LAB PROJECT Nº3

PERFORMANCE OF MANET ROUTING PROTOCOLS

1 INTRODUCTION

Ad Hoc networks are self-organized networks where the nodes can communicate without an infrastructure. The nodes themselves support the functionalities required to manage the shared medium and route the traffic to the destination, provided that there is a multi-hop path formed by nodes within communications range of each other between the source and the destination of data traffic. Ad Hoc networks are used in several different contexts, appearing in different flavors, each with its own set of challenges:

- Mobile Ad Hoc Networks (MANETs): where nodes are mobile. Scenarios may range from pedestrian to vehicular communications.
- Vehicular Ad Hoc Networks (VANETs): where nodes are vehicles, usually assumed to move along roads.
- Wireless Sensor and Actuator Networks (WSNs): where nodes are sensors or actuators, usually considered static and energetically autonomous.
- Wireless Mesh Networks (WMNs): where nodes constitute relay points of a telecommunications infrastructure (e.g., access points or cellular base stations), but interconnected through broadband wireless links instead of cabled technologies.

This lab assignment considers IEEE 802.11 technology in scenarios with and without mobility, thus being more related with MANETs and WMNs.

Throughout this document, the students shall be asked to build simulation script files. Although the main guidelines for scenario construction are provided, additional procedures may be necessary, which require initiative from the students. The students shall also be asked to answer questions regarding the simulated network environment and performance results. The answers shall be included in the report, which is due in the week that immediately follows the end of the project. Together with the report, the students must deliver all the scripts and spread sheets that resulted from their work.

2 WORK DESCRIPTION

The students will compare different Ad Hoc routing protocols regarding their performance in different topologies and mobility settings. An example scenario, *aodv_LAB3*, is provided and should be added to the project tree under */inet/examples/*. This example includes three configurations: Static (*Stationar yMobility* model for all nodes), Static2 (static grid example) and Low Speed Mobile (mix of *StationaryMobility* and *MassMobility*).

2.1 Analysis of AODV

Answer the following questions:

Q2.1.1) Run the *aodv_LAB3* demo under the Static configuration. Run the simulation and watch the message exchanges until data starts to arrive at *host[0]*. Be sure to select a random number seed that results in a network without partitions from the sender to the receiver host.

a) Explain why ARP is used before RREP packets and never before RREQ packets.
b) Explain why ARP Reply packets are acknowledged at the MAC layer and ARP Request packets are not.

Q2.1.2) Run the *aodv_LAB3* demo under the Static configuration for 5 seconds. Compare the end-to-end delay of the packets received by *host[0]* using the chart associated with the *rcvdPkLifetime* vector statistic. Explain the results.

2.2 Performance of AODV, DYMO and GPSR in Static Networks

For each different routing protocol, build a new network, consisting of a 10×10 static grid topology of nodes, which run the *UdpBasicApp* (this is already done for AODV in the Static2 configuration of the provided example). Each node in the grid is only able to directly communicate with the nodes that are deployed next to them vertically, horizontally and diagonally (see Figure 1).

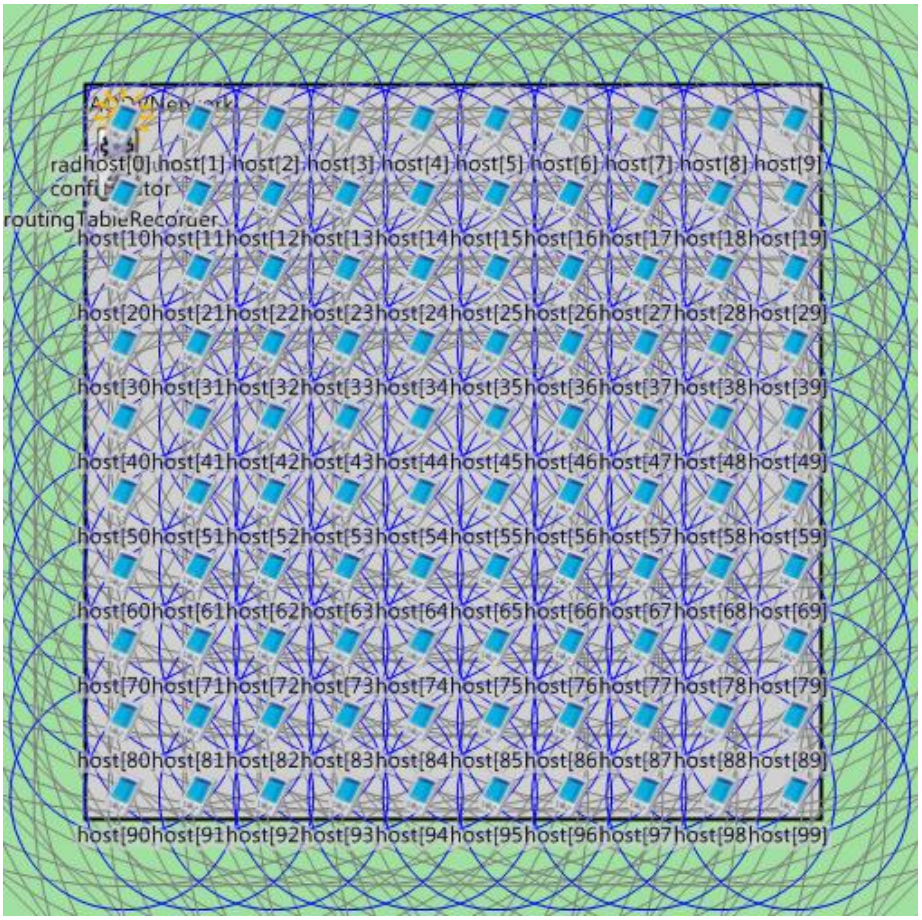

Figure 1: Static 10 × 10 grid topology.

Using the scenarios that were just built, answer the following questions in your report:

Q2.2.1) Configure a scenario where node *host[99]* (lower right corner) sends data to *host[0]* (upper left corner). The packet size is fixed at 20 octets. Measure the following quantities for AODV, DYMO and GPSR:

- Average application throughput (kbit/s);
- Average application latency (s);
- Average number of MAC transmitted frames per successfully received application packet (frame/packet).

Each routing protocol setting should be simulated at least 3 times, using different random seeds. Application data traffic (over UDP) should start being sent at 11 seconds and the simulation time limit should be set to 31 seconds. The confidence intervals should also be provided. Please read Section 10.4 of the OMNET++ User Manual in order to get more info on how to perform parameter studies and repeat experiments with different random seeds. Explain the results.

Q2.2.2) Set-up a scenario similar to Q2.2.1, but at this time changing the mobility model to *ConstSpeedMobility* for all nodes except *host[0]* and *host[99]*, which should remain stationary in the same positions. However, note that the starting positions of all nodes should be the same as in Q2.2.1. Measure the impact of average speed on the following quantities:

- Application throughput (kbits/s);
- Application message latency (s);
- Average number of MAC transmitted packets per successfully received application packet (frame/packet).

The packet size is fixed at 20 octets. The following speeds should be considered: 0, 1, 5 and 10 m/s. The speed 0 m/s should be a copy of the results from Q.2.2.1. The results should be presented in three charts (throughput, latency and transmitted bits per received packet), each with three curves, one curve for each different routing protocol: AODV, DYMO and GPSR. Each point in the chart should be simulated at least 3 times, using different random seeds. Traffic start times and simulation time limit are the same as in Q2.2.1. The confidence intervals for the points in the chart should be represented as error bars or included in a table. Explain the results.

The chart represented in Figure 2 is an example of what the intended graphics should look like. The values are nonsense and should not be taken as a reference.

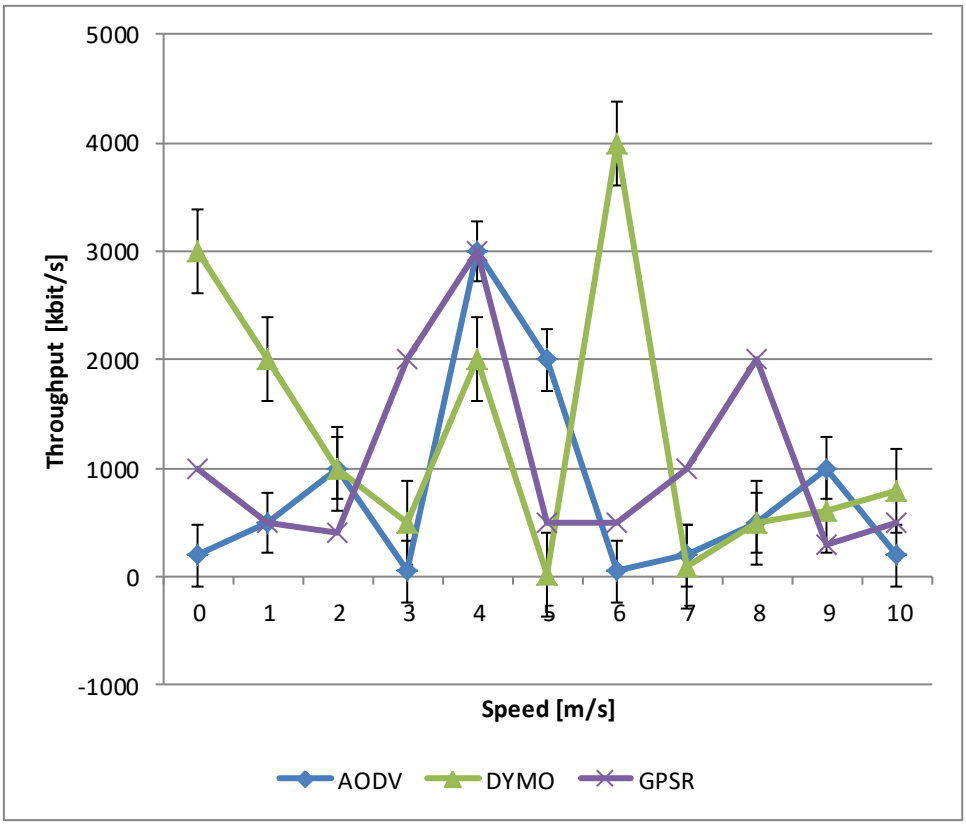

Figure 2: Example of chart representing throughput as a function of speed.

Q2.2.3) Setup a similar scenario to Q.2.2.2, but at this time, there is no application traffic. Measure the total number of transmitted MAC frames, as a function of speed. Represent it in a similar chart. Explain the results.

2.3 Grading

Grading of the responses shall be performed according to Table 1.

Table 1: Grading of LAB3 responses.

Question	Value
Q2.1.1a	1.0
Q2.1.1b	1.0
Q2.1.2	2.0
Q2.2.1	4.0
Q2.2.2	8.0
Q2.2.3	4.0

The organization of the delivered report and scenario files contributes with 0.0-3.0 negative points to the final mark.