# Performance Evaluation and Analysis of the Proactive and Reactive Routing Protocols for MANETs


Yuxia Bai
Department of Electrical and Computer Engineering
California State University, Fresno
Fresno, USA
arkshara@mail.fresnostate.edu

Yefa Mai
Department of Electrical and Computer Engineering
California State University, Fresno
Fresno, USA
maiyf1991119@mail.fresnostate.edu

Dr. Nan Wang
Department of Electrical and Computer Engineering
California State University, Fresno
Fresno, USA
nwang@csufresno.edu



***Abstract*- Mobile Ad Hoc Network contains wireless mobile nodes to construct a dynamic network without support of any fixed infrastructure. Those nodes or hosts in the network are all movable and self-configurable. At the same time, they serve as routers to deliver data from sources to the destinations. To meet performance requirements of such kind of network, the routers have to work efficiently together. Routing algorithm plays a very import role in MANET architecture design due to the specific characteristics. This paper presents performance evaluation and analysis for two flat routing protocol categories, Proactive and Reactive routing protocols. This paper will also show a simulation methodology to evaluate routing overhead, throughput and end-to-end delay of a MANET. Furthermore, a performance justification of the simulation results will be presented.**



***Keywords—MANET; Proactive Routing, Reactive Routing; TORA; DSDV; AODV; DSR; FSR***


## I. INTRODUCTION

Mobile Ad hoc Network (MANET) emerged as a promising solution for wireless communication between movable nodes where fixed infrastructure is unavailable. Due to mobility of the nodes, the interconnections between nodes are always changed and reconfigured dynamically. All the nodes in a MANET can move individually in any direction at any time, therefore the connections between them need to be updated accordingly. The biggest challenge in MANET design is to make each of the nodes maintain connections with its neighbors and direct information traffic to the appropriate destinations.

MANET is generally used in the locations that a fixed infrastructure can't be formed due to certain reasons. Disaster areas, war zones, and emergent sites are good examples of such kind of situation. All the hosts are mobile and can be installed in cars, soldiers, ships, buses, airplanes and emergency response teams to form a temporary network as shown in Fig.1. Any of the hosts can move out of the range at any time, result in a reconfiguration of the network. There are several MANET types, including Vehicular Ad Hoc Networks (VANETs), Smart Phone Ad Hoc Networks (SPANs), Internet Based Mobile Ad Hoc Networks (iMANETs) and Military or Tactical MANETs [1].

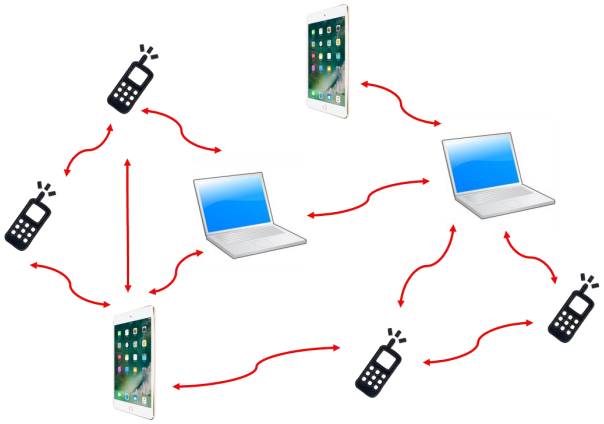

Fig.1. A Mobile Ad-Hoc Network (MANET)

The nodes in a MANET serve as routers to deliver data from sources to the destinations. To meet rigid performance requirements of such a network, the routers have to work efficiently together. Routing protocol plays a very import role in MANET design due to the specific characteristics.

Some research on the topic of MANET Routing Protocol Design has been carried out in last several years. AODV, DSDV and DSR routing algorithms have been simulated and compared [4-7]. Study and evaluation of the MANET routing protocols based on difference network configurations were presented [8-11].

In this paper, the performance of four typical MANET routing protocols is evaluated and compared using NS2 wireless communication simulator. Among the routing protocols, the DSDV and FSR algorithms are Proactive type and the AODV and DSR algorithms are Reactive type. The simulation results of the Proactive and Reactive protocols based number of total nodes and packet size will be directly compared and justified.

The organization of this paper is as follows. Section 2 discusses the five typical MANET routing protocols. Section 3 presents the simulation methodology. The performance justification and analysis are presented in Section 4. Finally, Section 5 concludes the paper.

## II. AD-HOC NETWORK ROUTING PROTOCOLS

There are two types of flat routing protocols, Proactive routing (Table-driven Routing Protocols) and Reactive routing (On-demand Routing Protocols), in MANET to direct data from a host to the destination as shown in Fig.2.

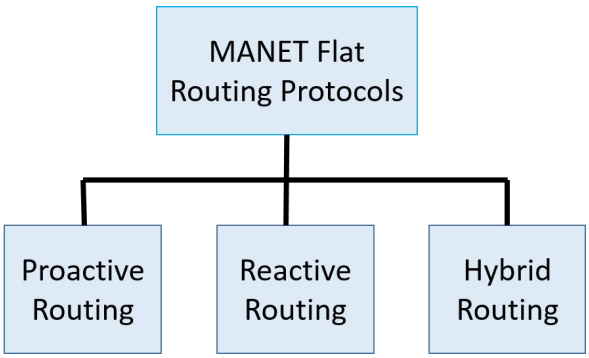


Fig.2. MANET Routing Protocols

### A. *Proactive Protocols*

In Proactive routing protocols, each node maintains and updates one or more tables that contain routing information to other nodes. The information in these tables will be updated so as to keep routing information consistent and updated as the network status changed.

The Destination Sequence Distance Vector (DSDV) routing algorithm is based on the classical Bellman-Ford Routing Algorithm. In DSDV routing algorithm, all the nodes keep the information of the neighboring node and will direct data to its next nodes. Before the nodes in any route pass data package to the next nodes, an agreement must be acknowledged by both nodes. As result, all the nodes will update their routing tables to keep all position information in the network consistent and up to date. This will promise no disturbance in the route [2].

In the Fisheye State Routing (FSR), all the nodes keep very accurate routing information of the nearby neighbors but the accuracy decreases with distance from the node. The levels and radius of node scope can be defined based size of the network [3].

### B. *Reactive Protocols*

In Reactive Protocols (On-demand Routing Protocols), there is no need for the nodes in the network to keep routing information. Whenever a node needs to send data to a destination, a route generation mechanism will create a route based on current network situation. The route will be canceled when the transaction is done.

In the Ad hoc On-Demand Distance Vector (AODV) routing algorithm, all the nodes work separately and do not hold any information of its adjacent nodes. Instead, all the nodes have information of predefined routes through which a data can be delivered to the destination. A route will be formed only when a data arrives at a node and needs to be delivered through it to the destination node.

The Dynamic Source Routing (DSR) protocol is a source routed on-demand routing protocol. In DSR, all the nodes have a route cache to keep the routing information from the source nodes. If the source node needs to send data to a destination, it will check the route cache first. If the route from the source to the destination is valid, then it will send the packets. If there is no valid route, it will start to discover and try to build a route by sending a route request packet which contains the address of the source and the destination. A route will be created if the request packet reaches a node which already has a route from the source to the node.

The Temporary Ordering Routing Algorithm (TORA) is a very efficient, adaptive and scalable routing algorithm for highly dynamic MANET. In TORA, all the nodes have routing information of its neighboring nodes. When needed, all the possible shortest paths from a source to destination will be woken up. Then the most efficient route for the data will be generated. Route generation, Route maintenance, and route deletion are three main functions implemented in TORA routing algorithm.

### C. *Hybrid Protocols*

Hybrid Protocols use features of both Proactive Protocols and Reactive Protocols. Zone Routing Protocol (ZRP) is one of the Hybrid Routing Protocols. In ZRP, performance is improved by selecting either Proactive Protocol or Reactive Protocol based on which is the most efficient algorithm under the current network status.

## III. SIMULATION SETUP

Simulation has been carried out on two Proactive protocols, the DSDV and FSR, and two Reactive protocols, the AODV and FSR routing algorithms using NS2, a wireless network simulator in Linux Ubuntu operating system. The simulation environment is set up as shown in Table I.

TABLE I. SIMULATION PARAMETERS

| Parameter | Value |
|---|---|
| Operating System | Ubuntu 14.04 |
| Channel Type | Wireless Channel |
| Number of Nodes | 5, 10 ,30 |
| Speed (m/s) | 10 |
| Data Type | UDP |
| Simulation Time | 100 |
| MAC Protocol | 802.11 |
| Data Packet Size | 64, 256, 512 |
| Area of Simulation | 500*500 |
| Radio Prop. Model | TwoRayGround |

| Routing Protocols | DSDV, FSR, AODV, DSR,TORA |
|---|---|

The four MANET routing protocols were simulated based on the following performance metrics.

- Throughput (THPT): ratio of amount of received packets to the duration of simulation time.
- Packet Delivery Ratio (PDR): the ratio of the number of packets successfully delivered to the destinations.
- Average End-to-end Delay (AETED): the average time to deliver a packet from source to the destination.

## IV. Simulation Results and Justification

The simulations were carried out on the MANET with 5, 10 and 30 nodes, topologies as shown in Fig.3. The primary goal was to compare the performance between the two major MANET protocol types, Proactive and Reactive protocols. Through the simulations, the performance can be evaluated and analyzed using different simulation setup, such as varied number of nodes (5, 10 and 30), varied packet size (64, 256 and 1024) and so on.

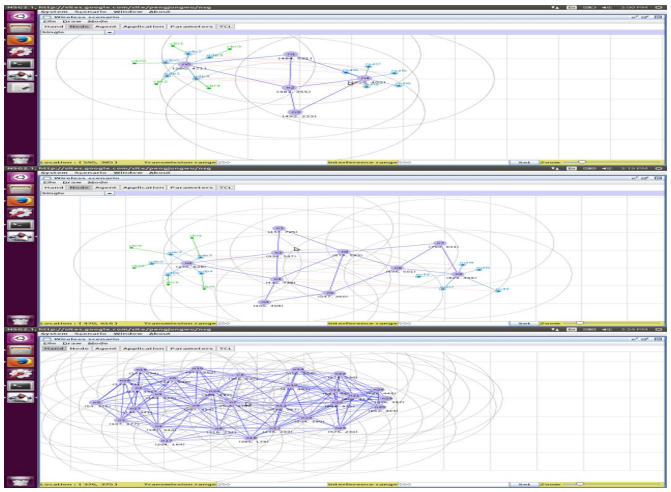

Fig.3. MANET topologies with 5, 10 and 30 nodes

### *A. Simulation Results*

Simulation results of the MANET with 5, 10 and 30 nodes are shown in Table II, III, IV and Fig.4, Fig.5, Fig.6 respectively. The best results in rows are highlighted in red.

TABLE II. Simulation Results (Number of Node:5)

| Packet size | MTRS | Proactive Protocols | | Reactive Protocol | |
|---|---|---|---|---|---|
| | | DSDV | FSR | AODV | DSR |
| 64 | THPT | 264.626 | 264.37 | 255.03 | 201.64 |
| | PDR | 46.0828 | 46.0384 | 44.4128 | 46.0897 |
| | AETED | 0.1228 | 0.123 | 0.1231 | 0.1228 |
| 256 | THPT | 386.412 | 386.182 | 372.373 | 334.27 |
| | PDR | 76.3831 | 76.3364 | 73.6076 | 76.4017 |
| | AETED | 0.1462 | 0.1463 | 0.1476 | 0.1463 |
| 1024 | THPT | 418.968 | 418.598 | 403.741 | 369.97 |
| | PDR | 82.4307 | 82.3614 | 79.4243 | 82.5 |
| | AETED | 0.1478 | 0.1479 | 0.1499 | 0.1479 |

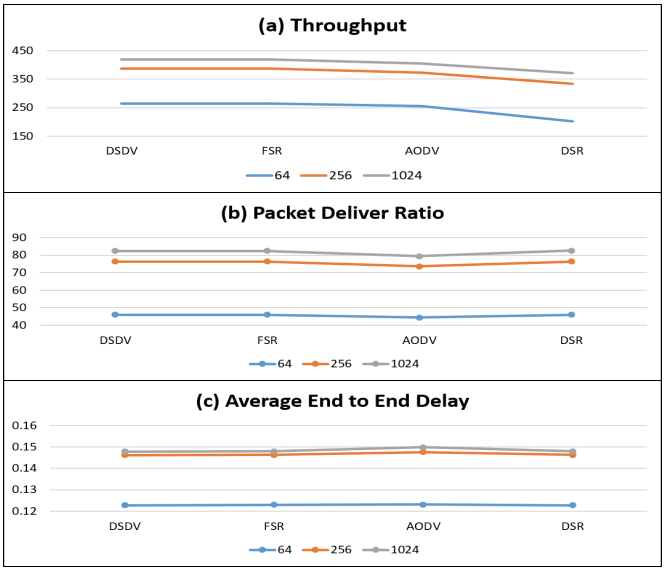


Fig.4. Simulation results-five nodes (a) Throughput (b)Packet Delivery Ratio (c) End to End Delay

TABLE III. Simulation Results (Number of Node:10)

| Packet size | MTRS | Proactive Protocols | | Reactive Protocol | |
|---|---|---|---|---|---|
| | | DSDV | FSR | AODV | DSR |
| 64 | THPT | 262.8688 | 263.4576 | 264.7288 | 201.6399 |
| | PDR | 45.7767 | 45.8788 | 46.1003 | 46.0863 |
| | AETED | 0.1229 | 0.1234 | 0.1228 | 0.1228 |
| 256 | THPT | 383.8725 | 384.8087 | 386.5628 | 334.3208 |
| | PDR | 75.8793 | 76.0659 | 76.411 | 76.411 |
| | AETED | 0.1464 | 0.14158 | 0.1462 | 0.1463 |
| 1024 | THPT | 416.3334 | 417.1573 | 419.2222 | 369.8347 |
| | PDR | 81.9136 | 82.0789 | 82.4733 | 82.468 |
| | AETED | 0.1479 | 0.1485 | 0.1479 | 0.1482 |

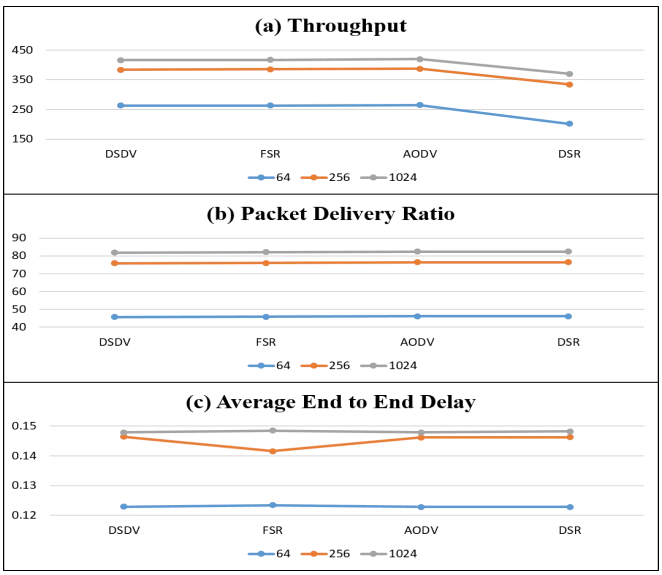

Fig.5. Simulation results-10 nodes (a) Throughput (b)Packet Delivery Ratio (c) End to End Delay

TABLE IV. SIMULATION RESULTS (NUMBER OF NODE:30)

| Packet size | MTRS | Proactive Protocols | | Reactive Protocol | |
|---|---|---|---|---|---|
| | | DSDV | FSR | AODV | DSR |
| 64 | THPT | 201.5899 | 247.5965 | 264.6076 | 201.5899 |
| | PDR | 46.0758 | 43.1183 | 46.0804 | 46.0758 |
| | AETED | 0.1229 | 0.1313 | 0.1229 | 0.1229 |
| 256 | THPT | 383.8693 | 359.1517 | 386.399 | 369.812 |
| | PDR | 75.8793 | 70.9954 | 76.3784 | 82.4574 |
| | AETED | 0.1472 | 0.1573 | 0.1464 | 0.1481 |
| 1024 | THPT | 416.0277 | 390.6297 | 419.0505 | 398.335 |
| | PDR | 81.8497 | 76.855 | 82.4414 | 89.0146 |
| | AETED | 0.1499 | 0.1591 | 0.1482 | 0.1496 |

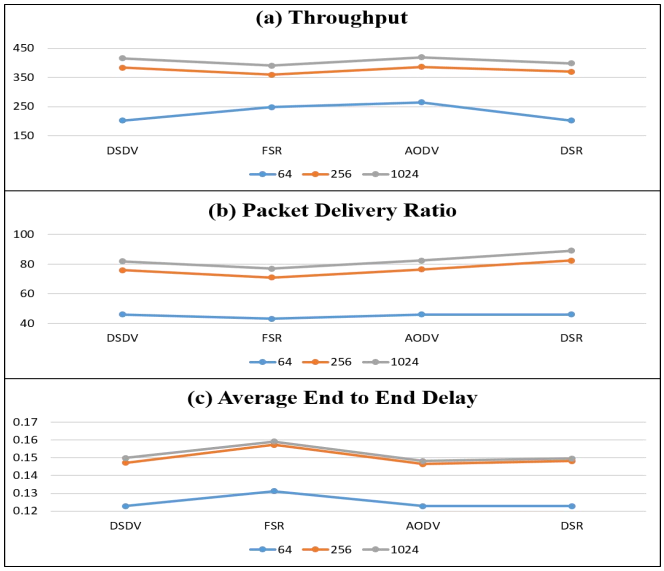


Fig.6. Simulation results-30 nodes (a) Throughput (b)Packet Delivery Ratio (c) End to End Delay

### *B. Simulation Result justification*

Fig.4, Fig.5 and Fig.6 present graphical representations of the data seen in Table II, Table III and Table IV respectively. From the simulation results, the following conclusions can be easily drawn:

- As the packets size increased, Throughput, Packet Delivery Ratio and Average End-to-end Delay are all increased for all the routing protocols on the MANETs with 5, 10 and 30 nodes.
- At node number of 5, the DSDV of Proactive type and DSR of Reactive type are competitive. But as the MANET size increased, the protocols of Reactive type (AODV and DSR) perform better than the Proactive type protocols (DSDV and FSR).
- When comparing throughput between the routing protocols, it was found the DSDV and FSR of Proactive type and the AODV of Reactive type are very competitive, AODV performs the best as the number of nodes and packet size increased. At the same time, the DSR of Reactive type is the worst one.
- For Packet Delivery Ratio, as the number of nodes and packet size increased, the DSR of Reactive type becomes the best performer while the performance of the other three algorithms remains at a similar level. The FSR of Proactive type is the worst algorithm.
- The Average End-to-end delay for the AODV of Reactive type becomes better or competitive as the number of nodes increased. It goes to the opposite way for the other three routing protocols. Therefore, the AODV of Reactive type is the best and the FSR of Proactive type is the worst one.

## V. CONCLUSION

Several MANET routing protocols have been implemented and evaluated in this paper. Two main types of the MANET routing protocols, Proactive and Reactive types, are compared and analyzed head-to-head based on various simulation setups. Test results demonstrate that the AODV algorithm of Reactive type performs better in term of Throughput and Average End-to-end delay. The DSR of Reactive type is a little better among the routing algorithms in term of Packet Delivery Ratio. New routing algorithms will be developed for real world MANET applications in the future.

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