Real Time Experimental Analysis of Mobile Ad-Hoc Traffic in Indoor and Outdoor Environment

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Abstract—The use of mobile ad hoc network varies from collaborative computing to time critical applications in indoor and outdoor environment. Mobility of ad hoc network makes very attractive in all areas of mobile applications. Connection sustainability is the main problem in wireless ad hoc network. This paper analyse straight up, flat topologies of mobile ad hoc traffic in indoor and outdoor environment in real time campus network and evaluate the scenarios based on performance metrics. The results show that the mobiles nodes in straight up and flat topologies are affected by connection, mobility and obstacles with all other topologies. It is also observed that straight up static topology for indoor shows better performance in all metrics.

Keyword-Real time, Traffic analysis, Indoor and outdoor, Ad hoc networks.

I. INTRODUCTION

A mobile ad hoc network is a temporary network connected by a group of wireless mobile nodes and work together by routing packets to each other. The use of mobile ad hoc network varies from collaborative computing to time critical applications in indoor and outdoor environment. Mobility and routing are key issues of MANETs. Simulation of MANETs is quite easy and inexpensive in order to understand protocols and algorithms. Most of simulators are based on different radio models which harm signal strength distributions in indoor environment. But gray zone effect [1] is not considered in standard simulators. In previous literature survey, there is a considerable discrepancy between real time scenario and simulation [2], [3]. To verify the simulation results, real time data are required and a lot of test beds have been created to time bound [4]. This paper investigates the performance of a MANET test bed for different topologies and environment. In this paper 15 different locations in a campus wireless network are implemented and the performance metrics are evaluated.

II. TESTBED DESCRIPTION

Initially, a mobile ad hoc network test bed of 5 laptop machines was used to collect wireless traffic. Fedora 13 was installed on these machines with kernel 3.1.0. The external wireless cards are from Atheros-AR5B125. The antenna gain of 2dbi and transmitting power of 16+/- 1dbm and receiving sensitivity of -80bm are verified with first hop link. Apart from our mobile ad hoc network, other wireless ad hoc network and access points are scattered within the campus and cannot eliminate the other traffic interference. Different topologies were used to collect the wireless traffic.

A. Indoor Topology Flat

In the real time implementation, two scenarios in each topology that are static and moving are created. Initially all 5 mobile nodes are in a static state within 5 metres in a room and starts communicating with each other which is shown in Fig. 1. Then the distance between mobile nodes are increased and kept in static state (within 50 meters). Out of 5 nodes, node 1, 5 were placed inside the room and node 2, 3 in the corridor and node 4 in the next room. It is shown in Fig. 2. In second scenario, out of 5 mobile nodes, two nodes are moving in opposite direction with each other. The distances between two nodes are increased incrementally up to 50 meters. It is shown in Fig. 3.

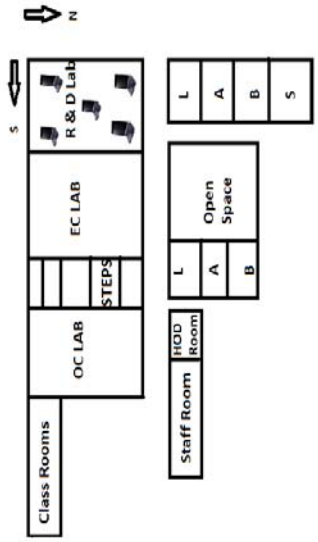

Fig. 1. Flat Static (5M)

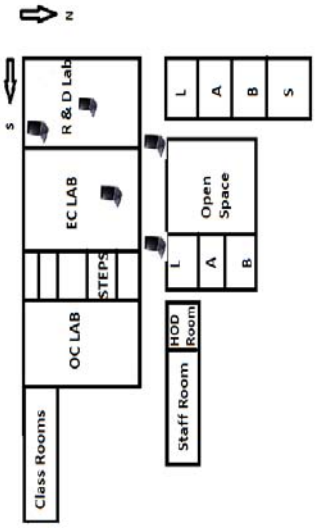

Fig. 2. Flat Static (50M)

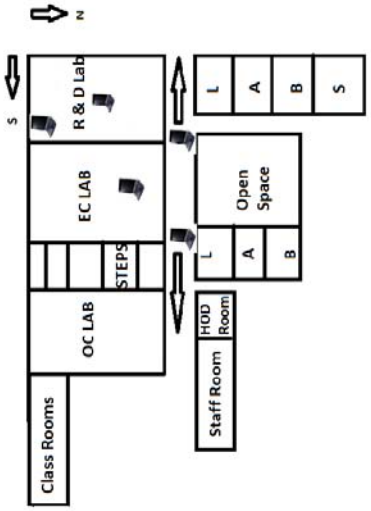

Fig. 3. Flat Moving

B. Indoor Topology Straight up

In the first scenario, initially 5 mobile nodes are placed in a static state within 20 meters distance between two floors and successful communication is established with each other which is shown in Fig. 4. Second scenario is that, out of 5 mobile nodes, two nodes are moving. One node is moving in upward direction and another node is moving downward. This is shown in Fig. 5.

Fig. 4. Perpendicular Static

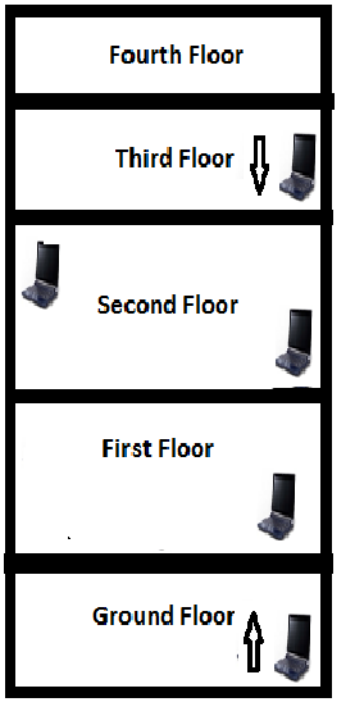

Fig. 5. Perpendicular Moving

C. Outdoor Topology Flat

Initially all 5 mobile nodes are in a static state within 10 meters in open space and communicating with each other. In second scenario, 3 mobile nodes are kept in static state and 2 mobile nodes are moving in opposite direction in open environment. Table I shows the Topology details.

TABLE I. Mobile Node Status With Respect to Topology

Topology	Scenario	Mobile node status
Indoor Topology Flat	Static	All 5 nodes static
	Moving	1,4,5 static & 2,3 moving
Indoor Topology Straight up	Static	All 5 nodes static
	Moving	1,3,5 static & 2,4 moving
Outdoor Topology Flat	Static	All nodes static
	Moving	1,2 ,5 static & 3,4 moving

III. EXPERIMENTAL SETTINGS

The data are collected from the real time traffic. Collected data are analysed for three metrics: packet delivery ratio, throughput and delay. The packet size is of 64 bytes. All experiments have been performed in outdoor and indoor environment, at the second floor and at the stairs of our college building. All laptops are in radio range of others and node 2, 3, 4 and 5 are communicating individually to node 1. The time for one experiment was about 60 seconds. Total of 10 trials have been taken and averaged to evaluate the parameters. In moving scenarios, nodes are stopped at corners for about three seconds before moving again. Table II gives the details of experimental parameters.

TABLE III. Experimental Parameters

Function	Value
No of nodes	5
Flow Type	CBR
Packet Size	64 bytes
No of Trials	10
Duration	60 sec

A. *Parameters Evaluated*

1) *Packet Delivery Ratio*: It is the ratio of the number of delivered data packets to the destination to that of the number of packets sent from the source.

$$\text{PDR} = \frac{\sum \text{No. of packets received}}{\sum \text{No. of packets sent}}$$

2) Delay: The time taken by the data packet to reach the destination from the source. This metric is calculated by subtracting the time at which first packet was transmitted by source from the time at which first data packet arrived to destination.

3) *Throughput:* It is the average rate of successful data delivery over a communication channel. It is measured in kbps.

IV. RESULT DISCUSSION

A. Indoor Environment

1) *Flat Topology*: For flat topology, it is noticed that there is a better performance in PDR, delay and throughput for static compared to moving. In the static mode the nodes within 5 meters range showed higher performance compared to nodes kept in 50 meters range. It is observed that performance metrics of node 4 is less compared to other nodes. The mobility and obstacles reduce the PDR, delay and throughput in static and moving. Following graphs shows the comparison of performance metrics for different scenarios.

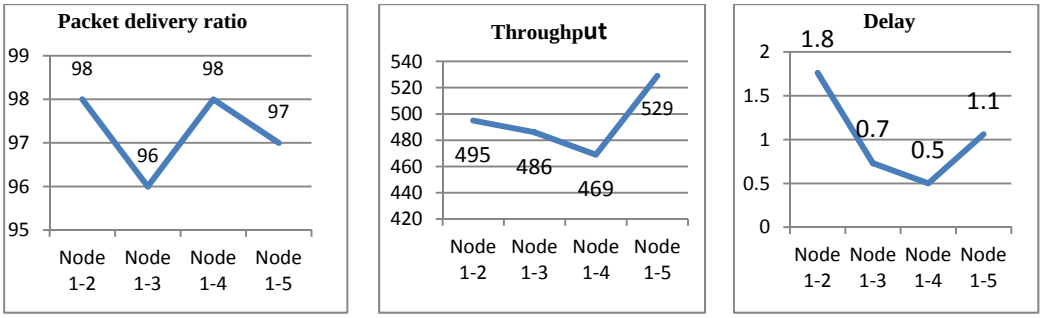

Fig. 6. Scenario 1: Flat static

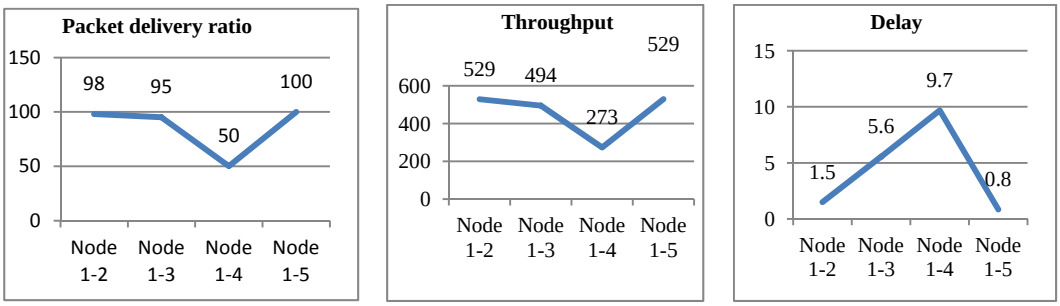

Fig. 7. Scenario 2: All nodes are stationary within 50 meters

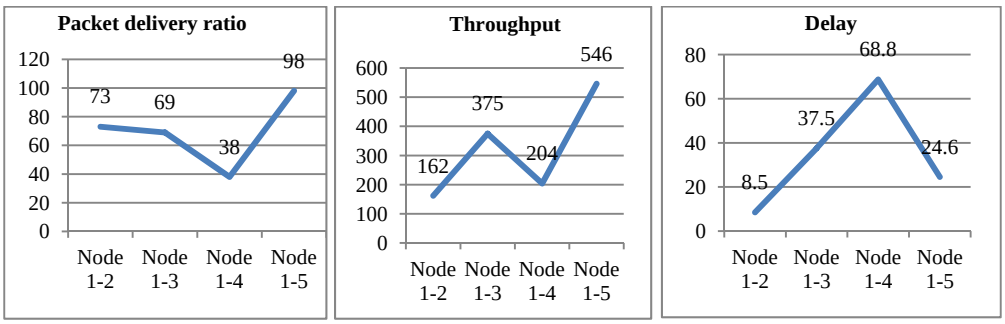

Fig. 8. Scenario 3: 2, 5 stationary nodes and nodes 3, 4 moving in opposite direction within 50 meters

2) Straight up Topology: The parameters PDR, delay and throughput shows better values in static mode compared to moving in straight up topology. All the nodes in straight up show good PDR as the nodes are kept in the line of sight communication range. The delay parameter shows fluctuations depending on the distance from the node 1. In straight up moving the performance metrics are degraded due to mobility. The Fig. 9 shows the comparison of the performance of the straight up static.

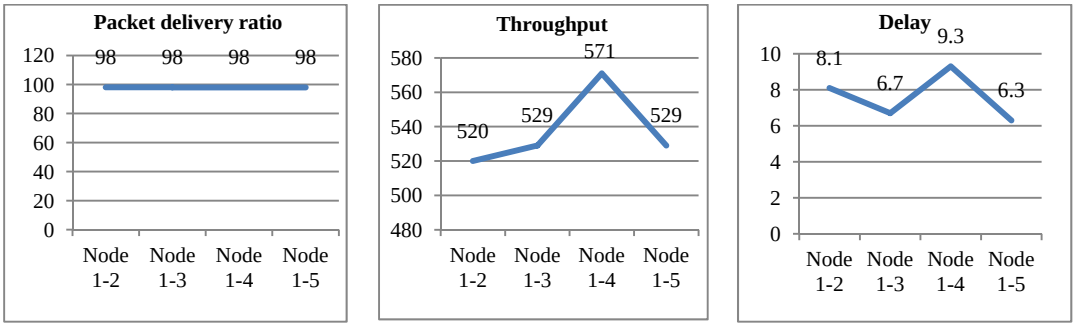

Fig. 9. Scenario 4: Straight up Static

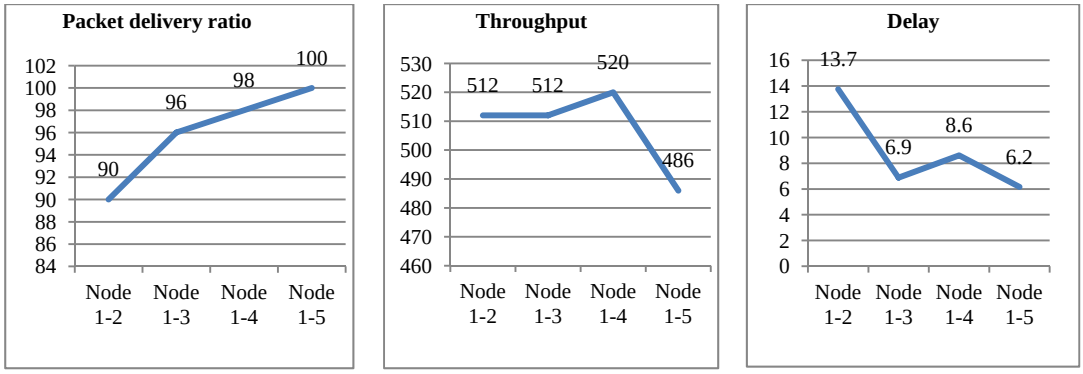

Fig. 10. Scenario 5: Straight up moving: node 2 moving to ground floor and node 4 moving to III floor in opposite direction

B. *Outdoor Environment*

Flat Topology: The PDR and delay are less in outdoor flat static compared to indoor flat static mode. The PDR in 1-3 node communication is decreased due to the obstacle in the communication range. While in moving topology, the PDR of node 3 is improved as it not affected by the obstacle. It is also observed that delay is higher in node 4 as it is kept farther from the node 1. The delay and PDR in node 4 is improved in moving as it was moving towards node 1.

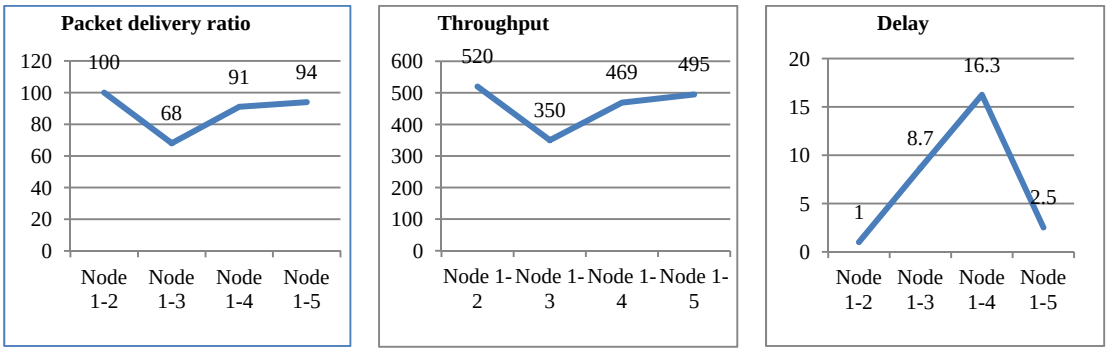

Fig. 11. Scenario 6: Outdoor static

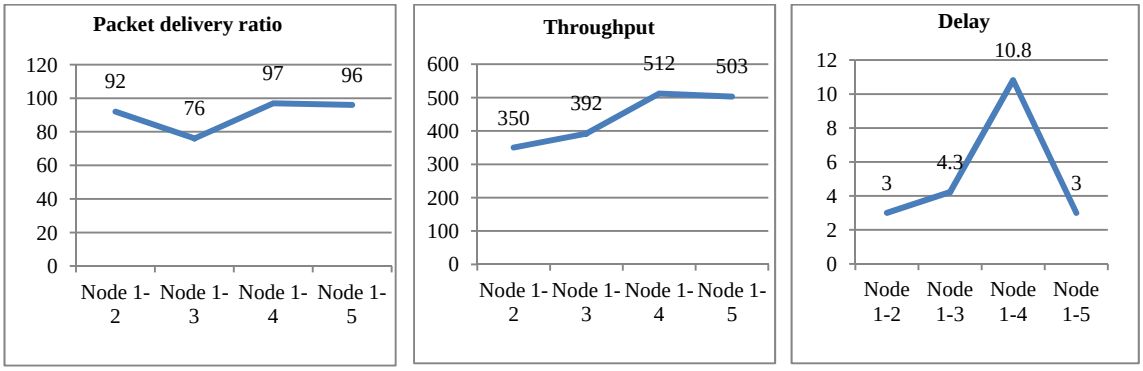

Fig. 12. Scenario 7: 1, 2, 5 are stationary nodes and nodes 3, 4 moving in opposite direction within 50 meters

V. COMPARISON GRAPH FOR ALL SCENARIOS

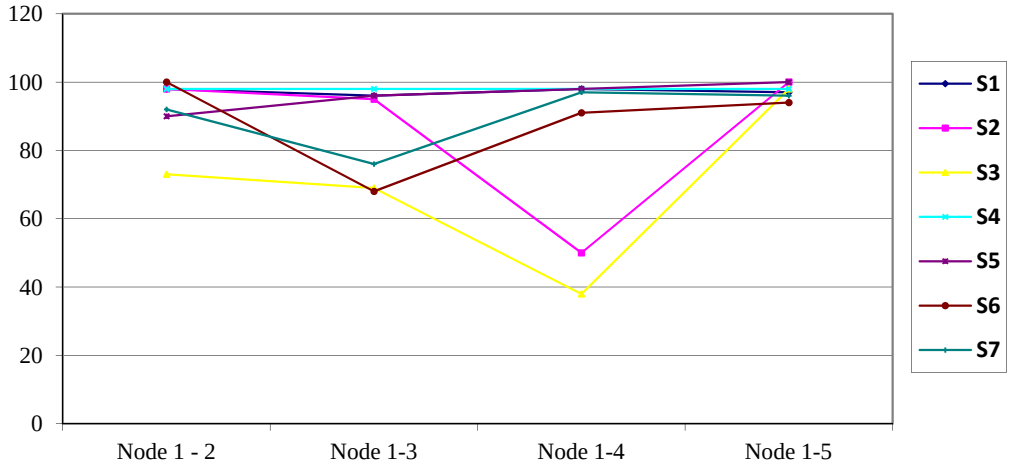

Fig.. 13. Comparison Graph for Packet Delivery Ratio

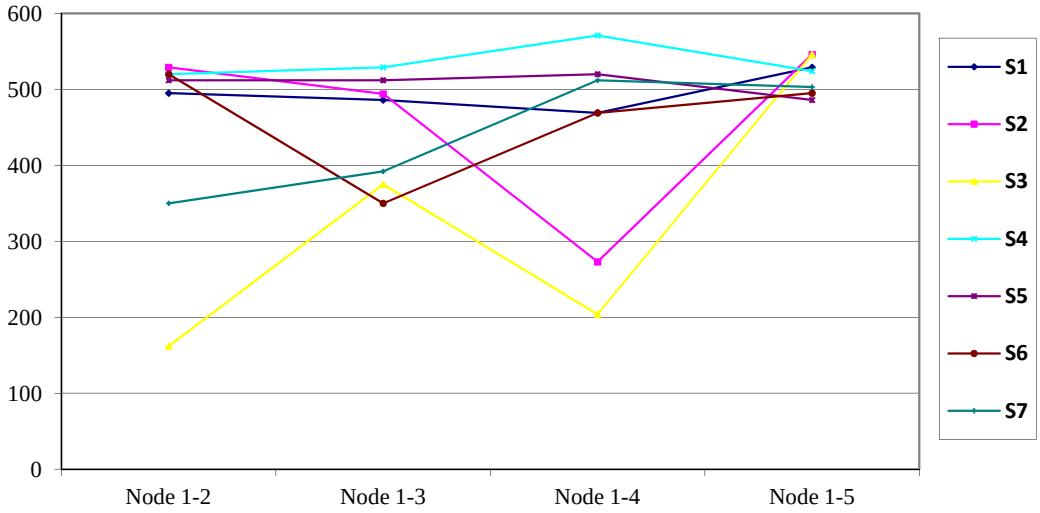

Fig. 14. Comparison Graph for Throughput

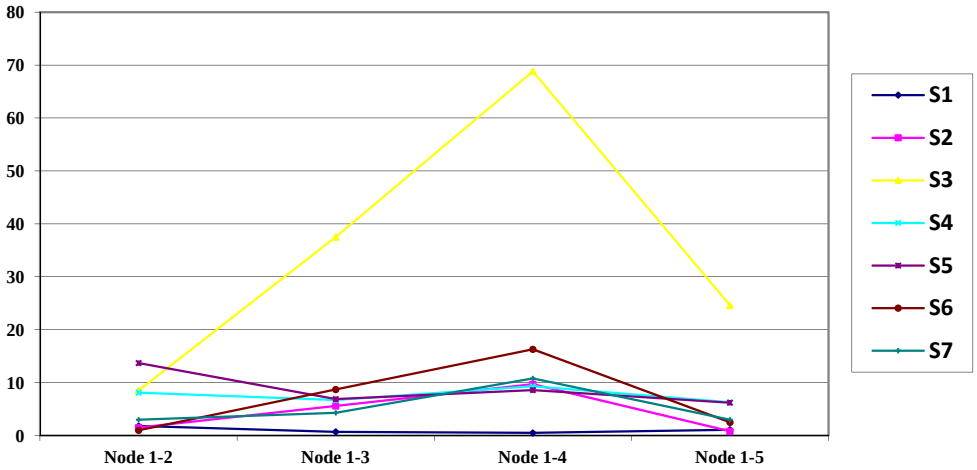

Fig. 15. Comparison Graph for Delay

VI. CONCLUSION

In this paper, MANET test beds for flat and straight up scenarios are implemented. Seven scenarios are created and the performance of the test bed is analysed in terms of packet delivery ratio, throughput and delay. From the experiments it is found that in the case of Flat topology both indoor and outdoor, the PDR varies as the distance from the reference node increases and due to the obstacles. A large increase in the delay parameter is observed in indoor flat moving topology as the communication becomes difficult due to mobility and obstruction of obstacles. In straight up static topology the parameters shows better performance as the nodes are in the line of communication and less degradation in the performance is observed as the nodes move towards the reference node. It is observed that straight up static topology for indoor shows better performance in all metrics.

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