ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Distributed Computing

HS 2010 Prof. Dr. Roger Wattenhofer, Philipp Sommer, Johannes Schneider

Ad Hoc And Sensor Networks
TinyOS Lab Exercise

Assigned: October 18, 2010
Due: December 24, 2010

1 Exercise Setting

This is the hands-on exercise where you will learn how to program a sensor network. In particular, you will develop applications for the TinyNode sensor node using the TinyOS platform. To spread the project workload it is possible to do this exercise in groups of up to three people. Since special hardware is required we provide a workplace. We installed an online reservation system on the course website to facilitate lab management and to guarantee you a free workplace upon reservation. The key for the lab has to be picked up at our office (ETZ G64.1) when your lab slot starts and must be returned after work. The exercise is due by the end of the semester. Nevertheless, it may be wise not to defer the work for too long since the lab schedule might be quite tight towards the end of term. Once you finished the exercise, you will present us your achievements and send us all relevant files by email.

You will use the TinyOS plug-in for Eclipse to develop your applications. An introduction on how to build a TinyOS project inside eclipse can be found at `http://tos-ide.ethz.ch/`. To get familiar with the TinyOS 2.x platform we strongly advice you to first work through the short TinyOS tutorial (*'Getting Started with TinyOS'*) which is available on the course website. Please read through the tutorial at home such that you do not waste time in the lab.

Once you have done the tutorial you are ready to develop your own program. Below, two applications are described. As a guideline, the first one is easier. However, the second one is a bit more challenging but also more fun (who would not want to have a Morse telegraphy enabled sensor node :-)). For both applications code skeletons are provided. You are expected to be able to successfully implement at least the first one.

The lab computer is equipped with all needed software. We installed the Eclipse plug-in for TinyOS and created projects including skeletons for all the applications. We maintain a FAQ linked from the course website. If your questions are not already answered there feel free to ask one of us personally or via mail.

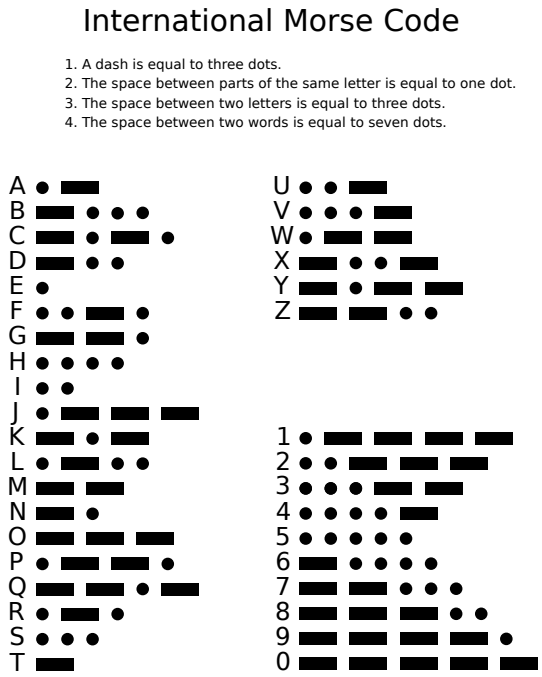
Submission:
Once you have finished the exercise, we ask you to export a copy of your workspace to a zip-file and send it by mail to Philipp Sommer (`sommer@tik.ee.ethz.ch`).

2 Application 1: Light Sensing

The *Light Sensing* application setup consists of two sensor nodes. Node A measures the ambient light intensity. Node B is used to visualize any intensity change by its LEDs. Therefore, A is sampling the light sensor periodically and broadcasts the corresponding value over the radio. On successful message transmission the green LED is toggled. In case of a transmission failure A turns on all LEDs. Node B listens for these messages. It then compares the current sensor reading with the last received value. If the light intensity change is within a given threshold the yellow LED is set. If the new intensity is getting lower the red LED is set. If the intensity is increasing the green LED is set. The code skeleton for node A is in the SensingSender Project. The files for node B can be found in the SensingReceiver Project. Note that the return value of a sensor reading is in millivolt. The output provides voltages from 0 mV (complete dark) up to around 1200 mV (direct sunlight).

3 Application 2: Morse Telegraph

For this application you are supposed to implement a Morse telegraph. As with the Light Sensing application the *Morse Telegraph* also uses two sensor nodes. The goal of this exercise is to transmit simple text messages from node A to node B using infrared light. Using a Java GUI the user enters a message. The message is first translated to the Morse alphabet and then the PC instructs node A to switch on or off the infrared LED according to the Morse codes. Node A's red LED is switched on or off simultaneously with the infrared LED so that we can see that the system is working correctly. Node B continuously samples the voltage at the infrared receiver, decodes the transmitted characters, and writes them on the serial port. Using `cutecom`, a standard terminal application connected to the corresponding serial port, you can see the result of your transmitted message (the TinyNode operates at a baud rate of 115200 and without flow control enabled). You will have to implement the receiver. That is, you will develop node B's code based on the given Skeleton (MorseReceiver project). The Java program on the PC and the code for node A (MorseSender project) are provided by us. The Java GUI can be started by typing `java -jar Morser.jar` in the shell.



4 YETI - An Eclipse Plug-in for TinyOS

During the lab exercise you will work with YETI, an Eclipse plug-in for TinyOS developed in our group. Documentation about the plug-in is available at the project website at `http://tos-ide.ethz.ch`. If you are already familiar with Java development in Eclipse, working with YETI is easy. However, due to the way the TinyOS toolchain works compiling and running your applications is really different than in Java.

4.1 Compiling, Installing and Running TinyOS Applications with YETI

On the lab PC two make options are configured for each TinyOS project as shown in Figure 1:

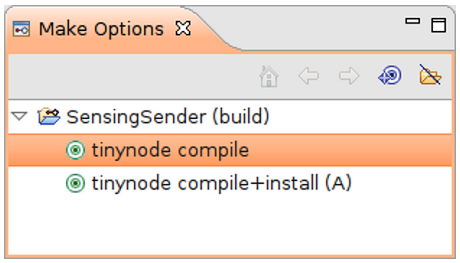


Figure 1: Screenshot of the *Make options* dialog in YETI.

- **tinynode compile**: Compiles a TinyOS application into a binary image for the TinyNode platform
- **tinynode compile+install**: Compiles an application first and then writes the binary image into the program memory of the corresponding TinyNode (A or B).

After a new binary image is written to the TinyNode, the node reset itself and starts to execute the new image. The node can also be reset by pressing the reset button on the TinyNode extension board.

Please note: Writing applications to the node is done using the serial port (UART) of the TinyNode. Therefore, installing a new binary will fail if the serial port is already in use (e.g. by the `cutecom` terminal application). Please close `cutecom` before trying to install a new binary to the node.

4.2 Hyperlinks to Interface/Function declarations

Eclipse provides *hyperlinks* to the declaration of an interface/function. Hold down the `CTRL`-key and navigate with the mouse over a function belonging to an interface or a global variable. When you click the left mouse button, Eclipse will jump to the file where the interface/function is defined.

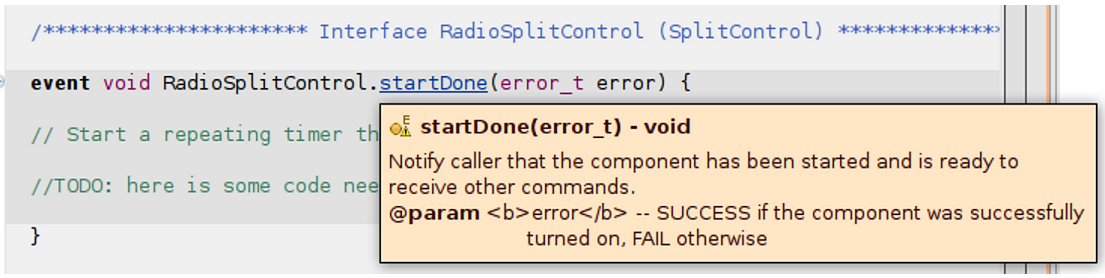


Figure 2: Tooltips and hyperlinks for interface/function declarations in Eclipse.