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 collection problems (raco FIB)
  - Try to do the problems beforehand
  - Solve assessments and final exams! (web)
  - Find textbooks and related links at the web page. Not necessary to follow the course.

- 1 x 2h laboratory/week
  - Buy the manual. Study and prepare sessions beforehand.
  - 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:

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

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
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.
- 1990s: The Internet is opened to the general public.
Unit 1: Introduction

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.
Unit 1: Introduction

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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 Gbps, ...
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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Standardization Bodies

- 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*.

![Diagram of OSI Reference Model]

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:
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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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 (*Assigned Numbers*). In a unix machine can be found in /etc/services.
- The server is a *daemon* waiting for client requests.

![Diagram of Client Server Paradigm]

- **Processes**
  - Host A
  - Host B

- **Socket interface**
  - Ephemeral port (≥1024)
  - Well known port <1024

- **TCP/UDP**
  - Host A: dst port = y1, src port = x1
  - Host B: dst port = x1, src port = y1

- **Operating System**
  - Client
  - Server

- **Socket**
  - Interface

- **TCP/UDP header**
Unit 1: Introduction

Client Server Paradigm – UNIX /etc/services File

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

```
linux> cat /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
```