Instituto Superior Técnico – 2020-2021

Telecomunicações e Redes de Computadores

Telecommunications and Computer Networks

Mestrado em Engenharia e Gestão Industrial

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TÉCNICO LISBOA

Main themes:

- Telecommunications based on electrical signals.
- Information Theory.
- Computer networks

Telecommunications based on electrical signals.

From the first telegraph in 1837 to the global network that keeps people working together, electrical signals are perhaps the most elementary single factor on which the society depends.

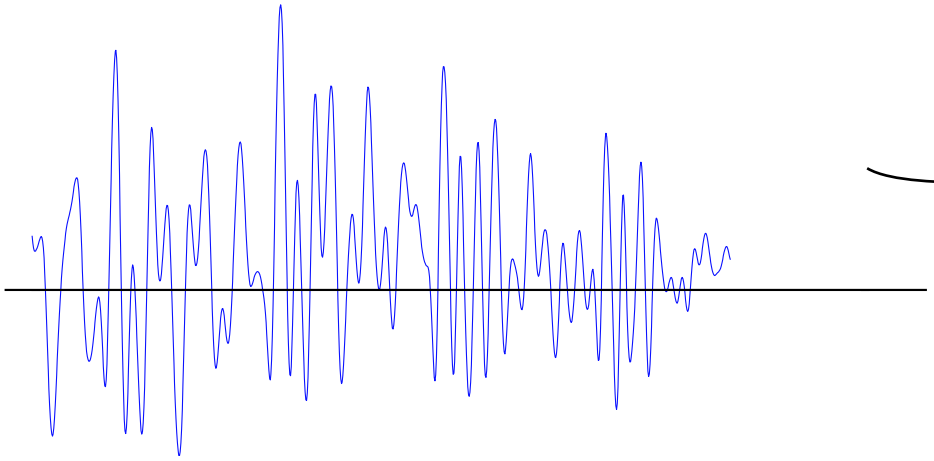
The ongoing pandemic crisis is just an example of the importance of Telecommunications.

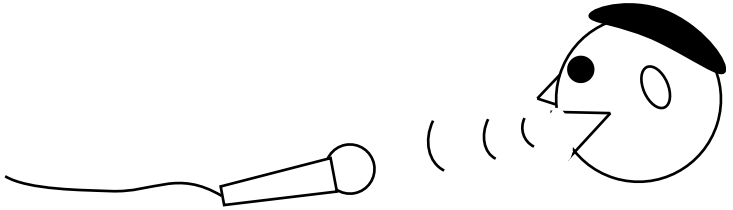
Telecommunications based on electrical signals.

- Basic communication systems and how they have grown in complexity and capabilities.
- The motivation for systems and signal analysis.
- Basic mathematical tools for signal and system analysis.
- Analog signals and carrier modulation.
- Digital signals and digital carrier modulation.
- Analog to digital conversion - PCM

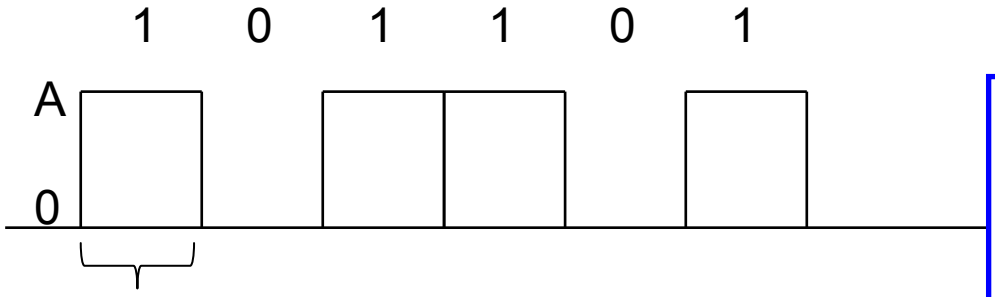
Telecommunications based on electrical signals.

Analog signals versus digital signals





Voice signal. Amplitude is a real (continuous) variable



T_b – Duration of the amplitude that represents a bit

Digital signal example. Computers communicate using binary digits or **bits**. Two possible amplitude values represent “0“ and “1”.

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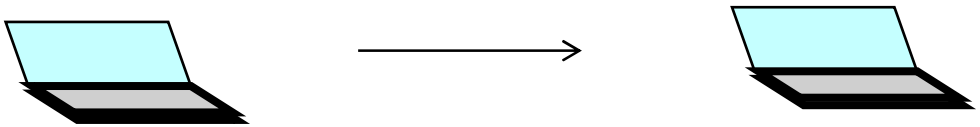
Information Theory.

How to compress without loss the output of a digital source of information?

How to correct the errors that may occur in the communication between two computers?



Information theory establishes the principles to address both problems - - - - - - - - - -

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Information Theory.

- Discrete memoryless sources and Information Gain
- Entropy.
- Source coding. Huffman algorithm and Lempel-Ziv algorithm.
- Channel coding. Error detection and correction.

Source coding achieves compression by eliminating redundancy.

However we know that redundancy found in natural languages helps the listener/reader to correct errors.

Channel coding adds redundancy in a planned way in order to help the receiver to correct transmission errors.

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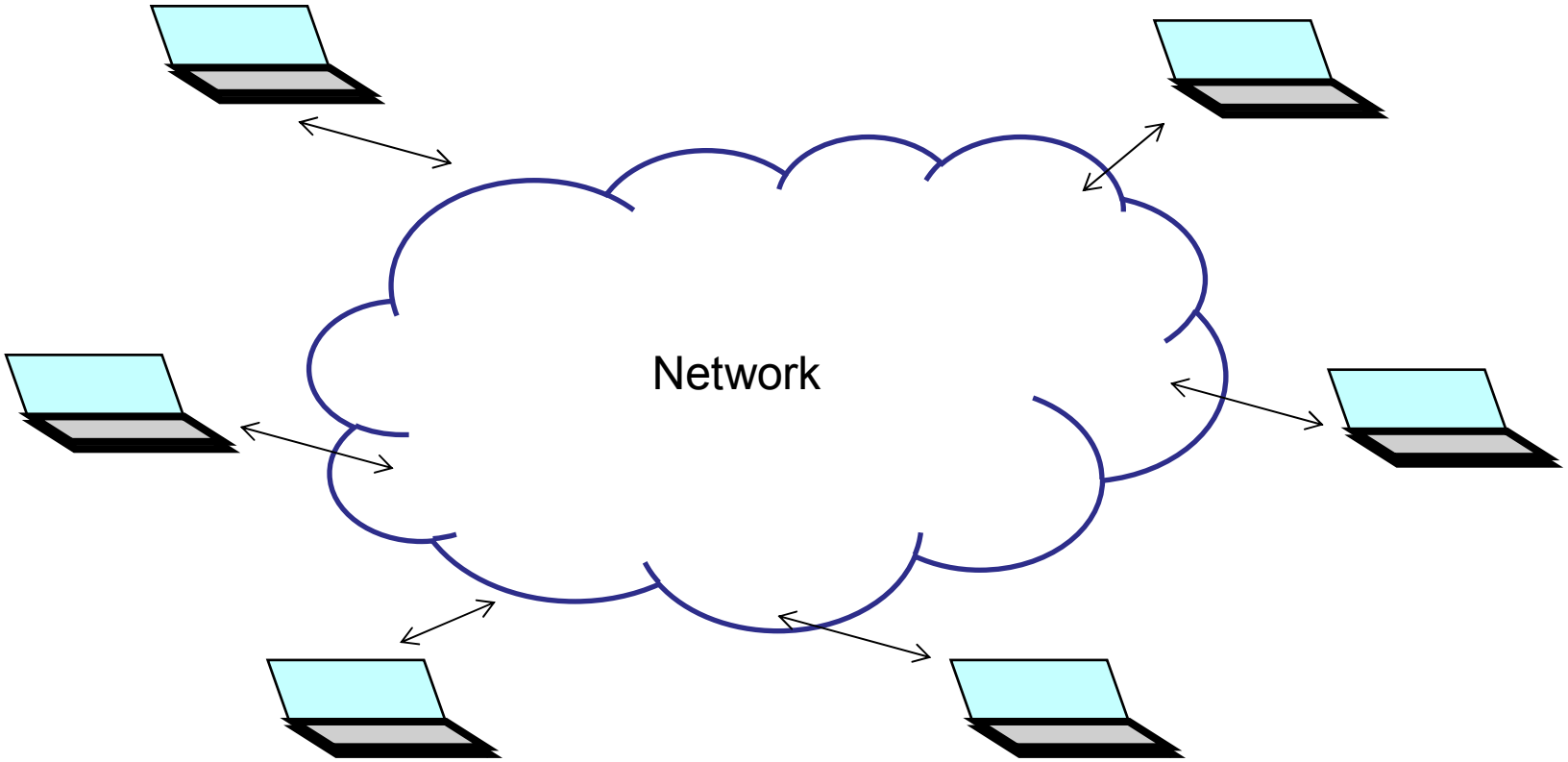
Computer Networks.



How to get millions of computers communicating with each other within a huge network, guaranteeing reliability, speed, privacy and safety ? - - - - - - - -

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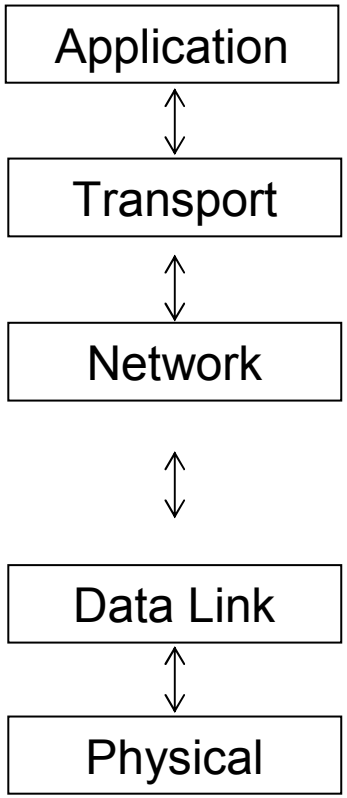
Computer Networks.

A layered top-down approach to computer communication



- Application – Programs (like web browsers) working only at the end-points.
- Transport – Provides packetization of messages and reliability at the end-points
- Network – Provides adequate packet routing through the network – Works both in routers and end-points.
- Data link – Carries data from one router to the next one.
- Physical – Communicates between nodes using electrical signals

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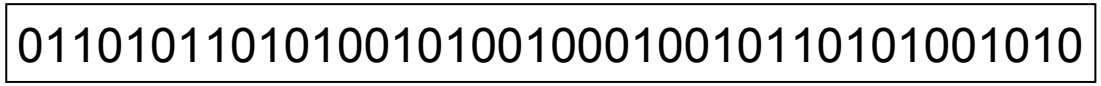
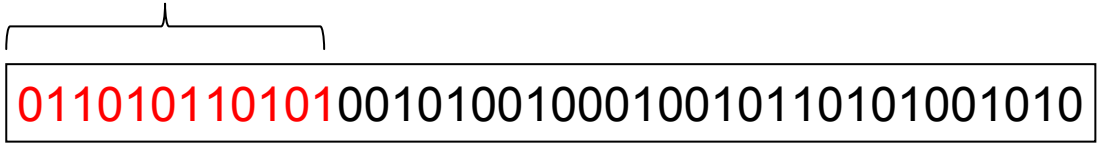
Computer Networks

Computers in the network communicate using units called **packets**.

A packet is a sequence of bits:



A section in the packet – the header – carries information with a special meaning to the different devices in the network.



Each layer in the model defines a packet structure encapsulating the packet format defined in the layer above.

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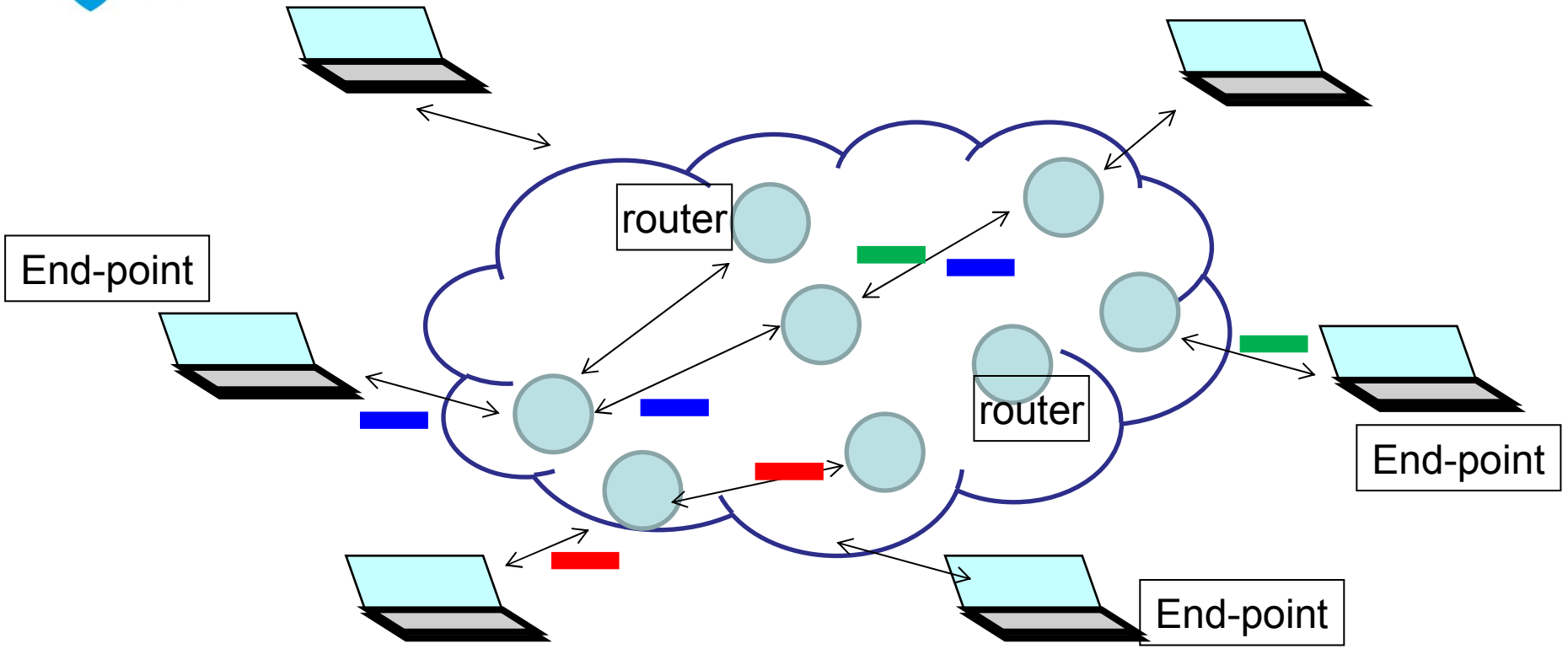
Computer Networks.



The Internet carries millions of packets of information, routing them from node to node until they reach their final destination. Each packet carries the destination address which is unique in the global network. Packets going from source to destination may follow different paths inside the global network. Ordering at destination may be required.

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Course materials.

- Lecture Slides in English. (with remote lessons guide in English)
- Sets of problems in English.
- Course texts in Portuguese.
- Tutorial in English.

- Books:
  - Carlson – Communication Systems
  - Kurose – Computer Networking – A top-down approach

- Evaluation: Two Tests/Exams (80%) and a Research Work (20%).
    - Final grade improvement is possible at exams.