ECE6615: Sensor Networks
Spring 2015
Mid-term Exam: March 11, 2015

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Instructions

- Put your **CODEWORD** next to your name in **EACH PAGE**!!!
- Open book exam (everything allowed except laptops, ipads, electronic devices, and cell phones, any communication devices).
- Duration: 75 minutes.
- Each question has 25 points.
- Answer the questions **RIGHT TO THE POINT**.
- Avoid long explanations; couple sentences will be enough as long as they are correct!!
- **All answers for Question 1 must be given on the Question sheet. All answers for Questions 2, 3 and 4 must be written on the provided blank pages.**

QUESTION 1. LAB ASSIGNMENTS

1. What is TinyOS?

2. The command to install an application to a sensor mote is
   a. micaz install, 1 mib520,/devttyUSB0
   b. make micaz download, 1 mib520,/devttyUSB0
   c. make micaz install, 1 mib520,/devttyUSB0

3. You can install two applications to a sensor mote at the same time.
   a. True
   b. False

4. An application is composed of two main files, the application configuration file (AppC) and the module code (C). The components are "wired" in module code.
   a. True
   b. False

5. All the interfaces used in an application are declared in the module code.
   a. True
   b. False

6. If you take the batteries out of the sensor mote, the application that you installed is erased.
   a. True
   b. False

7. When the sensor mote is connected to the programming board, the Leds on the programming board shows both the status of the mote programming and the value shown on the sensor mote's Leds.
   a. True
   b. False

8. Sampling frequency of the sensors on the mote is NOT adjustable by the application.
   a. True
   b. False

9. What was the approximate range of the micaz sensor board that you measured during Lab Part2?

10. In which frequency band micaz sensor motes work?

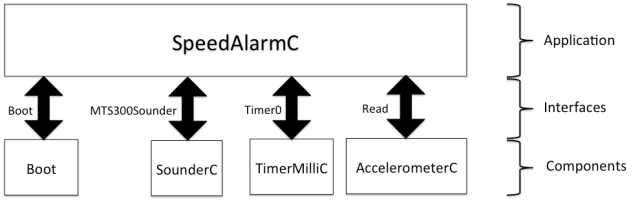
11. A simple application configuration is given below for the application SpeedAlarmApp which periodically senses the acceleration, calculates the speed and if the speed is above the limit it gives an alarm signal using the sounder. Complete the code using the architecture of the application given in the figure.

```
**************************SpeedAlarmAppC.nc**************************
configuration SpeedAlarmAppC {}
implementation {

  components MainC;
  components                          // ADD YOUR CODES HERE




}
*********************************************************************
```



12. The following code of a module and two interface definitions contains some errors. Mark the errors directly in the code and add a short comment indicating what is wrong (e.g. missing return value).

**********SnowAlertC.nc**********

```
module SnowAlertApp{
        provides {
                interface Control;
                interface Detection;
         }
}
implementation{
        uint8_t holiday;
         result_t Control.init(){
                holiday = 0;
                return SUCCESS;

 }
        call void MeasureSnowAcc(){
                 return holiday;
         }
        call result_t Detection.SnowFall(){
                holiday=1;
                return SUCCESS;
         }
}
```

********** Detection.nc **********

```
interface Detection {
        command uint8_t MeasureSnowAcc ();
        event result_t SnowFall(); }
```

********** Control.nc **********

```
interface Control {
        command result_t init();
        command result_t start();
        command result_t stop(); }
```


QUESTION 2. PHYSICAL LAYER

Consider a chain topology of 5 nodes where inter-node distance is 15m. End-to-end packet error rate of 10^(-2) is required for an application. State any assumptions you make.

a) Assuming independent and identical errors at each hop, except that the first hop has a packet error rate of 10^(-3). What is the required packet error rate for the other hops?

b) For a packet size of 50bytes, and independent and identical bit errors, what is the required bit error rate at the first hop?

c) For a sensor mote that uses 2-FSK modulation, what is the required bandwidth to support SNR=10 dB and the data rate of 100kbps? Use the bit error rate from part b).

d) Consider a log-normal shadow fading channel model with (X=-6dB). At SNR=15 dB and transmit power of 0dBm, what is the maximum path loss exponent that can be accommodated to guarantee the error requirement? Assuming PL(d=1m) = 50dB, and the noise power Pn=-105dBm.

QUESTION 3. ENERGY MODELING, MAC LAYER, ERROR CONTROL

a) What is the relationship between Energy Consumption and Packet Size?
b) In the version RTS-CTS-DATA-ACK version of the CSMA/CA, can the data communication of participants collide? If yes or no, explain the reason.
c) What is the role of NAV?
d) How is the LATENCY problem partly solved in S-MAC?
e) Why is the CCA (Clear Channel Assessment) algorithm introduced in BMAC?
f) How does Z-MAC take care of the possible waste of time slots of the owners who do not have packets to transmit?
g) Why would you not use ARQ protocol for error control in WSNs?

QUESTION 4. ROUTING LAYER

a) What is the routing metric for all routing algorithms we handled in the class?
b) Why was SPIN EC introduced?
c) Why is the Energy consumption in case of Directed Diffusion without Negative Reinforcement higher than the Directed Diffusion with Negative Reinforcement?
d) What type of MAC protocol can be used with the LEACH routing algorithm?
e) Are the clusters of LEACH fixed during the lifetime of WSNs? Why or why not?
f) What is the major criticism of Geographical Routing algorithms?