Computer Networks. Unit 1: Introduction

Notes of the subject *Xarxes de Computadors, Facultat Informàtica de Barcelona, FIB*

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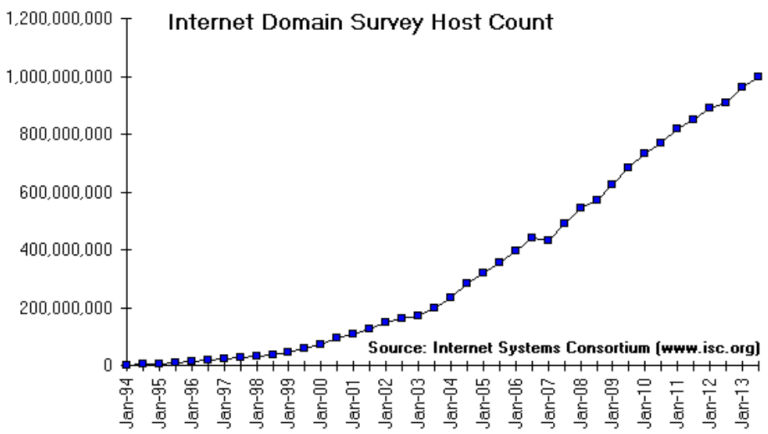
Contents

1 Unit 1: Introduction

1.1 What is a Computer Network?

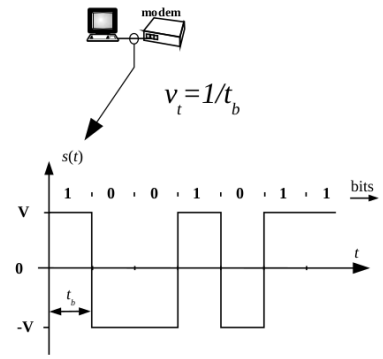
Brief history:

- 1830 Telegraph
- 1875 Alexander Graham Bell patent the telephone
- 1951 First commercial computer
- 1960s ARPANET. Public networks rediris geant
- 1972 First International and commercial Packet Switching Network, X.25 Red UNO
- 1990 The Internet is opened to the general public



1.2 Bits per second (bps)

- line bitrate and throughput

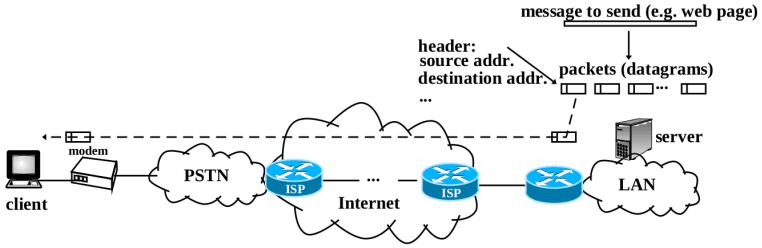


NRZ signal

- Prefixes:
  - k, kilo: 10^3
  - M, Mega: 10^6
  - G, Giga: 10^9
  - T, Tera: 10^{12}
  - P, Peta: 10^{15}

1.3 Packet switching URL

- **Virtual Circuit**, WAN, e.g. X.25, ATM.
- **Datagram**: Internet.



Datagram packet switching

1.4 Standardization Bodies

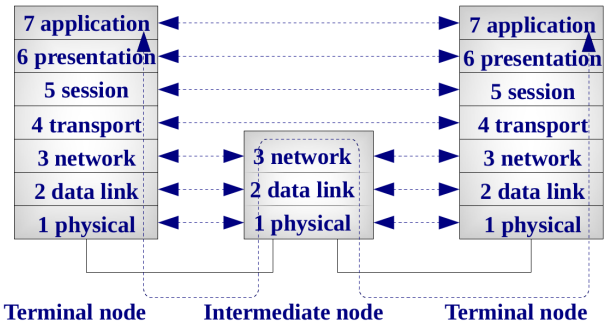
1. *Int. Telecommunication Union*, ITU
   - WAN standards. URL
2. *Int. Organization for Standardization*, ISO
   - Industrial standards. URL.
3. *Institute of Electrical and Electronics Engineers*, IEEE
   - LAN standards. URL.
4. *European Telecommunications Standards Institute*, ETSI
   - Mobile phone standards (GSM). URL.
5. *Telecommunications Industry Association*, TIA
   - Cabling standards. URL.
6. *World Wide Web Consortium*, W3C. URL

Internet:

1. *Internet Engineering Task Force*, IETF. URL.
   - Request For Comments, RFCs. URL

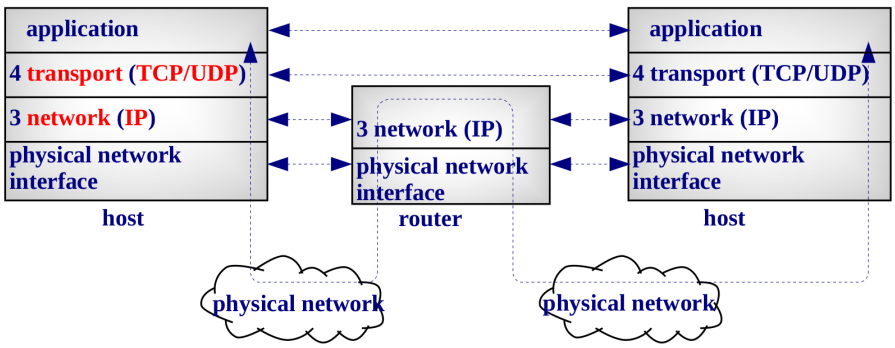
1.5 ISO OSI Reference Model URL

OSI: *Open Systems Interconnection*

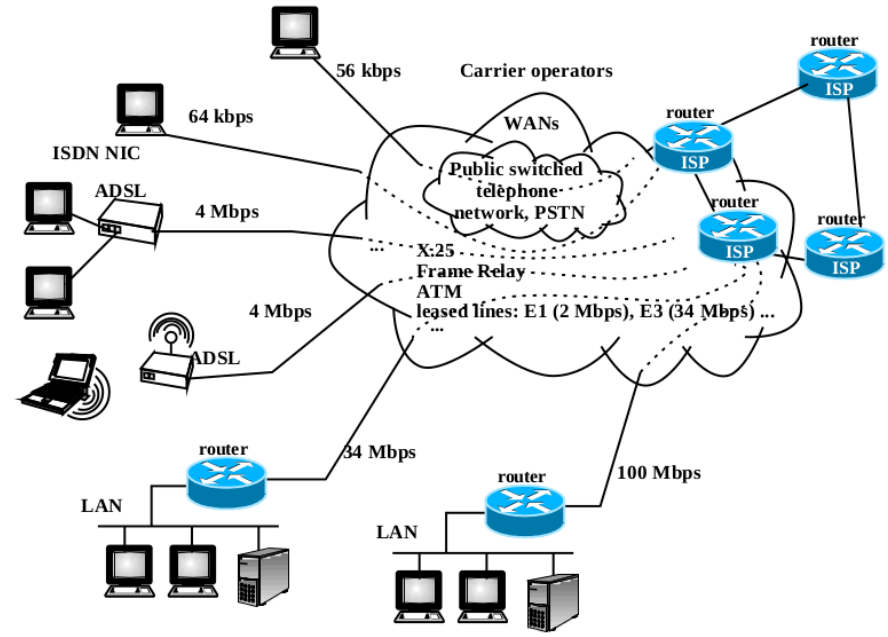


1.6 TCP/IP Architecture URL

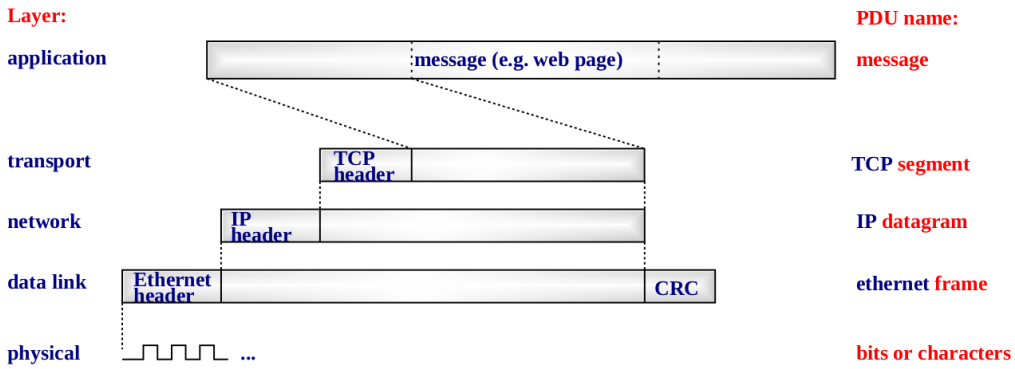
- No RFC specifies the TCP/IP model.



1.7 Internet Architecture URL



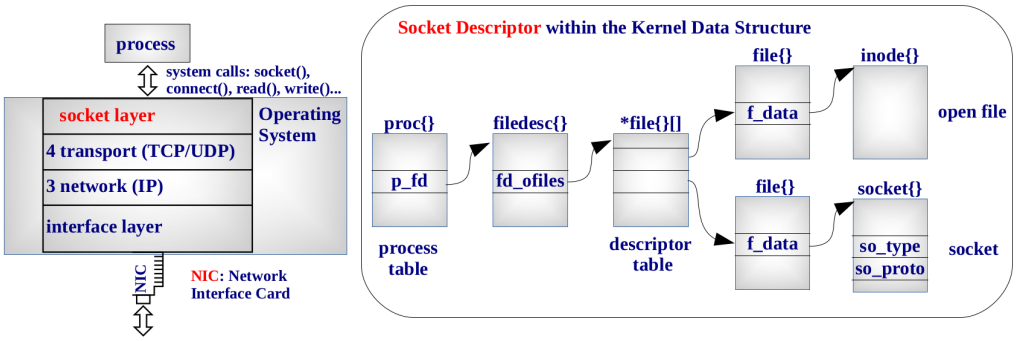
1.8 Encapsulation URL



Network sniffers (bash)

```
sudo tcpdump -ni wlan0 # command line sniffer
sudo wireshark         # graphical sniffer
```

1.9 TCP/IP Implementation URL



TCP and UDP sockets (bash)

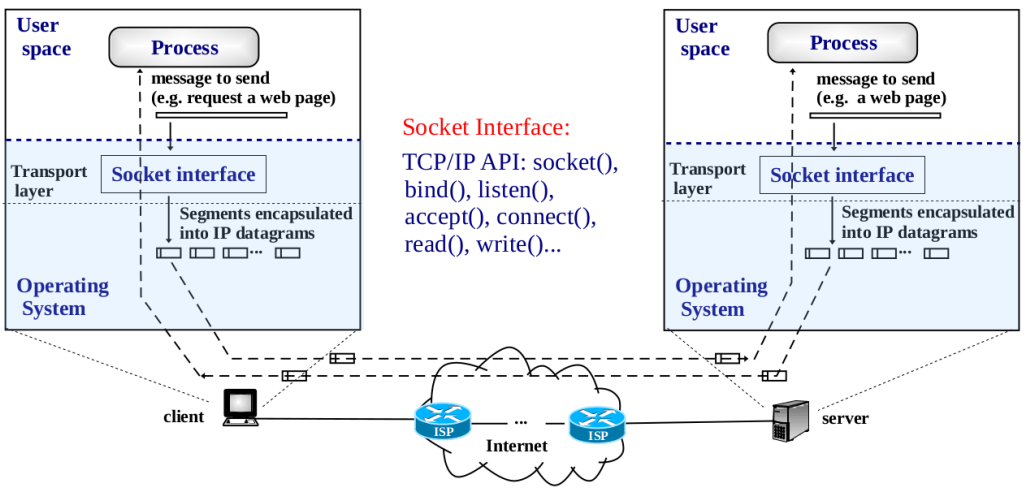
```
netstat -nt # list TCP sockets
netstat -nu # list UDP sockets
```

Sockets opened by a browser (bash)

```
netstat -nt
```

1.10 Client Server Paradigm URL

- The server "listens" a *well known port* (< 1024).
- The client connects with an *ephemeral port* (>=1024).

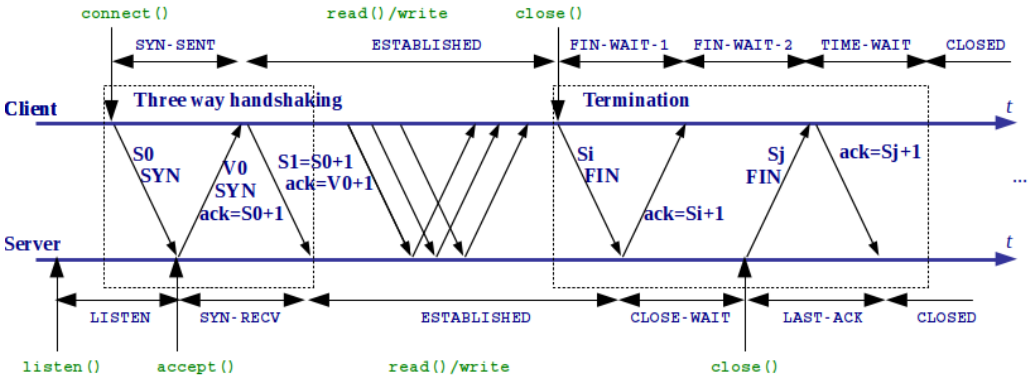


TCP and UDP servers (bash)

```
netstat -nat
netstat -nau
file /etc/services
```

1.11 Transport layer: UDP/TCP

- UDP *User Datagram Protocol*: Connectionless, no reliable.
- TCP *Transmission Control Protocol*: Connection oriented, reliable.



1.12 Practical examples

Minimal UDP sender (perl)

```perl
#!/usr/bin/perl -w
use IO::Socket;
use strict;
use Data::Dumper;

my $sock = IO::Socket::INET->new(
    Proto    => 'udp',
    PeerPort => 3555, # server port
    PeerAddr => '127.0.0.1',
) or die "Could not create socket: $!\n";

(my $message = sprintf "%-50s", "1") =~ tr/ /1/;
print localtime() . ": sending " . substr($message, 0, 10) . " x " . length($message) . "\n" ;
$sock->send($message) or die "Send error: $!\n";
```

Minimal TCP server (perl)

```perl
#!/usr/bin/perl -w
use IO::Socket::INET; use Term::ANSIColor;

print "Sart TCP server.\n" ;
my $s_sock = IO::Socket::INET->new(
    LocalHost => '127.0.0.1',
    LocalPort => 5000,
    Proto     => 'tcp',
    Listen    => 5
) or die "Could not create socket!\n";

while(1) {
  my $c_sock = $s_sock->accept() ;
  printf colored("Accepted: ", 'green')."%s, %s\n",
    $c_sock->peerhost(), $c_sock->peerport() ;
  while(<$c_sock>) {
    print "Received from Client : $_";
  }
  printf colored("Closed: ", 'red'),"%s, %s\n",
    $c_sock->peerhost(), $c_sock->peerport() ;
}
```

Minimal TCP client (perl)

```perl
#!/usr/bin/perl -w
use IO::Socket::INET;

print "Sart TCP client.\n" ;
my $socket = IO::Socket::INET->new(
    PeerHost => '127.0.0.1',
    PeerPort  => 5000,
    Proto     => 'tcp'
) or die "Could not create socket: $!\n";

print "TCP Connected.\n" ;
while (<>) {
  print "sending $_" ;
  $socket->send($_);
}
```