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.

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Evaluation:

\[ F = 0.20 \times L + 0.80 \times \max\{E; (0.15 \times C + 0.85 \times E)\} \]

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

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.
- 1990s: The Internet is opened to the general public.

Brief History of the Internet
- 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.

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

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

Bitrate

$t_b$ is the transmission time of 1 bit.

$\frac{1}{t_b}$ 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 Gpbs, ...

Types of Switching

- Circuit switching, e.g. PSTN
- Packet switching:
  - Virtual Circuit, e.g. X.25, ATM.
  - Datagram: Internet.
Unit 1: Introduction

Standardization Bodies

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.

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

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.

```
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
# discard  9/tcp  Discard
# daytime  13/tcp  Daytime (RFC 867)
# chargen  19/tcp  Character Generator
# ftp-data  20/tcp  File Transfer [Default Data]
# ftp  21/tcp  File Transfer [Control]
# ssh  22/tcp  SSH Remote Login Protocol
# telnet  23/tcp  Telnet
# ...  ...
```

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.