1 Introduction to TCP connection management (Level 1)

1.1 Introduction

When an application process in a client host seeks a reliable data connection with a process in another host (say, server), the client-side TCP then proceeds to establish a TCP connection with the TCP at the server side. A TCP connection is a point-to-point, full-duplex logical connection with resources allocated only in the end hosts. The TCP connection between the client and the server is established in the following manner and is illustrated in Figure 1-1.

1. The TCP at the client side first sends a special TCP segment, called the SYN packet, to the TCP at the server side.
2. Upon receiving the SYN packet, the server allocates TCP buffer and variables to the connection. Also, the server sends a connection-granted segment, called the SYN-ACK packet, to the TCP at the client side.
3. Upon receiving the SYN-ACK segment, the client also allocates buffers and variables to the connection. The client then acknowledges the server's connection granted segment with an ACK of its own.

This connection establishment procedure is often referred to as the three-way handshake. The special TCP segments can be identified by the values in the fields SYN, ACK and FIN in the TCP header (see Figure 1-2). We also note that the TCP connection is uniquely identified by the source and destination port numbers (see Figure 1-2) exchanged during TCP connection establishment and the source and destination IP addresses.

Once a TCP connection is established, the application processes can send data to each other. The TCP connection can be terminated by either of the two processes. Suppose that the client application process seeks to terminate the connection. Then, the following handshake ensures that the TCP connection is torn down.

1. The TCP at the client side sends a special TCP segment, called the FIN packet, to the TCP at the server side.
2. When the server receives the FIN segment, it sends the client an acknowledgement segment in return and its own FIN segment to terminate the full-duplex connection.

3. Finally, the client acknowledges the FIN-ACK segment (from the server) with an ACK of its own. At this point, all the resources (i.e., buffers and variables) in the two hosts are deallocated.

During the life of a TCP connection, the TCP protocol running in each host makes transitions through various TCP states. Figure 1-1 illustrates the typical TCP states visited by the client and the server during connection establishment and data communication.

TCP is defined in RFCs 793, 1122, 7323 and, 2018. A recommended textbook reference for TCP is Chapter 3: Transport layer, of Computer Networking: A top-down approach, by James Kurose and Keith Ross (Pearson).

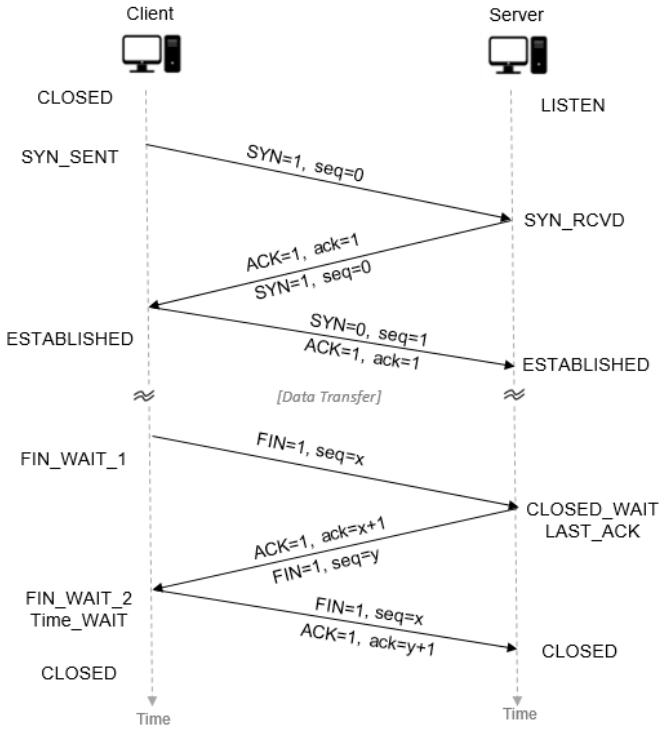

Figure 1-1: TCP connection establishment between a client and a server

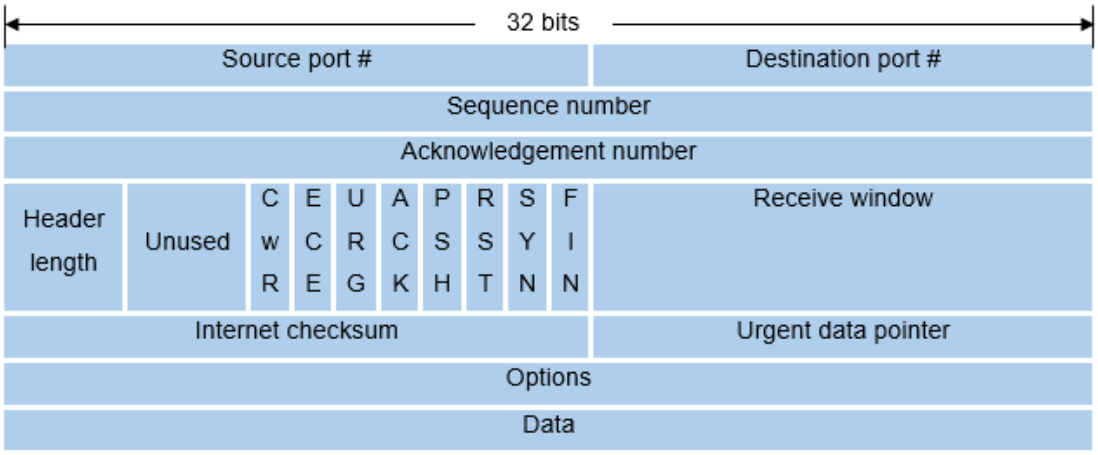

Figure 1-2: TCP Header

1.2 Network Setup

Open NetSim and click on **Experiments >Internetworks> TCP> Introduction to TCP connection management** then click on the tile in the middle panel to load the example as shown in below Figure 1-3.

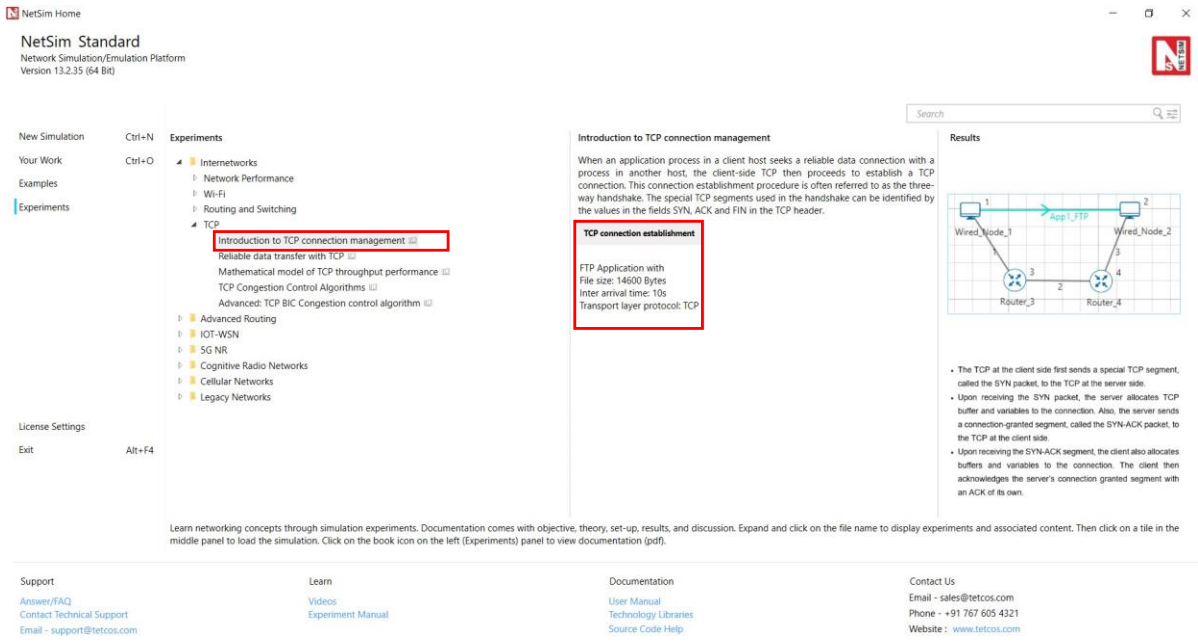

Figure 1-3: List of scenarios for the example of Introduction to TCP connection management

NetSim UI displays the configuration file corresponding to this experiment as shown below Figure 1-4.

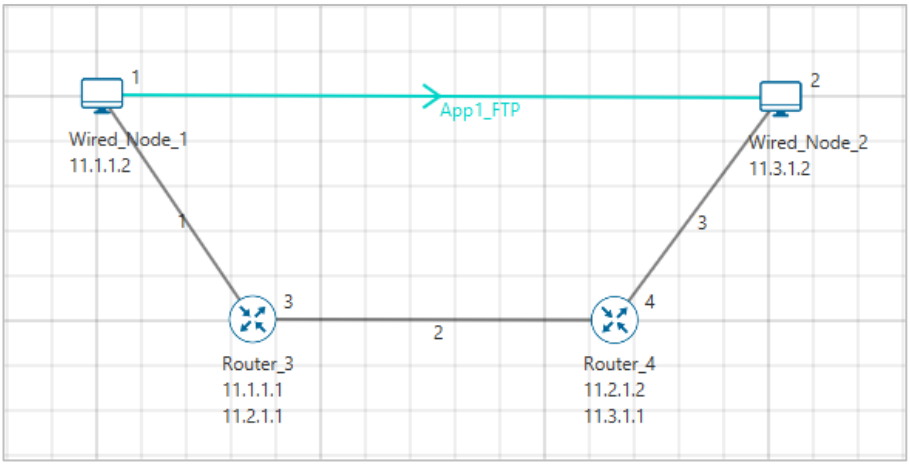

Figure 1-4: Network set up for studying the Introduction to TCP connection management

1.3 Procedure

The following set of procedures were done to generate this sample.

Step 1: A network scenario is designed in NetSim GUI comprising of 2 Wired Nodes and 2 Routers in the **"Internetworks"** Network Library.

Step 2: In the General Properties of Wired Node 1 i.e., Source, Wireshark Capture is set to Online. Transport Layer properties Congestion plot is set to true.

NOTE: Accept default properties for Routers as well as the Links.

Step 3: Right-click the link ID (of a wired link) and select Properties to access the link's properties. Set Max Uplink Speed and Max Downlink Speed to **10** Mbps. Set Uplink BER and Downlink BER to **0**. Set Uplink Propagation Delay and Downlink Propagation Delay as **100** microseconds for the links 1 and 3 (between the Wired Node's and the routers). Set Uplink Propagation Delay and Downlink Propagation Delay as **50000** microseconds for the backbone link connecting the routers, i.e., 2.

Step 4: Right click on the Application Flow **App1 FTP** and select Properties or click on the Application icon present in the top ribbon/toolbar.

An FTP Application is generated from Wired Node 1 i.e., Source to Wired Node 2 i.e., Destination with File Size set to 14600 Bytes and File Inter Arrival Time set to 10 Seconds.

Step 5: Click on Display Settings > Device IP check box in the NetSim GUI to view the network topology along with the IP address.

Step 6: Enable the plots and click on Run simulation. The simulation time is set to 10 seconds.

1.4 Output

We have enabled Wireshark capture in Wired Node 1. The PCAP file is generated at the end of the simulation and is shown in Figure 1-5.

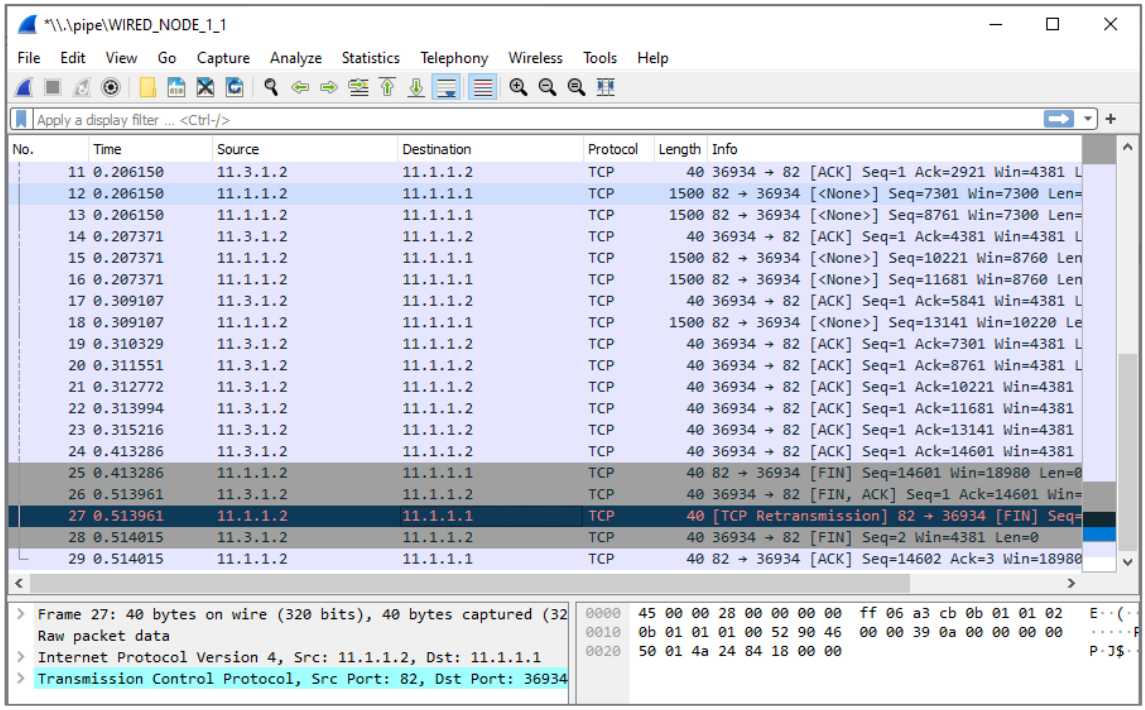

Figure 1-5: Wireshark Packet capture at Wired_Node_1

1. The 3-way handshake of TCP connection establishment and TCP connection termination is observed in the packet capture (Figure 1-5).
2. Data is transferred only after the TCP connection is established.
3. We can access the packet header details of the TCP segments (SYN, SYN-ACK, FIN, FINACK) in Wireshark.