NETWORK LAYER

#Continue….

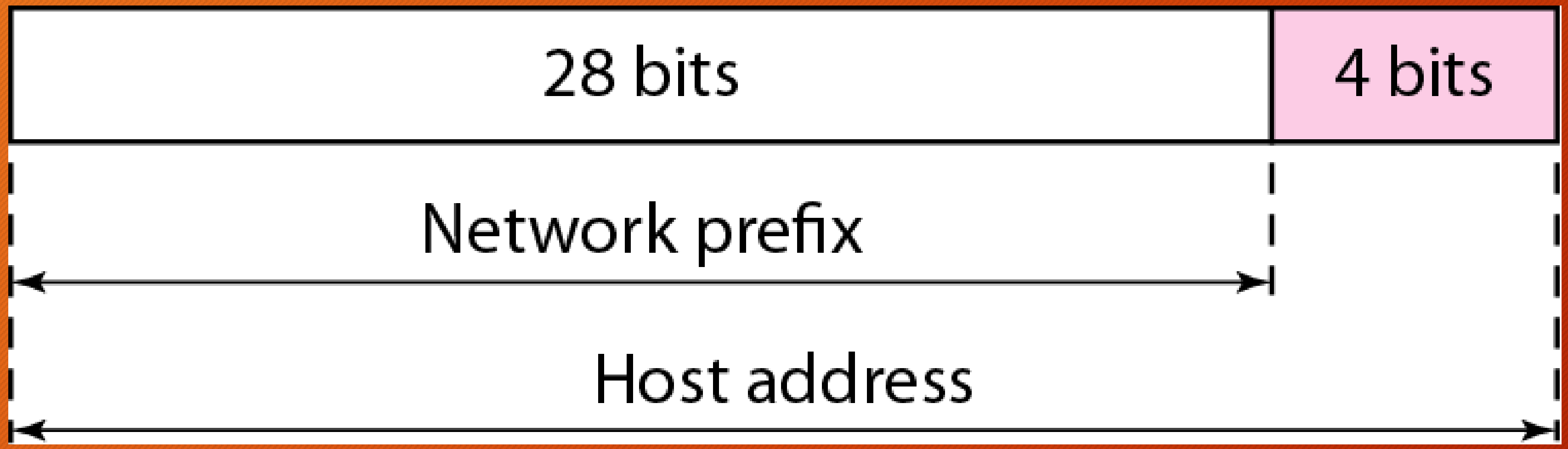
By

Abdul Ghofir, M.Kom

Ref: Forouzan, Data Communications and Networking

Classless Addressing Hierarchy

1. Two-Level Hierarchy: No Subnetting
   - An IP address can define only two levels of hierarchy when not subnetted.
   - The *n* leftmost bits of the address *x.y.z.t*/*n* define the network (organization network); the 32 – *n* rightmost bits define the particular host (computer or router) to the network.
   - The two common terms are prefix and suffix.
     - ➢ The part of the address that defines the network is called the prefix
     - ➢ The part that defines the host is called the suffix.



Two levels of hierarchy in an IPv4 address

Classless Addressing Hierarchy

Each address in the block can be considered as a two-level hierarchical structure:
the leftmost *n* bits (prefix) define the network;
the rightmost 32 − n bits define the host.

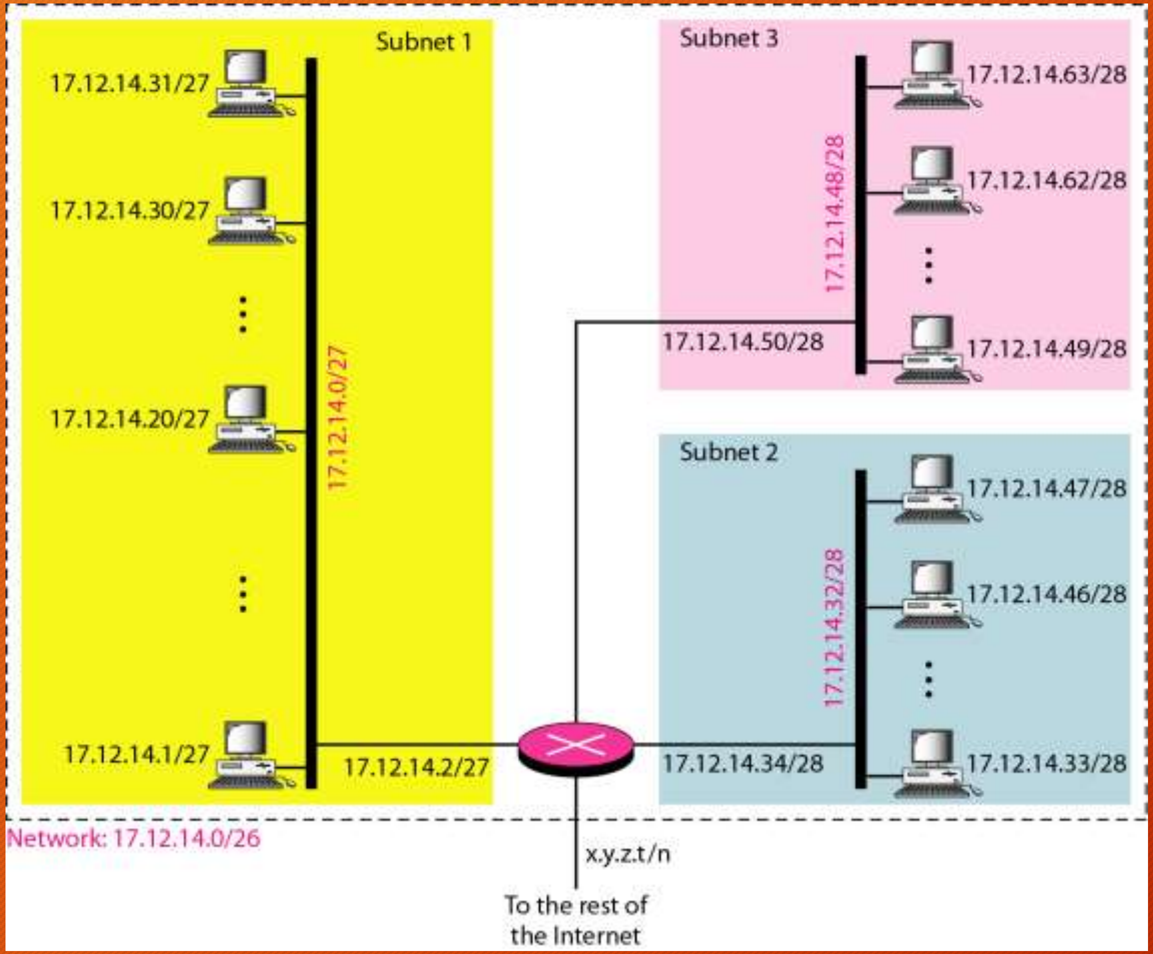
Classless Addressing Hierarchy

2. Three-Levels of Hierarchy: Subnetting
   - An organization that is granted a large block of addresses may want to create clusters of networks (called subnets) and divide the addresses between the different subnets.
   - The organization, however, needs to create small subblocks of addresses, each assigned to specific subnets.
   - The organization has its own mask; each subnet must also have its own.

Classless Addressing Hierarchy

- As an example, suppose an organization is given the block 17.12.14.0/26, which contains 64 addresses. The organization has three offices and needs to divide the addresses into three sub blocks of 32, 16, and 16 addresses. We can find the new masks by using the following arguments:
  1. Suppose the mask for the first subnet is n1, then 2^{32-n} must be 32, which means that n1 =27.
  2. Suppose the mask for the second subnet is n2, then 2^{32-n} must be 16, which means that n2 = 28.
  3. Suppose the mask for the third subnet is n3, then 2^{32-n} must be 16, which means that n3 =28.

  This means that we have the masks 27, 28, 28 with the organization mask being 26.



Configuration and addresses in a subnetted network

Let us check to see if we can find the subnet addresses from one of the addresses in the subnet.

a. In subnet 1, the address 17.12.14.29/27 can give us the subnet address if we use the mask /27 because:

Host	: 00010001 00001100 00001110 00011101
Mask	: /27
Subnet	: 00010001 00001100 00001110 00000000 (17.12.14.0)

Let us check to see if we can find the subnet addresses from one of the addresses in the subnet.

b. In subnet 2, the address 17.12.14.45/28 can give us the subnet address if we use the mask /28 because:

Host : 00010001 00001100 00001110 00101101

Mask : /28

Subnet : 00010001 00001100 00001110 00100000 (17.12.14.32)

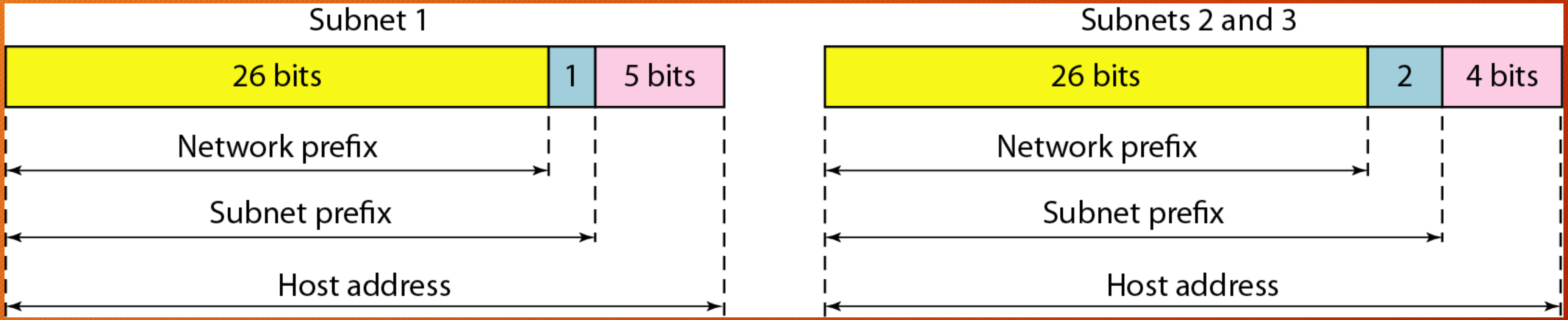
Let us check to see if we can find the subnet addresses from one of the addresses in the subnet.

c. In subnet 3, the address 17.12.14.50/28 can give us the subnet address if we use the mask /28 because:

Host : 00010001 00001100 00001110 00110010

Mask : /28

Subnet : 00010001 00001100 00001110 00110000 (17.12.14.48)



Three-level hierarchy in an IPv4 address

Example 1

An ISP is granted a block of addresses starting with 190.100.0.0/16 (65,536 addresses). The ISP needs to distribute these addresses to three groups of customers as follows:

a. The first group has 64 customers; each needs 256 addresses.
b. The second group has 128 customers; each needs 128 addresses.
c. The third group has 128 customers; each needs 64 addresses.

Design the subblocks and find out how many addresses are still available after these allocations.

Solution

Group 1

For this group, each customer needs 256 addresses. This means that 8 ($^{2}\log$ 256) bits are needed to define each host. The prefix length is then $32 - 8 = 24$. The addresses are:

1st Customer:	*190.100.0.0/24*	*190.100.0.255/24*
2nd Customer:	*190.100.1.0/24*	*190.100.1.255/24*
. . .		
64th Customer:	*190.100.63.0/24*	*190.100.63.255/24*

Total $= 64 \times 256 = 16{,}384$

Solution

Group 2

For this group, each customer needs 128 addresses. This means that 7 ($^{2}\log$ 128) bits are needed to define each host. The prefix length is then 32 − 7

= 25. The addresses are:

1st Customer:	*190.100.64.0/25*	*190.100.64.127/25*
2nd Customer:	*190.100.64.128/25*	*190.100.64.255/25*
. . .		
128th Customer:	*190.100.127.128/25*	*190.100.127.255/25*

Total = $128 \times 128 = 16{,}384$

Solution

Group 3

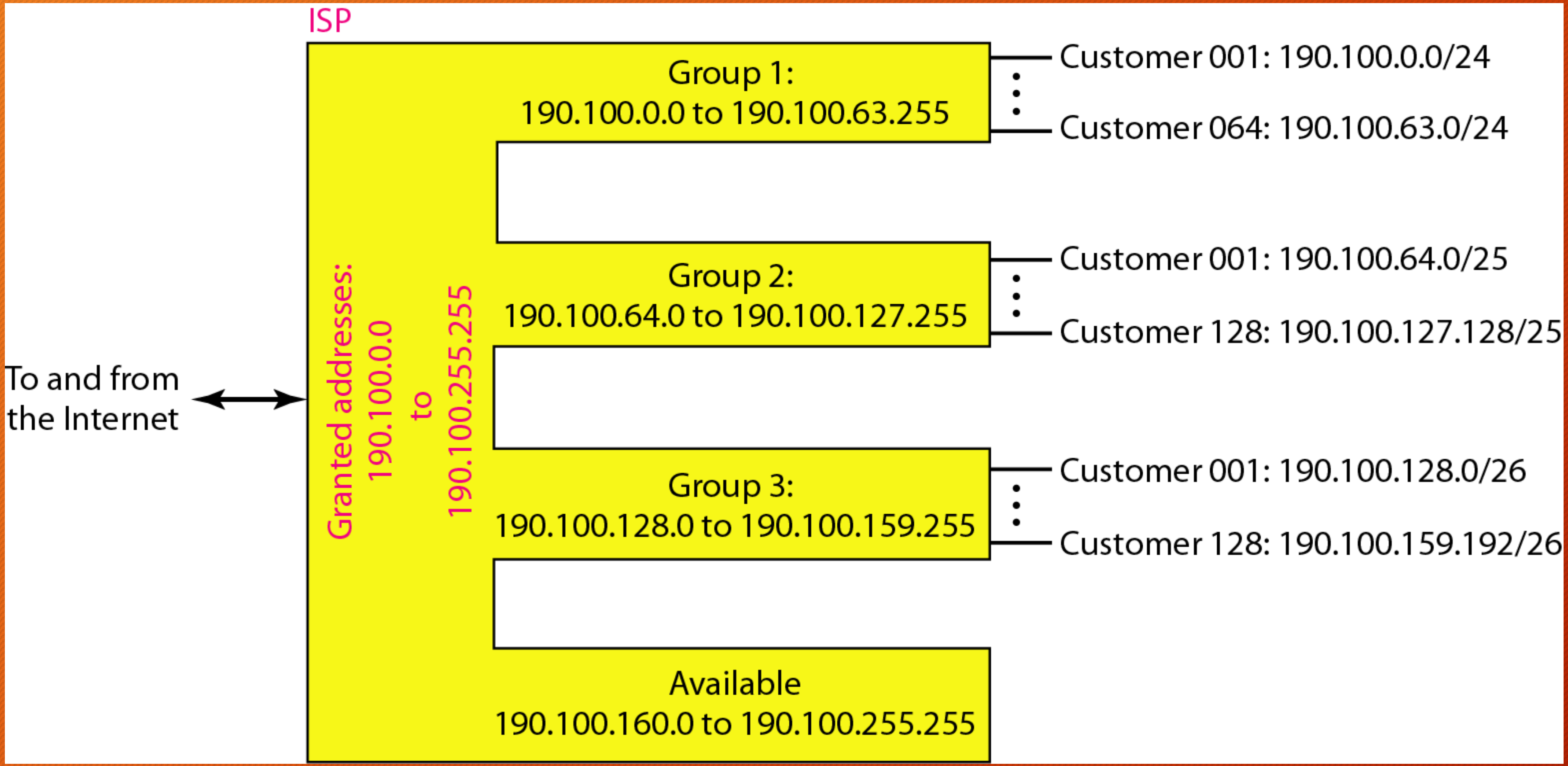
- For this group, each customer needs 64 addresses. This means that 6 ($^{2}\log$ 64) bits are needed to each host. The prefix length is then 32 − 6 = 26. The addresses are:

1st Customer:	*190.100.128.0/26*	*190.100.128.63/26*
2nd Customer:	*190.100.128.64/26*	*190.100.128.127/26*
. . .		
128th Customer:	*190.100.159.192/26*	*190.100.159.255/26*

Total $= 128 \times 64 = 8192$

Solution

Number of granted addresses to the ISP: 65,536
Number of allocated addresses by the ISP: 40,960
Number of available addresses: 24,576



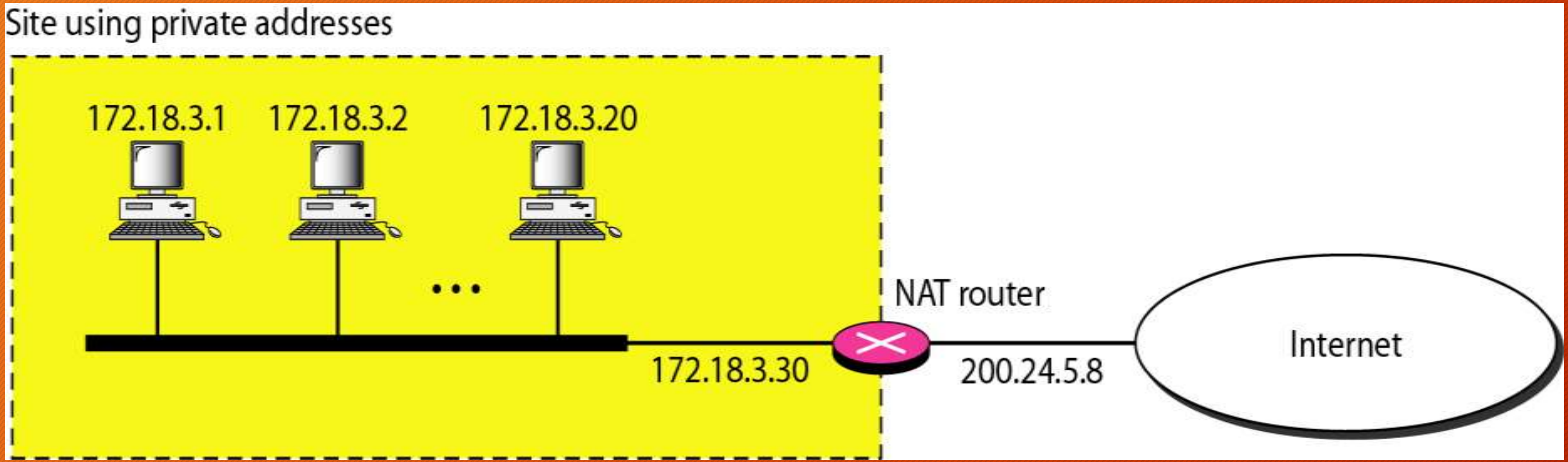
An example of address allocation and distribution by an ISP

Network Address Translation (NAT)

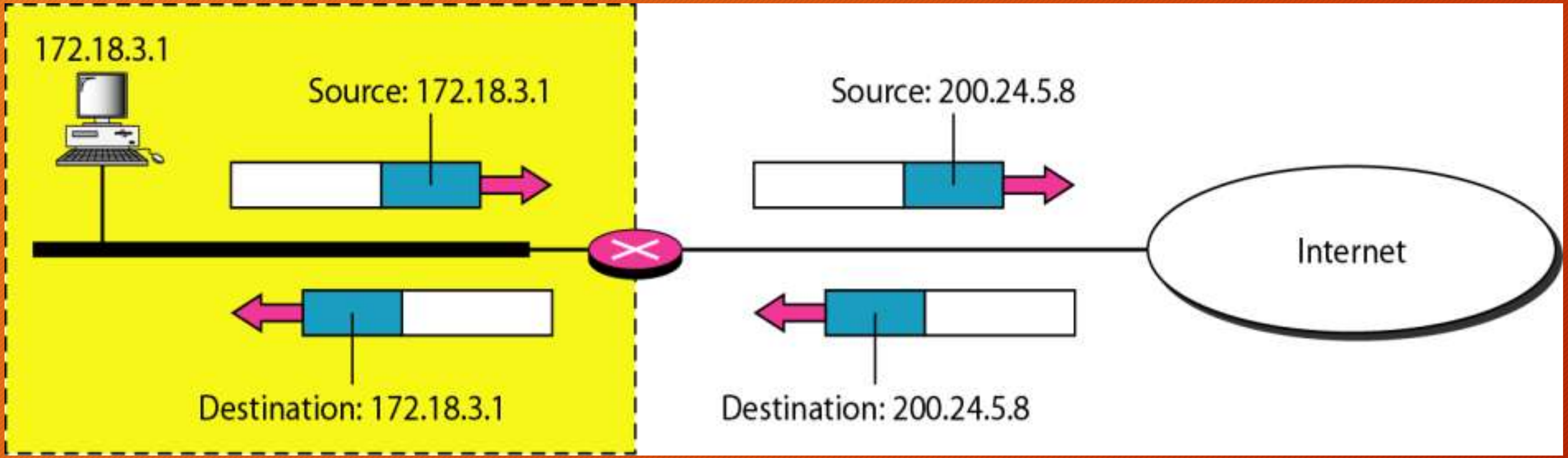
- NAT enables a user to have a large set of addresses internally and one address, or a small set of addresses, externally.
- To separate the addresses used inside the home or business and the ones used for the Internet, the Internet authorities have reserved three sets of addresses as private addresses.

Range			Total
10.0.0.0	to	10.255.255.255	2^{24}
172.16.0.0	to	172.31.255.255	2^{20}
192.168.0.0	to	192.168.255.255	2^{16}

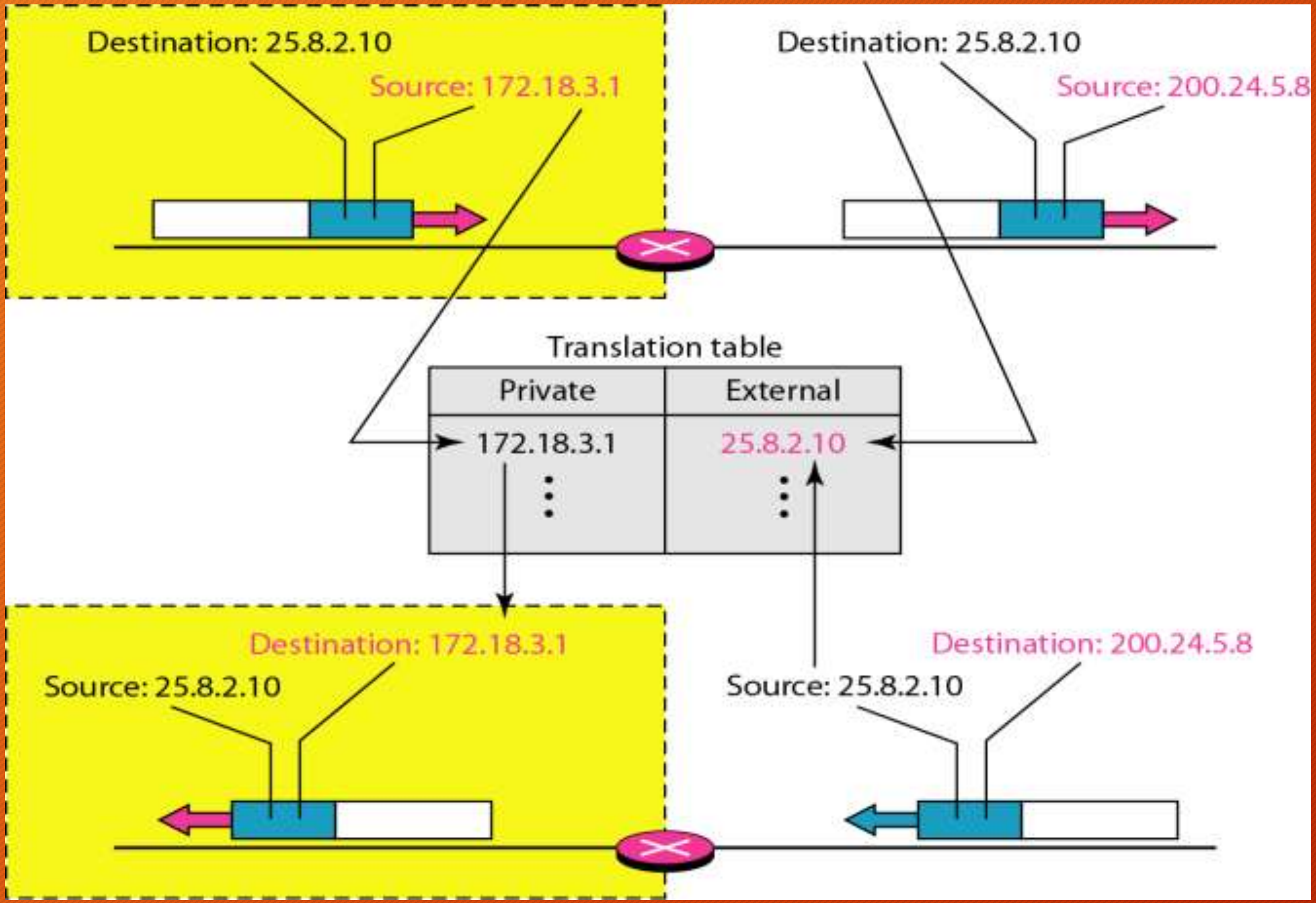
Addresses for private networks



A NAT implementation



Addresses in a NAT



NAT address translation

Task 4

An ISP is granted a block of addresses starting with 150.80.0.0/16. The ISP wants
to distribute these blocks to 2600 customers as follows.

a) The first group has 200 medium-size businesses; each needs 128 addresses.
b) The second group has 400 small businesses; each needs 16 addresses.
c) The third group has 2000 households; each needs 4 addresses.

Design the subblocks and give the slash notation for each subblock. Find out how many addresses are still available after these allocations.

THANK YOU