Benha University
Faculty of Engineering at Shoubra
Electrical Engineering Department
Pre- M.Sc. (Electronics & Communications Engineering)

Final Term Exam (Spring 2015)
Date: Tuesday (26/5/2015)
Subject: Sensors Networks
Duration: 3 hours

- **Answer all the following questions**
- **No. of questions : 5**
- **Total Mark: 210 Marks**

Model Answer

Question (1) (75 Marks)

Choose the correct answer:

1- ……is core of sensors networks.
   a. Data centric b. Environment interaction c. Application specific
2- To operate the transceivers, ……. is required
   a. high duty cycle b. low duty cycle
3- Topology control is useful in
   a. light network b. dense network
4- In topology control algorithms, the stretch factor should be ……..
   a. big b. small c. it depends
5- Partition nodes into groups of nodes is called ……
   a. localization b. back bone c. clustering
6- The participant that is interested in receiving data from WSN is called …..
   a. Source b. sink c. actuator
7- Sampling rate is one feature of …….
   a. ADC b. DAC c. signal conditioner
8- In infra-structure based wireless networks, administrative tasks are performed using …..
   a. base station b. gateway c. IP backbone d. ID backbone e. mobile nodes
9- …… is a decentralized type of wireless network that does not rely on a pre- existing infrastructure.
   a. PAN b. WLAN c. WANET d. PDA
10- Participants must use…….. when no central node exists.
   a. adaptive protocols b. self organization c. multi hopping
11- MANET & WSN are different in……
   a. self organization b. scale c. energy efficiency
12- …….. means that the Network has to adapt to changes, self-monitoring, adapt operation.
   a. Scalability b. Maintainability c. Programmability
13- Major energy problem in wakeup receivers is ……
   a. transmitting b. receiving c. idle d. sleep e. all of them
14- In Sensor networks, Sensors are used to measure…….
   a. continuous and discrete variables b. discrete parameters c. continuous variables
15- ADC resolution depends on ……..
   a. no. of quantization levels b. sampling rate c. conversion time

16- Hydraulic actuators use …….. to amplify the controller command signal.

a. fluid b. gas pressure c. compressed air

17- Primary batteries are ……..

a. chargeable b. not chargeable c. it depends

18- When using energy scavenging, the cost of sensor node cost …….

a. Increases b. decreases c. doesn't change

19- Increasing the number of instructions, …….. the battery life time.

a. Increases b. decreases c. doesn't change

20- The power consumption of using ROM is ……. using RAM.

a. more than b. less than c. the same as

21- The consumption power in case of computation is…. communicate the data without make any processing on it.

a. more than b. less than c. the same as

22- Node mobility happens in …….

a. WSN b. MANET c. both d. none

23- Counting all overheads in intermediate node is called …….

a. energy per correctly recevied bit b. energy per reported event c. energy per uniqe event

24- When we change the resolution of measured temperature in a sensor network, this is an example of …..

a. data centric networking b. adaptive fidelity c. signal processing

25- To solve the battery operated devices challenge in WSN, we exploit ……

a. adaptive protocols b. multi-hopping c. self-organization d. energy efficient operation

Question (2) (30 Marks)

1- What are the challenges for ad hoc networks? Give some solutions to solve them.

Problems are due to

a. Lack of central entity for organization available
b. Limited range of wireless communication
c. Mobility of participants
d. Battery-operated entities

Solutions:

- ***self-organization- multi-hop network- adaptive protocols - energy-efficient operation***

2- Give some applications for WSN.

Disaster relief operations - Intelligent buildings- Biodiversity mapping- Precision agriculture - Medicine and health care - …

3- What are the deployment options for WSN?

Random deployment & Regular deployment

4- What are the characteristic requirements for WSN? Mention the mechanisms that can be exploited to meet these requirements.

characteristic requirements

Type of service, Quality of Service, Fault tolerance , life time, scalability, programmability, maintainability

Mechanisms

Multi-hop wireless communication, Energy-efficient operation, Auto-configuration, Collaboration & in-network processing

5- Compare between MANETs & WSNs.

Many commonalities: Self-organization, energy efficiency, (often) wireless multi-hop

Many differences

- ***Applications, equipment***: MANETs more powerful (expensive) equipment assumed, often "human in the loop"-type applications, higher data rates, more resources
- ***Application-specific***: WSNs depend much stronger on application specifics; MANETs comparably uniform
- ***Environment interaction***: core of WSN, absent in MANET
- ***Scale***: WSN might be much larger (although contestable)
- ***Energy***: WSN tighter requirements, maintenance issues
- ***Dependability/QoS***: in WSN, individual node may be dispensable (network matters), QoS different because of different applications
- ***Data centric*** vs. id-centric networking
- ***Mobility***: different mobility patterns like (in WSN, sinks might be mobile, usual nodes static)

Question (3) (40 Marks)

1- Give some options for the controller used in a sensor network node and discuss which is the most suitable one between them.

  - Microcontroller – general purpose processor, optimized for embedded applications, low power consumption
  - DSPs – optimized for signal processing tasks, not suitable here
  - FPGAs – may be good for testing
  - ASICs – only when peak performance is needed, no flexibility

most suitable one is microcontroller

2- Mention the different operational states in a transceiver.

Transmit - Receive – Idle - Sleep

3- What is meant by wakeup receiver?

Receiver that can (only) check for incoming messages

- When signal detected, wake up main receiver for actual reception
- Ideally: ***Wakeup receiver*** can already process simple addresses

4- What are the main types of sensors and what are the different types of actuators?

Sensors:

1. Analog
2. Discrete (Binary , Digital)

Also Active & Passive

Actuators:

Electrical, Hydraulic, Pneumatic

5- Discuss the computation vs. communication energy cost issue.

It's a tradeoff as :

Directly comparing computation/communication energy cost not possible

But: put them into perspective!

Energy ratio of "sending one bit" vs. "computing one instruction": Anything between 220 and 2900 in the literature

To communicate (send & receive) one kilobyte = computing three million instructions!

Hence: we try to compute instead of communicate whenever possible

So the key technique in WSN is – ***in-network processing!*** i.e. Exploit compression schemes, intelligent coding schemes, …

6- What is the transmitter power required to transmit a 1K bits, given

- α_{amp}= 174 mW, β_{amp}= 5, P_{tx}=0 dBm,
- the bit rate and coding rate are 250 kbps and 1/3 respectively,
- it takes a 3u sec. and an average power of 0.01 mW to leave the sleep mode.
- and the device electronics consumes 0.07 mW.

Using the parameters: $P_{amp} = \alpha_{amp} + \beta_{amp} P_{tx}$ = 174mW + 5 x 0dBm , P_{txElec} = 0.07 mW , n = 1K bit, R = 250 kbps , R_{code} =1/3 , T_{start} =3u sec. P_{start}= 0.01 mW

The transmitter power/energy = $\mathbf{E_{tx} = T_{start} P_{start} + n / (R * R_{code}) (P_{txElec} + \alpha_{amp} + \beta_{amp} P_{tx})}$

Question (4) (25 Marks)

1- What are the different sources of mobility in WSN?

- Node mobility - Sink mobility - Event mobility

2- What are the optimization goals in WSN?

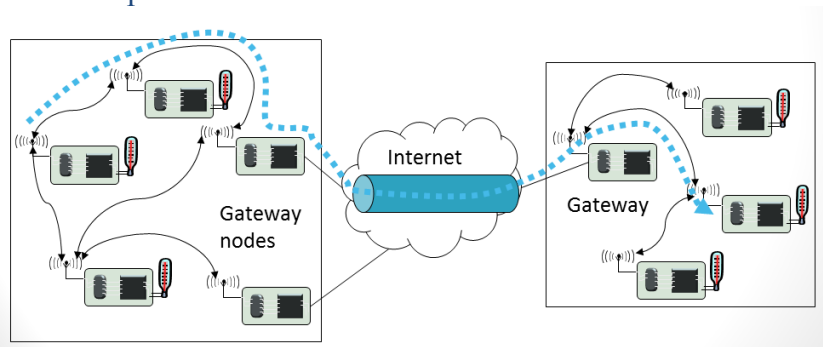
Quality of Service QoS – Energy Efficiency – Scalability

3- Discuss the data centric networking design principle.

In typical networks (including ad hoc networks), network transactions are addressed to the ***identities*** of specific nodes which is called "node-centric" or "address-centric" networking paradigm
In a redundantly deployed sensor networks, specific source of an event, alarm, etc. might not be important
Redundancy: e.g., several nodes can observe the same area
Thus: focus networking transactions on the data directly instead of their senders and transmitters ! ***data-centric networking***

4- What is meant by WSN tunneling?

Use the Internet to "tunnel" WSN packets between two remote WSNs



5- What is meant by localization and positioning in WSN?

Means that determine ***physical position*** or ***logical location***

a. Coordinate system or symbolic reference
b. Absolute or relative coordinates

Question (5) (40 Marks)

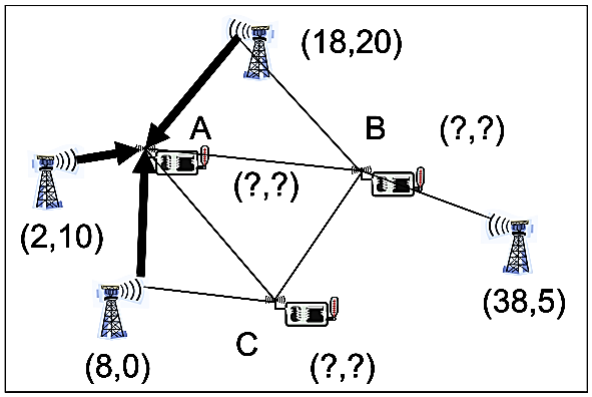
1- Discuss how can we estimate the distances in WSN?

Using one of the following methods:

- Received Signal Strength Indicator
  - Send out signal of known strength, use received signal strength and path loss coefficient to estimate distance
- Time of arrival (ToA)
  - Use time of transmission, propagation speed, time of arrival to compute distance

    - Problem: Exact time synchronization
- Time Difference of Arrival (TDoA)
    - Use two different signals with different propagation speeds

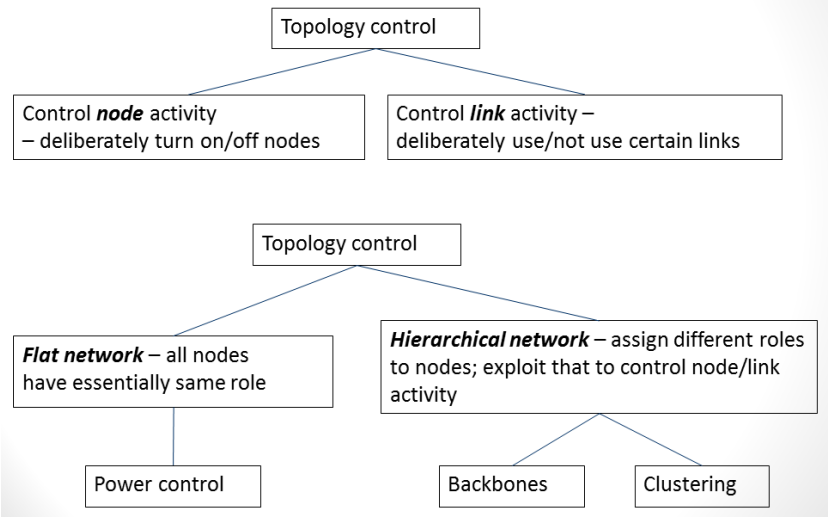
2- Using the iterative trilateration method, determine the locations of the nodes A, B and C.



Using trilateration matrix equation to solve for the x,y coordinates for the nodes A,B,C respectively & assuming r1=1,r2=2 and r3=3.

$$2\begin{bmatrix} x_3 - x_1 & y_3 - y_1 \\ x_3 - x_2 & y_3 - y_2 \end{bmatrix}\begin{bmatrix} x_u \\ y_u \end{bmatrix} = \begin{bmatrix} (r_1^2 - r_3^2) - (x_1^2 - x_3^2) - (y_1^2 - y_3^2) \\ (r_2^2 - r_3^2) - (x_2^2 - x_3^2) - (y_2^2 - y_3^2) \end{bmatrix}$$

3- Discuss the different classifications of the topology control.



4- Show how we can select the cluster head and discuss the rotating of clusterheads issue.

select the cluster head

Choose the clusterhead using the nodes with highest resources e.g. clock speed, powerful battery,…etc.

Rotating Clusterheads:

- Serving as a clusterhead can put additional burdens on a node
    - For MAC coordination, routing, …
- Let this duty rotate among various members
    - Periodically reelect – useful when energy reserves are used as discriminating attribute
    - LEACH – determine an optimal percentage P of nodes to become clusterheads in a network

- Use 1/P rounds to form a period
- In each round, nP nodes are elected as clusterheads
- At beginning of round r, node that has not served as clusterhead in this period becomes clusterhead with probability P/(1-p(r mod 1/P))

Good Luck,
Dr. Ahmad El-Banna