Bluetooth: A Technical Overview  
(Part 1 of 3)  
by Max Robert

Introduction

Bluetooth, a standard defining very short range wireless communications, has been a topic of considerable buzz in the telecommunications industry for the past several months. Bluetooth is named after a 10th-century Viking king known for his success in uniting Denmark and Norway during his rule around 960 AD. Just as King Harald Bluetooth is known for uniting different people, today’s Bluetooth-enabled devices promise to unite different information devices.

Many publications about Bluetooth tout the revolutionary lifestyle Bluetooth will enable while leaving technically oriented readers somewhat at a loss as to its true technical capabilities. This paper is first in a three-part series designed to address the technical issues of Bluetooth.

This first installment presents a general technical description of the Bluetooth standard with details derived from [3]. We begin with a description of Bluetooth’s application potential and the general environment in which it can operate before describing Bluetooth’s position in the protocol stack and its general connectivity methodology. Part two of this paper will present the standard’s physical interface, error control schemes, and link management process. Part three of this paper will describe available packet types, specifications supporting audio, and the security specification.

Bluetooth Overview

As a frame of reference, Bluetooth’s origin and short-term market potential must be considered. Bluetooth emerged through the efforts of a SIG (Special Interest Group) comprised of companies like Ericsson and Motorola. The Bluetooth SIG today is comprised of more than 2000 members [1]. The expected semiconductor market potential for Bluetooth is expected to top $3 billion by 2005 [2], while the production of devices is expected to reach 200 million by 2003. This market estimate does not take into account revenue from new markets defined by new Bluetooth-enabled applications.

The Bluetooth specification describes radio devices designed to operate over very short ranges – on the order of 10 meters. The original intent of these links was to replace the use of cables between information devices. The goals of the specification were to describe a device that is simple and robust, consumes little power, and, with particular emphasis, is very inexpensive to produce.

Bluetooth Capabilities

To cover most home and office short range applications, a Bluetooth device must support two general types of information: voice and data. The necessary link requirements for voice are different from those for data. While voice can tolerate a certain number of errors in a link, it is highly susceptible to jitter. Therefore, Bluetooth needs to support a synchronous data stream on the order of tens of kilobits per second without the strict requirement that the received data be error-free. Data, while generally lacking the strict timing requirements posed by voice streams, requires information to be error-free. Thus, depending on the data requirements, Bluetooth needs
a strong error recovery scheme, though timing requirements may be loose. Bluetooth has been structured to support both voice and data.

Given the short ranges involved and the types of links expected, the number of users supported within interference range of one another is relatively small. While a cellular system may be required to support thousands of users, a 10-meter network will only support a handful of devices. Bluetooth has been designed with a multiple-access scheme that, while only supporting a limited number of devices, greatly simplifies the synchronization task required to support a single cell (known within the Bluetooth specifications as a “piconet”).

**Bluetooth Applications**

Although the list of applications is limited only by a designer’s imagination, the Bluetooth SIG suggests five applications that provide a good illustration of the capabilities of the standard [4]: a three-in-one phone, an Internet bridge, an interactive conference, a headset, and an automatic synchronizer.

The three-in-one phone is a phone that can operate over a fixed-line phone line when within range, a mobile phone when outside the home, or as a walkie-talkie with another Bluetooth-enabled device when within range.

The Internet bridge example allows a mobile computer to interact with another device within Bluetooth range. The device the computer is interacting with has access to the Internet, whether through a fixed line or a mobile phone.

The interactive conference example allows the sharing of documents among several computers during a live conference. Bluetooth-enabled machines can interact with each other regardless of the available information infrastructure.

A Bluetooth-enabled headset can connect to any Bluetooth-enabled device that requires voice input or can provide sound, such as a wireline phone, mobile phone, or a music player.

An automatic synchronizer is an application that allows multiple devices, such as desktop computers, laptops, PDAs, and/or mobile phones to synchronize with each other such that appointments and contact information available in the different devices matches.

Beyond these five, the list of potential applications using this standard is practically limitless. Bluetooth has the ability to simplify the wireless connection between two devices to a level of complexity similar to that required today when connecting two devices using a simple wire.
Technical Overview

Position in the Protocol Stack

The Bluetooth specification covers details of the physical and data layers of the communications link. It should be noted that the strict partitioning of the different layers of the typical protocol stack defined by the OSI model is losing its significance in wireless implementations. It is sometimes in the best interest of an application to be aware of the current condition of the physical layer interface; in these cases the partition between the layers becomes fuzzy. Bluetooth provides a method for establishing an RF channel with a particular device and also provides an error recovery method.

Figure 1 is a diagram of the layers described by the Bluetooth specifications.

Connectivity

The basic Bluetooth network is called a piconet. A piconet is defined as the set of at most seven active devices operating under the control of a single device. A set of Bluetooth piconets is called a scatternet.

The piconet is centered on a single Bluetooth device called a master. The master device controls a single channel (defined in part two of this paper) and all the slave devices operating in that channel. To become a master, a device requests a connection with another device: if the paged device accepts the link, the calling device becomes a master for that link and the responding device becomes a slave. Every Bluetooth device is exactly the same except for a 48-bit device identifier (BD_ADDR). The application residing above Bluetooth is the part of the system that determines which device is master or slave by the simple act of requesting a Bluetooth device to establish a link.
As can be inferred from the simple manner in which a device can become a master or a slave, the network layout for a set of Bluetooth devices is a dynamic environment. This dynamic behavior is supported by the set of modes in which devices can operate. These modes allow the sharing of devices across multiple piconets in a scatternet. These modes also give devices the freedom to enter power-saving states.

Figure 2 shows an example of the link style Bluetooth employs; a scatternet consisting of two piconets, and an example of a slave device shared between two different piconets in a scatternet is shown.

This culminates the first part of this paper. Part 2 describes Bluetooth’s physical interface, its error control schemes, and its link management process.

Reference:
2 - [http://www.pcsdata.com/CahnersBluetooth.htm](http://www.pcsdata.com/CahnersBluetooth.htm)
4 - [http://www.bluetooth.com/bluetoothguide/models/two_in_one.asp#top](http://www.bluetooth.com/bluetoothguide/models/two_in_one.asp#top)

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