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Lastname _____

Student number

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Ubiquitous Computing academic year 2012-2013

Rules

- This is a closed books exam.
- The operation of any electronic device is prohibited (e.g. no calculator, phone or PDA).
- Answer the questions being *precise, complete, and formal*.
- Write as *clearly* as possible, both in terms of handwriting and wording.

Questions

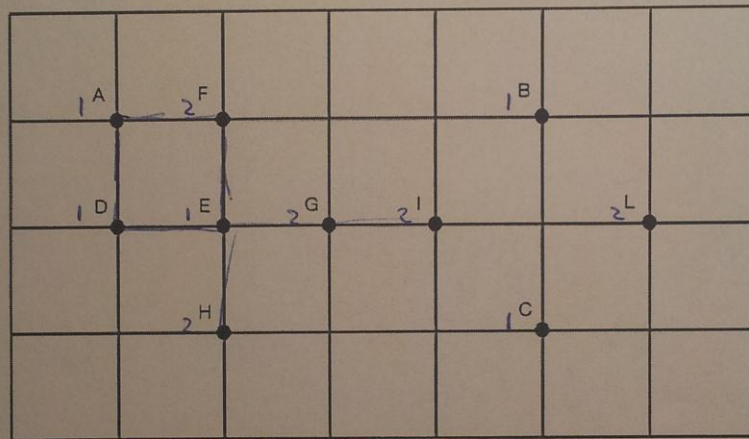
1. Consider the systems listed below. State what types of context each system recognizes, state whether these are primary or multi-sensor context, and finally categorize each system into contextual information, contextual commands, or context-triggered actions:
 - (a) A GPS client;
 - (b) An ocean-monitoring float from the Argo system (discussed in the lecture on Wireless Sensor Networks);
 - (c) The Xerox ParcTab pilot from '94;
 - (d) A self-driving car;
 - (e) The Google Maps app on a smartphone;
 - (f) A smart thermostat;
 - (g) The (Android) Llama Location Profiles app (discussed in the lecture on Context Awareness).
2. List the important performance factors relevant to a localization system, and briefly define each. Sort (approximately) the following localization systems by their accuracy:
 - (a) A system localizing people using chair pressure sensors;
 - (b) The (public) GPS system;
 - (c) A system locating objects using Radio-frequency identification (RFID) tags;
 - (d) An indoor localization system based on UltraWideBand (UWB);
 - (e) The Google Maps localization system (when based only on WiFi and GSM signals).
3. Describe the differences between Android and Linux, in what concerns:
 - (a) Kernel composition;
 - (b) Application permission checking; and
 - (c) Application development (e.g., the programming language, and how the application accesses kernel services).

4-5. A wireless sensor network is formed by two types of motes:

Motes of Type 1 have a battery with a capacity of $1 A \cdot h$, they can transmit a message with power $10 dB$ consuming $26,7 mA$, with power $-20 dB$ consuming $5,3 mA$, and receive a message using $9,2 mA$.

Motes of Type 2 have a battery with a capacity of $500 mA \cdot h$, they can transmit a message with power $10 dB$ consuming $20 mA$, with power $-20 dB$ consuming $4 mA$, and receive a message using $7 mA$.

With the power of $10dB$ the messages can travel 30 meters, with the power of $-20 dB$ the messages can travel 10 meters. The wireless sensor network is composed of 10 motes, which are laid on a grid as shown in the figure below. Each square in the figure has an area of $100 m^2$. Motes A, B, C, D, E are of Type 1; and F, G, H, I, L are of Type 2.



Handwritten notes on the right side of the page:

1: 1Ah
 30m - 26.7
 10m - 5.3
 rec - 9.2

2: 500mAh
 30m - 20
 10m - 4
 rec - 7

1:
 30 + rec = 35.9
 10 + rec = 14.1

2:
 30 + rec = 27
 10 + rec = 11

1. Topology: what is the full communication graph of the WSN, i.e., an edge for any two nodes that can directly communicate with each other? Either draw the graph, or list the edges.
2. Topology control: what is the controlled graph by applying the Relative Neighborhood Graph approach (edge iff minimal distance between two nodes)? Is it a spanning tree of the original graph?
3. Topology control: give a dominating set for the graph starting from node E.
4. Routing: how can A discover a route to L using a flooding approach?
5. Routing: What is a route from A to L that minimizes the energy necessary to send one message (explain the answer)?
6. Routing: What is a minimum battery cost route from A to L (explain the answer)?
7. Routing: Assume that all batteries are fully charged and that A sends a message to L every minute. No other events take place in the network. Using the routing approach of Point 5, when will the network stop functioning due to battery depletion?
8. Routing: Assume that all batteries are fully charged and that A sends a message to L every minute. No other events take place in the network. Using the routing approach of Point 6, when will the network stop functioning due to battery depletion?
9. Topology: If all nodes just use the low power communication ($-20 dB$) what is the communication graph?
10. Topology: Is the graph connected?