

TCP Connection Establishment: Three-way Handshake

In this lesson, we'll discuss how a TCP connection is established!

WE'LL COVER THE FOLLOWING

- Initiating a Connection
- Responding to an Initial Connection Message
- Acknowledging The Response
- Quick Quiz!

A TCP connection is established by using a **three-way handshake**, which we briefly touched upon in a previous lesson. The connection establishment phase uses the **sequence number**, the **acknowledgment number**, and the **SYN flag**.

Initiating a Connection

When a client host wants to **open a TCP connection** with a server host, it creates and sends a TCP segment with:

- The **SYN** flag set
- The sequence number set to a random initial value. So the sequence numbers **do not start with 0!** Can you guess why?



Why sequence numbers are set to random values

Responding to an Initial Connection Message

Upon reception of this segment (which is often called a **SYN** segment), the server host replies with a segment containing:

- the **SYN flag** set

- the *SYN* flag set
- the *sequence number* set to a random number.
- The **ACK flag** set
- The **acknowledgment number** set to the sequence number of the received *SYN* segment incremented by $1 \bmod 2^{32}$, because the *SYN* segment consumes one byte. This new number may exceed 2^{32} , which is the limit of the *ACK* header field, so the modulus by 2^{32} of this number is taken. This allows the number to cycle back and start from 0.



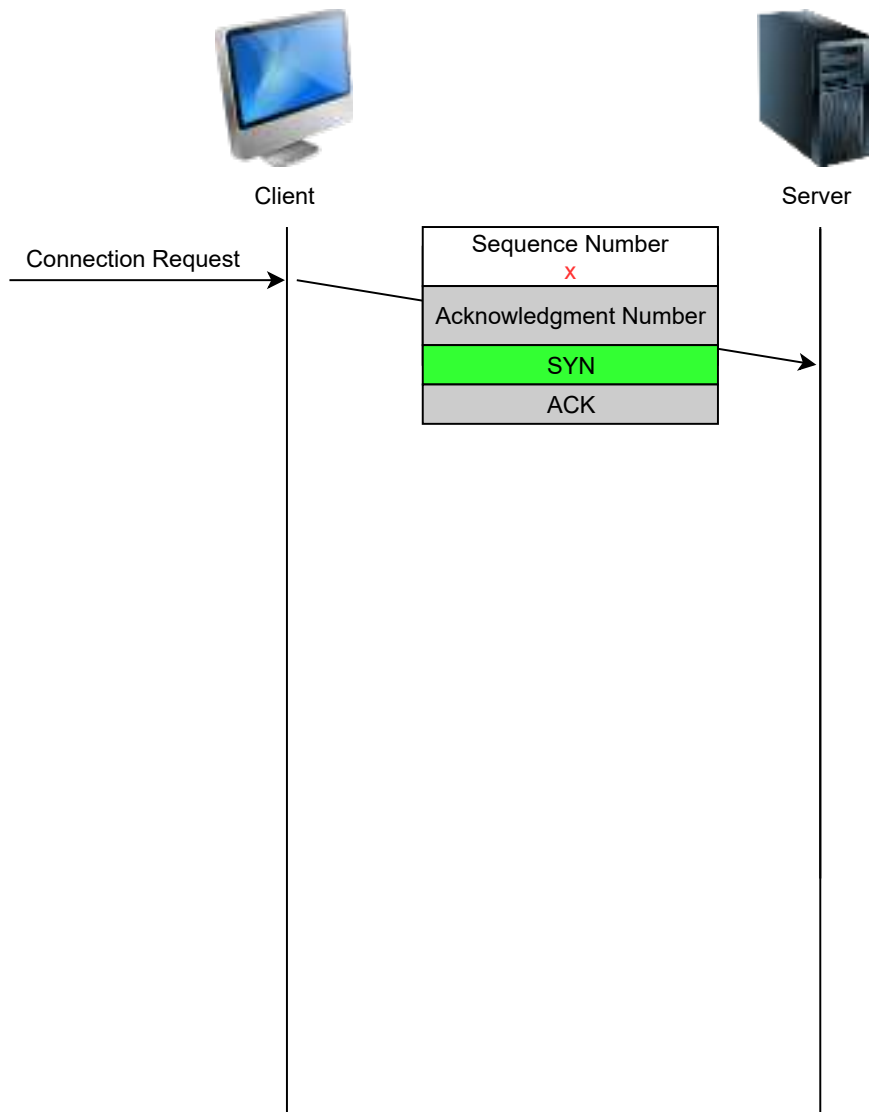
Note When a TCP entity sends a segment with $x + 1$ as the acknowledgment number, it means that it has received all the segments up to and including the segments with the sequence number x , and that it's expecting data having sequence number $x + 1$.

This segment is often called a *SYN+ACK* segment. The acknowledgment confirms to the client that the server has correctly received the *SYN* segment. The random sequence number of the *SYN+ACK* segment is used by the server host to verify that the client has received the segment.

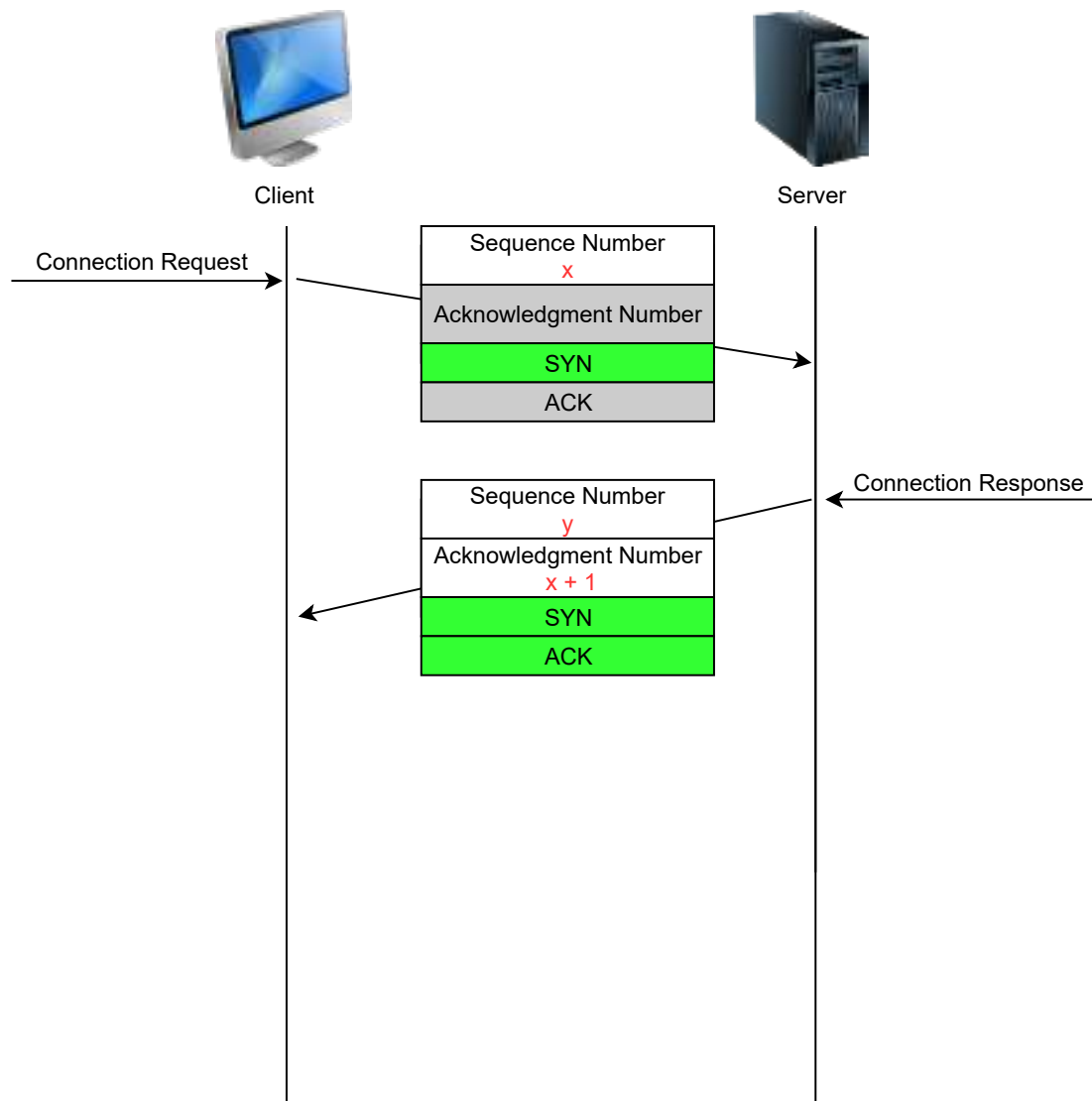
Acknowledging The Response

Upon reception of the *SYN+ACK* segment, the client host replies with a segment containing:

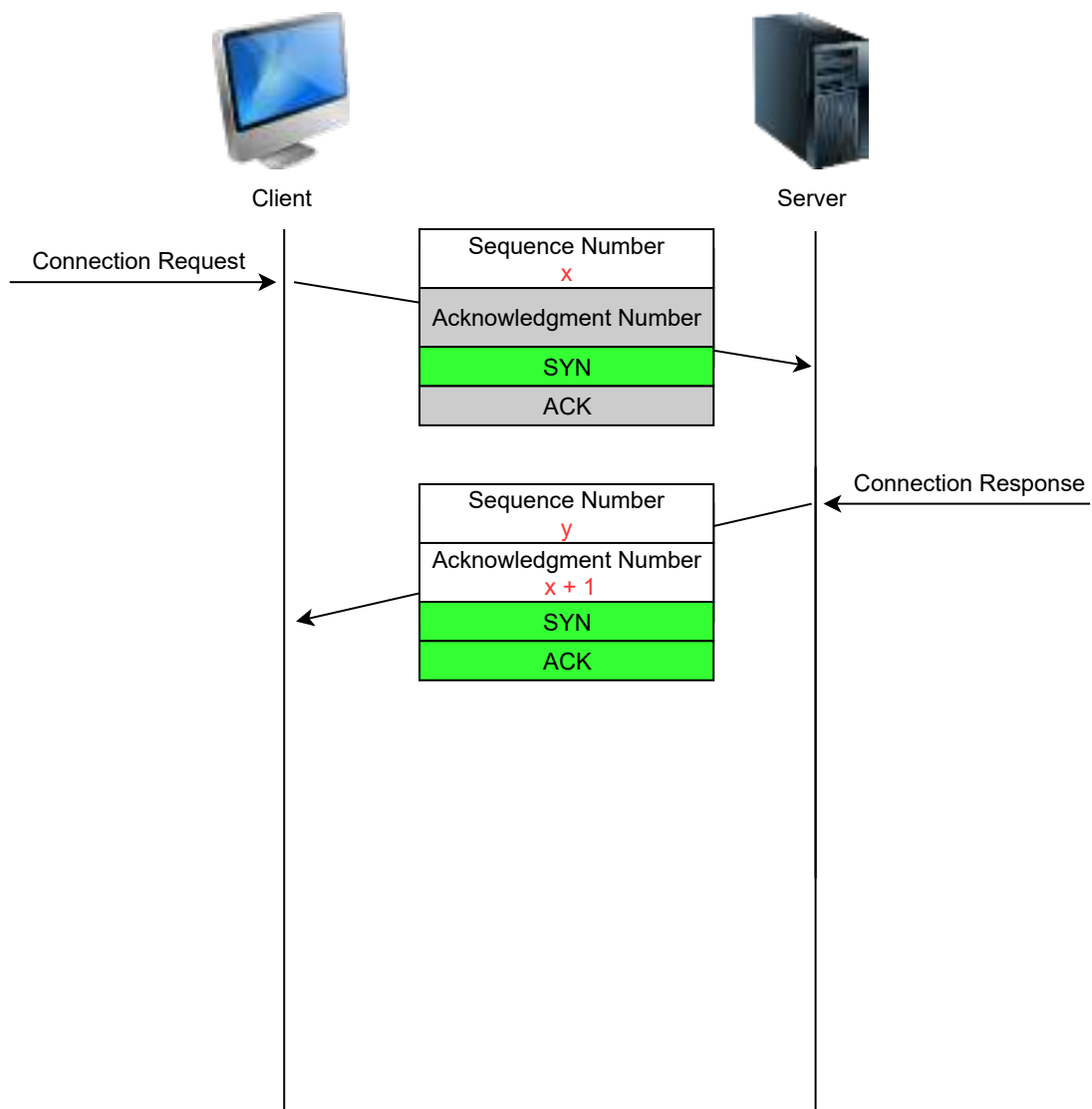
- The **ACK flag** set
- The **acknowledgment number** set to the sequence number of the received *SYN+ACK* segment incremented by 1. The modulus of the number by 2^{32} is obviously taken. At this point, the TCP connection is open and both the client and the server are allowed to send TCP segments containing data. This is illustrated in the figure below:



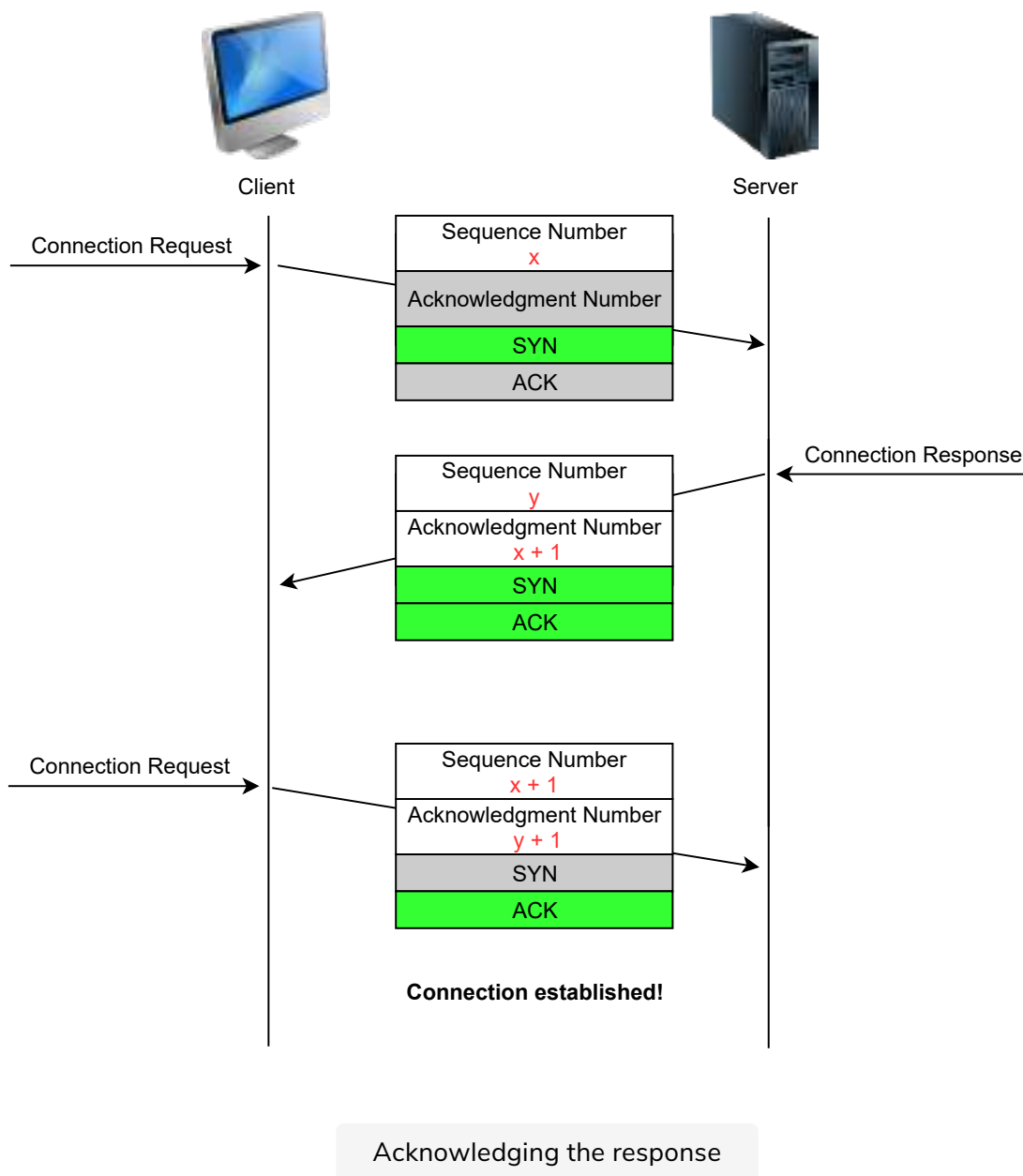
Initiating a Connection



Responding to the initial connection message



Acknowledging the response



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In the figure above, the connection is considered to be established by the client once it has received the *SYN+ACK* segment, while the server considers the connection to be established upon reception of the *ACK* segment.

Quick Quiz!

1

A client is establishing a connection with a server. The first segment sent from the client to the server contains _____ in the flags field.

COMPLETED 0%



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A server could, of course, refuse to open a TCP connection upon reception of a *SYN* segment. This refusal may be due to various reasons. Let's discuss the details in the next lesson.