5.1 The IP (Internet Protocol) Addresses

IP is the transmission mechanism used by the TCP/IP protocols. It is an unreliable and connectionless datagram protocol a ***best-effort*** (IP provides no error checking or tracking) delivery service. IP assumes the unreliability of the underlying layers and does its best to get transmission through to its destination, but with no guarantees. IP address is a 32-bit integer, composed of 4-octets, and that from 1 to 3 of the leading octets specify the network address; the remaining one (s) specify the host ID within that network.

5.2 Assignment of IP Addresses

In addition to the physical addresses (contained on NICs) that identify individual devices, the Internet requires an additional addressing convention; an address that identifies the connection of the host to its network. The IP address is globally unique. A central authority, the Network Information Center (NIC), is responsible for handing out blocks of IP addresses; also it has delegated that authority to other organizations, each one of which "owns" a top-level domain (e.g. EDU=Educational Institutions, COM=Commercial Enterprises, GOV=Governmental Organizations, MIL=Military Organizations, NET=Network Organizations, and ORG=Miscellaneous Organizations).

There are separate domains for countries (e.g. UK=United Kingdom, and CA=Canada).

5.3 IP Address Format

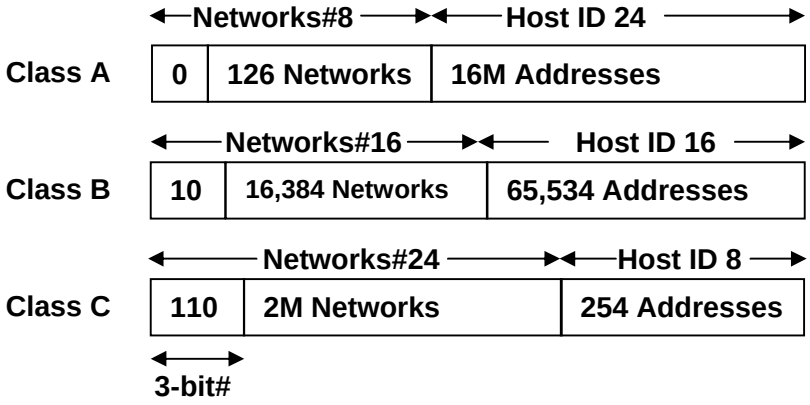
Each Internet address consists of four bytes (32-bits), defining three fields: class type, Net ID, and Host ID. These parts are varying lengths, depending on the class of the address. The classes meet the needs of large, medium, and small sub-networks of the Internet. A state university might have class B address and small company may have class C address. Also class A addresses are numerically the lowest and accommodate more hosts than class B, or class C networks. A full addresses are available in class C only. The remaining unassigned octets of the four are assigned locally by the network administrator (master).

Table (1) Class A, B & C IP Addresses.

e.g. Class B
128.138.0.0

IP Address Class	Network #/Host ID Split	Network #
A	N.H.H.H	N.0.0.0
B	N.N.H.H	N.N.0.0
C	N.N.N.H	N.N.N.0

5.4 IP Address Class Identification



Network Address Range
A=1.0.0.0 → 126.0.0.0
B=128.0.0.0 → 191.255.0.0
C=192.0.0.0 → 233.255.255.0

IP Address Range
A=1.0.0.1 → 126.255.255.254
B=128.0.0.1 → 191.255.255.254
C=192.0.0.1 → 233.255.255.254

Figure (2) Class A, B & C network addresses

5.4.1 Class A Address

There are only 126 networks, because network numbers of 0 and 127 are reserved for special purpose. So the octets range from 0000 0001 to 0111 1110, which are the decimal values of 1 to 126.

The IP address obtained by the allowing the host ID octets to range from 0 to 255, with the exception that no network number or host ID may be all 0's or all 1's.

5.4.2 Class B Address

The most significant 2-bits (10) are interpreted as the network address. The first octets range from 1000 0000 to 1011 1111, yielding decimal values of 128 to 191, and the second octet can range from 0000 0000 to 1111 1111, that is 0 to 255 decimal.

5.4.3 Class C Address

The first octet of this class is range from 1100 0000 to 1101 1111, which is 192 to 223 decimal.

Example: Consider the network node with IP address 185.121.9.12, decipher an IP address.

Solution:

185=1011 1001

∴ The leading bits are (10) and so the signature of a class B address.

The network address is 185.121.0.0

Host ID is 9.12

Note: any device connected to more than one network (e.g. any router) must have more than one Internet address (a device has different addresses for each network connected to it).

5.4.4 Broadcast Address

If a packet is directed to all hosts in the network the host field of the destination IP is to be replaced by all ones bits. The broadcast address is used in some special uses, e.g. in dynamic address assignment protocols.

Example: What is the broadcast address for the network number 148.19.0.0?

Solution:

Since the network is class B which means that the 3rd and 4th octets are the host field.

Then broadcast IP is: 148.19.255.255

Note: All ones makes the value $(255)_{10}=(1111\ 1111)_2$

The following figure shows the IP addresses distribution for different type of LAN topologies.

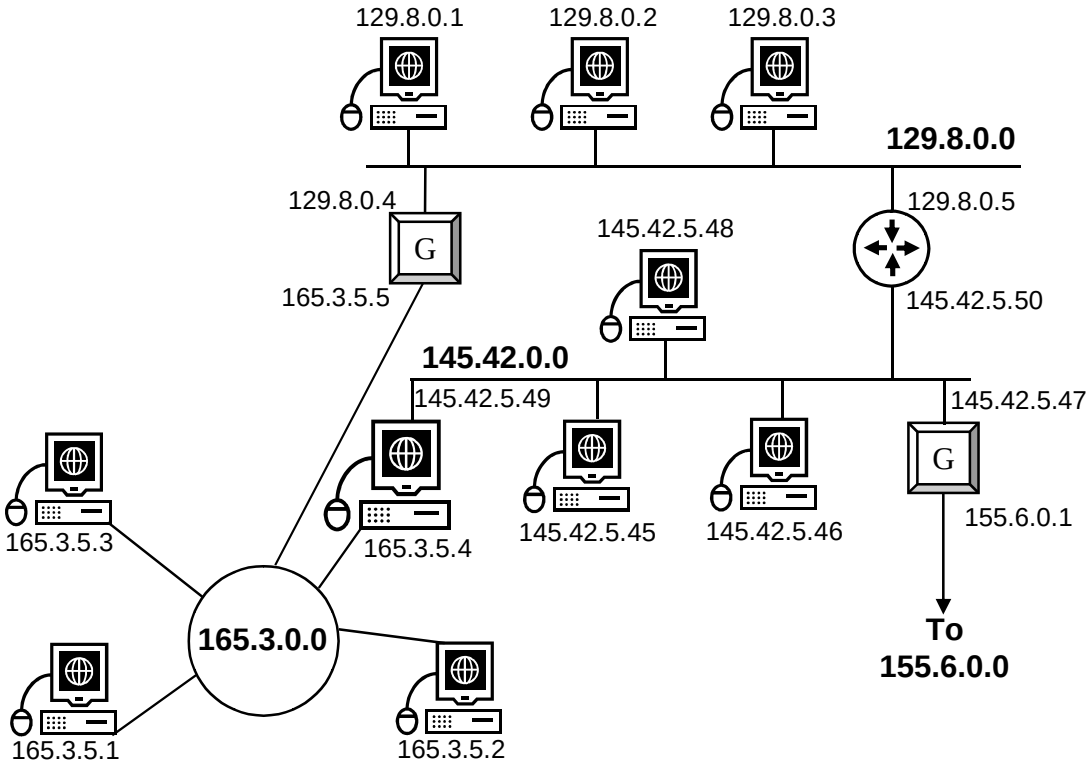


Figure (1) Network and hosts addresses in an Internet.

Homework: Draw a network with the following specifications: (a) Two ring networks with four hosts (class A). (b) Two bus networks with four hosts (class C). (c) The 1st ring is connected to 1st bus by a router and to the 2nd bus by a gateway. (d) The 2nd ring is connected to 1st bus by a gateway and to the 2nd bus by a router. (e) The 1st ring is connected to 2nd ring by a gateway.

Show all the hosts (computers), with their addresses and connections. The address selection is up to you.

5.5 Subnets

With too many hosts to have on a single LAN, the users begin to notice a slowdown in LAN performance. So network administrators with many hosts interconnecting the LANs by router. This partitioning of the domain reduces overall network traffic within it, because routers isolate local LAN traffic within the local LAN.

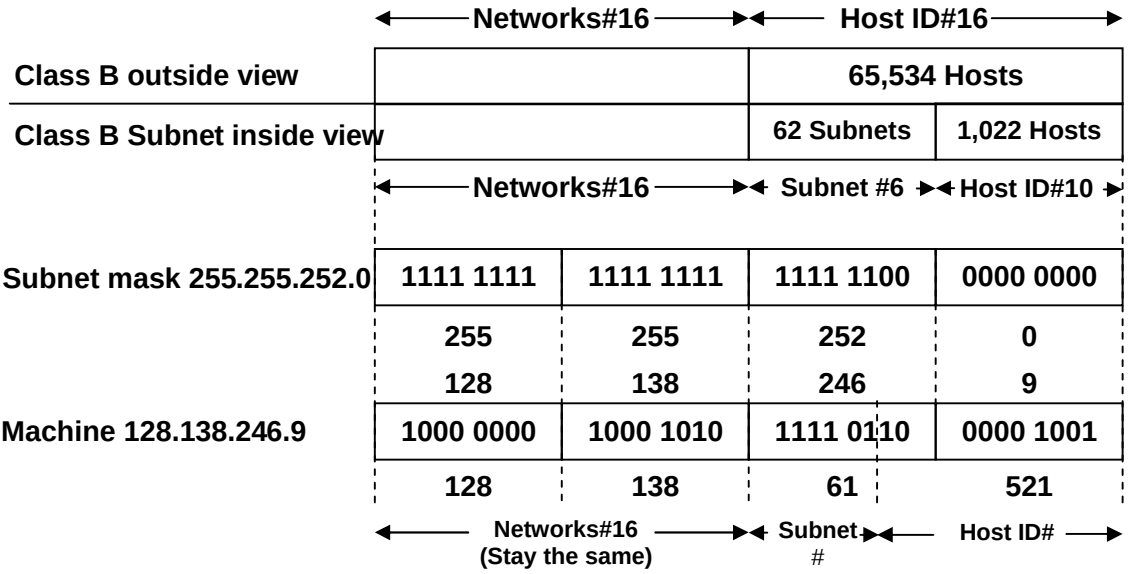


Figure (3) Example of a class B network with a 6-bit subnet.

5.6 Network and Sub Network Masks

In the routing section, routers used a network mask to isolate the network# from the host ID#. That mask will be 255.0.0.0 for class A address, 255.255.0.0 for class B, and 255.255.255.0 for class C. With subnetting, the network administrator creates a subnet mask for use within the LAN routers of the administrated network that includes both the network mask bits and the subnet mask bits. This creates more networks within the domain and allows the routers to route to the sub networks within the main network.

Notice the following points:

1. The IP address does not change! It remains (128.138.246.9) regardless of the subnetting scheme. This is because in dotted decimal notation the dots separate octets, and the bit pattern of the assigned address does not change.
2. What changes is the subnet mask. It enlarges to include the subnet bits, and in so doing, it generates a subnet number and a new host ID number.
3. To a router inside the 128.138 domain, the machine resides on subnet 61 and has a host ID of 521, but this is normally of concern only to the network system administration personnel.

5.7 More Subnetting Masks Ways for Class B

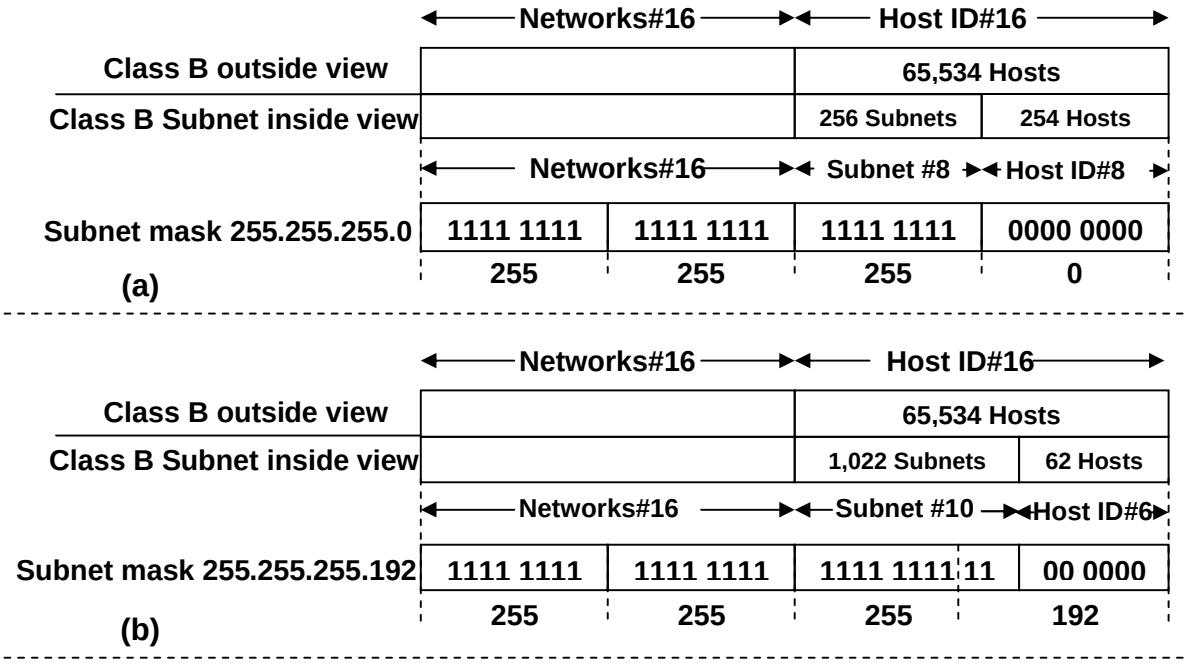


Figure (4) Subnetting a class B network: (a) an 8-bit subnet address. (b) an 10-bit subnet address

Example: Consider the network node with IP address 148.62.191.1, decipher an IP address, then find the subnet number and host ID number with network administrator of 6-bits.

Solution: 148=1001 0100 ⇒ The leading bits are (10) and so the signature of a class B address. So the network address is 148.62.0.0, and Host ID is 191.1 with Machine 148.62.191.1

148	62	191	1
1001 0100	0011 1110	1011 1111	0000 0001
148	62	47	769
		Subnet#	Host ID#

Example: Consider the network node with IP address 182.85.201.12, decipher an IP address, and then find the subnet number and host ID number with network administrator of 7-bits.

Solution: 182=1011 0110 ⇒ The leading bits are (10) and so the signature of a class B address. So the network address is 182.85.0.0, and Host ID is 201.12 with Machine 148.62.191.1

182	85	201	12
1011 0110	0101 0101	1100 1001	0000 1100
182	85	100	268
		Subnet#	Host ID#