CS4222/CS5422
Semester 2, 2021/2022

Assignment 1

Programming the SensorTag
CC2650 with Contiki

Total Marks: 15 (3% weightage for CS4222/CS5422)

This is an **INDIVIDUAL** assignment.

1   OVERVIEW

In this hands-on assignment, you will learn how to setup your computer system to be able to compile and run program on your TI SensorTag CC2650. The latter is a programmable device with 10 sensors, including light, digital microphone, accelerometer, gyroscope, magnetometer, object temperature, and ambient temperature. Wireless networking support is provided with both ZigBee and BLE for Internet of Things applications.

The OS to be used is Contiki (https://github.com/contiki-ng/contiki-ng). Contiki is an open source operating system, initially developed by Adam Dunkels (http://dunkels.com/adam/). Now, Contiki is supported by a large community of developers. Apart from for supporting both IPv4 and IPv6, it also includes multiple low-power wireless standards. Moreover, it runs on multiple low-power devices, where the SensorTag is one of them.

2   Setting up your environment

2.1   *Windows User*

The environment setup guidance for windows users is given in the separated document

2.2   *Ubuntu User*

2.2.1 Installing Contiki OS sources

```
git clone https://github.com/contiki-ng/contiki-ng.git --recursive
```

```
sudo apt-get install gcc-arm-none-eabi
```

2.2.2 Install ARM GCC compiler

2.3 *Mac User*

2.3.1 Installing Contiki OS sources

```
git clone https://github.com/contiki-ng/contiki-ng.git --recursive
```

2.3.2 Install Xcode compiler

```
xcode-select –install
```

2.3.3 Install ARM GCC Toolchain

```
brew tap ArmMbed/homebrew-formulae
brew install arm-none-eabi-gcc
```

You can refer to this tutorial for further explanation: https://www.lewuathe.com/how-to-make-arm-cross-compilation-on-macos.html

You should be able to find the compiler eventually. You can make sure this by running:

```
arm-none-eabi-gcc --version
```

2.4 *Flash programmer (For Ubuntu and Mac User)*

You can download and install from:

Download: https://www.ti.com/tool/UNIFLASH#downloads click "Download options" then choose "UniFlash Linux Installer" or "UniFlash MacOS Installer"

2.5 *Using a Single Board Computer (LattePanda)*

If you are unable to install on either the Windows or Ubuntu platform, you can request for a single board computer (LattePanda) that has been installed with Contiki running on Ubuntu. For such request, send email to chanmc@comp.nus.edu.sg, with the subject "CS4222/CS5422: LattePanda).

3 *Running your first program*

3.1 Compiling

Go to 'hello-world' folder inside examples: ~/contiki-ng/examples/hello-world/

```
sudo make TARGET=cc26x0-cc13x0 BOARD=sensortag/cc2650
PORT=/dev/ttyACM0 hello-world
```

### 3.2 Flashing the SensorTag with the binary file

3.2.1 Open the **Uniflash** program

Make sure that your SensorTag is connected to your computer. Then based on your choice of flashing the SensorTag from section 2.2.3 (shown below in the Ubuntu VM provided), start the Uniflash application.
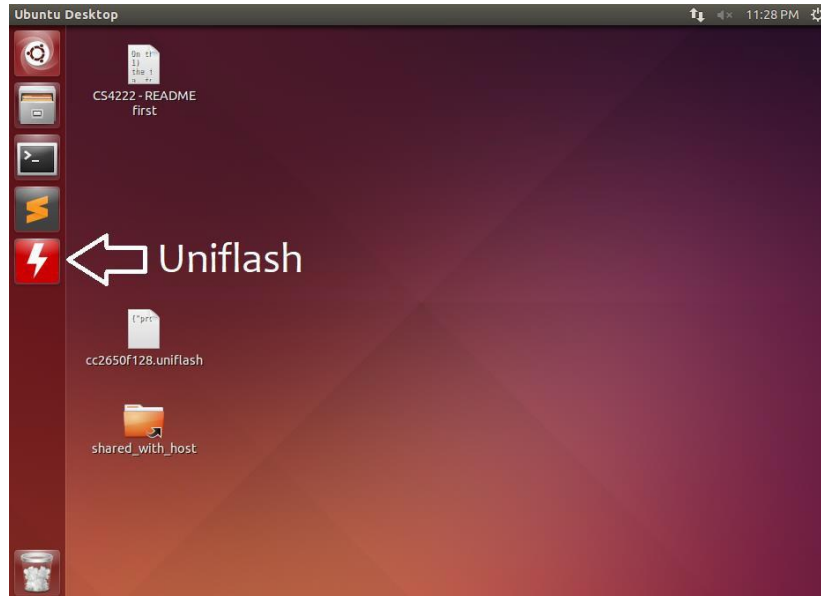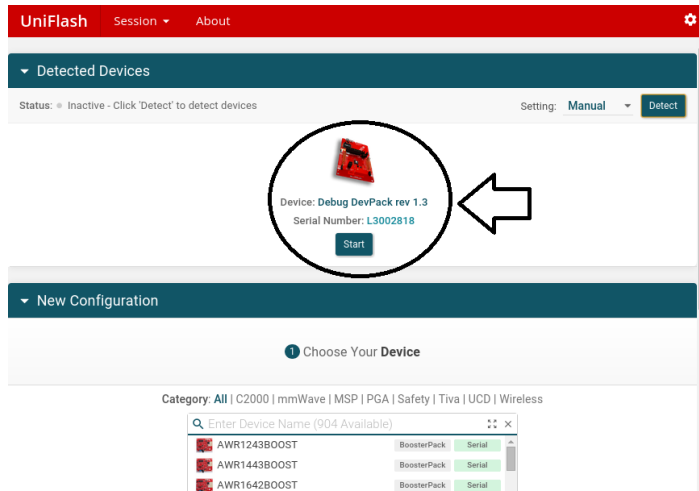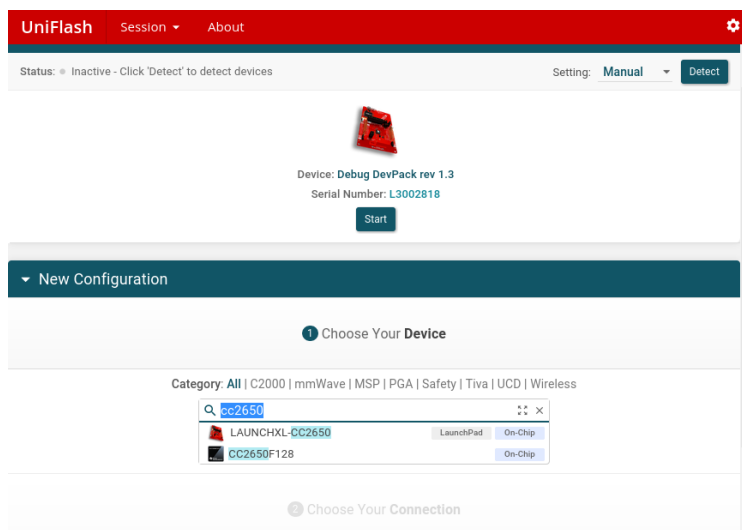

3.2.2 Session configuration

The first step is the SensorTag Debugger board detection. It starts with the **Auto** setting.
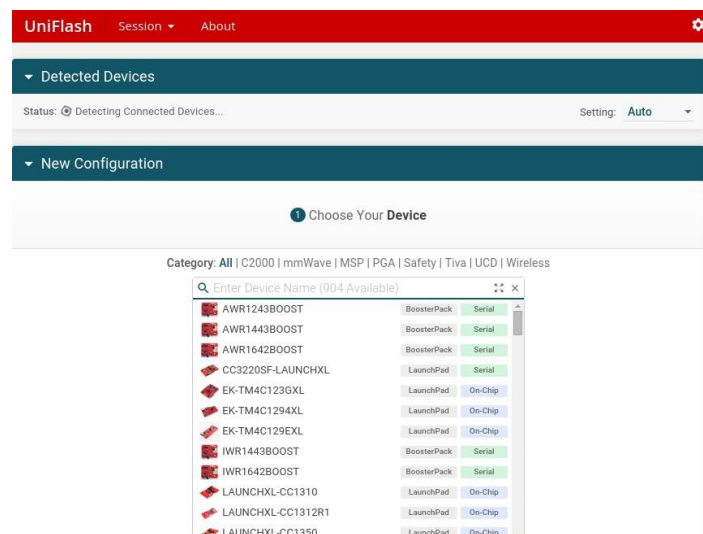
If your SensorTag Debugger board is not detected, change the setting to **manual** and click on **detect**. Wait until it is detected as shown below:
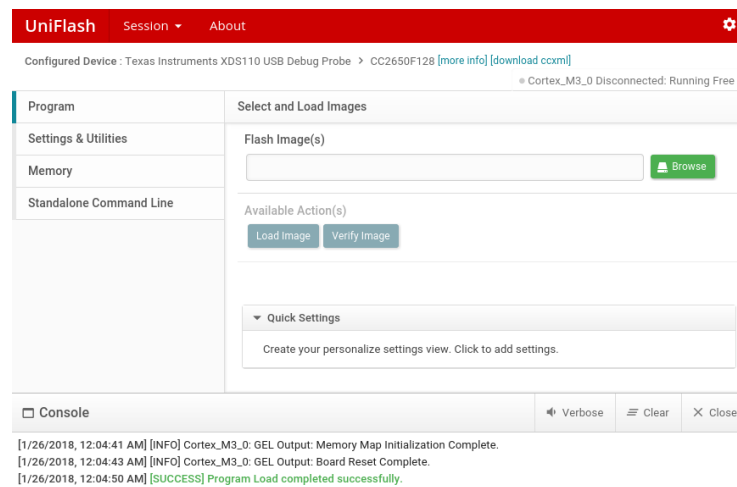
Next, choose your device by typing **CC2650** in the search field and select **CC2650F128**.
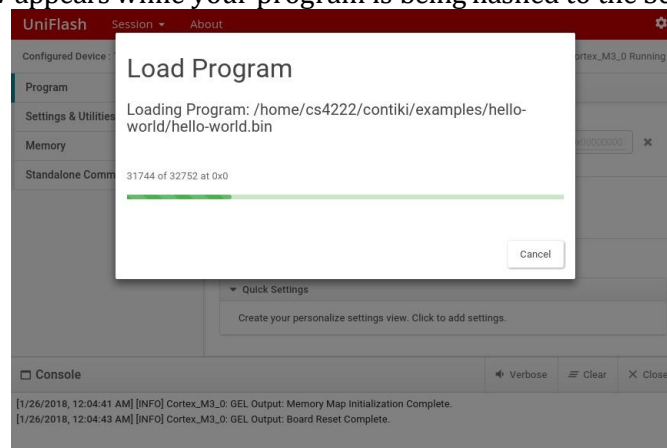

Next, choose the connection **Texas Instruments XDS110 USB Debug Probe** and hit the **Start** button as shown below.
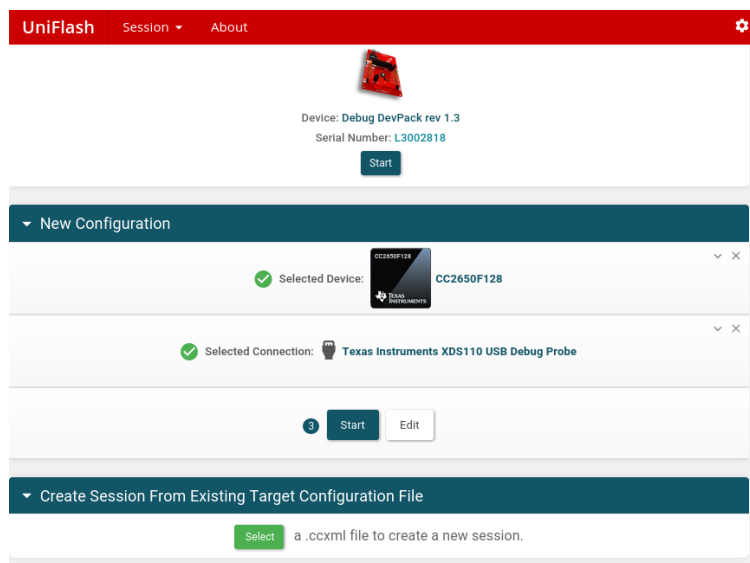
Finally, browse for the file generated from the compilation phase (**hello-world.bin**) and click on **Load Image**

The following window appears while your program is being flashed to the SensorTag:

If you get **error** during your flashing, the link below may be helpful:
https://www.zigbee2mqtt.io/information/flashing_via_uniflash.html
Basically you just need to go to step "Erase entire flash" and then continue with "Load image"

3.3   Reading the output from your SensorTag

Check your installation by reading output from the SensorTag over the USB link. In order to establish serial connection with your Sensortag, you can use serialdump/cat/… or any other application to read from the serial port of the SensorTag.

For Ubuntu or Virtualbox user you can try this:

```
cat /dev/ttyACM0
or
contiki-ng/tools/sky/serialdump-linux -b115200 /dev/ttyACM0
```

If *ttyACM0* doesn't work you can try *ttyACM1* or to make sure which usb's name belong to the sensortag, you can find this by run `ls /dev/ttyACM*`

For Mac user you can try this:

```
Contiki-ng/tools/sky/serialdump-macos -b115200
/dev/tty.usbmodemXXXXX
```

To know *XXXXX* you need to know which usb's name belong to the sensortag. You can find this by

run `ls /dev/tty* | grep usb`

Expected output:

```
connecting to /dev/ttyACM0 (115200) [OK]
Starting Contiki-3.x-3341-g80dbe5c
With DriverLib v0.47020
```


```
TI CC2650 SensorTag
IEEE 802.15.4: Yes, Sub-GHz: No, BLE: Yes, Prop: Yes
 Net: sicslowpan
 MAC: CSMA
 RDC: ContikiMAC, Channel Check Interval: 16 ticks
 RF: Channel 25
 Node ID: 29189
Hello, world
```

Reset the Sensortag by pressing the Reset button on the debugger board if you cannot find any output.

Help Sessions and Submission Guideline:

During the tutorial periods in Week 3 (Jan 24) or Week 4 (Jan 31), you need to demonstrate to the Lecturer, or one of the TAs that you have successfully installed the CC2650 development tool on your personal laptop (or LattePanda) by running the "Hello-World" program.

<u>Important:</u> In your demonstration, you should change the output to print your "<u>Name</u>" instead of the string "Hello World".

If you are unable to complete the demonstration during the tutorials, you can email the Lecturer, or one of the TAs for an appointment.

Grading/demonstrate should be completed by Feb 4, 2022.

Late penalty is 10% per day after Feb 4, 2022.