■ ECE/CS 4984: Wireless Networks and Mobile Systems ■

Pre-lab and In-class Laboratory Exercise 8 (L08)

Part I – Objectives and Lab Materials

Objective

The objectives of this lab are to:

- Familiarize students with the operation of the Optimized Link State Routing (OLSR) protocol for mobile ad hoc networks (MANETs).
- Investigate delay, throughput, connectivity and overhead in MANETs.

After completing the assignment, the student should be able to:

- Understand the operation of the OLSR routing protocol.
- Evaluate multi-hop ad hoc routing protocols in wireless environments.

Hardware to be used in this lab assignment

Each student group needs the following hardware:

- One (1) Dell Latitude C640 laptop computer (*It is especially important that you come to lab with a fully charged battery since some nodes will be mobile.*)
- One (1) Xircom 802.11b wireless Ethernet adapter

Software to be used in this lab assignment

- OS: Red Hat Linux 7.3
- OLSR INRIA implementation with NRL modifications (http://pf.itd.nrl.navy.mil/projects/olsrv3)

Part II – Pre-lab Assignment

This portion of the assignment ***must*** be completed ***prior*** to the in-class lab session.

Reading Assignment

- Read the documents for the in-class and take-home assignment. Each student must be familiar with the procedures to successfully coordinate with other students in this lab experiment.
- Browse the OLSR INRIA homepage http://menetou.inria.fr/olsr/ for more information on the OLSR implementations.

Tasks

- Log into your Linux system as user **root**. Download the file **lab9.tgz** from the course website (Week 9 course documents), and place the file in the home directory **/root**. (If you have trouble setting up an Internet connection from Linux, you may use another system to download the file and then copy the file to the Linux system.)
- Extract the source and script files from **lab9.tgz** as follows.

```
# cd ~
# tar –zxf lab9.tgz
```

You will see manet.tgz and snmp.tgz extracted in current folder.

- Extract and start SNMP agent as follows.

```
# cd ~
# tar –zxf snmp.tgz                    // extract files
# cd snmp
# ./snmp_install                       // install and run snmp agent
```

Extract the source and script files from manet.tgz as follows.

```
# cd ~
# tar  -zxf  manet.tgz                 // extract files for this lab
# cd manet
# tar  -zxf  olsr.tgz                  // extract source files for OLSR
```

- The OLSR source was customized for testing purposes. Compile and install the OLSR routing daemon and tools as follows.

```
# cd ~/manet/olsr/
# make
# make install
```

Check that OLSR version 1.0a9 was properly installed using the procedure below. The "-v" option is only supported in the customized OLSR implementation.

```
# olsrd -v
OLSR 1.0a9
```

Part III – In-Class Lab Assignment

Overview

In this lab experiment, we will observe the operation and evaluate the performance of the OLSR protocol in a real-world environment. The mobile ad hoc environment introduces many challenges in routing, such as rapid topology changes, unidirectional links, and high error rates. The following experiment data will be collected for analysis.

1) Topology, routing table, and routing daemon logs will be automatically saved when running the OLSR routing daemon.
2) Delay, connectivity, and throughput are to be measured between mobile nodes. A specific test bed configuration has been developed for coordinating the experiment.

Each student group will need to analyze the results in the take-home assignment. **The results may depend on how the experiments are carried out, thus coordination and cooperation among all groups are strictly required**. Specifically, we will conduct the tests using two specific topologies.

1) All participating mobile nodes are located in close proximity in the classroom and, thus, can directly communicate with each other.
2) Some of the mobiles nodes will move outside of the classroom to assigned locations, thus forming some multi-hop connections.

The GTA will form a maximum of seven teams and assign team numbers for this in-class experiment. The GTA will setup the controlling node as team 8. Each team needs one laptop computer and one 802.11b card. To avoid interference, other laptops not used for the experiment should be turned off.

All participating teams are expected to conduct the following tasks.

Task A - Setup the Ad-hoc Network

1. **Remove any 802.11b cards from the PC card slots before starting the notebook computer**. Boot into Red Hat Linux and log into the system as user **root**. Open a command console and setup the wireless network interface as follows.

```
# cd ~/manet
# ./setup_manetA  <TeamNumber>  <RFChannel>          // for team A
# ./setup_manetB  <TeamNumber>  <RFChannel>          // for team B
```

   The team number is assigned by the GTA and will range from A1 to A7 and B1 to B7. The GTA will assign RF channel for team A and B. All participating teams in team A and B will use same channel number. The ***setup_manet*** script will modify the default configuration for wireless interface **eth1** (/etc/sysconfig/network-scripts/ifcfg-eth1). The following options are used:

For team A

MODE	Ad-hoc	ESSID	MANET_A
RATE	Auto	CHANNEL	: <RFChannel>
IP address	10.0.1.<TeamNumber>	NETMASK	255.255.255.0
Broadcast	10.0.1.255		

For team B

MODE	Ad-hoc	ESSID	MANET_B
RATE	Auto	CHANNEL	: <RFChannel>
IP address	10.0.2.<TeamNumber>	NETMASK	255.255.255.0
Broadcast	10.0.2.255		

   Now insert your 802.11b card into one of the PC card slots. The network interface will be setup automatically using the above configuration. As shown below, use ***iwconfig*** to change the transmission power to **1 mW** and check that the ad hoc network is properly setup. We will bring down the interface **eth0**, which is not used. Ping the controlling node **10.0.1.8 and 10.0.2.8** to ensure the network is correctly configured. The GTA will check all participating nodes before continuing with the experiment.

```
# iwconfig eth1 txpower 1mW          // set 1mW to reduce range
# iwconfig eth1                      // check eth1 interface status
# ifconfig eth1                      // check eth1 info.
# ifdown  eth0                       // bring down eth0 interface
```

2. To analyze the time-stamped logs on all mobile nodes, we need to synchronize the system time with the controlling node, **10.0.1.8 for team A and 10.0.2.8 for team B**, which is running the time-udp service. Use the following command.

```
# rdate  -u  -s  10.0.1.8 (for team A)
# rdate  -u  -s  10.0.2.8 (for team B)
```

Note: All participating nodes and the controlling node must use the same time zone (use command "cat /etc/timezone" to check the current time zone).

Task B – Test 1

The following steps conduct measurement for the first topology – where all mobile nodes are stationed within the classroom and can directly communicate with each other.

3. Team **1** and **2** from each A and B group should run the *iperf* server on TCP port 5000 before others start the test. Run the *iperf_server* script and report throughput to log file ~/manet/test1/iperf_serverA.log and ~/manet/test1/iperf_serverB.log.

```
# cd  ~/manet
#  ./iperf_server  test1/iperf_serverA.log     (for team A)
#  ./iperf_server  test1/iperf_serverB.log     (for team B)
```

4. All teams (including teams 1 and 2) should run the *start_test1A of start_test1B* shell script and wait for the GTA's signal to start. A greeting screen for the MANET routing test will appear. *Since some of the teams will run the performance measurement differently, it is very important that you specify the correct team number*.

```
# cd ~/manet/
# ./start_test1A <TeamNumber>    (for team A)
# ./start_test1B <TeamNumber>    (for team B)
```

When you press the <Enter> key to start the test, the script will automatically start the OLSR routing daemon. The test will run for **5** minutes and the routing daemon will be automatically shutdown. The total remaining time is printed on the console. Follow the instructions printed on the console. Each team needs to conduct the following steps during the test.

1) Use the *ping* command to test the connection to other participating mobile nodes.

2) Use the *olsrquery* command to query the routing table as follows. **Make a screen capture of the results and include it in your report.**

```
# olsrquery  -r  <YourIPAddress>
```

The above command will send a query to the OLSR routing daemon to retrieve the current routing table.

3) Use the *olsrquery* command to query the neighbor list as follows. **Make a screen capture of the results and include it in your report.**

```
# olsrquery  -n  <YourIPAddress>
```

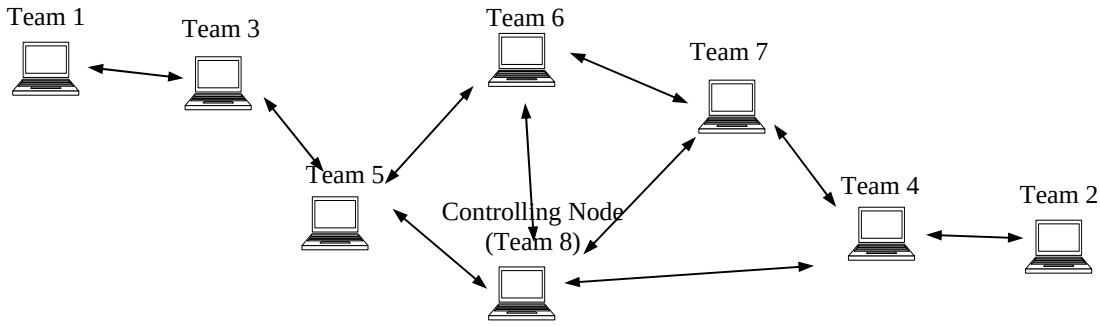
The above command will send a query to the OLSR routing daemon to retrieve the current list of neighbors. Links in OLSR are listed as being one of three types: (i) symmetric ("SYM"), where bidirectional connectivity has been confirmed; (ii) asymmetric ("ASYM"), where only unidirectional connectivity has been observed; and (iii) MPR selector links.

The following measurements will be performed automatically by the *start_test1* shell script.

1) The *ping_test* shell script on Teams 1 and 2 will run to measure the delay and connectivity to the controlling node 10.0.1.8 or 10.0.2.8. It will repeatedly run the *ping* command every **15** seconds and report the statistics to the log file (~/manet/test1/pingtest.log). We will use the log file to evaluate the connectivity and delay for the OLSR routing protocol.
2) Teams **3** and **4** each will run two *iperf* clients and connect to the *iperf* servers of teams **1** and **2**. The throughput will be reported every **15** seconds and saved to the log files (~/manet/test1/iperf_1.log and ~/manet/test1/iperf_2.log).
3) The routing table on each mobile node will be saved to log file /var/log/olsrd_rt.log every **2** seconds. General log messages will be saved to /var/log/olsrd.log. Changes in the kernel routing table will be saved to /var/log/olsrd_rtupd.log. These log files will be copied automatically to directory ~/manet/test1 when the test stops.

Task C – Test 2

The following steps conduct measurements for the second topology. The GTA will conduct a site survey before the class to plan the network topology. The GTA will explain the procedures and assign locations to participating teams. All teams will be initially stationed in the classroom. Some teams will then move slowly to outside of the classroom to form a multi-hop configuration. The actual topology layout may be affect by some environmental factors. A sample topology planning is illustrated below.



5. Teams **1** and **2** need to run the *iperf* server on TCP port 5000 before others start the test. Run the *iperf_server* script and report throughput to log file ~/manet/test2/iperf_server.log.

```
# cd  ~/manet
#  ./iperf_server  test2/iperf_serverA.log   (for team A)
#  ./iperf_server  test2/iperf_serverB.log   (for team B)
```

6. All teams (including Teams 1 and 2) should run the *start_test2* shell script and wait for the GTA's signal to start. A greeting screen for the MANET routing test will appear.

```
# cd ~/manet/
# ./start_test2A <TeamNumber>     (for team A)
# ./start_test2A <TeamNumber>     (for team B)
```

When you press the <Enter> key to start the test, the script will automatically start the OLSR routing daemon. The test will run for **10** minutes and the routing daemon will be automatically shutdown.

The total remaining time is printed on the console. Follow the instructions printed on the console. Each team needs to conduct the following steps during the test.

1) Use the *ping* command to test the connection to other participating mobile nodes. Some teams will move slowly outside the classroom and check their connection to other nodes from time to time. The GTA will provide more instructions for these teams on how to form the planned topology.

2) Use the *olsrquery* command to query the routing table as follows. **Make a screen capture of the results and include it in your report.**

```
# olsrquery  -r  <YourIPAddress>
```

The above command will send a query to the OLSR routing daemon to retrieve the current routing table.

3) Use the *olsrquery* command to query the neighbor list as follows. **Make a screen capture of the results and include it in your report.**

```
# olsrquery  -n  <YourIPAddress>
```

The above command will send a query to the OLSR routing daemon to retrieve the current list of neighbors.

4) You can also use the *olsrquery* command to query the routing table and neighbors of other mobile nodes. Try to determine the topology and verify the routing table by querying your neighboring nodes.

The following measurements will be performed automatically by the *start_test2* shell script.

1) The *ping_test* shell script on teams 1 and 2 will run to measure the delay and connectivity to the controlling node 10.0.1.8 or 10.0.2.8. It will repeatedly run the *ping* command every **15** seconds and report the statistics to the log file (~/manet/test2/pingtest.log). We will use the log file to evaluate the connectivity and delay for the OLSR routing protocol.

2) Teams **3** and **4** each will run two *iperf* clients and connect to the *iperf* server of teams **1** and **2**. The throughput will be reported every **15** seconds and saved to the log files (~/manet/test2/iperf_1.log and ~/manet/test2/iperf_2.log).

3) The routing table on each mobile node will be saved to log file /var/log/olsrd_rt.log every **2** seconds. General log messages will be saved to /var/log/olsrd.log. Changes in the kernel routing table will be saved to /var/log/olsrd_rtupd.log. These log files will be copied automatically to directory ~/manet/test2 when the test stops.

Task D - Upload Results

7. For analyzing the operations of the OLSR routing protocol, we need all logs from all participating nodes. After completing the two tests, copy and upload these log files to the controlling node 10.0.2.8 as follows.

For team A

```
# cd ~/manet
# tar -c  test1 | gzip -9 > teamA<TeamNumber>_test1.tgz
# tar -c  test2 | gzip -9 > teamA<TeamNumber>_test2.tgz
# scp  team*.tgz  student@10.0.1.8:/home/pub/
```

For team B

```
# cd ~/manet
# tar -c  test1 | gzip -9 > teamB<TeamNumber>_test1.tgz
# tar -c  test2 | gzip -9 > teamB<TeamNumber>_test2.tgz
# scp  team*.tgz  student@10.0.2.8:/home/pub/
```

Remember to replace <TeamNumber> in the commands with your assigned team number. When prompted for the password of user "**student,**" use "**wireless**" as the password.

After all teams finish uploading the results, student groups can download the results for analysis as follows.

```
# scp  student@10.0.1.8:/home/pub/team*.tgz   ~/manet/results/    (for team A)
# scp  student@10.0.2.8:/home/pub/team*.tgz   ~/manet/results/    (for team B)
```

The GTA will also collect the results of all participating nodes (including the controlling node), and make them available on the course web site. All student groups need this data for analysis.