Computer Network Home_1

1. Computer Networks and Internets 6th

1.5 Brief History of Internet

The Internet story starts with ARPAnet , a long - distance computer network devised by the US Government ' s Advanced Research Projects Agency . From an initial 4 computers in 1969, this grew over the next 10 years to connect 200 computers in military and research establishments throughout the US , with a few overseas links . The largest computer network in the world was established . This made it very easy to communicate and transfer data over large distances , increasing work productivity as the flow of information increased . It proved , beyond doubt , the practicality and the value of Internetworking.

Designed as a deterrent to World War Three , the Internet really started to catch on in the early 1980' s . People who used the Internet were still mostly academics (including students) and government types . It was popular for its email , news groups , and file transfer capabilities . There was little , if any , commercial activity . It was funded by the Pentagon for national security . If a nuclear attack had come , the computer network was so designed that information could still flow around the country even if half the network were destroyed . This method of data flow is one of the main reasons for the success of the Internet . Unlike a smaller network it doesn ' t grind to a halt when a router or a hub fails.

It ' s ironic that we owe the commercialisation of the Internet to the fall of the Soviet Union , because after the major nuclear war threat was gone , the government did not really need it any more . The academics used it more and more and looked for new ways to utilise the technology .

1.6(1.5 in Chinese Edition) What is packet-switching, and why is packet switching relevant to the Internet?

Packet switching divides data into small blocks, called packets, and includes an identification of the intended recipient in each packet. Packet switching changed networking in a fundamental way, and provided the basis for the modern Internet. Packet switching allows multiple senders to transmit data over a shared network.

1.12 Major Standardization Organizations

List major standardization organizations that create standards for data communications and computer networking

Various national and international organizations are involved in standardization of communications and networking services. To list few:

- International Organization for Standardization (ISO)
- International Telecommunications Union , Telecommunication Standardization Sector (ITU - T)
- Institute of Electrical and Electronics Engineers (lEEE)
- Internef Engineering Task Force (lETF)

1.13(1.12 in Chinese Edition) Explain how headers are added and removed as data passes through a layered protocol stack.

Each layer on the sending computer prepends extra information onto the packet; the corresponding protocol layer on the receiving computer removes and uses the extra information.

5.3 Which piece of a data communications system handles analog input

The information source parts of a communication system are responsible for handling analog input. In addition, the subtopic focuses on the conversion between analog and digital representations of information.

5.5(5.3 in Chinese Edition) What are the conceptual pieces of a data communications system?

A communication can be a simple or complex one depending on the technology, the need and the environment being deployed. A complex communication system involving many parties and different types of services may involve the following conceptual pieces :

Information Sources

● Source Encoder and Source Decoder

●Eneryptor and Decryptor

●Channel Encoder and Channel Decoder

●Multiplexor and Demultiplexor

● Modulator and Demodulator

● Physical Channel and Transmission

6.11 The Definition of Baud

Baud is defined as the number of times that a signal can change per second.

6.12(6.11 in Chinese Edition) Suppose an engineer increases the number of possible signal levels from two to four. How many more bits can be sent in the same amount of time? Explain.

The number of levels that can be represented by n bits is given by 2^n . So if the number of levels changes from 2 to 4, it means the number of bits goes from 1 to 2.

6.17(6.18 in Chinese Edition) What is the chief advantage of a Differential Manchester Encoding?

The most important property of differential encoding is that the encoding works correctly even if the two wires carrying the signal are accidentally reversed.

7.3 Three types of wiring are used to reduce interference from noise

There are three forms of wiring that help reduce interference from electrical noise, these are namely:

- Unshielded Twisted Pair (UTP)
- Coaxial Cable
- Shielded Twisted Pair (STP)

7.18 Three types of communications satellites , and the characteristics of each

Major categorization of communication satellites :

● Low Earth Orbit (LEO)

● Medium Earth Orbit (MEO)

● Geostationary Earth Orbit (GEO)

Features of LEO Satellites

- A network of LEO satellites are needed for global coverage as their orbits are not geostationary.
- These satellites are not as powerful as the MEO and GEO satellites.
- Due to their high speeds, satellites move in and out of the earth station’ s range from time to time. So, data is handed off from one satellite to the other to achieve uninterrupted data communication.
- They are very much energy efficient. It takes much less energy to place the LEO satellites in their orbits, in comparison to MEOs and GEOs. Also, their amplifiers consume less power.
- They are quite cheap in comparison with other data communication modes. So, they can be used as a more economical way of communication for underdeveloped areas.
- They can be used for establishing networks in remote terrains where it is not feasible to lay land lines.

Features of MEO Satellites

Medium earth orbit (MEO) satellites lie between the two Van Allen Belts. MEOs are also called Intermediate Circular Orbits (ICOs).

The altitudes of these satellites range from 2,000 km to 35,000 km, i.e. above the low earth orbits and below the geosynchronous orbits. The orbital periods of MEOs range from 2 hours to more than 23 hours, depending upon their attitudes.

Features of GEO Satellites

A geostationary satellite is in an orbit that can only be achieved at an altitude very close to 35,786 km (22,236 miles) and which keeps the satellite fixed over one longitude at the equator. The satellite appears motionless at a fixed position in the sky to ground observers. There are several hundred communication satellites and several meteorological satellites in such an orbit.

8.3 What is a codeword, and how is it used in forward error correction ?

1. A **codeword** is an element of error-correcting code C. If C has length n, then a **codeword** in C has the form (c1,c2……cn), where each ci is a letter in the alphabet of C.

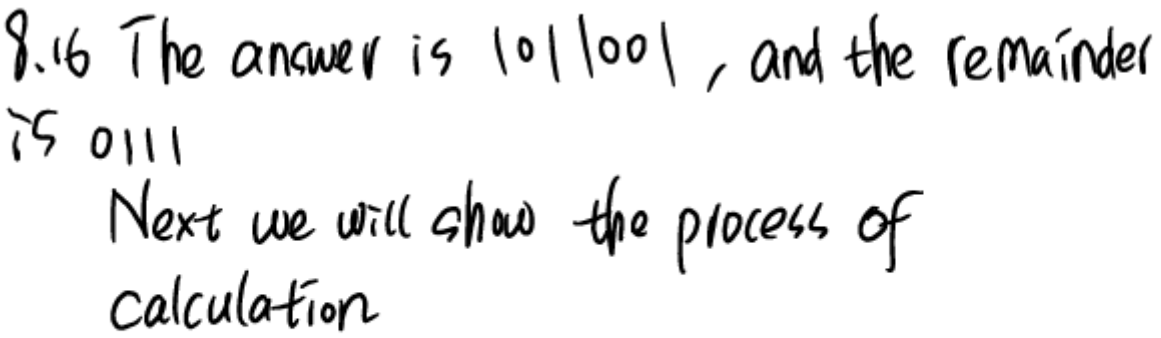
2. Forward error correction works by adding redundant bits to a bitstream to help the decoder detect and correct some transmission errors without the need for retransmission. The name *forward* stems from the fact that the flow of data is always in the forward direction (i.e., from encoder to decoder).

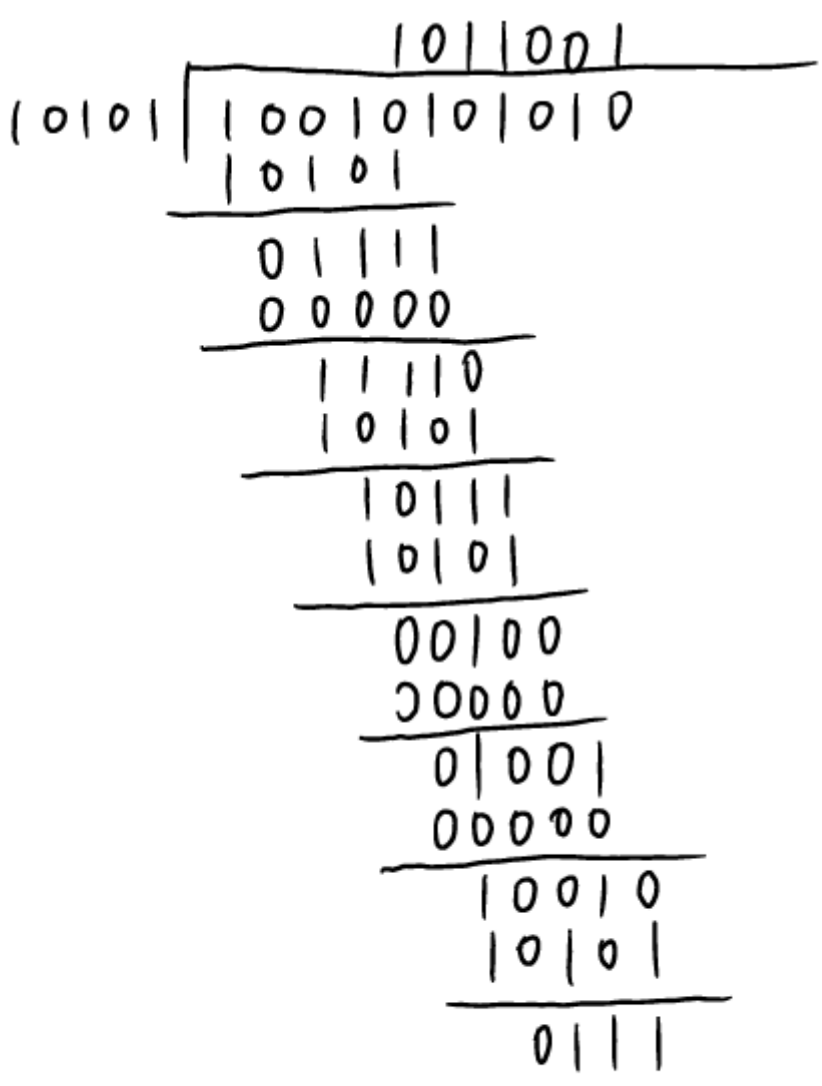
For example, in block codes the transmitted bitstream is divided into blocks of *k* bits. Each block is then appended with *r* parity bits to form an *n*-bit codeword. This is called an (*n*, *k*) code.

8.4(8.3 in Chinese Edition) In a burst error, how is burst length measured?

For a burst error, the burst size, or length, is defined as the number of bits from the start of the corruption to the end of the corruption.

8.16 The division of 10010101010 by 10101





8.17 (8.16 in Chinese Edition) Express the two values in the previous exercise as polynomials.

10010101010: $x^{10} + x^7 + x^5 + x^3 + x$

10101: $x^4 + x^2 + 1$

9.4 When transmitting a 32- bit 2' s complement integer in big - endian order , when is the sign bit transmitted ?

9.10(9.18 in Chinese Edition) When two humans hold a conversation , do they use simplex, half-duplex ,or full-duplex transmission?

lt depends, but most appropriate type of communication between two reasonable human being would be half-duplex.

9.8 When using a synchronous transmission scheme , what happens when a sender does not have data to send ?

To insure that the sender and receiver stay synchronized , a frame starts with a special sequence of bits .

Furthermore , most synchronous systems include a special idle sequence (or idle byte) that is transmitted when the sender has no data to send.

10.1 When using amplitude modulation , does it make sense for a 1 Hz carrier to be modulated by a 2 Hz sine wave ? Why or why not ?

11.10 Is a TDM system required to use round-robin service

Some TDM systems use a round-robin service while some others may not use round-robin, variations exist, based on the need.

12.1 Why do service providers distinguish between upstream and downstream communication ?

A typical residential subscriber receives much more information than the subscriber transmits . Internet access technologies are designed to transfer more data in one direction than the other. The networking industry uses the term downstream to refer to data traveling from an ISP to a subscriber, and upstream to refer to data traveling from a subscriber to an ISP .

12.2 Access Technology

Access Technology: A **technology** that captures an expression of functional intent (e.g. physical movement or physiological change) from the user via sensors, and processes the ensuing electrical signal into a control signal that drives some user interface (e.g., AAC, ECU or computer). The **access technology** encompasses an **access** pathway and a signal processing block.

12.7 Why is splitter used with DSL?

The main purpose of the DSL over POTS splitter, is to separate the transmission of POTS signals and DSL signals, which enables the simultaneous transmission of both voice and data on the same twisted pair, i.e. the POTS + DSL line. The splitter also provides isolation to the POTS signal from interference from DSL signals.

12.9 Why would a service provider choose Hybrid Fiber Coax instead of Fiber To The Premises?

It depends on the existing infrastructure or cost related issues . Each case should be considered on its own circumstances.

13.3 If someone wanted to broadcast a copy of a video presentation , is a circuit switching system or a packet switching preferable ? Why ?

Packet switching has the characteristie of establishing arbitrary , asynchronous communication means that can allow a sender to communicate with one recipient or multiple recipients .Also, a given recipient can receive messages from one sender or multiple senders .

13.5 Name the two sublayers of layer 2 protocols defined by IEEE , and give the purpose of each .

The Layer 2 protocols defined by IEEE defines two sub-layers as mentioned below :

- Logical Link Control (LLC) Addressing and demultiplexing
- Media Access Control (MAC) Access to shared media

13.11 Unicast , Multicast , and Broadcast addresses

Three categories of communication types are listed and described below :

1. **Unicast** : Uniquely identifies a single computer, and specifies that only the identified computer should receive a copy of the packet
2. **Broadcast** : Corresponds to all computers , and specifies that each computer on the network should receive a copy of the packet
3. **Multicast** : Identifies a subset of the computers on a given network , and specifies that each computer in the subset should receive a copy of the packet

13.12 Given an IEEE MAC address, how can one tell if the address refers to unicast?

In the 48-bit IEEE MAC address, one bit determines the type of connection. The value of the bit at position 8 specifies type of communication; 0(unicast)1(multicast)

13.15 Why is framing used?

Framing is used to represent the communication aspect which leads to the people’ s preference by consenting one meaning to another. Framing is an important aspect where an issue can be highlighted to make sense of the events. It can regulate the audience’ s perception and also the acceptance of a particular meaning.

14.8 In the Aloha protocol , what happens if two stations attempt simultaneous transmission on the inbound frequency , and how is the problem handled ?

If two stations simultaneously attempt to transmit on the inbound frequency , the signals will interfere and the two transmissions will be garbled . We use the term collision , and say that the two transmitted packets collide in the medium . The protocol handles a collision by requiring a sender to retransmit each lost packet .

14.11 What is binary exponential backoff?

Doubling the range of the random delay after each collision is known as binary exponential backoff. In essence , exponential backoff means that an Ethernet can recover quickly after a collision , because each computer agrees to wait longer times between attempts when the cable becomes busy . Even in the unlikely event that two or more computers choose delays that are approximately equal , exponential backoff guarantees that contention for the cable will be reduced after a few collisions .

That is, Binary Exponential Backoff (BEB) is an algorithm to determine how long entities should backoff before they retry. With every unsuccessful attempt, the maximum backoff interval is doubled. BEB prevents congestion and reduces the probability of entities requesting access at the same time, thereby improving system efficiency and capacity utilization.

BEB was initially proposed for computer networking where multiple computers share a single medium or channel. It's most famously used in Ethernet and Wi-Fi networking standards.

15.5 How did a computer attach to a Thicknet Ethernet?

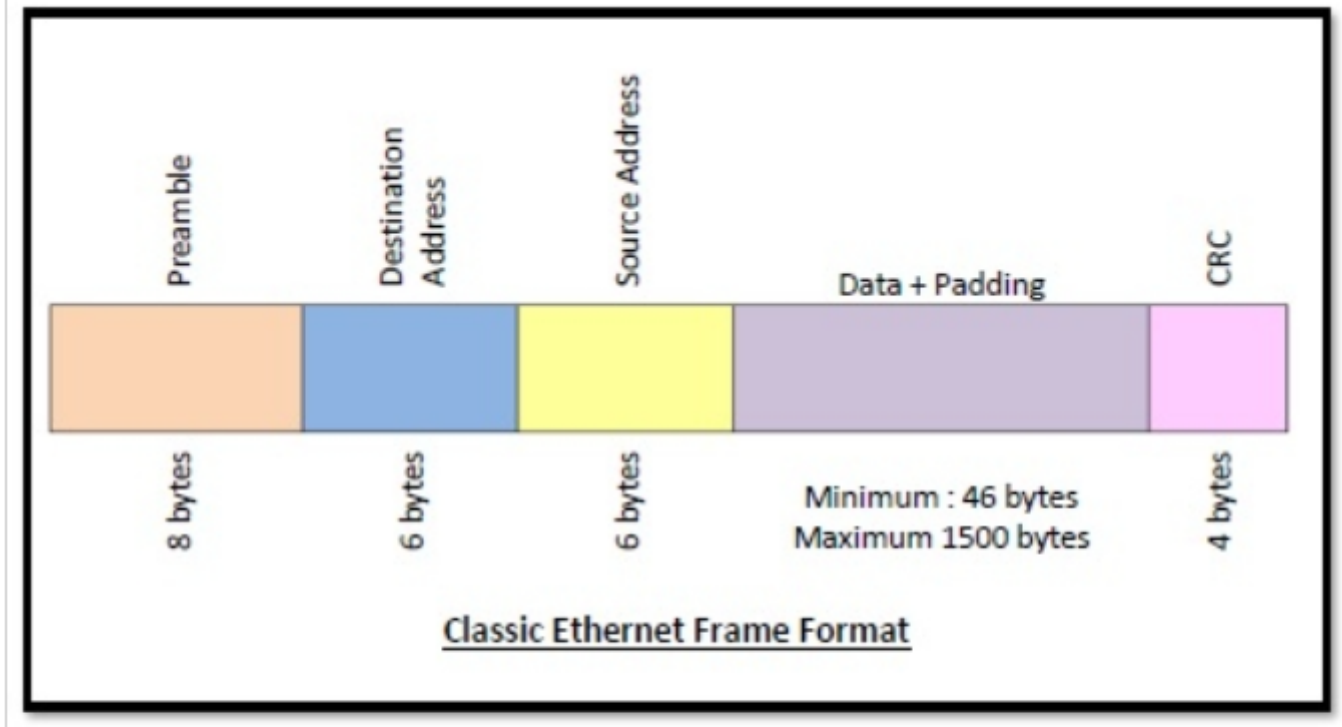
Hardware used with Thicknet was divided into two major parts :

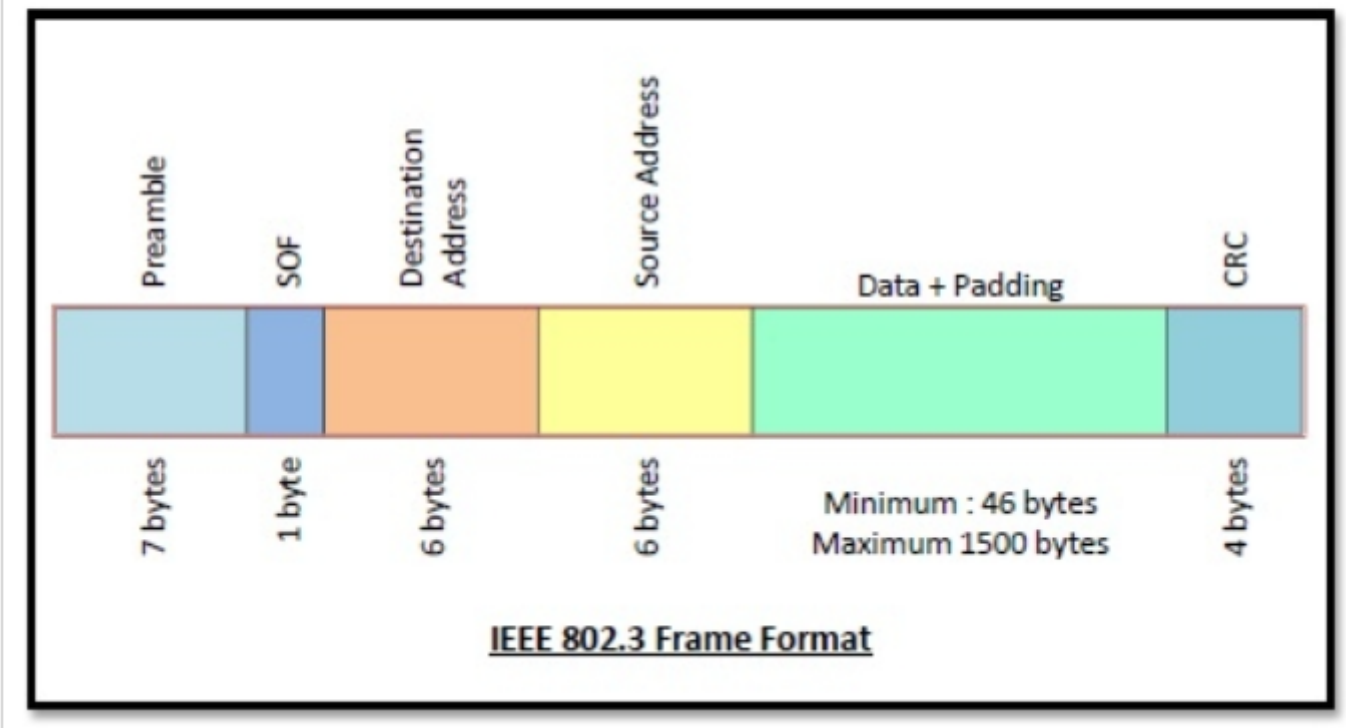
● Transceiver : A network interface card (NIC) handled the digital aspects of communication , and a separate electronic device called a transceiver connected to the Ethernet cable and handled carrier detection , conversion of bits into appropriate voltages for transmission , and conversion of incoming signals to bits.

● AUI : A physical cable known as an Attachment Unit Interface (AUI) connected a transceiver to a NIC in a computer . A transceiver was usually remote from a computer .

15.6 The differences between traditional Ethernet and 802.3 Ethernet

Ethernet is a set of technologies and protocols that are used primarily in LANs. It was first standardized in 1980s by IEEE 802.3 standard. IEEE 802.3 defines the physical layer and the medium access control (MAC) sub-layer of the data link layer for wired Ethernet networks. Ethernet is classified into two categories: classic Ethernet and switched Ethernet.





16.1 What are the three blocks of frequencies used by wireless LANs and PANs ?

The following range of frequencies are allocated for the usage of LANs and ISM applications without paying license fee :

1. Range of 902-928 MHz
2. Range of 2.4-2.482 GHz
3. Range of 5.725-5.850 GHz

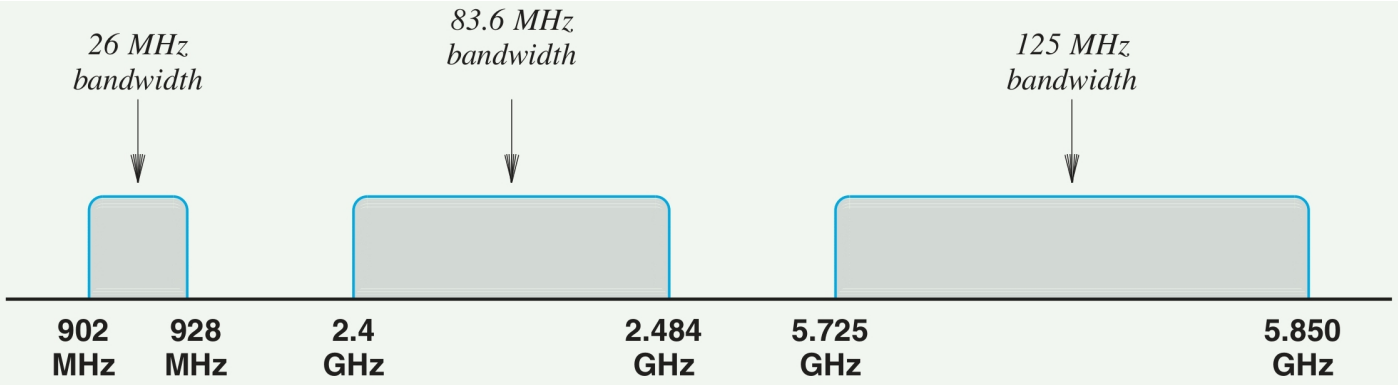


Figure 16.3 Blocks of frequencies that constitute the ISM bands and the bandwidth of each.

16.4 What is ISM wireless?

ISM stands for Industrial, Scientific and Medical. The use case followed initially. However, over the years, the use of the **ISM** Bands has become more widespread for short-range, low power **wireless** communications systems like cordless phones, **WiFi**, Bluetooth, NFC and a host of other short range **wireless** applications.

16.8 List the IEEE standards that have been proposed or created for wireless LANs

The question needs to be clarified further. But, the point is IEEE has created many wireless networking standards that handle various types of communication. Each standard specifies a frequency range, the modulation and multiplexing to be used, and a data rate . Figure 16.6 lists the major standards that have been created or proposed, and gives a brief deseription of each.

In 2007, IEEE “ rolled up ” many of the existing 802.1l standards into a single document known as 802.11-2007. The document describes basics , and has an appendix for each variant.

Standard	Purpose
802.11a	The first variant of 802.11 that was created to improve speed; no longer popular
802.11e	Improved quality of service, such as a guarantee of low jitter
802.11h	Like 802.11a, but adds control of spectrum and power (primarily intended for use in Europe)
802.11i	Enhanced security, including Advanced Encryption Standard; the full version is known as WPA2
802.11k	Will provide radio resource management, including transmission power
802.11p	Dedicated Short-Range Communication (DSRC) among vehicles on a highway and vehicle-to-roadside
802.11r	Improved ability to roam among access points without losing connectivity
802.11s	Proposed for a mesh network in which a set of nodes automatically form a network and pass packets

Figure 16.6 Major 802.11 standards and the purpose of each.

17.3 Give a precise statement of conditions under which an adaptive bridge will forward a packet. Explain.

When a frame arrives from a given segment, the bridge extracts the source address from the header, and adds the address to a list of computers attached to the segment. The bridge must then extract the MAC destination address from the frame, and use the address to determine whether to forward the frame using a forwarding table.

17.7 Do computers on bridged Ethernet receive spanning tree packets? Explain.

Ethernet bridges communicate among themselves. Computers on the bridged Ethernet are not aware of the spanning tree.

17.12 According to Figure 17.6, can two computers attached to switched LAN transmit packets simultaneously? Explain.

If the figure is analyzed carefully, it can be seen that two pairs of computers can communicate simultaneously without affecting each other.

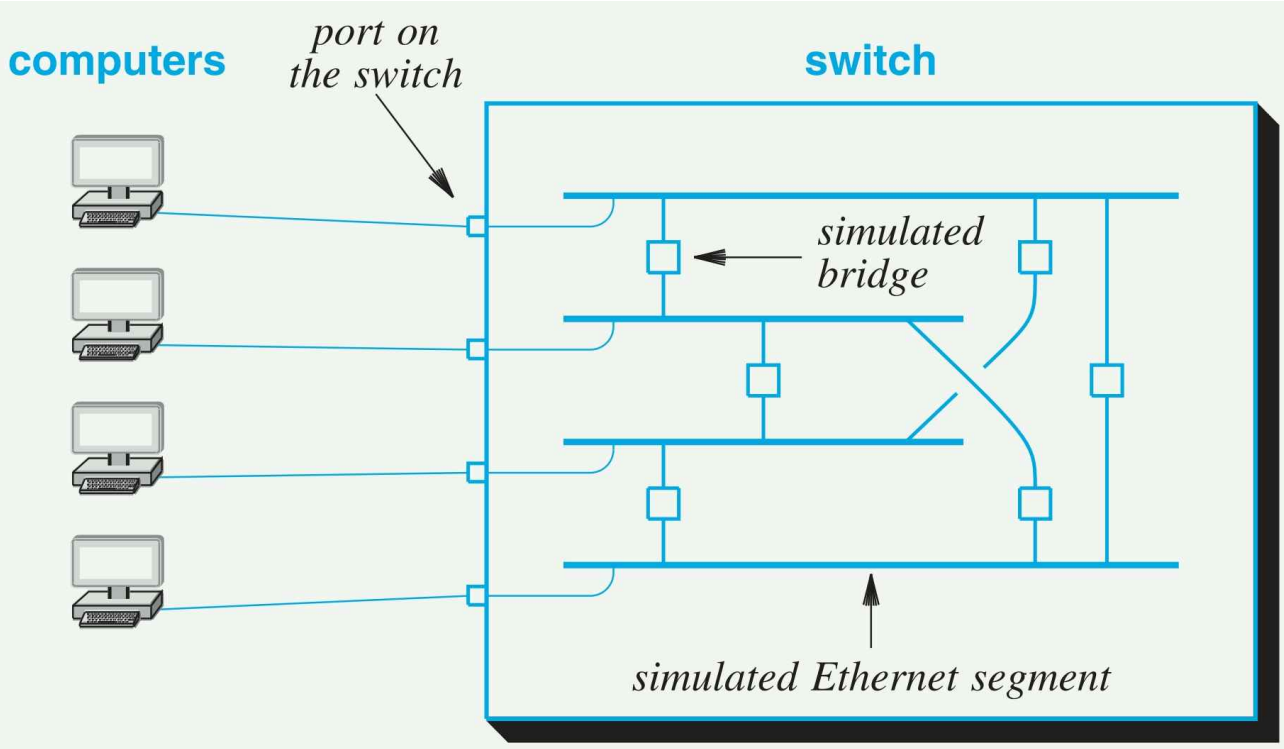


Figure 17.6 Conceptual organization of a switched LAN.

17.13 Can a bridge connect a Wi-Fi network to an Ethernet? Can a switch? Why or why not?

1. **Bridge can connect a Wi-Fi network to an Ethernet.**

Types of Wireless Bridging:

Hardware that supports wireless network bridging includes:

- Wi-Fi to Ethernet bridge: **This hardware allows Wi-Fi clients to connect to an Ethernet network.** The hardware integrates with Wi-Fi wireless access points and is useful for older computers or devices that don't have Wi-Fi capability.
- Wi-Fi to Wi-Fi bridge: This bridge joins two Wi-Fi networks, often to increase the coverage area of a Wi-Fi hotspot. Some wireless AP hardware supports bridging in Ethernet as well as Wi-Fi mode.
- Bluetooth to Wi-Fi bridge: This bridge connects devices that communicate with consumer Bluetooth gadgets and interface with a Wi-Fi home network.

2. **Network switches cannot connect to a Wi-Fi network or allow devices to connect to it wirelessly.** The closest concept to a wireless switch is a signal booster or repeater, but these are considered to be hubs rather than switches.

The reasons why Wireless Switches do not Exist are:

Network switches are designed in such a way to take a signal in from a particular port and then rebroadcast it out on a specific port that it knows has previously had the device expecting to receive the signal connected to it.

Should this port not have anything plugged in, or a different device is connected, the switch will rebroadcast the signal across all the ports until it can find the recipient for the signal.

A hub works slightly differently in that it is always broadcasting across all of the ports.

Wireless networks don’ t have an equivalent of how wired ports work and instead work more similarly to a hub. Previously, you would have needed an additional device to sit in the middle of a network that is responsible for keeping an eye out for signals on a network segment that were intended for the other segment and then rebroadcasting the signal back and forth between the

two. This device is what you and I refer to as a router. And this is actually how a router still works today. It takes the signal from WAN (wide area network), LAN (local area network), and WLAN (wireless local area network) networks and passes it on as necessary.

Routers were aware of gateways and protocol addresses, amongst other things, and therefore sat at a higher level than switches as they were considered to be more intelligent, more capable devices.

Another reason for wireless network switches not existing comes down to switches generally having one “wire”. This is referred to as the space, for lack of a better word, between the devices that are part of a network.

All of the devices share the same “space” so only one of them will send a packet of data at a time to mitigate the chances of there being a collision.

With wireless, you can have multiple “wires” by using several different sets of distinct radio frequencies, which allows different devices to communicate with each other at the same time when they are running on different frequencies.

It is for this reason that you will find a range of different frequencies within each wireless standard. You could be using one frequency, or channel, whilst your neighbor uses a different one, so your devices don’t interfere with each other.

There are some wireless access point protocols that allow different devices to use different frequencies whilst remaining connected to the same network, but we won’t go into that here.

If you only have only a small number of devices and there are no other local networks using the same frequency ranges, you won’t get one collision domain per device like you would if you were using a wired network switch.

Instead, you would get just the one collision domain per frequency range being used.

18.12 Write a computer program that implements Dijkstra ' s algorithm for finding shortest paths in a graph.

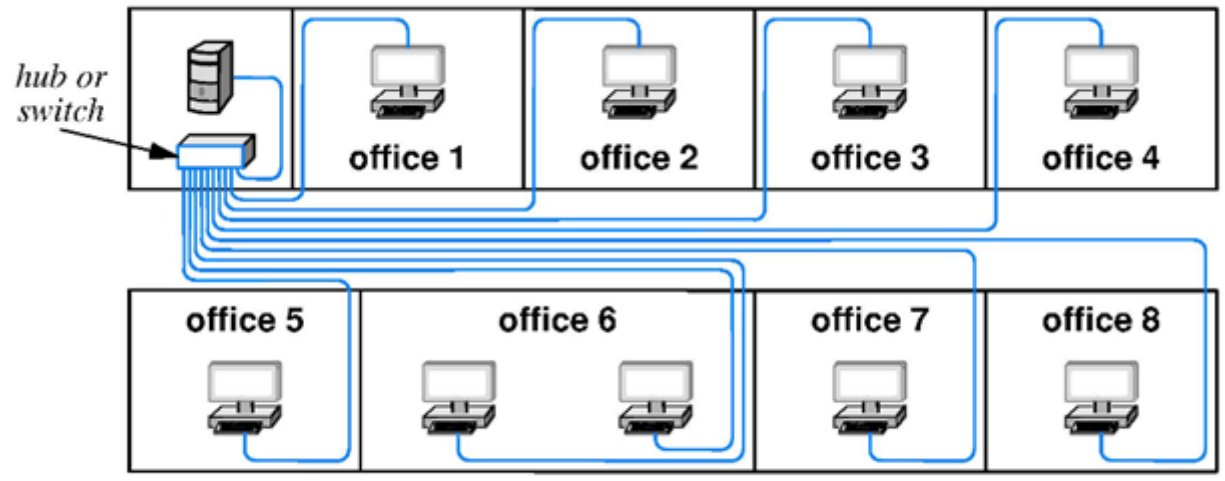
Below are the detailed steps used in Dijkstra’s algorithm to find the shortest path from a single source vertex to all other vertices in the given graph.
Algorithm
1) Create a set *sptSet* (shortest path tree set) that keeps track of vertices included in shortest path tree, i.e., whose minimum distance from source is calculated and finalized. Initially, this set is empty.
2) Assign a distance value to all vertices in the input graph. Initialize all distance values as INFINITE. Assign distance value as 0 for the source vertex so that it is picked first.
3) While *sptSet* doesn’t include all vertices
….**a)** Pick a vertex u which is not there in *sptSet* and has minimum distance value.
….**b)** Include u to *sptSet*.
….**c)** Update distance value of all adjacent vertices of u. To update the distance values, iterate through all adjacent vertices. For every adjacent vertex v, if sum of distance value of u (from source) and weight of edge u-v, is less than the distance value of v, then update the distance value of v.

```
// A C++ program for Dijkstra's single source shortest path algorithm.
// The program is for adjacency matrix representation of the graph

#include <limits.h>
#include <stdio.h>

```

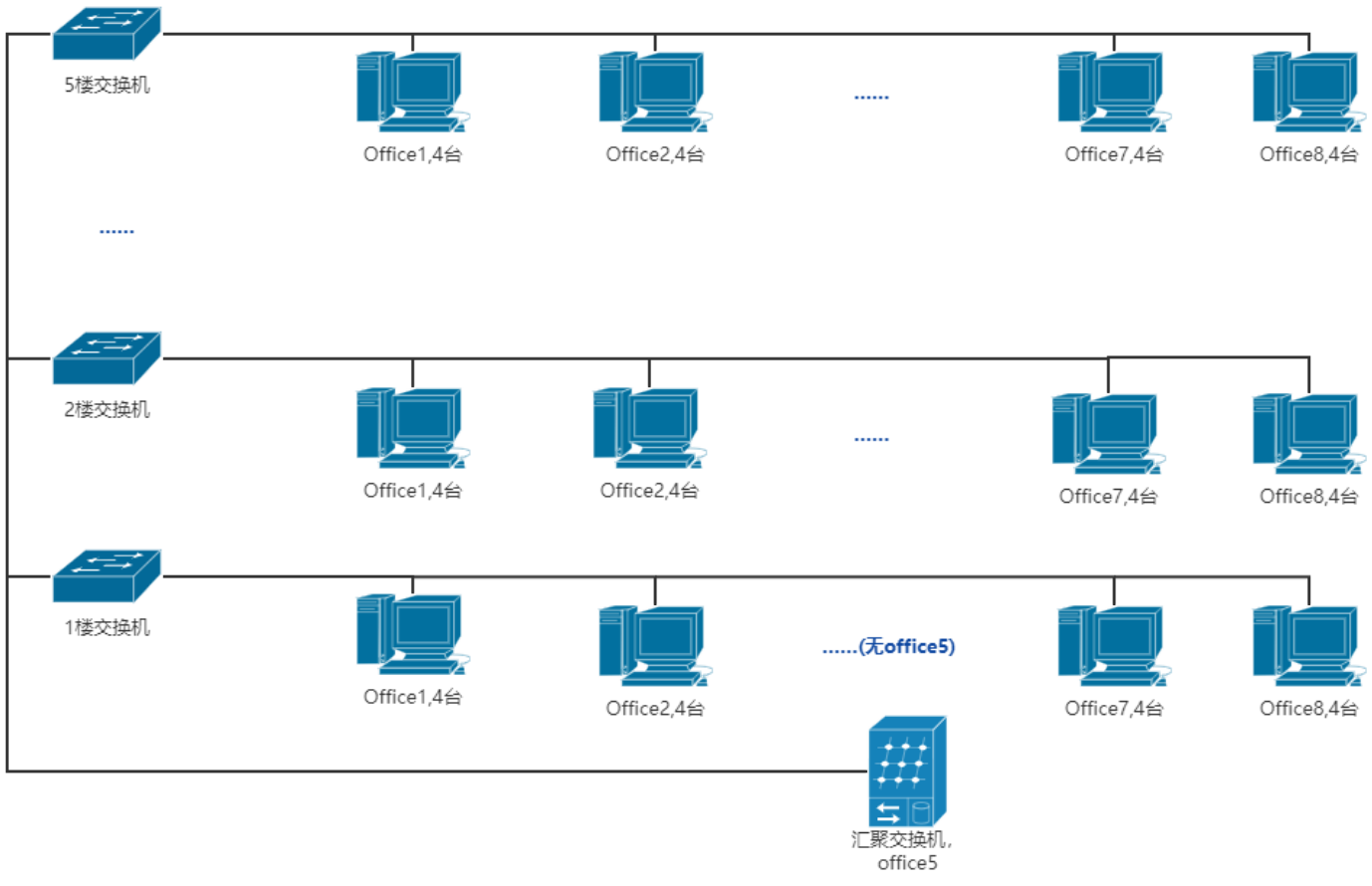
```c
// Number of vertices in the graph
#define V 9

// A utility function to find the vertex with minimum distance value, from
// the set of vertices not yet included in shortest path tree
int minDistance(int dist[], bool sptSet[])
{
    // Initialize min value
    int min = INT_MAX, min_index;

    for (int v = 0; v < V; v++)
        if (sptSet[v] == false && dist[v] <= min)
            min = dist[v], min_index = v;

    return min_index;
}

// A utility function to print the constructed distance array
int printSolution(int dist[], int n)
{
    printf("Vertex   Distance from Source\n");
    for (int i = 0; i < V; i++)
        printf("%d \t\t %d\n", i, dist[i]);
}

// Function that implements Dijkstra's single source shortest path algorithm
// for a graph represented using adjacency matrix representation
void dijkstra(int graph[V][V], int src)
{
    int dist[V]; // The output array.  dist[i] will hold the shortest
    // distance from src to i

    bool sptSet[V]; // sptSet[i] will be true if vertex i is included in shortes
    // path tree or shortest distance from src to i is finalized

    // Initialize all distances as INFINITE and stpSet[] as false
    for (int i = 0; i < V; i++)
        dist[i] = INT_MAX, sptSet[i] = false;

    // Distance of source vertex from itself is always 0
    dist[src] = 0;

    // Find shortest path for all vertices
    for (int count = 0; count < V - 1; count++) {
        // Pick the minimum distance vertex from the set of vertices not
        // yet processed. u is always equal to src in the first iteration.
        int u = minDistance(dist, sptSet);

        // Mark the picked vertex as processed
        sptSet[u] = true;

        // Update dist value of the adjacent vertices of the picked vertex.
        for (int v = 0; v < V; v++)

            // Update dist[v] only if is not in sptSet, there is an edge from
            // u to v, and total weight of path from src to  v through u is
            // smaller than current value of dist[v]
            if (!sptSet[v] && graph[u][v] && dist[u] != INT_MAX
                && dist[u] + graph[u][v] < dist[v])
```

```
                dist[v] = dist[u] + graph[u][v];
    }

    // print the constructed distance array
    printSolution(dist, V);
}

// driver program to test above function
int main()
{
    /* Let us create the example graph discussed above */
    int graph[V][V] = { { 0, 4, 0, 0, 0, 0, 0, 8, 0 },
                        { 4, 0, 8, 0, 0, 0, 0, 11, 0 },
                        { 0, 8, 0, 7, 0, 4, 0, 0, 2 },
                        { 0, 0, 7, 0, 9, 14, 0, 0, 0 },
                        { 0, 0, 0, 9, 0, 10, 0, 0, 0 },
                        { 0, 0, 4, 14, 10, 0, 2, 0, 0 },
                        { 0, 0, 0, 0, 0, 2, 0, 1, 6 },
                        { 8, 11, 0, 0, 0, 0, 1, 0, 7 },
                        { 0, 0, 2, 0, 0, 0, 6, 7, 0 } };

    dijkstra(graph, 0);

    return 0;
}
```

2. Comprehensive Questions



Third Generation (twisted pair or fiber)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Office8,4台
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