Birla Institute of Technology & Science, Pilani, Pilani Campus

II Semester 2022-2023
EEEG627 Network Embedded Applications
Comprehensive Examination (Closed Book)

Date: 12-05-2023 **Duration: 1 hour 15 minutes** **Max Marks: 15**

Q1-Q6 are short answer questions. Partial marking will not be awarded. Hence be precise while answering the questions. Read questions carefully and avoid vague answers.

Q.1.

(a) Mention the three configurable parameters in Lora communication that decides the nominal bit rate. **[1.5M]**

(b) What is the difference between the two functions sx1272.getRSSIpacket() and sx1272.getRSSI(); used in Lora communication using Waspmote? Which function is most appropriate for RSSI based positioning ? Justify your answer. **[1.5M]**

Q.2.

(a) Mention two main limitations of XBee transparent mode when compared to Xbee API mode.

(b) You are required to instruct a novice engineer about the minimum configurations required to configure two Xbee supported motes to communicate in a unicast manner to each other. What are the configurations that you will suggest. Most important 4 configurations can be mentioned. [The configuration of a parameter on both modes will be considered as a single configuration only.] **[1.5M+1.5M]**

Q.3.

(a) Give a scenario in which SDN is advantageous when compared to traditional IP network architecture? Mention the specific advantage provided by SDN for the choosen scenario. **[1.5M]**

(b) Which devices are considered as forwarding devices in an SDN ? **[0.5M]**

Q.4.

(a) Explain Mobicast routing in vehicular networks. Is multicast communication used in mobicast? Explain your answer **[1.5M]**

(b) How are event triggered frames transmitted in LIN? Give two advantages of Flexray over LIN protocol that makes it more suitable for communication among critical ECUs. **[1.5M]**

Q.5.

(a) Ethernet power link will provide **deterministic behavior, fairness, and real-timeliness** over traditional Ethernet. Do you agree with this statement? Justify your answer. Your answer should reflect your understanding of the EPL protocol. **[1.5M]**

(b) Ring topology is the most preferred topology when compared to the daisychained topology for SERCOS communication. What is the advantage given by ring topology? SERCOS is considered to be more robust than Traditional Ethernet. Why? **[1.5M]**

Q.6. Compare SMAC and DMAC in terms of scalability and throughput. You may identify the relatively best protocol (among the two) in terms of each parameter and provide justification (not more than 2 lines each). Your answer should reflect your understanding about both protocols **[1M]**

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II Semester 2022-2023
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Comprehensive Examination (Open Book)

Date: 12-5-2023 **Duration: 1 hour 45 minutes** **Max Marks: 20**

Q. 1.

Read the complete question before attempting to answer.

The networked system has to be designed for the monitoring of a gas pipeline.
Although the underground pipelines constitute the safest way to transport large amounts of fluids over long distances, the pipelines are exposed to multiple hostile environmental factors, such as extreme soil conditions, corrosion, and malicious attacks, which may cause leakage in the pipelines. Pipeline leakages may lead to significant economic loss, combined with environmental pollution or pose risk to human lives. Thus, the security and maintenance of the pipeline infrastructure is one of the major concerns.

System Architecture

The Pipeline to be monitored is a cross-country pipeline system. The pipeline is monitored using a wired network integrated to an available SCADA system. The pipeline is also monitored using WSN. Assume you have to monitor a pipeline deployed across a distance of 100km.

Wired Network Design:

Typical Supervisory Control and Data Acquisition (SCADA) system architectures focus on centralized data collection and control. Wired network is used for collecting critical data from the pipelines such as pressure, temperature, the acoustic vibrations caused by the leakages and rate of flow of the gases flowing through the pipes that will help to identify potential cracks (in future) or leakages in the pipelines. Motes are fitted with appropriate sensors for the measurement of the parameters at suitable distances within the pipeline. As the pipeline is spread over long distance, an hierarchical mote deployment (various wired segments are used) is preferred. 2 Motes are placed within a distance of 0.5km. The motes are connected in wired segments which then ultimately gets connected to the centralized computer of the SCADA systems. The data from motes are expected to be collected at the SCADA system periodically in a robust manner as fast as possible. SCADA systems are designed to provide real-time security status of the entire pipeline so that necessary action may be taken by the human agents monitoring the central information.
Answer the following questions:

(a) Which industrial network will you choose for the wired network and justify the choice citing technical reasons matching with the requirements?
(b) How many motes can be in a wired segment. What is the preferred topology of connection of motes? Why ?
(c) Show the hierarchal industrial network architecture and how you will connect it to the centralized computer of the SCADA system.

WSN System

The WSN System is also deployed for monitoring the pipeline. The WSN is deployed inside the pipeline.

The WSN inside the pipeline is a redudanct deployment to the wired network, is used for collecting critical data from the pipelines such as pressure, temperature, the acoustic vibrations caused by the leakages and rate of flow of the gases flowing through the pipes that will help to identify potential cracks (in future) or leakages in the pipelines. The WSN inside pipeline is a prototype depyoment in testing stage which might

replace the wired network in future. You can assume that the sensing range and communication range of motes within the pipeline is 40m. The WSNs motes inside the pipeline together collect data and send to checkpoint motes which are available at every 500m of the pipeline. The checkpoint motes are integrated with the wired network to send data to the SCADA system. The WSN motes are battery operated.

For WSN inside the pipeline

(d) What will be the topology of deployment of the WSN motes. Describe the network deployment and topology. If you are using an available technology/standard mention the standard and the specific topology supported by the standard which will be used in the application.

(e) Would a time synchronization Algorithm be required? If so , which one will you use and why?Which node will be the master node here (based on the deployment pattern) ? Describe the synchronization process.

(f) Would a Localization Algorithm be required? If so, which one will you use and why?

(g) Would you use Clustering? If so which algorithm and why? Will this clustering be hierarchal? Justify

(h) What would be the MAC protocol that you will use? If you are using an available technology/standard mention the protocol supported by the standard.

(i) Which Routing Algorithm will you use and why?

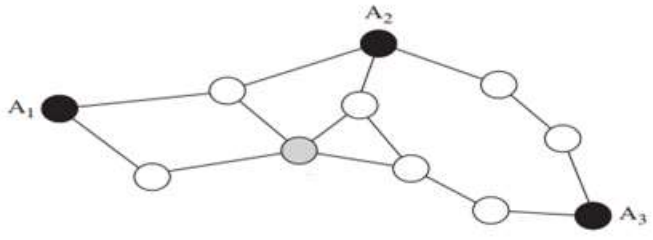
Vehicular Network:

The check point motes are also connected to the closest Roadside unit. The Roadside units are used to raise alerts about the leakage in pipeline by raising an alarm. The Roadside units will co-ordinate to ensure that the alerts are also sent to the vehicles so that vehicles can be stopped from coming to the area. Assume that Roadside units are enabled using 802.11p standard and are placed at a distance of 500m.

(j) Mention the effective strategy of disseminating/routing the alert messages so that the vehicles can be prevented from reaching the area with gaseous leakage and divert the traffic effectively. Write assumptions if any. Also, you have to also ensure that old information should not be circulated in the network.

(k) What will be the network architecture of the checkpoint motes? **[14M]**

Q.2. The network set up for fire monitoring in an agricultural field has three anchor nodes, A1, A2, and A3 spread across around 500m x 500m field.



Initially, the data was routed to the sink/root node A3 through the shortest path by using coarse-grained distance estimation. Assuming that the nodes are later on enabled with 6LoWPAN and more nodes are air-dropped into the system. Nodes are then reconfigured using over-the-air programming to use RPL protocol for routing. You are expected to route the information by maximizing the lifetime of the network at the same time by avoiding network partitioning. Identify the strategies to maximize lifetime of network and prevent network partitioning while routing. Formulate two objective metrics (write equations) for RPL when used together will maximize the network's lifetime and avoid network partitioning. **[3M]**

Q.3. In a large-scale agricultural farm, you are planning to utilize different methods of routing strategies or protocols such as flooding, proactive routing, reactive routing, SPIN, directed diffusion based on the requirement. For each scenario given below (a-c), mention the most suited routing strategy/protocol. Also, mention the type of medium access protocol- contention-free, contention-based, or hybrid suitable for the following scenarios. Consider each scenario as independent of other scenarios. **[3M]**

(a) To Inform the base station about a fire in a particular section of the farm

(b) A cluster head has collected some data which may be of interest to the other cluster heads and is willing to pass on the information on demand

(c) To send configuration messages to the nodes in the farm (e.g.: the base station may want to transmit the threshold values for various parameters e.g.- soil moisture level, such that the nodes may transmit the information, provided their recorded parameters by the nodes are above a certain value). Configuration messages will be sent at an interval of 8hours.