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Bluetooth Stacks for Data Transmission

Introduction

Bluetooth communication technology is pervasive in modern devices. It can be found in phones, laptops, headphones, and other devices as a means of locally transferring data between two devices. Bluetooth is designed for low power and short range communication, however, the actual power usage and communication distance depends on the application. In comparison to WiFi, another networking technology, Bluetooth uses %50 less power for small file transfers [1]. Communication between two devices is made possible by Bluetooth transceiver hardware modules and the software to manage them, also known as a Bluetooth software stack. This paper reviews the available Bluetooth stacks on the market which implement serial data transfer.

Commercial Applications

Due to the fact that Bluetooth communication is openly specified by the Bluetooth Special Interest Group (SIG), Bluetooth software stacks on the market range from being freely available to having a price-per-unit licensing structure [2]. The Microchip Corporation allows their software stack to be used freely for development, but in order to use their stack for resale, they charge a fee of $4,250 for up to 5,000 units, with the price-per unit decreasing as more units are purchased [3]. Bluez, the Linux operating system's official implementation of the Bluetooth specification, is open-source and thus is able to be used without licensing costs in commercial applications [4]. Bluez is the software stack used by the Android operating system, which can be found in 52% of smartphones worldwide [5].

Underlying Technology

The Bluetooth specification is split into two parts – the Bluetooth Controller which handles the technical aspects of hardware communication and interfaces (operating frequencies, necessary hardware components), and the Bluetooth Host which manages the higher-level concepts like communication protocols and profiles [6]. The software stack must at least implement three mandatory communication protocols in the Controller layer: LMP, L2CAP, and SDP [6]. For the Host layer, a stack can chose to implement a variety of protocols and profiles depending on the data being transferred. Protocols define how Bluetooth modules communicate (handshaking mechanisms, packet headers and size) and profiles dictate how Bluetooth modules should behave in certain applications. Profile examples include: Headset, Hands-Free, Object Push Profile, and Serial Port Profile[6].

Bluetooth device applications are grouped into three different categories, or classes: Class 1 devices have a max power output of 100mw and a max range of 100m; Class 2 devices have a max power output of 2.5mw and a max range of 10m; and Class 3 devices have a max power output of 1mw and a range of 1m [7].

Implementation of Technology

To implement Bluetooth communication between two devices, each device must include a Bluetooth transceiver module as well as a Bluetooth software stack tailored to each respective device. Hardware modules must conform to the Bluetooth controller specification, which includes an RF component operating in the 2.4 to 2.485 GHz range [7]. The software stack must implement the core Bluetooth Host and Controller specifications. In addition to these core specifications are protocols which define what kind of data will be sent over the radio. To send serial data over Bluetooth, the software stack must implement the RFCOMM protocol and the Serial Port Profile[6].

The software stack is typically included as a library (or series of libraries) in a device capable of running software – a computer, or microcontroller. If the device is a microcontroller, the library must be customized specifically for that hardware. The device will then use the Application Programming Interface (API) specified by the Bluetooth stack to operate the hardware and communicate with the paired device.

References

[1] Friedman, R.; Kogan, A.; Krivolapov, Y.; , "On power and throughput tradeoffs of WiFi and Bluetooth in smartphones," *INFOCOM, 2011 Proceedings IEEE* , pp.900-908, 10-15 April 2011
doi: 10.1109/INFCOM.2011.5935315
Available: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5935315&isnumber=5934870

[2] Bluetooth Special Interest Group, "Building with the Technology: Overview," *Bluetooth Special Interest Group*, 2012. [Online]. Available: https://www.bluetooth.org/Building/overview.htm. [Accessed Jan. 25, 2012].

[3] Microchip Inc., Bluetooth® Stack for PIC24, dsPIC and PIC32. [Online]. Available: http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=2680&dDocName=en551866. [Accessed Jan. 25, 2012].

[4] Android Open Source Project, "Bluetooth FAQ," [Online]. Available: https://sites.google.com/a/android.com/opensource/projects/bluetooth-faq . [Accessed Jan. 25, 2012].

[5] J. Yarow, "GARTNER: Android Market Share Doubles, iOS Drops In Q3," Nov. 15, 2011. [Online]. Available: http://articles.businessinsider.com/2011-11-15/tech/30400455_1_ios-iphone-smartphone-market. [Accessed Jan. 25, 2012].

[6] Bluetooth Special Interest Group, "Architecture Overview," *Bluetooth Special Interest Group*, 2012. [Online]. Available: https://www.bluetooth.org/Building/HowTechnologyWorks/Architecture/Overview.htm.

[7] Bluetooth Special Interest Group, "Specification of the Bluetooth System: Core Version 4.0," *Bluetooth Special Interest Group*, 30 June 2010 . [Online]. Available: https://www.bluetooth.org/docman/handlers/downloaddoc.ashx?doc_id=229737.