Redes de Comunicação 2021/2022

T01
IPv4 addressing
Simple network scenarios

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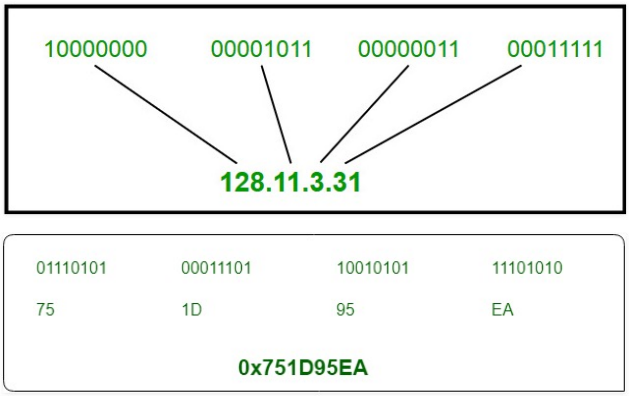
T01: IP addressing

Overview:

- What is an IP address?
- IPv4 vs IPv6
- IPv4 classful addressing
- IP addresses and netmasks
- Special addresses
- Reserved IP addresses
- Challenges

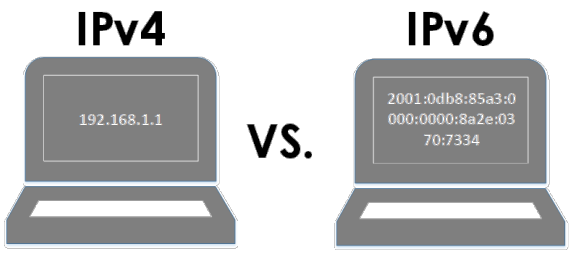
What is an IP address?

- IP addresses allow to *uniquely* identify and communicate with hosts (servers, laptops, smartphones, sensors, etc) in the Internet
- IPv4 addresses are written as four numbers separated by periods (Dotted-decimal notation), each number can be 0 to 255
- Alternatively, may be written in hexadecimal notation



IPv4 vs IPv6 addresses

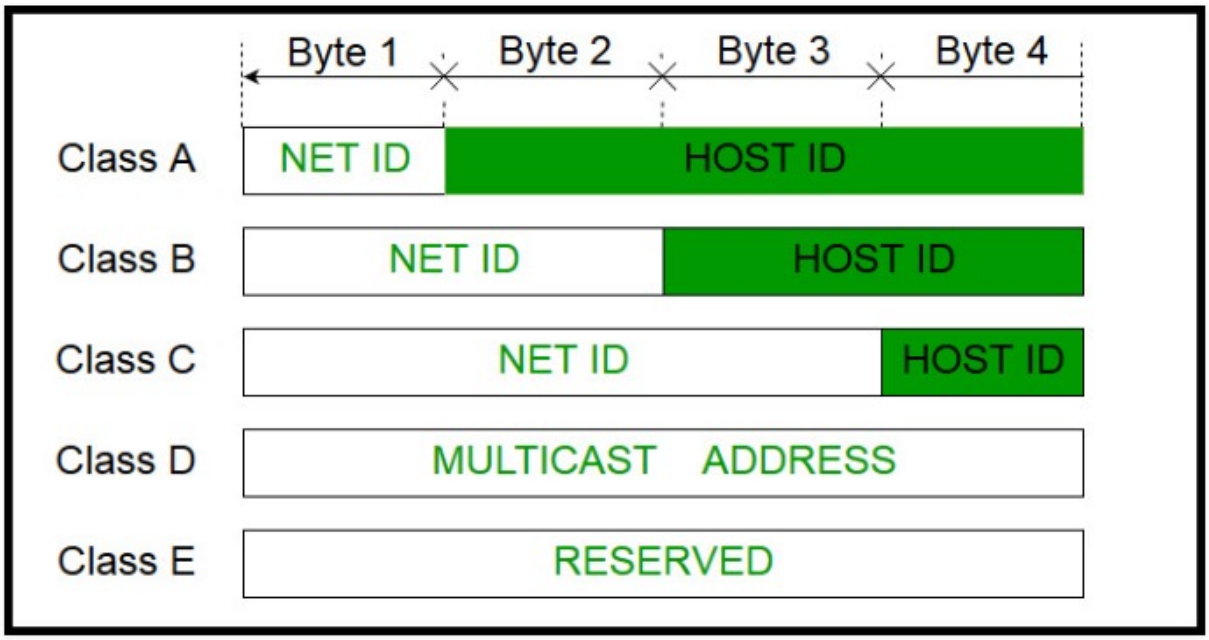
- IPv4
  - 32 bits used for addresses
  - Provides a total of 4,294,967,296 addresses
- IPv6
  - 128 bits used for addresses
  - Provides a total of 340,282,366,920,938,463,374,607,431,768,211,456 addresses
  - That's about 3.7×10^{21} addresses per square inch of the earth's surface!



IPv4 classful addressing

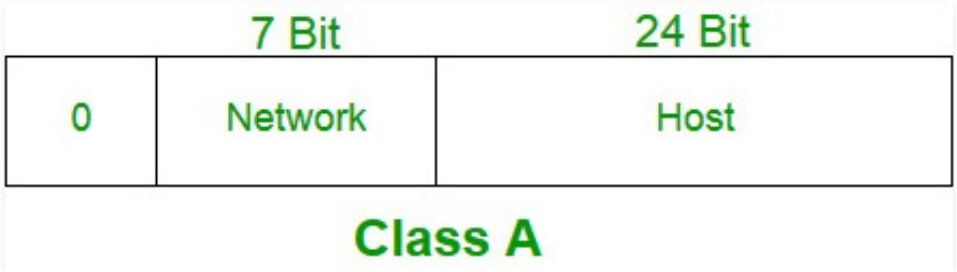
- 32-bit IP addresses are divided into five sub-classes: A, B, C, D and E
- Each of the classes has a valid range of IP addresses
- The order of bits in the first octet (byte) determine the classes of IP addresses
- Each IP address if divided in the Network ID and Host ID
- The class of IP address determines the number of total networks and hosts possible in that particular class.
- IP addresses are globally managed by the Internet Assigned Numbers Authority (IANA) and Regional Internet Registries (RIR)
- Each ISP or network administrator assigns IP address to each device that is connected to its network

IPv4 classful addressing



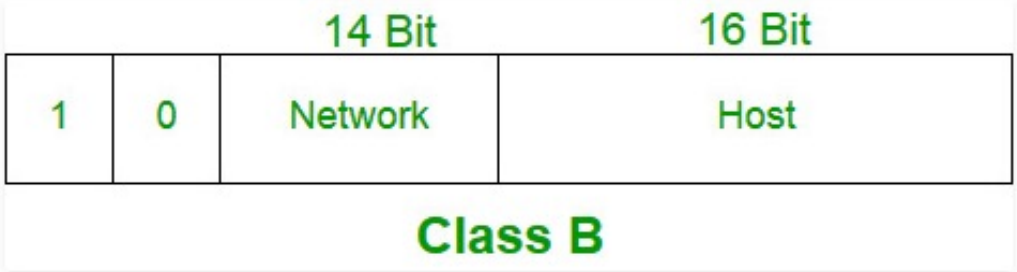
IPv4 classful addressing

- **Class A** IPv4 addresses:
  - Assigned to networks that contain a large number of hosts
  - Network ID is 8 bits long, Host ID is 24 bits long
  - Higher order bit of the first byte is always 0
  - From 1.0.0.1 to 126.255.255.254



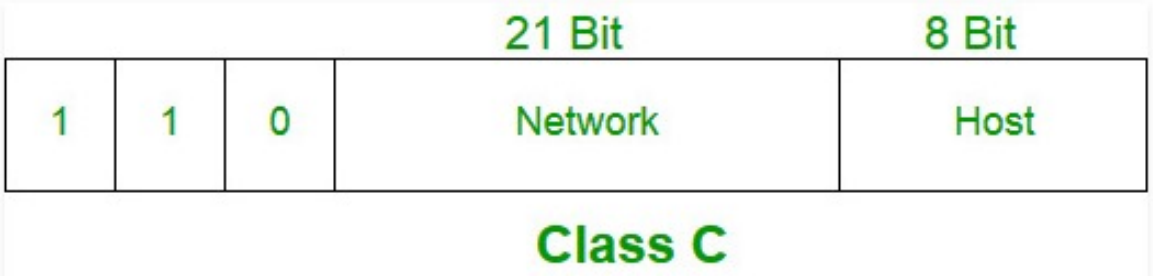
IPv4 classful addressing

- **Class B** IPv4 addresses:
  - Assigned to medium-sized to large-sized networks
  - Network ID is 16 bits long, Host ID is 16 bits long
  - Higher order bits of the first byte is always 10
  - From 128.1.0.1 to 191.255.255.254



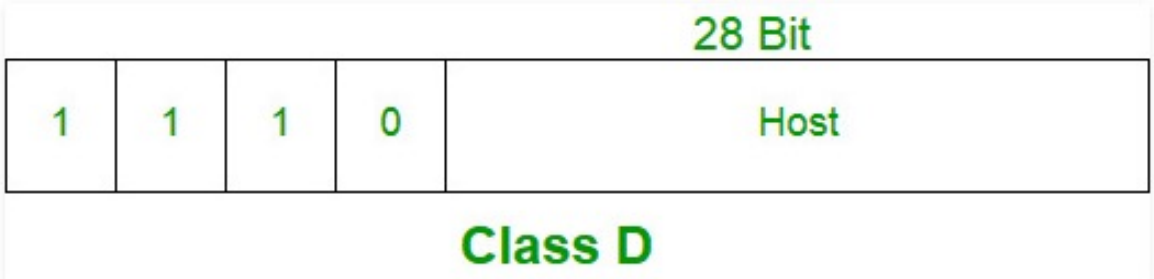
IPv4 classful addressing

- **Class C** IPv4 addresses:
  - Assigned to small-sized networks (most common)
  - Network ID is 24 bits long, Host ID is 8 bits long
  - Higher order bits of the first byte is always 110
  - From 192.0.1.1 to 223.255.255.254



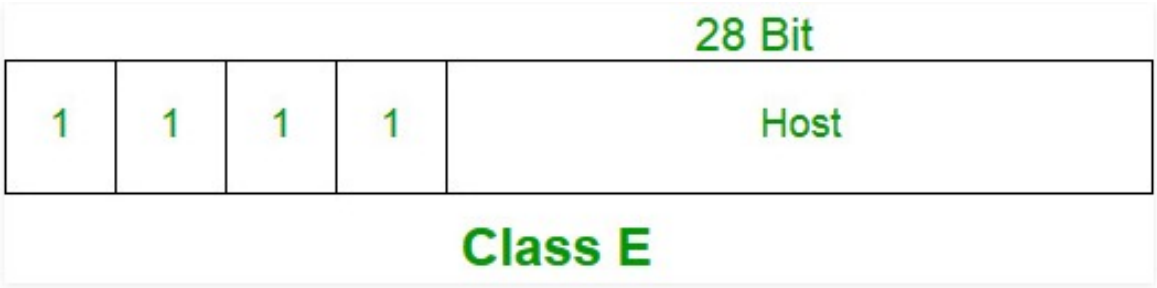
IPv4 classful addressing

- **Class D** IPv4 addresses:
  - Reserved for multicast communications
  - Higher order bits of the first byte is always 1110
  - From 224.0.0.0 to 239.255.255.255



IPv4 classful addressing

- **Class E** IPv4 addresses:
  - Experimental and research purposes
  - Higher order bits of the first byte is always 1111
  - From 240.0.0.0 to 255.255.255.254



IPv4 classful addressing

CLASS	LEADING BITS	NET ID BITS	HOST ID BITS	NO. OF NETWORKS	ADDRESSES PER NETWORK	START ADDRESS	END ADDRESS
CLASS A	0	8	24	2^7 (128)	2^{24} (16,777,216)	0.0.0.0	127.255.255.255
CLASS B	10	16	16	2^{14} (16,384)	2^{16} (65,536)	128.0.0.0	191.255.255.255
CLASS C	110	24	8	2^{21} (2,097,152)	2^8 (256)	192.0.0.0	223.255.255.255
CLASS D	1110	NOT DEFINED	NOT DEFINED	NOT DEFINED	NOT DEFINED	224.0.0.0	239.255.255.255
CLASS E	1111	NOT DEFINED	NOT DEFINED	NOT DEFINED	NOT DEFINED	240.0.0.0	255.255.255.255

Special addresses

- Lookback addresses (127.0.0.1 to 127.0.0.8):
  - Most common is 127.0.0.1
  - Used for communications between applications in the same system
  - Used for diagnostic testing of the local TCP/IP installation
- Automatic private IP addressing addresses (169.254.0.0 to 169.254.255.255)
  - Self-assigned IP addresses, when computer is unable to get an address from the network
- Network address:
  - First address in the range (**Host ID bits are all set to 0**), used to **represent the local network**
- Broadcast address:
  - Last address in the range (**Host ID bits all set to 1**), used to **communicate with all systems in the local network**

IP addresses and netmasks

- Netmask designate which bits of an IP address represent the network portion (bits with 1) of the address and which bits represent the host portion (bits with 0)
  - Class A: 255.0.0.0 (or /8)
  - Class B: 255.255.0.0 (or /16)
  - Class C: 255.255.255.0 (or /24)
- The netmask also allows to know the network size (how many hosts can be addressed)
- Netmask for a class C network (alternative representations):

  255.255.255.0
  11111111 11111111 11111111 00000000
  /24

IP addresses and netmasks

- Further subdivision of the addressing space is possible and very useful!
- This is known as "subnetting", as we will study later…

Subnet Mask	CIDR	Subnet Mask	CIDR
255.128.0.0	/9	255.255.240.0	/20
255.192.0.0	/10	255.255.248.0	/21
255.224.0.0	/11	255.255.252.0	/22
255.240.0.0	/12	255.255.254.0	/23
255.248.0.0	/13	255.255.255.0	/24
255.252.0.0	/14	255.255.255.128	/25
255.254.0.0	/15	255.255.255.192	/26
255.255.0.0	/16	255.255.255.224	/27
255.255.128.0	/17	255.255.255.240	/28
255.255.192.0	/18	255.255.255.248	/29
255.255.224.0	/19	255.255.255.252	/30

Reserved IP addresses

- Designed to be used on a private network behind a NAT (Network Address Translation) device (e.g. firewall or router)
- Cannot be used to communicate directly with other systems over the Internet
- Common usage in home, office and academic networks

Class A IP Range	Subnet Mask
10.0.0.0 – 10.255.255.255	255.0.0.0
172.16.0.0 – 172.31.255.255	255.240.0.0
192.168.0.0 – 192.168.255.255	255.255.0.0

Class C addresses: challenges

1. Consider the following Class C network:
   10.5.0.0/24 (netmask 255.255.255.0 or /24)

- Is this a **reserved (or official)** IP network?
- Is the address 10.5.1.23 part of this network?
- What is the **broadcast** address?
- What is the address of the **network**?
- What is the **range of addresses** that can be used to identify hosts in this network?

Class C addresses: challenges

2. Consider the following IP address:
   193.136.239.12

- Is this a **reserved (or official)** IP address?
- To what **Class C network** does this address belong?

3. Consider the following IP address:
   192.168.12.257

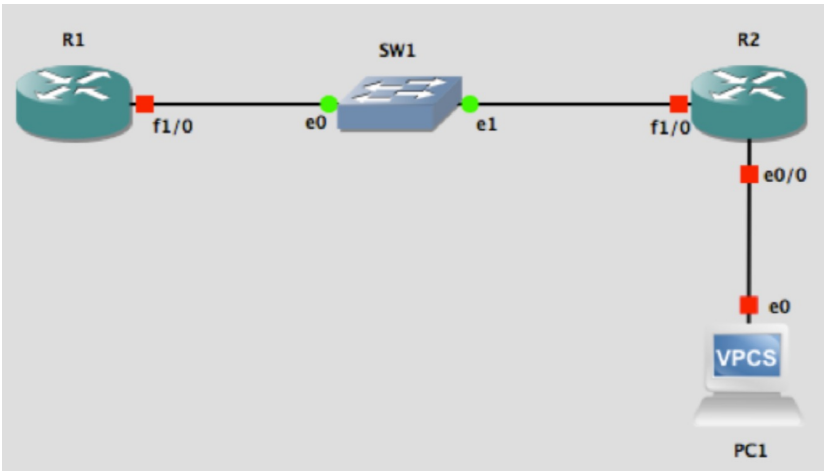
- Is this a **valid** IP address?

Network scenarios: challenges

1. Configure the network interface of the two routers, using a private IP network. For each interface indicate:

   IP address
   Netmask
   Default Gateway

Network scenarios: challenges



1. Configure the network interface of Router R1: IP address, netmask, default gateway

2. Configure the network interface of PC1: IP address netmask, default gateway

T01: Summary

What we have covered?

- A few fundamental aspects of how IP addresses are used in the Internet
- The division of IPv4 addresses in classes
- The purpose of special and reserved addresses
- The purpose of netmasks and network addresses
- A few examples on the usage of Class C (the most common) addresses
- A few examples of configuring addressing in simple network scenarios

- *Later in the course we will study how IP networks can be further subdivided (IP subnetting)!*