Computer Networks Manual

1. Introduction

The Internet is a network of networks.
Communication in Internet is performed using network sockets.

2. Socket Programming

Communication in Internet is performed using network sockets.
The socket API allows 2 or more processes (on the same machine or on different machines) to communicate with each other using Unix file descriptors. The two most common sockets are UDP and TCP.

2.1. General concepts

- a endpoint of a socket is defined by a protocol, and the pair (IP, port)
- Ports range from 0 to 65535. Ports 0 to 1024 are reserved for services and cannot be used by a regular user.
- socket system calls

UDP	TCP
socket()	socket()
bind()	bind()
sendto()/recvfrom()	listen()
	accept()/connect()
	send()/recv()

2.2. UDP sockets

- connectionless
- usually faster than TCP
- unreliable
- a UDP socket is created with parameters AF_INET, SOCK_DGRAM

2.3. TCP sockets

- connection oriented
- usually slower than UDP
- reliable
- a TCP socket is created with parameters AF_INET, SOCK_STREAM

Socket programming examples

3. TCP/IP Stack

Application	DHCP, HTTP, DNS, SSH
Transport	UDP, TCP
Internet	ICMP, IPv4, IPv6
Link	ARP

4. Encapsulation

5. Link Layer

5.1. Ethernet Cables

- straight-through
- crossover

5.2. Topologies

- **bus**
- **ring**
- **star**
- hierarchical
- mesh

5.3. Network Interfaces

- coper
- optical
- wireless

5.4. MAC address (physical address)

The physical (MAC – media access control) address of a network interface is a 48 bits unique identifier usually represented by 6 groups of 2 hexadecimal numbers. MAC address can be changed by software, in most network interfaces.

The broadcast MAC address is FF:FF:FF:FF:FF:FF.

ARP (Address Resolution Protocol) maps IP addresses to MAC addresses sending a query to the MAC broadcast address.

5.5. Link layer (only) networking equipments

- A **hub** always sends all incoming packets to all outgoing interfaces, flooding the network with packets.
- A **switch** can associate MAC addresses to an interface so it will send a packet to a particular MAC only to that interface, reducing the flood, the number of collisions and increasing overall performance in a LAN.
- A **wireless access point** acts like a hub that interconnects a wired network to one or more wireless clients. It is sometimes integrated with a witch in a **wireless router**.

Link layer devices can transport any type of IP packets.

6. Internet Layer

6.1. IPv4 Address

An IPv4 addres is 32 bits long, represented in as 4 bytes in decimal separated by "."(dot).

A network interface can have one or more IP addresses.

Special IP addreses:

localhost	127.0.0.1
private ip classes	10.0.0.0/8 from 10.0.0.0 to 10.255.255.255
	172.16.0.0/12 from 172.16.0.0 to 172.31.255.255
	192.168.0.0/16 from 192.168.0.0 to 192.168.255.255

Localhost address cannot be used as network address or broadcast address.

6.2. Netmask

A netmask is 32 bits long and it is formed by zero or more binary 1 followed by zero or more bynary 0.

11.........100.........0

32 bits; x 1s; 32-x 0s; 0<=x<=32.

A netmask is represented either as an IP address (4 bytes in decimal separated by ".") or in short **/x** where x is the number of 1s in the netmask.

Example: 11111111000000000000000000000000=255.0.0.0=/8

The netmask associated to an IP specifies the boundaries of the network that IP belongs to.

In a network with a netmask /x there are $2^{(32-x)}$ IP addresses. The first IP address is the address of that network, and the last one is the broadcast address. These to IPs can not be configured for network interfaces.

Adresa de retea.

Adresa de broadcast.

6.3. LAN

6.4. Internet layer networking equipment
- router
- wireless router

6.5. Gateway

6.6. Routing
- static routing
- dynamic routing

7. Transport Layer

7.1. TCP

7.2. UDP

8. Application Layer

8.1. HTTP (Hypertext Transfer Protocol)

HTTP is the most popular Internet protocol. It is used for distributing web pages. The HTTP server runs (usually) on port 80, and the secure version HTTPS runs (usually) on port 443.

8.2. DNS (Domain Name System)