Exercise 4: Design your own IoT system
Learning outcomes assessed: LO1, LO2, LO3 & LO4

1) Propose your own IoT system for a specific application. This must not be a close version of any of the systems described in this coursework. Give a detailed description of the functionalities of your system.
2) Give a detailed critical literature review of existing related systems with clear references, and demonstrate the novelty of your proposed system. **600 words excluding references**.
3) Identify and justify the technologies needed for the implementation of the proposed IoT system.
4) Implement your system in Packet Tracer. **You must submit the pkt file together with your coursework.**
5) Give the simulation in Packet Tracer (**screenshots**) of the main functionalities of your system.
6) Identify and justify the data analytics and visualisation techniques that apply to your proposed system.

Exercise 5: Modelling and Analysis
Learning outcomes assessed: LO1 & LO4

A Simple Infostation-based Communication System

An infostation system is an infrastructural system concept that provides *many-time*, *many-where* wireless data services. This case study is a simple context-aware infostation-based system, which allows users to exchange **text messages** using mobile devices such as laptops, smart phones or tablet computers. Typically, an infostation system comprises one central *infostation centre* (ISC) and many wireless access points, called *infostations* (ISs), deployed at key positions to maximise coverage. The ISs are physically connected to the ISC via network cables.

In this example we consider a university that has 2 campuses A and B. Each campus has its own infostation system (with one ISC and many ISs). The ISCs of the 2 campuses are physically connected by cables to a network *hub* to enable users located at different campuses to exchange messages, as depicted in Fig. 3.

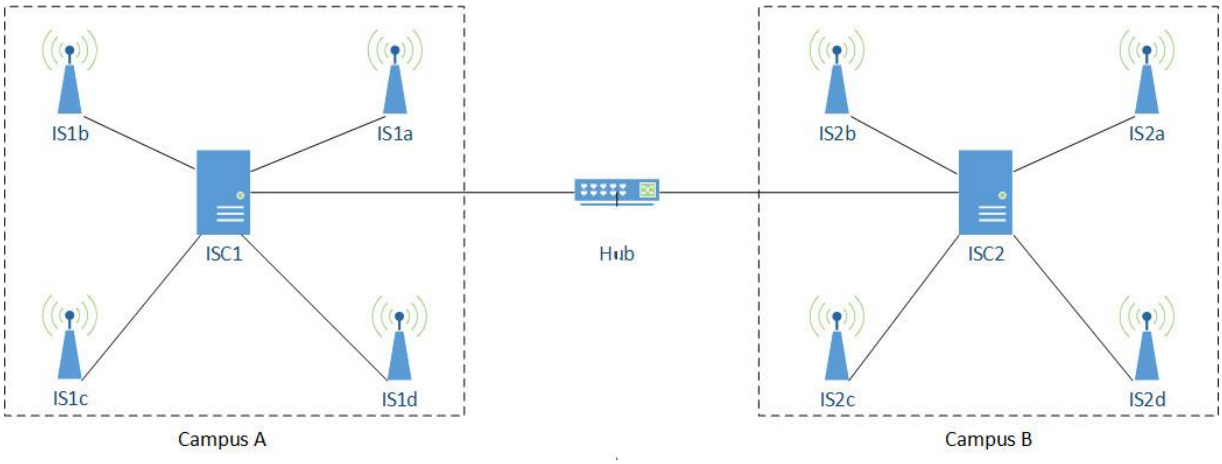

Fig. 3: An infostation-based communication system

An infostation is aware of any mobile device within its range and is able to interact with the device, e.g. by exchanging messages. A user within the range of an infostation can send or receive text messages using a mobile device. For the sake of simplicity, we assume that a text message has the following format: (sender, recipient, message). E.g. send(bob, alice, hello) means **bob** is the sender, **alice** the recipient and **hello** the message.

Once an infostation receives a text message, it checks if the recipient is within range in which case it forwards the message to the recipient. If the recipient is not within the range of that infostation, the infostation forwards the message to the infostation centre it is connected to.

An infostation centre is aware of all the infostations connected to it and subsequently of all the devices within the ranges of these infostations. However, an infostation centre has direct communications only with the infostations and the network hub connected to it. When an infostation centre receives a text message from an infostation, it looks for the infostation where the recipient is located and forwards the message to this infostation. The infostation where the recipient is located then forwards the request to the recipient mobile device. If the recipient is not found in one campus, the message is forwarded via the network hub to the infostation centres of the other campus for delivery.

When the network hub receives a message from one ISC, it sends the message to the other ISC.

What to Do

You are required to model the Simple Infostation-based Communication System in the *Calculus of Context-aware Ambients (CCA)* and to analyse this model using the CCA simulator *ccaPL*. We assume there are four ISs and one ISC in each campus, named as in Fig. 3 (IS1a, IS1b, ...) and two user mobile devices (Bob's and Alice's). Each of these entities and the network hub can be modelled as an ambient in CCA. We say that a user's mobile device is ***in the range*** of an infostation IS if the ambient modelling that mobile device is a child ambient of the ambient representing the infostation IS.

Answer the questions 1) to 8).

Modelling

1) Give a ccaPL specification of the ambient modelling the infostation IS1a.
2) Give a ccaPL specification of the ambient modelling the infostation IS2a.
3) Give a ccaPL specification of the ambient modelling the infostation centre ISC1.
4) Give a ccaPL specification of the ambient modelling the infostation centre ISC2.
5) Give a ccaPL specification of the ambient modelling the network hub.

Analysis

Assume Bob is initially in the range of the infostation IS1a in the Campus A. He then moves from IS1a to IS1d, sends a hello message to Alice, and finally moves to IS1c. In the meantime, Alice is in the range of the infostation IS2b in the Campus B, but on the move to IS2c and then to IS2a. She will receive Bob's message at some point during this journey. For simplicity, it is assumed that a single ambient called bob represents Bob and his mobile device. Similarly, Alice and her mobile device are modelled as a single ambient **alice**.

6) Give the specification of the ambient representing Bob's mobile device.
7) Give the specification of the ambient representing Alice's mobile device.
8) Give the simulation results of the system for the scenario described above. These results must include: (i) the listing of the execution output; (ii) the corresponding communication graph; (iii) the corresponding behaviour graph; and (iv) a clear explanation of the execution output. (4x1.5% = 6%)