R&D DOCUMENT FOR ASSIGNMENT SUBMISSION - CELEBAL TECHNOLOGIES

🧑‍💻 **Submitted To:** Celebal Technologies, Summer Internship Program – Cloud Infra and Security

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TOPIC 1: IP Addressing and Subnetting (IPv4 & IPv6)

1. Introduction to IP Addressing:
IP (Internet Protocol) addressing is a fundamental part of networking. Every device connected to a network requires a unique IP address to communicate with other devices. There are two types of IP addresses:

- **IPv4:** 32-bit numeric address written in decimal as four numbers separated by periods (e.g., 192.168.0.1)
- **IPv6:** 128-bit address written in hexadecimal separated by colons (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334)

2. IPv4 Addressing:

- **Format:** Dotted decimal (e.g., 192.168.1.1)
- **Classes and Ranges:**

Class	Address Range	Default Subnet Mask
A	1.0.0.0 – 126.255.255.255	255.0.0.0 (/8)
B	128.0.0.0 – 191.255.255.255	255.255.0.0 (/16)
C	192.0.0.0 – 223.255.255.255	255.255.255.0 (/24)

- **Private IP Ranges:**
    - Class A: 10.0.0.0 – 10.255.255.255
    - Class B: 172.16.0.0 – 172.31.255.255
    - Class C: 192.168.0.0 – 192.168.255.255

3. Subnetting in IPv4:
Subnetting divides a network into smaller sub-networks. It improves network performance and security.

- **Subnet Mask:** Determines which part of the IP address is network and which is host.
    - Example: 255.255.255.0 = /24

- **CIDR Notation:** Classless Inter-Domain Routing (e.g., 192.168.1.0/24)
- **Formula:**
    - Total Hosts = 2^(32 - subnet bits)
    - Usable Hosts = Total - 2 (network + broadcast addresses)

Subnet	Subnet Mask	Usable Hosts	CIDR Notation
1	255.255.255.0	254	/24
2	255.255.255.192	62	/26
3	255.255.255.224	30	/27

4. IPv6 Addressing:

- **Format:** 128-bit hexadecimal address, divided by colons (e.g., 2001:db8::1)
- **Advantages:**
    - Vast address space
    - Simplified header format
    - Built-in security and mobility
- No need for NAT due to large address space
- **Subnetting in IPv6:** Defined by the prefix length (e.g., /64 is standard)

Feature	IPv4	IPv6
Address Length	32-bit	128-bit
Address Format	Decimal (e.g., 192.0.2.1)	Hexadecimal (e.g., 2001:db8::1)
Header Complexity	Complex	Simplified
NAT Required	Often	Not needed
Security	Optional (IPSec)	Built-in

TOPIC 2: MAC Addressing and ARP/RARP

1. MAC Addressing Basics:

- MAC (Media Access Control) address is a unique identifier assigned to network interfaces for communication at the data link layer (Layer 2).
- **Format:** 48 bits, usually represented as 6 groups of 2 hexadecimal digits (e.g., 00:1A:2B:3C:4D:5E)

- Burned into NIC (Network Interface Card) by manufacturers

2. Functionality of ARP (Address Resolution Protocol):

- ARP maps an IP address to a MAC address.
- Essential for IPv4 networks to determine destination MAC address for packet delivery.
- **ARP Table:** Stores mappings to avoid repeated ARP requests

3. Functionality of RARP (Reverse Address Resolution Protocol):

- RARP maps a MAC address to an IP address.
- Useful for diskless workstations to determine their IP address at boot time
- Largely obsolete now, replaced by protocols like BOOTP and DHCP

Protocol	Full Form	Purpose	Status
ARP	Address Resolution Protocol	IP to MAC resolution	Active
RARP	Reverse Address Resolution Protocol	MAC to IP resolution	Obsolete

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Conclusion:
Understanding IP addressing, subnetting, and MAC-level addressing is crucial for designing, configuring, and troubleshooting networks. Mastery of these fundamentals ensures efficient network design, resource allocation, and secure communication..

References:

- GeeksforGeeks: IP Addressing
- GeeksforGeeks: Subnetting
- GeeksforGeeks: MAC Address
- GeeksforGeeks: ARP and RARP
- [Cisco Networking Basics]
- [RFC 791 (IPv4), RFC 2460 (IPv6)]