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2 Week Assignment

IP Addressing and Subnetting IPv4 & IPv6

Introduction to IP Addressing

IP addresses are unique identifiers assigned to devices on a network to enable communication.
There are two versions of IP addresses: IPv4 and IPv6.

IPv4 Addressing

Structure of an IPv4 Address

An IPv4 address is a 32-bit number divided into four octets, represented in decimal format (e.g., 192.168.1.1).

Classes of IPv4 Addresses

- Class A: 1.0.0.0 to 126.0.0.0 (Default Subnet Mask: 255.0.0.0)
- Class B: 128.0.0.0 to 191.255.0.0 (Default Subnet Mask: 255.255.0.0)
- Class C: 192.0.0.0 to 223.255.255.0 (Default Subnet Mask: 255.255.255.0)

Private vs. Public IP Addresses

- Private IP Addresses: Used within private networks (e.g., 192.168.0.0/16).
- Public IP Addresses: Used on the public internet.

Subnetting in IPv4

Subnet Masks and CIDR Notation

A subnet mask divides the IP address into network and host portions. CIDR (Classless Inter-Domain Routing) notation specifies
the number of bits used for the network portion (e.g., /24).

In order to subnet a network, extend the natural mask with some of the bits from the host ID portion of the address in order to create a subnetwork ID. For example, given a Class C network of 192.168.5.0 which has a natural mask of 255.255.255.0, you can create subnets in this manner:

```
192.168.5.0     - 11000000.10101000.00000101.00000000
255.255.255.224 - 11111111.11111111.11111111.11100000
```

```
192.168.5.0 255.255.255.224     host address range 1 to 30
192.168.5.32 255.255.255.224    host address range 33 to 62
192.168.5.64 255.255.255.224    host address range 65 to 94
192.168.5.96 255.255.255.224    host address range 97 to 126
192.168.5.128 255.255.255.224   host address range 129 to 158
192.168.5.160 255.255.255.224   host address range 161 to 190
192.168.5.192 255.255.255.224   host address range 193 to 222
192.168.5.224 255.255.255.224   host address range 225 to 254
```

Creating Subnets with Examples

Given a network 192.168.1.0/24:
- Subnet mask: 255.255.255.0
- Number of subnets (if we use 4 bits for subnets): 2^4 = 16
- Number of hosts per subnet: 2^(32 - 24 - 4) - 2 = 14 (subtracting 2 for network and broadcast addresses)

IPv6 Addressing

Structure of an IPv6 Address

An IPv6 address is a 128-bit number, represented in hexadecimal format (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334).

Types of IPv6 Addresses

- Global Unicast: Unique across the internet.

- Link-Local: Used for communication within a single network segment.
- Multicast: Delivered to multiple interfaces.

Subnetting in IPv6

Prefix Length and Subnetting

IPv6 uses prefix length similar to CIDR notation in IPv4. For example, a /64 prefix means the first 64 bits are the network portion.

Creating Subnets with Examples

Given a network 2001:0db8::/64:
- Number of subnets (if we use 16 bits for subnets): 2^16 = 65,536
- Number of hosts per subnet: 2^(128 - 64 - 16) = 2^48

VLSM

In all of the previous examples of subnetting, notice that the same subnet mask was applied for all the subnets. This means that each subnet has the same number of available host addresses. You need this in some cases, but, in most cases when there is the same subnet mask for all subnets, it wastes address space

```
netA: must support 14 hosts
netB: must support 28 hosts
netC: must support 2 hosts
netD: must support 7 hosts
netE: must support 28 host
```

Determine what mask allows the required number of hosts.

```
netA: requires a /28 (255.255.255.240) mask to support 14 hosts
netB: requires a /27 (255.255.255.224) mask to support 28 hosts
netC: requires a /30 (255.255.255.252) mask to support 2 hosts
netD*: requires a /28 (255.255.255.240) mask to support 7 hosts
netE: requires a /27 (255.255.255.224) mask to support 28 hosts
```

The easiest way to assign the subnets is to assign the largest first. For example, you can assign in this manner:

```
netB: 192.168.5.0/27  host address range 1 to 30
netE: 192.168.5.32/27 host address range 33 to 62
netA: 192.168.5.64/28 host address range 65 to 78
netD: 192.168.5.80/28 host address range 81 to 94
netC: 192.168.5.96/30 host address range 97 to 98
```

CIDR

Classless Interdomain Routing (CIDR) was introduced in order to improve both address space utilization and routing scalability in the Internet. It was needed because of the rapid growth of the Internet and growth of the IP routing tables held in the Internet routers.

CIDR moves away from the traditional IP classes (Class A, Class B, Class C, and so on). In CIDR , an IP network is represented by a prefix, which is an IP address and some indication of the length of the mask. Length means the number of left-most contiguous mask bits that are set to one. So, network 172.16.0.0 255.255.0.0 can be represented as 172.16.0.0/16. CIDR also depicts a more hierarchical Internet architecture, where each domain takes its IP addresses from a higher level. This allows for the summarization of the domains to be done at the higher level. For example, if an ISP owns network 172.16.0.0/16, then the ISP can offer 172.16.1.0/24, 172.16.2.0/24, and so on to customers. Yet, when advertising to other providers, the ISP only needs to advertise 172.16.0.0/16.