# Evaluation Of Classic Bluetooth Based On The Spectrums For Its Usability In Industrial Applications

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***Abstract* -- In modern world, wireless technologies have been of great use in various sectors including industries such as those dealing with the energy automation products. The wireless technologies can give great flexibility in the operation and control of devices across a certain range depending on the technology that is being used. Addition of wireless technologies can help in serviceability and maintainability of these devices when installed in remote stations. It is significant to evaluate the Classic Bluetooth technology and to recommend its applicability with respect to the Industrial Applications.**

***Keywords* -- Classic Bluetooth, SPP, Server, Client.**

## I. INTRODUCTION

Bluetooth enabled devices have been a major reform in the field of wireless communication. This technology encompasses a simple low-cost global radio system for integration into remote mobile devices. Use of this technology over the years has now made Bluetooth enabled devices a norm in cell phones and other appliances. Bluetooth is well known to the public as a technology that provides a wireless link for local connectivity between phones, computers, or act as a cable replacement.

Bluetooth technology was originally designed for continuous, streaming data applications including voice and has successfully eliminated wires in many consumer as well as industrial and medical applications. Classic Bluetooth technology will continue to provide a robust wireless connection between devices ranging from headsets and cars to industrial controllers and streaming medical sensors.

The Bluetooth basic packet is as follows: [1]

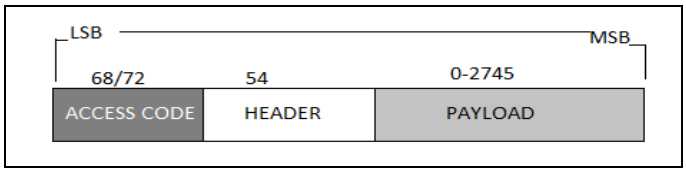


Fig.1. Bluetooth Basic Packet

The paper presents a SPP(Serial Port Profile) application, its configuration and testing for spectrums which will evaluate Classic Bluetooth technology that can be used to connect devices wirelessly to each other in an industrial setting.

## II. BLUETOPIA ARCHITECTURE

The core stack consists of the following layers/protocols/profiles:

- HCI (protocol)
- L2CAP (protocol)
- SDP (protocol)
- RFCOMM (protocol)
- SPP (Serial Port Profile)
- GAP (Generic Access Profile)

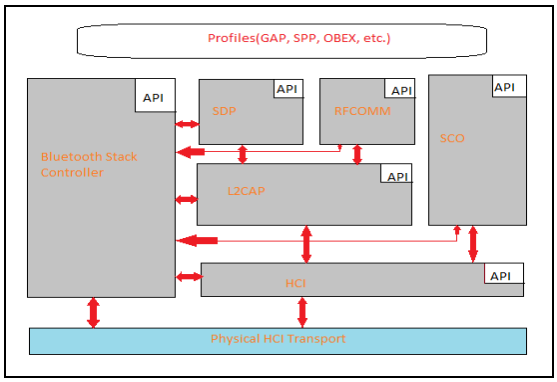


Fig. 2. Bluetopia Architecture

The Bluetooth Protocol Stack, like all networking protocol stacks, is very asynchronous in nature. This implies that some asynchronous notification schema is implemented to notify the host application of events that may have happened. Bluetopia implements its Event Notification schema via callback functions.

All levels of the Bluetooth Protocol Stack are self contained. Each level encapsulates all processing required for the functionality contained in that level. For example, L2CAP handles all segmentation/re-assembly tasks, and the lower layer (HCI) and upper layers (SDP, RFCOMM, etc.) are not concerned with this internal functionality.

This encapsulation means that each layer might require RAM to buffer/queue data. Currently, each individual layer is responsible for its own memory allocation/deallocation. No layer allocates memory that is deallocated by another (higher or lower) layer. This approach leads to more potential memory copying, however allows encapsulation at each layer and simplifies debugging. It is possible to optimize the current



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schema to use a common packet/data pool if required. In practice, the current relatively low bandwidth of Bluetooth has not shown this design decision to be a problem.

## III. SERIAL PORT PROFILE(SPP)

The application created to evaluate the CC2564 Bluetooth module is called SPP(Serial Port Profile). SPP defines how to set up virtual serial ports and connect two Bluetooth enabled devices. This application shows how to utilize the SPP module and also how to handle the different callback events. The application can be used to interface with a remote SPP Client or Server.

The SPP defines two roles, Device A and Device B.

Device A : This is the device that takes initiative to form a connection to another device (initiator).

Device B : This is the device that waits for another device to take initiative to connect (acceptor).

The Baseband, LMP and L2CAP are the OSI layer 1 and 2 Bluetooth protocols. RFCOMM is the Bluetooth adaptation of GSM TS 07.10, providing a transport protocol for serial port emulation. SDP is the Bluetooth Service Discovery Protocol. The port emulation layer shown in the figure 3 is the entity emulating the serial port, or providing an API to applications.

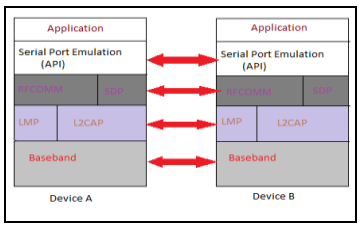


Fig. 3. SPP Model

## IV. APPLICATION WORKING/METHOD USED

The application allows the user to use a console to send Bluetooth commands, setup a Bluetooth Device to accept connections, connect to a remote Bluetooth device and communicate over Bluetooth.

It also allows to set the Mode for the module to act as the server or the client.

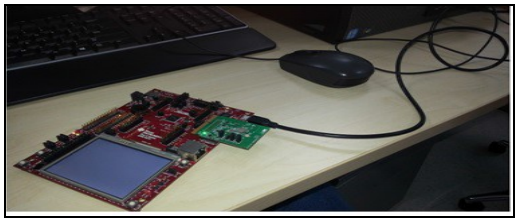

Fig. 4. Experimental Setup

To open a server, at the "Server" prompt, enter "Open 1". You can replace 1 with any number between 1 and 30, as long as there is no server open on that port. Once you see "Server opened: 1", you have a SPP server open on port 1.

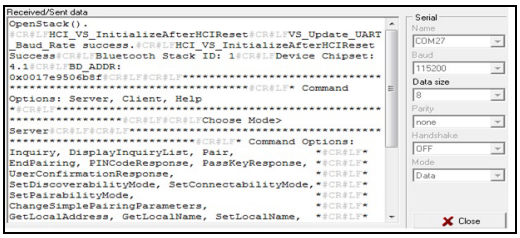


Fig 5. Server Side Configuration(Step 1)

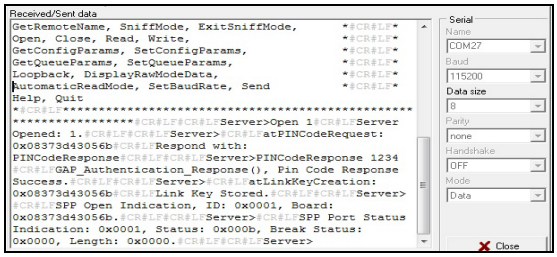


Fig. 6. Server Side Configuration(Step 2)

On the client side we can either use one more module to set it as a client or we can use mobile for detection or a certain app on android to transmit the data and observe it. To connect to the device, open blueterm, press the menu button and hit connect to device. Blueterm is an app that can be used to connect an Android device to the SPP APP.

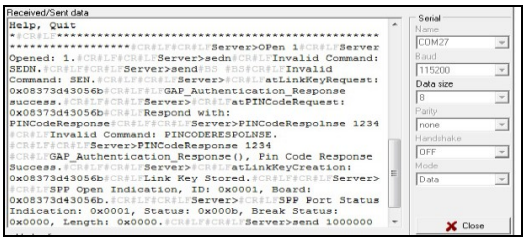


Fig. 7. Server Side transmitting the bytes

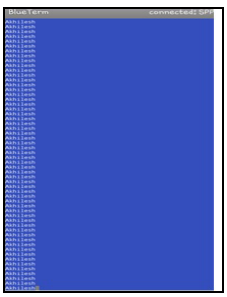

Fig. 8. Client side receiving the bytes

## V. GRAPHS AND SIMULATION

The result for the Bluetooth Spectrum was generated in MATLAB Simulink as follows.

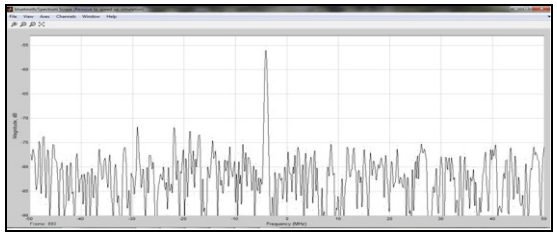

Fig. 9. Spectrum based on MATLAB Simulink Simulation



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The Spectrum based on working of the Bluetopia Stacks and CC2564 Bluetooth Module using TIVA C Series Development Board are obtained as follows:


Fig. 10. Spectrums using Network Analyzer for checking the reliability for the SPP Application on CC2564 MODNEM


Fig. 11. Spectrums showing occupied Bandwidth for the data being transferred using SPP Application


Fig. 12. Spectrums showing Channel Power for the data being transferred using SPP Application

The above two graphs are similar in nature and almost similar power values proving the reliability to be successfully used for the data transmission for industrial applications thereby using SPP application replacing the cables for wireless maintenance and control of the remote stations with the data updates.

The Spectrum Emission Mask (SEM) measurement is a method to detect spurious emissions or intermodulation products of a signal. When performing a SEM measurement, the R and S FSC checks the signal against a spectral mask to see whether the signal complies with a specific standard or not.

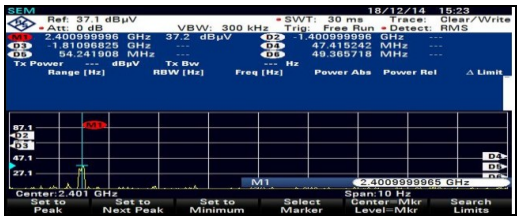


Fig. 13. Spectrum Emission Mask

## VI. CONCLUSION

The paper was focused on the study and evaluation of Classic Bluetooth and proving the reliability of SPP application to be used in industrial areas for wireless transmission of the data for the maintenance and servicing of the remote stations by reliable data updates with the help of spectrums and its comparison with the simulated model in MATLAB.

The paper also proves that Classic Bluetooth hence can be used specifically for replacing the wired cable transmission with wireless approach without any attenuation of the data since the spectrums obtained have comparatively higher peaks for the data and can travel distances specified by bluetooth technology without any loss of data and can achieve reliable transmissions in industrial applications such as those dealing with automation products, substations etc. for real time data updates.

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