Ministry of Higher Education and Scientific Research
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2^{nd} licence year

IPv4 addressing course

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1 Addressing Purpose

The purpose of addressing is to provide a universal communication service allowing any machine to communicate with any other machine. Machines must be accessible by both humans and other machines.

A machine must therefore be able to be identified by :

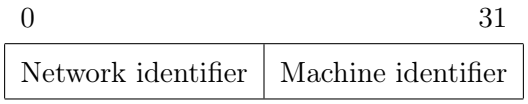
– a name (mnemonic for users),

– an address which must be a universal machine identifier,

– a route specifying how the machine can be reached.

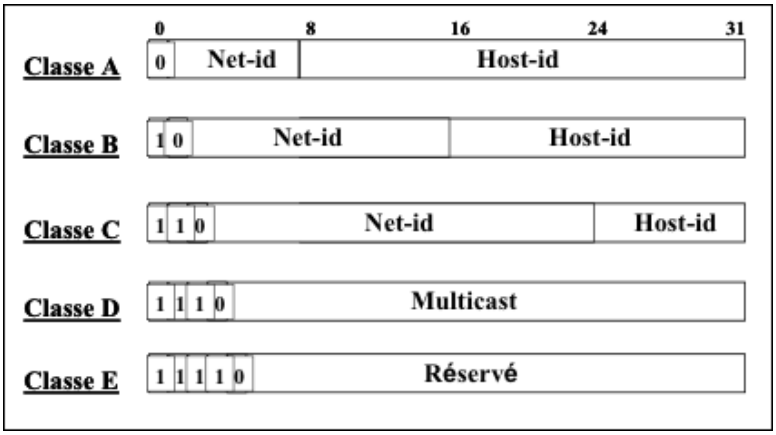
2 Principle of IP addressing

Les adresses IP permettent d'identifier à la fois les réseaux et les machines. IP addresses are used to identify both networks and machines. An IP version 4 address consists of 32 bits structured in two parts : network identifier and machine identifier.



Network identifiers are controlled by the Network Information Center (NIC) in California, but machine identifiers are controlled locally.

IP addresses are organized into five classes :



– Class A is the class of very large networks such as ARPANET and MILNET, it includes 126 networks of 17 million machines each.

– Class B is the class of medium networks, it includes 16384 networks of 65000 machines.

– Class C is the class of local networks, it is the most used class in the Internet, it includes two million networks of 254 machines each.
– Class D is the Multicast class.
– Class E is an experimental class, reserved for trial use or future use.

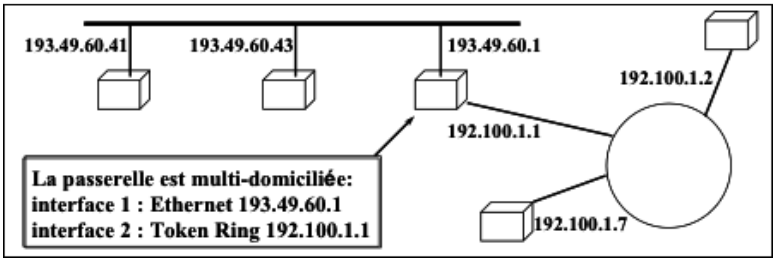
3 Decimal notation

Binary IP addresses are difficult to handle, so decimal notation is used which represents the IP address in the form of four decimal values between 0 and 255 representing the values of the four bytes of the binary address.

10000000		00001010		00000010		00011110
128	.	10	.	2	.	30

We write : 128.10.2.30

Exemple



4 Special addresses

In each class, there are addresses reserved for a particular use and which cannot be attributed to any machine and which have a particular meaning. In general :

– An address field (Netid or Hostid) all 1 means all objects (networks or machines) (used for broadcasting)
– An address field (Netid or Hostid) all 0 means this object (network or machine) (used in case of ignorance of identifiers)

Examples

– The network address has a machine identifier value where all bits are zero (0)
– An address containing network bits at 0 means this network
– A broadcast address in the home network (local) has all 32 IP bits set to 1 (full 1 or all 1s) (Used during startup when you don't know your IP address).

- An all 0 address means this computer is only authorized during the boot process.
- An address which has the first byte equal to 01111111 (127) is called a Loopback address, it is used for intra-machine communications for test purposes or for communication between applications in the same machine. Class A addresses from 10.0.0.0 to 10.255.255.255, class B addresses from 172.16.0.0 to 172.31.255.255 and class C from 192.168.0.0 to 192.168.255.255 are reserved for networking private otherwise called intranet 1.
- Class A addresses from 10.0.0.0 to 10.255.255.255, class B addresses from 172.16.0.0 to 172.31.255.255 and class C addresses from 192.168.0.0 to 192.168.255.255 are reserved for setting up private networks otherwise known as intranets

5 Exercises

1. We want to send a message to all hosts on a local network with address 1024. Which IP address to use in binary and decimal format ?
2. Can a machine have more than one IP address ? Justify.
3. Can an IP address be assigned to more than one machine ? Justify.
4. Give the address ranges (low and high addresses) of the different classes and specify the number of addressable machines.

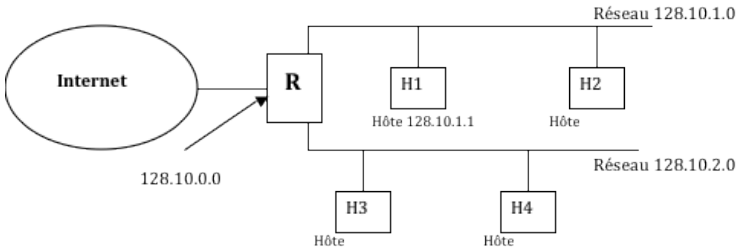
6 Sub Netting

Designers of IP addressing, working in a world of big, expensive systems, thought of an Internet of a few dozen networks and a few hundred machines. They did not foresee the explosion in the number of small individual networks, the growth was exponential and we saw a doubling in size every nine months. The large number of elementary networks ended up causing problems :

- The task of managing IP addresses is enormous
- Routing tables become gigantic or even saturated.
- Class C (2 million networks) quickly became insufficient.
- The use of class B also generates problems : the number of networks is insufficient and the management of 65000 machines within each network is very difficult.

Hence the need to subdivide. subnet addressing or subnetting is a standardized technique in IP addressing, it allows the use of a single network address with several networks (sub-

networks) by cutting out the part reserved for the address of the machines on a network into two parts, the first of which will be a subnet identifier. Thus a single class B network, on which we could name 65536 machines, can be broken down into 254 subnets of 254 machines.



For the Internet, there is only one network 128.10.0.0 and all routers treat datagrams destined to this network in the same way. On the other hand, the router R uses the third byte (equal to 1 or 2) of the address contained in the datagrams which come to it to direct them towards the subnetwork for which they are intended thus ensuring a hierarchical routing.

0		31	
NetID	HostID		Old IP address
Partie Internet	Local part		
Internet Part	sub net	Host	New IP address

The choice of the number of bits representing the subnet identifier is left to the local administrator. If this number is fixed for all the sub-networks, then one speaks of fixed sub-addressing, otherwise one speaks of variable sub-addressing. Variable sub-addressing is used when a company, for example, has both small and large networks. In fixed addressing (often used), a compromise must be made between the number of networks and the number of machines.

Number of bits of subnet	Number of subs network	Number of hosts
2	2	16382
3	6	8190
4	14	4094
.	.	.
.	.	.
.	.	.

6.1 subnet masks

The TCP/IP standard indicates that a site that uses subnetting must choose a mask (subnet mask) for each subnet that will be registered on each machine. The mask allows a machine to know the number of bits assigned to the identifier of the subnet and to that of the machine. A subnet mask is a 32-bit word containing bits at 1 instead of the identifier network and subnet and bits to 0 instead of the machine identifier. **Examples of masks**

11111111	11111111	11111111	00000000
Network			Host
255	255	255	0

11111111	11111111	11110000	00000000
Network			Host
255	255	240	0

11111111	11111111	11111111	11110000
Network			Host
255	255	255	240

6.2 Membership of a machine to a subnet

So, from the address of a datagram and its subnet mask a machine can determine if the datagram is intended for a machine on its own subnet, for a machine on another subnet of its network or to a machine outside its subnet.

To verify that the machine with address IPDest belongs to the subnet with address IPRes having the mask N, we calculate

$$V = IPdest \wedge N$$

If $V = IPres$ then the machine is in the same subnet and the messages are sent to it, otherwise the messages are sent to a gateway (router) which transmits them to the rest of the network which is responsible for routing them to their destination .

For example, in the context of the network presented at the beginning of this section where the subnet mask is 255.255.255.0 suppose that our machine is the one identified by the IP address 128.10.1.2 (H2).

- If the destination address is 128.10.1.1, an "and" between the binary representation of this address is that of the subnet mask gives 128.10.1.0, namely the address of the subnet of our machine, so the datagram is destined for a machine on that same subnet.
- If the destination address is 128.10.2.1, a similar calculation gives 128.10.2.0 ie the address of another subnet of the same network.
- If the destination address is S.T.U.V (with (S,T) $\neq$ (128,10)) the result will be the address of a network different from the one our machine belongs to.