- To find the first address in a block, we set the rightmost 32 - n bits to 0.
- To find the number of addresses in the block, we calculate 2^{32-n}, where n is the prefix length.
- To find the last address in the block, we set the rightmost 32 - n bits to 1.
- Subnetting increases the value of n.
- The global authority for address allocation is ICANN. ICANN normally grants large blocks of addresses to ISPs, which in tum grant small subblocks to individual customers.
- IPv6 addresses use hexadecimal colon notation with abbreviation methods available.
- There are three types of addresses in IPv6: unicast, anycast, and multicast.
- In an IPv6 address, the variable type prefix field defines the address type or purpose.

19.6 PRACTICE SET

Review Questions

1. What is the number of bits in an IPv4 address? What is the number of bits in an IPv6 address?
2. What is dotted decimal notation in IPv4 addressing? What is the number of bytes in an IPv4 address represented in dotted decimal notation? What is hexadecimal notation in IPv6 addressing? What is the number of digits in an IPv6 address represented in hexadecimal notation?
3. What are the differences between classful addressing and classless addressing in IPv4?
4. List the classes in classful addressing and define the application of each class (unicast, multicast, broadcast, or reserve).
5. Explain why most of the addresses in class A are wasted. Explain why a medium-size or large-size corporation does not want a block of class C addresses.
6. What is a mask in IPv4 addressing? What is a default mask in IPv4 addressing?
7. What is the network address in a block of addresses? How can we find the network address if one of the addresses in a block is given?
8. Briefly define subnetting and supemetting. How do the subnet mask and supemet mask differ from a default mask in classful addressing?
9. How can we distinguish a multicast address in IPv4 addressing? How can we do so in IPv6 addressing?
10. What is NAT? How can NAT help in address depletion?

Exercises

11. What is the address space in each of the following systems?
    a. A system with 8-bit addresses
    b. A system with 16-bit addresses
    c. A system with 64-bit addresses

12. An address space has a total of 1024 addresses. How many bits are needed to represent an address?
13. An address space uses the three symbols 0, 1, and 2 to represent addresses. If each address is made of 10 symbols, how many addresses are available in this system?
14. Change the following IP addresses from dotted-decimal notation to binary notation.
    a. 114.34.2.8
    b. 129.14.6.8
    c. 208.34.54.12
    d. 238.34.2.1
15. Change the following IP addresses from binary notation to dotted-decimal notation.
    a. 01111111 11110000 01100111 01111101
    b. 10101111 11000000 11111000 00011101
    c. 11011111 10110000 00011111 01011101
    d. 11101111 11110111 11000111 00011101
16. Find the class of the following IP addresses.
    a. 208.34.54.12
    b. 238.34.2.1
    c. 114.34.2.8
    d. 129.14.6.8
17. Find the class of the following IP addresses.
    a. 11110111 11110011 10000111 11011101
    b. 10101111 11000000 11110000 00011101
    c. 11011111 10110000 00011111 01011101
    d. 11101111 11110111 11000111 00011101
18. Find the netid and the hostid of the following IP addresses.
    • a. 114.34.2.8
    b. 132.56.8.6
    c. 208.34.54.12
19. In a block of addresses, we know the IP address of one host is 25.34.12.56/16. What are the first address (network address) and the last address (limited broadcast address) in this block?
20. In a block of addresses, we know the IP address of one host is 182.44.82.16/26. What are the first address (network address) and the last address in this block?
21. An organization is granted the block 16.0.0.0/8. The administrator wants to create 500 fixed-length subnets.
    a. Find the subnet mask.
    b. Find the number of addresses in each subnet.
    c. Find the first and last addresses in subnet 1.
    d. Find the first and last addresses in subnet 500.

22. An organization is granted the block 130.56.0.0/16. The administrator wants to create 1024 subnets.
    a. Find the subnet mask.
    b. Find the number of addresses in each subnet.
    c. Find the first and last addresses in subnet 1.
    d. Find the first and last addresses in subnet 1024.
23. An organization is granted the block 211.17.180.0/24. The administrator wants to create 32 subnets.
    a. Find the subnet mask.
    b. Find the number of addresses in each subnet.
    c. Find the first and last addresses in subnet 1.
    d. Find the first and last addresses in subnet 32.
24. Write the following masks in slash notation *(In).*
    a. 255.255.255.0
    b. 255.0.0.0
    c. 255.255.224.0
    d. 255.255.240.0
25. Find the range of addresses in the following blocks.
    a. 123.56.77.32/29
    b. 200.17.21.128/27
    c. 17.34.16.0/23
    d. 180.34.64.64/30
26. An ISP is granted a block of addresses starting with 150.80.0.0/16. The ISP wants to distribute these blocks to 2600 customers as follows.
    a. The first group has 200 medium-size businesses; each needs 128 addresses.
    b. The second group has 400 small businesses; each needs 16 addresses.
    c. The third group has 2000 households; each needs 4 addresses.

    Design the subblocks and give the slash notation for each subblock. Find out how many addresses are still available after these allocations.
27. An ISP is granted a block of addresses starting with 120.60.4.0/22. The ISP wants to distribute these blocks to 100 organizations with each organization receiving just eight addresses. Design the subblocks and give the slash notation for each subblock. Find out how many addresses are still available after these allocations.
28. An ISP has a block of 1024 addresses. It needs to divide the addresses among 1024 customers. Does it need subnetting? Explain your answer.
29. Show the shortest form of the following addresses.
    a. 2340:1ABC:119A:AOOO:0000:0000:0000:0000
    b. 0000:00AA:0000:0000:0000:0000:119A:A231
    c. 2340:0000:0000:0000:0000:119A:AOO1:0000
    d. 0000:0000:0000:2340:0000:0000:0000:0000

30. Show the original (unabbreviated) form of the following addresses.
    a. 0::0
    b.O:AA::O
    c. 0: 1234::3
    d. 123::1:2
31. What is the type of each of the following addresses?
    a. FE80::12
    b. FECO: :24A2
    c. FF02::0
    d. 0::01
32. What is the type of each of the following addresses?
    a. 0::0
    b. 0: :FFFF:O:O
    c. 582F:1234::2222
    d. 4821::14:22
    e. 54EF::A234:2
33. Show the provider prefix (in hexadecimal colon notation) of an address assigned to a subscriber if it is registered in the United States with ABC1 as the provider identification.
34. Show in hexadecimal colon notation the IPv6 address
    a. Compatible to the IPv4 address 129.6.12.34
    b. Mapped to the IPv4 address 129.6.12.34
35. Show in hexadecimal colon notation
    a. The link local address in which the node identifier is 0:: 123/48
    b. The site local address in which the node identifier is 0:: 123/48
36. Show in hexadecimal colon notation the permanent multicast address used in a link local scope.
37. A host has the address 581E: 1456:2314:ABCD:: 1211. If the node identification is 48 bits, find the address of the subnet to which the host is attached.
38. A site with 200 subnets has the class B address of 132.45.0.0. The site recently migrated to IPv6 with the subscriber prefix 581E:1456:2314::ABCD/80. Design the subnets and define the subnet addresses, using a subnet identifier of 32 bits.

Research Activities

39. Find the block of addresses assigned to your organization or institution.
40. If you are using an ISP to connect from your home to the Internet, find the name of the ISP and the block of addresses assigned to it.
41. Some people argue that we can consider the whole address space as one single block in which each range of addresses is a subblock to this single block. Elaborate on this idea. What happens to subnetting if we accept this concept?
42. Is your school or organization using a classful address? If so, find out the class of the address.