

# CS4222/CS5422

## Semester 2, 2019/2020

### 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 (<http://www.contiki-os.org/>). 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 supporting both IPv4 and IPv6, it also includes multiple low-power wireless standards. Moreover, it runs on multiple low-power devices (<http://www.contiki-os.org/hardware.html>), where the SensorTag is one of them.

### 2 Setting up your environment

#### 2.1 Windows User

You will first need to install an Oracle Virtualbox on your machine to run the VM file. You can download the latest version here:

<https://www.comp.nus.edu.sg/~ghadi/CS4222/VirtualBox-6.1.16-140961-Win.exe>

The following file is also required (TI emulator pack) to update the sensortag's firmware

[https://www.comp.nus.edu.sg/~ghadi/CS4222/ti\\_emupack\\_setup\\_9.2.0.00002\\_win\\_64.exe](https://www.comp.nus.edu.sg/~ghadi/CS4222/ti_emupack_setup_9.2.0.00002_win_64.exe)

After installing the TI emulator, open your command prompt (open as administrator), go to your install path (e.g. C:\ti) and cd to C:\ti\ccs\_base\common\uscif\xds110.

Your SensorTag device should be attached to the XDS110 development board. Connect the XDS development board to your laptop using the USB cable provided.

Now run this in your command prompt

```
xdsdfu -m
```

and make sure you get this response.

```
D:\Softwares\Installed\ti\ccs_base\common\uscif\xds110>xdsdfu -m

USB Device Firmware Upgrade Utility
Copyright (c) 2008-2019 Texas Instruments Incorporated. All rights reserved.

Scanning USB buses for supported XDS110 devices...

<<<< Device 0 >>>>

VID: 0x0451    PID: 0xbef3
Device Name:   XDS110 Embed with CMSIS-DAP
Version:       2.3.0.18
Manufacturer: Texas Instruments
Serial Num:    L850L850
Mode:          Runtime
Configuration: Standard

Switching device into DFU mode.
```

Then run this in your command prompt

```
xdsdfu -f firmware_3.0.0.13.bin -r
```

And you should get this response.

```
D:\Softwares\Installed\ti\ccs_base\common\uscif\xds110>xdsdfu -f firmware_3.0.0.13.bin -r

USB Device Firmware Upgrade Utility
Copyright (c) 2008-2019 Texas Instruments Incorporated. All rights reserved.

Scanning USB buses for supported XDS110 devices...

Downloading firmware_3.0.0.13.bin to device...
```

Now, when you run `xdsdfu -f` you should get your sensortag version has been changed

```
D:\Softwares\Installed\ti\ccs_base\common\uscif\xds110>xdsdfu -m

USB Device Firmware Upgrade Utility
Copyright (c) 2008-2019 Texas Instruments Incorporated. All rights reserved.

Scanning USB buses for supported XDS110 devices...

<<<< Device 0 >>>>

VID: 0x0451    PID: 0xbef3
Device Name:   XDS110 Embed with CMSIS-DAP
Version:       3.0.0.13
Manufacturer: Texas Instruments
Serial Num:    L850L850
Mode:          Runtime
Configuration: Standard

Switching device into DFU mode.
```

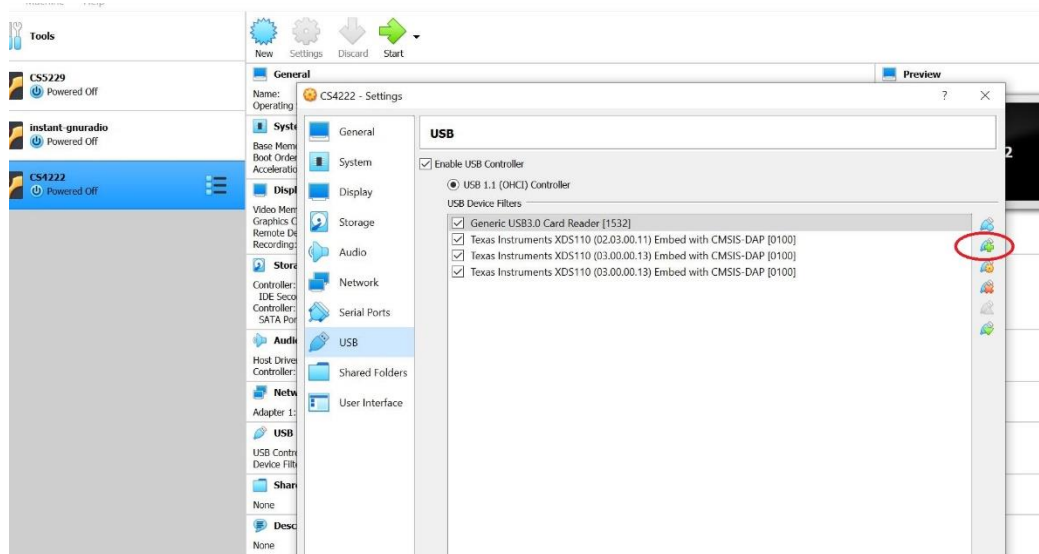
The next step is downloading the prepared disk image from <https://www.comp.nus.edu.sg/~ghadi/CS4222/CS4222.zip> (~3.8GB)

The Ubuntu VM, with both username and password as **cs4222**, has already been configured to

compile and flash your Contiki programs and their corresponding binary file on the SensorTag respectively.

A known issue when using VMs is that before flashing, you have to wait a few seconds after connecting the SensorTag to the VM and in case of flashing issues, you can press the Reset button on the SensorTag's debugger board and restart the flashing. If flashing problems persist, use the cloud version from your host computer, listed below, for flashing your SensorTag with your binaries.

To make your sensortag is detected by the VM, add your sensortag usb in the *Settings -> USB*



## 2.2 Ubuntu User

### 2.2.1 Installing Contiki OS sources

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

### 2.2.2 Install ARM GCC compiler

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

## 2.3 Mac User

### 2.3.1 Installing Contiki OS sources

```
git clone https://github.com/contiki-os/contiki.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:

Ubuntu: [https://www.comp.nus.edu.sg/~ghadi/CS4222/UniFlash/uniflash\\_sl.6.1.0.2829.run](https://www.comp.nus.edu.sg/~ghadi/CS4222/UniFlash/uniflash_sl.6.1.0.2829.run)

Mac : [https://www.comp.nus.edu.sg/~ghadi/CS4222/UniFlash/uniflash\\_sl.6.1.0.2840.dmg](https://www.comp.nus.edu.sg/~ghadi/CS4222/UniFlash/uniflash_sl.6.1.0.2840.dmg)

## 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

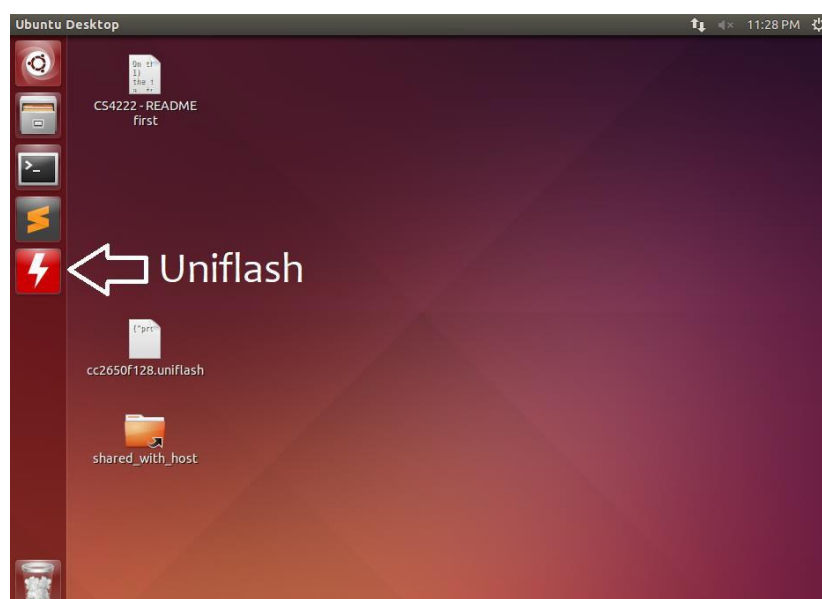
Go to 'hello-world' folder inside examples: ~/contiki/examples/hello-world/

```
make TARGET=srf06-cc26xx BOARD=sensortag/cc2650 hello-world.bin  
CPU_FAMILY=cc26xx
```

## 3.2 Flashing the SensorTag with the binary file

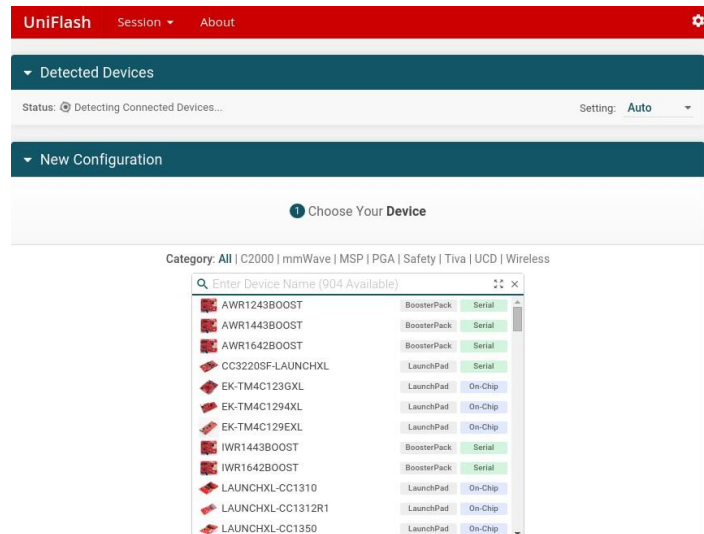
### 3.2.1 Open the Uniflash program

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.

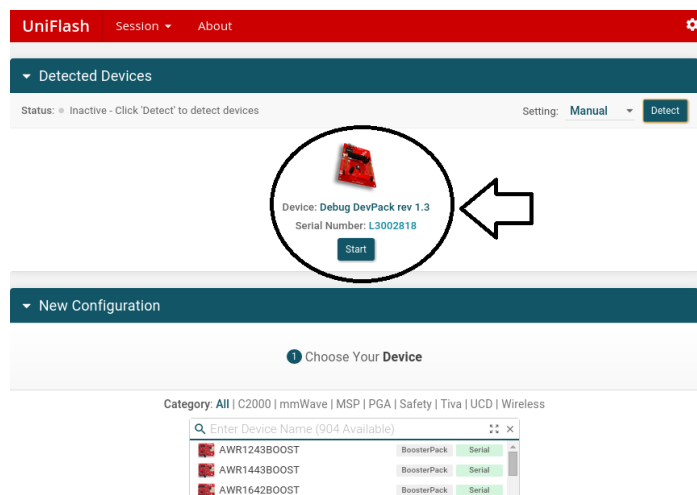


### 3.2.2 Session configuration

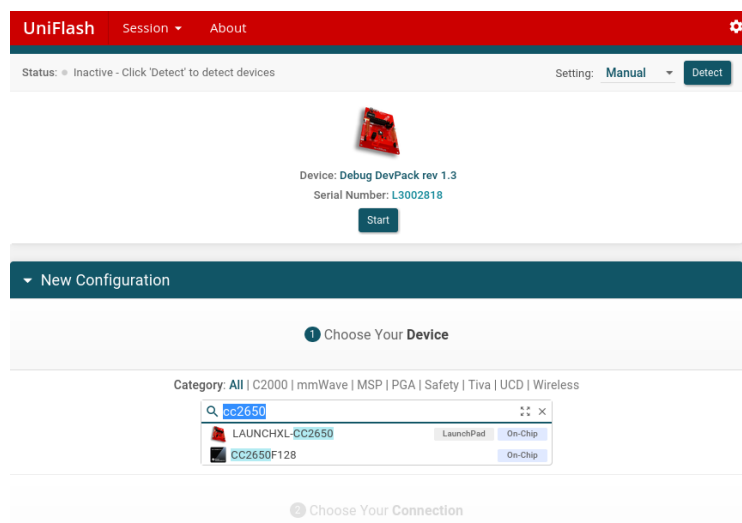
The first step is the SensorTag Debugger board detection. It starts with the **Auto** setting.



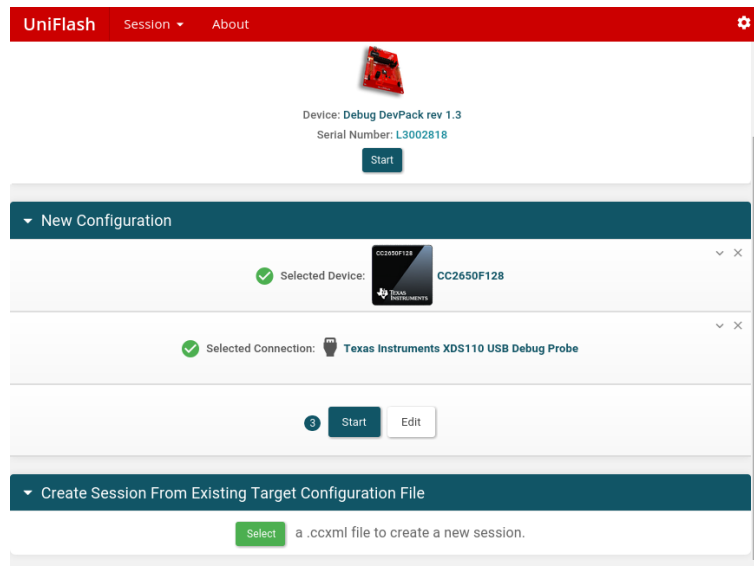
If your SensorTag Debugger board is not detected, change the setting to **manual** and click on **detect**. Wait until it is detected as shown below:



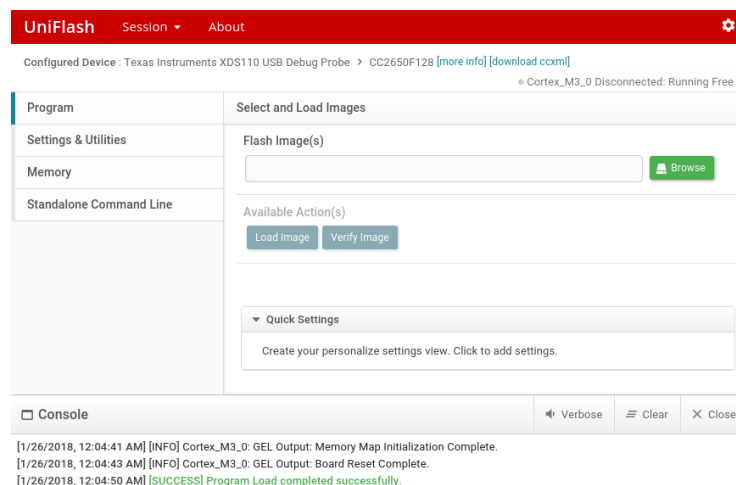
Next, choose your device by typing **CC2650** in the search field and select **CC2650F128**.



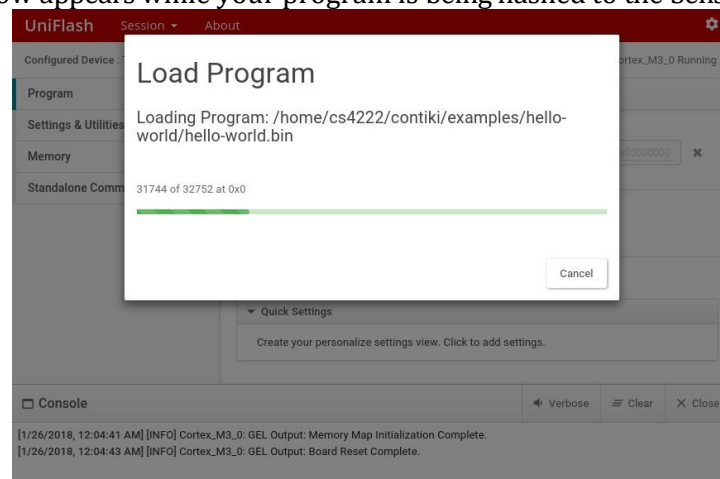
Next, choose the connection **Texas Instruments XDS110 USB Debug Probe** and hit the **Start** button as shown below.



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](https://www.zigbee2mqtt.io/information/flashing_via_uniflash.html)

### 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:

```
contiki/tools/sky/serialdump-linux -b115200 /dev/ttyACM0
or
cat /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/tools/sky/serialdump-macos -b115200 /dev/tty.usbmodemXXXXXX
```

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 25) or Week 4 (Feb 1), 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.

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 5, 2021.

Late penalty is 10% per day after Feb 5, 2021.