Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	WIRELESS SENSOR AND MOBILE AD HOC NETWORKS
COURSE CODE	:	BEB42003
PROGRAMME	:	BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS
EXAMINATION DATE	:	DECEMBER 2015/JANUARY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 Consider a wireless sensor network shown in **Figure Q1(a)**. All the nodes are stationary.

(a) Show and explain the flowchart of sensor node and clusterhead operation in one round.

(11 marks)

(b) Let the sources of energy consumption come from the following Node and CH activities as shown in **Table Q1(b).**

Table Q1(b)

Node	sensing , transmitting
Clusterhead (CH)	sensing, receiving and transmitting

The propagation model is assumed to follow the free space fading with path loss exponent of 4. The weighting factor is given as,

$$\{ h_1 , h_2 , h_3 , h_4 \} = \{ 1.2 , 1.2 , 1.1 , 1.1 \}.$$

(i) Analyze the energy consumption in each node and clusterhead.

(5 marks)

(ii) Develop the total energy model for this sensor network in terms of variables in **Table Q1(b)(ii)**.

(5 marks)

(iii) Calculate the total energy consumption using the values given in **Table Q1(b)(ii)**. (4 marks)

Q2 (a) Consider the superframe structure of IEEE 802.15.4 protocol, shown in **Figure Q2(a)**.

(i) Differentiate between beacon enabled and non-beacon enabled operation.

(5 marks)

(ii) Describe the operation in the Contention Access Period (CAP) and Contention Free Period (CFP)

(5 marks)

(b) Derive the general expression for the throughput of the IEEE 802.15.4 protocol, in terms of overall delay. Define all the terms used.

(15 marks)

Q3 One of the most important issues in Wireless Sensor Network is localization. It can be described as the the process of providing location information to a node. It can determine its relative position with respect to the anchors.

(a) Describe the mechanism of Received Signal Strength Indicator (RSSI) to estimate the distance using the free space propagation model.

(8 marks)

(b) Consider three anchor nodes with known position, (x_1, y_1), (x_2, y_2) and (x_3, y_3). The unknown node is located at position (x_u, y_u). Assume that the distance from (x_u , y_u) to all three nodes are perfect distances.

(i) Formulate the necessary linear matrix equation to represent the solution of (x_u, y_u).

(10 marks)

(ii) **Figure Q3(b)(ii)** shows three anchors of known position and a node of unknown location. If the distances r_1, r_2 and r_3 are given as $\sqrt{10}$, 2 and 3 respectively, deduce the coordinate of the unknown node.

(7 marks)

Q4 Dynamic Source Routing (DSR) is a well known protocol for mobile ad hoc network. It consists of a number of sub-protocols namely, route discovery, route maintenance and packet transmission.

(a) Compare the function of RREQ (Route Request Packet) and Route Reply Packet (RREP) with regard to the DSR protocol.

(4 marks)

(b) Produce the flowchart related to the route discovery protocol at the source nodes. Elaborate briefly on all the elements of the flowchart.

(12 marks)

(c) Consider a network of mobile nodes arranged in a grid formation as shown in **Figure Q4(c)**, running on DSR 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 transmission range, but not the nodes that are in diagonal to each other. 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 $C_4 = 0.05$.

(9 marks)

Q5 (a) Consider the system of mobile ad hoc network of **Figure Q5(a)** consists of two nodes n_1 and n_2. Node n_1 is stationary. The concentric circle around n_1 is the maximum transmission range of node n_1. Discuss the following scenarios in terms of the node connectivity time between n_1 and n_2.

(i) increasing the angle of arrival.

(ii) increasing the velocity of node n_2.

(iii) the range of contraction and range of expansion.

(6 marks)

(b) Consider two nodes, one stationary and the other moves at a certain velocity into the transmission range of the stationary node. Assume the node transmission range is 200 m. The mean node connectivity time ($\overline{T}_{NCT}$) is defined as the average time a node is within the transmission range of the other node, hence during this period they are fully connected. The mean node connectivity time depends on its probability density function (pdf), which is given as,

$$f_{NCT}(t) = \frac{4R}{\pi . V_m} \cdot \frac{1}{t^2} \cdot \left[1 - \sqrt{1 - \left(\frac{V_m t}{2R} \right)^2} \right] \quad \text{where} \quad 0 \le t \le \frac{2R}{V_m}.$$

(i) Derive the expected mean node connectivity time for the two nodes operation.

(15 marks)

(ii) For a given average velocity of 10 m/s, 15 m/s, 20 m/s and 30 m/s, calculate the corresponding mean node connectivity time.

(4 marks)

- END OF QUESTIONS -

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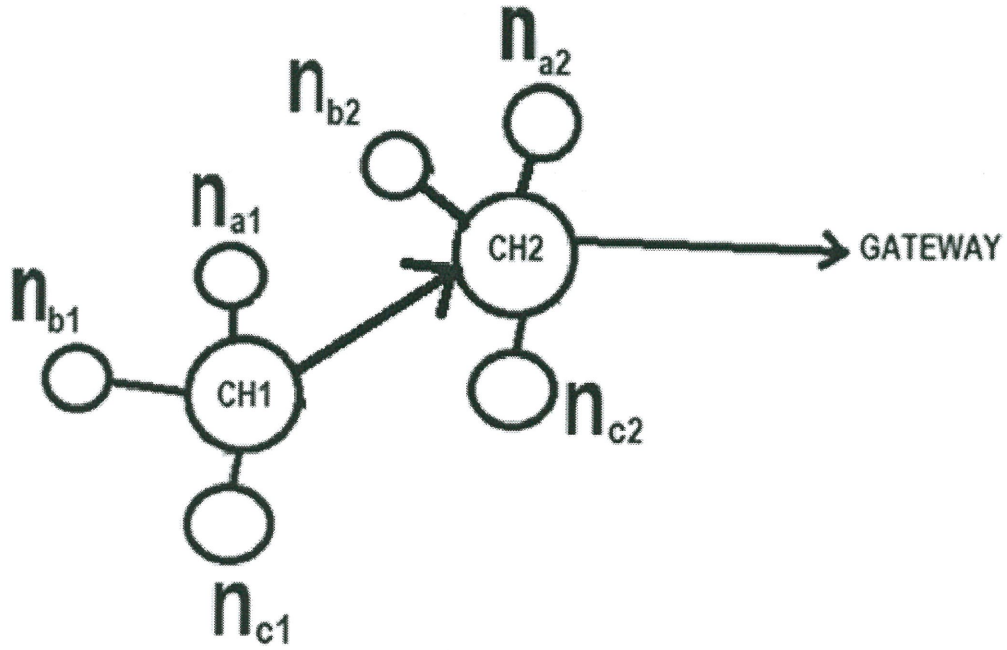

CH1 = child clusterhead **CH2 = parent clusterhead**

Figure Q1(a)

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Table Q1(b)(ii)

SYMBOL	DESCRIPTION	VALUE
N_{cyc}	Number of clock cycles per task	0.97×10^6
C_{avg}	Avg. capacitance switch per cycle	22 pF
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	2 kb
E_{elec}	Energy dissipation: electronics	50 nJ/bit
E_{amp}	Energy dissipation: power amplifier	100 pJ/bit/m2
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_{sense}	Time duration: sensor node sensing	0.5 ms
I_{sense}	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

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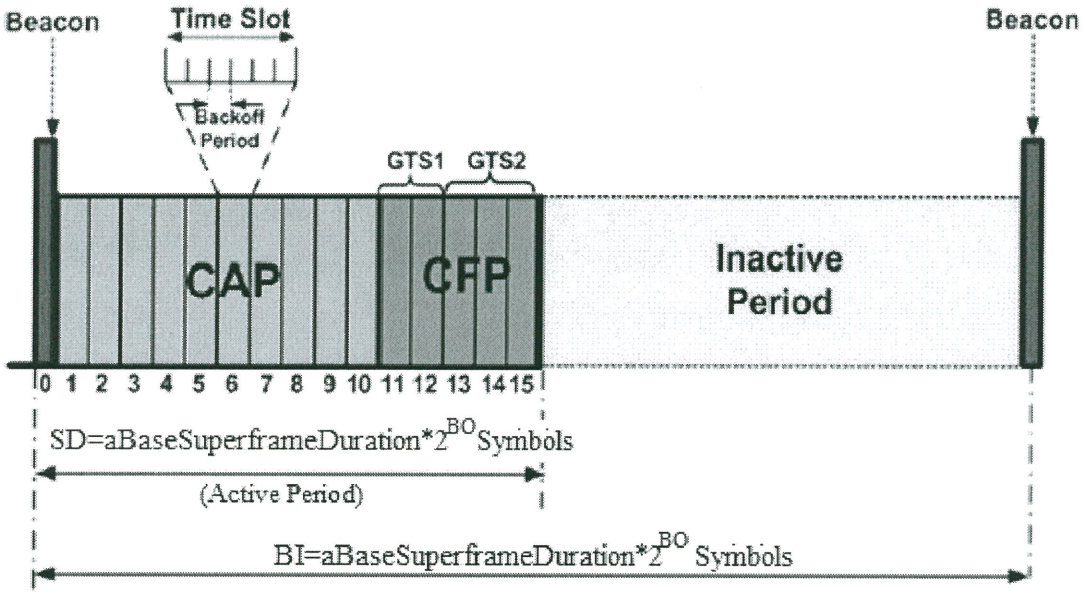

FIGURE Q2(a)

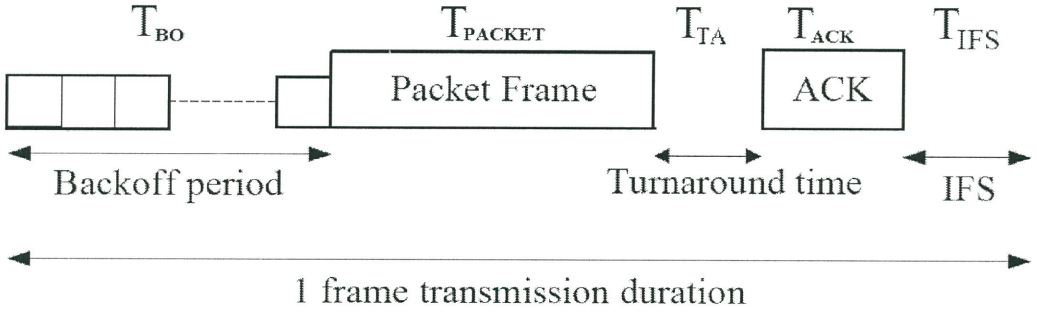

FIGURE Q2(b)

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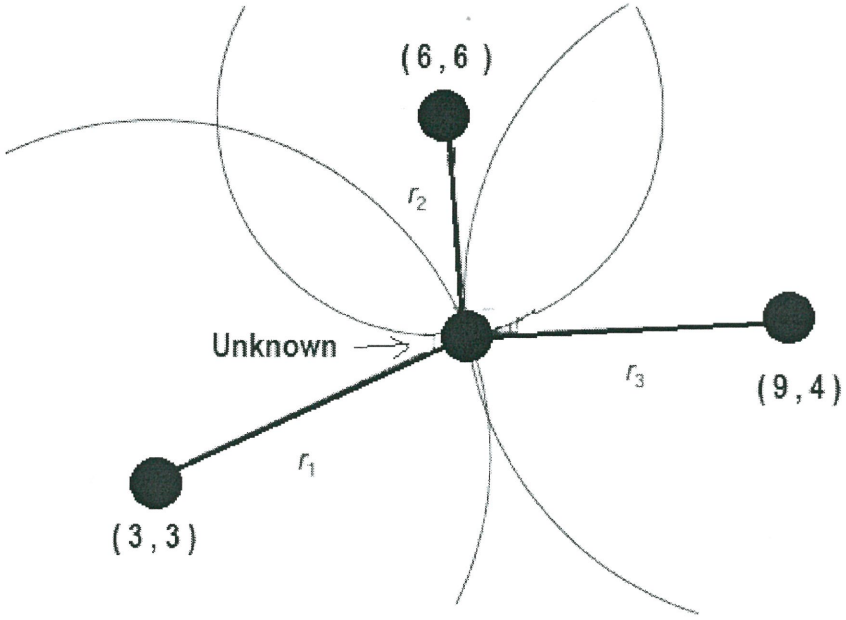

FIGURE Q3(b)(ii)

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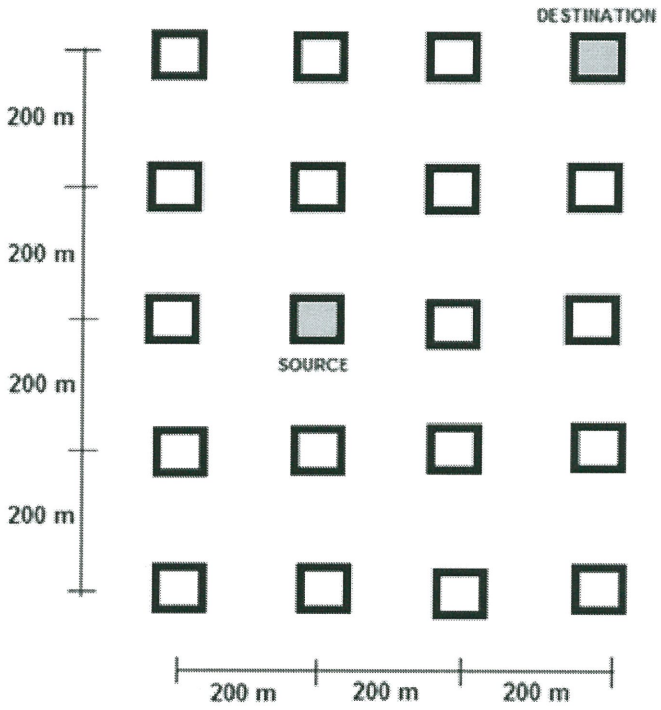

FIGURE Q4(c)

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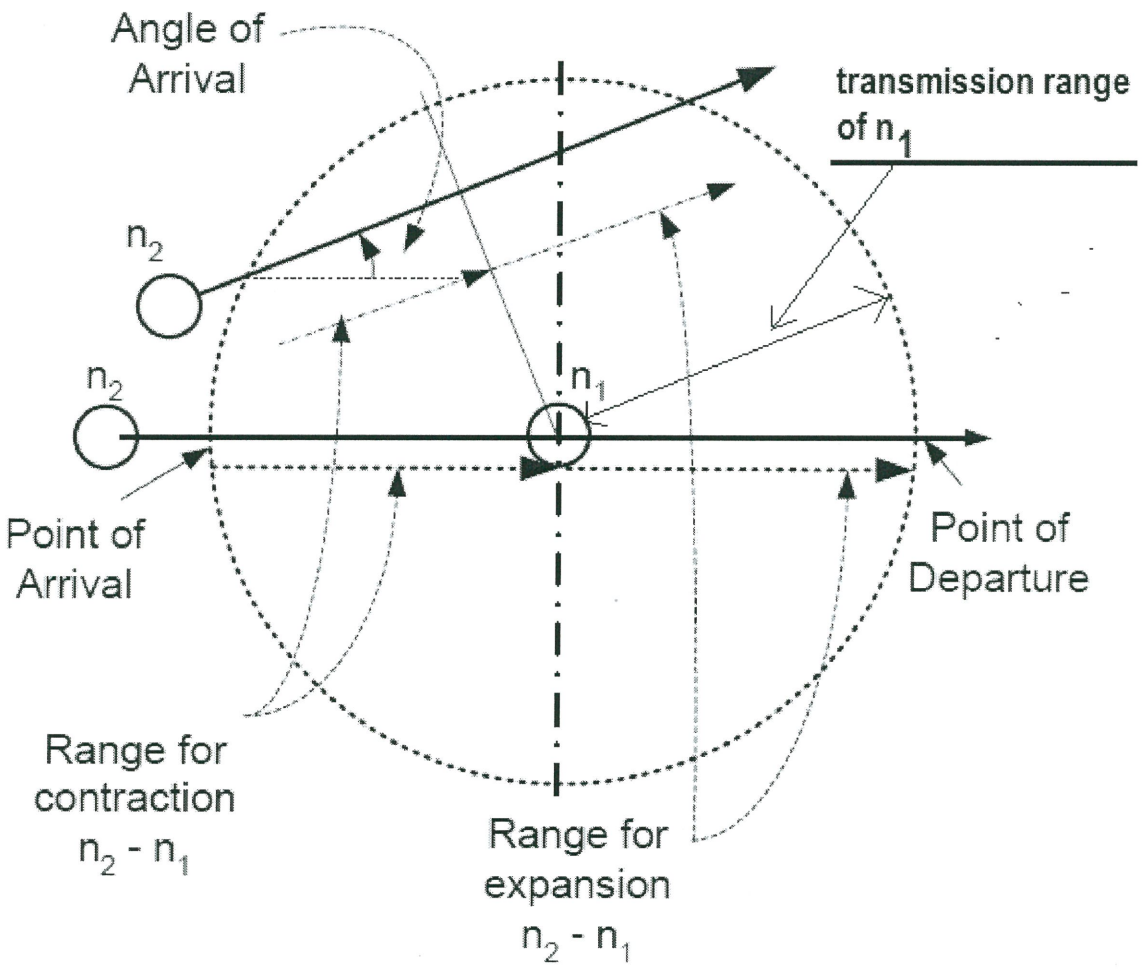

FIGURE Q5(a)