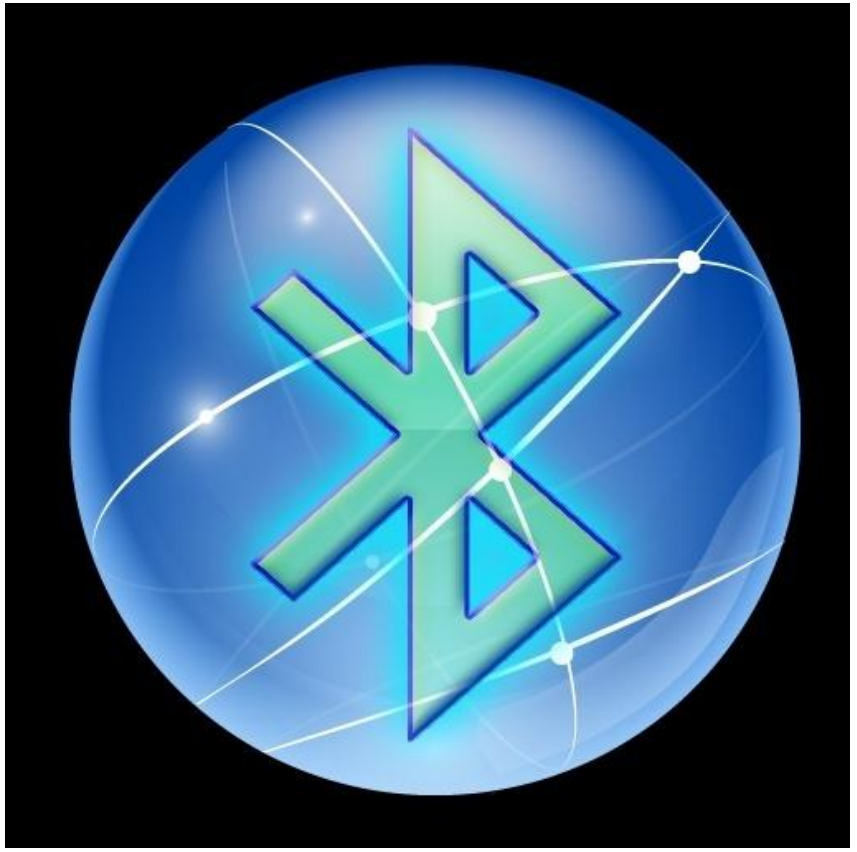
Bluetooth



Definition of Bluetooth.

Bluetooth is a short range and low power wireless technology originally developed for exchanging data over short distances from fixed and mobile devices, creating wireless personal area network.

Why the name Bluetooth?

The name was adopted as a tribute to the tenth-century vikingking Harald Blatand who peacefully united Denmark and Norway.Harald liked to eat blueberries, which gave his teeth the coloration that lead to the nickname "Bluetooth."

Characteristics of Bluetooth

Limited range <10meter

Low cost

Data rate 1Mbps

Operating frequency 2.4GHz (ISM) band

Standard: IEEE 802.15

Bluetooth WPAN support 8 devices within 10 m radius

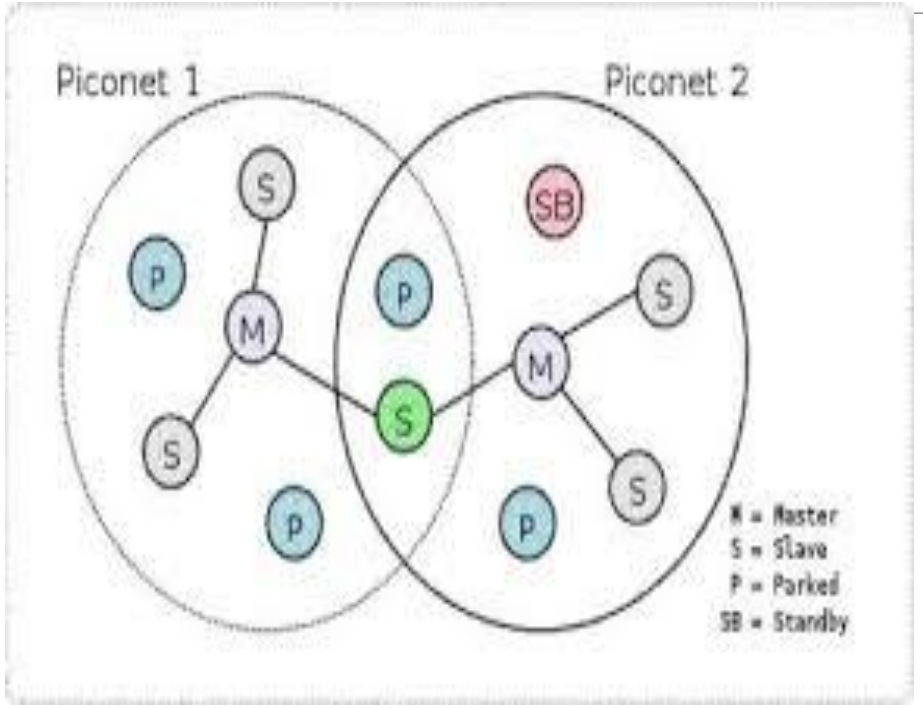
Characteristics of Bluetooth

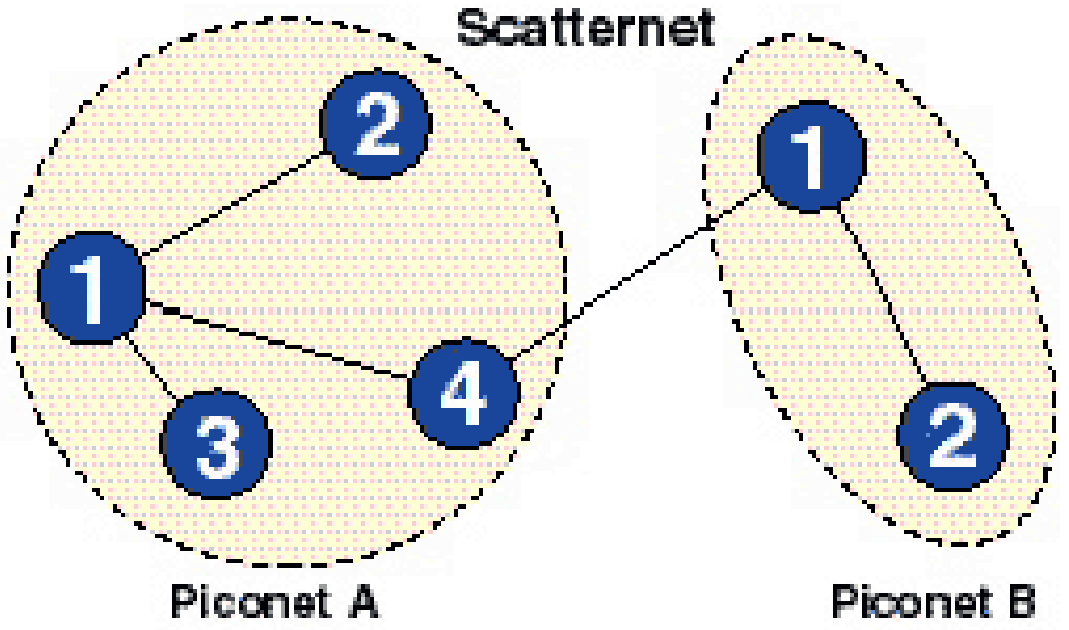
- There are three classes of Bluetooth devices.
  - Class 3 Radio: have range up to 1 meters or 3 feet.
  - Class 2 Radio: most commonly found in mobile devices – have range of 10 metes or 30 feet.
  - Class 1 Radio: used primarily in Industrial use cases – have range of 100 meters or 300 feet.

Applications

- Laptops
- PDA’s
- Headphones
- Wireless printer adapter
- Onboard Bluetooth adapter
- Keyboard/mouse
- Cell phones

Terms Used in Bluetooth





Terms Used in Bluetooth (contd….)

Pico net:- A collection of devices connected via Bluetooth technology in an ad-hoc fashion.

Scatter net:- Two or more independent and non synchronized Pico nets that communicate with each other. A slave or master unit in one piconet can establish this connection by becoming a slave in other piconet

Master unit:-The device in the piconet whose clock and hopping sequence are used to synchronize all other devices in the piconet.

Slave unit:-all devices in a piconet that are not the master upto seven active units for each master

MAC address:- A 3 bit medium access control address which are used to distinguish between units participating in the piconet.

Parked units:-Devices in a piconet which are time synchronized but do not have MAC address.

Sniff and Hold mode:-devices that are synchronized to a piconet, and which have temporarily entered power-saving mode in which device activity is reduced.

Working of Bluetooth

- More than one PICONET is called SCATTERNET.
- Up to Eight devices are allowed in PICONET.
- Each PICONET is identified by a different frequency hopping structure.
- Connections can be made up to 10 meters or can be extended to 100 meters.
- Power consumption is 0.3 mA

Types of Bluetooth Wireless Technology

Depending on the power consumption and range of the device, there are 3 Bluetooth Classes as:

- Class 1: Max Power – 100mW ; Range – 100 m
- Class 2: Max Power – 2.5mW ;

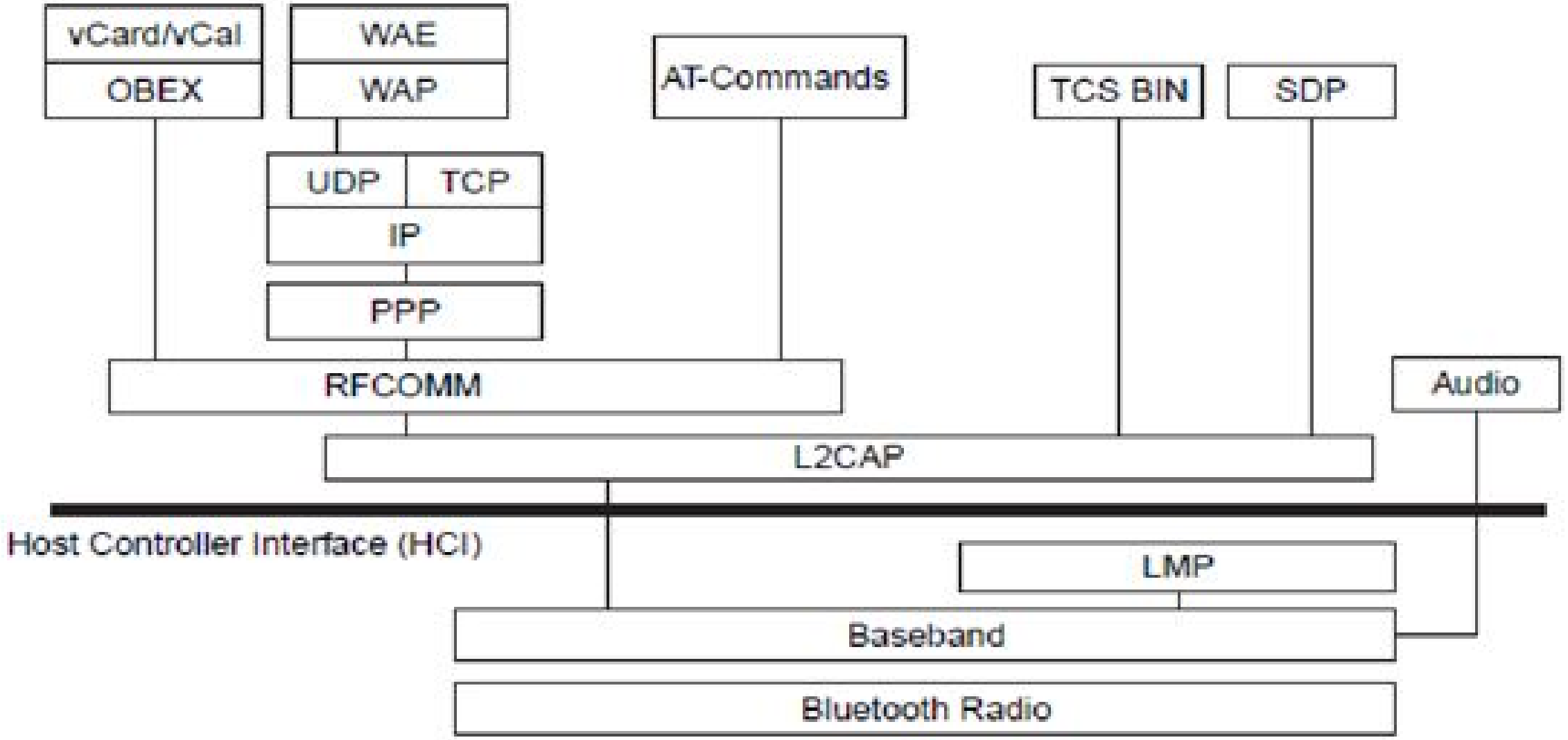
  Range – 10 m
- Class 3: Max Power – 1mW ;

  Range – 1 m

Bluetooth Basics

- *Specification*- Bluetooth specification gives developers data link and application layer definitions
- *Spectrum*-Bluetooth operates between 2.4 and 2.485 GHz using a frequency hopping spread spectrum.
- *Interference*- is reduced using Adaptive Frequency Hopping allowing a better efficiency and greater performance.

Bluetooth protocol stack



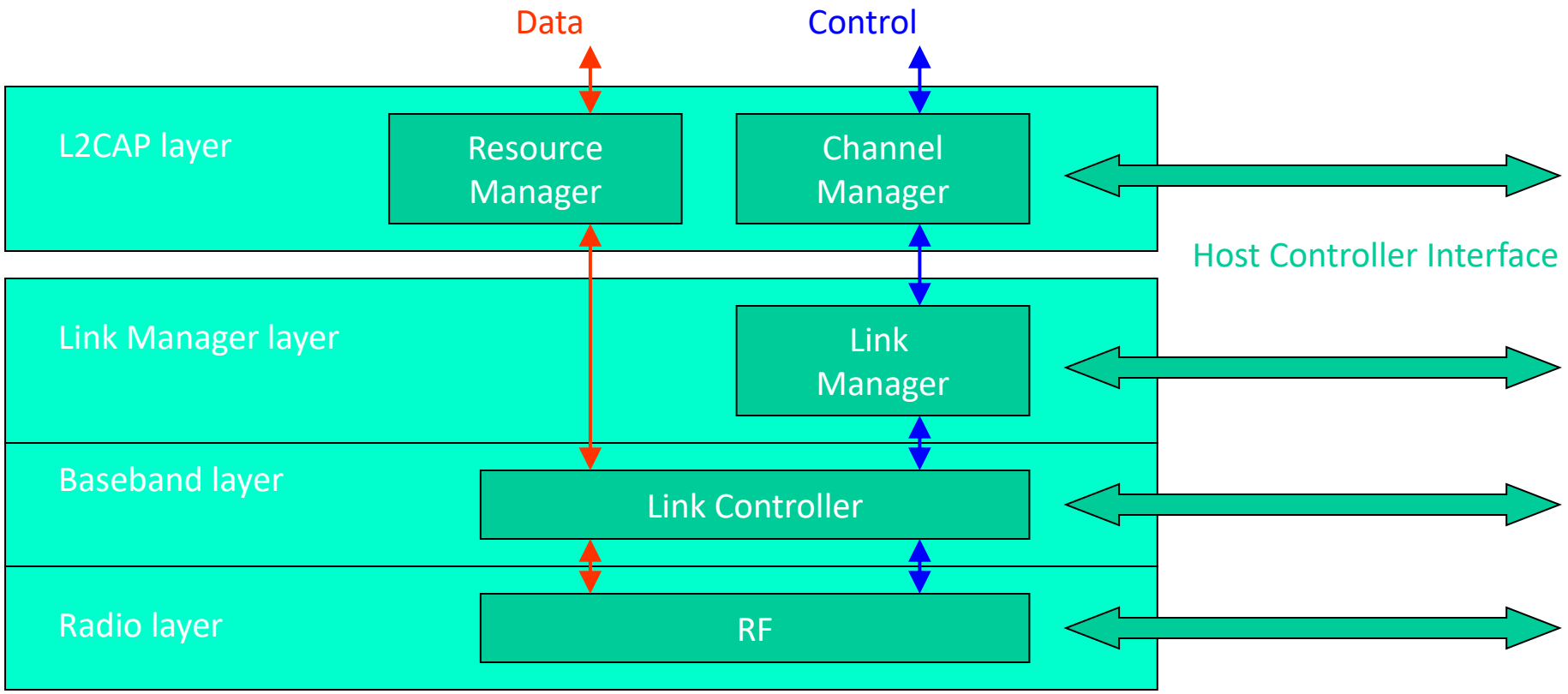
Protocol Stack

A protocol stack refers to a group of protocols that are running concurrently that are employed for the implementation of network protocol suite.

The protocols in a stack determine the interconnectivity rules for a layered network model such as in the OSI or TCP/IP models.

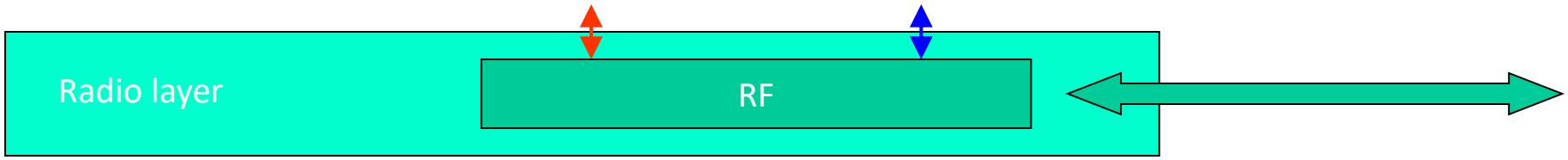
To become a stack the protocols must be interoperable being able to connect both vertically between the layers of the network and horizontally between the end-points of each transmission segment.

Bluetooth core system architecture



Radio layer (physical layer)

The radio layer specifies details of the air interface, including the usage of the frequency hopping sequence, modulation scheme, and transmit power

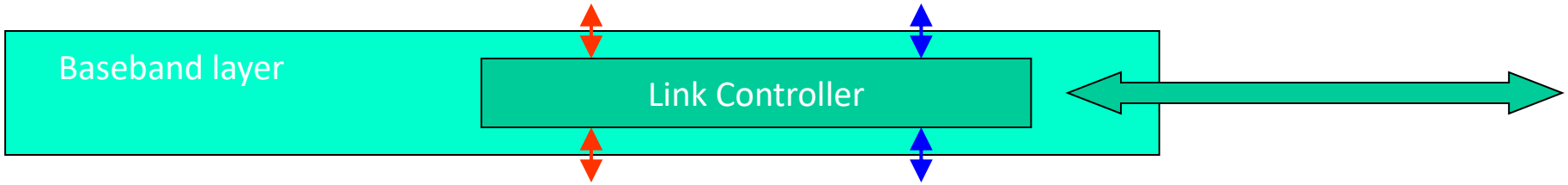


Bluetooth radio and baseband parameters

Topology	Up to 7 simultaneous links
Modulation	Gaussian filtered FSK
RF bandwidth	220 kHz (-3 dB), 1 MHz (-20 dB)
RF band	2.4 GHz ISM frequency band
RF carriers	79 (23 as reduced option)
Carrier spacing	1 MHz
Access method	FHSS-TDD-TDMA
Freq. hop rate	1600 hops/s

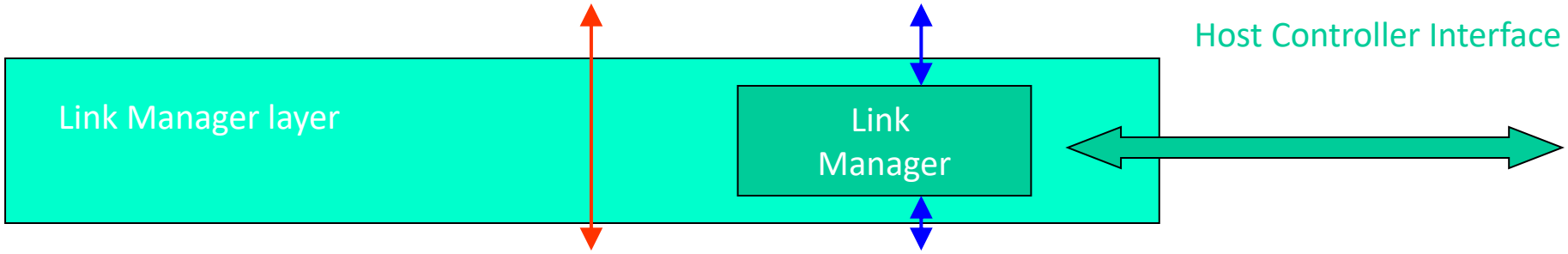
Baseband layer

The baseband layer specifies the lower level operations at the bit and packet levels, e.g., forward error correction (FEC) operations, encryption, cyclic redundancy check (CRC) calculations, and handling of retransmissions using the Automatic Repeat Request (ARQ) Protocol



Link Manager layer

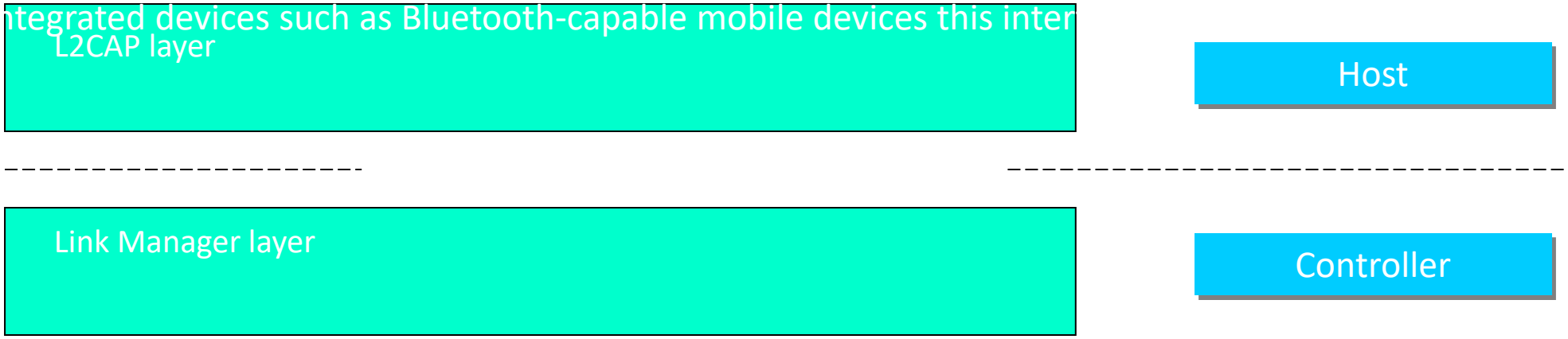
The link manager layer specifies the establishment and release of SCO and ACL links, authentication, traffic scheduling, link supervision, and power management tasks. These are "control plane" tasks. This layer is not involved in "user plane" tasks (i.e., handling of the user data).



Host controller interface

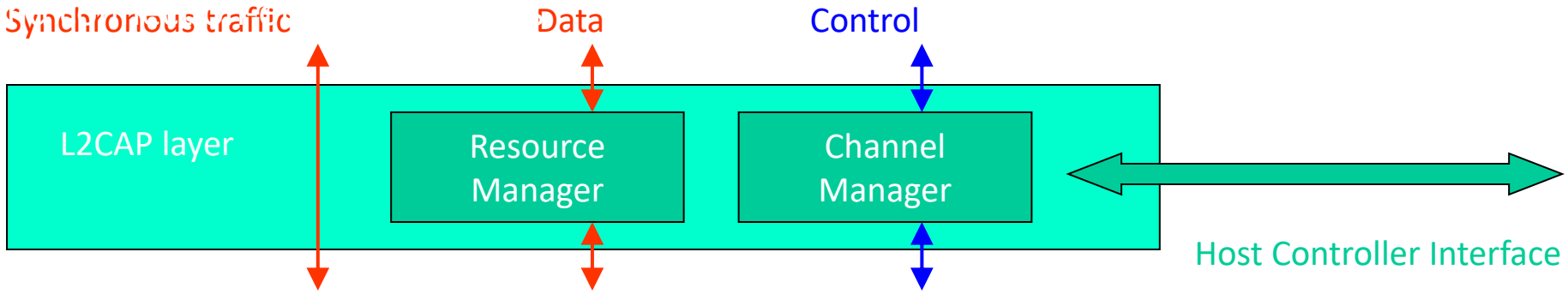
host controller interface

The open host controller interface resides between the Bluetooth controller (e.g. PC card) and Bluetooth host (e.g. PC). In integrated devices such as Bluetooth-capable mobile devices this interface has little or no significance.



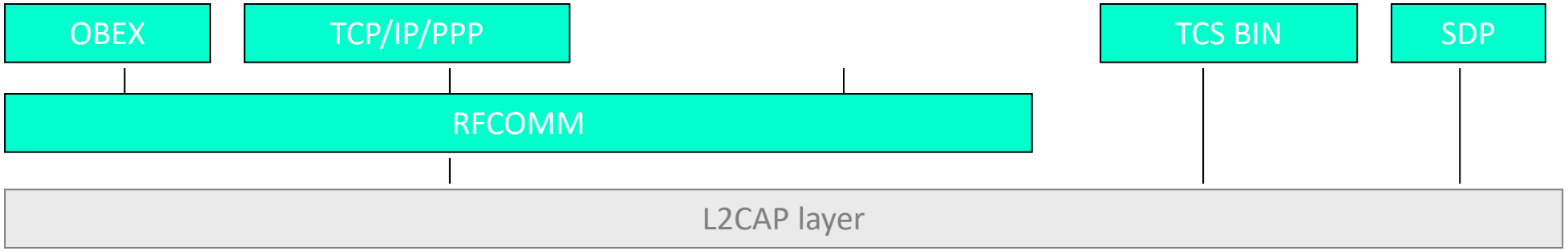
L2CAP layer

The Logical Link Control and Adaptation Protocol (L2CAP) layer handles the multiplexing of higher layer protocols and the segmentation and reassembly (SAR) of large packets. The L2CAP layer provides both connectionless and connection-oriented services.



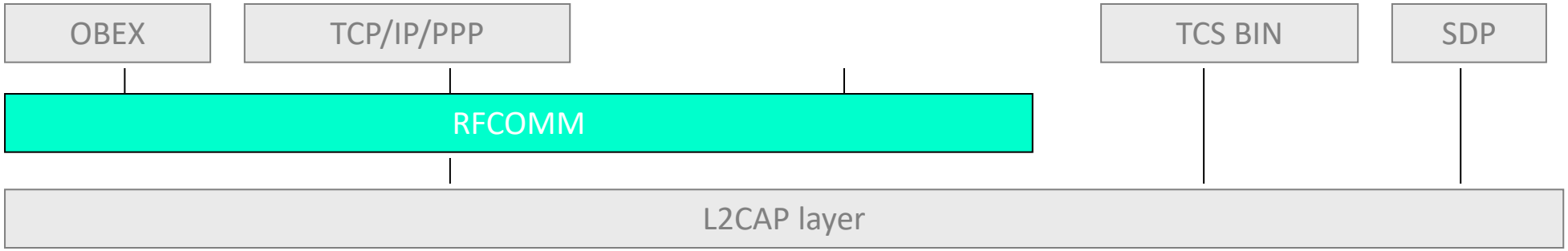
Higher protocol layers (1)

The operation of higher protocol layers is outside the scope of the IEEE 802.15.1 standard (but included in the Bluetooth SIG standards). The usage of these protocols depends on the specific Bluetooth profile in question. A large number of Bluetooth profiles have been defined



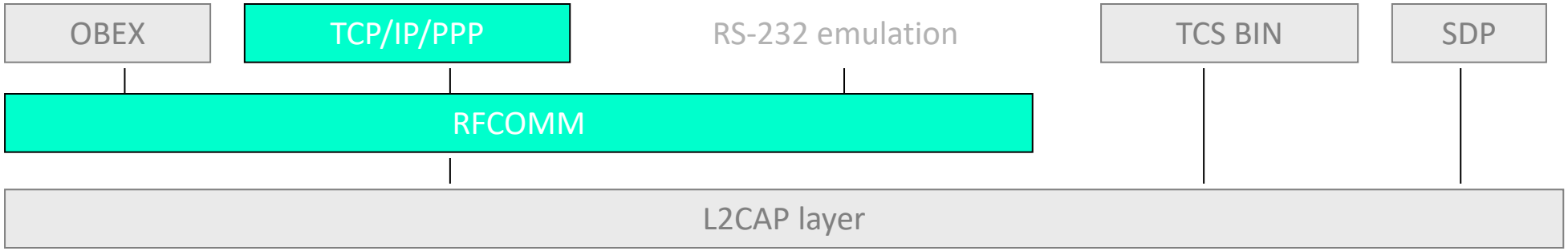
Higher protocol layers (2)

The radio frequency communication protocol RFCOMM enables the replacement of serial port cables (carrying RS-232 control signals such as TxD, RxD, CTS, RTS, etc.) with wireless connections. Several tens of serial ports can be multiplexed into one Bluetooth device



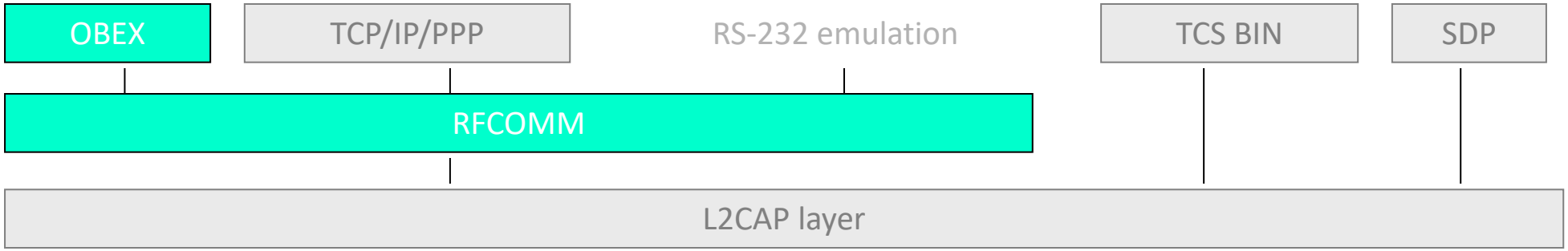
Higher protocol layers (3)

TCP/IP based applications, for instance information transfer using the Wireless Application Protocol (WAP), can be extended to Bluetooth devices by using the Point-to-Point Protocol (PPP) on top of RFCOMM.



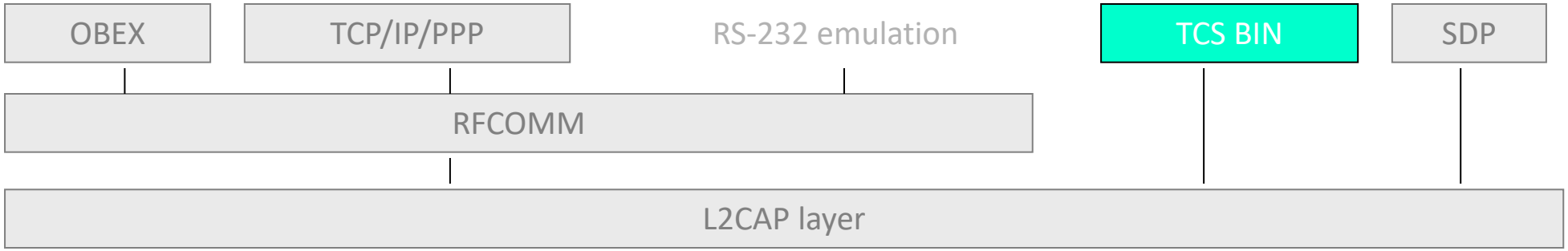
Higher protocol layers (4)

The Object Exchange Protocol (OBEX) is a session-level protocol for the exchange of objects. This protocol can be used for example for phonebook, calendar or messaging synchronisation, or for file transfer between connected devices.



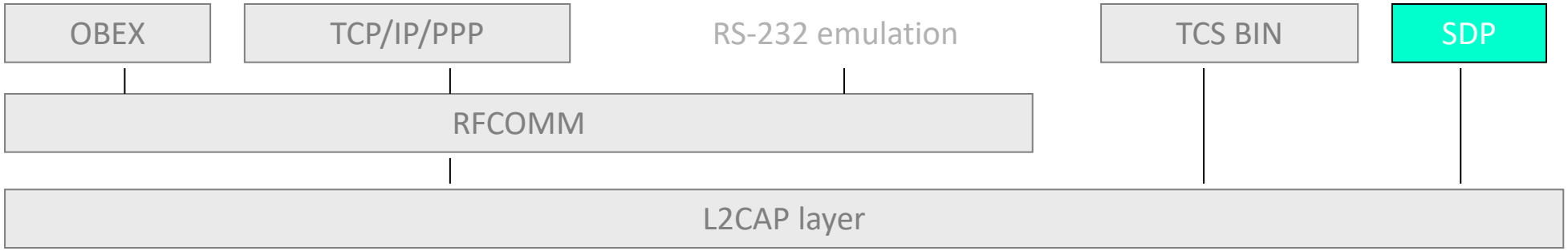
Higher protocol layers (5)

The telephony control specification - binary (TCS BIN) protocol defines the call-control signalling for the establishment of speech and data calls between Bluetooth devices. In addition, it defines mobility management procedures for handling groups of Bluetooth devices



Higher protocol layers (6)

The Service Discovery Protocol (SDP) can be used to access a specific device (such as a digital camera) and retrieve its capabilities, or to access a specific application (such as a print job) and find devices that support this application.



Bluetooth Topology

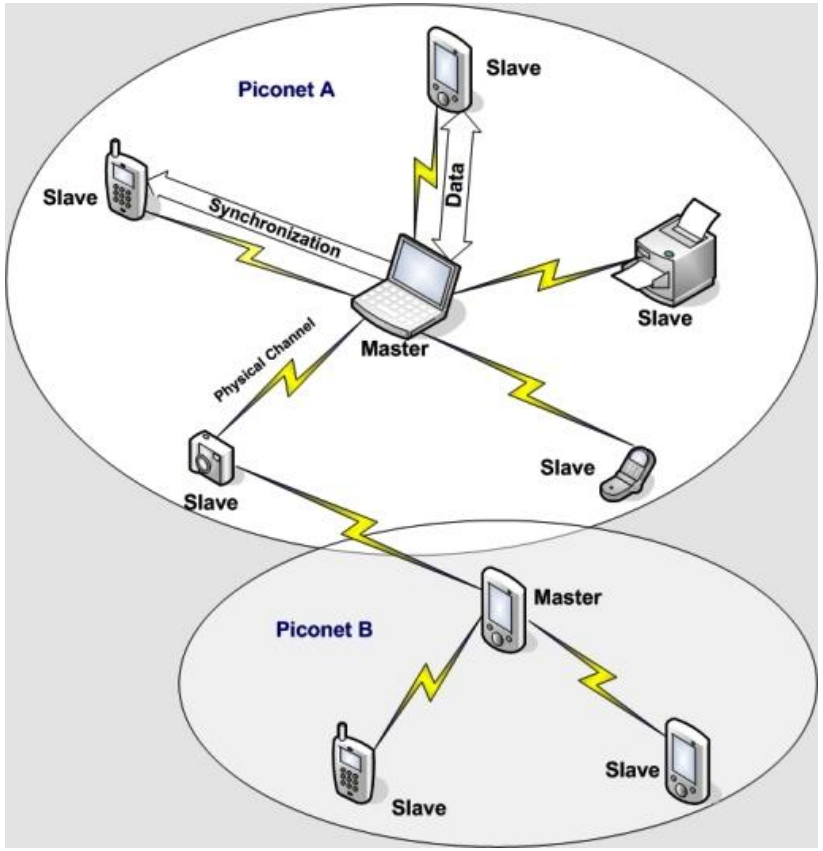
2 main topologies are as:

i.PICONET TOPOLOGY,

&

ii.SCATTERNET TOPOLOGY

Piconet Topology



ii.Scatternet Topology

- Scatternet consists of several piconets connected by devices participating in multiple piconet.
- There is a ‘BRIDGE’ connecting 2 piconets which is also a slave in individual piconets.

Advantages of Scatternet :

- Higher throughput
- Multi-hop connections between devices indifferent piconets

Bluetooth Link Types

The Bluetooth baseband technology supports two link types:

1) synchronous connection oriented (SCO) type (used primarily for voice) and
2) asynchronous connectionless (ACL) type (used primarily for packet data).

Different master-slave pairs of the same Piconet can use different link types and the link type may change arbitrarily during a session.

Each link type supports up to sixteen different packet types.

Four of these are control packets and are common for both SCO and ACL links.

Bluetooth Link Types

Both link types use a time division duplex (TDD) scheme for full-duplex transmission.

The SCO link is symmetric and typically supports time-bounded voice traffic.

SCO packets are transmitted over reserved intervals. Once the connection is established, both master and slave units may send SCO packets without being polled.

The SCO link type supports circuit-switched, point-to-point connections and is used often for voice traffic. The data rate for SCO links is 64 kbps.

Bluetooth Link Types

The ACL link is packet oriented and supports both symmetric and asymmetric traffic.

The master unit controls the link bandwidth and decides how much Piconet bandwidth is given to each slave, and the symmetry of the traffic.

Slaves must be polled before they can transmit data. The ACL link also supports broadcast messages from the master to all slaves in the Piconet.

Multi slot packets can be used in ACL and they can reach maximum data rates of 721 bps in one direction and 57.6 kbps in the other direction if no error correction is used.

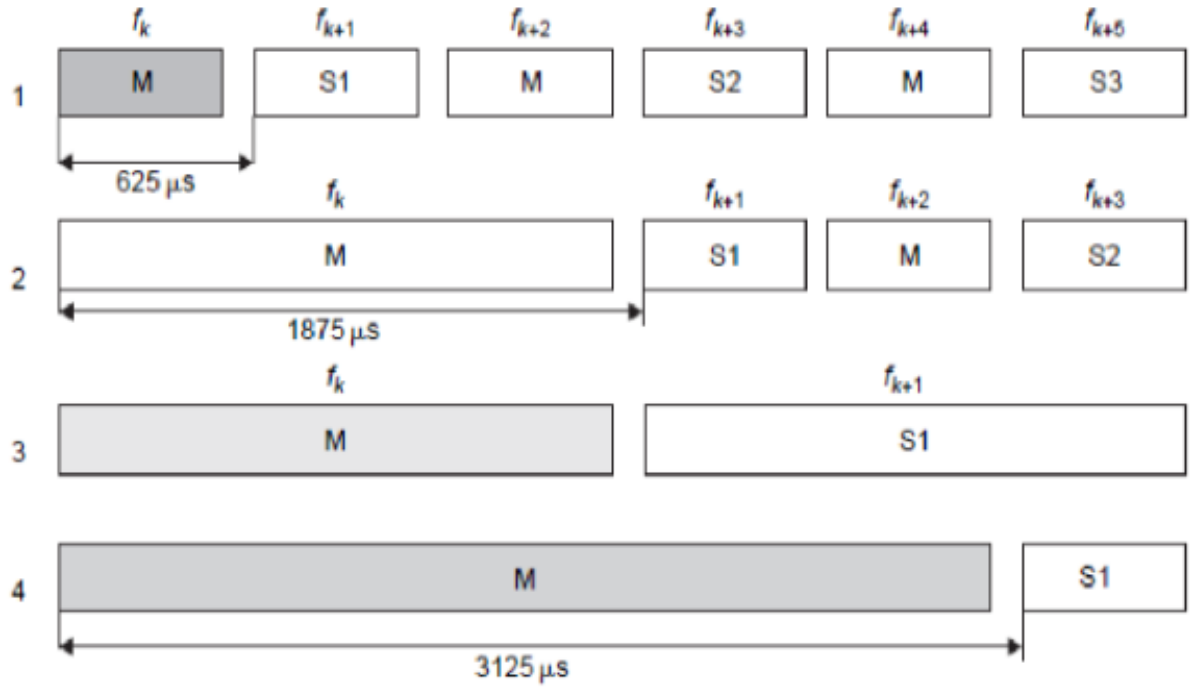
ACL

- It exists as soon as a connection is established.
- 1 ACL link between a Master and Slave
- View it as a packet-switched connection.
- Under the control of the Master: a Slave can only respond if it has been addressed by the Master in the preceding M-to-S slot.
- Broadcast packets are ACL packets.

SCO

- Provides a symmetric link between Master/Slave
- Reserved channel bandwidth (reserved slots)
- Up to 3 SCO links between Master and 1 or more slaves.
- SCO packets are never retransmitted
- A SCO link is set up by a Link Manager (LM) command from Master to Slave
- Master transmits SCO packets to Slave at regular intervals, defined by T_{SCO}.

Bluetooth Packets



1. One-slot symmetrical; 2. Three-slot asymmetrical; 3. Three-slot symmetrical;
4. Five-slot asymmetrical

Bluetooth Packets

Data packets protected by automatic retransmission query (ARQ)

When packet arrives, a check is performed on it.

If there is an error detected, the receiving unit indicates this in return packet.

Retransmission done only on faulty packets.

Retransmission not feasible for voice so better error protection is used

Packet Structure

- Packet

– Access code: 72 bit field, synchronization bits, identifier of the master to distinguish the frame of one piconet from another

– Header: 18 bit field repeated three times control info (slave id)

– Payload For ACL 2740 bits max

For SCO fixed 30 bytes (source data of 10,

20, or 30 bytes with 1/3, 2/3, or none encoding)

Packet Header (18 bits)

- AM_ADDR (3 bits): 7 slaves, 1 bcast, at paging.
- Packet Type (4 bits) NULL, POLL, FHS, DM1..
- Flow (1 bit) : Set by a device when it is unable to receive more data due to lack of local buffer
- ARQN (1 bit) : Set by a device to indicate that the previous reception was OK.
- SEQN (1 bit): toggles for each new packet
- HEC (8 bits): Header error correction

Advantages of Bluetooth

- Bluetooth devices are wireless
- Bluetooth technology is inexpensive
- Bluetooth is automatic
- Share voice and data
- Low energy consumption
- Accessible from anywhere

Disadvantage of Bluetooth

- Low data rate.
- Short range.
- Low security.
- Interference with other devices.