Computer Networks - *Xarxes de Computadors*

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Slides: http://studies.ac.upc.edu/FIB/grau/XC

Outline

- **Course Syllabus**
- Unit 1: Introduction
- Unit 2. Network applications
- Unit 3. IP Networks
- Unit 4. TCP
- Unit 5. LANs

Course Syllabus

Course Organization

- 2+1h lectures/week: theoretical + problems
  - Print the problems collection from the racó
  - Try to do the problems beforehand
  - Find textbooks and related links at the web page.
- Laboratory sessions of 2h on selected weeks
  - Buy laboratory documentation in CPET. Study and prepare sessions before hand.

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

Course Syllabus

Evaluation:

NF = 0.20 * NL + 0.10 * max{EF, C1} + 0.10 * max{EF, C2} + 0.60 * EF

Where:

- NF = Final mark

- NL = Laboratory: 25% average of lab sessions, and 75% a final laboratory exam.

- EF = Final exam

- C1, C2 = Control: 2 assessments of 1,5 hours duration.

- Traversal Competence: Autonomous learning.
  - Home labs evaluated with a specific final lab exam.

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Unit 1: Introduction

Outline

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

Unit 1: Introduction

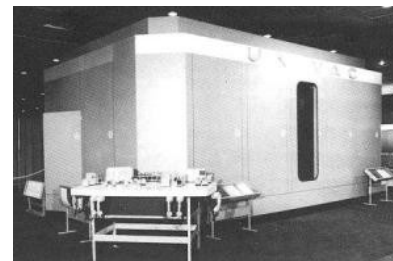## Brief history of Computer Networks

- 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.
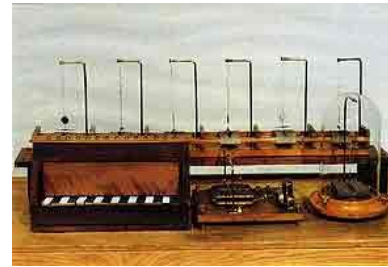
Pavel Shilling Telegraph, 1832.

New York Telephone Cabling, 1888

Major Telegraph Lines, 1891.

Telephone Central Office in London, 1926

UNIVAC: First commercial computer, 1951

Source: wikipedia

Today's Networking Equipment.

Unit 1: Introduction
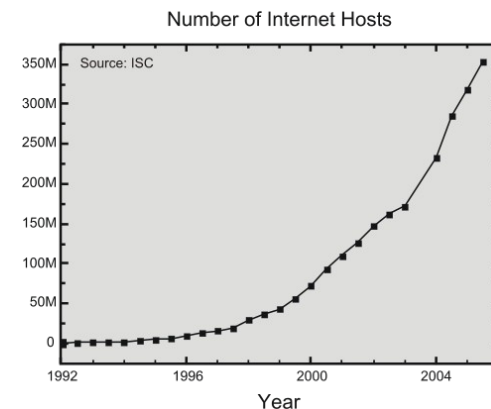
Brief History of the Internet

- 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.
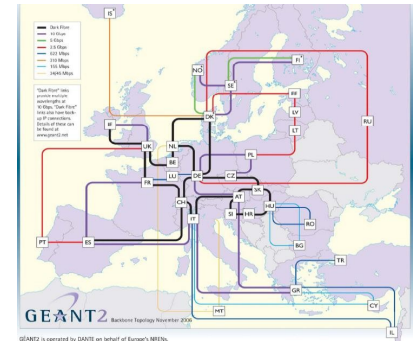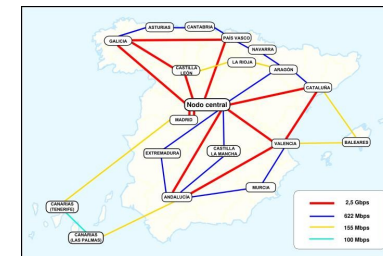
http://www.geant2.net

http://www.rediris.es

Number of Internet Hosts
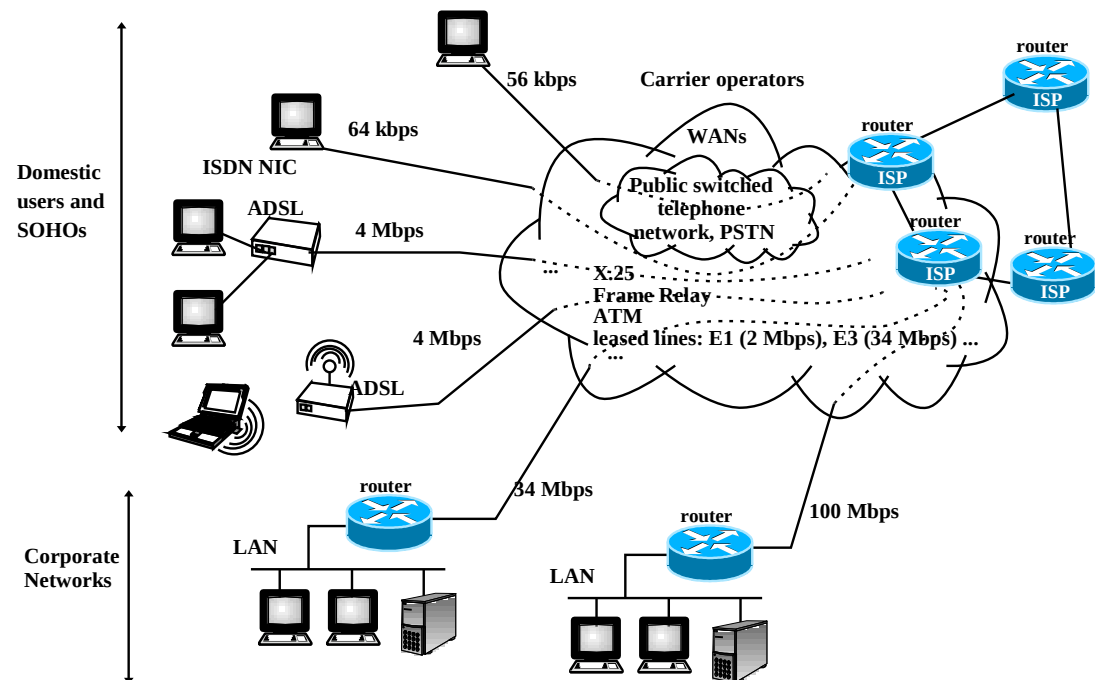
Unit 1: Introduction

Outline

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

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
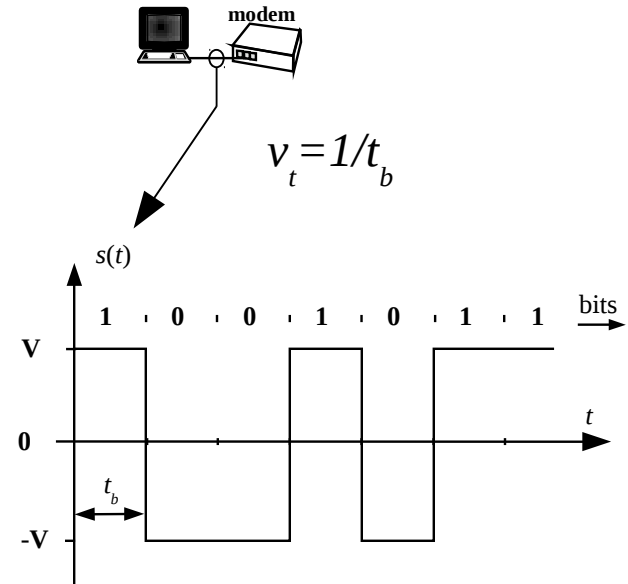
Bitrate

t_b is the transmission time of 1 bit.

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

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

- Examples:
    - Public Switched Telephone Network (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 Gpbs, ...

modem

$$v_t = 1/t_b$$

$s(t)$

| 1 | 0 | 0 | 1 | 0 | 1 | 1 | bits |

V

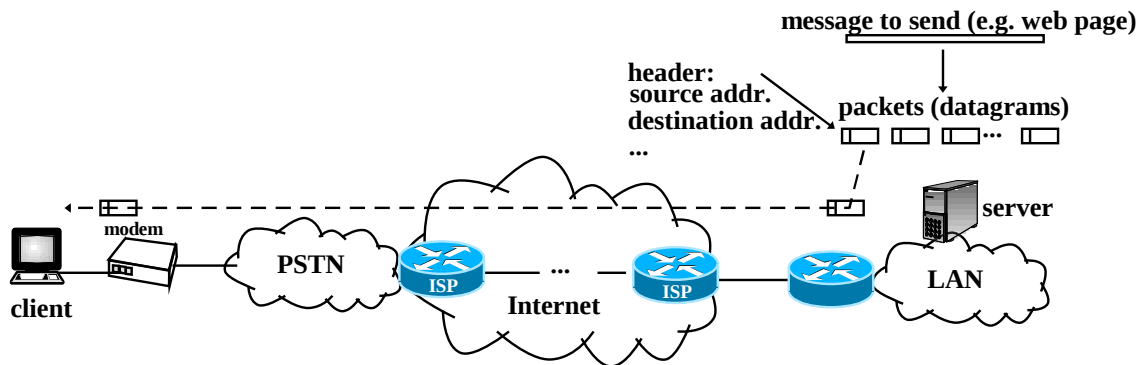**0**

t_b

-V

t

NRZ signal

Unit 1: Introduction

Types of Switching

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

Datagram packet switching

Unit 1: Introduction

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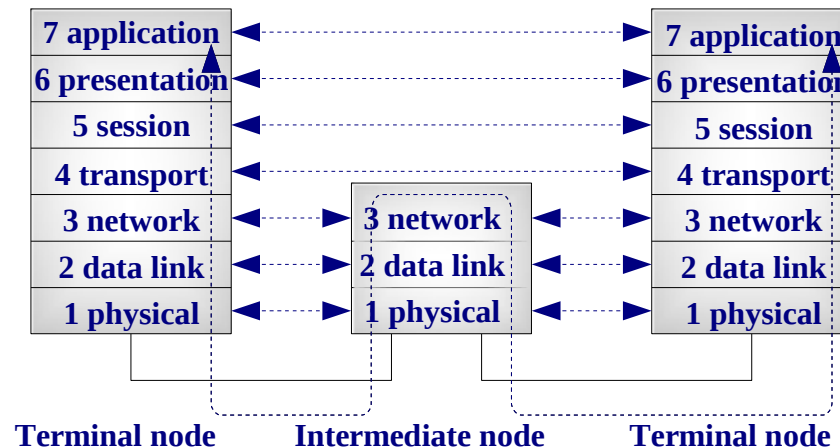
Unit 1: Introduction

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

- World Wide Web Consortium (W3C). http://www.w3.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*.

7 application		7 application
6 presentation		6 presentation
5 session		5 session
4 transport		4 transport
3 network	3 network	3 network
2 data link	2 data link	2 data link
1 physical	1 physical	1 physical

Terminal node   Intermediate node   Terminal node

Unit 1: Introduction

TCP/IP Architecture

- No RFC specifies the TCP/IP model.
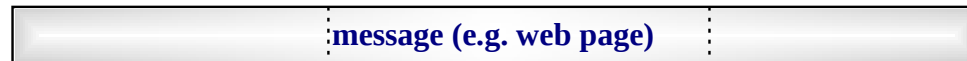- Networking literature usually identifies the layer model:
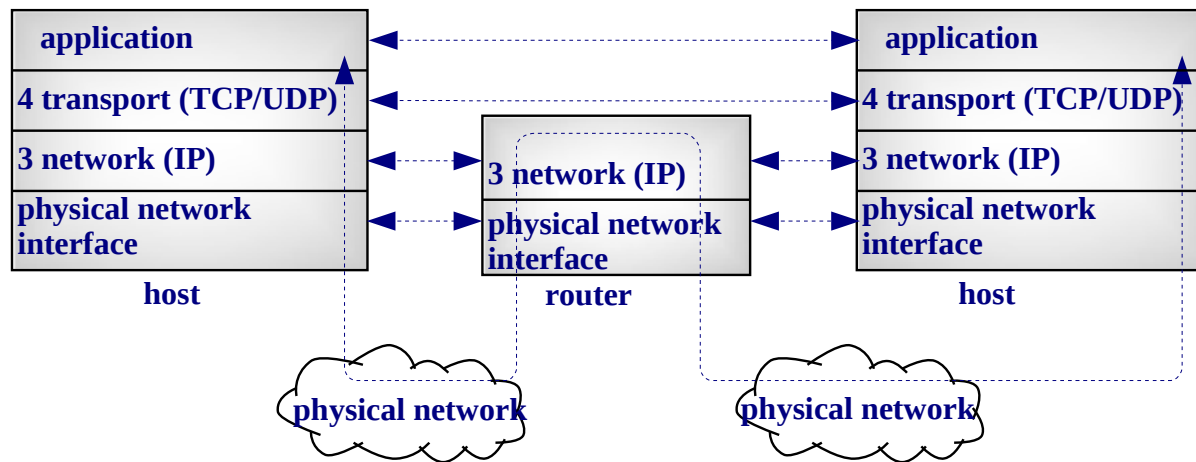
Unit 1: Introduction

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.