

Design and Bring Up of IoT Devices

Ameen Kubra¹, Sanket N Shettar², Juniad³

¹PG Student, ²Assistant professor,

^{1,2}Department of Electronics and Communication Engineering

GSSS Institute of Engineering and Technology for Women, Mysuru

³VP–Hardware Design, WaferLabs Embedded Tech Pvt Ltd, Bengaluru

Abstract. This paper presents a design and prototype implementation of Atmosphere which is an innovative platform that enables quick and easy development of Bluetooth Low Energy (BLE, also known as Bluetooth Smart) applications for iOS and Android mobile operating systems. A cloud-based development environment and local programming application are combined to create a unique means of building a variety of applications by bridging communication through BLE between a mobile device and embedded hardware.

Keywords: *Anaren Atmosphere, Bluetooth Low Energy (BLE), Integrated Development Environment (IDE), Anaren Integrated Radio (AIR), Atmosphere Application Programming Interface (API), Light Emitting Diode (LED).*

I. INTRODUCTION

The developer use Atmosphere to easily construct the mobile applications, and make use of a mobile app to control a remote device through BLE. Atmosphere is used to develop both the application's mobile interface and the embedded hardware code and uses its innovative browser-based “drag-and-drop” development environment while still allowing code customization.

Most of the platforms focal point is on either embedded hardware or mobile

software, where as Atmosphere develops both simultaneously. The concurrent development of programming an application to embedded hardware and mobile code to a mobile device, Atmosphere achieves rapid application development to give an efficient and user-friendly experience [1].

II. BLOCK DIAGRAM

While using Atmosphere, the application is first created by using Atmosphere Developer, Atmosphere's easy-to-use integrated development environment (IDE). Cloud server is used to compile the application once it is built, and Atmosphere Programmer computer-based programming software is used to programs the application into the embedded hardware. At the same time, on mobile device the application's mobile code is downloaded using Atmosphere app. The result is a cohesive solution of the embedded hardware and mobile device seamlessly working together [1].

Atmosphere is a collection consisting of several pieces of software and hardware working together to create mobile applications. These include:

a) *Atmosphere Account*: This gives access to Atmosphere development tools, created projects and resources.

b) *Atmosphere Developer*: This is a cloud-based integrated development environment where applications are build.

c) *Atmosphere Programmer*: It is a computer-based software which program

an application's firmware to intended hardware.

d) *Atmosphere App*: In order to run Atmosphere applications on a mobile device this app is used.

e) *Atmosphere Application Programming Interface (API)*: this is a set of C-based APIs for use in the application's code to add numerous functions and features.

The figure 1 below shows the block diagram of Atmosphere to create a project:

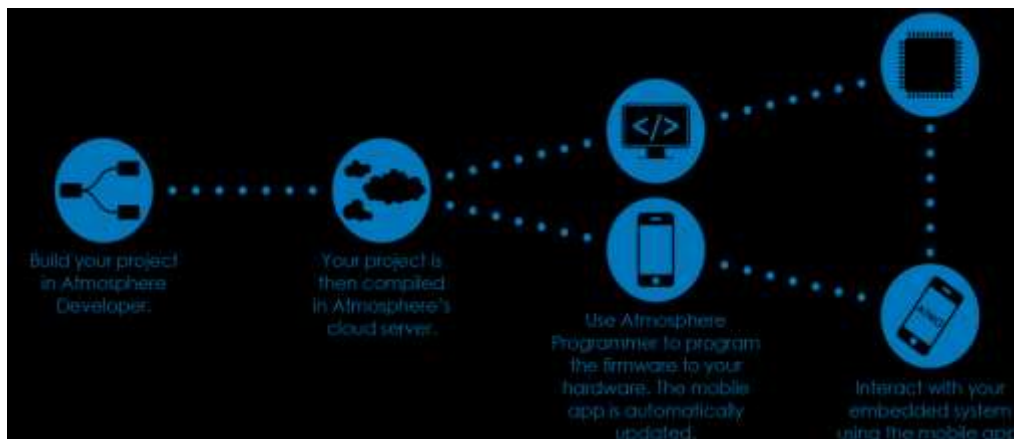


Fig 1: Block diagram of ATMOSPHERE

Atmosphere Developer. Figure 2 above shows Atmosphere Developer. It is a cloud-based integrated development environment can be used in any Internet browser which allows users of all levels to create and build applications easily [3]. Within this tool you create, layout, and build your application. The elements can be dragged and drop to the "Code View" layout and it simultaneously creates an application for a mobile device and it will program the firmware with the hardware.

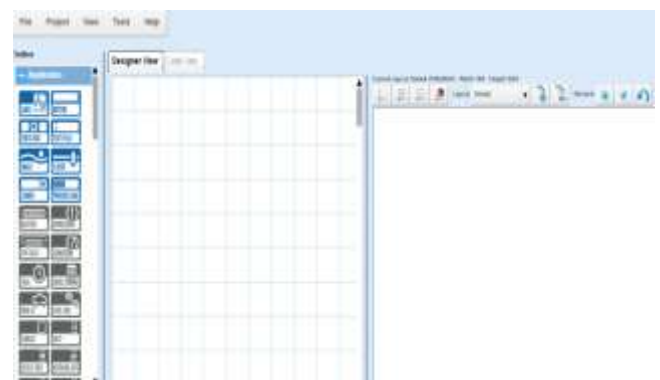


Fig 2: Atmosphere Developer IDE

The Atmosphere cloud portal is used to store and manage the projects created in Atmosphere Developer, enabling easy use and reuse. Atmosphere Developer is

accessed by clicking Atmosphere IDE on the website.

Atmosphere Programmer. The figure 3 shows the Atmosphere Programmer which is a client-side computer application. It allows developer to program the application's firmware created with Atmosphere Developer into Atmosphere-supported hardware that is the Anaren A20737 Module.

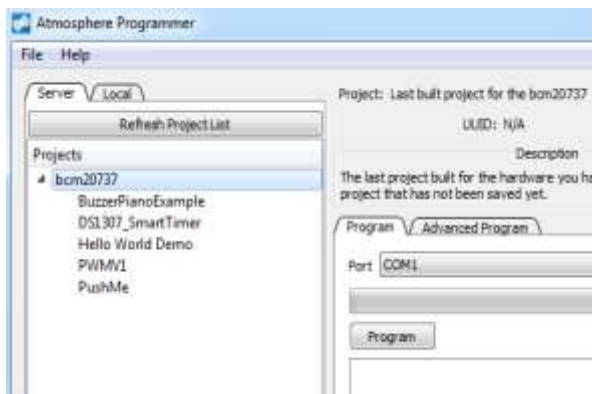


Fig 3: Atmosphere Programmer

Atmosphere App: The figure 4 shows the Atmosphere App that is a mobile app which runs on either Android or iOS and allows the user to operate Atmosphere projects on their mobile device. Atmosphere cloud portal is connected with user's Atmosphere account credentials on their mobile device. The Atmosphere app is available for download in the Apple App Store for iOS, or Google Play Store for Android [2].



Fig 4: Mobile App

Anaren Integrated Radio (AIR) Hardware: Anaren AIR for WICED A20737 module is used to run the code generated on Atmosphere [4]. The MSDB contains the BLE module for application development and testing and the programming hardware to program the board, the MSBD consist of the following functions:

- Accelerometer
- Magnetometer
- Infrared temperature sensor
- Buzzer
- Coin cell battery holder
- Tri-color (RGB) LED light
- Navigation switch (joystick)

III. BLUETOOTH MULTI-SENSOR DEVELOPMENT BOARD

The Anaren Bluetooth Multi-Sensor Development Board (MSDB) shown in figure 5 is a platform to develop and test created on Atmosphere for the Anaren A20737 Module with Bluetooth Low Energy. The MSBD board includes various sensors on different communication bus types to allow users to explore and test various features of the A20737 module. The developers can

rapidly develop prototypes and gain a better understanding of how to use the Anaren A20737 module [4].

FEATURES OF MULTI-SENSOR DEVELOPMENT BOARD

The MSDB consist of several sensors to allow the user to develop application. The pins on the MSBD module are broken out into two rows of pin headers that run up and down the board in a standardized configuration for Anaren development boards.

a) *Anaren A20737 Module:* The MSDB uses the Anaren incorporates a BLE transceiver and an ARM micro-controller cor. All the communication and application level software is executed in this. To allow the user to easily prototype their designs, the module signals have been brought out to headers and external devices and voltage sources. An FTDI dual UART-to-USB interface IC is also included with it so as to enable the PC programmer to program the module over USB. It also includes a debug UART. Both serial connections can be enabled or disabled with switches.

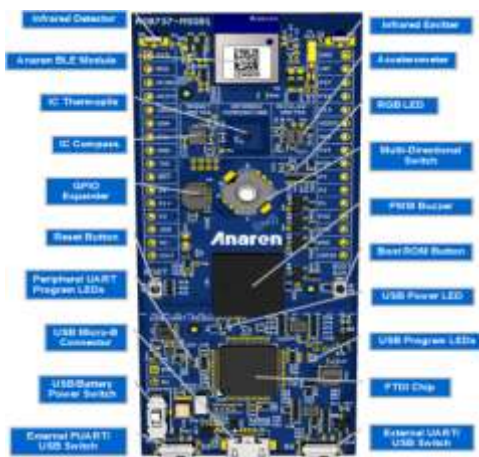


Fig 5: MSBD description

b) *Magnetometer:* I2C address is 0x1E. The MSDB is equipped with a Honeywell HMC5883 magnetometer that is attached to the I2C bus.

c) *Accelerometer:* The figure 6 gives the Accelerometer Axis Orientation. The MSDB is equipped with a SPI bus that is attached to STMicroelectronics LIS3DH accelerometer [8].



Fig 6: Accelerometer Axis Orientation

d) *Infrared Temperature Sensor:* I2C Address is 0x40. The MSDB includes a Texas Instruments TMP006B infrared thermopile sensor that is attached to I2C bus [9].

e) *Buzzer:* The MSDB is equipped with a Murata PKLCS1212E4001-R1 buzzer that is attached to P14 on the A20737 module is represented by the Buzzer Element.

f) *Tri-color LED:* The MSDB is equipped with a Lumex SML-LX0404SIUPGUSB Tri-Color LED that is attached to P27(Green) and P13(Blue) on the A20737 module, P26(Red). In Atmosphere Developer, GPIO Write Element is used to control the tri color LED.

g) *Joystick:* The MSDB is equipped with an I2C GPIO expander attached to ALPS SKRHABE010 joystick.

h) Reset Button: this is used to pull the module's reset line low and cause the module to restart.

l) GPIO Expander: Its I2C address is 0x10. The XRA1201 Driver is the GPIO expander used.

j) Current Sensor: The INA216A2 has a fixed gain of 50x. The MSDB is equipped with a Texas Instruments INA216A2 current sense amplifier which measures current through a 0.2 ohm resistor.

k) Programming Interface: The MSDB includes a built-in programmer that can be used to program the EEPROM on the module. This programmer uses the FTDI FT2232H USB to dual serial port IC, U10 on the schematic. This IC is the USB interface for the board and has dual UARTs plus several miscellaneous GPIO pins. One UART is used for the HCI programming interface and the other is used as a user UART. This IC also has LED outputs that illuminate during Tx/Rx.

l) Power Supply: The MSDB can be powered from its built-in 3.3V LDO (U14) or from a battery supply. Supply is switched with S5. This is then routed through a 0.2Ω current measurement shunt resistor, R24.

IV. CONCLUSION

In this paper the design and implementation of a compact, low-cost, low-power single-board that utilizes Bluetooth Low Energy and Wi-Fi is presented. Also an elaborate description about the hardware and software design considerations are discussed, which allow the users to access the sensors and possibly

activate actuators remotely and effectively which yields in the automation of the existing systems.

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