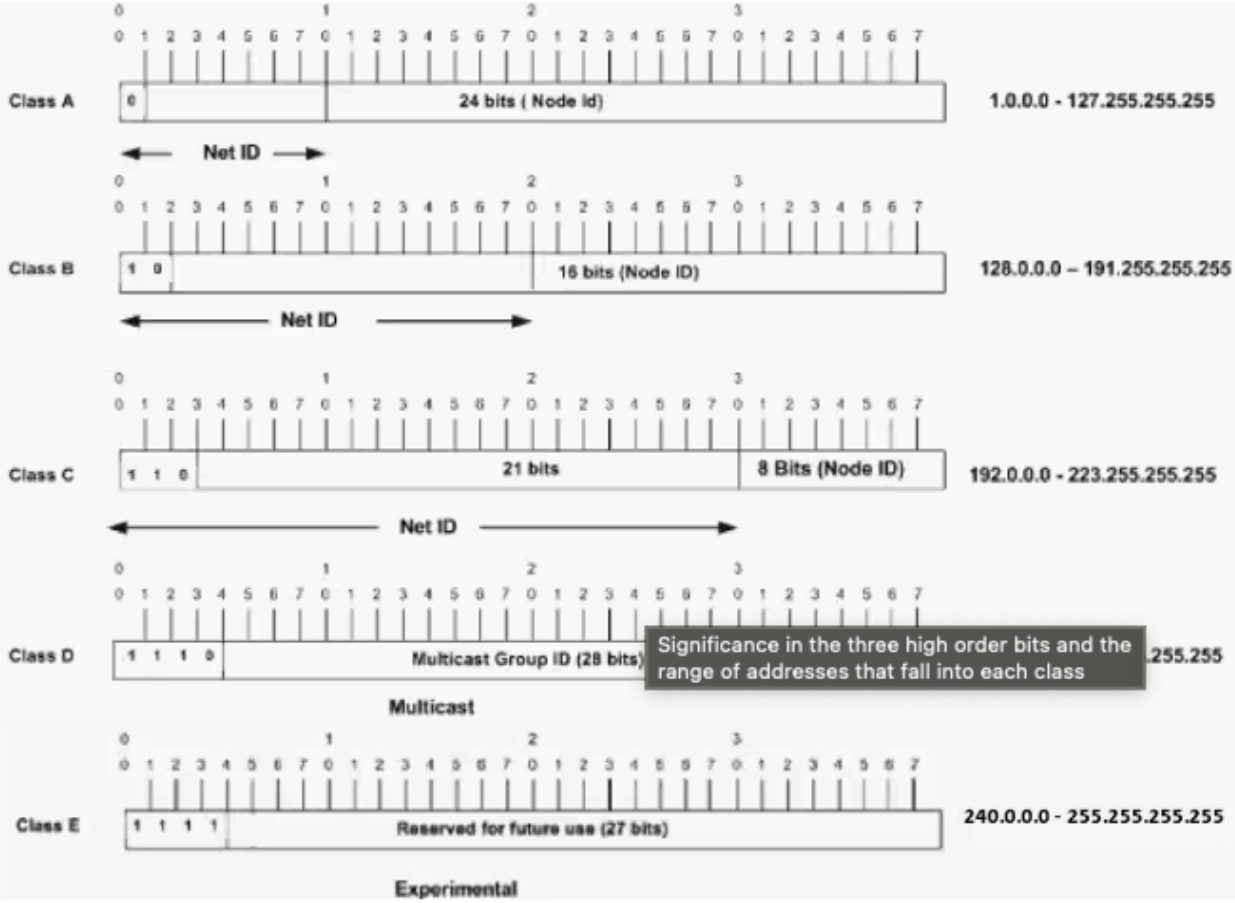
Introduction to Router Configuration and Subnetting

Prerequisites

Before diving into router configuration and subnetting, it is recommended to have a basic understanding of binary and decimal numbers.

Components Used

The principles and configurations discussed here are not tied to specific hardware or software versions. The examples provided are based on a controlled lab environment with default configurations. If you are applying these configurations in a live network, be sure to understand the potential impacts.



Key Vocabulary

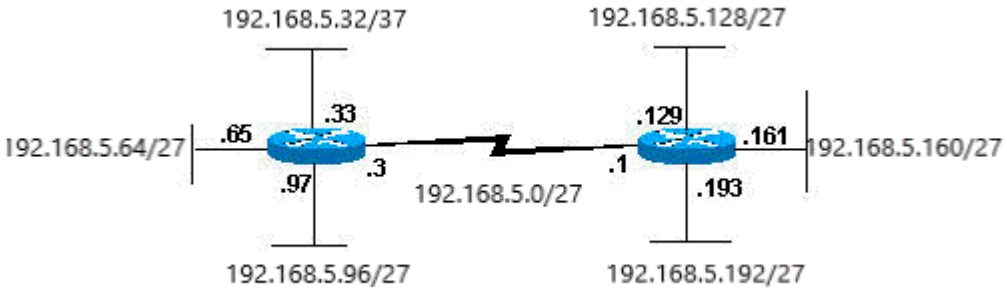
1. **Address**: A unique number assigned to a host or interface in a network.
2. **Subnet**: A segment of a network sharing a particular subnet address.
3. **Subnet Mask**: A 32-bit number that divides the IP address into network and host parts.
4. **Interface**: A point of network connection.

IP Addresses

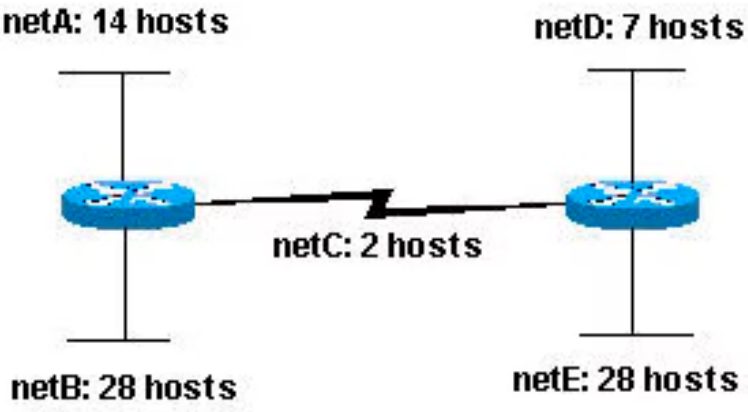
An IP address uniquely identifies a device on an IP network. It consists of 32 binary bits divided into four octets. Each octet is converted to decimal and separated by periods (dots), forming the dotted decimal format (e.g., 172.16.81.100). Each octet ranges from 0 to 255 in decimal or 00000000 to 11111111 in binary.

Binary to Decimal Conversion

- **Example 1**: All bits set to 1
  ```
  Binary: 11111111
  Decimal: 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 = 255
  ```




  ```
- **Example 2**: Mixed bits
  ```
  Binary: 01000001
  Decimal: 64 + 1 = 65
  ```
  ```



Example IP Address

A typical IP address can be represented in both binary and decimal:
```
Decimal: 10.1.23.19
Binary: 00001010.00000001.00010111.00010011
```

Classes of IP Networks

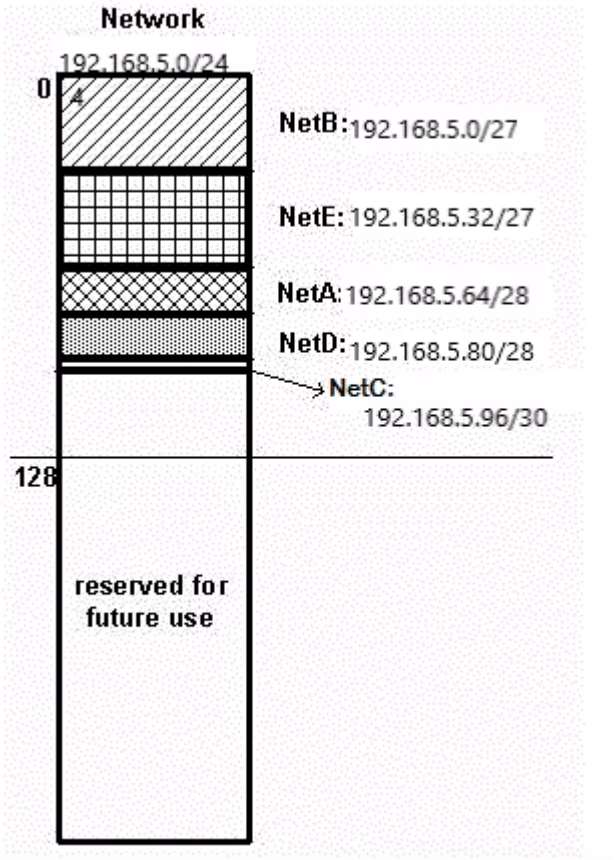
There are five classes of IP addresses, A to E, but only A to C are commonly used for host addressing:

1. **Class A**: Network portion in the first octet. Range: 1.0.0.0 to 127.255.255.255
2. **Class B**: Network portion in the first two octets. Range: 128.0.0.0 to 191.255.255.255
3. **Class C**: Network portion in the first three octets. Range: 192.0.0.0 to 223.255.255.255

Subnetting

Subnetting divides a larger network into smaller, manageable sub-networks. It involves extending the default subnet mask to include bits from the host portion of the address.

Example of Subnetting



For a Class C network 192.168.5.0 with a natural mask of 255.255.255.0, subnetting can be done as follows:

1. **Initial Configuration**
   ```
   Network: 192.168.5.0
   Default Mask: 255.255.255.0
   ```

2. **Subnet Mask Extension**
   ```
   Subnet Mask: 255.255.255.224 (three additional bits for subnetting)
   Binary: 11111111.11111111.11111111.11100000
   ```

3. **Subnets Created**
   ```
   Subnets: 8 (2^3 = 8)
   ```

Host Addresses per Subnet: 32 (2^5 = 32, but 30 usable)
```

Subnet Address Ranges

1. 192.168.5.0/27: Host range 1-30
2. 192.168.5.32/27: Host range 33-62
3. 192.168.5.64/27: Host range 65-94
4. 192.168.5.96/27: Host range 97-126
5. 192.168.5.128/27: Host range 129-158
6. 192.168.5.160/27: Host range 161-190
7. 192.168.5.192/27: Host range 193-222
8. 192.168.5.224/27: Host range 225-254

Variable Length Subnet Masks (VLSM)

VLSM allows for different subnet masks within the same network, optimizing IP address allocation by varying the subnet sizes based on needs.

Example with VLSM

Using the same network (192.168.5.0/24) and requirements for different subnets:
- **netA**: 14 hosts, requires /28 mask (255.255.255.240)
- **netB**: 28 hosts, requires /27 mask (255.255.255.224)
- **netC**: 2 hosts, requires /30 mask (255.255.255.252)
- **netD**: 7 hosts, requires /28 mask (255.255.255.240)
- **netE**: 28 hosts, requires /27 mask (255.255.255.224)

#### Assigning Subnets with VLSM

1. netB: 192.168.5.0/27 (1-30)
2. netE: 192.168.5.32/27 (33-62)
3. netA: 192.168.5.64/28 (65-78)
4. netD: 192.168.5.80/28 (81-94)
5. netC: 192.168.5.96/30 (97-98)

### CIDR (Classless Interdomain Routing)

CIDR enhances address space utilization and routing efficiency by moving away from fixed IP classes. It represents networks with a prefix and length, such as
```

172.16.0.0/16.

Example

An ISP with a network 172.16.0.0/16 can allocate subnets like 172.16.1.0/24 and 172.16.2.0/24 to customers, but advertise a single aggregate route of 172.16.0.0/16.

Special Subnets

1. **31-bit Subnets**: Used for point-to-point links, providing exactly two host addresses without a broadcast address (e.g., 192.168.1.0/31).
2. **32-bit Subnets**: Used for single-host interfaces like loopbacks (e.g., 192.168.2.1/32).

Appendix: Sample Configuration

Router A Configuration
```plaintext
hostname routera
ip routing
interface ethernet0
  ip address 172.16.50.1 255.255.255.0
interface ethernet1
  ip address 172.16.55.1 255.255.255.0
interface serial0
  ip address 172.16.60.1 255.255.255.0
interface serial1
  ip address 172.16.65.1 255.255.255.0
router rip
  network 172.16.0.0
```

Router B Configuration
```plaintext
hostname routerb
ip routing
interface ethernet0
  ip address 192.168.10.200 255.255.255.240
interface ethernet1
  ip address 192.168.10.66 255.255.255.240
```

```
interface serial0
  ip address 172.16.65.2 255.255.255.0
router rip
  network 192.168.10.0
  network 172.16.0.0
```

Host/Subnet Quantities Table

# bits	Mask	Subnets	Hosts
1	255.255.128.0	2	32766
2	255.255.192.0	4	16382
3	255.255.224.0	8	8190
4	255.255.240.0	16	4094
5	255.255.248.0	32	2046
6	255.255.252.0	64	1022
7	255.255.254.0	128	510
8	255.255.255.0	256	254
9	255.255.255.128	512	126
10	255.255.255.192	1024	62
11	255.255.255.224	2048	30
12	255.255.255.240	4096	14
13	255.255.255.248	8192	6
14	255.255.255.252	16384	2