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COMP 4320: Assignment 4

Problem 1:

Imagine you are responsible for designing and managing the IP addressing scheme for a large enterprise network that spans multiple locations. Using your understanding of IP addressing, subnetting, CIDR, and DHCP, answer the following questions:

* 1. **Explain the structure of an IP address, including how it is divided into network and host portions. Discuss the role of subnetting, and how it helps efficiently allocate IP addresses in large networks. Given a /16 network that is divided into /20 subnets, calculate: a. The number of available subnets. b. The maximum number of hosts per subnet.**

The structure of an IP address is made of a 32-bit label. It is divided into 4 octets. The network part of the address shows the network to which the device is related to. The host part of the address reveals the device within the network. The idea of subnetting is when one large network is cut into smaller parts. This makes many easily manageable subnetworks. This allows for better efficiency because all you have to do is monitor a smaller part of the network multiple times. It also helps with security because you can monitor the parts of the networks better. The subnetting assists in better IP address usage because it reduces unnecessary usage in large networks. The number of subnets available in a /16 network that is divided into /20 is 2(20-16) = 24 = 16 subnets. The number of maximum number of hosts per subnet is 12 bits for the host address and the 212 – 2 = 4094 hosts.

* 1. **Explain Classless Inter-Domain Routing (CIDR) and how it differs from classing addressing. Discuss how CIDR enables more efficient use of IP address space and allows flexible subnetting. Discuss how an ISP assigns subnet blocks to organizations, and how enterprises can further divide their allocated address space.**

CIDR takes the place of the class-based address system by using flexible subnetting. Some of the differences from classing addressing is that classing networks take use of steady subnet masks which lead to inefficient IP assignment. CIDR also allows defining subnet masks by determining what the need is which avoids fixed classes. CIDR avoids fragmentation of IP space. This makes sure that ISPs can assign block at a more efficient rate. Enterprises can divvy up the allocation by taking advantage of VLSM where you can assign smaller subnets in parts where not as many hosts are needed.

* 1. **Explain the DHCP process, including the sequence of messages exchanged between a client and a DHCP server. Discuss the benefits of DHCP over static IP configuration, including support for mobile users and address reuse. Analyze a scenario where a client moves between two different subnets and explain how DHCP handles IP reassignment in this situation.**

DHCP allows for automatic IP assignment. This minimizes the administrative overhead. The process includes message exchanges. DHCP discover is when the client broadcasts ask for an IP. DHCP offer is when the server sends back an IP address and details. The DHCP request is when the client asks for the IP confirmation. The DHCP ACK is when the server locks in the assignment and then the client is good to go to use the IP. Some of the benefits of DHCP over static assignment are automatic IP configuration, allows for roaming users by assigning IPs, IPs are able to be used after the expiration time. In the scenario when a client moves between 2 subnets a new DHCP discover message will be sent. An IP will be assigned to the client by the DHCP server of the new subnet. The past IP will be let go by the client after a certain amount of time or manually by the client.

Problem 2:

Imagine you are a network administrator designing a network for an organization that requires secure and scalable access to the Internet. Using your understanding of Network Address Translation (NAT), private IP addressing, and NAT traversal, answer the following questions:

* 1. **Explain how Network Address Translation (NAT) works, including the process of modifying IP addresses and port numbers. Describe the benefits of NAT, including how it conserves IPv4 addresses and enhances network security. Discuss the role of a NAT translation table, explaining how it maps private IP addresses to a single public IP address.**

The NAT will alter the IP address that are located in packet headers. This allows for many different private IP addresses to use a single IP. This is achieved through the NAT table which involves changing between private and public IPs. The benefits of the NAT are IPv4 maintenance and better security. NAT takes use of these types. Static NAT is assigning private to public IPs at a one-to-one ratio. Dynamic NAT gives public IPs from a pool. PAT allows for a mapping of many private IPs to only one public IP by the method of taking use of different port numbers.

* 1. **Discuss why NAT has been considered controversial, particularly in relation to the end-to-end argument in networking. Explain why NAT complicates certain applications like peer-to-peer communication, VoIP, and gaming. Describe the limitations of NAT in IPv4 networks and how IPv6 adoption can resolve these issues.**

NAT interrupts the end-to-end idea by adding address translation. P2P applications are disrupted because NAT stops direct inbound connections. VoIP and gaming are messed with because it needs NAT traversal mechanism. The issues that arise with security because certain encryption rules need a consistent IP address. This can be solved via IPv6 because it gives a larger address space and allows for device-to-device communication.

* 1. **Explain the NAT traversal problem, particularly how clients behind a NAT cannot easily accept incoming connections. Describe common solutions to NAT traversal, such as port forwarding, STUN (Session Traversal Utilities for NAT), and VPNs. Given a scenario where a remote client must access a private server behind a NAT, propose a strategy to enable successful communication.**

NAT resists connection coming from the outside. This throws a wrench in the idea of remote access. The solutions to this include port forward, STUN, and VPNs. Port forwarding manually assigns inbound traffic rules. STUN assists the client in giving them their public IP and NAT type. VPNs are able to create tunnels that can get past the NAT. Finding a solution to the scenario includes having the server administrator setting up port forwarding or VPN. Another way to access it is to use a STUN and TURN which will assist with talking for applications such as VoIP and gaming.

Problem 3:

Refer to the example that was discussed in the IP Addressing lecture where a large number of consecutive IP addresses are available from 198.16.0.0. Suppose that four companies A, B, C, and D respectively require 4000, 2000, 4000, and 8000 addresses (requests arrive in that order). In the lecture, we covered the first three companies A, B, and C, continue the example by giving:

1. **The first IP address assigned for company D,**

213 = 8192

198.16.64.0

1. **The last IP address assigned for company D,**

Last IP = Starting IP + (8192 -1)

8191 = 00011111.11111111 = 0.0.31.255

198.16.64.0 + 0.0.31.255

198.16.95.255

1. **The allocation block for company D, using the notation w.x.y.z/s.**

32 -13 = 19

198.16.64.0/19

**YouTube Links**

Problem 1: <https://youtu.be/_nPrR2rTG-o>

Problem 2: <https://youtu.be/H1DOBIzQJsQ>

Problem 3: <https://youtu.be/B8nb2jNpg4c>