UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	WIRELESS SENSOR AND MOBILE AD HOC NETWORKS
COURSE CODE	:	BEB 42003
PROGRAMME	:	BEJ
EXAMINATION DATE	:	DECEMBER 2019/ JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **TWO (2)** QUESTIONS FROM **SECTION A** AND **TWO (2)** QUESTIONS FROM **SECTION B** ONLY

THIS PAPER CONSISTS OF **TEN (10)** PAGES

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SECTION A: ANSWER TWO (2) QUESTIONS ONLY

Q1 Consider the MAC and PHY frame of the IEEE 802.15.4 protocol is shown as in **Figure Q1** and its related packet data **Table Q1**.

(a) Outline the algorithm for the Unslotted CSMA/CA channel access mechanism of the IEEE 802.15.4, operating in a non-beacon enabled mode.

(6 marks)

(b) Calculate:

(i) the size of data payload in bytes;

(ii) the data frame transfer time; and

(iii) the effective data rate.

(12 marks)

(c) Next, consider the system as a non-ideal and only one retry is allowed with up to 20% Packet Error Rate. The related data is given in **Table Q1**. Analyze this scenario and determine,

(i) the actual data rate; and

(ii) the time taken to transfer 3 MByte of data.

(7 marks)

Q2 Low Energy Adaptation Clustering Hierarchy (LEACH) algorithm is one of well known WSN routing algorithms. It is hierarchical based and need to select a leader in each round of data transmission.

(a) Distinguish the characteristics of Low Energy Adaptation Clustering Hierarchy (LEACH) algorithm.

(8 marks)

(b) Examine in detail the operation of LEACH, including all of its phases involved, the flow diagrams, the **TWO (2)** mechanisms of cluster head selection.

(17 marks)

Q3 Energy consumption is the main concern in a sensor node and the whole wireless sensor network system, since it determine the node and network lifetime.

(a) Differentiate the operation of cluster head and ordinary node for one round operation using flow diagram.

(8 marks)

(b) Consider a wireless sensor network shown in **Figure Q3(b).** It consists of two cluster headers, CH1 and CH2. CH1 is connected to one ordinary node and CH2 to two ordinary nodes. Assume that the sources of energy consumption come from the ordinary nodes and Cluster Head activities given below.

Types of Node	Sources of Energy Consumption
Ordinary Nodes	Sensing and Transmitting
Cluster Head	Sensing, Receiving and Transmitting

Assume the free space fading as the propagation model with exponent 2, the number of sensing bit is ***b*** and the weighting factor for sensing, transmitting and receiving only is $\{ h_2 , h_3 \} = \{1.4, 1.6 \}$.

(i) Derive the total energy model for the network in terms of the variables concerned.

(12 marks)

(ii) Calculate the total energy consumed for the network. The variables are shown in **Table Q3.**

(5 marks)

SECTION B: ANSWER TWO(2) QUESTIONS ONLY

Q4 (a) Routing protocol is one of the very important elements in the management of mobile ad hoc network. State **THREE (3)** design objectives of routing protocols with regards to wireless mobile ad hoc network. Explain briefly each of them.

(9 marks)

(b) Ad Hoc On Demand Distance Vector (AODV) is a well known protocol for mobile ad hoc network. It consists of a number of sub-protocols namely Route Discovery and Route Reply.

(i) Explain the operation of Route Discovery Protocol at the source, intermediate and at the destination.

(10 marks)

(ii) Evaluate some optimization processes as applied to AODV protocol.

(6 marks)

Q5 One of the constraints in the wireless mobile ad hoc network is the routing protocol overhead.

(a) The major sources of routing protocol overhead are the number of neighbors and the number of hops. Explain in detail the effect of number of neighbors and the effect of the number of hops on the performance of mobile ad hoc networks.

(10 marks)

(b) Consider a network of mobile nodes arranged in a grid formation as shown in **Figure Q5**, running on AODV protocol. Assume that the nodes are static. The networking area is given as 800 m by 600 m. The transmission range is set as 200 m. Two nodes in the vertical and horizontal location are within the communication range, but not the nodes that are in diagonal to each other. The same packet must not be on the same node two times. Calculate the total number of overhead packets that are generated for the successful of route discovery. You may consider additional coverage $C_1 = 0.41$, $C_2 = 0.19$, $C_3 = 0.09$ and $C_4 = 0.05$.

(15 marks)

Q6 In mobile ad hoc network, the most effective connectivity is through MAC protocol, IEEE 802.11 Wireless Local Area Network (WLAN).

(a) Explain the Theoretical Maximum Throughput (TMT) as applied to IEEE 802.11 and state the assumptions for it to be true.

(11 marks)

(b) Consider the IEEE 802.11, with HR-DSSS MAC schemes operating at 5.5 Mbps and 11 Mbps. Consider the performance of CSMA/CA and RTS/CTS for a value of MSDU given as 1400 bytes. Calculate the total delay and TMT. Tabulate the results. For all the calculations, **Table Q6(b)(i)** and **Table Q6(b)(ii)** are required.

(14 marks)

- END OF QUESTIONS -

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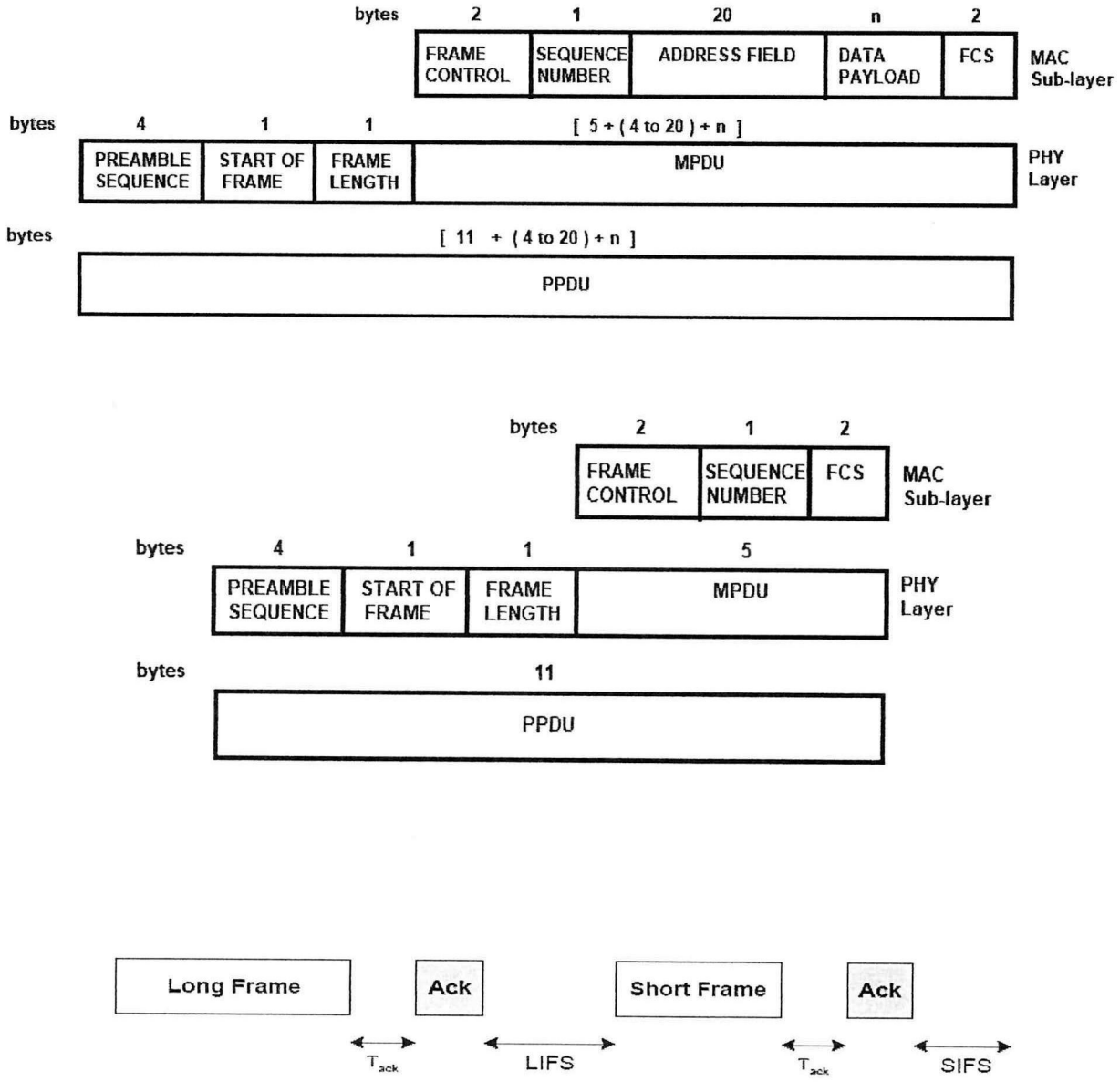

Figure Q1

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Table Q1. Data related to 802.15.4 MAC Protocol

Parameters	Values
aUnitBackOffPeriod	20 symbols
CCA detection time	8 symbols
InitialBackOffPeriod	$\{2^{BE}-1\}$
Maximum Over The Air Data Rate	250 kbps
One Symbol Period	16 µs
aMaxPHYPacket Size	127 bytes
Minimum Frame Overhead when using short addressing	13 bytes
SHR	5 bytes
PHR	1 byte
Turnaround Time	192 µs
ackFrameSize	11 bytes
maxACKWaitDuration	54 symbols

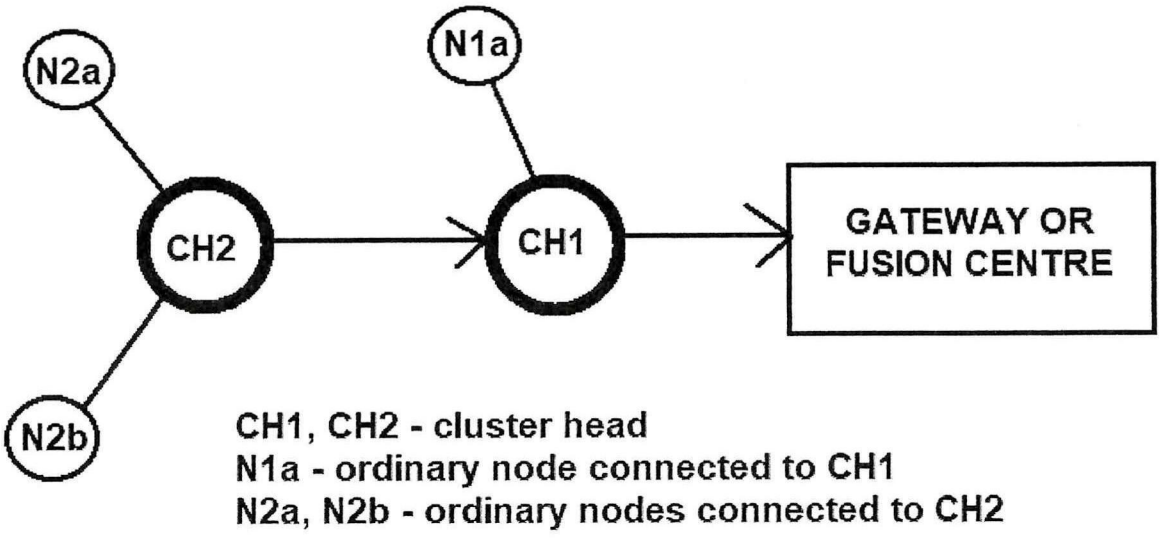

Figure Q3(b)

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Table Q3: Energy Consumption Calculation Data

SYMBOL	DESCRIPTION	VALUE
N_{cyc}	Number of clock cycles per task	0.97 x 10^6.
C_{avg}	Average capacitance switch per cycle	22pF
V_{sup}	Supply voltage to sensor	2.7 V
f	Sensor frequency	191.42 MHz
n_p	Constant depending on the processor	21.26
n	Path loss exponent	2 or 4
I_o	Leakage current	1.196 mA
V_t	Thermal voltage	0.2 V
b	Transmit packet size	2048 bits
E_{elec}	Energy dissipation: electronics	50 nJ/bit
E_{amp}	Energy dissipation: power amplifier	100 pJ/bit/m^2
T_{tranON}	Time duration: sleep -> idle	2450 µs
$T_{tranOFF}$	Time duration: idle -> sleep	250 µs
I_A	Current: wakeup mode	8 mA
I_S	Current: sleeping mode	1 µA
T_A	Active Time	1 ms
T_S	Sleeping Time	299 ms
T_{tr}	Time between consecutive packets	300 ms
T_{sens}	Time duration: sensor node sensing	0.5 mS
I_{sens}	Current: sensing activity	25 mA
I_{write}	Current: flash writing 1 byte data	18.4 mA
I_{read}	Current: flash reading 1 byte data	6.2 mA
T_{write}	Time duration: flash writing	12.9 mS
T_{read}	Time duration: flash reading	565 µs
E_{actu}	Energy dissipation: actuation	0.02 mJ
h_1	CH weight factor, for processing	1.2
h_2	CH weight factor, for transmission and receiving.	1.4
h_3	CH weight factor, for sensing	1.6
h_4	CH weight factor, for sensor logging	1.8
d	Transmission range	30 m

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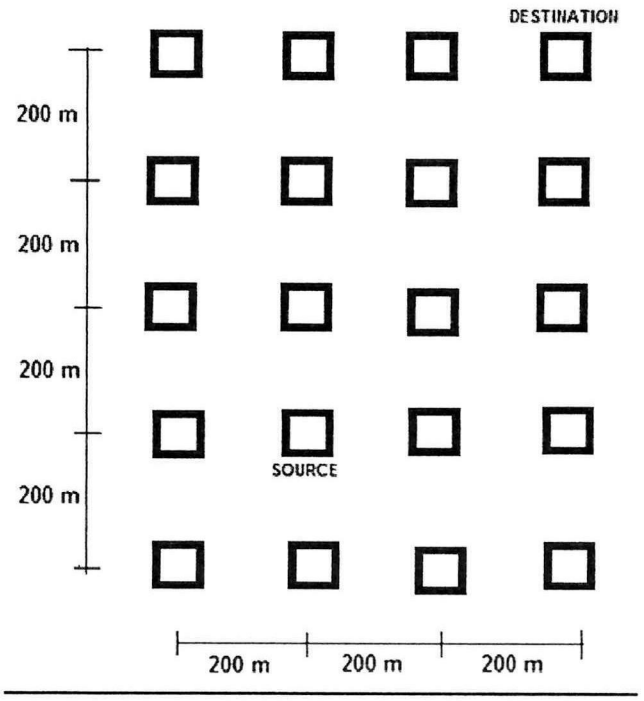

Figure Q5

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Table Q6(b)(i)

Delay components for different MAC schemes and spread spectrum techniques

Scheme	Constant and varying delay components (10^{-6} s)						
	T_{DIFS}	T_{SIFS}	T_{BO}	T_{RTS}	T_{CTS}	T_{ACK}	T_{DATA}
CSMA/CA							
HR-DSSS-5.5	50	10	310	NA	NA	304	192+8×(34+MSDU)/5.5
HR-DSSS-11	50	10	310	NA	NA	304	192+8×(34+MSDU)/11
RTS/CTS							
HR-DSSS-5.5	50	10×3	310	352	304	304	192+8×(34+MSDU)/5.5
HR-DSSS-11	50	10×3	310	352	304	304	192+8×(34+MSDU)/11

Table Q6(b)(ii)

TMT parameters for MAC schemes and spread spectrum

Scheme	Data Rate	a	b
CSMA/CA			
HR-DSSS	5.5 Mbps	1.45455	915.45
HR-DSSS	11 Mbps	0.72727	890.73
RTS/CTS			
HR-DSSS	5.5 Mbps	1.4545	1591.45
HR-DSSS	11 Mbps	0.72727	1566.73