Computer Network

Lecture-29

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Logical Addressing

Classless Addressing

In this scheme, there are no classes, but the addresses are still granted in blocks.

Address Blocks

- In classless addressing, when an entity, small or large, needs to be connected to the Internet, it is granted a block of addresses. The size of the block (the number of addresses) varies based on the nature and size of the entity.
- For example, a household may be given only two addresses; a large organization may be given thousands of addresses. An ISP may be given thousands or hundreds of thousands based on the number of customers it may serve.

Logical Addressing

Restriction

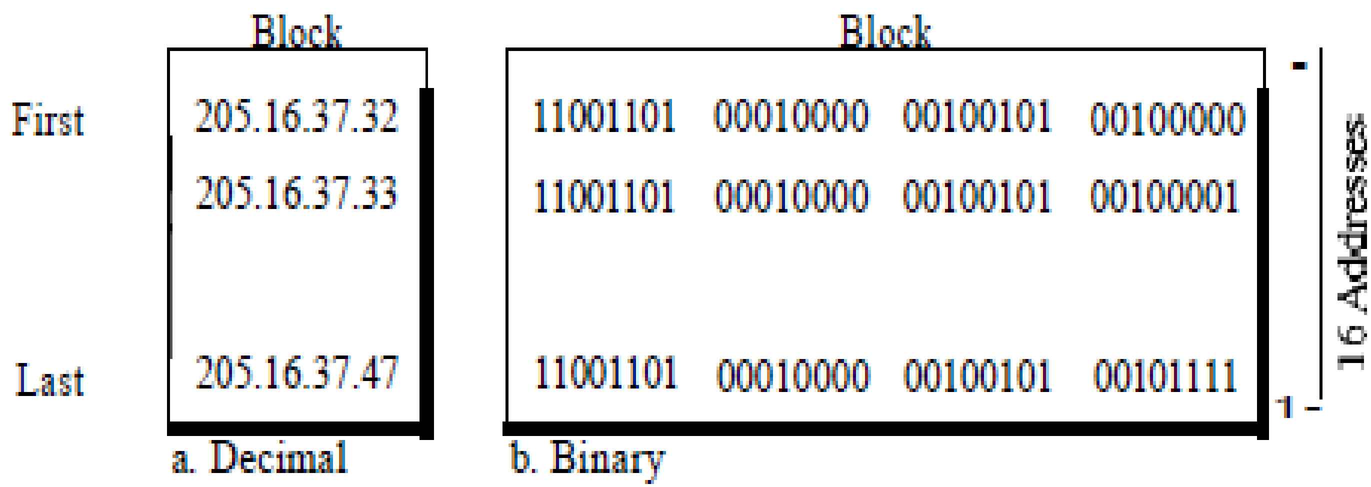
The Internet authorities impose three restrictions on classless address blocks:

1. The addresses in a block must be contiguous, one after another.
2. The number of addresses in a block must be a power of 2.
3. The first address must be evenly divisible by the number of addresses.

Logical Addressing

Example

Following figure shows a block of addresses, in both binary and dotted-decimal notation, granted to a small business that needs 16 addresses.



Logical Addressing

Mask

- A better way to define a block of addresses is to select any address in the block and the mask.

- In IPv4 addressing, a block of addresses can be defined as

  x.y.z.t/n

  in which x.y.z.t defines one of the addresses and the /n defines the mask.

- The address and the /n notation completely define the whole block (the first address, the last address, and the number of addresses).

Logical Addressing

First Address

The first address in the block can be found by setting the 32-n rightmost bits in the binary notation of the address to 0s.

Last Address

The last address in the block can be found by setting the 32-n rightmost bits in the binary notation of the address to 1s.

Number of Addresses

The number of addresses in the block is the difference between the last and first address. It can easily be found using the formula $\mathbf{2^{32-n}}$.

Logical Addressing

Example

A block of addresses is granted to a small organization. We know that one of the addresses is 205.16.37.39/28.

(a) What is the first address in the block?
(b) What is the last address in the block?
(c) Find the number of addresses in this block.

Logical Addressing

Network Addresses

A very important concept in IP addressing is the network address.

The first address is called the network address and defines the organization itself to the rest of the world.

Logical Addressing

Hierarchy

IP addresses have levels of hierarchy.

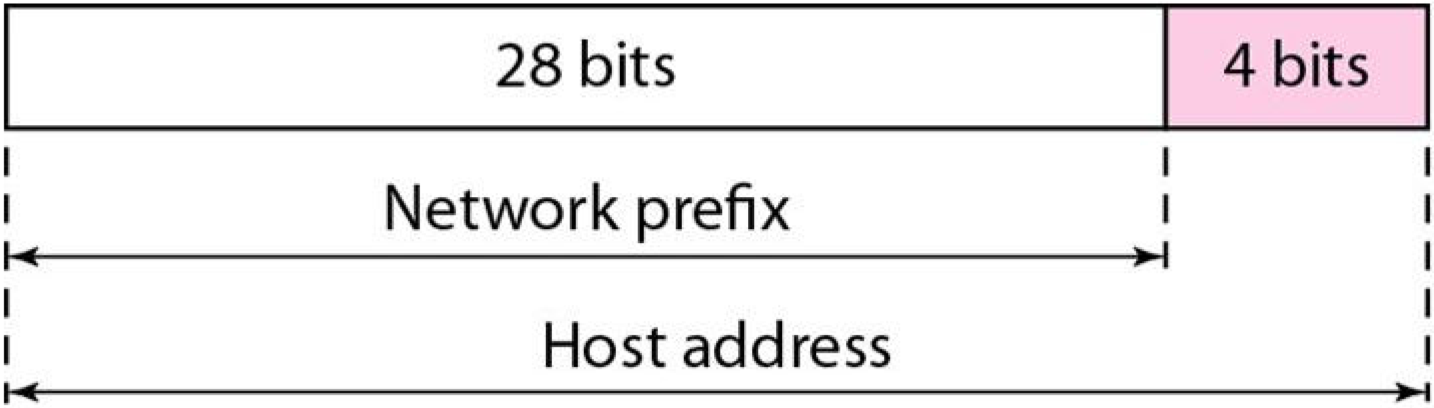
Two-Level Hierarchy: No Subnetting

- 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.

Logical Addressing

Following figure shows the hierarchical structure of an IPv4 address.

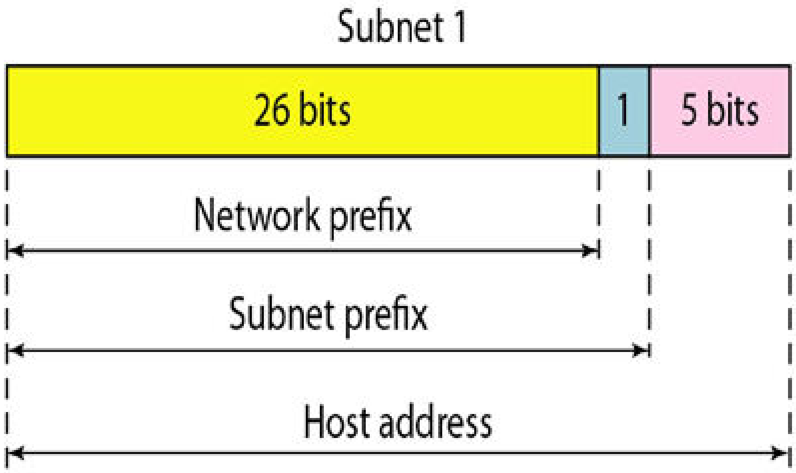
Two levels of hierarchy in an IPv4 address



Logical Addressing

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 rest of the world still sees the organization as one entity; however, internally there are several subnets. The organization has its own mask; each subnet must also have its own.



Logical Addressing

Example:

Suppose an organization is given the block 17.12.40.0/26, which contains 64 addresses. The organization has three offices and needs to divide the addresses into three subblocks of 32, 16, and 16 addresses. Find the mask of these three offices.

Solution:

(a) Suppose the mask for the first office is n1. Therefore,
$2^{32-n1} = 32$, n1 = 27.

(b) Suppose the mask for the first office is n2. Therefore,
232-n2 = 16 , n2 = 28.

(c) Suppose the mask for the first office is n3. Therefore,
232-n3 = 16 , n3 = 28.

Logical Addressing

Example

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.

Logical Addressing

Solution:

(a) Group 1

For this group, each customer needs 256 addresses. This means that 8 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 to 190.100.0.255/24

2nd Customer: 190.100.1.0/24 to 190.100.1.255/24

……………………………………………………………………………

……………………………………………………………………………

64th Customer: 190.100.63.0/24 to 190.100.63.255/24

Total = 64 X 256 =16,384

Logical Addressing

Solution:

(b) Group 2

For this group, each customer needs 128 addresses. This means that 7 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 to 190.100.64.127/25

2nd Customer: 190.100.64.128/25 to 190.100.64.255/25

……………………………………………………………………………

……………………………………………………………………………

128th Customer: 190.100.127.128/25 to 190.100.127.255/25

Total = 128 X 128 =16,384

Logical Addressing

Solution:

(c) Group 3

For this group, each customer needs 64 addresses. This means that 6 bits are needed to define each host. The prefix length is then 32 - 6 = 26. The addresses are

1st Customer: 190.100.128.0/26 to 190.100.128.63/26

2nd Customer: 190.100.128.64/26 to 190.100.128.127/26

……………………………………………………………………………

……………………………………………………………………………

64th Customer: 190.100.159.192/26 to 190.100.159.255/26

Total = 128 X 64 = 8192

Number of granted addresses to the ISP = 65536

Number of allocated addresses by the ISP = 16,384 + 16,384 + 8192

= 40960

Number of available addresses = 65536 – 40960

= **24576**