Wireless Networks (18COP531) Coursework Specification

This coursework represents 60% of the module assessment

Title: Building an Ad Hoc Wireless Sensor Network

Lecturer: Professor Shuang-Hua Yang (S.H.Yang@lboro.ac.uk)

The coursework will be set in Week 14, the demonstration will be carried out on Friday in Week 15, and the report must be submitted via LEARN before the deadline specified. You need to form a group with 4 or 5 students. Each group is required to submit one coursework ONLY.

Task:

In this coursework, you are required to build an Ad Hoc wireless sensor network by developing and implementing a light-weight routing protocol on the provided hardware platform (four or more sensor nodes and a PC with a programming environment). The development can be split into two stages:

Stage one: You are required to design a protocol stack for achieving data transmission between a source node (device) and a destination node (device) in an Ad Hoc wireless sensor network. The wireless sensor network consists of six sensor nodes where the data packet sent by the source device could take one, two or more hops to reach the destination device. Your stage one protocol design simply implements a route discovery mechanism to find any possible paths from the source device to the destination device.

Stage two: You need to design and implement a routing algorithm to choose an appropriate path from the ones obtained from Stage one, which satisfies certain requirements defined in the following specification. Meanwhile, the impact of the dynamic change of the intermediate nodes to the route should be displayed.

The designed sensor network must have the following specifications:

- The network accommodates six sensor nodes. For instance, one sensor node acts as the source device, another one as the destination device which connects to the PC, the remaining three sensor nodes act as the intermediate nodes responsible for relaying data packets.

- A temperature sensor and a voltage sensor are equipped on the source device. The measurement of temperature and voltage should be read on a regular basis (e.g. every 2 seconds). The gathered information is required to be sent to the destination device through the designed Ad Hoc wireless sensor network.

- In order to achieve a robust, sustainable, and reliable wireless sensor network, an appropriate routing algorithm should be designed and implemented in this course work. The routing algorithm should allow the source device to decide the next hop of the transmission by analyzing the route response received from the intermediate nodes. The route response information includes the number of hops from the destination node, battery level (voltage sensor) and Radio Signal Strength Indication (RSSI) of the intermediate nodes. These three measurements have different priorities defined in the following further information, and must be taken into consideration in the design of the expected routing algorithm.

- The destination node, namely coordinator, connects to a computer to display the received messages. The message should indicate the nodes on the route selected in the implementation of the relay task.

Further Information:

All the wireless sensor nodes provided are equivalent in hardware, which means each of them is capable of sending, receiving, and processing messages. When a router discovery mechanism is implemented, the source device will broadcast a route request to its neighborhood. The nodes which receive the route request will re-broadcast the request if it is not the desired destination device. If the destination device receives the request, it will send back a response toward the source device. Therefore the route from the source device to the destination device can be established. This router discovery mechanism is actually a simplified AODV (Ad hoc On Demand Vector) routing algorithm.

The lifetime of the whole network is critical and should be considered in the design of the wireless sensor network. As indicated in the specification part, the battery level, and RSSI of the intermediate node will be gathered along with the number of hops travelled from the destination node and sent to the source device. The source device analyzes the information, selects the most appropriate sensor node as a router to relay the data packets and therefore perform multi-hop routing if necessary. The routing algorithm should be designed as the node with a lower number of hops and a higher RSS is regarded as a better selection. In this coursework, the criterion (route index) used in the routing is that

the route with the maximum value of the average of intermediate node RSSI levels per hop is chosen, i.e.

route index = $\frac{\sum_{i} RSS_i}{N \times H}$, where RSS_i is the i^{th} intermediate node RSS level, N is the number of the intermediate nodes and H is the number of hops from the source node to the destination node on the route.

Testing Functions:

Use the sensor nodes provided to establish a multi-hop wireless sensor network to demonstrate the following four functions:

1. The temperature reading and the battery level of the source device should be read, reported, and displayed regularly in all the nodes over which the readings are transmitted.

2. The temperature reading and the battery level of the source device should be read, reported, and displayed on demand, for example, every time when pressing a button in the source device.

3. The destination node connects to a computer to display the received message, which includes the temperature reading and the battery level of the source device, the nodes on the route selected to implement the relay task, and the corresponding route index.

4. By changing the conditions of the intermediate node, the source node will be notified by the route response and change the next hop selection correspondingly. The change can be achieved by: 1) changing the position of the intermediate node

(change RSSI), and 2) Changing the battery level by switching off the power (simulate the energy consumption). The output message from the destination device should indicate the change of the intermediate node selected.

Method of Presentation

1. A formal design report including but not limited to design method, routing principle, the flowchart of the system, description of the source code, and reference etc.

2. The program test procedure, results (screenshot) and analysis to prove that your routing algorithm is fully (partly) working and can reflect the change of the intermediate nodes selected.

3. The submission package including all C source code, binary file, and design document, should be submitted via LEARN.

4. Demonstration of your wireless sensor network in the lab.

Marking Scheme:

Design report: 20%

Demonstration: 10%;

Function	**Fully working**	**Partly working**	**Not working**
Function 1	10%	5-9%	0-5%
Function 2	10%	5-9%	0-5%
Function 3	16-20%	5-15%	0-5%
Function 4	26-30%	5-25%	0-5%