Bluetooth™ General Information White Paper

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Introduction

The *Bluetooth* wireless technology is the world's new short-range RF transmission standard for small form factor, low-cost, short-range radio links between portable or desktop devices. The technology promises to eliminate the confusion of cables, connectors and protocols confounding communications between today's high tech products. Mobile phones, pagers, laptops, PDAs, digital cameras and more, all now have a common structure for communicating across their product platforms.

Bluetooth wireless technology provides a solution to a continuously increasing need for mobile freedom. The increase in the number of users, and the constant shrinking, of portable computers, as well as the trend towards the replacement of desktop computers from portable ones, form an ideal market environment for a solution that eliminates the annoying cable and its limitations regarding flexibility and range.

Bluetooth is a low-cost, low-power, secure and robust standard for short-range connectivity. The technology has been designed for ease of use, simultaneous voice and data and multi-point communications. It supports a range of 10 meters, which can be increased up to 100 meters with the use of an amplifier.

The initiative for the specification belongs to the *Bluetooth* Special Interest Group (SIG) (www.*bluetooth*.com) which was founded in February 1998. At the start, it consisted of Ericsson Mobile Communications, Intel, IBM, Toshiba and Nokia Mobile Phones. This group represented the diverse market support that was needed to generate good support for the new technology. With over 2,000 companies now part of the *Bluetooth* Special Interest Group (SIG), tomorrow's products will fall into one of two categories: those that are enabled with *Bluetooth* and those that are not.

Apart from the definition of the radio and link protocols, the job of the *Bluetooth* SIG is to ensure the same interpretation of the *Bluetooth* standard by all future vendors. Therefore, it has defined a number of user models and protocol profiles, as well as specific procedures for interoperability verification.

How Does It Work?

Any *Bluetooth* system has four basic parts: a radio (RF) that receives and transmits data and voice; a baseband or link control unit that processes the transmitted or received data; link management software that manages the transmission; and supporting application software.

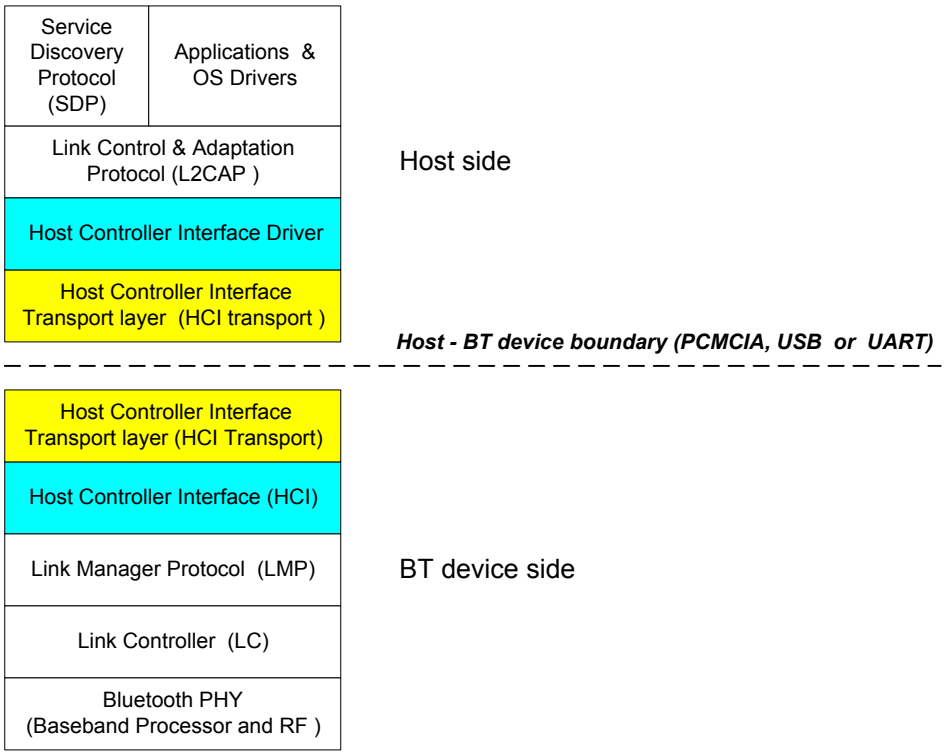
The *Bluetooth* radio is a short-distance, low-power radio that operates in the unlicensed spectrum of 2.4 GHz. This spectrum is shared by other types of equipment (e.g. microwave ovens). In order to avoid interference, the *Bluetooth* specification employs Frequency Hopping Spread Spectrum (FHSS) techniques. Using a nominal antenna power of 0 dBm, the range is 10 meters (33 feet). Optionally, a range of 100 meters (328 feet) may be achieved by using an antenna power of 20 dBm. Data is transmitted at a maximum gross rate of up to 1 Mbps. Protocol overhead limits the practical data rate to a little over 721 kbps. Interference or being out of range may further decrease the achievable data rate.

Baseband is the hardware that turns received radio signals into a digital form, which can be processed by the host application. It also converts digital or voice data into a form that can be transmitted using a radio signal. The baseband processor takes care of converting data from one form to another (such as voice to digital data), compressing it, putting it into packets, taking it out from packets, assigning identifiers and error correction information and then reversing the entire process for data that is received. In *Bluetooth*, the baseband function is called the link controller.

The link manager software runs on a microprocessor and manages the communication between *Bluetooth* devices. Each *Bluetooth* device has its own link manager, which discovers other remote link managers, and communicates with them to handle link setup, negotiate features, authenticate QoS and to encrypt and adjust data rate on link, dynamically.

The application software is embedded in the device that operates an application over the *Bluetooth* protocol stack (see Figure 1). This software allows the PDA, mobile phone, or keyboard to do its job. All *Bluetooth* devices must have compatible sections in their *Bluetooth* stack, so that all *Bluetooth* devices will be able to interoperate with each other.

Figure 1. The *Bluetooth* Protocol Stack



The Components of a *Bluetooth* System

All *Bluetooth* designs require an antenna, a transceiver and a baseband controller that meet the *Bluetooth* specification (see Table 1). A microcontroller (MCU) to run the link control, link manager and Host Controller Interface (HCI) and/or Logical Link Control and Adaptation Protocol (L2CAP) firmware, as well as memory to store the firmware, configuration information and short-term operating information are also needed. Alternatively, developers can choose to implement protocols up to and including, HCI on the microcontroller, and to implement the HCI driver and L2CAP on the machine that hosts the *Bluetooth* chipset.

Quite a few combinations for the *Bluetooth* hardware are possible. These range from single-chip solutions (RF, Baseband, Microcontroller and memory integrated into one chip), up to four-chip solutions (RF, Baseband, Microcontroller and memory in separate chips).

Table 1. *Bluetooth* V1.0 Specification Summary

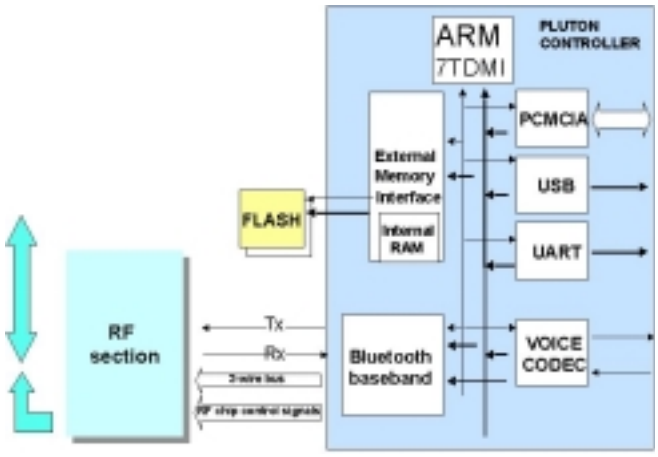
Radio Frequency	2.45GHz (ISM band)
Spread Spectrum Technique	Frequency Hopping
Hop Frequencies	79 (spaced 1 MHz apart)
Hop Rate	1,600 hops/sec (625 µs dwell time)
Transmitting Power	1 - 100 mW
Max. Range	10 m (0 dBm)/100 m (20 dBm)
Max. Gross Bit Rate	1 Mbps
Max. Practical Bit Rate (ACL-Symmetric)	433.9 Kbps
Max. Practical Bit Rate (ACL-Asymmetric)	723.2 Kbps/57.6 Kbps
Bit Rate (SCO)	64 Kbps
Max. Piconet Units	8 (1 master - 7 slaves)
Power Save Modes	Hold-Sniff-Park

Atmel Offering

Atmel, a *Bluetooth* SIG member, is one of the world's few companies that offers systems designers a complete, single-vendor *Bluetooth* solution – RF, baseband/microcontroller, Flash, software and firmware. Atmel has its main chip fab facilities in Colorado Springs, Colorado, in Rousset, France and Heilbronn, Germany and has extensive experience refining its process technologies to achieve the system-level integration of all the components of the *Bluetooth* standard.

Currently, Atmel offers a complete three-chip solution: baseband and microcontroller functions into one chip, RF transceiver and Flash memory. Our roadmap includes the eventual integration of these three chips into a single-chip solution.

Figure 2. Atmel's AT76C551 *Bluetooth* Module



Atmel's *Bluetooth* ICs

Atmel's *Bluetooth* baseband controller, in conjunction with a 2.45 GHz transceiver, provides a low-chip count solution for a wide range of digital communication devices and computer peripherals. The baseband is based on an AR7TDMI™ processor, includes 64K bytes of internal SRAM and supports three different interfaces: PCMCIA, USB and UART. Some versions will also include a 16-bit voice Codec capable of either log PCM or CVSD voice coding.

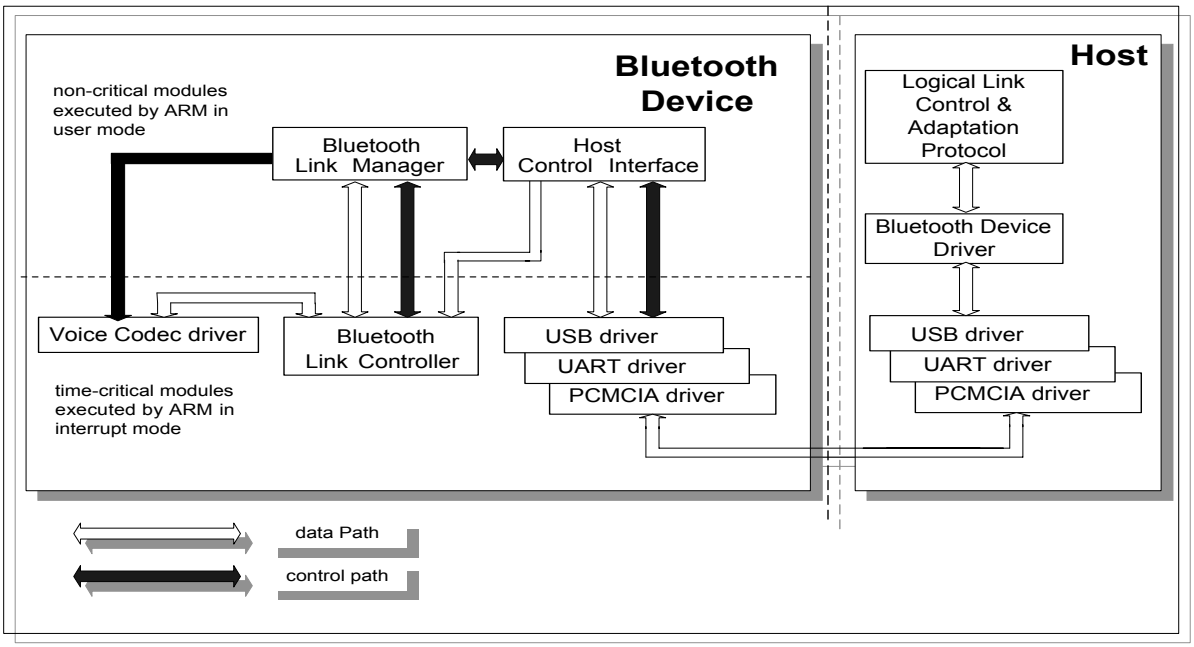
For the RF part, Atmel offers T2901, which is a 0 dBm RF transceiver with integrated synthesizer and VCO. The transceiver supports *Bluetooth*'s 10 meter "Pico-Cable" specification and features a proprietary image rejection mixer and advanced closed loop modulation. It does not require mechanical tuning.

Also, Atmel offers T7024, which is a 20 dBm RF front end supporting *Bluetooth*'s 100 meter "Mega-Cable" specification. The chip features 23 dBm P_{OUT} typ, low noise (2.0 dB typ), high gain and ramp controlled output.

Atmel's *Bluetooth* Firmware and Software

ATMEL provides customers all firmware on the device side. L2CAP and Service Discovery Protocols on the host side can be made available to qualified customers. Software is available up through the HCI transport layer, as well as drivers for PCMCIA and UART interfaces. Drivers for the USB interface will soon be available.

Figure 3. ATMEL *Bluetooth* Firmware Architecture Model



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