Project

- Students are expected to form teams with not more than 4 team members
- Students can attempt either 1 of the problems given below or select a problem of their own (submit the problem statement to IC for topic approval).
- Mention the team member details in the excel sheet on or before 15th November 10 am. https://docs.google.com/spreadsheets/d/1F7X7vHKG5MFeGW8lyrf5x6zF20APwZrjp5yQNiKGGlk/edit?usp=sharing
- Teams will be given a chance to discuss the problem with IC (maximum two times) between 17th Nov -21th Nov, 6-7 pm. Students are expected to seek an appointment for the same
- Deadline Nov 27th-11.59pm
- The simulation will be evaluated for 4 marks, Design -11 marks (Scope of simulation can be discussed with IC).
- Students are allowed to expand the problem statements – However, the requirements mentioned in the problem statement should be achieved.
- Mention assumptions if any while submitting the solution.
- Submission should have-
    - On paper design & Analysis- PDF
    - Simulation – A folder containing –
        - PDF with Objective, Observations, results
        - Code
        - Video - demonstration

Problem 1: Smart Energy Management System

A networked embedded system has to be designed for energy management in a particular locality of interest. In the locality, there are two types of buildings- buildings under be construction (Smart buildings) and buildings which are to be "retrofit" to make them "smart". The objective is to design a networked system to monitor the energy consumption, generate methods to reduce energy consumption, and then control the devices (on/off/finer control of appliances) in the buildings to reduce energy consumption without causing discomfort to the users. [You are not required to develop the algorithm to reduce energy consumption- Type of data to be collected, network design for the same and network design for controlling the appliances should be the focus)

Characteristics of buildings (which are to be "retrofit" to be made smart)

These are 5 apartments that are to be monitored. Each apartment has 12 levels, each level with 5 houses. Each house has 7 rooms. Each room has 6 devices that are retrofitted to be smart. There is a home level controller, which aggregates data from the individual devices in the house and there is also one controller/level (level controller) for the apartments. In addition to this, there is an apartment level controller, which will aggregate data from the level controllers. The apartment level controller communicates with a central controller which monitors the energy consumption of smart buildings and provides recommendations for energy-efficient usage. The devices, home level controllers, and level controllers support only wireless communication. More devices may be included in the system in the future.

Characteristics of smart buildings

These buildings are to be constructed to be smart and the buildings have single levels. Such 10 buildings are to be monitored. Each building has 7 rooms, with each room having 6 devices. Wired or Wireless communication can be used for the same.

The system has to be fault-tolerant and reliable. The central controller is common for the smart buildings and the buildings to be made smart.

Answer the following questions- You are requested to read all the questions before attempting the answers.

a. Identify the various traffic patterns (periodic, event-based, query, etc)

Network for buildings (which are to be made smart).

b. Select a standard or set of standards that you will utilize for the wireless network. Provide valid justifications for the choice.

c. Mention with reasons if wired or wireless communication is preferred for the communication between house level controller, apartment level controller, and the central controller. Based on the analysis mention how is communication established with the home controller, level controller & apartment controller

d. Describe if time synchronization is required. Which node will be the master node here? Describe the synchronization process.
e. Is localization required? Justify the answer. If required suggest the method of localization
f. Discuss the MAC protocol required for the application. If the selected standard defines a MAC protocol(s) (which you will be utilizing) mention the same.
g. Discuss the routing protocol(s).

Network for smart buildings
h . Mention the networking scheme for the building.

For the complete system
i. Mention the addressing scheme for the devices.
j. Which layers of the OSI scheme are implemented
k. Show the complete network architecture including the buses and gateways.
j. Is the architecture scalable? Provide your comments. How will you make the same scalable?
k. What are the security vulnerabilities you may have in this system?
l.What are the performance metrics (as far as the network) is concerned?

Problem 2: IoT based Geriatric Health Care System.

This comprehensive system should include the following nodes

1. End-device(s) or nodes-worn by the elderly
2. Static nodes mounted in the building
3. Mobile robot.

The system should perform the following functions

1.
   a. Sensing of vital body parameters of the elderly.
   b. Analysis of sleep patterns of the elderly.
   c. Fall prediction/detection using multi-modal analysis.
   d. Context-based (health record, age, weight, gender) identification of abnormal health conditions.
   e. Alerting the concerned person (such as caregiver, physician etc.,) regarding any abnormal condition.
   f. Providing Alerts for medicine
2. Remote access of recorded data from the end device by the authorized personnel.
3. Indoor Localization System to locate the elderly person in the case.
4. An interactive mobile robot-assisted monitoring system for elderly care. This is aimed to assist the elderly to live independently at home for a longer duration without feeling isolated or lonely thereby increasing their quality of life. A proto-type buddy robot which is a robot on wheels, about half the height of an average man, with a steel pole for a body and a video camera for ahead will be developed. The robot will also serve as a mobile coordinator node. The robot will be capable of performing user identification and location, indoor localization, and navigation.
5. The robot can be controlled remotely via the internet. Family members, caregivers, or clinical practitioners can establish a connection with the robot via a secure internet connection. Once the connection is established, the robot will locate and navigate towards the user and the authorized personnel can virtually visit the elderly. In case of any abnormal health condition, the remote observer can view the patient, and aid till care reaches the person. This can bring down the cost of travel, hospital admissions, and prolonged nursing homestays. It provides a better opportunity for the elderly to live in their own homes longer. The buddy robot can be configured to serve multiple users. 6. Once an abnormal condition is identified by the vital signal monitoring unit, the concerned people can activate the buddy robot remotely to locate the person and a live feed of the elderly person will be made available. The medical practitioner will also be able to observe the elderly person through the buddy robot via the multimedia feed from the video camera. This will reduce the delay in deciding the medical services to be given to the elderly.
7. Data from the wearable unit is periodically uploaded on the cloud and predictive analysis of future health risks can be identified.

Questions to be answered:

(a)Draw a complete deployment diagram –showing where the nodes are to be placed, assumptions regarding the placement, type of nodes other than those mentioned (required if any- say there can be cluster head node with heterogeneous capability than the static nodes) how are they are mounted/placed.

(b)What are the performance metrics (as far as the network) is concerned?

(c)Mention the various communication standards or customized communication stack used for the interconnection between different kinds of nodes. [eg: Zigbee for communication between the type of node x and node y or 802.15.4 with custom network layer or 2.4Ghz radio with customized stack and so on]

(d) Draw the complete network architecture indicating the different types of nodes, the communication standard, gateways, and router required if any. How do they connect to the internet?

(e)How and where will the data be converted to knowledge?- example- how do you decide that the person is in danger, how do you decide as to when and where will the alerts be produced for medication?

(f)What are the restrictions and challenges designing the network for the system?

(g) Decide the relevant protocols for

- time synchronization
- localization
- Medium access control
- Routing

If you are using customized protocols- mention the need for the same. Identify if the selected protocol satisfies the performance metrics.

h. Mention the addressing scheme for the devices.

i. Which layers of the OSI scheme are required to be implemented

j. Is the architecture scalable? Provide your comments. How will you make the same scalable ?

k. What are the security vulnerabilities you may have in this system?