

Note to Students:

1. Please follow all the *Instructions to Candidates* given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. Assumptions made if any, should be stated clearly at the beginning of your answer.

Q.1 Preamble about Application

Monitoring different parameters of interest in a crop has been proven a useful tool to improve agricultural production. The use of Wireless Sensor Networks(WSNs) results in low-cost and low-power consumption deployments. It is also well-known that crops are also negatively affected by intruders (humans or animals) and by insufficient control of the production process. Video surveillance is a solution to detect and identify intruders as well as to take care of the production process better.

Details about WSN Needed

The WSN is to be deployed in a fertile farming belt. In this geographical area, the usual farm distribution consists of different small crops (approximately 1 ha) separated from each other by several meters. Furthermore, most of the farmers are associated in Cooperatives with the objective of favourably marketing their products.

In this framework, the system architecture design takes into account that the information path goes from the crop to the Farmers' Cooperative and then to the particular farmer/user. The user interacts with the system, modifying the monitoring and video- surveillance parameters.

The WSN has to acquire data from different sensors such as samples of salinity, pH, temperature and soil-moisture. The sensing range of these nodes is 75 m and the perfect sensing range is 60m. In addition, motion detection (PIR - Passive Infrared Sensor) and identification (camera) sensors are in charge of the video-surveillance, therefore taking care of the crop security and control functions. The camera range with sufficient resolution for object detection is up to 200m. The WSN has to cater to atleast 50 farmers. The farming belt covers atleast 60 ha (1 ha = 10,000 m²). The deployment aims to collect the following information: dissolved oxygen, light (photosynthetic irradiance), pressure, salinity, temperature and turbidity.

Data Collection is of four types at (i) Regular Sampling Intervals of 10 Minutes (ii) Irregularity in sensed data may cause remote system to instruct the motes to reduce the sampling interval (iii) event-based intruder detection, (iv) There might on-demand monitoring of certain areas of the farm of any farmer -based on user requirements and intruder detection

Answer the following questions.

- (a) (a)What is the deployment pattern - how many nodes will be required, are all nodes of the same type, classify requirements as nodes (sensing, relay, sensing and relay) and super nodes, where will you place each node/super node? Justify.
- (b) (b)For the application scenario - what are the characteristics that the network protocol stack should possess (In terms of energy conservation, processing and memory requirements, fault tolerance, data criticality, real-time operations, tenability, maintenance)?
- (c) (c)Would a time synchronization Algorithm be required? If so, which one will you use and why?
- (d) Would a Localization Algorithm be required? If so, which one will you use and why?
- (e) (e)Is the data collection proactive or reactive or hybrid?
- (f) (f)Would use Clustering? If so which algorithm and why? Will this clustering be hierarchical? Justify
- (g) (g)Which Routing Algorithm will you use and why?
- (h) (h)Topology Control requirement is necessary- Suggest a protocol that would work ideally in such an environment.
- (i) (i)What is the addressing method you will use in the WSN?
- (j) (j) Analyze your protocol stack with the characteristics you have defined in Part (b) of this question. Does your protocol stack satisfy all requirements?

[25 Marks]