ECSE426 Microprocessor Systems
Fall 2017
Final Project
IoT – Sensor Data Management from Hardware to Cloud

Introduction

For the final project, we will develop a system to explore the interaction of embedded peripherals and sensors with cloud-enabled services, which is one of the main hallmarks of Internet of Things (IoT) designs. The F4-Discovery board will be augmented by a Bluetooth Low Energy (BLE) connection to connect to Internet via a smartphone. The BLE interface will be realized through a STM32F401RE Nucleo board, along with an IDB04A1 BLE daughter board, which will be connected to the Discovery board by a serial link. The BLE module should transmit and receive data between the F4 Discovery and the smartphone. The smartphone will employ the cloud services for upload, download and processing of the files.

The system will allow the board to send audio data and other optional data such as a push button status, over the BLE connection to the smartphone device. This data will be saved in a file and uploaded to the cloud services. The processing such as filtering can be done on chip or online in the cloud service. Students are free to choose any type of processing or filtering with proof of advantages.

Project Details and Design

The project is composed of four units. Each of the units needs to accomplish specific function.
Functionality Outline by Hardware Parts:

1. STM Discovery board
    - Read the audio data (reading on ship microphone),
    - Apply processing if needed,
    - Transmit data serially to the Nucleo board.
2. STM Nucleo board with BLE board
    - Interconnects Discovery board with smartphone. Provides BLE functionality to the Discovery board.
3. Smartphone
    - Interconnects Nucleo board with cloud service. Accesses cloud services, including the authentication. Sends processed data back to Nucleo board if needed.
4. Cloud Service
    - Stores Discovery board data, manipulated files, makes data visible to clients on any platform, and apply basic processing such as filtering.
    - Bonus: Performs advanced processing such as voice recognition and decision.

STM Discovery Board

The purpose of the Discovery board is to read the audio data for at least 2 seconds (recommended 2 to 4 seconds). This data should be a simple “Yes”, “No” or one to two digits number. When the blue button is pressed, after a short delay, the microphone should starts recording. Once the record is done, the data

should be transmitted to the Nucleo board. The recording duration should be represented by a LED to let the user know the start and end of records. A double tap detection would make the design more interesting. The system should stay in sleep mode when non of the above functions are running. This serial communication should be done via a UART connection, at the fastest Baudrate you can achieve.

BLE Transceiver (STM32F401RE Nucleo board + IDB04A1 BLE board)

The purpose of the Nucleo board is to provide the Bluetooth Low Energy functionality to F4-Discovery board. Using a BLE daughter board, the Nucleo board will connect the Discovery board to the outside world where it can eventually reach the cloud. The Nucleo board needs to obtain the data readings from the Discovery board and transmit them to the phone over BLE. Receiving the data from BLE to the board is optional. The drivers and API for using BLE are provided, and the documentation can be found in (DOC_20 to DOC_23).

The board must be configured to operate as a BLE Peripheral server. There will be at minimum a microphone data BLE service, and a button service if needed. The characteristics will have properties 'READ' and 'NOTIFY'. The button service will need the property 'NOTIFY'.

Android/iOS application

BLE

You will have to connect your phone to the board using Bluetooth Low Energy and obtain the readings from it and store them to the cloud. It is recommended to use an Android smartphone, and a good IDE to use for this is Android Studio. If you wish to proceed with iOS devices, or if you need assistance acquiring an Android device, do not hesitate to contact the TAs.

For this section, reference material will be provided, and it will be covered during the tutorial. For a good example of code, the Android developer website contains a sample application of BLE use. This application searches for all BLE devices, and after connecting to a device provides all services and characteristics provided by the device. This application can only receive the data.

Cloud services

A tutorial and requirements for the cloud services will be provided by a TA.

Bonus part – Cloud processing

Being a bonus part, using the cloud services for processing such voice recognition and providing relative feedback to the board. The result of "Yes" or "No" can be a control on a LED and the input number can be the number of times you toggle a LED. You can use a different processing service if you would prefer. If you would prefer to not do cloud data processing at all, this implies that you can process the data off cloud, on smartphones or other clients attached to your data in the cloud. Hence, the alternative places for data processing could be the phone itself, the Nucleo or Discovery board. Important to note is that if you select to apply the data processing off-cloud, you still must demonstrate that the data is uploaded in cloud.

Demonstration

There will be two stages of demonstration

- Progress Demo will take place during the week of Nov 30 to Dec 3. Every group is obliged to provide the specification of all functionality that will be provided during the final demo.
- Final demo will take place on Dec 4 to 8 (being announced later).

Report

The final project report is supposed to be more formal than the lab reports which you wrote during this semester. You should naturally consider all feedback you have received this semester while preparing your report. This report should be like a user manual for a new person whose using your system. In particular, we would like to stress the need for the extra following points in your report:

- The used components in your system.
- A timeline of work and a breakdown between team members.
- A block diagram of your system, showing roughly how modules interact.
- Proper screenshots of your application.

As always, you should explain the reasoning behind your design choices and provide sufficient information on how the details are realized. The contributions of each member should be clearly delineated in one place in a concise manner. The working code on embedded, phone, and cloud sides will need to be included in the project submission, in **one zip file**. The code by itself should be clean and well-documented.

Important! Obtaining and returning your Kits

Final project groups can borrow Nucleo boards as soon as the final project groups are formed. All groups should return all components to ECE labs within one week of the final project demo. The parts returned should exactly match the ones given to you (specs, models, and part numbers). They should all be in a fully working condition. This include all boxes, kits (discovery and wireless), tools (screwdrivers and wire wrappers), breadboards and peripheral components. On the occasion of your failure to return the kit on time, or having any missing components, you will be penalized 40% of the total project grade.