

AN ILLUSTRATIVE DESIGN OF IOT DEVICES USING A CLOUD ENVIRONMENT

Sanket N Shettar¹, Padma R²

^{1,2}Assistant Professor, Dept of ECE, GSSSIETW, Mysuru

¹sanket@gsss.edu.in, ²padmar@gsss.edu.in

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. It combines a cloud-based development environment and local programming application to create a unique means of building a variety of applications by bridging communication via BLE between a mobile device and embedded hardware.

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

I. INTRODUCTION

An atmosphere is designed to help the developer easily construct the mobile applications, and utilize a mobile app to control a remote device through BLE. Atmosphere allows you to develop both the application's mobile interface and the embedded hardware code at the same time using its innovative browser-based "drag-and-drop" development environment while still allowing code customization.

While most platforms focus on either embedded hardware or mobile software, Atmosphere develops both simultaneously. Through the concurrent development of programming an application to embedded hardware, and mobile code to a mobile device, Atmosphere achieves true rapid application development to provide an efficient and user-friendly experience.

II. BLOCK DIAGRAM

To use Atmosphere, your application is first created using Atmosphere Developer, Atmosphere's easy-to-use integrated development environment (IDE). Once built, the application is then compiled through a cloud server, and Atmosphere Programmer, computer-based programming software, programs the application into the

embedded hardware. Simultaneously, the application's mobile code is downloaded to the Atmosphere app on your mobile device. The result is a cohesive solution of the embedded hardware and mobile device seamlessly working together.

Atmosphere is a suite consisting of several pieces of software and hardware all working together to develop mobile applications. These include:

- **Atmosphere Account:** The account to gain access to Atmosphere development tools, resources, and created projects.
- **Atmosphere Developer:** The cloud-based integrated development environment used to build applications.
- **Atmosphere Programmer:** The computer-based software used to program an application's firmware into the intended hardware.
- **Atmosphere App:** The mobile app used to run Atmosphere applications on a mobile device.
- **Atmosphere Application Programming Interface (API):** A set of C-based APIs for use in the application's code to add numerous functions and features.

The figure 1 below is a diagram illustrating the simple process how the Atmosphere works to create a project:

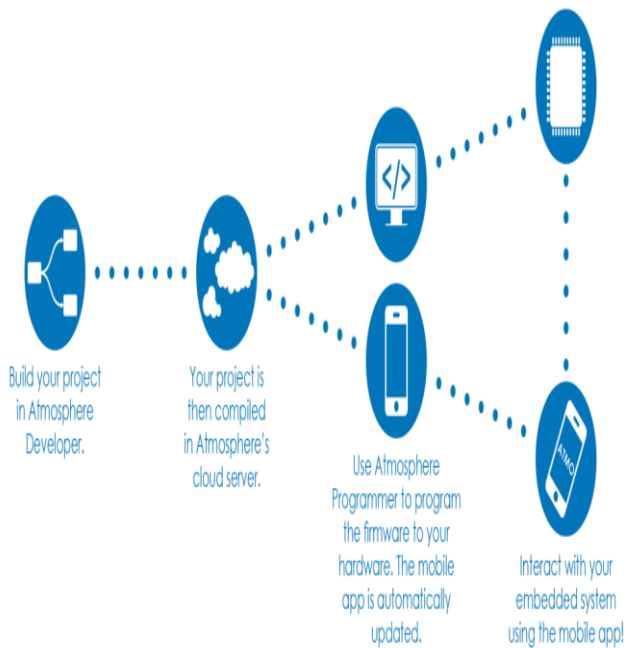


Fig 1: Block diagram of ATMOSPHERE

2.1 ATMOSPHERE DEVELOPER

Figure 3.2 shows Atmosphere Developer. It is a cloud-based integrated development environment that can be used in any Internet browser and allows users of all levels to easily create and build applications.

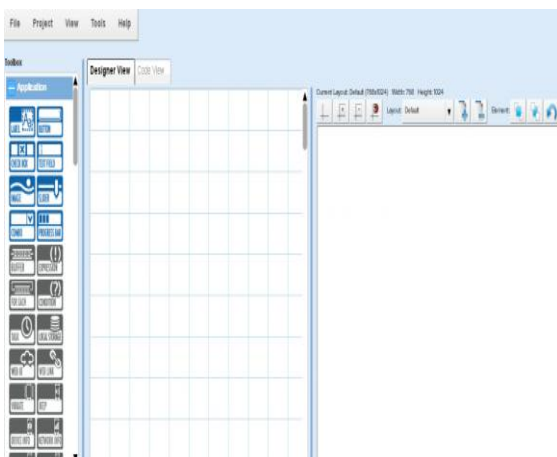


Fig 2: Atmosphere Developer IDE

Within this tool you create, layout, and build your application. From simple drag-and-drop elements, to the powerful “Code View,” you are simultaneously creating an application for a mobile

device and the firmware that will be programmed into the hardware. All projects created in Atmosphere Developer are stored and managed in the Atmosphere cloud portal, enabling easy use and reuse. Atmosphere Developer is accessed by clicking Atmosphere IDE on the website.

2.2 ATMOSPHERE PROGRAMMER

The figure 3.3 shows the Atmosphere Programmer. It is a client-side computer application that allows you to program your application’s firmware created with Atmosphere Developer into Atmosphere-supported hardware (specifically, into the Anaren A20737 Module).

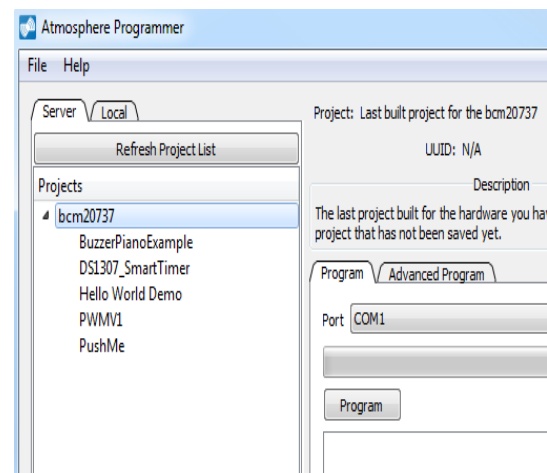


Fig 3: Atmosphere Programmer

Atmosphere Programmer can be downloaded from the Atmosphere Downloads section of the website.

2.3 ATMOSPHERE APP

The figure 3.4 shows the Atmosphere App. It is a mobile app that runs on either iOS or Android and allows the user to run Atmosphere projects on their mobile device.

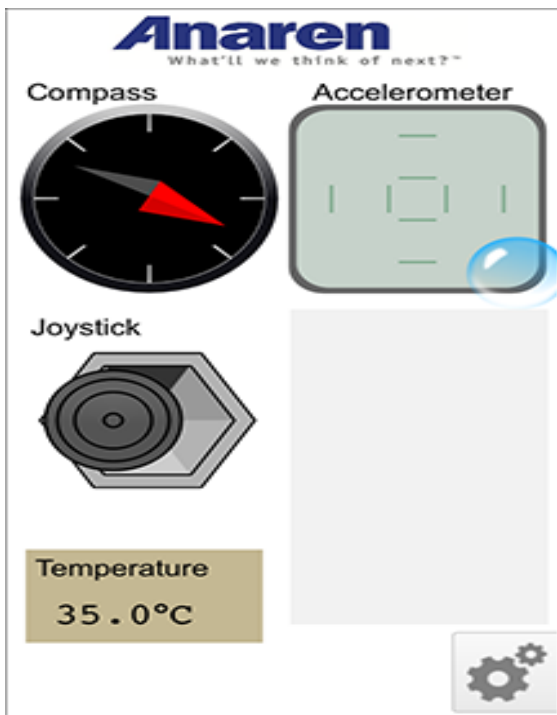


Fig 4: Mobile App

It is connected to the Atmosphere cloud portal with a user's Atmosphere account credentials. The Atmosphere app is available for download in the Apple App Store for iOS, or Google Play Store for Android.

2.4 ANAREN INTEGRATED RADIO (AIR) HARDWARE

Atmosphere generates code that runs on the Anaren AIR for WICED A20737 module. For application development and testing, the MSDB contains the BLE module, the programming hardware to program the board, and the following functions:

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

III. BLUETOOTH MULTI-SENSOR DEVELOPMENT BOARD

The Anaren Bluetooth Multi-Sensor Development Board (MSDB) shown in figure 5 provides a platform to test and develop applications for the Anaren A20737 Module for Bluetooth Low Energy. Developers can use either Atmosphere to develop their application or the Cypress (Broadcom) WICED Smart SDK 2.0 or greater. The development board includes various sensors on different communication bus types to allow developers to test and explore the various features of the A20737 module. Combined with Atmosphere, developers can rapidly develop prototypes for solutions and gain a better understanding of how to use the Anaren A20737 module.

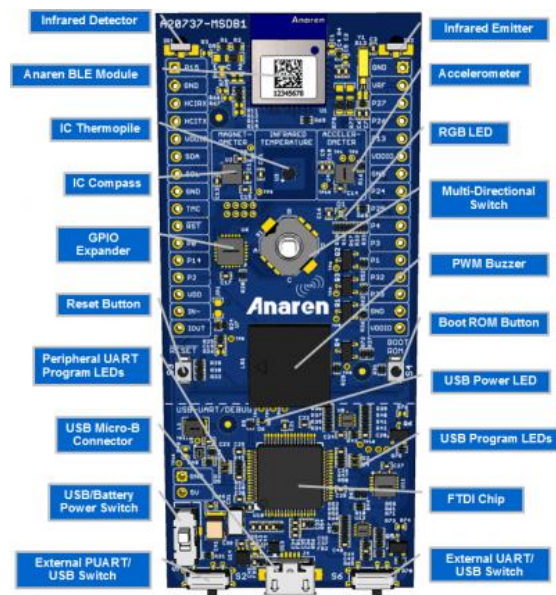


Fig 5: MSDB description

3.1 FEATURES MULTI-SENSOR DEVELOPMENT BOARD

The MSDB comes equipped with several sensors to allow the user to develop novel application using the provided devices. Additionally, all the pins on the 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 A20737 Module. This module incorporates an ARM micro-controller core and a BLE transceiver. It is where all the communication and application level software is executed. The module signals have been brought out to headers and external devices and voltage sources to allow the user to easily prototype their designs. The MSDB includes an FTDI dual UART-to-USB interface IC. This enables the PC programmer to program the module over USB. It also provides a debug UART. Both of these serial connections may be enabled or disabled with switches, as explained below.

B) MAGNETOMETER

The MSDB is equipped with a Honeywell HMC5883 magnetometer that is attached to the I2C bus. I2C address is 0x1E.

C) ACCELEROMETER



Fig 6: Accelerometer Axis Orientation

The figure 6 gives the Accelerometer Axis Orientation. The MSDB is equipped with a STMicroelectronics LIS3DH accelerometer that is attached to the SPI bus.

D) INFRARED TEMPERATURE SENSOR

The MSDB is equipped with a Texas Instruments TMP006B infrared thermopile sensor that is attached to I2C bus. I2C Address is 0x40.

E) BUZZER

The MSDB is equipped with a Murata PKLCS1212E4001-R1 buzzer that is attached to

P14 on the A20737 module. This 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 P26(Red), P27(Green) and P13(Blue) on the A20737 module. In Atmosphere Developer, the tri-color LED is controlled by the GPIO Write Element. See LED Example for an example of how to use the tri-color LED.

G) JOYSTICK

The MSDB is equipped with an ALPS SKRHABE010 joystick that is attached to the I2C GPIO expander.

H) RESET BUTTON

The reset button pulls the module's reset line low and causes the module to restart.

I) GPIO EXPANDER

The XRA1201 Driver is the GPIO expander used. Its I2C address is 0x10.

J) CURRENT SENSOR

The MSDB is equipped with a Texas Instruments INA216A2 current sense amplifier measuring current through a 0.2 ohm resistor. The INA216A2 has a fixed gain of 50x. The Current Measurement Example demonstrates how to use the current sensor.

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.

To control the module's reset signal, the FT2232H is connected to U11, a non-inverting

buffer with open drain outputs. This will pull reset low when needed by the programmer.

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. The voltage drop across R24 is amplified 50x using a TI INA216A2 Current Shunt Monitor U7. Note that the current sense signal has a low pass filter on the output comprised of C19 and R25. The filter cutoff frequency is left as an exercise for the reader. The rest of the board can be powered directly (normal condition) or through a TI TPS72630 switching DC to DC converter, U9. This voltage, VDDIO, is 2.1V as long as the DC-DC converter is not in bypass (normal state).

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.

REFERENCES

- [1] WaferLabs company information [online] available at www.waferlabs.com [accessed on 5-8-2016].
- [2] NASSCOM information [online] available at www.10000startups.com [accessed on 20-8-2016].
- [3] WaferLabs products information [online] available at www.angel.co/waferlabs [accessed on 10-9-2016].
- [4] WaferLabs article [online] available at www.technovelgy.com/ct/technology-article.asp [accessed on 10-9-2016].
- [5] Anaren Atmosphere information [online] available at www.atmosphere.anaren.com [accessed on 19-9-2016].
- [6] Anaren Atmosphere information [online] available at www.anaren.com/air/products/air-for-wiced-smart [accessed on 29-9-2016].
- [7] Anaren Atmosphere information [online] available at [www.atmosphere.anaren.com/Bluetooth Multi Sensor Development Board](http://www.atmosphere.anaren.com/Bluetooth%20Multi%20Sensor%20Development%20Board) [accessed on 29-9-2016].
- [8] WICED information [online] available at <http://www.broadcom.com/blog/tag/wiced/> [accessed on 20-10-2016].
- [9] Conferences information [online] available at <http://techstory.in/world-startup-expo-bangalore/> [accessed on 25-11-2016].
- [10] Conferences information [online] available at www.techstory.in/world-startup-expo-bangalore/ [accessed on 25-11-2016].
- [11] Neng- Shiang Liang; Li-Chen Fu; Chao-Lin Wu. "An integrated, flexible, and Internet-based control architecture for home automation system in the internet era". Proceedings ICRA '02. IEEE International Conference on Robotics and Automation, Vol. 2, pp.1101-1106, 2002.
- [12] R.Piyare, M.Tazil. "Bluetooth based home automation system using cell phone". IEEE 15th International Symposium on Consumer Electronics, 2011.
- [13] Internet of Things [online] available at <https://iot-analytics.com/10-internet-of-things-applications/> [accessed on 10-10-2016].
- [14] Internet of Things [online] available at www.thewhir.com/web-hosting-news/the-four-internet-of-things-connectivity-models-explained [accessed on 17-10-2016].
- [15] MEMS accelerometer information [online] available at www.analog.com/en/products/mems/accelerometers.html [accessed on 23-10-2016].
- [16] Temperature sensor information [online] available at www.ti.com/product/TMP006 [accessed on 16-11-2016].
- [17] IoT applications [online] available at www.internetofthingswiki.com/iot-applications-examples/541/ [accessed on 19-11-2016].
- [18] Sensors information [online] available at www.bing.com/search?qn=sensors&form [accessed on 26-11-2016].
- [19] Rakesh K. Deore, Vijay R. Sonawane, Pooja H. Satpute, "Internet of Thing Based Home Appliances Control", 2015 IEEE
- [20] Kumar Mandula, Ramu Parupalli, CH.A.S.Murty, E.Magesh, Rutul Lunagariya, "Mobile based Home Automation using Internet of Things(IoT) ", 2015 IEEE.