ASSIGNMENT 2 (with Answers)

Note:
All students are required to write the same answer for all questions and submit the hardcopy in the classroom on 27th August 2024 in the respective lecture. For Five marks we expect this much to be written.

1. Explain the differences between Class A, Class B, and Class C IP addresses, including their default subnet masks and address ranges.

Answer: IP addresses in IPv4 are divided into classes to define different network sizes:

- Class A:
  - Address Range: `1.0.0.0` to `126.0.0.0`
  - Default Subnet Mask: `255.0.0.0` (or `/8`)
  - Network/Host Allocation: First 8 bits for network, remaining 24 bits for host
  - Total Hosts: Approximately 16.7 million per network
  - Usage: Large organizations
- Class B:
  - Address Range: `128.0.0.0` to `191.255.0.0`
  - Default Subnet Mask: `255.255.0.0` (or `/16`)
  - Network/Host Allocation: First 16 bits for network, remaining 16 bits for host
  - Total Hosts: Approximately 65,534 per network
  - Usage: Medium-sized organizations
- Class C:
  - Address Range: `192.0.0.0` to `223.255.255.0`
  - Default Subnet Mask: `255.255.255.0` (or `/24`)
  - Network/Host Allocation: First 24 bits for network, remaining 8 bits for host
  - Total Hosts: 254 per network
  - Usage: Small networks

These classes define the size and scale of networks, with Class A being the largest and Class C the smallest.

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2. Describe the process of subnetting and explain its benefits in network management.

Answer: Subnetting is the practice of dividing a larger IP network into smaller, more manageable sub-networks (subnets) by borrowing bits from the host portion of the address to extend the network portion.

Process:

- Step 1: Determine how many bits to borrow from the host portion to create a subnet mask.
- Step 2: Calculate the number of subnets and the number of hosts per subnet.
- Step 3: Assign these subnets to different network segments.
- Step 4: Configure network devices to use the new subnetting scheme.

Benefits:

- Efficient IP Address Utilization: Prevents waste by using IP addresses more effectively.
- Improved Network Performance: Reduces broadcast domain size, decreasing congestion.
- Enhanced Security: Isolates network segments, improving security.
- Simplified Management: Makes large networks more manageable by breaking them into smaller sections.
- Scalability: Allows networks to grow in a structured way.

Subnetting optimizes network performance, enhances security, and simplifies administration.

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3. Explain how the DHCP (Dynamic Host Configuration Protocol) operates in a network and its advantages over static IP addressing.

Answer: DHCP (Dynamic Host Configuration Protocol) automates IP address allocation in a network.

Operation:

- Step 1: Discovery: A client broadcasts a DHCPDISCOVER message to locate a DHCP server.
- Step 2: Offer: The server responds with a DHCPOFFER, providing an IP address and configuration details.
- Step 3: Request: The client accepts the offer by sending a DHCPREQUEST.
- Step 4: Acknowledgment: The server confirms with a DHCPACK, and the client configures itself with the assigned IP.

Advantages Over Static IP Addressing:

- Automation: Reduces administrative burden by automatically assigning IP addresses.
- Efficiency: Optimizes IP address usage by dynamically allocating and reclaiming addresses.
- Error Reduction: Minimizes configuration errors like IP conflicts.
- Scalability: Easily handles large networks and supports growth.
- Flexibility: Devices can move between networks without needing manual reconfiguration.

DHCP simplifies network management and enhances operational efficiency.

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4. Compare and contrast IPv4 and IPv6 addressing, highlighting key differences and the benefits of IPv6.

Answer: IPv4 and IPv6 are two versions of the Internet Protocol used for addressing devices on a network.

Key Differences:

- Address Length: IPv4 uses 32-bit addresses, while IPv6 uses 128-bit addresses.

- Address Format: IPv4 addresses are in dotted decimal (e.g., `192.168.0.1`), whereas IPv6 uses hexadecimal and colons (e.g., `2001:0db8::1`).
- Address Space: IPv4 has ~4.3 billion addresses; IPv6 has 340 undecillion addresses.
- Header Complexity: IPv4 headers are simpler; IPv6 headers are more complex but more efficient.
- Security: IPv6 has built-in IPsec, making it more secure by default.
- NAT Requirement: IPv6 eliminates the need for Network Address Translation (NAT) due to its vast address space.
- Autoconfiguration: IPv6 supports stateless auto-configuration, unlike IPv4.

Benefits of IPv6:

- Vast Address Space: Solves IPv4 exhaustion with its enormous address range.
- Enhanced Security: Integrates IPsec for mandatory security.
- Improved Performance: More efficient routing and better support for modern networking needs.
- Mobility: Facilitates seamless connectivity for mobile devices across networks.

IPv6 is designed to overcome the limitations of IPv4, offering scalability, security, and efficiency.

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5. Describe the structure of an IPv6 address and explain how zero compression and zero omission techniques are used to simplify its notation.

Answer: An IPv6 address is 128 bits long, represented as eight groups of four hexadecimal digits, separated by colons

(e.g., `2001:0db8:85a3:0000:0000:8a2e:0370:7334`).

Structure:

- Global Unicast: Unique addresses used for routing.

- Link-Local: Non-routable addresses within a single network.
- Multicast: Addresses used to target multiple devices.
- Anycast: Delivered to the nearest device among multiple devices.

Zero Compression:

- Purpose: Compress consecutive zeros in an IPv6 address.
- Example: `2001:0db8:0000:0000:0000:0000:1428:57ab` becomes `2001:0db8::1428:57ab`.
- Limitation: Only one compression per address to avoid ambiguity.

Zero Omission:

- Purpose: Omit leading zeros within a group.
- Example: `2001:0db8:0000:0000:0000:0000:1428:57ab` simplifies to `2001:db8::1428:57ab`.

These techniques make IPv6 addresses more concise and easier to handle.

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6. Discuss the differences between static and dynamic routing, including their advantages and disadvantages in network environments.

Answer: Static Routing involves manually configuring routing tables, while Dynamic Routing uses protocols to automatically adjust routes based on network changes.

Static Routing:

- Advantages:
    - Simplicity: Easier to configure in small networks.
    - Stability: No unexpected changes, leading to predictable routing.
    - Security: Less vulnerable to routing loops or attacks.
- Disadvantages:
    - Scalability: Not suitable for large networks.
    - Inflexibility: Cannot adapt to network changes or failures.

Dynamic Routing:

- Advantages:
    - Adaptability: Automatically adjusts to network changes, ensuring continuous communication.
    - Scalability: Handles large networks efficiently.
- Disadvantages:
    - Complexity: Requires more expertise to configure and manage.
    - Resource Usage: Consumes more bandwidth and processing power due to constant updates.

Dynamic routing is preferred for large, dynamic networks, while static routing is suitable for small, stable environments.

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7. Describe the OSPF (Open Shortest Path First) routing protocol, including its key features and how it differs from RIP (Routing Information Protocol).

Answer: OSPF (Open Shortest Path First) is a link-state routing protocol used for routing IP packets within large networks.

Key Features:

- Hierarchical Design: Divides the network into areas to optimize routing and reduce overhead.
- Link-State Advertisements (LSAs): Routers share information about their links, enabling each router to build a complete network topology.
- Dijkstra's Algorithm: Calculates the shortest path to each destination, ensuring efficient routing.
- Fast Convergence: Quickly adapts to network changes.
- Support for VLSM: Allows for efficient IP address management with Variable Length Subnet Masking.

Differences from RIP (Routing Information Protocol):

- Convergence Speed: OSPF converges faster than RIP, making it more suitable for larger networks.
- Routing Metric: OSPF uses cost based on link bandwidth, while RIP uses hop count.
- Scalability: OSPF supports large networks with its hierarchical structure; RIP is limited to 15 hops.

- Update Mechanism: OSPF sends updates only when a change occurs, whereas RIP broadcasts updates periodically.

OSPF is preferred for large, complex networks, while RIP is simpler and used in smaller networks.

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8. Explain the significance of routing metrics and how they influence the path selection process in routing protocols.

Answer: Routing Metrics are values used by routing protocols to determine the most efficient path for data to travel across a network.

Significance:

- Path Selection: Routing metrics help routers evaluate multiple potential paths and select the best one based on criteria such as speed, reliability, and cost.
- Optimized Routing: Metrics ensure that data takes the most optimal route, reducing latency, congestion, and potential bottlenecks.
- Consistency: Metrics provide a consistent method for routers to make decisions, ensuring stable and predictable network performance.

Common Metrics:

- Hop Count: The number of routers a packet must pass through; used by RIP.
- Bandwidth: The capacity of the link; used by OSPF.
- Delay: The time it takes for a packet to traverse the path.
- Load: The current traffic load on a path.
- Reliability: The likelihood of a link failing.

Routing metrics directly influence the efficiency and reliability of network communication by guiding routers in choosing the best paths.

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9. Discuss the concept of link-state routing and how it enables faster convergence compared to distance-vector routing.

Answer: Link-State Routing is a type of routing protocol where each router has complete information about the entire network topology.

How It Works:

- LSAs (Link-State Advertisements): Routers exchange information about their connected links.
- Topology Database: Each router builds a complete map of the network, known as a link-state database.
- Shortest Path Calculation: Routers use algorithms like Dijkstra's to calculate the shortest path to every destination.

Faster Convergence Compared to Distance-Vector Routing:

- Immediate Updates: Link-state protocols update only when a change occurs, reducing convergence time.
- Complete Network View: Each router has full knowledge of the network, enabling rapid recalculation of paths.
- Localized Changes: Only affected routers need to update their routing tables, avoiding the slow, step-by-step updates seen in distance-vector protocols like RIP.

Distance-Vector Routing: Relies on routers sharing information about their neighbors' distances, leading to slower convergence and potential routing loops.

Link-state routing's comprehensive network knowledge and rapid update mechanism make it superior in terms of convergence speed and reliability.

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Question 10 and 11 (Do it yourself)

10. Find the subnet mask, network ID, subnet address, broadcast ID and the host range from the following IP address.

A) 192.168.30.112/28,
B) 172.160.16.224/20
C) 11.11.108.96/22.

11. A company has three networks into three different cities, namely Ahmedabad Delhi and Chennai Ahmedabad has three branches. A has 120 PCs, B has 170 PCs and C has 60 PCs. Delhi branch has 29 PC and 14 PC respectively and Chennai branch has 14 ,6 and 4 PC respectively. Determine the IP address scheme using VLSM and submitting summaries of the design in tabular form. Use class C Private address for the Design.

MCQ

Question 1:

Which of the following IP addresses is a Class C address?

a) 192.168.1.1

b) 10.0.0.1

c) 172.16.0.1

d) 224.0.0.1

Question 2:

What is the maximum number of usable host addresses in a /24 subnet?

a) 254

b) 256

c) 512

d) 1024

Question 3:

Which of the following is a private IP address?

a) 8.8.8.8

b) 172.31.255.255

c) 192.0.2.1

d) 203.0.113.0

Question 4:

What subnet mask corresponds to the CIDR notation /22?

a) 255.255.252.0

b) 255.255.255.0

c) 255.255.254.0

d) 255.255.248.0

Question 5:

Which of the following is the broadcast address for the subnet 192.168.10.0/24?

a) 192.168.10.0

b) 192.168.10.1

c) 192.168.10.255

d) 192.168.10.254

Question 6:

What is the main advantage of IPv6 over IPv4?

a) Shorter addresses

b) Simpler address notation

c) Larger address space

d) Faster data transmission

Question 7:

Which of the following is a valid IPv6 address?

a) 2001:0db8:85a3::8a2e:0370:7334

b) 192.0.2.1

c) 172.16.0.1

d) 10.0.0.1

Question 8:

What technique is used to shorten IPv6 addresses by removing leading zeros and replacing consecutive zeros with "::"?

a) IPv6 Compression

b) Zero Compression

c) Subnetting

d) Tunneling

Question 9:

How many bits are used in an IPv6 address?

a) 32

b) 64

c) 128

d) 256

Question 10:

Which of the following is the correct expanded form of the IPv6 address 2001:db8::1?

a) 2001:0db8:0000:0000:0000:0000:0000:0001

b) 2001:db8:0:0:0:0:0:1

c) 2001:db8::1

d) 2001:db8:1:0:0:0:0:0

Question 11:

Which routing protocol is a distance-vector protocol?

a) OSPF

b) BGP

c) EIGRP

d) RIP

Question 12:

Which of the following is a characteristic of static routing?

a) Automatically adapts to network changes

b) Suitable for large dynamic networks

c) Requires manual configuration

d) Uses routing protocols to update routes

Question 13:

What metric does RIP use to determine the best path?

a) Bandwidth

b) Hop count

c) Delay

d) Cost

Question 14:

Which routing protocol is considered a link-state protocol?

a) RIP

b) EIGRP

c) OSPF

d) BGP

Question 15:

Which routing protocol is primarily used for routing between autonomous systems on the Internet?

a) RIP

b) EIGRP

c) OSPF

d) BGP

Question 16:

What is the main advantage of dynamic routing over static routing?

a) Less configuration required

b) More control over routing decisions

c) Adapts automatically to network changes

d) Lower overhead from routing protocols

Question 17:

Which of the following is true about OSPF?

a) It uses hop count as a metric.

b) It requires manual updates when the network changes.

c) It supports hierarchical network design.

d) It is a distance-vector protocol.

Question 18:

In a routing table, what does the metric represent?

a) The next hop router address

b) The total number of hops to the destination

c) The desirability or cost of a path

d) The IP address of the destination network

Question 19:

Which command would you use to view the current routing table on a Linux-based system?

a) Ifconfig

b) traceroute

c) netstat -r

d) ping

Question 20:

What is the primary purpose of a router in a network?

a) To connect devices within a single network

b) To forward packets between different networks

c) To assign IP addresses to devices

d) To provide wireless connectivity