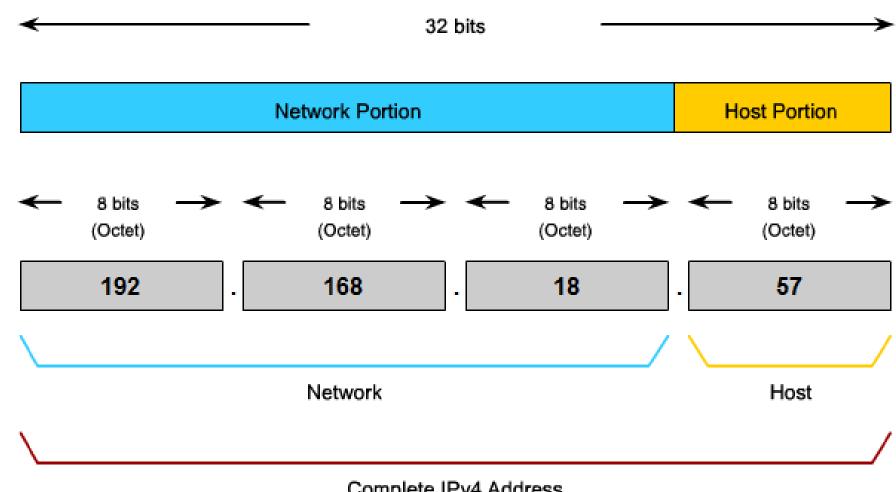# IP Addressing

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IP Addressing

Address Class

Class	High Order Bits	Start	End
Class A	0	0.0.0.0	127.255.255.255
Class B	10	128.0.0.0	191.255.255.255
Class C	110	192.0.0.0	223.255.255.255
Multicast	1110	224.0.0.0	239.255.255.255
Experimental	1111	240.0.0.0	255.255.255.255

Classful Addressing

	1st Octet	2nd Octet	3rd Octet	4th Octet	Subnet Mask
Class A	Network	Host	Host	Host	255.0.0.0 or /8
Class B	Network	Network	Host	Host	255.255.0.0 or /16
Class C	Network	Network	Network	Host	255.255.255.0 or /24

Number of Networks and Hosts per Network for Each Class

Address class	First Octet Range	Number of Possible Networks	Number of Host per Network
Class A	0 to 127	128 (2 are reserved)	16,777,214
Class B	128 to 191	16,348	65,534
Class C	192 to 223	2,097,152	254

Binary to Decimal Conversion

	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Exponent								
Position	128	64	32	16	8	4	2	1
Bits	1	1	1	1	0	1	0	1

1 BYTE / 1 Octet

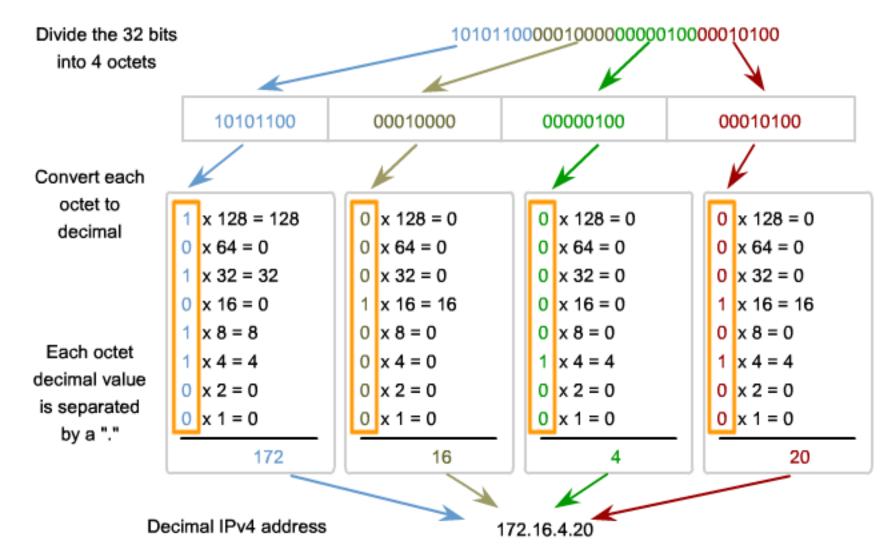Add these numbers together: 128 + 64 + 32 + 16 + 0 + 4 + 0 + 1

Decimal: 245

A 1 in this position means 64 is added to the total.

A 0 in any position means that 0 is added to the total.

Binary to Decimal Conversion

Divide the 32 bits into 4 octets

10101100000100000000010000010100

| 10101100 | 00010000 | 00000100 | 00010100 |

Convert each octet to decimal

1 x 128 = 128	0 x 128 = 0	0 x 128 = 0	0 x 128 = 0
0 x 64 = 0	0 x 64 = 0	0 x 64 = 0	0 x 64 = 0
1 x 32 = 32	0 x 32 = 0	0 x 32 = 0	0 x 32 = 0
0 x 16 = 0	1 x 16 = 16	0 x 16 = 0	1 x 16 = 16
1 x 8 = 8	0 x 8 = 0	0 x 8 = 0	0 x 8 = 0
1 x 4 = 4	0 x 4 = 0	1 x 4 = 4	1 x 4 = 4
0 x 2 = 0	0 x 2 = 0	0 x 2 = 0	0 x 2 = 0
0 x 1 = 0	0 x 1 = 0	0 x 1 = 0	0 x 1 = 0
172	16	4	20

Each octet decimal value is separated by a "."

Decimal IPv4 address   172.16.4.20

Address Types

- Network Address
  - The address by which we refer to the network

- Broadcast Address
  - A special address used to send data to all hosts in the network

- Host Address
  - The addresses assigned to the end devices in the network

Private and Public IP Address

- Public IP Address:
  - Registered by IANA/RIR
  - Routable through public internet

- Private IP Address
  - Only used in internal network
  - Not visible in global routing table

- Private IP Block

Class	Network	Address Range
Class A	10.0.0.0/8	10.0.0.0 – 10.255.255.255
Class B	172.16.0.0/12	172.16.0.0 – 172.31.255.255
Class C	192.168.0.0/16	192.168.0.0 – 192.168.255.255

Private and Public

64.104.0.22

192.168.3.5

192.0.2.15

172.32.35.2

172.16.30.30

192.168.11.5

10.55.3.168

209.165.201.30

Public

Private

Subnet Mask

- A demarcation of Network and Host bits
- Subnet mask is formed placing network bit as '1' and host bit as '0'
- Can be calculated from '/' notation
- Number of Host: 2^Number of host bit
- Network address: First IP of the Network (all host bit is '0')
- Broadcast address: Last IP of the Network (all host bit is '1')
- Usable IP: All host IP except the network and broadcast address

Calculate Subnet Mask

- Recall the Binary-Decimal Table

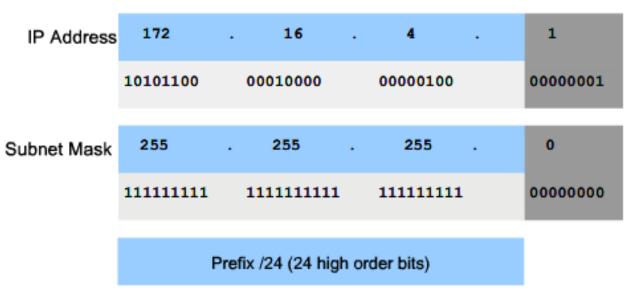| Octet	Decimal Calculation	Summation
1 0 0 0 0 0 0 0	128	128
1 1 0 0 0 0 0 0	128+64	192
1 1 1 0 0 0 0 0	128+64+32	224
1 1 1 1 0 0 0 0	128+64+32+16	240
1 1 1 1 1 0 0 0	128+64+32+16+8	248
1 1 1 1 1 1 0 0	128+64+32+16+8+4	252
1 1 1 1 1 1 1 0	128+64+32+16+8+4+2	254
1 1 1 1 1 1 1 1	128+64+32+16+8+4+2+1	255

Example

- Host address: 192.168.1.34
  - Network Bit: Upto 24 bits from LHS
  - Binary representation: 11111111.11111111.11111111.00000000
  - Decimal representation: 255.255.255.0
  - Number of Host IP: 2^8 = 256
  - Network Address: 192.168.1.0/24
  - Broadcast Address: 192.168.1.255
  - Usable IP: 192.168.1.1 - 192.168.1.254
- Host address: 203.139.5.45/18
  - Network Bit: Upto 18 bits from LHS
  - Binary representation: 11111111.11111111.11000000.00000000
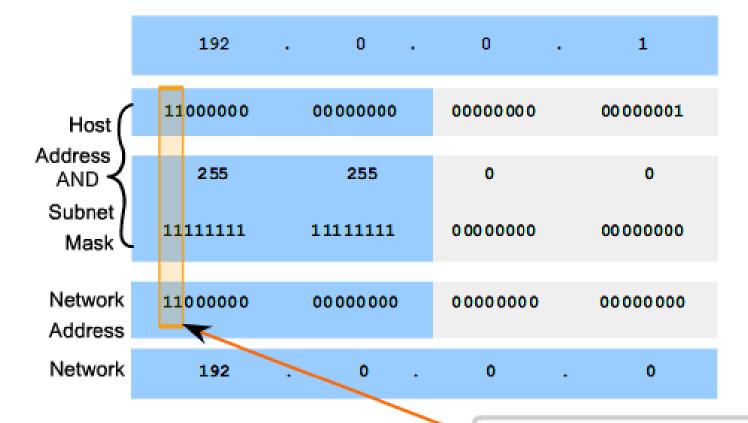 - Decimal representation: 255.255.192.0
  - Number of Host IP: 2^14 = 16384
  - Network Address: 203.139.0.0/24
  - Broadcast Address: 203.139.63.255
  - Usable IP: 203.139.0.1 - 203.139.63.254

Calculate Network Address

- Logical AND of IP address with Subnet mask will provide network address

- 1 and 1 = 1

- 1 AND 0 = 0

- 0 AND 1 = 0

- 0 AND 0 = 0

IP Address	172	.	16	.	4	.	1
	10101100		00010000		00000100		00000001

Subnet Mask	255	.	255	.	255	.	0
	111111111		1111111111		111111111		00000000

Prefix /24 (24 high order bits)

Calculate Network Address

| | 192 | . | 0 | . | 0 | . | 1 |

Host Address AND Subnet Mask

| 11000000 | 00000000 | 00000000 | 00000001 |

| 255 | 255 | 0 | 0 |

| 11111111 | 11111111 | 00000000 | 00000000 |

Network Address

| 11000000 | 00000000 | 00000000 | 00000000 |

Network

| 192 | . | 0 | . | 0 | . | 0 |

1 in the host AND 1 in the mask puts 1 in the network address.

Calculate Network Address

	192	.	0	.	0	.	1

Host Address AND Subnet Mask

11000000	00000000	00000000	00000001
255	255	0	0
11111111	11111111	00000000	00000000

Network Address

11000000	00000000	00000000	00000000

Network

192	.	0	.	0	.	0

0 in the host AND 1 in the mask puts 0 in the network address.

Calculate Network Address

	192	.	0	.	0	.	1

Host Address AND Subnet Mask

Host	11000000	00000000	00000000	00000001
255	255	255	0	0
	11111111	11111111	00000000	00000000

Network Address	11000000	00000000	00000000	00000000

Network	192	.	0	.	0	.	0

0 in the host AND 0 in the mask puts 0 in the network address.

Calculate Network Address

1 in the host AND 0 in the mask puts 0 in the network address.
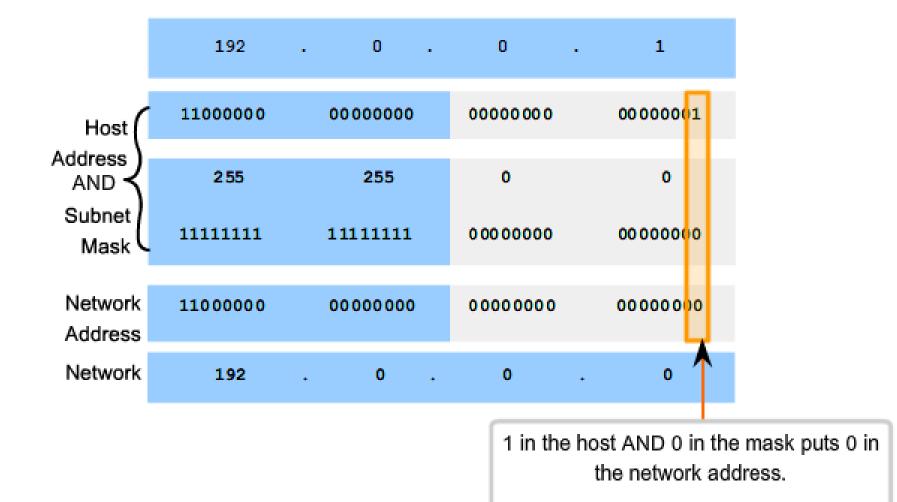
VLSM and CIDR

- Classless concept

- Helps to optimize IP address plan

- However, two addresses are wasted for each network

- How it works
  - Arrange the host address requirement per segment
  - Determine network address for each segment