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IEEE Standard for Information technology— Telecommunications and information exchange between systems— Local and metropolitan area networks— Specific requirements

Part 15.1: Wireless medium access control (MAC) and physical layer (PHY) specifications for wireless personal area networks (WPANs)

IEEE Computer Society

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LAN/MAN Standards Committee

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Abstract: Methods for communicating devices in a personal area network (PAN) are covered in this standard.
Keywords: Bluetooth™, communications protocol, ISM, personal area network, WPAN

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6. Architecture

This standard is a formalization of Bluetooth wireless technology, a short-range communications system intended to replace the cable(s) connecting portable and/or fixed electronic devices. Key features are robustness, low power, and low cost. Many features of the core specification are optional, allowing product differentiation.

The term *core system* is used in this clause to denote the combination of a radio frequency (RF) transceiver, BB, and protocol stack. The system offers services that enable the connection of devices and the exchange of a variety of classes of data between these devices.

This clause of this standard provides an overview of the system architecture, communication topologies, and data transport features. This clause is informative.

6.1 General description

The RF (PHY) operates in the unlicensed ISM band at 2.4 GHz. The system employs a frequency hop transceiver to combat interference and fading and provides many frequency hopping spread spectrum (FHSS) carriers. RF operation uses a shaped, binary frequency modulation to minimize transceiver complexity. The symbol rate is 1 Msymbol/s supporting the bit rate of 1 Mb/s.

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 in the technology.

Devices in a piconet use a specific frequency hopping pattern, which is algorithmically determined by fields in the device address and the 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 coexistence with static (nonhopping) ISM systems when these are collocated and implements some of the recommendations of IEEE Std 802.15.2-2003.

The physical channel is subdivided into time units known as *slots*. Data are transmitted between devices in packets, which 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 the reception of packets. This standard 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. These are discussed in more detail in 6.4.4 through 6.5, but are introduced here to aid the understanding of the remainder of this clause.

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.

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A control protocol for the BB layer and PHY is carried over logical links in addition to user data. This is the LMP. Devices that are active in a piconet have a default asynchronous connection-oriented (ACL) logical transport that is used to transport the LMP signalling. For historical reasons, this is referred to 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 LM function uses LMP to control the operation of devices in the piconet and provide services to manage the lower architectural levels (i.e., PHY and BB). The LMP is carried only on the default ACL logical transport and the default broadcast logical transport.

Above the BB, L2CAP provides a channel-based abstraction to applications and services. It carries out segmentation and reassembly (SAR) of application data and multiplexing and demultiplexing 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 may be carried on any logical link that supports the L2CAP.

6.2 Core system architecture

The core system covers the four lowest segments and associated protocols defined by this standard, and the overall profile requirements are specified in the generic access profile (GAP) (see Annex B). A complete application generally requires a number of additional service and higher layer protocols that are defined in the Bluetooth specification and are not described in this standard. The core system architecture is shown in Figure 1.

Core system architecture shows the four lowest layers, each with its associated communication protocol. The lowest three layers are sometimes grouped into a subsystem (known as the *controller*). This is a common implementation involving a standard physical communications interface (i.e., the host controller interface or HCI) and remainder of the system. This includes the L2CAP, service, and higher layers (known as the *host*). Although this interface is optional, the architecture is designed to allow for its existence and characteristics. This standard enables interoperability between independent systems by defining the protocol messages exchanged between equivalent layers and also interoperability between independent subsystems by defining a common interface between controllers and hosts.

A number of functional blocks are shown in Figure 1 and the path of services and data between these. The functional blocks shown in the diagram are informative; in general, this standard does not define the details of implementations except where this is required for interoperability. Thus the functional blocks in Figure 1 are shown in order to aid description of the system behavior. An implementation may be different from the system shown in Figure 1.

Standard interactions are defined for all interdevice operation, where devices exchange protocol signalling according to this standard. The core system protocols are the Radio Frequency (RF) Protocol, Link Control Protocol (LCP), LMP, and L2CAP, all of which are fully defined in subsequent parts of this standard.

The core system offers services through a number of service access points (SAPs) that are shown in Figure 1 as ellipses. These services consist of the basic primitives that control the core system. The services can be split into three types:

— Device control services that modify the behavior and modes of a device
— Transport control services that create, modify, and release traffic bearers (channels and links)
— Data services that are used to submit data for transmission over traffic bearers

It is common to consider the first two as belonging to the C-plane and the last as belonging to the U-plane.

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