Networking and IP Addressing

TELECOMMUNICATIONS AND NETWORKING

Addressing Schemes

FLAT

1. Used by Intranetworks
2. Used by Layer 2
3. Used in MAC address
4. Is assigned statically based on next available number or random
   - Social Security Number
   - Your Name
   - MAC- C0:AD:00:23:4F:89

HIERARCHICAL

1. Used by Internetworks
2. Used by Layer 3
3. Used by IP address
4. Is assigned dynamically based on your location
   - Phone System
   - ZIP Code
   - IP- 182.157.63.219

Internet Protocol Address (IP Address)

1. A unique numerical label assigned to each device participating in a network
2. Every device on the Internet must have a unique IP address to identify itself
3. **Internet Assigned Numbers Authority** (IANA)
4. Manages the IP address space allocations globally
5. Delegates five **regional Internet registries** (RIRs) to allocate IP address blocks to local Internet registries (Internet service providers)
6. For an IP to be routable over the Internet, it must have:
   - IP address
   - Subnet Mask
   - Default Gateway
   - DNS address (only for address lookup, i.e. web sites)

Types of Addressing

1. **Static IP address**
   - Manually assigned to a device by an administrator
   - Constant and does not change.
2. **Dynamic IP address**
   - Assigned to device each time it starts
   - Requires less human intervention
   - Less administration
   - Uses Dynamic Host Configuration Protocol (DHCP)
   - Enabled by default
   - No user intervention

Classful vs Classless

CLASSFUL

1. Divided into 5 classes A, B, C, D (multicast) and E (reserved)
2. Does not send subnet information
3. All networks are the same size
4. Have the same subnet mask

CLASSLESS

1. Also known as CIDR (Classless Inter-Domain Routing)
2. Sends subnet information
3. Network can be different sizes
4. Networks can have different subnet masks using VLSM (Variable Length Subnet Mask)

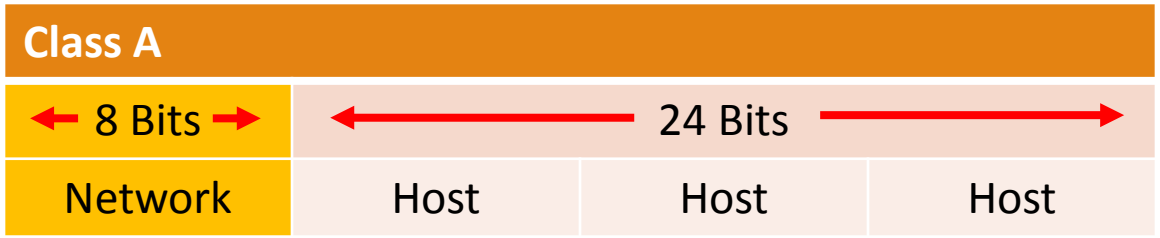
Network & Host Number Formulas

	1 Byte ← 8 Bits →	1 Byte ← 8 Bits →	1 Byte ← 8 Bits →	1 Byte ← 8 Bits →
Class A	**N**	**H**	**H**	**H**
Class B	**N**	**N**	**H**	**H**
Class C	**N**	**N**	**N**	**H**

The formulas are the default configuration for each class:

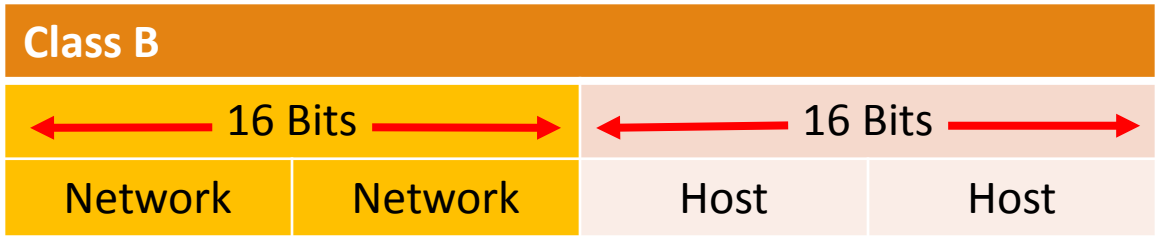
1. **N = Network Number**
   - Assigned by the American Registry for Internet Numbers (ARIN)
   - Administrator has no control over this part of the address
2. **H = Host Number**
   - Assigned and controlled by the network administrator

Class A Addresses



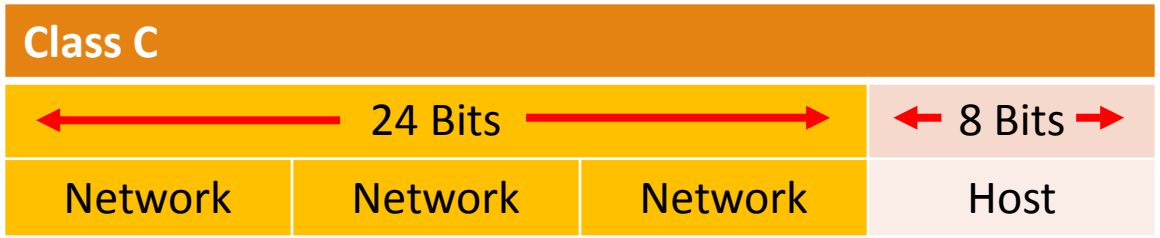
1. First octet only identifies the network
2. When written in a binary format, the first (leftmost) bit of a Class A address is always **0 (zero)**
3. Class A IP address example: 124.95.44.15
4. Range from **1-126** in their first octet
5. 127 is part of a class A range but has been reserved for loopback testing
6. Zero (0) can't be used
7. Remaining three octets can be used for the host portion of the address
8. 2^{24} or 16,777,216, possible IP addresses per class A network

Class B Addresses



1. When written in a binary format, the first (leftmost) bit of a Class B address is always **10 (one and zero)**
2. Class B IP address example: 151.10.13.28
3. The first two octets identify the network number assigned by ARIN
4. Range from **128 to 191** in their first octet
5. Remaining two octets can be used for the host portion of the address
6. 2^{16} or 65,536, possible IP addresses per class B network

Class C Addresses



1. When written in a binary format, the first (leftmost) bit of a Class C address is always **110 (one, one and zero)**
2. Class C IP address example: 201.110.213.28
3. The first three octets identify the network number assigned by ARIN
4. Range from **192 to 223** in their first octet
5. Last octet can be used for the host portion of the address
6. 2^8 or 256, possible IP addresses per class C network

Address Ranges

IMPORTANT!!!
MEMORIZE

Class A	1 – 126	N.H.H.H
Class B	128 – 191	N.N.H.H
Class C	192 – 223	N.N.N.H

Converting to Binary

1. An IP Address is made up of 32 bits broken down into 4 Octets (8 bits each)

2. 11000000.00001100.00000101.10101010
   or
   192.12.5.170

3. Known as the Dotted Decimal

Converting to Binary

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

Decimal to Binary

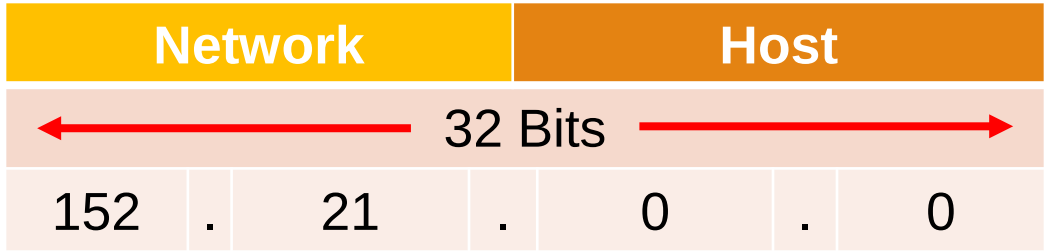
Binary to Decimal

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

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

Binary

Network Address



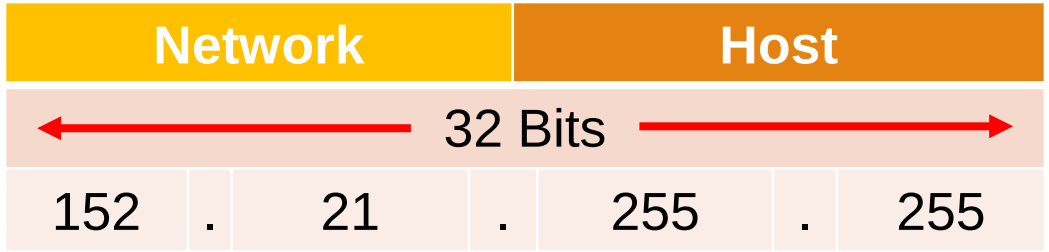
1. **Ends with binary 0s in all host bits**
2. Also know as the **wire address**
3. Never used as a device IP address
4. Used by routers to forward data
5. Example IP address: 152.21.2.3
   - Class B
   - First two octets are assigned
   - Last two octets are host numbers used for devices in the network
   - Network address: 152.21.0.0

Examples of Network Numbers

What is the network number for this IP address?

1. 194.78.112.6 → **194.78.112.0**
2. 117.23.8.3 → **117.0.0.0**
3. 156.132.64.12 → **156.132.0.0**
4. 208.150.112.16 → **208.150.112.0**
5. 91.118.125.2 → **91.0.0.0**

Broadcast Address



1. **End with binary 1s in host bits**
2. Used to send data to all devices on a network
3. Never used as a device IP address
4. Example IP address: 152.21.2.3
   - Class B address
   - First two octets are assigned
   - Last two octets are host numbers used for devices in the network
   - Broadcast address: 152.21.255.255

Examples of Broadcast Address

What is the Broadcast address for this IP address?

1. 194.78.112.6 → **194.78.112.255**
2. 117.23.8.3 → **117.255.255.255**
3. 156.132.64.12 → **156.132.255.255**
4. 208.150.112.16 → **208.150.112.255**
5. 91.118.125.2 → **91.255.255.255**

Network Number and Broadcast Address

1. All 0's in the host address is the Network Number
2. All 1's in the host address in the Broadcast Address
3. These two addresses can never be used when assigning IP's
4. When finding the number of useable host addresses, you will always subtract 2 (network & Broadcast)

Default Subnet Mask

1. Formal name: **Extended Network Prefix**
2. Tells the network devices which part of an address is the network field and which part is the host field
3. 32 bits long and 4 octets, just like an IP address
4. Step to determine the subnet mask:
   - Express the subnetwork IP address in binary form
   - Replace the network portion of the address with all 1s
   - Replace the host portion of the address with all 0s
   - Convert the binary expression back to dotted-decimal notation

Examples of Default Subnet Mask

What is the Default Subnet Mask for this IP address?

1. 194.78.112.6 → **255.255.255.0**
2. 117.23.8.3 → **255.0.0.0**
3. 156.132.64.12 → **255.255.0.0**
4. 208.150.112.16 → **255.255.255.0**
5. 91.118.125.2 → **255.0.0.0**

Default Subnet Mask

Class	Formula	Slash Notation	Default Mask
Class A	N.H.H.H	/8	255.0.0.0
Class B	N.N.H.H	/16	255.255.0.0
Class C	N.N.N.H	/24	255.255.255.0

Default Gateway

1. A port on a router
2. Your connection to the Internet
3. IP address **MUST** be part of the network
4. Usually the first or last IP address in the network