
# ECE6615: Sensor Networks
# Spring 2018
# Homework 2

**Given: February 18, 2018**
**Due: March 9, 2018 (Midnight) + 1 week for "off Campus" students**

**Submission Instructions:**

Submit your homework as a **single** DOC or PDF file to infocom@ece.gatech.edu
Attach the MATLAB codes as a single zip file.
Mention "**[ECE6615] Homework 2**" in the subject line.
No hardcopies will be accepted. Scanned pages are fine.

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**Question 1 (Routing Protocols – Data Centric routing)**

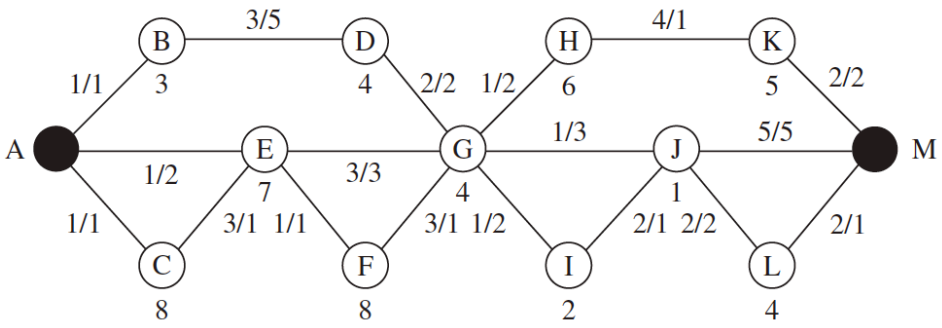
For the network topology shown in figure below, identify the optimal routes for source A to sink M according to the following criteria (a)~(d) (Show the procedures to compute the cost for the optimal route). The numbers X/Y along each link indicate the latency (X) and energy cost (Y) for transmitting a single packet over the link. The number Z under each node indicates the node's remaining energy capacity.

(a) Minimum number of hops

(b) Minimum energy consumed per packet

(c) Maximum average energy capacity (eliminate hops that would result in a higher average but unnecessarily add to the route length!)

(d) Shortest latency




**Question 2 (Routing Protocols – Geographical Routing)**

The table below summarizes the routing information of all nodes in a WSN, that is, each row indicates the routing knowledge of that particular node. For example, the first row shows that node A knows that it can reach nodes B and C via 1 hop and nodes D and E via 2 hops. Given this information, draw the network topology and determine the landmark radius for each node.

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| A | 0 | 1 | 1 | 2 | 2 | – | – | – |
| B | 1 | 0 | 1 | 1 | 1 | 2 | – | – |
| C | 1 | 1 | 0 | 2 | 1 | – | 2 | – |
| D | – | 1 | 2 | 0 | 1 | 1 | 2 | 2 |
| E | 2 | 1 | 1 | 1 | 0 | – | 1 | – |
| F | – | 2 | – | 1 | 2 | 0 | 1 | 1 |
| G | – | 2 | 2 | 2 | 1 | 1 | 0 | 1 |
| H | – | – | 3 | 2 | – | 1 | 1 | 0 |

**Question 3 (Localization Techniques)**

i) Two nodes A and B are known to be positioned at locations (0, 0) (node A) and (1, 1) (node B) in two-dimensional space. A third node C wishes to determine its position using trilateration. Based on ranging techniques, node C knows its distances to node A ($d(A,C) = \sqrt{0.75}$) and node B ($d(B,C) = \sqrt{0.75}$). What are the two possible positions of C?

ii) Three nodes A, B, and C are known to be positioned at locations (0, 0), (10, 0), and (4, 15), respectively. Node D is estimated to be a distance of 7 from A, a distance of 7 from B, and a distance of 10.15 from C. Determine the location of D using trilateration.

iii) Two nodes A and B do not know their own positions, but they can hear beacons in their proximities. Node A can hear beacons located at (4, 2) and (2, 5). Node B can hear beacons located at (2, 5) and (3, 7). All nodes have a radio range of 2 units. Answer the following questions:
(a) Are either (3, 3.5) or (3, 4.5) possible locations for node A?
(b) Are either (2, 6) or (4, 5) possible locations for node B?

**Question 4 (Transport Layer)**

Figure below shows a wireless sensor network used to measure the temperature inside an industrial refrigerated room. In this picture, red nodes represent sensors that have detected a sudden increase in the temperature (corresponding to the same event). These nodes need to report this information to the sink or command center. The radio range of each node is *r*.

a) Explain qualitatively explain how PSFQ and ESRT will perform in this situation and compare both protocols in terms of total number of packets transmitted.

b) How does this affect the total energy consumption? Under which protocol is the network more likely to be congested?

Consider the following assumptions:

1. Consider that the network has been working for some time and that ESRT is working under no congestion and with high reliability. Assume that in this condition, only 50% of the nodes will

report the event.

2. Consider that all packets are sent using the shortest path and that routes have already been pre-established.
3. Consider that a simple MAC protocol is used and that only 1 of every 4 packets is lost.