Classless Addressing (CIDR) - Complete Study Notes

Introduction

- **Topic**: Classless Addressing
- **Year Introduced**: 1993 (came after Classful Addressing)
- **Full Form**: CIDR = Classless Inter Domain Routing

Key Differences from Classful Addressing

Classful Addressing Problems

- IP addresses divided into 5 rigid classes (A, B, C, D, E)
- Lack of flexibility
- Significant wastage of IP addresses
- **Example**: User needs 1000 IP addresses
  - In Classful: Must assign Class A (1 crore addresses) - huge wastage
  - User gets 10,000,000 times more than needed

Classless Addressing Solution

- **No Classes**: Forget about Class A, B, C, D concepts
- **Block-based**: Concept of blocks instead of classes
- **Flexible allocation**: If user wants x IP addresses, provide exactly x IP addresses
- **Managed by**: IANA (Internet Assigned Number Authority)
- **Result**: Very less wastage of IP addresses

Block Structure

Components

1. **Block ID** (instead of Network ID)
2. **Host ID** (same concept)

IP Address Structure (IPv4 = 32 bits)

- **MSB bits**: Represent Block ID
- **Remaining bits**: Represent number of hosts in that block
- **Not fixed** like in Classful addressing

CIDR Notation

Format: x.y.z.w/n

- **x.y.z.w**: Standard 4 octets (same as before)
- **/n**: New addition - the mask notation

What /n Represents

- **n = mask** or **number of bits representing block/network**
- **n = number of continuous 1s**
- **n = number of bits used for Network ID/Block ID part**

Detailed Example: 200.10.20.40/28

Step 1: Understanding the Notation

- **IP Address**: 200.10.20.40
- **/28**: 28 continuous 1s (mask bits)

Step 2: Calculate Host Bits

- **Total bits**: 32 (IPv4)
- **Network/Block bits**: 28
- **Host bits**: 32 - 28 = 4 bits

Step 3: Calculate Number of Hosts

- **Formula**: 2^(host bits)
- **Calculation**: 2^4 = 16 hosts
- **Answer**: This network can have 16 hosts

Step 4: Find the Subnet Mask

Converting /28 to dotted decimal:

```
28 bits = 28 continuous 1s
11111111.11111111.11111111.11110000
  8       16      24     4 = 28 total

Conversion:
11111111 = 255
11111111 = 255
11111111 = 255
11110000 = 240 (128+64+32+16 = 240)

Final Mask: 255.255.255.240
```

Step 5: Find Network ID/Block ID

Method 1: Keep Network Bits, Zero Host Bits

1. **Network bits**: 28 (don't touch these)
2. **Break down**:
   - 200 = 8 bits (keep as is)
   - 10 = 8 bits (keep as is)
   - 20 = 8 bits (keep as is)
   - 40 = need to analyze (contains both network and host bits)
3. **Convert 40 to binary**: 00101000
4. **Bit allocation**:
   - First 24 bits: 200.10.20 (keep as is)
   - Next 4 bits from 40: 0010 (network part - keep)
   - Last 4 bits from 40: 1000 (host part - make zero)
5. **Result**: 0010|0000 = 32 in decimal
6. **Network ID**: 200.10.20.32/28

Method 2: AND Operation

```
IP:   200.10.20.40
Mask: 255.255.255.240

AND operation:
200 AND 255 = 200 (copy as is)
10  AND 255 = 10  (copy as is)
20  AND 255 = 20  (copy as is)
40  AND 240 = ?

Converting to binary:
40  = 00101000
240 = 11110000
AND = 00100000 = 32

Result: 200.10.20.32/28
```

Three Rules for Classless Addressing

Rule 1: Addresses Should Be Contiguous

- **Meaning**: All addresses in a block must be consecutive
- **Example**: If first address is 200.10.20.32, then sequence should be:
  - 200.10.20.32
  - 200.10.20.33
  - 200.10.20.34
  - 200.10.20.35
  - ... and so on
- **Invalid**: Skipping numbers in between (non-contiguous)

Rule 2: Number of Addresses Must Be Power of 2

- **Meaning**: Block size must be 2^n
- **Valid examples**: 2, 4, 8, 16, 32, 64, 128, 256, etc.
- **Our example**: 16 addresses = 2^4 ✓ (Valid)
- **Invalid example**: 17 addresses (not a power of 2)

Rule 3: First Address Must Be Evenly Divisible by Block Size

- **Meaning**: Network ID should be divisible by the number of addresses in the block

- **Our example check**:
  - Network ID: 200.10.20.32
  - Block size: 16
  - Check: Is 32 divisible by 16? Yes (32 ÷ 16 = 2) ✓

Quick Method for Rule 3 Verification

Instead of actual division, check the binary representation:

- **Block size**: 16 = 2^4
- **Method**: Last 4 bits of first address should be 0000
- **32 in binary**: 00100000
- **Last 4 bits**: 0000 ✓ (Rule satisfied)

Counter Example

If Network ID was 33:

- **33 in binary**: 00100001
- **Last 4 bits**: 0001 ✗ (Rule violated)
- This would be invalid for a block size of 16

Important Questions Types

Question 1: Find Network and Number of Hosts

Given: Any IP with /n notation
Find:

- Which network does this IP belong to?
- How many hosts are in that network?

Question 2: Verify CIDR Rules

Given: A block specification
Verify: All three CIDR rules are satisfied

Key Advantages of Classless Addressing

1. **Flexibility**: Exact allocation based on user requirements
2. **Efficiency**: Minimal wastage of IP addresses

3. **Scalability**: Better utilization of IPv4 address space
4. **No rigid classes**: Freedom from A, B, C class limitations

Memory Aids

Quick Calculations

- **Host bits to hosts**: 2^(host bits)
- **Network bits**: 32 - host bits
- **Mask conversion**: Groups of 8 ones = 255

Binary to Decimal (Powers of 2)

- 2^0 = 1
- 2^1 = 2
- 2^2 = 4
- 2^3 = 8
- 2^4 = 16
- 2^5 = 32
- 2^6 = 64
- 2^7 = 128
- 2^8 = 256

Common /n Values and Their Meanings

- /24 = 255.255.255.0 (8 host bits, 256 hosts)
- /25 = 255.255.255.128 (7 host bits, 128 hosts)
- /26 = 255.255.255.192 (6 host bits, 64 hosts)
- /27 = 255.255.255.224 (5 host bits, 32 hosts)
- /28 = 255.255.255.240 (4 host bits, 16 hosts)
- /29 = 255.255.255.248 (3 host bits, 8 hosts)
- /30 = 255.255.255.252 (2 host bits, 4 hosts)