

Computer Networks - *Xarxes de Computadors*

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Slides: <http://studies.ac.upc.edu/FIB/XC>

Outline

- **Course Syllabus**
- Unit 1: Introduction
- Unit 2. IP Networks
- Unit 3. Point to point protocols -TCP
- Unit 4. LANs
- Unit 5. Data transmission

Course Syllabus

Course Organization

- 2 x 2h lectures/week: theoretical + problems
 - Print the problem collection from the web
 - Try to do the problems beforehand
 - Solve control and final exams!
 - Find textbooks and related links at the web page. I will put a non printable version of my book in the *raco*.
- 1 x 2h laboratory/week
 - Buy documentation in CPET. Study and prepare sessions before hand.
 - 2 laboratory sessions are devoted to problems: you can participate and obtain 0,2 points over the final exam.

web page: <http://studies.ac.upc.edu/FIB/XC>

Course Syllabus

Evaluation:

$$F = 0.20 * L + 0.80 * \max\{E; (0.15 * C + 0.85 * E)\}$$

Where:

- F = Final mark
- L = Laboratory: 25% Mini-assessments of 15 min. at each session (except the first), and 75% a final laboratory exam.
- E = Final exam
- C = Control, 1 hour duration (week 8~9)

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Unit 1: Introduction

Outline

- **Brief history of Computer Networks and Internet**
- Introduction to Internet
- Standardization Organizations and OSI Reference Model
- Client-Server Paradigm

Unit 1: Introduction

Brief history of Computer Networks

- 1830: Telegraph
- 1866: First transatlantic telegraph cable
- 1875: Alexander Graham Bell invented the telephone
- 1951: First commercial computer
- 1960: Concept of Packet Switching.
- 1960s: ARPANET project, origins of the Internet.
- 1972: First International and commercial Packet Switching Network, X.25.
- 1990s: The Internet is opened to the general public.



Pavel Shilling Telegraph, 1832.



New York Telephone Cabling, 1888



Major Telegraph Lines, 1891.



Telephone Central Office in London, 1926



UNIVAC: First commercial computer, 1951



Today's Networking Equipment.

Unit 1: Introduction

Brief History of the Internet

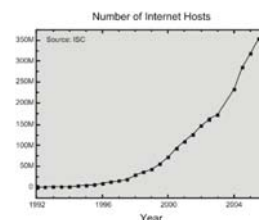
- 1966: Defense Advanced Research Projects Agency (DARPA). ARPANET project.
- ARPANET connected Universities and military centers. Military portion separated in 1983.
- 1970s: End-to-end reliability was moved to hosts, developing TCP/IP. TCP/IP was ported to UNIX Berkeley distribution, BSD.
- 1990s: The Internet is opened to commerce and the general public by the Internet Service Providers, ISP.



<http://www.geant2.net>



<http://www.rediris.es>



Unit 1: Introduction

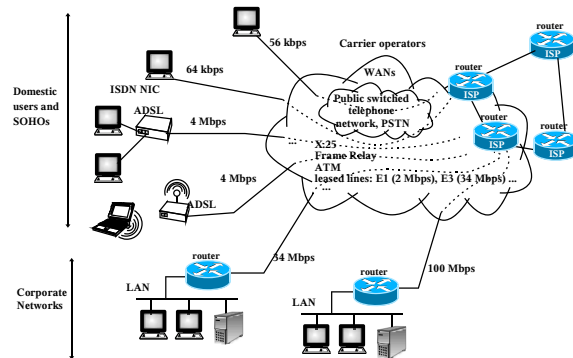
Outline

- Brief history of Computer Networks and Internet
- **Introduction to the Internet**
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- Client-Server Paradigm

Unit 1: Introduction

Organization of the Internet and Terminology

- Host
- Access Network
- LAN
- WAN
- Telephone company, telco, or carrier.
- Router
- Line Bitrate
- Bits per second, bps.



Unit 1: Introduction

Bitrate

t_b is the transmission time of 1 bit.

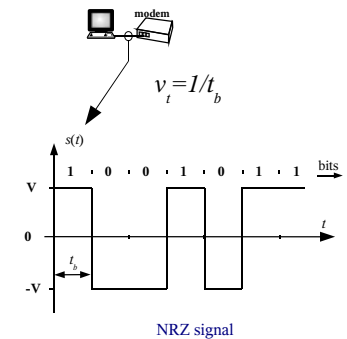
• $v_t = 1/t_b$ is the bitrate in bits per second (bps)

• typical SI-Prefixes used for bitrates:

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

• Examples:

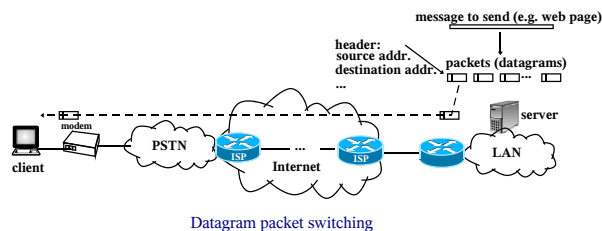
- PSTN modem: 56 kbps
- ADSL: 4 Mbps
- LAN Ethernet: 10 Mbps, 100 Mbps, 1Gbps, 10 Gbps.
- carrier lines E3: 34 Mbps, OC-192: 9,9 Gbps, ...



Unit 1: Introduction

Types of Switching

- Circuit switching, e.g. PSTN
- Packet switching:
 - Virtual Circuit, e.g. X.25, ATM.
 - Datagram: Internet.



Unit 1: Introduction

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Unit 1: Introduction

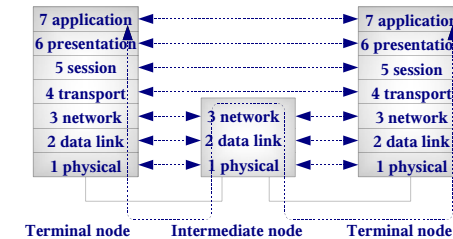
Standardization Bodies

- International Telecommunication Union, ITU: WAN standards. <http://www.itu.org/>.
- International Organization for Standardization, ISO: Industrial standards. <http://www.iso.org/>.
- Institute of Electrical and Electronics Engineers, IEEE: LAN standards. <http://www.ieee.org/>.
- European Telecommunications Standards Institute, ETSI: Mobile phone standards (GSM). <http://www.etsi.org/>.
- Electronic Industries Alliance, EIA: Cabling standards. <http://www.eia.org/>.
- Internet Engineering Task Force, IETF: Internet standards. <http://www.ietf.org>. Standardization proposals are done through *Request For Comments*, RFCs. They are mirrored around the world, e.g. <http://www.rfc-editor.org>

Unit 1: Introduction

ISO Open System Interconnection (OSI) Reference Model

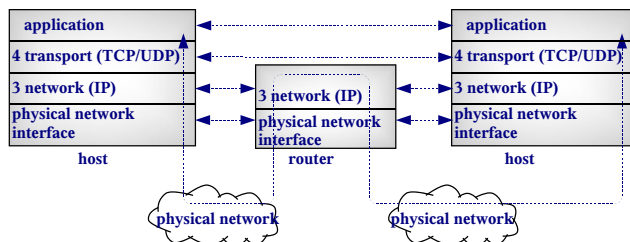
- Layers or Levels*: Physical or Layer 1 (L1), ...
- Peer layers communicate using a *protocol*.
- Protocols from different layers are independent.
- Layer *i* offers services (e.g. send a datagram to a given address) to layer *i* + 1: *Service Access Points* (SAP).
- Peer layers exchange *Protocol Data Unit* (PDU), which consists of a *header* and *payload*.



Unit 1: Introduction

TCP/IP Architecture

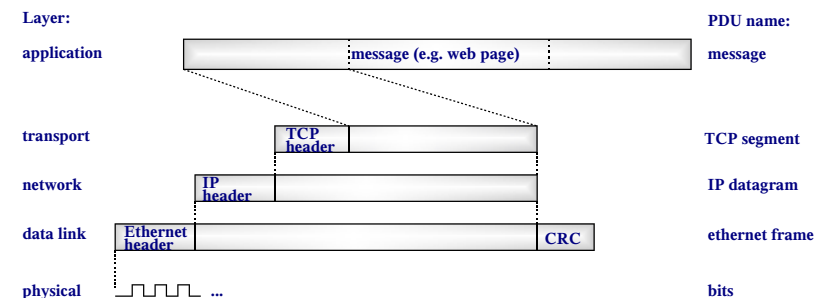
- No RFC specifies the TCP/IP model.
- Networking literature usually identifies the layer model:



Unit 1: Introduction

Encapsulation

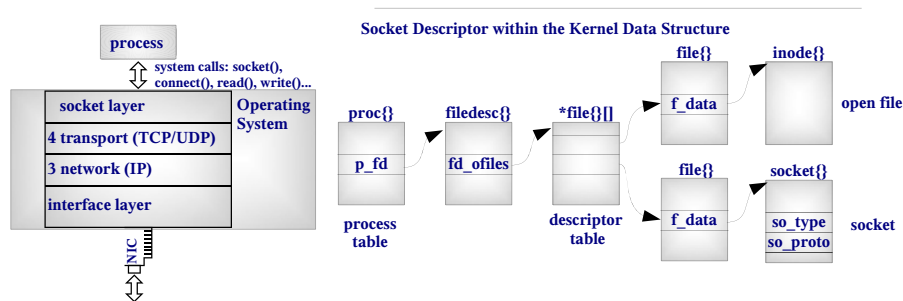
- Each layer adds/remove the PDU header.



Unit 1: Introduction

TCP/IP Implementation

- TCP/IP Networking code is part of the Operating System kernel.
- *Socket interface*: Is the Unix networking interface for the processes. It was first implemented in Berkeley Software Distribution, BSD.
- The *socket system call* creates a *socket descriptor* used to store all information associated with a network connection, similarly as an inode descriptor for a file.



Unit 1: Introduction

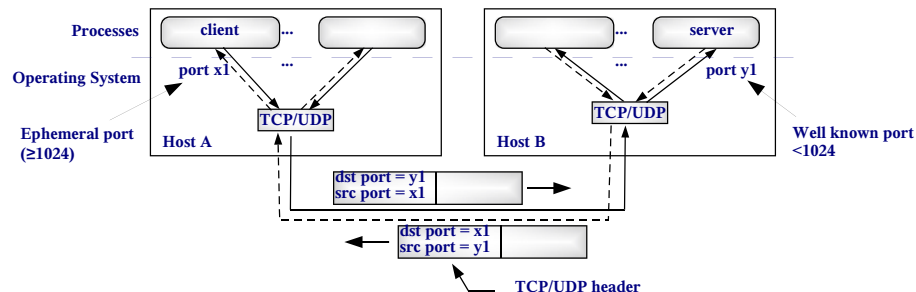
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Unit 1: Introduction

Client Server Paradigm

- How connection is established among processes?
- The client always initiates the connection towards a known IP address, in the IP header, and a *well known port* (< 1024), in the TCP/UDP header.
- Well known ports are standardized by IANA in RFC-1700. In a unix machine can be found in /etc/services.
- The server is a *daemon* waiting for client requests.



Unit 1: Introduction

Client Server Paradigm – UNIX /etc/services File

- Enables server and client programs to convert service names to well known ports.

```
linux> more /etc/services
# Network services, Internet style
# Note that it is presently the policy of IANA to assign a single well-known
# port number for both TCP and UDP; hence, most entries here have two entries
# even if the protocol doesn't support UDP operations.
# This list could be found on:
#   http://www.iana.org/assignments/port-numbers
# *****
# WELL KNOWN PORT NUMBERS
# The Well Known Ports are assigned by the IANA and on most systems can
# only be used by system (or root) processes or by programs executed by
# privileged users.
#
# Keyword  Decimal  Description
# -----  -
echo      7/tcp    Echo
echo      7/udp    Echo
discard   9/tcp    # Discard
discard   9/udp    # Discard
daytime   13/tcp   # Daytime (RFC 867)
daytime   13/udp   # Daytime (RFC 867)
chargen   19/tcp   # Character Generator
chargen   19/udp   # Character Generator
ftp-data  20/tcp   # File Transfer [Default Data]
ftp-data  20/udp   # File Transfer [Default Data]
ftp       21/tcp   # File Transfer [Control]
ssh       22/tcp   # SSH Remote Login Protocol
ssh       22/udp   # SSH Remote Login Protocol
telnet    23/tcp   # Telnet
telnet    23/udp   # Telnet
...
```