TYPES OF ADDRESSES AND LEVELS OF USE IN THE TCP/IP PROTOCOL STACK

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Abstract. *The publication comments on certain moments of the method of teaching the types of addresses and their use in the TCP/IP protocol stack.*

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1. General presentation

This publication focuses on the types of addresses and the levels at which they function in the TCP/IP protocol stack. What is impressive, the students and pupils from 9-12th grade specialized training of Information Technologies, learning the Computer Networks and Communications subject show preliminary knowledge of some types of addresses as they refer to them as independent terms (IP addresses are learn in two education's levels). The attention paid to the model, to which they belong, is not adequate. It may lead to incomprehension of their role and use.

The publication is intended to present the existing levels of addresses in the TCP/IP protocol stack, as well as to review some moment of the methods of teaching this material. The aim is to make the trainees familiar first with the structure, hierarchy and functioning of the protocol stack in order to be able to realize the need and role of each of the mentioned addresses.

2. Address in TCP/IP

TCP/IP consists of 4 layers, as the division into layers is not as strict as in the OSI model [1, p. 22-23] [2, p. 262-265]. For example, there exist routing protocols (RIP and OSFP), which use the services of UDP functioning at a transport level. It does not mean that we do not have definite identification of the objects from the various layers, just on contrary – every layer uses an address.

2.1. Local Address

This type of address applies in the channel layer. Its type is determined by the used technology. As regards LAN this is the MAC address of the network adapter or port. Every such address is unique and is assigned by the company-manufacturer. It is set on a hardware level and every change of such type of device results in a change in the MAC address. It consists of 6 bytes.

Example: 00-24-D2-B5-73-04

The senior 3 bytes represent an identifier of the company-manufacture, and the junior 3 bytes identify the product and are assigned by the company itself.

During the introduction of this type of addresses to the audience, it must be noted that the MAC address identifies in a unique manner every host in the local network, guaranteeing thereby its proper functioning. The transmitted cadres in the channel layer are distributed between the hosts due to recognized MAC addresses.

2.2. IP Addresses

The IP address is unique. It is used in the network layer [1, p. 59-64] [2, p. 269-272]. It identifies a host or a port of an intermediate network node. If we take into account the currently effective standard IPv4 the IP address is a 4-byte one and it is recorded by 4 decimal numbers in the interval from 0 to 255, divided by points.

Example: 192.168.1.1

Logically it is to be divided in two parts: the network address (Net ID) and the host address (Host ID). The role of a divider is played by the so called network mask, which is also a 4-byte one and guarantees flexibility in the determination of the boundaries [1, p. 65-81].

Example: 255.255.255.0

The network mask always accompanies an IP address. When in a binary form, it is required to start with the number one, provided that after the sequence is over the rest of the positions are to be filled in with binary zeros. It is not allowed to shift the positions between 0 and 1. It participates in the operation binary multiplication with an IP address and helps in the determination of the network segment, in which the device is located.

On the grounds of these criteria, tasks may be formulated for determination of the validity of specific network masks.

Example: 255.255.255.0; 255.128.0.0 – valid network masks

255.64.0.0 – invalid network mask (64 represented in a binary form allows the presence of 0 in its most senior bits, thus violating the condition for continuity of the consecutive 1)

Task 1: Indicate the invalid network mask: 255.255.255.252, 255.255.64.0, 255.255.192.0, 255.255.252.0.

There are 5 classes of IP addresses (under IPv4). Their scope divides them in public and private ones. Public addresses are valid for the entire IP network, wherein they function, and the private may only be assigned to local network hosts (a computer with such an address may not be directly presented in the Internet).

2.3. class A

The class A IP addresses start with decimal number from 1 to 126, inclusive. The network address (Net ID) takes up one byte, and the other three bytes represent a host address (Host ID) in it. The following form may be used to illustrate:

0NetID.HostID, where 0 is the first bit (it guarantees the interval [1,127]), and NetID substitutes the other 7 positions of the first byte, HostID corresponds to the following 3 bytes of the address.

This class ensures 127 networks and 2^{24} or 16 777 216 addresses, for each of them [5].

The standard network mask is 255.0.0.0. The value 255 in the first byte guarantees the preservation of the first 8 bits of the network address upon binary multiplication. The decimal zero is not used as a first number of a IP address. Addresses starting with the number 127 are only used for specific purposes (for example, 127.0.0.1 is used for loopback, i.e. the data generated by the node are transmitted back to the top layers as if they have just been received by the network).

Example: 101.0.0.0 – network address, 101.0.0.10 – host address in the network

It must be noted that in a network address, unlike a host address, all positions set aside for *HostID* are filled in by binary 0.

2.4. class B

The class B IP addresses start with a decimal number from 128 to 191, inclusive. The network address (Net ID) and the host (Host ID) take up 2 bytes each. The following form may be used to illustrate:

10NetID.HostID, where 10 are the first 2 bits (they guarantee the interval [128,191]), and NetID replaces the remaining 14 positions from the first 2 bytes, HostID corresponds to the remaining 2 bytes of the address.

This class ensures 16 384 networks and 2^{16} or 65 536 addresses, for each of them.

The standard network mask is 255.255.0.0. The value 255.255 in the first byte guarantees the preservation of the first 16 bits of the network address upon binary multiplication.

Example: 129.33.0.0 – network address, 129.33.0.10 – host address in the network

2.5. class C

The class C IP addresses start with a decimal number from 192 to 223, inclusive. The network address (Net ID) takes up the first three bytes, and the last byte represents the host address (Host ID). The following form may be used to illustrate:

110NetID.HostID, where 110 are the first 3 bytes (they guarantee the interval [192,223]), and NetID replaces the remaining 21 positions from the first 3 bytes, HostID corresponds to the remaining 1 byte of the address.

This class ensures 2 097 152 networks and 2^8 or 256 addresses, for each of them.

The standard network mask is 255.255.255.0. The value 255.255.255 guarantees the preservation of the first 24 bits of the network address upon binary multiplication.

2.6. class D

The class D IP addresses start with a decimal number from 224 to 239 inclusive. The first byte of these addresses starts with the binary combination 1110. They are used for sending of multicast communications to a certain group of hosts, to which the specified address is assigned. The multicast address does not divide into a Net ID and Host ID.

2.7. class E

The class D IP addresses start with a decimal number from 240 to 254 inclusive. The first byte of these addresses starts with the binary combination 11110. This class of addresses is reserved for special applications.

In the presentation of these addresses it must be noted that private addresses exists as well for every class, which private addresses assist in the configuration of local networks, without any need to capture a valid internet address.

The following three areas are defined for private addresses [5]:

- **class A** – 10.0.0.0/8 - - addresses from 10.0.0.1 to 10.255.255.254.
- **class B** – 172.16.0.0/12 – addresses from 172.16.0.1 to 172.31.255.254
- **class C** – 192.168.0.0/16 – addresses from 192.168.0.1 to 192.168.255.254

Designations of the type 10.0.0.0/8 are of the used alternative for classless addressing based on the classless inter-domain routing CIDR [1, p. 82-83] [4]. The number 8 after the solidus means that the 8 bits situated on the leftmost side are used for network identification and the others – for host recognition. CIDR allows more effective distribution of IP addresses.

The third strategy used in this respect is called Variable-Length Subnet Masking (VLSM) [6] and uses sub-net masks (the number of ones is different from theses of the standard masks) for subnet mask definition. The manners of calculation may be commented in another publication.

Tasks may be defined for calculation of subnet masks, subnets, network device addresses.

Task 2: What network mask must be set to enable a network with address 131.162.0.0 to break down to at least 3 subnets?

Task 3: What are the newly obtained subnets, gateways and IP addresses for assignment?

2.8. Port

This type of addresses is used in the transport layer. Ports are used by the TCP and UDP protocols for connection to the application processes. The port represents

a 16-bit number. Some of the ports are reserved as a standard (for example port 21 – for the FTP protocol).

The port and IP address jointly form a socket, for example: 89.68.180.5:21. A pair of sockets (on the two ends of the communications) identifies definitely one TCP connection. One socket may participate in several connections at a time.

2.9. DNS name

DNS names are host names used in the application layer [7] [2, p. 272-273]. They are introduced for convenience of users who generally remember names better than IP addresses. DNS names are assigned by network administrators. They consist of several parts (domains, areas), divided by points as the senior domain is on the rightmost side. The Internet domain is a logical merger of the hosts, possible even from various physical networks. Each domain consists of subdomains for the purpose of its easier administration. Subdomains, on their part, may also have their subdomains, etc.

The syntax of DNS names is, as follows:

subdomain_N.subdomain_N-1. … .subdomain_1.domain

An example of a DSN names is the name www.fmi.uni-plovdiv.bg, which describes the host www from the fmi domain (the Faculty of Mathematics and Informatics), which is a subdomain of the uni-plovdiv (Plovdiv University) domain, which is on its part a subdomain of the bg (Bulgaria) domain. The names are a part of a distributed database called DSN /Domain Name System/. It maintains a hierarchic system of names for identification of the nodes and resources in Internet. The main designation of DNS is an automatic search of an IP address under its respective DSN name. For this purpose the DSN for the application layer is used. The DSN specification is determined by the documents RFC 1034 and RFC1035.

3. Brief notes

The logical binding of the types of addresses to the separate layers of the TCP/IP protocol stack in the methodical approaches of teaching this section would support an easier and permanent acquisition of knowledge. The tracking of the operation of main protocols from the network level of the stack under consideration (ARP, RARP, IP) will help to realize the need of transformation of local hardware addresses to logical protocol addresses (IP addresses). The trainee shall be able to understand the mechanism of functioning of a local network and its connection to the global network Internet.

References

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