Graphic simulator of TCP communications

User guide

Last revision: August 2020

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1. The application

This web application allows you to simulate, through parameters that the user can choose, a TCP communication between a client and a server, showing a communication diagram as a result. In section 2. TCP you can learn briefly more about this protocol.

For a proper functioning of the application it is recommended to use Google Chrome or Chromium-based browsers, such as Vivaldi, Microsoft Edge or Opera.

1.1. Considerations

The following is taken into account for the simulation:

- The propagation time will be 'half a tick'.
- The data length of SYN, SYN ACK, ACK, FIN will be 0 bytes.
- Communications will be between two entities, 'client' (which starts the communication and sends data) and 'server' (which responds with more data).

1.2. Parameters that can be entered by the user

The parameters that the user can enter are the following (* mandatory):

- **IP (Internet Protocol)*:** Identifier of the network interface of a device. IPv4 (32 bits) will be used, with format [0-255].
- **MSS (Maximum Segment Size)*:** Maximum size, in bytes, that a device can receive in a single segment without fragmentation.
- **Data*:** Size, in bytes, of the data to be sent.
- **SN (Sequencial Number)*:** Initial sequence number, exchanged at the beginning by both devices, are the identifiers of the data within the byte stream in order to identify and count the bytes of the application.
- **Lost segments:** Segments of data to be sent that do not reach the destination. In the simulation there will be no loss of packets in the connection and closing phase.
- **Reception window*:** Buffer, in bytes, which has the device in which to store received frames.
- **Timeout:** Maximum time, in ticks, to consider a package lost because it has not received its corresponding confirmation.

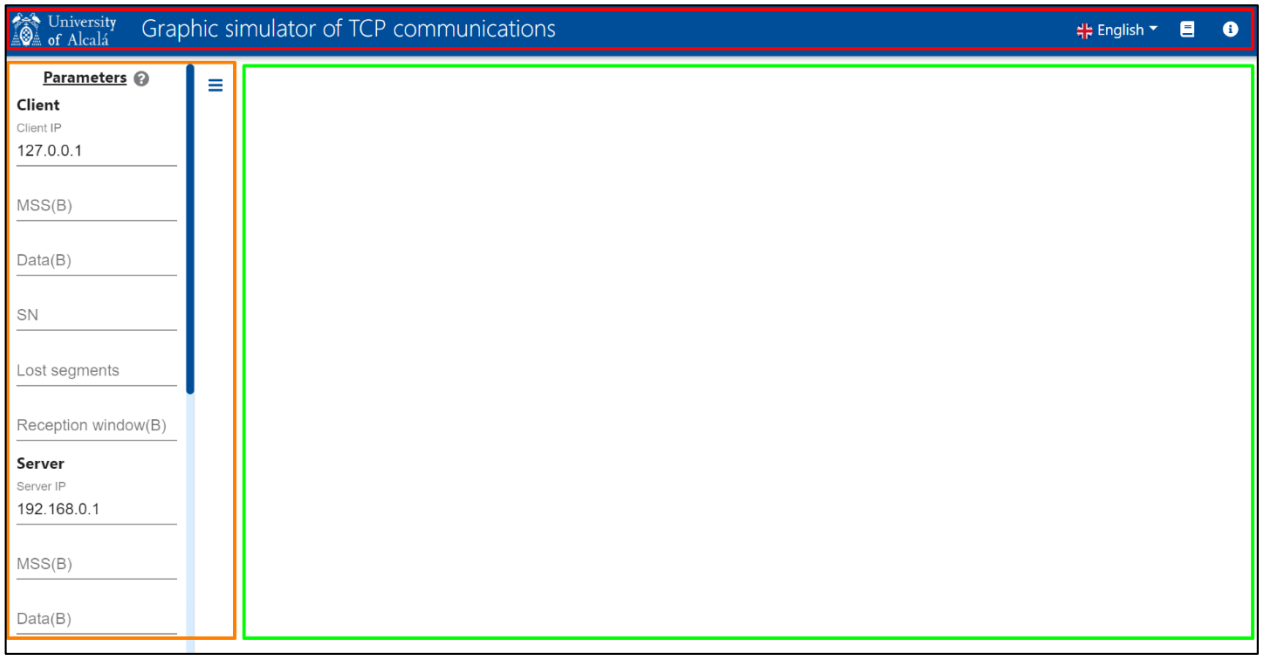
- **Congestion algorithm*:** Algorithm to be used when there is congestion in the network. In this case you can choose between TCP Tahoe and TCP Reno. These are still under development, so they will not be taken into account and will be simulated only with the Congestion Avoidance algorithm.

- **Threshold/Ssthresh*:** Congestion window limit from which to switch to Congestion Avoidance (CA) mode.

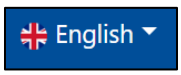
- **Connection closure*:** Which device will initiate the end of connection.

1.3. User interface

The interface has three clearly defined areas:



- **Top bar (in red):** Logo of the University of Alcalá that redirects to its website, application title (visible or hidden depending on screen size) and language selection buttons (currently available in Spanish and English), user guide (this document) and application information ("about").

  - Language selection: 

  - User guide: 
  - Application information: 

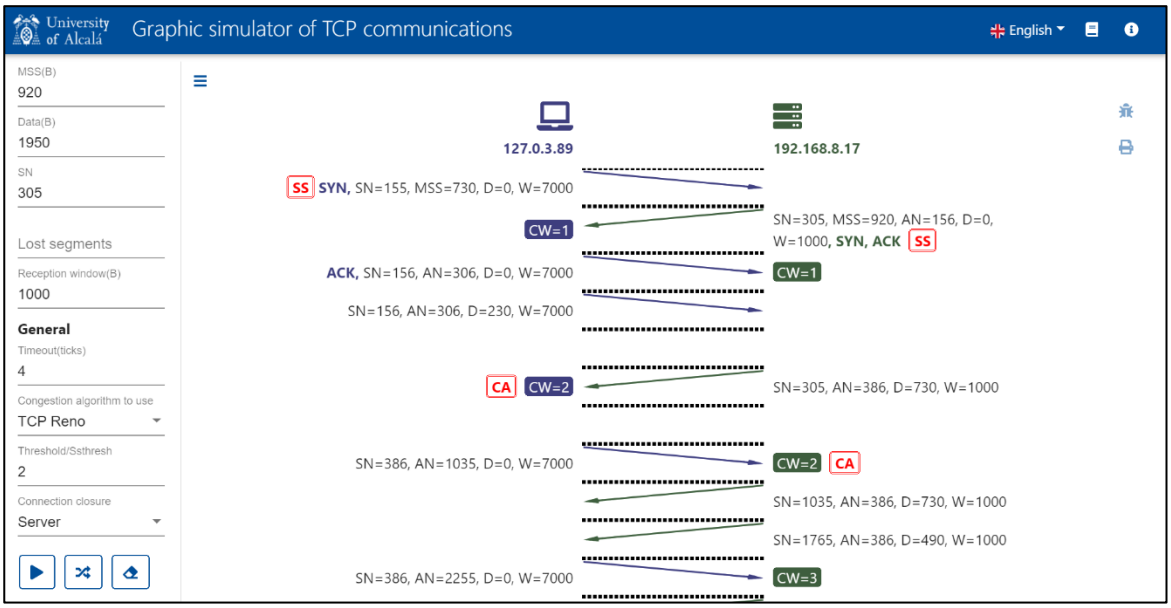
- **Parameter menu (in orange):** Next to the word "Parameters" there is a button with the considerations that have been taken into account for the simulation and information about the parameters to be entered, same as points 1.1. Considerations and 1.2. Parameters that can be entered by the user. At the end of the menu, scrolling with the sidebar, there are three buttons:

    - Simulate (): When pressed, if the parameters required to carry out the simulation have been filled in, the communications diagram is carried out and displayed. If any parameter is missing or wrong, alerts will appear indicating what is wrong or missing.
    - Fill in with random data (): Fill in the parameter form with random values, except for missing segments, for both client and server.
    - Clean form (): Clean form ( ): Returns the application to its initial state, cleaning the form and removing the simulation if one is displayed.

- **Simulation (in green):** This part shows the fins generated in case there were any when trying to run the simulation or, if everything is correct, the resulting communications diagram.

1.3.1. The simulation

If all parameters are correct, the simulation is calculated and the communications diagram is displayed next to two buttons on the right of the screen:

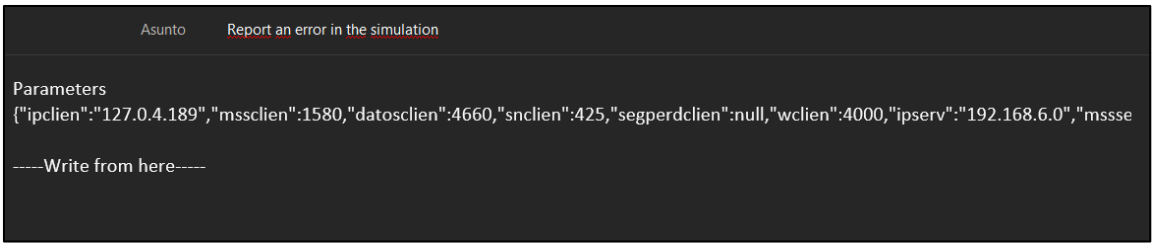


The data we can see in the simulation are the following:

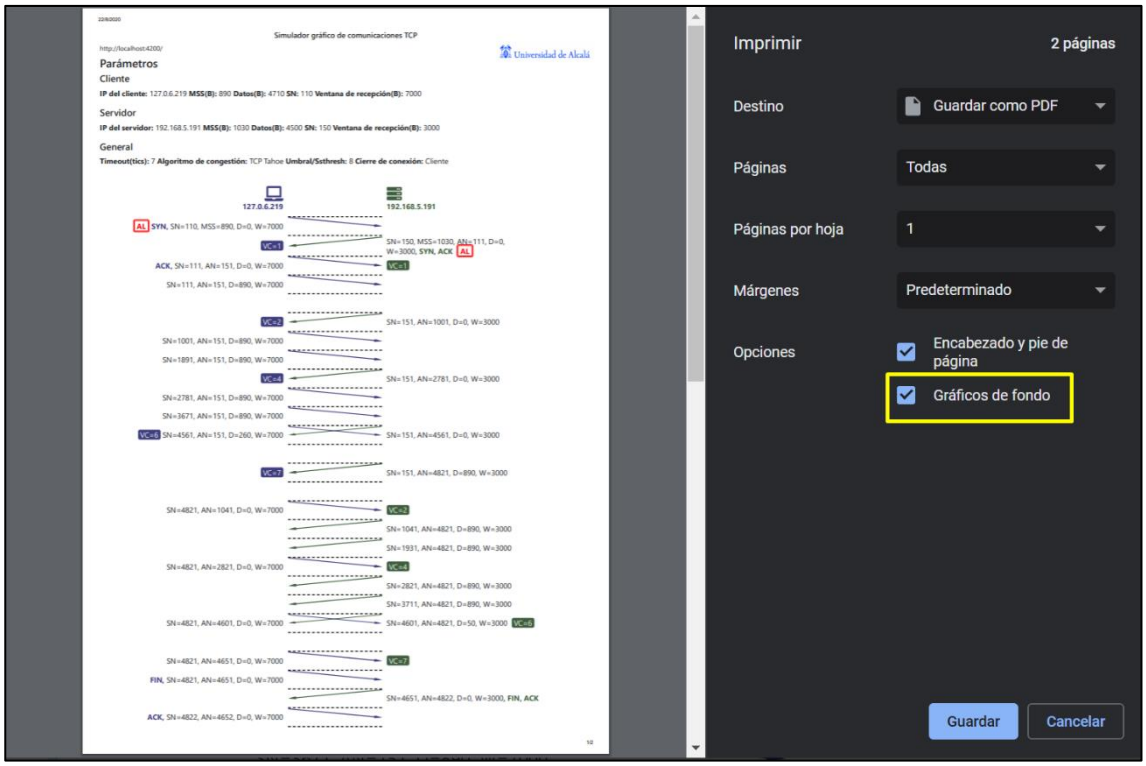
- **SS, CA and FR**: algorithms used, which are Slow Start (SS), Congestion Avoidance (CA) and Fast Recovery (FR).
- **SYN, ACK, FIN**: Sent segment, synchronisation (SYN), acknowledgement (ACK) and finalisation (FIN) flags.
- **SN**: Sequence number.
- **AN**: Recognition number.
- **MSS**: Maximum segment size.
- **D**: Data.
- **W**: Reception window
- **VC**: Congestion window.

Regarding the two buttons on the right:

- **Report an error in the simulation ( ):** It can also be used to contact the webmaster to suggest changes and/or improvements. By clicking on it, the user's predefined mail manager opens, with the application's administrator as the recipient and a predefined subject and body. It is important that you do not change anything above the line that says "Write from here". If you are going to report a bug or suggest any changes and/or improvements, thank you in advance.

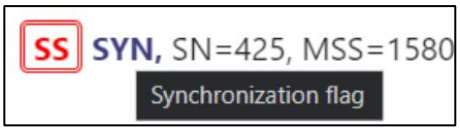


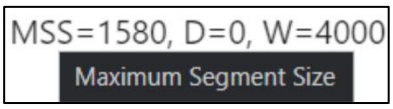
- **Print simulation ( ):** It opens the browser print window with the simulation and all the parameters entered by the user. It is recommended to activate the option "Background graphics", or similar, for a correct printing.

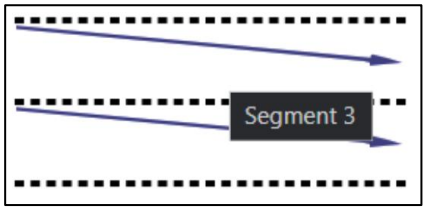


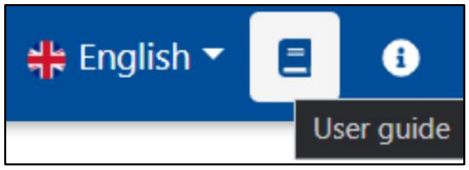
1.3.2. Information/Help

Every element in the application has a tooltip, so you only have to put the mouse pointer over it, from the buttons to the simulation segments. For example:





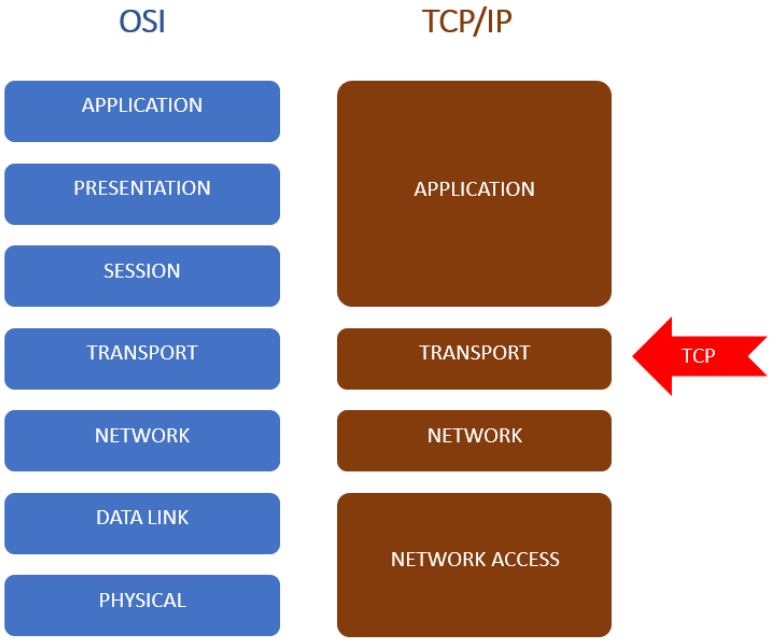




2. TCP

To learn about TCP, as well as how computer networks work, it is recommended that you read the book “Computer Networking: A Top-Down Approach” by James F. Kurose and Keith W. Ross, publisher in Pearson (ISBN: 9780134296159).

In summary, TCP is the acronym for Transmission Control Protocol and is one of the many protocols used in the network. It was created by the same people who created the model that takes its name, Vinton Cerf and Robert E. Kahn, in the mid-1970s and is located at the layer that communicates the network layer (IP, Internet Protocol) with the application layer, known as the transport layer.



Comparison between the OSI model and the TCP/IP model

In contrast to the UDP (User Datagram Protocol), TCP is connection-oriented, which means that both machines, sender and receiver, must recognize each other and establish a reliable communication, for which three steps are distinguished: establishment of connection, data transfer and connection closure. This involves a point-to-point connection, a single transmitter and receiver, with all the advantages and disadvantages that this entails.

An advantage could be the control over the packets, because if a packet is lost it is sent again, as well as the control of the congestion to avoid the network to be saturated. On the other hand, the disadvantage is that, being a connection-oriented protocol, data transfer is slower than in UDP, being less preferable its use in programs that require extreme immediacy or low latency.

TCP, to guarantee a correct operation, uses several congestion control algorithms. These are, if no segments are lost, Slow-start, applied in the connection phase and used until the congestion threshold is reached; and Congestion Avoidance, where, when the congestion threshold has been reached, the window increases in a linear way. In the case that the receiver receives a segment with a sequence number that it should not by the loss of a segment, the Fast Recovery algorithm is used. In addition, improving the above mentioned algorithms, a wide range of them are available, such as TCP Reno and TCP Tahoe, but they are not the only ones[1].

This document has been translated with the help of DeepL.

[1] Wikipedia. (2020). TCP congestion control, from Wikipedia. Website: https://en.wikipedia.org/wiki/TCP_congestion_control#Algorithms