

**ELEC 6851**  
**DESCRIPTION OF THE FINAL PHASE OF THE PROJECT**  
**GROUPS:** In each group there may be at most two students

The description of the simulation project using Qualnet Software is given below,

- Create four wireless subnetworks, let us refer them as *A, B, C, D*.
- Each subnetwork should have at least five nodes per subnetwork. Nodes should be randomly placed. All the nodes located in the same subnetwork will be able to hear each other's transmissions.
- The subnetworks should have connectivity to its neighboring subnetworks through routers. For example, we may have,

$A \leftrightarrow B \leftrightarrow C \leftrightarrow D$

Thus each node in any subnetwork will be able to communicate with any node in another subnetwork. Provide a router between following subnetworks,

$A \leftrightarrow B, \quad B \leftrightarrow C, \quad C \leftrightarrow D$

**Only routers should be allowed to forward packets between the subnetworks. The forwarding of the packets by regular nodes should be disabled as explained on p. 4 of the QualNet tutorial under the heading *Enable IP Forwarding*. Thus if source and destination nodes are in different subnetworks the path of a packet will take at least two hops.**

- Use IEEE 802.11 as the MAC protocol.
- Assume IPv4 as the network protocol.

### Simulation Scenarios

- **Scenario A:**  
In this scenario generate two connections in the network, one UDP and the other TCP, choose the source and destination nodes for each connection in different subnetworks. **We note that the transmission of each TCP packet will generate an ACK packet from the destination. The ACK packets of TCP will be transmitted from destination to source node in the same way as data packets. We note that TCP ACK packets are different than those used by the MAC protocol in the three-way handshaking with RTS, CTS and ACK packets. TCP ACK packets are end-to-end, sent from the destination to the source node, while MAC protocol ACK packets are generated during the forwarding of a packet in each hop. Each of the UDP and TCP traffic sources should generate at least 500 packets. Run the simulation only one time for the**

chosen values of traffic generator parameters for no fading case. In the report provide the bar charts for the following performance measures,

- Application layer :

UDP      1- Traffic Client : Data units sent  
            2- Traffic Server : Data units received,  
                                 Average end to end delay

TCP      1- TCP Client : Total bytes sent  
                                 Throughput ( bits/sec)  
            2- TCP Server : Total bytes received  
                                 Throughput ( bits/sec)

- Transport layer :

1- UDP : Packets from application,  
            Packets to application  
2- TCP: Data packets received,  
            Data packets sent  
            Data packets retransmitted.

- MAC layer :

1- CTS packets sent  
2- RTS packets sent  
3- ACK packets sent  
4- Packets drop due to transmission limit  
5- Unicast sent  
6- Unicast received

- Scenario B:

Make the following assumptions for Scenario B simulation,

- Create multiple UDP connections in the network with source and destination nodes in different subnetworks. Assume that time interval between packet generation is exponential and packet lengths are also exponential. Keep average value of the packet lengths constant during the simulation.
- Run the simulation for different average time intervals for the generation of the UDP traffic. Each connection should generate at least 500 packets during each simulation run.
- Run the simulation both with and without fading at the physical layer. As a fading model choose Rayleigh model (not Fast Rayleigh model). This choice will enable you to see the deterioration of the communication between the fading and no fading environments.

- Choose one UDP connection in the network and collect data about the chosen connection to provide the following figures in your report,

**Fig. 1-** Average UDP packet delay with and without fading.

**Fig. 2-** UDP Client throughput( bits/sec) with and without fading.

**Fig. 3-** UDP Server throughput( bits/sec) with and without fading.

## **Report Requirements:**

The length of the report will be limited to 15 pages. The report should be typed and font size should be 12. The curves in the same figures should use different line styles if they are not in color. The figures should be large enough so that all the captions will be clearly readable. The report should include the followings,

- Provide a screenshot of your network. The screenshot should also include the IP addresses of the nodes ( Click on the button for the Open Display Settings from the QualNet main menu and choose IP Address from the displayed menu). The labels in the figures should be readable.
- **Provide a table that lists the nodes of each subnetwork and routers between the subnetworks.**
- Bar charts for Scenario A. Discuss the results in the bar charts: Show that the number of UDP and TCP packets sent, received, dropped and number of RTS, CTS, ACK packets all add up properly.
- Provide Fig. 1-3 for Scenario B. Discuss the behavior of the curves,
  - As the time interval between the packet decreases
  - Differences between the fading and no fading curves.