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Making Phones Feel Good

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Bluetooth®

## How Bluetooth Technology Works

**Bluetooth wireless technology is a short-range communications system intended to replace the cables connecting portable and/or fixed electronic devices. The key features of Bluetooth wireless technology are robustness, low power, and low cost. Many features of the core specification are optional, allowing product differentiation.**

**The Bluetooth core system consists of an RF transceiver, baseband, and protocol stack. The system offers services that enable the connection of devices and the exchange of a variety of data classes between these devices.**

## Overview of Operation

**The Bluetooth RF (physical layer) operates in the unlicensed ISM band at 2.4GHz. The system employs a frequency hop transceiver to combat interference and fading, and provides many FHSS carriers. RF operation uses a shaped, binary frequency modulation to minimize transceiver complexity. The symbol rate is 1 Megasymbol per second (Msps) supporting the bit rate of 1 Megabit per second (Mbps) or, with Enhanced Data Rate, a gross air bit rate of 2 or 3Mb/s. These modes are known as Basic Rate and Enhanced Data Rate respectively.**

**During typical operation, a physical radio channel is shared by a group of devices that are synchronized to a common clock and frequency hopping pattern. One device provides the synchronization reference and is known as the master. All other devices are known as slaves. A group of devices synchronized in this fashion form a piconet. This is the fundamental form of communication for Bluetooth wireless technology.**

**Devices in a piconet use a specific frequency hopping pattern which is algorithmically determined by certain fields in the Bluetooth**

**specification address and clock of the master. The basic hopping pattern is a pseudo-random ordering of the 79 frequencies in the ISM band. The hopping pattern may be adapted to exclude a portion of the frequencies that are used by interfering devices. The adaptive hopping technique improves Bluetooth technology co-existence with static (non-hopping) ISM systems when these are co-located.**

**The physical channel is sub-divided into time units known as slots. Data is transmitted between Bluetooth enabled devices in packets that are positioned in these slots. When circumstances permit, a number of consecutive slots may be allocated to a single packet. Frequency hopping takes place between the transmission or reception of packets. Bluetooth technology provides the effect of full duplex transmission through the use of a time-division duplex (TDD) scheme.**

**Above the physical channel there is a layering of links and channels and associated control protocols. The hierarchy of channels and links from the physical channel upwards is physical channel, physical link, logical transport, logical link and L2CAP channel.**

**Within a physical channel, a physical link is formed between any two devices that transmit packets in either direction between them. In a piconet physical channel there are restrictions on which devices may form a physical link. There is a physical link between each slave and the master. Physical links are not formed directly between the slaves in a piconet.**

**The physical link is used as a transport for one or more logical links that support unicast synchronous, asynchronous and isochronous traffic, and broadcast traffic. Traffic on logical links is multiplexed onto the physical link by occupying slots assigned by a scheduling function in the resource manager.**

**A control protocol for the baseband and physical layers is carried over logical links in addition to user data. This is the link manager protocol (LMP). Devices that are active in a piconet have a default asynchronous connection-oriented logical transport that is used to transport the LMP protocol signaling. For historical reasons this is known as the ACL logical transport. The default ACL logical transport is the one that is created whenever a device joins a piconet. Additional logical transports may be created to transport synchronous data streams when this is required.**

**The link manager function uses LMP to control the operation of devices in the piconet and provide services to manage the lower architectural layers (radio layer and baseband layer). The LMP protocol is only carried on the default ACL logical transport and the default broadcast logical transport.**

**Above the baseband layer the L2CAP layer provides a channel-based abstraction to applications and services. It carries out segmentation**

**and reassembly of application data and multiplexing and de-multiplexing of multiple channels over a shared logical link. L2CAP has a protocol control channel that is carried over the default ACL logical transport. Application data submitted to the L2CAP protocol may be carried on any logical link that supports the L2CAP protocol.**

## Glossary

### Ad Hoc Network
**A network typically created in a spontaneous manner. An ad hoc network requires no formal infrastructure and is limited in temporal and spatial extent.**

### Active Slave Broadcast (ASB)
**The ASB logical transport is used to transport L2CAP user traffic to all active devices in the piconet.**

### Advanced Audio Distribution Profile (A2DP)
**The A2DP profile describes how stereo quality audio can be streamed from a media source to a sink. The profile defines two roles of an audio source and sink. A typical usage scenario can be considered as the "walkman" class of media player. The audio source would be the music player and the audio sink is the wireless headset. A2DP defines the protocols and procedures that realize distribution of audio content of high-quality in mono or stereo on ACL channels.**

### Audio/Video Remote Control Profile (AVRCP)
**AVRCP is designed to provide a standard interface to control TVs, Hi-fi equipment, etc. This profile is used to allow a single remote control (or other device) to control all the A/V equipment that a user has access to. AVRCP defines how to control characteristics of streaming media. This includes pausing, stopping, and starting playback and volume control as well as other types of remote control operations.**

### Beacon Train
**A pattern of reserved slots within a basic or adapted piconet physical channel. Transmissions starting in these slots are used to resynchronize parked devices.**

### Basic Imaging Profile (BIP)
**BIP defines how an imaging device can be remotely controlled, how an imaging device may print, as well as how an imaging device can transfer images to a storage device. A typical scenario involves a mobile phone being used to control the shutter operation of a digital camera.**

### Basic Printing Profile (BPP)
**BPP allows devices to send text, e-mails, vCards, images or other items to printers based on print jobs. It differs from HCRP in that it needs no printer-specific drivers. This makes it more suitable for**

**embedded devices such as mobile phones and digital cameras, which cannot easily be updated with drivers dependent upon printer vendors.**

### Bluetooth wireless technology

**Bluetooth wireless technology is a wireless communication link, operating in the unlicensed ISM band at 2.4 GHz using a frequency hopping transceiver. It allows real-time AV and data communications between Bluetooth enabled hosts. The link protocol is based on time slots.**

### Bluetooth Baseband

**The part of the Bluetooth system that specifies or implements the medium access and physical layer procedures to support the exchange of real-time voice, data information streams, and ad hoc networking between Bluetooth enabled devices.**

### Bluetooth Clock

**A 28 bit clock internal to a Bluetooth controller sub-system that ticks every 312.5 ms. The value of this clock defines the slot numbering and timing in the various physical channels.**

### Bluetooth Controller

**A sub-system containing the Bluetooth RF, baseband, resource controller, link manager, device manager and a Bluetooth HCI.**

### Bluetooth Enabled Device

**A Bluetooth enabled device is a device that is capable of short-range wireless communications using the Bluetooth system.**

### Bluetooth Device Address

**A 48 bit address used to identify each Bluetooth enabled device. Often this is referred to in technical specifications as BD_ADDR.**

### BD_ADDR

**The Bluetooth device address, BD_ADDR, is used to identify a Bluetooth enabled device.**

### Bluetooth HCI

**The Bluetooth HCI provides a command interface to the baseband controller and link manager and access to hardware status and control registers. This interface provides a uniform method of accessing the Bluetooth baseband capabilities.**

### Bluetooth Host

**A Bluetooth Host is a computing device, peripheral, cellular telephone, access point to PSTN network or LAN, etc. A Bluetooth Host attached to a Bluetooth Controller may communicate with other Bluetooth Hosts attached to their Bluetooth Controllers as well.**

### Bluetooth Profiles

**Bluetooth profiles are general behaviors through which Bluetooth enabled devices communicate with other devices. Bluetooth technology defines a wide range of profiles that describe many different types of use cases. In order to use Bluetooth technology, a device must be able to interpret certain Bluetooth profiles. The profiles define the possible applications.**

### Channel
**Either a physical channel or an L2CAP channel, depending on the context.**

### Connect (to service)
**The establishment of a connection to a service. If not already done, this also includes establishment of a physical link, logical transport, logical link and L2CAP channel.**

### Connectable device
**A Bluetooth enabled device in range that periodically listens on its page scan physical channel and will respond to a page on that channel.**

### Connecting
**A phase in the communication between devices when a connection between them is being established. (Connecting phase follows after the link establishment phase is completed.)**

### Connection
**A connection between two peer applications or higher layer protocols mapped onto an L2CAP channel.**

### Connection Establishment
**A procedure for creating a connection mapped onto a channel.**

### Cordless Telephony Profile (CTP)
**The CTP defines how a cordless phone can be implemented over a Bluetooth wireless link. This profile can be used for either a dedicated cordless phone or a mobile phone that acts as a cordless phone when in proximity to a base station implementing the CTP. It is anticipated that mobile phones could use a Bluetooth CTP gateway connected to a landline when within the home, and the mobile phone network when out of range.**

### Coverage Area
**The area where two Bluetooth enabled devices can exchange messages with acceptable quality and performance.**

### Creation of a Secure Connection
**A procedure of establishing a connection, including authentication and encryption.**

### Creation of a Trusted Relationship

**A procedure where the remote device is marked as a trusted device. This includes storing a common link key for future authentication and pairing (if the link key is not available).**

### Device Discovery

**A procedure for retrieving the Bluetooth device address, clock, class-of-device field and used page scan mode from discoverable devices.**

### Dial-up Networking Profile (DUN)

**DUN provides a standard to access the Internet and other dial-up services over Bluetooth wireless technology. The most common scenario is accessing the Internet from a laptop by dialing up on a mobile phone, wirelessly.**

### Discoverable Device

**A Bluetooth enabled device in range that periodically listens on an inquiry scan physical channel and will respond to an inquiry on that channel. Discoverable device are normally also connectable.**

### Encryption

**Method of encoding data to prevent others from being able to interpret the information.**

### Extended Service Discovery Profile (ESDP)

**ESDP defines how universal plug and play runs over a Bluetooth wireless connection.**

### Fax Profile (FAX)

**The FAX profile defines how a FAX gateway device can be used by a terminal device. FAX is intended to provide a well-defined interface between a mobile phone or fixed-line phone and a PC with FAX software installed. A typical configuration is a personal computer using a mobile phone as a FAX gateway to send a FAX transmission to an arbitrary recipient.**

### File Transfer Profile (FTP)

**FTP defines how folders and files on a server device can be browsed by a client device. Once a file or location is found by the client, a file can be pulled from the server to the client, or pushed from the client to the server using GOEP.**

### General Audio/Video Distribution Profile (GAVDP)

**GAVDP provides the basis for A2DP and VDP, the basis of the systems designed for distributing video and audio streams using Bluetooth wireless technology. In a typical usage scenario, a device such as a "walkman" is used as the initiator and a headset is used as the acceptor.**

### Generic Access Profile (GAP)

**GAP provides the basis for all other profiles and defines a consistent means to establish a baseband link between Bluetooth enabled devices. The profile defines operations that are generic and can be**

**used by profiles referring to GAP and by devices implementing multiple profiles. GAP ensures that any two Bluetooth enabled devices, regardless of manufacturer and application, can exchange information via Bluetooth in order to discover what type of applications the devices support. Bluetooth enabled devices not conforming to any other Bluetooth profile must conform to GAP to ensure basic interoperability and co-existence.**

### Generic Object Exchange Profile (GOEP)

**GOEP is used to transfer an object from one device to another. The object may be any object such as a picture, document, business card, etc. The profile defines two roles, a server that provides the location form which an object is pulled or pushed, as well as a client that initiates the action. GOEP provides a generic blueprint for other profiles using the OBEX protocol .**

### Hands-Free Profile (HFP)

**HFP describes how a gateway device can be used to place and receive calls for a hand-free device. A typical configuration is an automobile using a mobile phone for a gateway device. In the car, the stereo is used for the phone audio and a microphone is installed in the car for sending outgoing audio of the conversation. HFP is also used for a personal computer to act as a speakerphone for a mobile phone in a home or office environment.**

### Hard Copy Cable Replacement Profile (HCRP)

**HCRP defines how driver-based printing is accomplished over a Bluetooth wireless link. The profile defines a client and a server role. The client is a device containing a print driver for the server on which the client wishes to print. A common configuration is a client personal computer printing using a driver to a printer acting as a server. This provides a simple wireless alternative to a cable connection between a device and a printer. HCRP does not set a standard regarding the actual communications to the printer, so drivers are required specific to the printer model or range.**

### Headset Profile (HSP)

**The HSP describes how a Bluetooth enabled headset should communicate with a computer or other Bluetooth enabled device such as a mobile phone. When connected and configured, the headset can act as the remote device's audio input and output interface.**

### Human Interface Device Profile (HID)

**The HID profile defines the protocols, procedures and features to be used by Bluetooth enabled HID, such as keyboards, pointing devices, gaming devices, and remote monitoring devices.**

### Inquiring Device

**A Bluetooth enabled device that is carrying out the inquiry procedure.**

### Inquiry
**A procedure where a Bluetooth device transmits inquiry messages and listens for responses in order to discover the other Bluetooth enabled devices within the coverage area.**

### Inquiry Scan
**A procedure where a Bluetooth enabled device listens for inquiry messages received on its inquiry scan physical channel.**

### Intercom Profile (ICP)
**Just as your voice can go unheard by others due to other noises, so too can Bluetooth radios go unheard due to other radio interference. This issue is especially a concern as Bluetooth wireless technology uses an unlicensed band for transmissions. Fortunately the technology was designed explicitly to be both a good citizen in these frequencies by not producing unnecessary noise but also to be able to avoid other radio waves. Some common radio technologies which can affect Bluetooth wireless products include microwave ovens and some models of cordless phones.**

### Interference
**Information in a stream where each information entity in the stream is bound by a time relationship to previous and successive entities.**

### Isochronous Data
**Information in a stream where each information entity in the stream is bound by a time relationship to previous and successive entities.**

### Known Device
**A Bluetooth enabled device for which at least the BD_ADDR is stored.**

### L2CAP Channel
**A procedure for establishing a logical connection on L2CAP level.**

### L2CAP Channel Establishment
**A procedure for establishing a logical connection on L2CAP level.**

### Link Establishment
**A procedure for establishing the default ACL link and hierarchy of links and channels between devices.**

### Link
**Shorthand for a logical link.**

### Link Key
**A secret key that is known by two devices and is used in order to authenticate each device to the other**

### LMP Authentication
**An LMP level procedure for verifying the identity of a remote device.**

### LMP Pairing
**A procedure that authenticates two devices and creates a common link key that can be used as a basis for a trusted relationship or a (single) secure connection.**

### Logical Channel
**Identical to an L2CAP channel, but deprecated due to an alternative meaning in Bluetooth Version 1.1**

### Logical link
**The lowest architectural level used to offer independent data transport services to clients of the Bluetooth system.**

### Logical Transport
**Used in Bluetooth wireless technology to represent commonality between different logical links due to shared acknowledgement protocol and link identifiers.**

### Name Discovery
**A procedure for retrieving the user-friendly name (the Bluetooth enabled device name) of a connectable device.**

### Object Exchange (OBEX) Protocol
**OBEX is a transfer protocol that defines data objects and a communication protocol two devices can use to exchange those objects. OBEX enables applications to work over the Bluetooth protocol stack as well as the IrDA stack. For Bluetooth enabled devices, only connection-oriented OBEX is supported. Three application profiles have been developed using OBEX which include SYNC, FTP and OPP.**

### Packet
**Format of aggregated bits that are transmitted on a physical channel.**

### Page
**The initial phase of the connection procedure where a device transmits a train of page messages until a response is received from the target device or a timeout occurs.**

### Page Scan
**A procedure where a device listens for page messages received on its page scan physical channel.**

### Paging Device
**A Bluetooth enabled device that is carrying out the page procedure.**

### Paired Device
**A Bluetooth enabled device with which a link key has been exchanged (either before connection establishment was requested or during connecting phase).**

### Pairing
**The process of establishing a new relationship between two Bluetooth enabled devices. During this process a link key is exchanged (either before connection establishment was requested or during connecting phase).**

### Parked Device
**A device operating in a basic mode piconet that is synchronized to the master but has given up its default ACL logical transport.**

### Passcode
**When pairing devices, it is strongly recommended to use a passcode to authenticate incoming connections. Also, in certain connection situations you may desire additional assurance that you are connecting to the device or person you expect. A passcode can normally be any combination of keys (letters or numbers). Do use caution as some devices do not map characters similarly. Passkeys are valid only for the connection and may be different for other devices or users.**

### Personal Area Networking Profile (PAN)
**PAN describes how two or more Bluetooth enabled devices can form an ad-hoc network and how the same mechanism can be used to access a remote network through a network access point. The profile roles include the network access point, group ad-hoc network and personal area network user.**

### Physical Channel
**Characterized by synchronized occupancy of a sequence of RF carriers by one or more devices. A number of physical channel types exist with characteristics defined for their different purposes.**

### Physical Link
**A baseband-level connection between two devices established using paging.**

### Piconet
**A collection of devices occupying a shared physical channel where one of the devices is the piconet master and the remaining devices are connected to it.**

### Piconet Physical Channel
**A channel that is divided into time slots in which each slot is related to an RF hop frequency. Consecutive hops normally correspond to different RF hop frequencies and occur at a standard hop rate of 1600 hops/s. These consecutive hops follow a pseudo-random hopping sequence, hopping through a 79 RF channel set.**

### Piconet Master
**The device in a piconet whose Bluetooth clock and Bluetooth device address are used to define the piconet physical channel characteristics.**

### Piconet Slave
**Any device in a piconet that is not the piconet master, but is connected to the piconet master.**

### PIN
**A user-friendly number that can be used to authenticate connections to a device before paring has taken place.**

### Participant in Multiple Piconets (PMP)
**A device that is concurrently a member of more than one piconet, which it achieves using time division multiplexing (TDM) to interleave its activity on each piconet physical channel.**

### The Parked Slave Broadcast (PSB)
**The Parked Slave Broadcast logical transport that is used for communications between the master and parked devices.**

### Range
**Area that a Bluetooth enabled radio can cover with signal. This area can be affected by many different factors.**

### Scatternet
**Two or more piconets that include one or more devices acting as PMPs.**

### Serial Port Profile (SPP)
**SPP defines how to set-up virtual serial ports and connect two Bluetooth enabled devices.**

### Service Layer Protocol
**A protocol that uses an L2CAP channel for transporting PDUs.**

### Service Discovery
**Procedures for querying and browsing for services offered by or through another Bluetooth enabled device.**

### Service Discovery Application Profile (SDAP)
**SDAP describes how an application should use SDP to discover services on a remote device. SDAP requires that any application be able to find out what services are available on any Bluetooth enabled device it connects to.**

### Silent Device
**A Bluetooth enabled device appears as silent to a remote device if it does not respond to inquiries made by the remote device.**

### SIM Access Profile (SAP)
**SAP allows devices such as car phones with built in GSM transceivers to connect to a SIM card in a Bluetooth enabled phone. Therefore the car phone itself does not require a separate SIM card.**

### Synchronization Profile (SYNC)

**The SYNC profile is used in conjunction with GOEP to enable synchronization of calendar and address information (personal information manager (PIM) items) between Bluetooth enabled devices. A common application of this profile is the exchange of data between a PDA and computer.**

### Unknown device

**A Bluetooth enabled device for which no information (Bluetooth device address, link key or other) is stored.**

### Video Distribution Profile (VDP)

**VDP defines how a Bluetooth enabled device streams video over Bluetooth wireless technology. Sample use cases include the streaming of a stored video from a PC media centre to a portable player or streaming from a digital video camera to a TV.**

### WAP Over Bluetooth Profile (WAP)

**WAP defines how the wireless application protocol suite can run over a Bluetooth wireless link. A typical configuration is a mobile phone connecting to a public kiosk over a Bluetooth wireless link and using WAP to browse for information. WAP works across a variety of WAN technologies bringing the Internet to mobile devices.**