applications including multimedia transmission. Multimedia streaming can be either audio, video, image or animation [1]. With advancements in technology, supporting different applications in MANETs has become imperative. Extending these applications on MANETs is a challenging task as the devices or nodes in MANETs have limited availability of various resources like bandwidth, energy, storage capacity etc.

For an effective multimedia communication between source to destination, it needs to be ensured that packet flow is continuous, packet loss is minimal and throughput is high. This can be done by providing acceptable Quality of Service (QoS) parameters for MANETs [2]. Major cause of high packet loss, high error rate and overall poor performance of any system is route failure. Hence, an efficient routing algorithm that supports the existing network and also provides effective backup routes should be provided. Reactive routing protocols like Ad Hoc On Demand Distance Vector (AODV), Dynamic Source Routing Algorithm (DSR) provide only single routes from source to destination resulting in packet loss when any intermediate node fails [3]. Ad Hoc On Demand Distance Vector Backup Route (AODV BR) tries to improve the QoS parameters by providing a backup route in case of a node failure [4]. However, on failure of the backup route the link to the destination again breaks resulting in packet loss and overall poor QoS parameters. Also, as the number of users increasing day by day, the routing protocol should be such that it works in a dense environment and also provides good QoS parameters in a congested environment.

In this paper, the authors have considered a dense MANET of 100 nodes to represent a system with many users. Simulation has been done in MATLAB and in the simulated environment, transmission of multimedia packets is done with Ad Hoc On Demand Distance Vector nth Backup Routing Protocol (AODV nthBR) [5][6]. In AODV nthBR protocol, nodes for packet transmission are selected on the basis of their distance from the failed node and energy efficiency. The main aim of the simulation is to ensure delivery of packets even in case of multiple route failures and to have a system that works well even in a congestion scenario. The results obtained with multimedia packets are compared with results obtained while transmitting data packets. Also, the QoS parameters obtained with AODV, DSR and AODV BR are compared with QoS parameters obtained with AODV nthBR protocol. The proposed protocol for transmitting multimedia packets is called AODV nthBR with mixed traffic and is shown to transmit multimedia packets successfully.

The paper is organized as follows: section 2 describes the related work on backup routing. In section 3 simulation set up and implementation is described. In section 4 simulated results are discussed and in section 5, work is summarized.

2. RELATED WORK

The routing protocols in ad hoc networks are mainly classified as table driven and on demand distance vector routing protocols. Table driven routing protocols maintain a routing table with routes to all destination but due to the ever changing topology of ad hoc networks they are not suitable to be used in MANETs [7]. On demand routing protocols establish nodes as and when necessary and are suitable to be used in a dynamic system like MANET. Since on demand routing protocols do not maintain any routing tables and also does not establish unnecessary routes, they considerably reduce overhead traffic which is quite important in a resource constrained system like MANET [8]. Ad Hoc On Demand Distance vector (AODV) and Dynamic Source Routing (DSR) are the prominent examples of on demand routing protocols used for route establishment in MANETs.

In AODV protocol, each and every node refers to a point towards its neighbor from which it expects a reply. Also, a routing table is maintained which stores the node identifier [9]. Although AODV reduces overhead when compared to proactive routing protocols but it still does not provide any solution in case of route failure. This problem becomes more prominent in case of multimedia data transmission as loss of intermediate packets may lead to poor quality of image, video etc. being received.

In DSR, there are two major operations: route discovery and route maintenance. To reduce the overhead incurred on route discovery, the nodes maintain a track of route reply packets. DSR protocol also considerably reduces overhead as compared to proactive protocols but keeping a track of all paths and route discovery as well as maintenance is not feasible in dynamically changing systems like MANETs. Also, there is no provision of backup routes in case of node failure. This again becomes a major problem while sending multimedia packets and also in emergency situations where route failure is not at all desirable.

Ad Hoc On Demand Distance Vector Backup Routing (AODV BR) was proposed by Lee. In AODV BR, a backup route provides an alternate route for packet transfer on the failure of primary route. The alternate route is established by overhearing the packets that are being transmitted and a repairing procedure occurs near the failed node. AODV BR provides alternate route in case of link or route failure between source and destination node. However, AODVBR does not propose any solution for backup route failure. In AODV BR when backup route fails, packet delivery becomes impossible. To overcome this problem, AODV with nth Backup Route (AODV nthBR) technique was proposed by the authors. AODV nthBR provides "n" backup routes in MANETs on failure of the original route. When any node in the transmission route fails, the next nearest energy efficient node is selected as a backup route. In case the node selected for backup route also fails then again the next backup route is found out by finding the nearest node and checking its energy efficiency. The process continues until a suitable path is selected for routing. AODV nthBR protocol ensures that data packets are transmitted to the destination even if the path experiences multiple node failure. Transmission to the destination is possible even if one capable node is available for transmission. In this protocol, nodes in the path of routing are selected on the basis of distance from the current node and its available energy. Nearest node to the failed node is selected using distance vector calculation and this node is checked for its energy efficiency and if the remaining energy is within the threshold value required for packet transmission then node is selected for backup route. Flooding in the network is avoided as multiple data packets are not transmitted simultaneously. For transmission of multimedia data packets, it needs to be ensured that packets are transmitted in sequence and packet loss as well as delay is minimal. Apart from these factors, congestion is also a major bottleneck in providing efficient QoS parameters. Previously many congestion control techniques like Cluster Based Congestion Control (CBCC), mobile agent based congestion control etc. have been proposed in literature [10]. However, the effectiveness of providing multiple backup routes in a congested environment needs to be tested. In this paper, multimedia transmission in a congested environment using AODV nthBR protocol has also been done. Apart from multimedia transmission, normal data packets are also transmitted in congested environment using AODV, DSR, AODV BR and AODV nthBR protocols and the obtained QoS parameters have been studied and compared.

This paper is an extension of the authors' previous work [11] and here to achieve multimedia transmission an image is transmitted with AODV nthBR protocol and QoS performance of AODV nthBR protocol is compared with AODV, DSR and AODV BR.

3. SIMULATION SETUP AND IMPLEMENTATION

3.1 NETWORK SETUP

The Fig.1 shows a rectangular field area of size (100m × 100m) with a destination that is initially placed in the centre. At the start of the data transmission, all nodes move randomly in the system. A dense system with 100 nodes and node mobility of 20m/s has been considered. Initially, all the nodes are placed randomly in the field area and initial energy of a node is 0.5J. Total packets to be transmitted are 4000 with each packet of size 1 bit and number of transmission rounds being 6000. The MANET set up created here is such that the value of node density and node mobility can be changed accordingly to show a sparse, medium or densely populated system. This paper presents a system with 100 nodes representing a large sized or dense MANET. A bitmap image of size611KB is chosen to be transmitted for simulation purpose and transmission of multimedia is referred as AODV nthBR with mixed traffic.

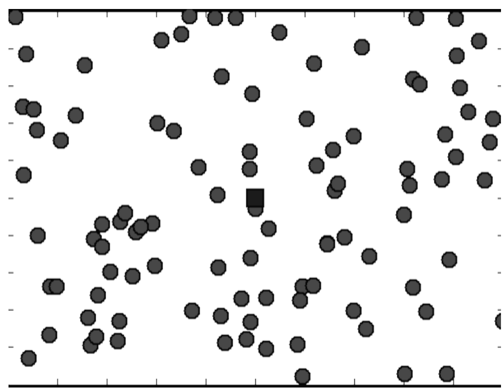

Fig.1. MANET Simulation Setup

3.2 IMPLEMENTATION OF PACKET TRANSMISSION

Distances between all the nodes are calculated using distance vector calculation [12] [13].

Average distance between the transmitting device and destination D_{bs}

$$D_{bs} = (\text{one dimension of field}) / \sqrt{2\pi k}\ (k = 1) \tag{1}$$

$$D_{bs} = (0.765 \times \text{one dimension of field}) / 2 \tag{2}$$

Also, the calculated average energy E_a of a node after a particular round is given by

$$E_a = E_t \times \left(\frac{1 - (r/R_{\max})}{n} \right) \quad (3)$$

R_{max} = Maximum number of Rounds

E_t = Total Energy

The total energy dissipated in the network during a round is calculated by:

$$E_t = bitsdata \times \left(2 \times n \times E_{tx} + n \times E_{da} + K_{opt} \times E_{mp} \times D_{bs}^4 + 4 \times n \times E_{fs} \times D_{ch}^2 \right) \quad (4)$$

E_{tx} = Electronics Amplifier energy

n = No. of nodes in field

E_{mp} = Transmit Amplifier Energy

E_{tx} = Received Amplifier Energy

E_{da} = Data Aggregation Energy

K_{opt} = Optimum number of node groups

D_{ch} =Average distance between transmitting node and the destination

E_{fs} = represent amplifier energy consumptions for a short distance transmission.

At the start of the data transmission, packets are sent to the destination through multihop transmission involving intermediatory nodes. In case of a node failure, the node that is nearest to the failed node is found out using distance vector calculation as given in Eq.(1) and Eq.(2). Also, the energy of the selected node and total energy dissipated in the network can be calculated with Eq.(3) and Eq.(4). If energy of the selected node is within the threshold value required for packet transmission, then the node is selected for backup routing else the next nearest node is found out using distance vector calculation and its energy is checked using the equations given above for energy calculation. If the next nearest node fulfills the criteria of distance and energy requirements, then the node is selected for packet transmission otherwise the process of finding the suitable backup node continues.

$$p(i) = \frac{p \times n \times \text{current energy} \times \text{residual energy}}{\text{initial energy} \times \text{average energy}} \quad (5)$$

Here p = Optimum election probability of a node to become a transmitting one or an active node.

After a node is selected as active node, energy models are applied to calculate the amount of energy $E_{tx}(l, d)$ spent by it on that particular round and complete the round of steady state phase.

$$E_{TX}(l,d) = \begin{cases} lE_{dec} + l\varepsilon_{fx} d^2, d < d_0 \\ lE_{dec} + l\varepsilon_{fx} d4, d \geq d_0 \end{cases} \quad (6)$$

Here $\varepsilon_{fx} d^2 = R$ represents amplifier energy consumption for a distance transmission

d = Distance between a transmitting node and destination

d_0 = Threshold distance

l = Bit per message (packet length, we considered it initially as 4000 packets)

If a node is not an active node and discarded from the criteria above, then it goes to a set of other node, and follows the behavior of other mobile devices and completes the round of steady state phase.

Network specifications for simulation are given in Table.1.

Table.1. Network Specifications

Simulation Parameters	
Field Size	100m × 50m (Normal field size) 50m × 50m (Field size for congestion Scenario)
Number of Nodes	100
Number of Packets	4000
Number of Rounds	6000
Speed of the nodes	20m/sec
Data Traffic	CBR(Constant Bit Rate)
Protocols	AODV, DSR, AODVBR, AODV nthBR, AODV nthBR with mixed traffic (for multimedia transmission)
Computation Time for AODV nthBR for 100 nodes	84.37 secs

3.3 SIMULATION OF AODV nthBR PROTOCOL IN CONGESTION SCENARIO

Here, a congestion scenario refers to the presence of a large number of active nodes that are capable of transmission. The number of nodes will be more than what is normally available in a particular area. To present this scenario the authors have considered dense MANETs (100 nodes) in a smaller area (50m × 50m). It is shown that in such a scenario also, AODV nthBR protocol gives better QoS parameters than other protocols. By taking a dense MANET in a smaller area, a fair idea of congestion scenario can be had. Other than the field size, all other parameters remain same for simulation of AODV nthBR protocol in congestion.

4. SIMULATION RESULTS

The simulations were performed in MATLAB, an open source package and QoS parameters were obtained in terms of throughput, lifetime of devices and packet delivery fraction.

4.1 THROUGHPUT

Throughput is the total number of data packets received by the destination over the total simulation time. As seen from Fig.2, throughput is seen to be maximum for AODV nthBR protocol, followed by AODV BR, then AODV and least for DSR protocol. In this paper, "with mixed traffic" means transmitting a multimedia image through AODV nthBR protocol. It is observed from Fig.2 that the number of packets transmitted per round is less in case of AODV nthBR with mixed traffic. It is to be noted that multimedia data on account of being of larger size always takes comparatively more time to transmit. Moreover, in this paper, aim of the authors is to find backup routes to avoid link failure so that transmission of packets of any type is achieved and the proposed AODV nthBR protocol with mixed traffic supports this. Throughput for the initial rounds is a little bit less for AODV nthBR as compared to AODV BR. This is because a dense system is being considered and due to more number of nodes being capable of transmission at the initial stage, it takes more time to find out distance from the failed node and to calculate energy efficiency of each node. However, the difference is marginal and as the number of rounds increases, the throughput clearly increases for AODV nthBR protocol. Throughput (number of bits transmitted) after round 1000 for AODV protocol is 75700 bits, it is 41930 bits for DSR, 96240 bits for AODV BR, 76830 bits for AODV nthBR and 349 bits for AODV nthBR with mixed traffic. After initial rounds, throughput increases and after 2000 rounds it is 75700 bits for AODV protocol, 41930 bits for DSR, 110400 bits for AODVBR, 11580 bits for AODV nthBR and 349 bits for mixed traffic. After 6000 rounds, the values(in bits) for AODV, DSR, AODVBR, AODV nthBR, AODV nthBR with mixed traffic is 75700, 41930, 110400, 115800 and 349 respectively. So, AODV nthBR is shown to transmit multimedia effectively without break in link between sources to destination.

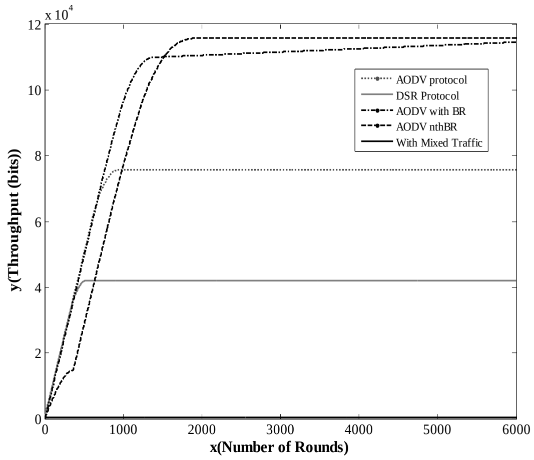

Fig.2. Throughput vs number of rounds

4.2 END TO END DELAY

End to end delay is the total latency experienced by a packet to traverse the network from the source to the destination and the total node delay includes the protocol processing time and the queuing delay at each node. The end to end delay, as shown in Fig. 3, is minimal in case of data transmission. However, since an image file is more in size, so it comparatively takes more time in transmission. At the end of round 1000, end to end delay for AODV nthBR with data transmission is 0.01302 secs and for AODV nthBR with mixed traffic it is 2.865 secs.

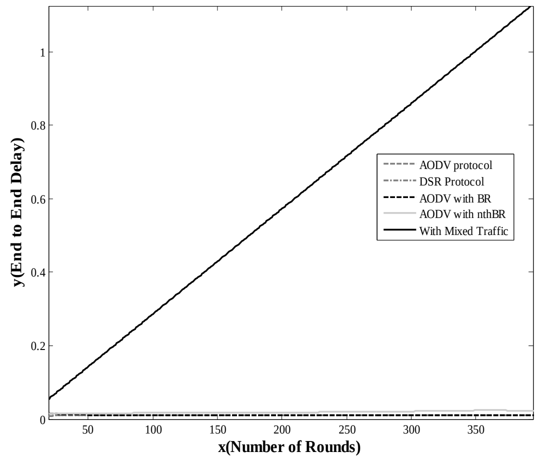

Fig.3. End to end delay vs number of rounds

4.3 PACKET DELIVERY FRACTION

Packet Delivery Fraction (PDF) is the ratio of the total number of data packets received by the destination to the total number of data packets transmitted. The Fig.4 shows the results for PDF. It is observed that best results are obtained when normal data packets are transmitted with AODV nthBR protocol. The results are compared with transmission done using AODV, DSR and AODVBR protocol. As explained earlier for the throughput case, AODV nthBR successfully transmits an image (AODV nthBR with mixed traffic) albeit with lesser packets being transmitted for the same number of rounds. This is on account of the large file size. However, an uninterrupted transmission for packet transfer between source and destination is achieved.

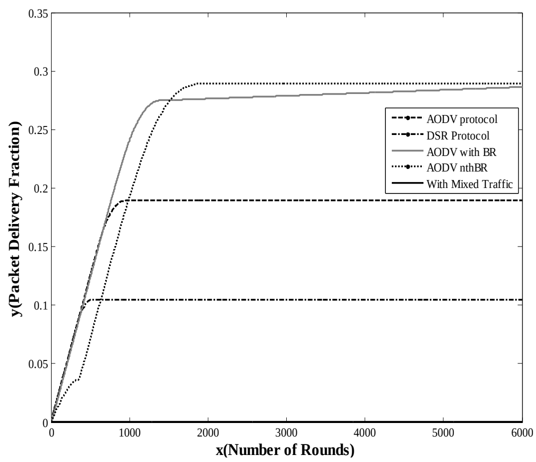

Fig.4. Packet Delivery Fraction vs number of rounds

4.4 CONGESTION SCENARIO

The Fig.5 and Fig.6 show throughput and packet delivery fraction for a dense MANET simulated in a 50m × 50m area. This simulation environment represents an area under congestion. As observed from Fig.5 and Fig.6, throughput and packet delivery fraction attained with AODV nthBR is maximum compared to other protocols. Also, it is shown that even multimedia packets can be transmitted in a congested environment using AODV nthBR protocol. After about 1968 rounds, value of throughput for AODV nthBR protocol is

140400 bits and for multimedia transmission (AODV nthBR with mixed traffic), the value of throughput is 384 bits.

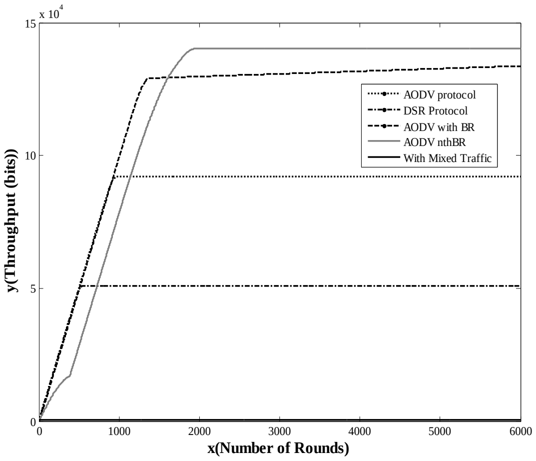

Fig.5. Throughput vs number of rounds (Congestion scenario)

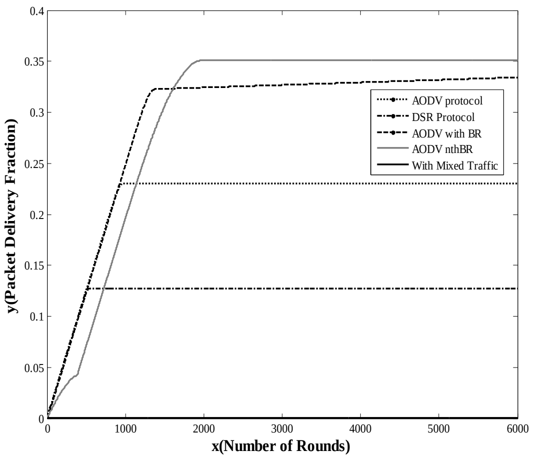

Fig.6. Packet Delivery Fraction vs number of rounds (Congestion scenario)

5. CONCLUSION

In this paper AODV nthBR protocol has been successfully simulated for data as well as multimedia transmission. Various QoS parameters have been evaluated and compared with other reactive routing protocols. Also, AODV nthBR protocol has been successfully tested in a simulated congestion scenario for data as well as multimedia transmission. AODV nthBR is shown to perform better than other traditional routing protocols for various QoS parameters and is also shown to successfully transmit multimedia data. This protocol can especially be very useful in situations where data to be transmitted is very important and any packet loss during transmission is not at all desirable. Emergency situations, rescue operations during natural disasters or military applications are prime examples where AODV nthBR protocol can be implemented. To summarize, the primary objective of this work was to obtain a backup routing protocol that minimizes the chances of a communication failure between source and destination by providing several backup routes in an efficient way and the authors have tried to simulate the scenario and have compared and presented the obtained results.

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