r) 2nd Semester 03 May 2023

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION **SUMMER SEMESTER, 2021-2022**

DURATION: 3 HOURS **FULL MARKS: 150**

CSE 4671: Wireless and Mobile Communication

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Figures in the right margin indicate full marks of questions.

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1. a) Conduct a comparative analysis between *ZigBee* and *Wi-Fi* networks in brief. 5

   b) How do flow control and congestion control differ from each other? Provide appropriate example for clarification. 6

   c) Figure 1 depicts the network topology of a multi hop wireless ad hoc network. The scenario involves multiple stations (A, B, C, D, and E), each with a distinct circular transmission range surrounding it. It is assumed that all stations operate in the same frequency band, and the *RTS/CTS* transmission mechanism is disabled. The transmission interference only occurs if two stations transmit simultaneously, and their transmission areas overlap.

      i. Identify two potential cases of the *Hidden Terminal* problems in the given scenario. 4

      ii. Mention few effective approaches to resolve the issue of *Hidden Terminal* problems. 6

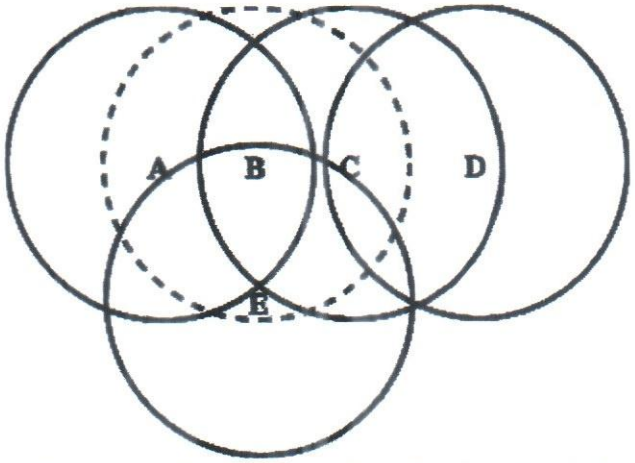

Figure 1: Network topology for Question 1.c)

2. a) State the reason for not using the CSMA/CA based MAC protocol for wireless sensor networks. Justify your answer with proper argument and diagram. 9

   b) Describe several efficient methods for conserving power in Wireless Sensor Networks (WSNs). 8

   c) How does the Low-Energy Adaptive Clustering Hierarchy (*LEACH)* protocol prolong the lifespan of energy constrained wireless sensor networks. Justify your answer with an appropriate diagram and arguments. 10

3. a) Using the sample topology for an *Energy Harvesting Wireless Sensor Networks (EH-WSN)* as shown in Figure 2 and the values for various network parameters listed in Table 1 and Table 2, determine the route that would maximize the overall remaining energy of the network for traffic originating from node A and destined for node E. It should be assumed that the maximum battery capacity of any node is B and the future period for predicting harvest and consumption is ΔT. 14

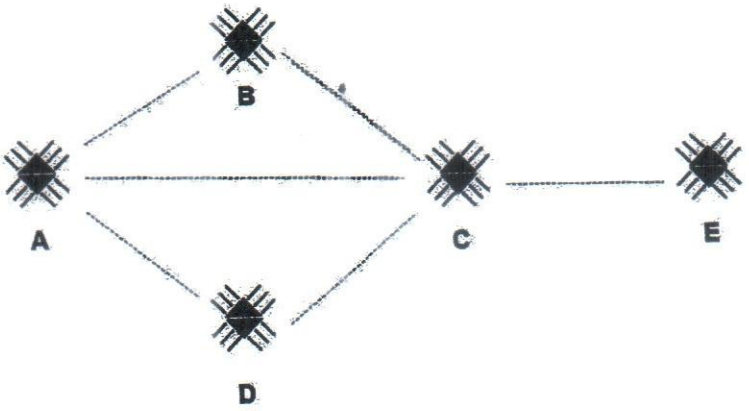

Figure 2: Network Topology for Question 3.a)

Table 1: Network Parameters of Nodes for Question 3.a)

Node	***Current Battery Level, E_p***	***Expected Energy Harvest over ΔT, E_h***
A	0.90 *B*	0.10 *B*
B	0.95 *B*	0.25 *B*
C	0.80 *B*	0.20 *B*
D	0.90 *B*	0.20 *B*
E	0.79 *B*	0.07 *B*

Table 2: Network Parameters of Links for Question 3.a)

Link	***Expected Energy Consumption over ΔT, Ec***
A—B	0.10 *B*
A—C	0.15 *B*
A—D	0.20 *B*
B—C	0.15 *B*
C—E	0.10 *B*
D—C	0.10 *B*

b) To transmit a high volume of data packets from a router located at IUT to a router at the University of Dhaka (DU) via a *Wireless Metropolitan Area Network* (*WMAN*), there are several potential routes to choose from. Identify the path that is anticipated to have the minimum transmission count in the network topology depicted in Figure 3. Table 3 contains the values for different link parameters. 13

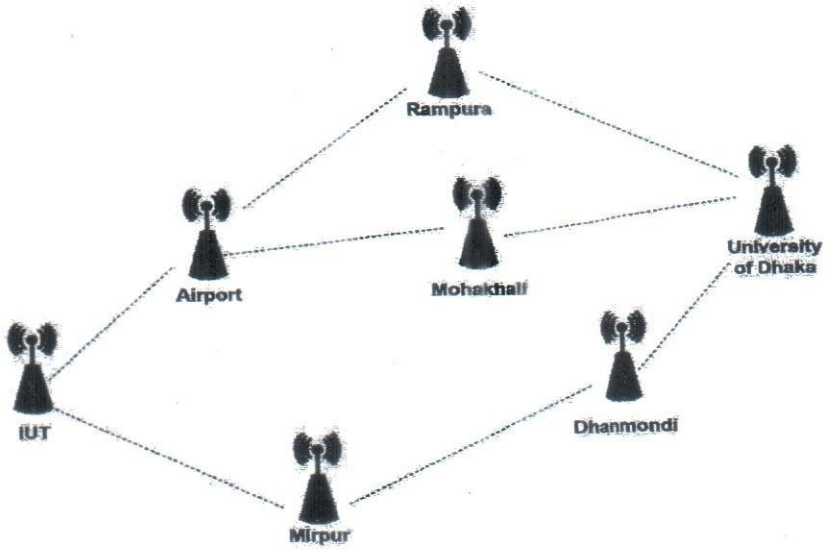

Figure 3: Network Topology for Question 3.b)

Table 3: Link Parameters for Question 3.b)

Link	***Forward Delivery Ratio, R_{fwd}***	***Reverse Delivery Ratio, R_{rev}***
IUT—Airport	0.85	0.92
IUT—Mirpur	0.70	0.93
Airport—Rampura	0.92	0.87
Airport—Mohakhali	0.76	0.73
Mirpur—Dhanmondi	0.88	0.90
Rampura—DU	0.77	0.87
Mohakhali—DU	0.88	0.66
Dhanmondi—DU	0.79	0.92

4. a) What is the reason for the poor performance of traditional *TCP* in *wireless networks*? 5

   b) What is the need for frequency reuse in a GSM network? 8

   c) Does migrating the *Backoff* operation to the *Frequency Domain* offer any advantages?
      i. Justify your answer with appropriate argument. 6
      ii. Enumerate the costs and benefits of implementing Frequency Domain Backoff. 4

5. a) In what ways does *Orthogonal Frequency-Division Multiplexing (OFDM)* enhance capacity when contrasted with traditional *FDM*? 6

   b) Consider a Basic Service Set (*BSS*) of *IEEE 802.11 Wireless LAN (WLAN)* consisting of three stations (*A*, *B*, and *C*). Assume that all the stations compete for accessing a shared channel by means of *Distributed Coordination Function (DCF)* and they can all hear each other's transmission. 20

   Draw a Timeline Diagram representing the sequence of actions for *one successful re-transmission of MAC Service Data Unit from Station C to Station A.*

The diagram should depict the detailed backoff procedure conducted by all the stations in this *BSS*. Consider the minimum Contention Window, CW_{min} value is seven (5). Consider the *RTS/CTS* transmission is enabled in this scenario.

Note that, the x-axis of the diagram should show time and y-axis should show one horizontal line for each of the contending stations. An action (i.e., transmission of a frame) is represented by a horizontal bold line where the line is placed in the same horizontal line of the station with line length representing period.

6. a) Explain what *Handoff* refers to in the context of cellular communication systems. 11
   b) Enumerate the various types of *Handoff* in cellular communication systems in brief. 6
   c) The degradation of throughput in Wireless Ad-hoc Networks is primarily caused by collisions. The existing contention mechanism employed in IEEE 802.11 networks called CSMA/CA depends on a fully decentralized random backoff, which is incapable of eradicating collisions. Consequently, network throughput is degraded as more contenders seek to access the channel. 9

   To resolve these situations, the current contention mechanism must be modified to produce a collision-free schedule that is fully decentralized, simple, and cost-effective. Analyze the effectiveness of *Deterministic Backoff* operation proposed in *CSMA/ECA* protocol in satisfying above mentioned requirements.