# Advance Serial Protocol

As infrared data communications, based on standards from the Infrared Data Association (IrDA), become widely available on personal computers and peripherals, a timely opportunity exists for effective and inexpensive short range wireless communications on embedded systems and devices of all types.

The Infrared Data Association (IrDA) is an industry-based group of over 150 companies that have developed communication standards especially suited for low cost, short range, cross-platform, point-to-point communications at a wide range of speeds. These standards have been implemented on various computer platforms and more recently have become available for many embedded applications.

**What is an IrDA Protocol Stack :**

Communications protocols deal with many issues, and so are generally broken into layers, each of which deals with a manageable set of responsibilities and supplies needed capabilities to the layers above and below. When you place the layers on top of each other, you get what is called a protocol stack, rather like a stack of pancakes or a stack of plates. An IrDA protocol stack is the layered set of protocols particularly aimed at point-to-point infrared communications and the applications needed in that environment.

**Below is a picture of the IrDA protocol layers.**

The layers within this stack can be divided into two groups : -- 1.required protocol

2.optional protocols.

Required IrDA Protocols : -

The required layers of an IrDA protocol stack are in unshaded boxes in the diagram above and include the following:

• Physical Layer: Specifies optical characteristics, encoding of data, and framing for various speeds.

• IrLAP: Link Access Protocol. Establishes the basic reliable connection.

• IrLMP: Link Management Protocol. Multiplexes services and applications on the LAP connection.

• IAS: Information Access Service. Provides a "yellow pages" of services on a device.


**Optional IrDA Protocols :**

The optional protocols are shown above in shaded boxes. The use of the optional layers depends upon the particular application. The optional protocols are:

• TinyTP: Tiny Transport Protocol. Adds per-channel flow control to keep things moving smoothly. This is a very important function and is required in many cases.

• IrOBEX: The Object Exchange protocol. Easy transfer of files and other data objects.

• IrCOMM: Serial and Parallel Port emulation, enabling existing apps that use serial and parallel communications to use IR without change.

• IrLAN: Local Area Network access, enabling walk-up IR LAN access for laptops and other devices.

**Physical Layer and the Framer :**

The Physical layer includes the optical transceiver, and deals with shaping and other characteristics of infrared signals including the encoding of data bits, and some framing data such as begin and end of frame flags (BOFs and EOFs) and cyclic redundancy checks (CRCs). This layer must be at least partially implemented in hardware, but in some cases is handled entirely by hardware.

In order to isolate the remainder of the stack from the ever-changing hardware layer, a software layer called the framer is created. Its primary responsibility is to accept incoming frames from the hardware and present them to the Link Access Protocol layer (IrLAP). This includes accepting outgoing frames and doing whatever is necessary to send them.

**IrLAP - Link Access Protocol :**

The framer we encounter the IrLAP layer, also known as the Link Access Protocol, or LAP for short. IrLAP is a required IrDA protocol corresponding to OSI layer 2 (data link protocol). It is based on High-Level Data Link Control (HDLC) and Synchronous Data Link Control (SDLC) with extensions for some unique characteristics of infrared communications.

**IrLAP provides reliable data transfer using the following mechanisms:**

• Retransmission.

• Low-level flow control. (TinyTP provides high-level flow control and should almost always be used in place of IrLAP flow control.)

• Error detection.

**Environmental Characteristics :**

Several environmental factors influenced the development of the IrLAP layer. These include the following:

• Point-to-point. Connections are one-to-one, such as camera to PC or data collector to printer. The range is typically zero to one meter, although extended range up to 10 meters or more is under development. This is not like a local area network (many-to-many) protocol.

• Half-duplex. Infrared light, and therefore data, is sent in one direction at a time. However, the link changes directions frequently and can simulate full duplex in cases where timing is not extremely sensitive.

• Narrow infrared cone. The infrared transmission is directional within a 15 degree half angle in order to minimize interference with surrounding devices.

• Hidden Nodes. Other IR devices approaching an existing connection may not be immediately aware of the connection if they approach from behind the current transmitter. They must wait and see if the link turns around before stepping in. Interference. IrLAP must overcome interference from fluorescent lights, other IR devices, sunlight, moonbeams, and so forth.

• No collision detection. The design of the hardware is such that collisions are not detected, so the software must handle cases where collisions cause lost data with methods such as random back off.

**Modes :-**

IrLAP is built around two modes of operation, corresponding to whether or not a connection exists.

**Normal Disconnect Mode (NDM) :**

NDM is also known as contention state, and is the default state of disconnected devices. In this mode a device must observe a set of media access rules. Of utmost importance, a device in NDM must check whether other transmissions are occurring (a condition known as media busy) before transmitting. This is accomplished by listening for activity. If no activity is detected for greater than 500 milliseconds (the maximum time for the link to turn around), the media is considered to be available for establishment of a connection.

**Normal Response Mode (NRM) :-**

NRM is the mode of operation for connected devices. Once both sides are talking using the best possible communication parameters (established during NDM), higher stack layers use normal command and response frames to exchange information.

**IrLAP Services :**

A number of services are defined in the IrLAP specification. Not all services are necessary for all devices, and the IrLAP specification (along with the IrDA Lite standard) describes the minimum requirements. The most important services include the following:

• Device Discovery: Explores the nearby IR-space to see who is present and get some hint as to what they can do

• Connect: Chooses a specific partner, negotiates the best possible communication parameters supported by both sides, and connects.

• Send Data: The whole reason for all this effort—used by higher layer protocols for almost all of their work.

• Disconnect: Closes down and returns to the NDM state, ready for a new connection.

- Invisible radiations of wavelength higher than that of red
- An LED or a solid-state laser emits IR rays when given 10–20 mA current from a low power battery or power source
- When the 1s and 0s are transmitted, the IR source current is modulated as per the 1s and 0s

- Wavelength-  900 nm
- From an LED detected at the receiver (photo-detector) to get the data
- The detector has 30? (?15?) window to detect the incoming radiation
- Used for remote control of TV

## IrDA Applications

- IR-based data transfer between a laptop (computer) and mobile hand-held PocketPC when the two come in vicinity and line-of-sight of the IR receivers and detectors in each of them

## IrDA data transfer rates

- IrDA 1.0 protocol for data rates up to 115 kbps
- Data rates of 1.152 Mbps to 4 Mbps (16 Mbps draft recommended)

https://www.slideshare.net/shoaibahmedsiddiqui7/zigbee-70666049

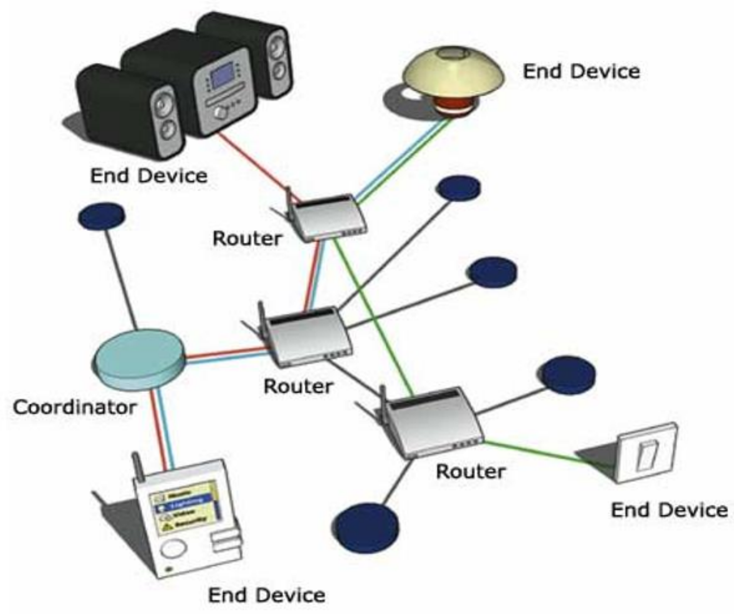
# ZigBee

## 1. Introduction

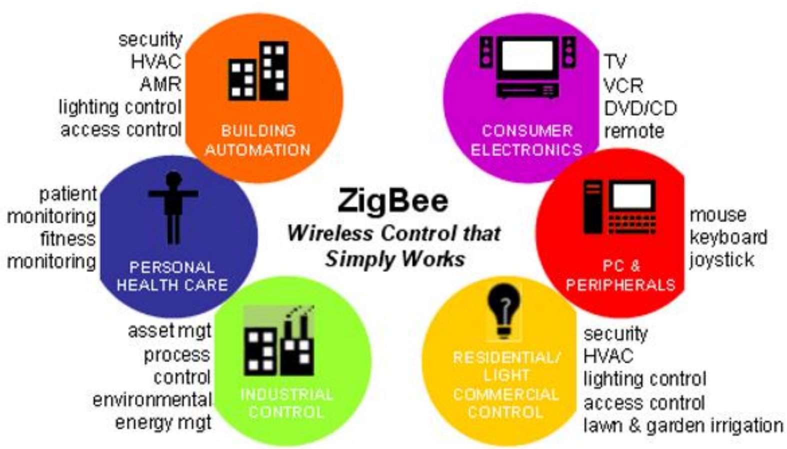
ZigBee is the most popular industry wireless mesh networking standard for connecting sensors, instrumentation and control systems. ZigBee, a specification for communication in a wireless personal area network (WPAN), has been called the "Internet of things." Theoretically, your ZigBee-enabled coffee maker can communicate with your ZigBee-enabled toaster. ZigBee is an open, global, packet-based protocol designed to provide an easy-to-use architecture for secure, reliable, low power wireless networks. ZigBee and IEEE 802.15.4 are low data rate wireless networking standards that can eliminate the costly and damage prone wiring in industrial control applications. Flow or process control equipment can be place anywhere and still communicate with the rest of the system. It can also be moved, since the network doesn't care about the physical location of a sensor, pump or valve

The benefits of this technology go far beyond, ZigBee applications include:

Home and office automation
Industrial automation
Medical monitoring
Low-power sensors
HVAC control
Plus many other control and monitoring uses




Zig bee network

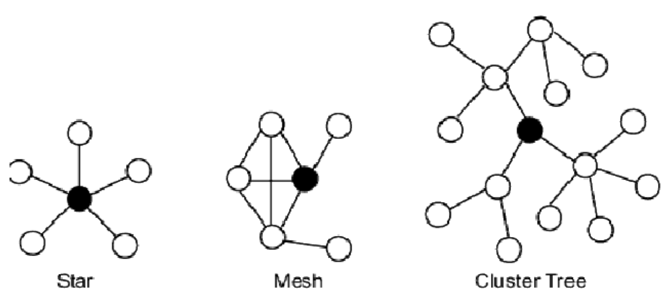



Zig bee applications

ZigBee is meant for global control/sensor network standard.  Features of Zig bee are as below :

1. Low power consumption, simply implemented – Batteries to last many months to years – -----ZigBee/IEEE 802.15.4 has active (transmit/receive) or sleep
2. Low cost (device, installation, maintenance)
3. Low cost to the users means low device cost, low installation cost and low maintenance.
4. ZigBee devices allow batteries to last up to years using primary cells (low cost) without any chargers (low cost and easy installation).
5. ZigBee's simplicity allows for inherent configuration and redundancy of network devices provides low maintenance
6. High density of nodes per network:   ZigBee's use of the IEEE 802.15.4 PHY and MAC allows networks to handle any number of devices.
7. Simple protocol, global implementation  : Simplicity is essential to cost, interoperability, and maintenance.  The IEEE 802.15.4 PHY adopted by ZigBee has been designed for the 868 MHz band in Europe, the 915 MHz band in N America, Australia, etc; and the 2.4 GHz band is now recognized to be a global band accepted in almost all countries.

Wireless Network Topologies
Network topologies supported by the IEEE 802.15.4 and ZigBee specifications.
The topology of a network describes how the nodes are connected, either physically or logically
The physical topology is a geometrical shape resulting from the physical links from node to node, as shown in the figure below. The logical topology maps the flow of data between the nodes.




IEEE 802.15.4 supports star and peer-to-peer topologies. The ZigBee specification supports star and two kinds of peer-to-peer topologies, mesh and cluster tree.

ZigBee-compliant devices are sometimes specified as supporting point-to point and point-to-multipoint topologies.

How Zigbee Works?

ZigBee basically uses digital radios to allow devices to communicate with one another. A typical ZigBee network consists of several types of devices. A network coordinator is a device that sets up the network, is aware of all the nodes within its network, and manages both the information about each node as well as the information that is being transmitted/received within the network. Every ZigBee network must contain a network coordinator.

Other Full Function Devices (FFD's) may be found in the network, and these devices support all of the 802.15.4 functions. They can serve as network coordinators, network routers, or as devices that interact with the physical world. The final device found in these networks is the Reduced Function Device (RFD), which usually only serve as devices that interact with the physical world. As mentioned above several topologies are supported by ZigBee, including star, mesh, and cluster tree.

As can be seen in above figure 3, star topology is most useful when several end devices are located close together so that they can communicate with a single router node. That node can then be a part of a larger mesh network that ultimately communicates with the network coordinator. Mesh networking allows for redundancy in node links, so that if one node goes down, devices can find an alternative path to communicate with one another.

| Comparison of Wireless Standards | | | |
|---|---|---|---|
| **Wireless Parameter** | **Bluetooth** | **Wi-Fi** | **ZigBee** |
| Frequency band | 2.4 GHz | 2.4 GHz | 2.4 GHz |
| Physical/MAC layers | IEEE 802.15.1 | IEEE 802.11b | IEEE 802.15.4 |
| Range | 9 m | 75 to 90 m | Indoors: up to 30 m<br>Outdoors (line of sight): up to 100 m |
| Current consumption | 60 mA (Tx mode) | 400 mA (Tx mode)<br>20 mA (Standby mode) | 25-35 mA (Tx mode)<br>3 μA (Standby mode) |
| Raw data rate | 1 Mbps | 11 Mbps | 250 Kbps |
| Protocol stack size | 250 KB | 1 MB | 32 KB<br>4 KB (for limited function end devices) |
| Typical network join time | >3 sec | variable, 1 sec typically | 30 ms typically |
| Interference avoidance method | FHSS (frequency-hopping spread spectrum) | DSSS (direct-sequence spread spectrum) | DSSS (direct-sequence spread spectrum) |
| Minimum quiet bandwidth required | 15 MHz (dynamic) | 22 MHz (static) | 3 MHz (static) |
| Maximum number of nodes per network | 7 | 32 per access point | 64 K |
| Number of channels | 19 | 13 | 16 |