**SENGUNTHAR ENGINEERING COLLEGE**

**THIRUCHENGODE**



 

Presented by,

**RAHUL P A**,3rd CSE,

Sengunthar Engineering College, Tiruchengode,

rahulmeppadi@gmail.com

**PUZHAKKALIL AJITH**,3rd CSE,

Sengunthar Engineering College, Tiruchengode,

Pajt.hacker@gmail.com

**WIBRREE**

Wibree is a feature of [Bluetooth](http://en.wikipedia.org/wiki/Bluetooth) 4.0 wireless radio technology, aimed at new, principally low-power and low-latency, applications for wireless devices[[1]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-BluetoothSIG-0) within a short range (up to 50 metres / 160 feet -see table below). This facilitates a wide range of applications and smaller form factor devices in the healthcare, fitness, security and home entertainment industries.

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**Lower power consumption**

Devices using Bluetooth low energy wireless technology are expected to consume a fraction of the power of Classic Bluetooth enabled products for Bluetooth communication. In many cases, products will be able to operate more than a year on a button cell battery without recharging. It will be possible to have sensors such as thermometers operating continuously, and intermittently communicating with other devices like a mobile phone. This may increase the concerns for privacy, as when the remote, low power, continuously on, sensor would be presence sensors or similar devices.[[1]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-BluetoothSIG-0)

Note that the lower power consumption is not achieved by the nature of the active radio transport, but by the design of the protocol to allow low duty cycles, and the use cases envisaged. A Bluetooth low energy device used for continuous data transfer would not have a lower power consumption than a comparable Bluetooth device transmitting the same amount of data; indeed, it would likely use more power, since the protocol is optimised for small bursts.

Several chip suppliers have released Bluetooth low energy chips. Other semiconductor companies are expected to release Bluetooth low energy chips in 2011. Some of these offered chip designs include the entire protocol suite implementation, others allow for special implementing strategies. Some of these chip designs allow for dynamic change of protocol suite even outside the Bluetooth technology/Bluetooth low energy standard, others are just tailored for one protocol suite. Those offering products include [Broadcom](http://en.wikipedia.org/wiki/Broadcom)[[2]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-1)[[3]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-2), [CSR](http://en.wikipedia.org/wiki/CSR),[[4]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-3), *EM Microelectronic*,[[5]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-4), [Nordic Semiconductor](http://en.wikipedia.org/wiki/Nordic_Semiconductor),[[6]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-5) and [Texas Instruments](http://en.wikipedia.org/wiki/Texas_Instruments)[[7]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-6).

The basic radio circuitry has almost similar power consumption as for standard Bluetooth radio (indeed, in dual-mode devices it is likely to be the same circuitry), but the overall power consumption is aimed to be lower, primarily by having a lower duty cycle. During transmission and reception these devices exhibit peak currents in the tens of milliamps (mA) range in both Bluetooth low energy technology and Bluetooth modes. In sleep modes, the aim is to have current consumption reduced to tens of nanoamps (nA). Because of very low duty cycles (of the order of 0.25%) average currents are therefore in the microamp (μA) range enabling button cell battery power sources to last up to a year.

**Bluetooth technology *vs* NFC**

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|  | **Bluetooth V2.1** | **Bluetooth low energy technology** | **NFC** |
| [**RFID**](http://en.wikipedia.org/wiki/RFID) **mode** | active | active | ISO 18000-3 |
| **Standardisation body** | Bluetooth SIG | Bluetooth SIG | ISO/IEC |
| **Network** [**Standard**](http://en.wikipedia.org/wiki/Technical_standard) | IEEE 802.15.1 | IEEE 802.15.1 | ISO 13157 etc. |
| **Network Type** | WPAN | WPAN | Point-to-point |
| **Cryptography** | available | available | not with RFID |
| **Range** | ~30 m (class 2) | ~50 m | < 0.2 m |
| **Frequency** | 2.4-2.5 GHz | 2.4-2.5 GHz | 13.56 MHz |
| **Bit rate** | 1-3 Mbit/s | ~200 kbit/s | 424 kbit/s |
| **Set-up time** | < 6 s | < 3 ms | < 0.1 s |

Bluetooth technology (2.45 GHz) and [Near Field Communication](http://en.wikipedia.org/wiki/Near_Field_Communication) (NFC 13.56 MHz) may both be used as short-range communication technologies. However, allowed transmission power for NFC 13.56 MHz is strongly limited implying short range, whilst Bluetooth technology has a range that reaches up to 100m, depending on its class. Integration with mobile phones is increasing, where Bluetooth technology is already part of almost all phone types. Bluetooth low energy technology set-up time has been designed to be faster than Classic Bluetooth technology.

There is no aim to make Bluetooth technology's WPAN implementation compatible with passive RFID. However, Bluetooth technology defines a well standardized new class of active RFID which requires comparably lower power consumption than NFC in passive read mode, due to different physical coupling: far field is used for Bluetooth technology, whilst near field/inductive is used for NFC.

**History**



In 2001, Nokia researchers determined that there were various scenarios that contemporary wireless technologies did not address. To address the problem, the Nokia Research Center[[8]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-7) started the development of a wireless technology adapted from the [Bluetooth](http://en.wikipedia.org/wiki/Bluetooth) standard which would provide lower power usage and price while minimizing difference between Bluetooth technology and the new technology. The results were published in 2004 using the name Bluetooth Low End Extension.[[9]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-8) After further development with partners, e.g., within [EU](http://en.wikipedia.org/wiki/EU) [FP6](http://en.wikipedia.org/wiki/FP6) project [MIMOSA](http://www.mimosa-fp6.com), the technology was released to public in October [2006](http://en.wikipedia.org/wiki/2006) with brand name Wibree.[[10]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-9) After negotiations with [Bluetooth SIG](http://en.wikipedia.org/wiki/Bluetooth_SIG) members, in June [2007](http://en.wikipedia.org/wiki/2007), an agreement was reached to include Wibree in future Bluetooth specification as a Bluetooth ultra-low-power technology, now known as [Bluetooth low energy technology](http://en.wikipedia.org/wiki/Bluetooth#Bluetooth_low_energy).[[11]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-10)[[12]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-11)

In December 2009, the Bluetooth SIG announced the adoption of Bluetooth low energy wireless technology as the hallmark feature of the Bluetooth Core Specification Version 4.0. Samples of sensors utilizing this specification are available from some silicon manufacturers today and shipments are anticipated to follow closely behind.

Integration of Bluetooth low energy technology with the Core Specification will be completed in early 2010 and the first Bluetooth low energy enabled products should be available before the end of the calendar year. Upon completion, mobile phone and PC manufacturers may enhance their Bluetooth product offerings with support for Bluetooth low energy wireless technology. End-user devices with Bluetooth v4.0 are expected to reach the market in late 2010 or early 2011.

**Actual status**

The Bluetooth low energy specification is available to the general public as part of Bluetooth Core Specification Version 4.0.[[13]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-12) Actual stage of specification includes some optional features. No commonly published document currently discloses which of these options will be included in the decided chip implementations.

Partners that currently license the technology and cooperate in defining the specification are [Alpwise](http://www.alpwise.com/), [Broadcom Corporation](http://en.wikipedia.org/wiki/Broadcom_Corporation), [CSR](http://en.wikipedia.org/wiki/CSR_plc), [Epson](http://en.wikipedia.org/wiki/Epson), [MindTree](http://en.wikipedia.org/wiki/MindTree), [Nordic Semiconductor](http://en.wikipedia.org/wiki/Nordic_Semiconductor), and [Texas Instruments](http://en.wikipedia.org/wiki/Texas_Instruments). Other contributors are [Suunto](http://en.wikipedia.org/wiki/Suunto) and [Taiyo Yuden](http://en.wikipedia.org/wiki/Taiyo_Yuden).[[14]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-13)

The first Bluetooth low energy chips, from [CSR](http://en.wikipedia.org/wiki/CSR_plc), [Nordic Semiconductor](http://en.wikipedia.org/wiki/Nordic_Semiconductor) and [Texas Instruments](http://en.wikipedia.org/wiki/Texas_Instruments), were released to mass-market in late 2010 and early 2011. Bluetooth low energy chips from other semiconductor manufacturers are expected to follow. The first Bluetooth low energy Intellectual Property has been qualified by [RivieraWaves](http://www.rivierawaves.com/) in 2010.

Currently (2010–12) the definitions of respective application profiles still are not fulfilled work-items of the standardisation bodies. The first consumer products using Bluetooth low energy technology are expected to debut in first half of 2011.

**Market demand**

The Bluetooth SIG follows the market demand for low energy consumption respectively lesser battery wear out. This 2007 Bluetooth SIG adoption move for the 2001 Nokia 'Wibree' proposal was necessary to include low battery consumption operational modes for newly designed devices to communicate with other Bluetooth devices yet deployed. However, the compatibility depends on applications that run on existing Bluetooth devices and made capable for digesting the respective low energy transmissions with software updates. In addition to creating a market for sensors, watches and other existing devices, Bluetooth low energy technology’s ability to connect low power devices to mobile phones offers a great variety of new applications.

The big advantage is the commonly available equipping of mobile appliances with Bluetooth chips, thus **requiring no additional infrastructure** for any [ad-hoc networking](http://en.wikipedia.org/wiki/Wireless_ad_hoc_network) in [topologies](http://en.wikipedia.org/wiki/Topology) of [peer networking](http://en.wikipedia.org/wiki/Peer-to-peer), [scatter networking](http://en.wikipedia.org/wiki/Scatternet) or [meshed networking](http://en.wikipedia.org/wiki/Wireless_mesh_network). Technically comparable solutions with other industry groups' standards (e.g. [*ZigBee*](http://en.wikipedia.org/wiki/ZigBee), [*ANT*](http://en.wikipedia.org/wiki/ANT_%28network%29)) under the umbrella of the international standard [IEEE 802.15.4-2006](http://en.wikipedia.org/wiki/IEEE_802.15.4-2006) show further paths, relying of special infrastructures.

**Technical details**

Bluetooth low energy technology operates in the same spectrum range (2402-2480 MHz) as Classic Bluetooth technology, but uses a different set of channels. Instead of Bluetooth technology's 79 1 MHz wide channels, Bluetooth low energy technology has 40 2 MHz wide channels. Bluetooth low energy technology uses a different frequency hopping scheme to Classic Bluetooth technology; as a result, whilst both FCC and ETSI classify Bluetooth technology as an [FHSS](http://en.wikipedia.org/wiki/FHSS) scheme, Bluetooth low energy technology is classified as a system using digital modulation techniques or a [direct-sequence spread spectrum](http://en.wikipedia.org/wiki/Direct-sequence_spread_spectrum).

Bluetooth low energy technology is designed with two equally important implementation alternatives: single-mode and dual-mode. Small devices like tokens, watches and sports sensors based on a single-mode Bluetooth low energy implementation will enjoy the low-power consumption advantages enabled for highly integrated and compact devices. In dual-mode implementations Bluetooth low energy functionality is integrated into Classic Bluetooth circuitry. The architecture will share Classic Bluetooth technology radio and antenna, enhancing currently chips with the new low energy stack—enhancing the development of Classic Bluetooth devices with new capabilities.[[1]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-BluetoothSIG-0)

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| **Technical Specification** | **Classic Bluetooth technology** | **Bluetooth low energy technology** |
| Distance/Range | 100 m (330 ft) | 50 m (160 ft) |
| Over the air data rate | 1-3 Mb/s | 1 Mb/s |
| Application throughput | 0.7-2.1 Mb/s | 0.26 Mb/s |
| Active slaves | 7 | Not defined; implementation dependent |
| Security | 56/128-bit and application layer user defined | 128-bit [AES](http://en.wikipedia.org/wiki/Advanced_Encryption_Standard) with Counter Mode [CBC-MAC](http://en.wikipedia.org/wiki/CBC-MAC) and application layer user defined |
| Robustness | Adaptive fast frequency hopping, [FEC](http://en.wikipedia.org/wiki/Forward_error_correction), fast [ACK](http://en.wikipedia.org/wiki/Acknowledgement_%28data_networks%29) | Adaptive frequency hopping, Lazy Acknowledgement, 24-bit CRC, 32-bit Message Integrity Check |
| Latency (from a non connected state) | Typically 100 ms | 6 ms |
| Total time to send data (det.battery life) | 100 ms | 6 ms[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed)], <3ms[[15]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-14) |
| Voice capable | Yes | No |
| Network topology | Scatternet | Star-bus |
| Power consumption | 1 as the reference | 0.01 to 0.5 (depending on use case) |
| Peak current consumption | <30 mA | <20 mA (max 15 mA to run on coin cell battery) |
| Service discovery | Yes | Yes |
| Profile concept | Yes | Yes |
| Primary use cases | Mobile phones, gaming, headsets, stereo audio streaming, automotive, PCs, security, proximity, healthcare, sports & fitness, etc. | Mobile phones, gaming, PCs, watches, sports and fitness, healthcare, security & proximity, automotive, home electronics, automation, Industrial, etc. |

More technical details may be obtained from official specification as published by the Bluetooth SIG. Note that power consumption is not part of the Bluetooth specification.

**Compatibility**

The Bluetooth low energy protocol is not backward compatible with classic Bluetooth protocol. However, Bluetooth low energy technology and Bluetooth technology operate on the same spectrum so the underlying hardware is likely to be similar. A given device may be able to operate as a Bluetooth low energy technology and Bluetooth device using the very same chip and radio hardware, though not simultaneously; this is a Bluetooth 4.0 *dual-mode* device.[[16]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-Apple_Adopts_Bluetooth_low_energy-15) More smartphones, laptops and tablets that support Bluetooth 4.0 (which includes both Classic Bluetooth technology and Bluetooth low energy technology) are expected to be released in late 2011 and early 2012.

**Application profiles**

The commonly available specification of Bluetooth low energy application profiles has to be expected prior to commonly available appliances. Currently there are hints that application profiles get commonly published. Membership in Bluetooth SIG is the minimum requirement to get access to readily edited specification documents.

The latest indication of ready designed and agreed profiles was on 2011-07-05 by [Nordic Semiconductor](http://en.wikipedia.org/wiki/Nordic_Semiconductor)[[17]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-16)

**Consumer profiles**

The first simple consumer profiles notified by members of Bluetooth SIG are

* *Find Me*: The *find me* profile shall support [electronic leash](http://en.wikipedia.org/wiki/Electronic_leash) applications.
* *Proximity*: The *proximity* profile shall support [wireless lock](http://en.wikipedia.org/wiki/Wireless_lock) applications as well as authentication procedures. There is no indication yet that said proximity profile contributes to qualification procedures according to [ISO/IEC 15408](http://en.wikipedia.org/wiki/ISO/IEC_15408).

**Health care profiles**

Main focus in health care with Bluetooth low energy technology is vital monitoring.[[18]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-17) A promoter of such applications in cooperation with Bluetooth SIG is [The Continua Health Alliance](http://en.wikipedia.org/wiki/The_Continua_Health_Alliance) as an industrial standardisation body.

* Health Thermometer Service[[19]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-18)
* Heart rate Monitor[[20]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-19)

Qualification of such approaches according to US ([Food and Drug Administration](http://en.wikipedia.org/wiki/Food_and_Drug_Administration)) or EU medical devices qualification directives[[21]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-20) is not reported.

**Sporting profiles**

Main focus in sports with Bluetooth low energy technology is locating as well as vital monitoring. The promoter of such applications is Bluetooth Special Interest Group (SIG)[[22]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-21) as an industrial standardisation body as well as Continua Health Alliance. Bluetooth low energy technology is in competition with other industry solution standards such as [ANT\_(network)](http://en.wikipedia.org/wiki/ANT_%28network%29).[[23]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-22)

 **Use cases**

Bluetooth low energy technology is the hallmark feature of v4.0 of the Bluetooth Core Specification. This enhancement to the Bluetooth Core Specification that will enable new functionality and applications for remote controls, healthcare monitors, sports sensors and other devices. Bluetooth low energy technology will enhance existing use cases and will enable new ones, widening the applicability and functionality of Bluetooth technology.

The respective chips may be integrated into products such as tokens, watches, manual controls, wireless keyboards, gaming pads and body sensors, which may then connect to host devices such as mobile phones, [smartphones](http://en.wikipedia.org/wiki/Smartphone), [personal digital assistants](http://en.wikipedia.org/wiki/Personal_digital_assistants) (PDAs), tablet PCs, notebook PCs, laptop PCs and other grades of and [personal computers](http://en.wikipedia.org/wiki/Personal_computers) (PCs).

However, currently in the tenth year after earliest publication with inventor [Nokia](http://en.wikipedia.org/wiki/Nokia) in 2001 (Wibree) there is no implementing on chip-basis or on protocol-basis to any of the current PC-like or PDA-like products or with any mobile phones nor any of the announced appliance products neither disclosed nor announced. All announcement but one is recognised still just with Bluetooth SIG and not beyond (2010-01-27). The notified exception is with [a wireless velo-odometer](http://www.velocomputer.com/), probably not recognised as the *killer-application* with mobilephones.

Bluetooth low energy technology hence may extend any personal area network according to the intentions with IEEE 802.15 WPAN to include watches and toys, sports and health care equipment, human interface (HIDs) and entertainment devices.

**Electronic leash**

Existing solutions of the [electronic leash](http://en.wikipedia.org/wiki/Electronic_leash) concept get improved with the better economised battery consumption of the Bluetooth v4.0 low energy protocols. Several suppliers yet offer the so-called [electronic leash](http://en.wikipedia.org/wiki/Electronic_leash) solution based on standard Bluetooth v2.1 protocols. This serves for wirelessly tethering mobile appliances with each other. The [RSSI](http://en.wikipedia.org/wiki/RSSI) estimate serves for a radial metrics, but without any certified calibration. Setting an alarm on unintentional loss is the key service offered with this concept. An advanced aspect has recently been launched with Bluetooth low energy technology for better economised battery life cycle. Special trimming serves for two years operation from a button cell.[[24]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-23)

**Automatic authentication**

Connection-based communication allows for design of secure communication under the qualification schemes of [ISO](http://en.wikipedia.org/wiki/ISO)/[IEC](http://en.wikipedia.org/wiki/IEC) 15408 [Common Criteria](http://en.wikipedia.org/wiki/Common_Criteria) standard, however connection-free communication limits the suitability of low energy for secure communications. Beyond classic configurarion of appliances, a personally carried duet of Bluetooth enabled smartphone and a Bluetooth enabled watch allow for an automatic two-factor authentication en passant. Then the watch delivers just an identity in the mode of active [RFID](http://en.wikipedia.org/wiki/RFID).

**Automatic context detection and automatic log-off**

Detecting [operational context](http://en.wikipedia.org/wiki/Operational_context) may be implemented by detection of coincidence of two or more Bluetooth v4.0 low energy protocol enabled tokens, appliances and smartphones. This qualifies for better protection of private and corporate data upon access for log-on to networked work positions as well as with mobile network clients.

Whereas currently known solutions rely just on transmission range limitations, the new Bluetooth v4.0 low energy protocol enables for qualified segregation of various operational distances based on assessment of received signal strength. In contrast to known proposals for locating, such unilateral estimation serves for good discrimination of cohesion in operational context, but does not pretend to deliver a certified accuracy, which is impossible due to variations in transmission conditions.

**Keeping pace**

The community openness of the standard with Bluetooth SIG and compatibility with wireless regulations under the IEEE framework as well as the downward compatibility of the chips allows for a wide acceptance of the additional protocol stack.

**Downloading software updates**

Presuming the availability of the low energy enabled chip and low energy protocol stack on the target device, the respective applications with existing and deployed devices may be opened to Bluetooth low energy technology by updates. This will enable the Bluetooth software defined radio to receive signals from Bluetooth low energy devices. However, the capability to communicate in duplex mode is limited with the defined frequency allocation schemes for Classic Bluetooth technology. The common appliances such as mobile phones, [personal digital assistants](http://en.wikipedia.org/wiki/Personal_digital_assistants) (PDAs) and [personal computers](http://en.wikipedia.org/wiki/Personal_computers) (PCs) may then receive as host devices for complex applications the signals transmitted from Bluetooth low energy devices.

Bluetooth low energy technology hence may extend any personal area network according to the intentions with IEEE 802.15 ([WPAN](http://en.wikipedia.org/wiki/Personal_area_network#Wireless_PAN)) to network personally carried simple devices with other appliances for complex local applications as well as for gateway support to transfer information to other networked entities.

**Standardisation**

In the market of proprietary connectivity solutions, Bluetooth low energy technology differentiates itself through its:

* widely adopted industry standard for protocols (Bluetooth SIG Bluetooth v4.0 and future later versions)
* widely commonalised application profiles agreed under the auspices of Bluetooth SIG
* multi vendor availability of respective chips
* internationally adopted industry standard for transmission (IEEE 802.15.1)
* possibility to emulate the protocol stack with compliant 2.45 GHz chips (IEEE 802.15)
* low price through single chip integration
* availability of new application via applet downloads
* continuous compatibility with yet deployed Bluetooth devices (V4.0 or later) via software updates

**Other examples of compatible devices**

* Apple's iPhone 4S[[25]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-24)
* Bluegiga's BLED112 and BLE112 modules[[26]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-25)
* Texas Instruments chip CC2540[[27]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-26)
* Nordic Semiconductor's chip nRF8001[[28]](http://en.wikipedia.org/wiki/Bluetooth_low_energy#cite_note-27)
* Apple MacBook air
* Apple Mac Mini