Performance evaluation of reactive routing protocols in MANET networks using GSM based voice traffic applications

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ABSTRACT

The mobility of nodes results in frequent and unpredictable changes of network topology, leads to regular route changes, network partitions and possibly packet losses, making routing a challenging task in MANET network. The mostly used routing protocols in such networks are proactive, reactive and hybrid, but a reactive routing strategy is the most popular technique for wireless adhoc routing that provides a scalable solution to relatively large network topologies. This paper evaluates the performance of AODV- and DSR-reactive routing protocols in MANET network using GSM quality voice traffic by calculating matrices such as voice end-to-end delay, network load, throughput, number of hops per route, route discovery time, voice traffic-sent and -received using OPNET Modeler 14.5.

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1. Introduction

A MANET is an autonomous group of mobile users that communicate over reasonably slow wireless links. MANET is a kind of wireless adhoc network and is a self-configuring network of mobile routers connected by wireless links making an arbitrary topology. The routers, the participating nodes act as router, are free to move randomly and manage 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 [1]. Nodes in these networks utilize the same random access wireless channel, cooperating in an intimate manner to engaging themselves in multi-hop forwarding. The node in the network not only acts as hosts but also as routers that route data to/from other nodes in network [2]. Within a cell, a base station can reach all mobile nodes without routing via broadcast in common wireless networks. In the case of adhoc networks, each node must be able to forward data for other nodes. This creates additional problems along with the problems of dynamic topology which is unpredictable connectivity changes [3]. Many routing schemes have been presented to provide adequate performance of adhoc networks. Adhoc routing is classified into proactive routing and reactive routing based on when routes are determined. Proactive routing (DSDV, WRP) continuously makes routing decisions so that routes are immediately available when packets need to be

transmitted. Reactive routing determines routes on an as-needed basis: when a node has a packet to transmit, it queries the network for a route. Proactive routing consumes a great deal of radio resources to exchange routing information. Also, pre-determined routes may rapidly lose their validity in an adhoc network because its topology changes rapidly. On the other hand, the routes, in reactive routing protocols, are created as and when required. When a transmission occurs from source to destination, it invokes the route discovery procedure. The route remains valid till destination is achieved or until the route is no longer needed. AODV and DSR belong to reactive routing protocols [4,5]. In this paper, MANET adhoc networks with reactive adhoc routing protocols are studied and evaluated using OPNET Modeler 14.5. Then performance comparison has been performed between various reactive adhoc protocols (ADOV and DSR) for various routing parameters and QoS in MANET for GSM quality voice traffics.

2. Simulation setup

Using OPNET 14.5 simulator [8,9], we have designed MANET network having 40 nodes with vector mobility within simulation area of 5 km × 5 km. Also, the high quality GSM voice network traffic is used during simulation interval of 15 min as shown in Fig. 2. Mobility model used is random waypoint model with mobility of 500 m. The performance of the MANET network is evaluated by implementing reactive adhoc routing protocol schemes such as ADOV and DSR in different scenarios. The buffer size of data is set to 2024 kbps for each mobile workstation at data rate of 11 Mbps with 802.11b PHY layer and DCF MAC Protocol implementation. The

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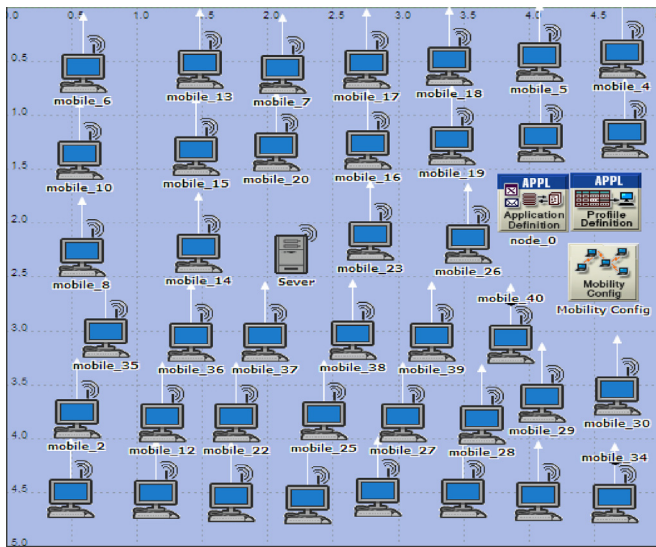E-mail address: er_vishusharma@yahoo.com (V. Sharma).

Fig. 1. Model of WLAN network using OPNET simulator.

traffic flows randomly between different voice applications work-stations placed at different distances as shown in Fig. 1 (Table 1).

3. Result and discussion

To evaluate the overall performance of various reactive adhoc routing protocols, we have determined the various QoS parameters such as throughput, end-to-end delay, route discovery time, number of hops per route, network load for MANET network. Fig. 2 shows a comparison between the routing protocols on the basis of throughput as a function of pause time and using different number of traffic nodes. Throughput describes the loss rate as seen by the transport layer and reflects the completeness and accuracy of the routing protocol. From Fig. 2(a), it is clear that through-put of ADOV increases sharply with simulation time and mobility and becomes nearly 2200 kbps at the end of simulation. On the other hand, there is a drop in throughput from initial 1200 kbps to 1000 kbps at the end of simulation in case of DSR. With the decrease in the number of nodes of the network i.e. from 40 to 20 nodes, there is a large throughput drop in case of ADOV as compare to DSR. This is due to reason that reactive protocols (DSR and AODV) drop a considerable number of packets during the route discovery phase, as route acquisition takes time proportional to the distance between the source and destination. Buffering of data packets while route discovery in progress, has a great potential of improving DSR and AODV performances. AODV uses route expiry, dropping some packets when a route expires and a new route must be found [10]. Fig. 3(a) calculates average packet end-to-end delay of each transmitted packet during the simulation time period in 40 nodes of MANET network. From the graph, it is observed that ADOV
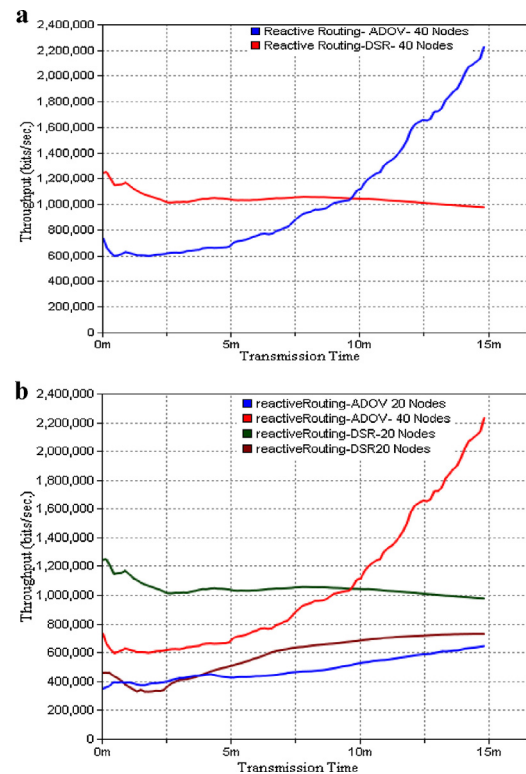
Table 1
Simulation parameters.

Routing protocols	AODV DSR
MAC layer	802.11 (DCF)
Packet size	512 bytes
MANET size	5 km × 5 km
Mobile nodes	40, 20
Mobility model	Random waypoint mobility
Traffic type	High quality GSM voice
Simulation time	900 s
PHY standard used	802.11b, 11 mbps

Fig. 2. (a) Measurement of throughput of MANET network using different reactive adhoc routing schemes. (b) Throughput measurement of throughput of MANET network using different reactive adhoc routing schemes with different numbers of nodes.

average delay performance is less, nearly 6 s, than that of DSR which is nearly 8 s for GSM voice traffic data. This is due to the fact that in case of congestion or high traffic, control messages get loss and thus, eliminating its advantage of fast establishing new route with DSR routing scheme [6,7]. Under such situations, DSR has a relatively high delay than AODV [11]. AODV and DSR show poor delay characteristics as their routes are typically not the shortest. Even if the initial rout discovery phase finds the shortest route, the route may not remain the shortest over a period of time due to node mobility.

However, AODV performs a little better than DSR and can possibly do even better with some fine-tuning of this timeout period by making it a function of node mobility. From Fig. 3(b), we see that the average packet delay increases with increase in number of nodes waiting in the interface queue in both cases of ADOV and DSR routing protocols.

Besides the actual delivery of data packets, the delay time is also affected by route discovery which is the first step to begin a communication session as shown in Figs. 4 and 5 shows ADOV protocol average number of hops per route (nearly 3.5) is more as compare to DSR (nearly 2.5) because of their route discovery takes more time as every intermediate node tries to extract information before forwarding the reply as shown in Fig. 4, where in case of 20 mobile nodes average number of hops per route is almost same. The same thing happens when a data packet is forwarded hop by hop. Hence, while ADOV routing makes route discovery more profitable, it slows down the transmission of packets [12] (Fig. 6). Although the voice traffic sent in different MANET networks using different adhoc routing technique is same, but in network using ADOV protocol has maximum traffic received as compare to DSR protocols and increases during entire simulation time and remain equal to 1200 bytes per second for entire simulation time, where for 20 mobile nodes
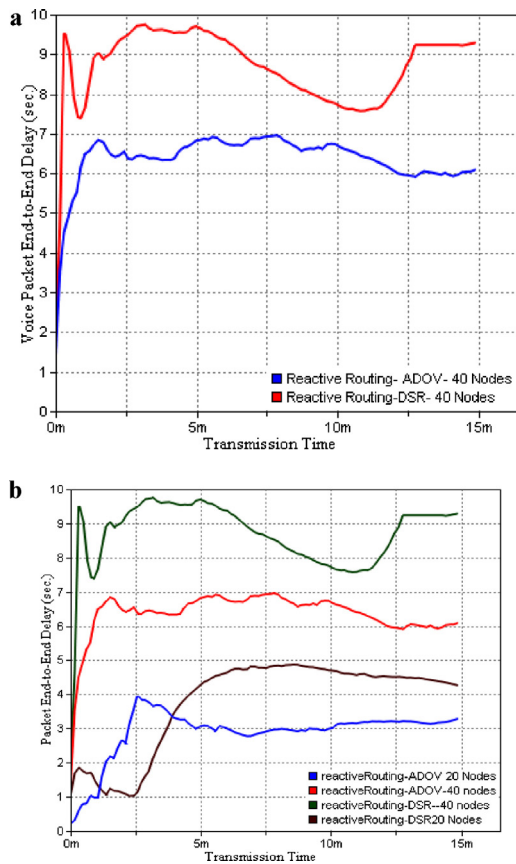
a

b

Fig. 3. (a) Measurement of end-to-end delay of traffic stations in MANET network using different reactive adhoc routing schemes. (b) Measurement of end-to-end delay of traffic stations in MANET Network using different reactive adhoc routing schemes with different number of nodes.

ADOV received traffic is slightly better nearly 1300 bytes per second than 40 mobile nodes network. In case of DSR traffic received is worst that is nearly equal to 5000 bytes per seconds for both 40- and 20-nodes of MANET network during its entire simulation period which is half of ADOV protocol networks as depicted in Fig. 5.

Based on wireless LAN load Fig. 7 shows that, for different number of nodes, loads are varying compared to each other. For
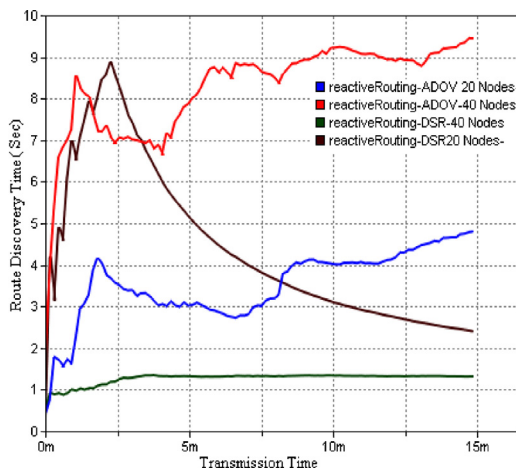

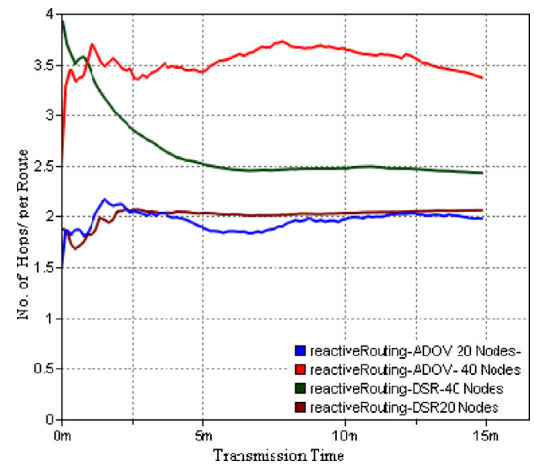**Fig. 4.** Route discovery time of MANET network using different reactive adhoc routing schemes.

Fig. 5. Number of hops per route in MANET network using different reactive adhoc routing schemes.
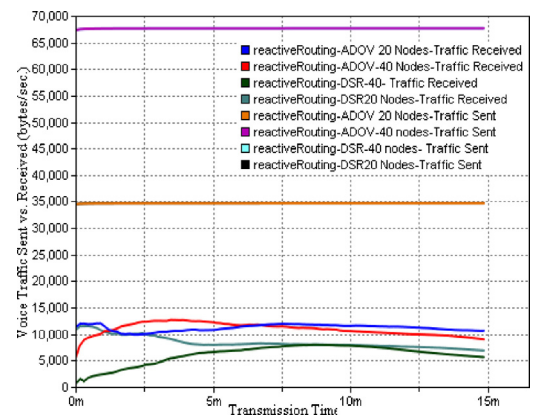

Fig. 6. Traffic sent vs. traffic received in MANET using different reactive adhoc routing schemes.

40 nodes, initial network load for DSR network is alarmingly high, but decreases sharply with simulation time and becomes 1200 kbps and remains nearly same for entire simulation period and 800 kbps for 20 nodes. Alternatively, for any load, AODV is showing a considerable good performance which is nearly 700 kbps and 500 kbps for both 40- and 20-nodes of MANET network respectively.
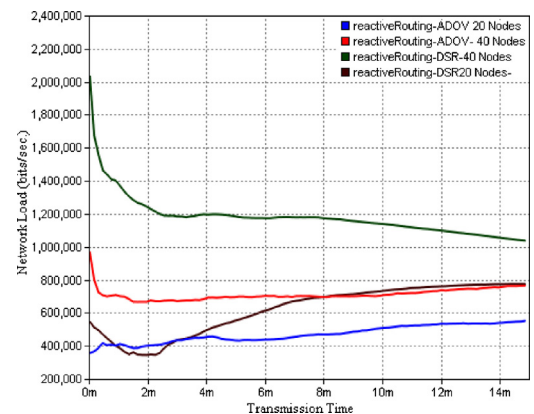

Fig. 7. Network load of MANET network using different reactive adhoc routing schemes with number of nodes used in network.

4. Conclusion

The simulation model of MANET network is developed using OPNET 14.5 simulator and analyzed for different reactive adhoc routing protocols with different mobile nodes transmitting GSM voice traffic data. It is concluded that AODV routing protocol has lowest end-to-end and lower network load as compare to DSR. Also, ADOV has maximum average throughput and traffic received as compare to DSR. The DSR routing protocol does not scale well with large sized networks. Simulation results also showed that ADOV reactive routing protocol is the best suited for MANET networks in dense population of nodes, whereas, DSR has very poor QoS in high populated node networks with GSM voice traffic data.

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