LAN Technologies

Local Area Network (LAN) is a data communication network connecting various terminals or computers within a building or limited geographical area. The connection among the devices could wired or wireless. In the 1980s and 1990s several different types of LANs were used. Almost every LAN except Ethernet has disappeared from the marketplace because Ethernet was able to update itself to meet the needs of the time.

➢ IEEE Project 802

In 1985, the Computer Society of the IEEE started a project, called Project 802, to set standards to enable intercommunication among equipment from a variety of manufacturers. Project 802 does not seek to replace any part of the OSI model or TCP/IP protocol suite. Instead, it is a way of specifying functions of the physical layer and the data-link layer of major LAN protocols.

The IEEE has subdivided the **data-link layer** into two sublayers: logical link control (**LLC**) and media access control (**MAC**). IEEE has also created several physical-layer standards for different LAN protocols.

➢ Ethernet Evolution

The Ethernet LAN was developed in the 1970s by Robert Metcalfe and David Boggs. Since then, it has gone through four generations:

1. **Standard Ethernet (10 Mbps)**
2. **Fast Ethernet (100 Mbps)**
3. **Gigabit Ethernet (1 Gbps)**
4. **10 Gigabit Ethernet (10 Gbps)**

Their details are as follows:

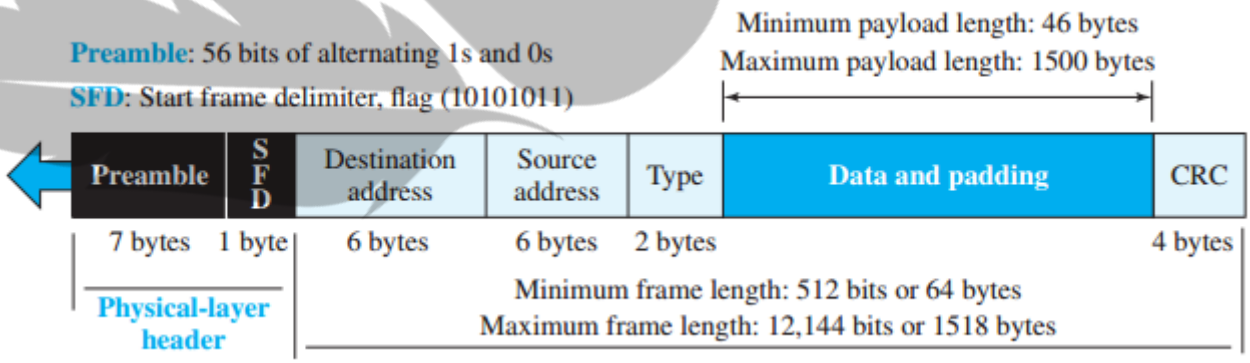
1. Standard Ethernet (10 Mbps)

We refer to the original Ethernet technology with the data rate of 10 Mbps as the Standard Ethernet. There are the following characteristics of standard Ethernet:

Connectionless and Unreliable Service

It provides a connectionless service, which means each frame sent is independent of the previous or next frame. Ethernet has no connection establishment or connection termination phases. The sender sends a frame whenever it has it; the receiver may or may not be ready for it. Which may result in dropping frames. If a frame drops, the sender will not know about it.

Frame Format



Standard Ethernet is popular because it strikes a good balance between speed, cost and ease of installation. The **Institute for Electrical and Electronic Engineers** developed an Ethernet standard known as IEEE Standard 802.3. This standard defines rules for configuring an Ethernet network and also specifies how the elements in an Ethernet network interact with one another.

2. Fast Ethernet (100 Mbps)

The Fast Ethernet standard (IEEE 802.3u) has been established for Ethernet networks that need higher transmission speeds. This standard raises the Ethernet speed limit from 10 Mbps to 100 Mbps with only minimal changes to the

existing cable structure. Fast Ethernet provides faster throughput for video, multimedia, graphics, Internet surfing and stronger error detection and correction.

The goals of Fast Ethernet can be summarized as follows:

- ✓ Upgrade the data rate to 100 Mbps.
- ✓ Make it compatible with Standard Ethernet.
- ✓ Keep the same 48-bit address.
- ✓ Keep the same frame format.

A new feature added to Fast Ethernet is called autonegotiation. It allows a station or a hub a range of capabilities. Autonegotiation allows two devices to negotiate the mode or data rate of operation. It was designed:

- ✓ To allow incompatible devices to connect to one another. For example, a device with a maximum capacity of 10 Mbps can communicate with a device with a 100 Mbps capacity (but which can work at a lower rate).
- ✓ To allow one device to have multiple capabilities.
- ✓ To allow a station to check a hub's capabilities.

3. Gigabit Ethernet (1 Gbps)

The need for an even higher data rate resulted in the design of the Gigabit Ethernet Protocol (1000 Mbps). The IEEE committee calls it the Standard 802.3z. The goals of the Gigabit Ethernet were to upgrade the data rate to 1 Gbps, but keep the address length, the frame format, and the maximum and minimum frame length the same. The goals of the Gigabit Ethernet design can be summarized as follows:

- ✓ Upgrade the data rate to 1 Gbps.
- ✓ Make it compatible with Standard or Fast Ethernet.
- ✓ Use the same 48-bit address.
- ✓ Use the same frame format.
- ✓ Keep the same minimum and maximum frame lengths.
- ✓ Support autonegotiation as defined in Fast Ethernet

4. 10 Gigabit Ethernet (10 Gbps)

10 Gigabit Ethernet is the fastest and most recent of the Ethernet standards. IEEE 802.3ae defines a version of Ethernet with a nominal rate of 10Gbits/s that makes it 10 times faster than Gigabit Ethernet. Unlike other Ethernet systems, 10 Gigabit Ethernet is based entirely on the use of optical fiber connections.

Name	Standard	Speed
Standard Ethernet	IEEE 802.3	10Mpbs
Fast Ethernet	IEEE 802.3u	100Mpbs
Gigabit Ethernet	IEEE 802.3z	1 Gbps (1000 Mbps)
10 Gigabit Ethernet	IEEE 802.3ae	10 Gbps

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Virtual LAN

A virtual LAN (Local Area Network) is a logical subnetwork that can group together a collection of devices from different physical LANs. Larger business computer networks often set up VLANs to re-partition their network for improved traffic management.

Dynamic and Static VLAN

Network administrators often refer to static VLANs as "port-based VLANs." A static VLAN requires an administrator to assign individual ports on the network switch to a virtual network. No matter what device plus into that port, it becomes a member of that same pre-assigned virtual network.

Dynamic VLAN configuration allows an administrator to define network membership according to characteristics of the devices themselves rather than their switch port location. For example, a dynamic VLAN can be defined with a list of physical addresses (MAC addresses) or network account names.

Advantages of VLAN

- **Performance:** The network traffic is full of broadcast and multicast. VLAN reduces the need to send such traffic to unnecessary destination .e.g.-If the traffic is intended for 2 users but as 10 devices are present in the same broadcast domain therefore all will receive the traffic i.e. wastage of bandwidth but if we make VLANs, then the broadcast or multicast packet will go to the intended users only.
- **Formation of virtual groups:** As there are different departments in every organization namely sales, finance etc., VLANs can be very useful in order to group the devices logically according to their departments.
- **Security:** In the same network, sensitive data can be broadcast which can be accessed by the outsider but by creating VLAN, we can control broadcast domains, set up firewalls, restrict access. Also, VLANs can be used to inform the network manager of an intrusion. Hence, VLANs greatly enhance network security.
- **Flexibility:** VLAN provide flexibility to add, remove the number of host we want.
- Cost reduction: VLANs can be used to create broadcast domains which eliminate the need for expensive routers.
- By using VLAN, the number of small size broadcast domain can be increased which are easy to handle as compared to a bigger broadcast domain.

Wireless LAN

A wireless local area network (WLAN) provides wireless network communication over short distances using radio or infrared signals instead of traditional network cabling. A WLAN is a type of local area network (LAN).

Difference between Wired LAN and Wireless LAN Architecture:

- **Medium**

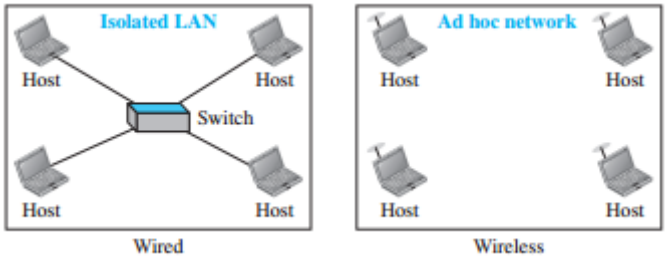
The first difference we can see between a wired and a wireless LAN is the medium. In a wired LAN, we use wires to connect hosts. In a wireless LAN, the medium is air.

- **Hosts**

In a wired LAN, a host is always connected to its network at a point with a fixed link layer address related to its network interface card (NIC). In a wireless LAN, a host is not physically connected to the network; it can move freely and can use the services provided by the network.

- **Isolated LANs**

The concept of a wired isolated LAN also differs from that of a wireless isolated LAN. A wired isolated LAN is a set of hosts connected via a link-layer switch (in the recent generation of Ethernet). A wireless isolated LAN, called an ad hoc network in wireless LAN terminology, is a set of hosts that communicate freely with each other.



WLAN Pros and Cons

Wireless local area networks definitely have their advantages, but we shouldn't overlook the downfalls:

Pros:

- ✓ A large number of devices are supported
- ✓ It's easy to set up a WLAN, especially when compared to laying cables for wired networks
- ✓ Accessing a WLAN is easier than a wired LAN since cable length isn't a factor
- ✓ WLANs are common even when away from a business or home, like in public areas

Cons:

- ✓ It's easier to hack a WLAN, which is why encryption is necessary
- ✓ Wireless interference can hijack the speed and stability of a wireless network
- ✓ More wireless devices, like repeaters, are needed to expand a wireless network

IEEE 802.11 Project

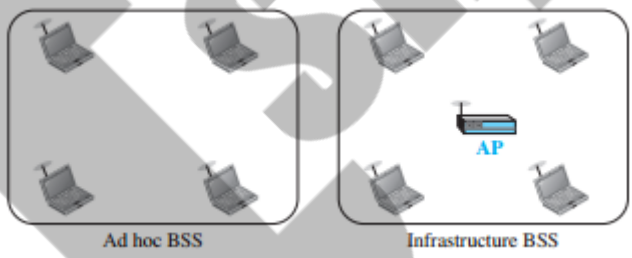
IEEE has defined the specifications for a wireless LAN, called IEEE 802.11, which covers the physical and data-link layers. It is sometimes called wireless Ethernet. In some countries, including the United States, the public uses the term WiFi (short for wireless fidelity) as a synonym for wireless LAN. WiFi, however, is a wireless LAN that is certified by the WiFi Alliance.

The standard defines two kinds of services: the basic service set (BSS) and the extended service set (ESS).

- ➢ **Basic Service Set (BSS)**

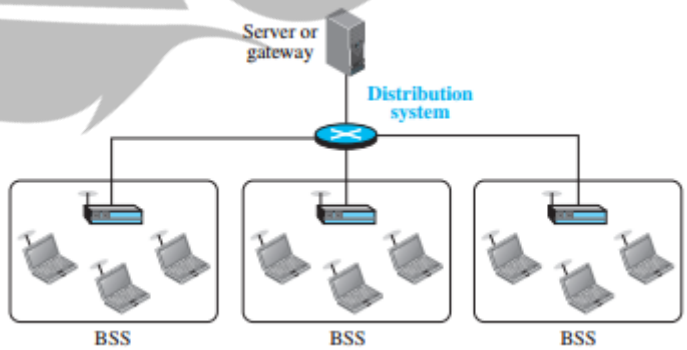
IEEE 802.11 defines the basic service set (BSS) as the building blocks of a wireless LAN. A basic service set is made of stationary or mobile wireless stations and an optional central base station, known as the access point (AP).

The BSS without an AP is a stand-alone network and cannot send data to other BSSs. It is called an ad hoc architecture. In this architecture, stations can form a network without the need of an AP; they can locate one another and agree to be part of a BSS. A BSS with an AP is sometimes referred to as an infrastructure BSS.



- ➢ **Extended Service Set (ESS)**

An extended service set (ESS) is made up of two or more BSSs with APs. In this case, the BSSs are connected through a distribution system, which is a wired or a wireless network. The distribution system connects the APs in the BSSs.



Station Types:

IEEE 802.11 defines three types of stations based on their mobility in a wireless LAN:

No Transition: It is a station either stationary (not moving) or moving only inside a BSS.

BSS Transition: It is station that can move from one BSS to another, but the movement is confined inside one ESS.

ESS Transition: It is a station that can move from one ESS to another. However, IEEE 802.11 does not guarantee that communication is continuous during the move.

1. **IEEE 802.11 Standard**
   One of the original 802.11 standards, now obsolete, used direct sequence spread spectrum (DSSS). It operates in the 2.4-GHz ISM band, at data rates of 1 Mbps and 2 Mbps.

2. **IEEE 802.11b Standard**
   IEEE 802.11b is an extension of the IEEE 802.11 DSSS scheme, providing data rates of 5.5 and 11 Mbps in the ISM band. The chipping rate is 11 MHz, which is the same as the original DSSS scheme, thus providing the same occupied bandwidth. To achieve a higher data rate in the same bandwidth at the same chipping rate, a modulation scheme known as complementary code keying (CCK) is used.

3. **IEEE 802.11a Standard**
   To meet the needs for a truly high-speed WLAN, IEEE 802.11a was developed. IEEE 802.11a utilizes more available bandwidth than 802.11b/g. IEEE 802.11a provides much higher data rates than 802.11b and the same maximum data rate as 802.11g. IEEE 802.11a uses a different, relatively uncluttered frequency spectrum (5 GHz).

   It uses OFDM (orthogonal frequency division multiplexing). OFDM, also called multicarrier modulation, uses multiple carrier signals at different frequencies. OFDM uses PSK and QAM for modulation. The common data rates are 18 Mbps (PSK) and 54 Mbps (QAM).

4. **IEEE 802.11g Standard**
   IEEE 802.11g extends 802.11b to data rates above 20 Mbps, up to 54 Mbps. Like 802.11b, 802.11g operates in the 2.4-GHz range and thus the two are compatible. IEEE 802.11g offers a wide array of data rate and modulation scheme options. IEEE 802.11g provides compatibility with 802.11 and 802.11b by specifying the same modulation and framing schemes as these standards for 1, 2, 5.5, and 11 Mbps. The IEEE 802.11 standards do not include a specification of speed versus distance objectives. Different vendors will give different values, depending on environment.

5. **IEEE 802.11n Standard**
   An upgrade to the 802.11 project is called 802.11n (the next generation of wireless LAN). The goal is to increase the throughput of 802.11 wireless LANs. The new standard emphasizes not only the higher bit rate but also eliminating some unnecessary overhead. The standard uses what is called MIMO (multiple-input multiple-output antenna) to overcome the noise problem in wireless LANs. The idea is that if we can send multiple output signals and receive multiple input signals, we are in a better position to eliminate noise. Some implementations of this project have reached up to 600 Mbps data rate.

Standard	802.11a	802.11b	802.11g	802.11n
Year introduced	1999	1999	2003	2000
Maximum data transfer speed	54 Mbps	11 Mbps	54 Mbps	65 to 600 Mbps
Frequency band	5 GHz	2.4 GHz	2.4 GHz	2.4 or 5 GHz
Channel bandwidth	20 MHz	20 MHz	20 MHz	20, 40 MHz
Highest order modulation	64 QAM	11 CCK	64 QAM	64 QAM
Spectrum usage	DSSS	OFDM	DSSS, OFDM	OFDM
Antenna configuration	1×1 SISO	1×1 SISO	1×1 SISO	Up to 4×4 MIMO

Bluetooth

Bluetooth is a wireless LAN technology designed to connect devices of different functions such as telephones, notebooks, computers (desktop and laptop) and cameras .etc. Bluetooth LAN is an ad hoc network, which means that the network is formed spontaneously; the devices, sometimes called gadgets, find each other and make a network called a **piconet**.

A Bluetooth LAN, by nature, cannot be large. Bluetooth technology has several applications. Peripheral devices such as a wireless mouse or keyboard can communicate with the computer through this technology.

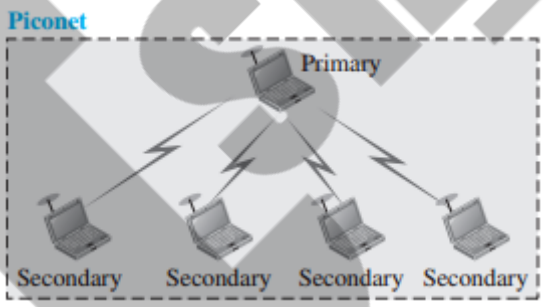
Bluetooth was originally started as a project by the Ericsson Company. It is named for Harald Blaatand, the king of Denmark (940-981) who united Denmark and Norway. Blaatand translates to Bluetooth in English. Today, Bluetooth technology is the implementation of a protocol defined by the IEEE 802.15 standard. The standard defines a wireless personal-area network (PAN) operable in an area the size of a room or a hall.

Types of Architecture

1. Piconet

A Bluetooth network is called a piconet, or a small net. A piconet can have up to eight stations, one of which is called the primary; the rest are called secondary's. All the secondary stations synchronize their clocks and hopping sequence with the primary. Note that a piconet can have only one primary station. The communication between the primary and secondary stations can be one-to-one or one-to-many.

Although a piconet can have a maximum of seven secondaries, additional secondaries can be in the parked state. A secondary in a parked state is synchronized with the primary, but cannot take part in communication until it is moved from the parked state to the active state. Because only eight stations can be active in a piconet, activating a station from the parked state means that an active station must go to the parked state.



2. Scatternet

Piconets can be combined to form what is called a scatternet. A secondary station in one piconet can be the primary in another piconet. This station can receive messages from the primary in the first piconet (as a secondary) and, acting as a primary, deliver them to secondaries in the second piconet. A station can be a member of two piconets.