**INTRODUCTION TO COMPUTER NETWORKING ASSIGNMENT 2**

Assignment 2

**COMPUTER SCIENCE 4 - REGULAR**

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**An organization with 13 branches scattered across Ghana acquired the IP address 176.184.238.73/16**

1. What class is the IP address?

**Answer:** Class B Address

**Explanation :** Since it is in the range of 128.0.0.0 and 191.255.255.255

1. What subnet is the address on?

**Answer:** 176.184.0.0

**Explanation :** /16 indicates the network mask or subnet mask , which

means first 16 consecutive bits of ones.

/ 16 = 11111111.11111111.00000000.00000000 in decimal notation is

= 255.255.0.0

1. What is the NetID?

**Answer:** 176.184

**Explanation :**

Since is a Class B address, the NetID is determined by the first 16 bits.

**Step 1** To get the NetID convert all the host portion of the address into binary and fill them with binary Zero’s

IP address given decimal notation => 176.184.238.73/16

In binary => 10110000.10111000.11101110.1001001

Since the subnet mask is /16 , it means the first 16 bits from your left represents the network portion and the last 16 bits represent the host portion

|  |  |
| --- | --- |
| **Network Portion** | **Host Portion** |
| 10110000.10111000. | 11101110.01001001 |

**Step 2**  Fill the host portion with binary Zero’s

|  |  |
| --- | --- |
| **Network Portion** | **Host Portion** |
| 10110000.10111000. | 00000000.00000000 |

NetID in binary => 10110000.10111000.00000000.00000000

In Decimal Notation => **176.184.0.0**

1. What is the HostID?

**Answer:** **238.73**

Hostid range = 176.184.**0.1** – 176.184.**255.254**

**Explanation :**

Since is a Class B address with a default mask, the HostId is the last 16 bits of the IP address given.

|  |  |
| --- | --- |
| **Network ID** | **Host ID** |
| 10110000.10111000. | 11101110.01001001 |

Host ID in binary => 00000000.00000000.11101110.01001001

HostID in decimal => 0.0.**238.73**

1. What is the SubnetID?

**Answer:** 176.184.0.0

**Explanation :**

`**Step 1** To get the subnet address convert all the host portion of the address into binary and fill them with binary Zero’s

IP address given decimal notation => 176.184.238.73/16

In binary => 10110000.10111000.11101110.01001001

Since the subnet mask is /16 , it means the first 16 bits represents the network portion and the last 16 bits represent the host portion .

|  |  |
| --- | --- |
| **Network Portion** | **Host Portion** |
| 10110000.10111000. | 11101110.01001001 |

|  |  |
| --- | --- |
| **Network Portion** | **Host Portion** |
| 10110000.10111000. | 00000000.00000000 |

**Step 2** Fill the host portion with binary Zero’s

Subnet Address => 10110000.10111000.00000000.00000000

In Decimal Notation => **176.184.0.0**

1. What is the site address?

**Answer:** 176.184.238.73

1. Give the address in its BITWISE notation.

**Answer:** 10110000.10111000.11101110.01001001

**Explanation :**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Decimal** | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 | **Binary** |
| 176 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 10110000 |
| 184 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 10111000 |
| 238 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 11101110 |
| 73 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 01001001 |

Therefore 176.184.238.73 in binary **=>** 10110000.10111000.11101110.01001001

1. What is the name of the /16 notation

**Answer :** Classless Inter - Domain Routing – CIDR

1. Give the dotted decimal notation of the /16 and also give bitwise notation equivalent.

**Answer: Decimal Notation :** 255.255.0.0

**Bitwise Notation :** 11111111.11111111.00000000.00000000

**Explanation:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Decimal** | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 | **Binary** |
| 255 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 11111111 |
| 255 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 11111111 |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 00000000 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 00000000 |

1. Design a suitable network for the organization ensuring most efficient usage of addresses.

**Answer:**

1. A star bus or tree topology will be used for the physical layout of the network.
2. Each branch will be given a router which will allow it to connect to the internet and also communicate with other branches.
3. An ISP or WAN service provider is used to link the headquarters with all the branches.
4. A single Subnet addresses will be allocated to each branch by subnetting the organisation allocated address of **176.184.238.73/16** into 16 subnets where each can support a host of 4094.
5. At the various branches, the subnet address allocated will be further subdivided to cater for the various departments and group of hosts
6. Each department or host with common needs will be connected to a switch which will be linked to the branch router.
7. At the various branches a segment of network provided for special host such as servers, printers and network devices.
8. Links to servers and hosts from network devices will be high speed.
9. Workstations will be connected to their own full duplex interface on a switch. \
10. Servers, printers and other network devices will be connected to their own full duplex interface with a switch.

**Subnetting the Allocated Address block**

Since the headquarters is assigned an address block of **176.184.0.0**/16 . we will have to subnet to at least 16 subnets to support all the branches. Where the first subnet will be used for the network and the last for broadcast address.

Since we are subnetting based on the number of subnets required, we shall use the formula 2n to find the number of networks, where the n is the number of bits which will be taken from the host side of the address to create a 2n networks.

**Step 1**

Work out the number of bits required to support 16 subnets

2n = 16

2n = 24

n = 4

Therefore to support 16 subnets we require 4 bits in binary from the host portion to append to the network portion.

**Step 2**

Convert the host portion of the Subnet Address into binary.

|  |  |
| --- | --- |
| **Network** | **Host** |
| 10110000.10111000. | **00000000.00000000** |

**Step 3**

Since we require 4 bits from the host side , we counts 4 bits from the left to right in the host portion and allocate it to the network portion.

|  |  |  |
| --- | --- | --- |
| **Network** | **Subnet** | **Host** |
| 10110000.10111000. | **0000** | 0000.00000000 |

**Step 4**

Calculate for the **network mask**

|  |  |
| --- | --- |
| **Network** | **Host** |
| 10110000.10111000.0000 | **0000.00000000** |

Total bits = 32

Host bits = 12

Network mask bits = Total bits – Host bits

= 32 – 12

= 20

**Therefore our Network Mask = /20 or 255.255.240.0**

**Step 5**

Work outs our new subnets by going through all the various binary combinations for the subnet portion of the address.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Network** | **Network ID** | **Subnet** | **Host ID** | **Subnet Address** |
| 1 | 10110000.10111000. | **0000** | 0000.00000000 | 176.184.0.0/20 |
| 2 | 10110000.10111000. | **0001** | 0000.00000000 | 176.184.16.0/20 |
| 3 | 10110000.10111000. | **0010** | 0000.00000000 | 176.184.32.0/20 |
| 4 | 10110000.10111000. | **0011** | 0000.00000000 | 176.184.48.0/20 |
| 5 | 10110000.10111000. | **0100** | 0000.00000000 | 176.184.64.0/20 |
| 6 | 10110000.10111000. | **0101** | 0000.00000000 | 176.184.80.0/20 |
| 7 | 10110000.10111000. | **0110** | 0000.00000000 | 176.184.96.0/20 |
| 8 | 10110000.10111000. | **0111** | 0000.00000000 | 176.184.112.0/20 |
| 9 | 10110000.10111000. | **1000** | 0000.00000000 | 176.184.128.0/20 |
| 10 | 10110000.10111000. | **1001** | 0000.00000000 | 176.184.144.0/20 |
| 11 | 10110000.10111000. | **1010** | 0000.00000000 | 176.184.160.0/20 |
| 12 | 10110000.10111000. | **1011** | 0000.00000000 | 176.184.176.0/20 |
| 13 | 10110000.10111000. | **1100** | 0000.00000000 | 176.184.192.0/20 |
| 14 | 10110000.10111000. | **1101** | 0000.00000000 | 176.184.208.0/20 |
| 15 | 10110000.10111000. | **1110** | 0000.00000000 | 176.184.224.0/20 |
| 16 | 10110000.10111000. | **1111** | 0000.00000000 | 176.184.240.0/20 |

Number of networks supported = 2n

= 24

= **16**

Number of host supported by each subnet = 212 = **4096**

Actual host supported excluding the network and broadcast address = 4096 – 2 = **4094**

**Step 6**

To get the host range addresses for each subnet

***To get the first host***, fill the host portion of an address with binary Zero’s except for the last bit which is set to 1.

Using the first Subnet Address 176.184.0.0/20

|  |  |  |
| --- | --- | --- |
| **Network ID** | **Host ID** | **In decimal** |
| 10110000.10111000.0000 | **0000.00000001** | **176.184.0.1** |

***To get the last host***, fill the host portion of the address with binary One’s except for the last bit which is set to 0

Using the first Subnet Address 176.184.0.0/20

|  |  |  |
| --- | --- | --- |
| **Network ID** | **Host ID** | **In decimal** |
| 10110000.10111000.0000 | **1111.11111110** | **176.184.15.254** |

Therefore the host range for 176.184.0.0/20 is 176.184**.0.1 to** 176.184.**15.254**

1. List all the subnet addresses

**Ans :**

|  |  |  |
| --- | --- | --- |
| **Network** | **Subnet Address** | **Host Address Range** |
| 1 | 176.184.0.0/20 | 176.184.0.1 - 176.184.15.254 |
| 2 | 176.184.16.0/20 | 176.184.16.1 - 176.184.31.254 |
| 3 | 176.184.32.0/20 | 176.184.32.1 - 176.184.47.254 |
| 4 | 176.184.48.0/20 | 176.184.48.1 - 176.184.63.254 |
| 5 | 176.184.64.0/20 | 176.184.64.1 - 176.184.79.254 |
| 6 | 176.184.80.0/20 | 176.184.80.1 - 176.184.95.254 |
| 7 | 176.184.96.0/20 | 176.184.96.1 - 176.184.111.254 |
| 8 | 176.184.112.0/20 | 176.184.112.1 - 176.184.127.254 |
| 9 | 176.184.128.0/20 | 176.184.128.1 - 176.184.143.254 |
| 10 | 176.184.144.0/20 | 176.184.144.1 - 176.184.159.254 |
| 11 | 176.184.160.0/20 | 176.184.160.1 - 176.184.175.254 |
| 12 | 176.184.176.0/20 | 176.184.176.1 - 176.184.191.254 |
| 13 | 176.184.192.0/20 | 176.184.192.1 - 176.184.207.254 |
| 14 | 176.184.208.0/20 | 176.184.208.1 - 176.184.223.254 |
| 15 | 176.184.224.0/20 | 176.184.224.1 - 176.184.239.254 |
| 16 | 176.184.240.0/20 | 176.184.240.1 - 176.184.255.254 |

l. Give the subnet address that this IP address resides on 176.184.238.73 255.255.240.0

**Answer: Since is in the host range of** 176.184.224.1 - 176.184.239.254 in network Number 15, its corresponding subnet Address is **176.184.224.0/20**

**Or by Calculation**

Given a subnet mask of 255.255.240.0 in binary 11111111.11111111.11110000.00000000 or /20

To get the subnet address convert all the host portion of the address into binary and fill them with binary Zero’s

IP address given decimal notation => 176.184.238.73/20

In binary => Since the subnet mask is /20 , it means the first 20 bits represents the subnet address.

|  |  |
| --- | --- |
| **Network Portion** | **Host Portion** |
| 10110000.10111000.**1110** | **1110**.01001001 |

Fill the host portion with binary Zero’s

|  |  |
| --- | --- |
| **Network Portion** | **Host Portion** |
| 10110000.10111000.**1110** | **0000**.00000000 |

Subnet Address => 10110000.10111000.1110**0000.00000000**

In Decimal Notation => **176.184.224.0**

m. What is the site address for the given address in 'l' above

**Answer:** 176.184.238.73/20

n. What is the NetID for the given address in 'l' above

**Answer:** 176.184.224

o. What is the HostID for the given address in 'l' above

**Answer: 14.73**

**Explanation**

|  |  |
| --- | --- |
| **Network Portion** | **Host Portion** |
| 10110000.10111000.**1110** | **1110**.01001001 |

Fill the network portion with zero’s

|  |  |
| --- | --- |
| **Network Portion** | **Host Portion** |
| 00000000.0000000.0000 | **1110**.01001001 |

Host Address => 00000000.0000000.0000**1110.01001001**

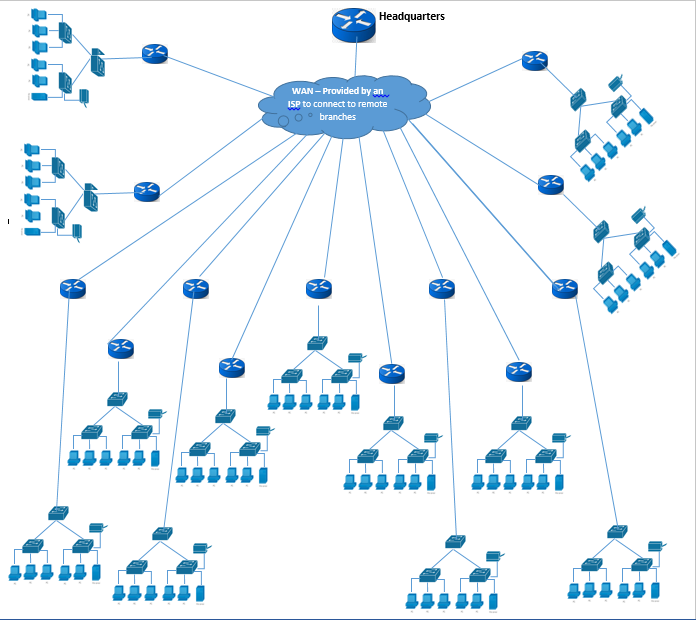
In Decimal Notation **:** 176.184.238.73

0.0.**14.73**

p. What is the SubnetID for the given address in 'l' above

**Answer:** 176.184.224.0/20

q. Draw the network diagram that can be used for the implementation of the organisation network



r. Explain the functionality of each if the devices in your network diagram and justify their purpose in your diag.

**Answer:**

* ***Switch***:*A* network device that connects multiple devices together and filters packets based on their destination within the connected devices. It is used as part of the networking diagram to receive incoming data packets and redirects them to their destination on the Local Area Network (LAN).
* ***Router***: A device that receives and analyzes packets and then routes them towards their destination. In some cases, a router will send a packet to another router; in other cases, it will send it directly to its destination. It is used as part of the network diagram to connect the different networks in Local Area Network (LAN) and Wide Area Network (WAN) and also to act as a firewall to to protect one network from the other.
* **Host Devices:** Laptop,Desktop,printer etc to interact with each other.
* **Cables:** Use to connect Networking devices and host devices

s. How will you ensure Internet connectivity for host at each branch.

**Answer:** By connecting the routers at the various branches to an Internet Service provider.

t. Explain type(s) of connections in your network diagram.

**Answer:**

**LAN: Communication between switches and Host devices in the diagram is based on LAN**

Local area network (LAN) is a computer network that overlaps with a small area. Usually, a LAN is tied to a single room, building or cluster, but one LAN can be connected to other LANs over any distance via telephone wires and radio waves.The system of LANs connected in this way is called a broadband network (WAN). The difference between LAN and WAN is that the wider area network scans the larger geographically. Usually, a WAN consists of two or more local networks (LANs) and is always connected by public networks.

**WAN: Communication between routers to connect two or more networks.**

WAN is a network that uses multiple links - Private Lines, Multiprotocol Label Switching (MPLS), Virtual Private Network (VPN), Wireless (Cellular), Internet - connects small metropolitan and campus networks in one place. The sites they connect to may be a few miles or half across the globe. In an organization, WAN's goals may include linking branch offices or individual remote workers to headquarters or data centers to share corporate offices and communications.

u. Explain the protocols for devices communication in your network diagram

**Answer:**

SNTP

**Transmission control Protocol – TCP**

TCP provides reliable delivery of data, therefore it supports – segmentation, multiplexing, sequencing and flow control. The disadvantages of using TCP is that, due to its complexity, it can introduce unwanted delays between communicating devices.

**User Datagram Protocol – UDP**

UDP provides rapid delivery of data, but without reliability. UDP only provides segmenting and multiplexing of data received from the application layer. Data from communication programs using voice and video are typically intolerant of delay and therefore use UDP

**SIMPLE NETWORK TIME PROTOCOL - SNTP**

Is a time synchronization protocol of TCP – IP protocol family. It is based on the connectionless user datagram protocol and can be used on all supporting devices to synchronize system time in IP

v. Explain protocol for 3 applications communication on your network

**Answer :**

**Post Office Protocol 3 (POP3)**

Used by email programs when they need to receive emails.

**Hyper Text Transfer Protocol (HTTP)**

Used by web browsers such as Edge and Firefox to request and transfer webpages from the WWW.

**File Transfer Protocol (FTP)**

Often used by file sharing programs in order to send and receive files between users across the Internet.

w. Explain the addressing mechanism in the movement of packets from one branch to the other.

Since the destination host is present in different network the packet will be delivered to the default gateway first which in turn delivers the packet to the destination host.

Here we have a router with two interfaces: **e1/1/1** (which I'll refer to as *E1*) and **e1/1/2** (which I'll refer to as *E2*).

The router's two interfaces are in separate subnets, separate collision domain as well as broadcast domain. When data arrives from one of the segment the router decides according to its routing table to which network to forward the data

E1 is connected to subnet: **10.128.200.0/21**

E2 is connected to subnet: **10.128.208.0/21**

Now, suppose Pc1 (with IP address **10.128.200.1/21** and therefore in subnet **10.128.200.0/21**) sends a message to Pc4 (with IP address **10.128.208.4/21** and therefore in subnet **10.128.208.0/21**)

1. Once that packet arrives at the router, the following happens:
2. Packet arrives on interface E1with subnet **10.128.200.0/21**
3. Router determines the destination address is **10.128.208.4/21**
4. Router examines its routing table to determine where the packet should go based on the NetId
5. The routing table indicates interface E2 is connected to subnet **10.128.208.0/21**
6. The router prepares the packet for transmission on interface E2.
7. The new packet is transmitted on interface E2

Once the packet is sent to the network segment connected to router interface E2 it is received by the switch which is then forwarded to the host.

x. Assuming each branch has 58 workstations and a printer, how many collision domains has your network diagram

**Answer :**

819

y. As follow-up question to 'x', how many broadcast domains has your network diagram

**Answer**:

26

z. Write a convincing summary statement to convince management of why they should invest money to deploy your network diagram. Your statement must clearly spell out the advantages of the network that the organization stands to gain if they implement it.

**Answer:**

The advantage of using this is that additional segments of network can easily be added in several places. Segments can be attached to a router for expansion in a given department or building or even a branch and if a segment needs to be secured, if the router has access list configured on them they can act as a firewall for network. Since each branch will be given one single block of address it can further be subnetted to create additional networks at each branch. Subnetworks can be created for host with common user needs.

Also since the Wide Area Network (WAN) operates over a much larger area, they are required to interconnect LANs at various branches to communicate and exchange data. It also allows the branches to connect to the internet. The reason for the company to rent a WAN service from an established service provider is due to the distance that WANs operate over, setting one up would cost a substantial amount of money as the company would need to purchase the necessary cabling, fibre and satellite systems. Setting up a WAN would therefore prove to be extremely expensive and time-consuming.

The star bus hybrid topology or tree topology used in the diagram enables the firm to economically connect all network computers. Is also popular and the components are easy to obtain and relatively easy to support. The tree topology will allow network administrators to easily manage and maintain the network and also offers easiest method for error detection and troubleshooting. It is scalable so you can increase your network size as the company grows in size.

Local Area Networks at the branch level are connected using cable instead of wireless connectivity due to sources of radio wave interference in the building, so using cable ensures that network communication will be reliable. Using a switch to join the links on the network satisfies the need for fast communication, as each host will have the full bandwidth available to use.