Socket Data structures
and
How the TCP protocol works

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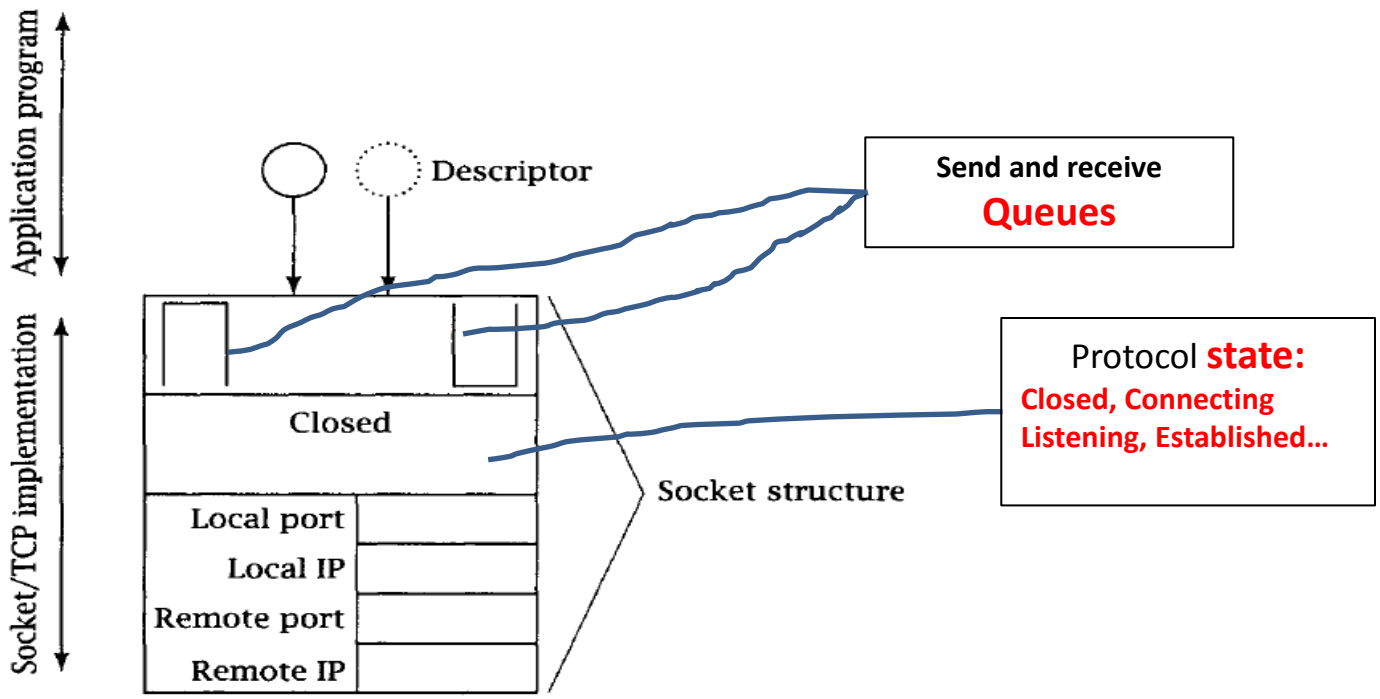
Class: CS457

Fall 2014

❖ Outline

- ❑ **Data structures for TCP socket**
- ❑ **Connection Establishment** (Client-side)
- ❑ **Socket setup** (Server-side)
- ❑ **Closing TCP Connection**

❖Socket structure (TCP socket)



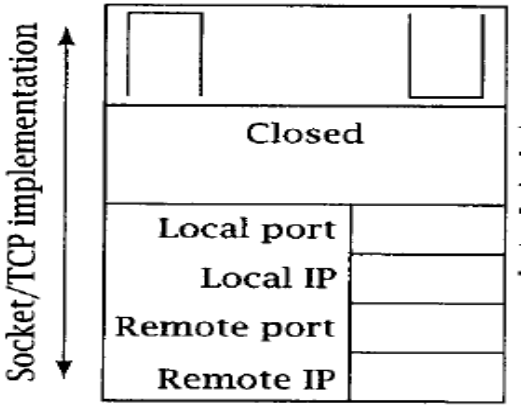
- Data structure associate with each socket
- Programs refer to data structures using descriptor returned by socket

  servSock= socket(PF_INET, SOCK_STREAM, IPPROTO_TCP))
- More than one descriptor can refer to the same socket structure

❖What happen when you create and use a socket?

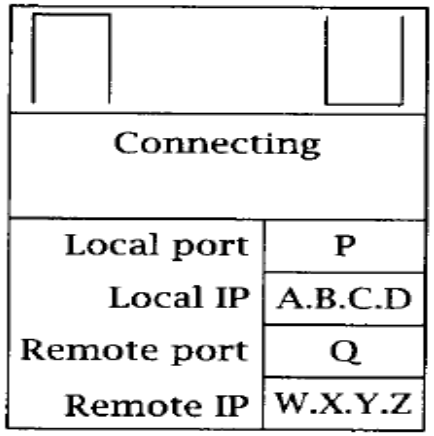
1. Connection Establishment (Client-side)

- When the client creates a new socket (***socket()***), it is in the closed state:



- When the client calls ***connect()*** with port number (Q) and IP address (W.X.Y.Z), the system fills in the four fields in the *socket structure.*

Fill in local address; send connection request to server

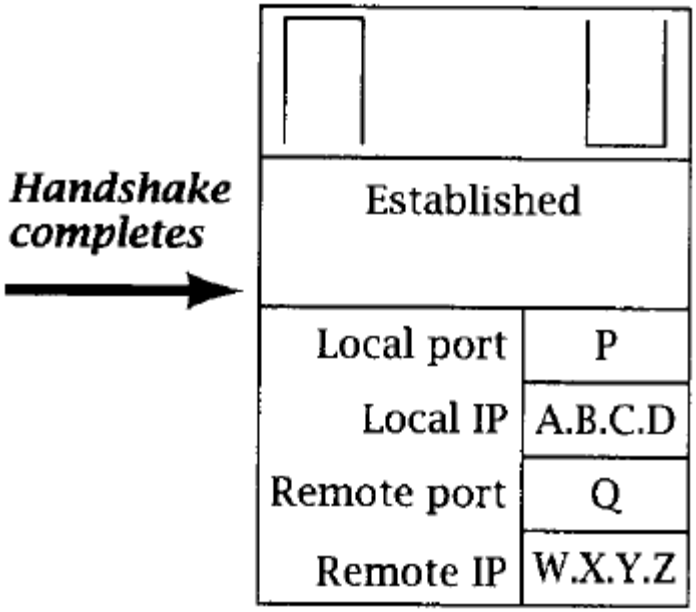


But we did not assign any Local port or Local IP

❖What happen when you create and use a socket?

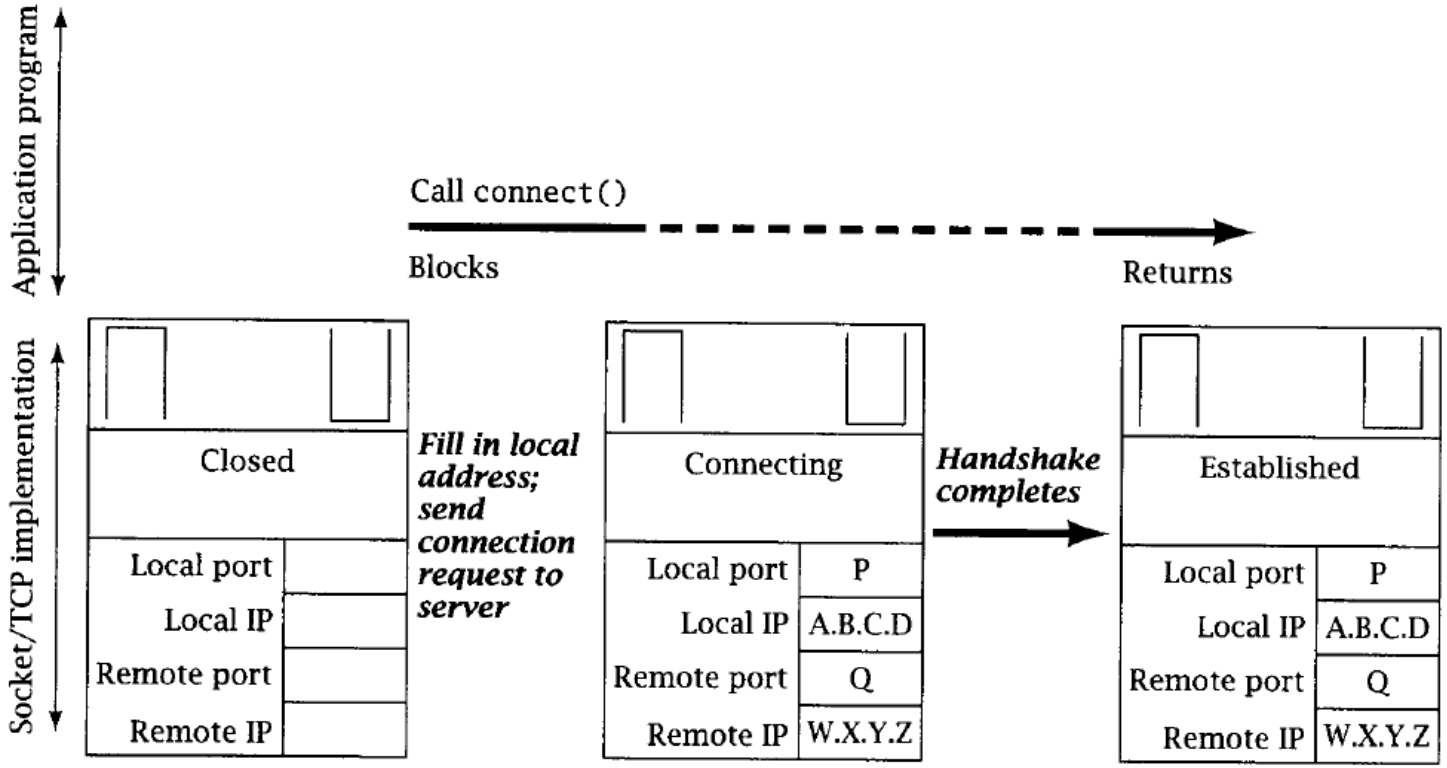
1. Connection Establishment (Client-side)

- TCP opens three-way handshake
  1. Connection request from the client to the server
  2. Acknowledgment from server to client
  3. Another Acknowledgment from client to server
- The client considers the connection as established when it received AK from the server.



❖What happen when you create and use a socket?

- **The whole process (client-side)**



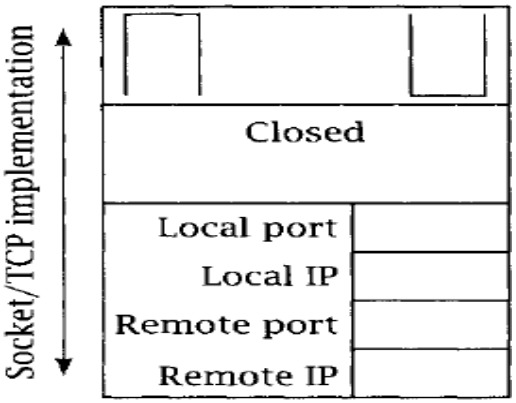
Note:

- If there is no acknowledgement received from the server, client times out and gives up.
- This may take order of minutes

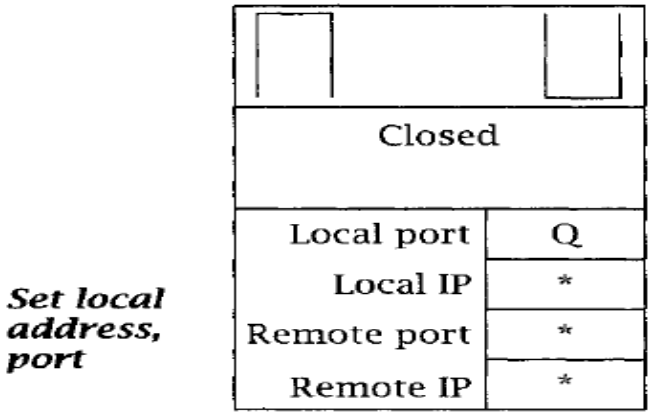
❖What happen when you create and use a socket?

2. Socket setup (Server-side)

- This step is similar as in the client when the ***socket()*** function is called



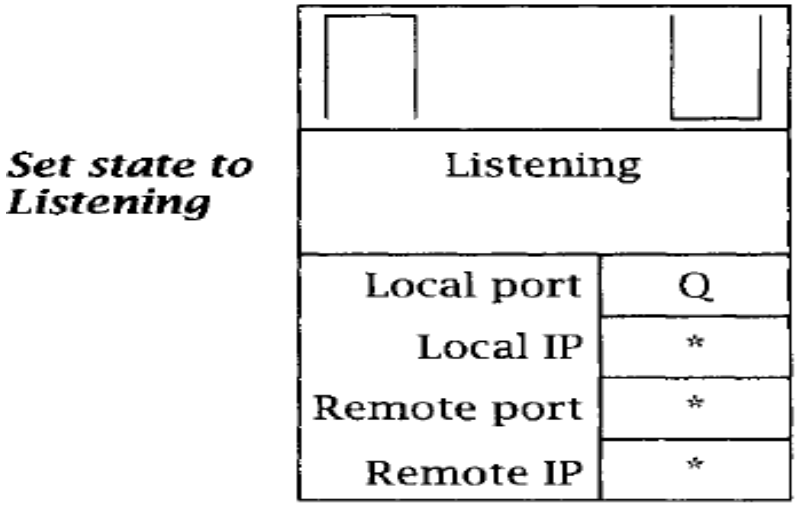
- Using the ***bind()*** function the server needs to bind to port number and IP address known to the client.



❖What happen when you create and use a socket?

2. Socket setup (Server-side)

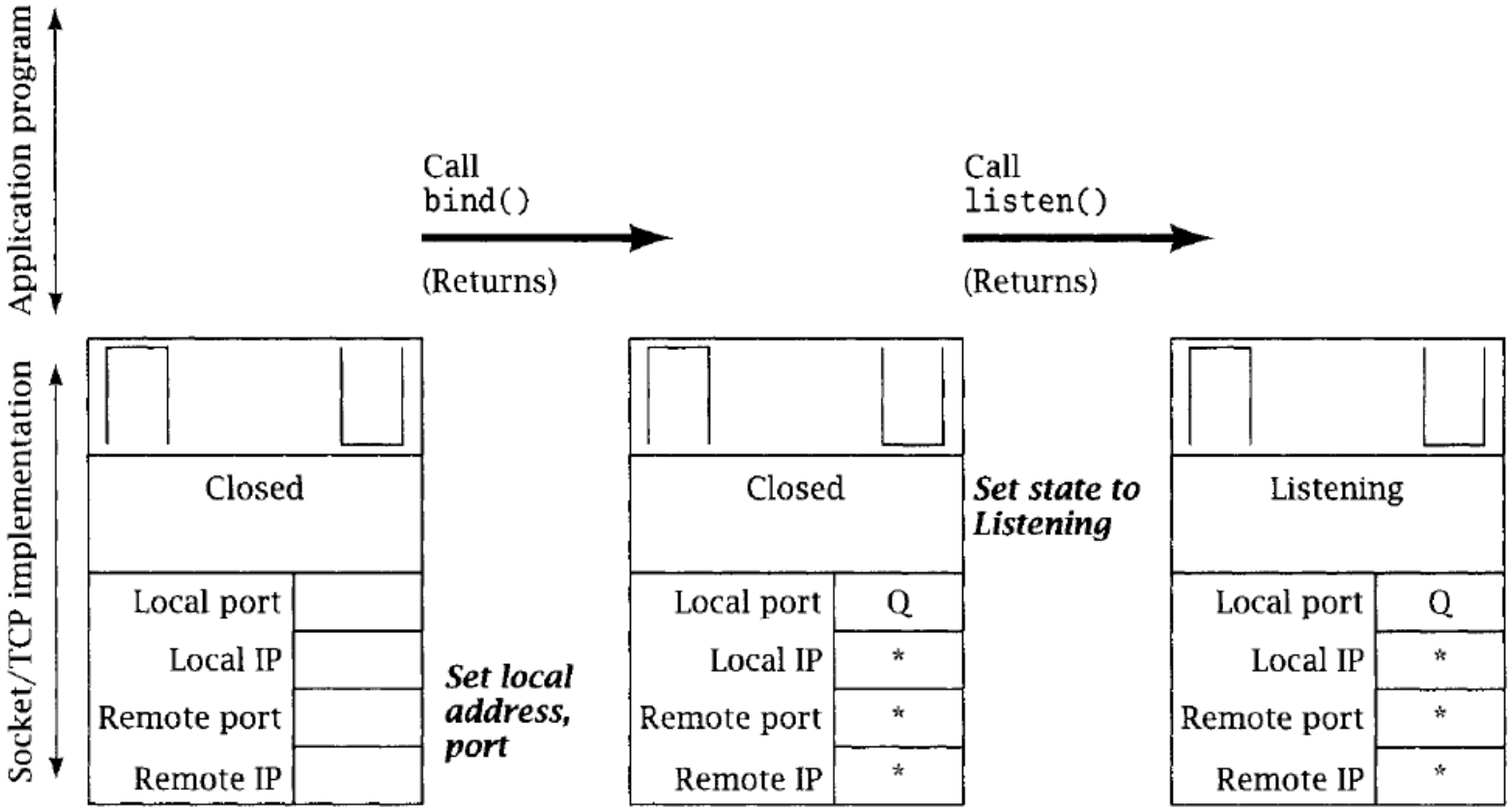
- When the server calls ***listen()*** function, the state of the socket is changed to listening (ready to accept new connection).



- Any client connection request comes to server before the call to ***listen()*** will be rejected.

❖What happen when you create and use a socket?

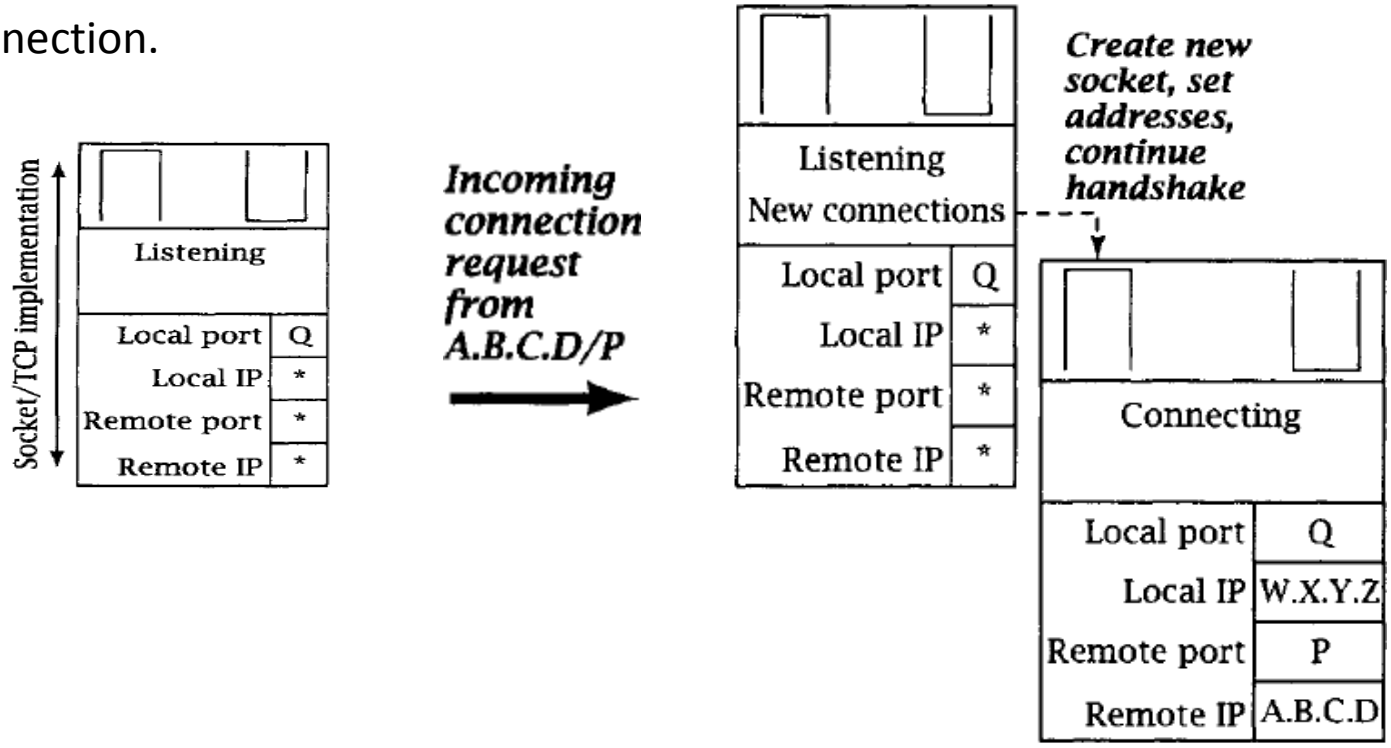
- **The whole process (server-side):** bind() and listen()



❖What happen when you create and use a socket?

2. Socket setup (Server-side): accept()

- When the client connection request arrives, a new socket structure is created for the connection.



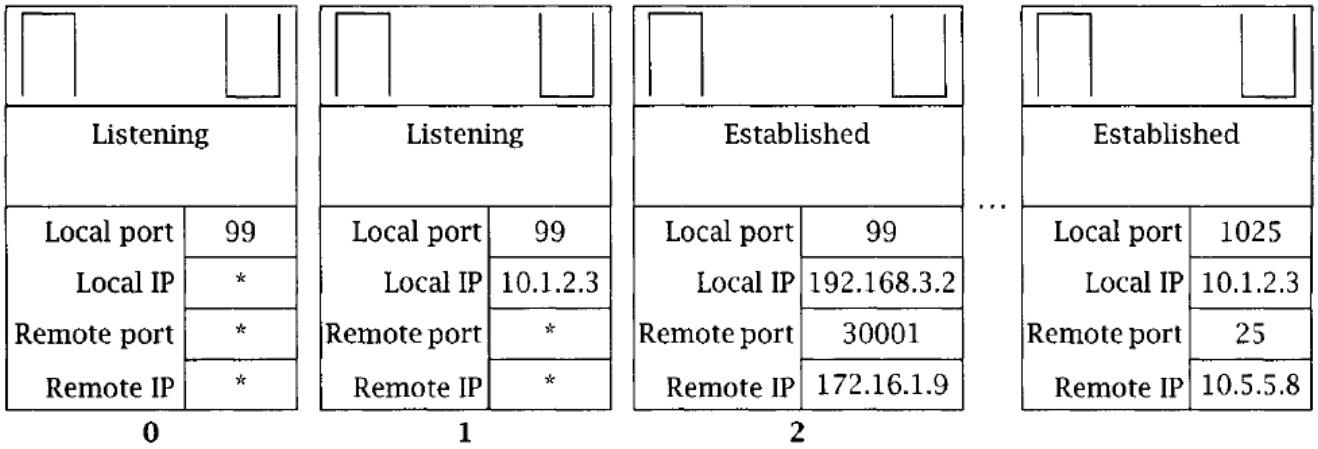
- The new socket state is set to ***connecting*** and it is added to not-quite-connected sockets.

Note: new socket port number and IP address is the same as the listening socket (Wait a minute).

❖What happen when you create and use a socket?

2. Socket setup (Server-side): accept()

- How an incoming packet can be matched to sockets in the same host which have the same local port number and IP Address?



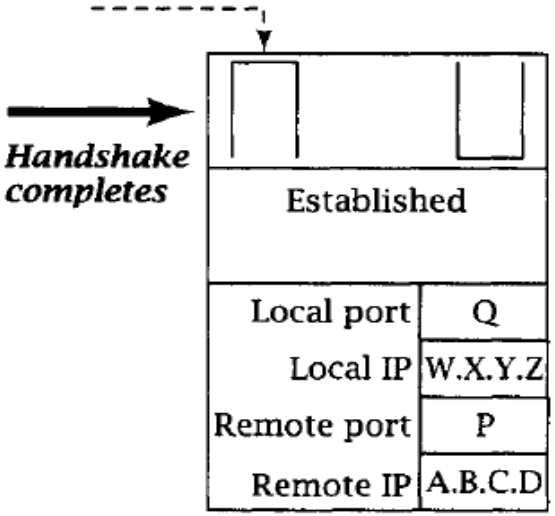
- **Example:**

Packet	
Source IP Address	172.16.1.10
Source Port	56789
Destination IP Address	10.1.2.3
Destination port	99

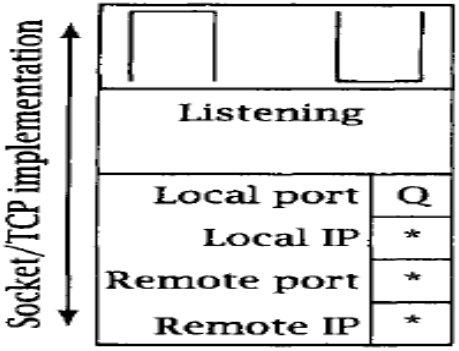
❖What happen when you create and use a socket?

2. Socket setup (Server-side): accept()

- When the third message (of the three handshakes messages) comes from the client, the new socket's state is set to Established

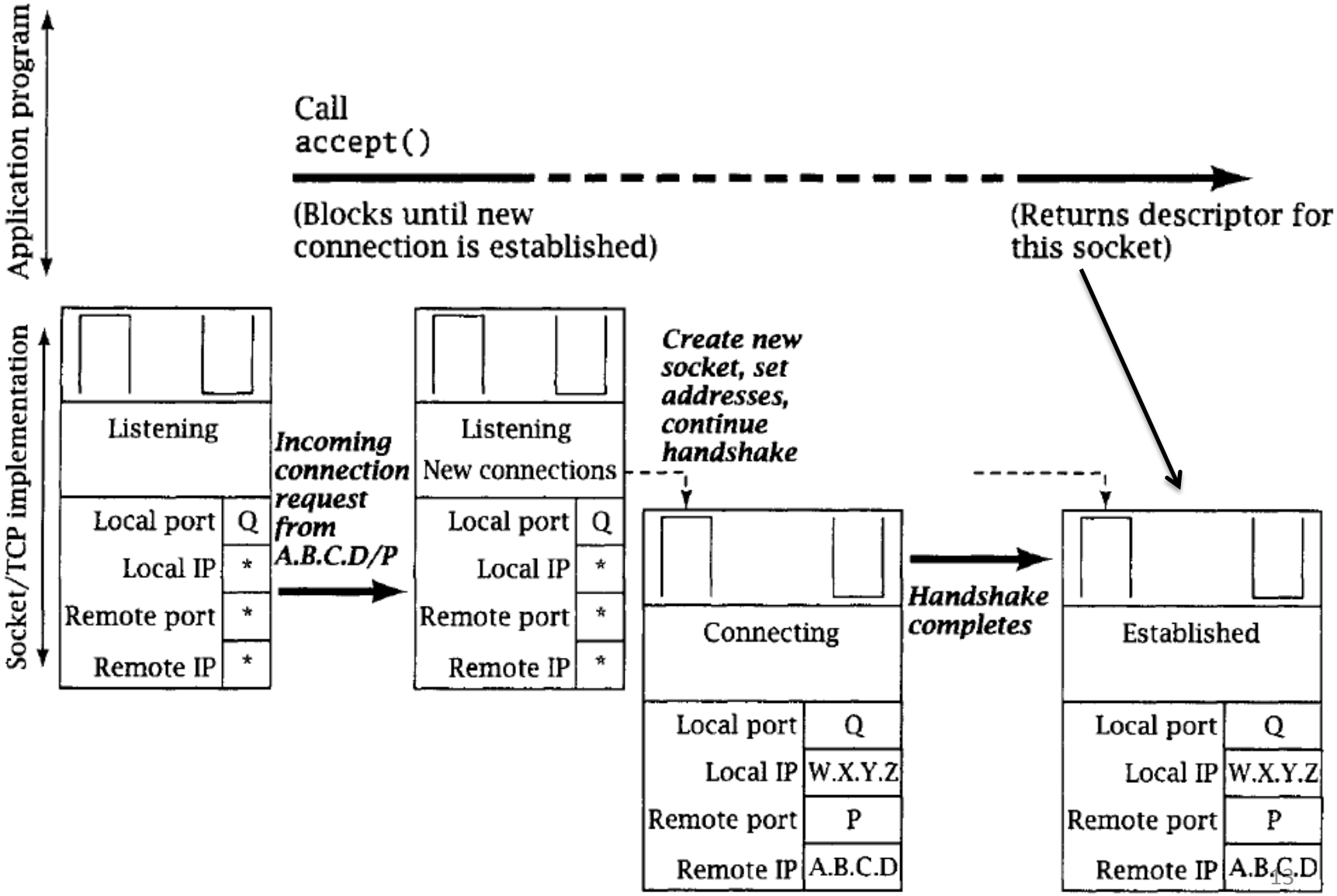


- The original server socket does not change state



❖What happen when you create and use a socket?

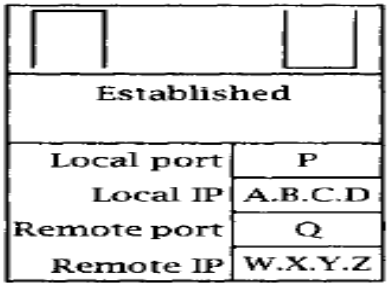
- **The whole process** (server-side): accept()

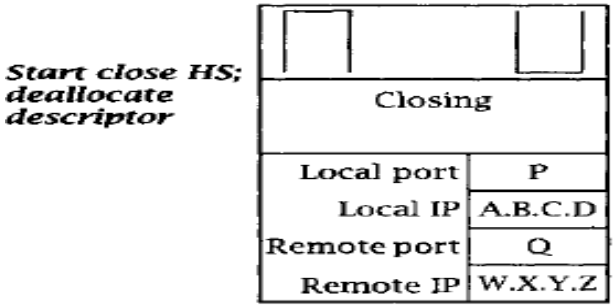


❖What happen when you create and use a socket?

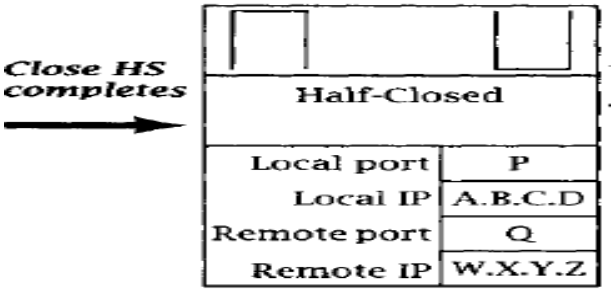
3. Closing TCP Connection

- When one application calls ***close()*** before the other end closes (what?):
  1. TCP implementation transmits any data remaining in the SendQ
  2. Handshake message is sent
  3. Descriptor is deallocated
  4. The state is set to closing





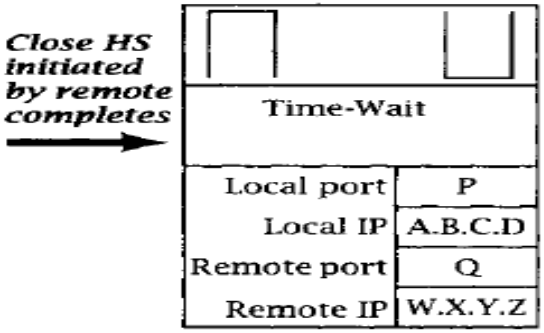
- When the acknowledgment for the close handshake is received, the sate changes to ***Half-Closed*** *(Remains until the other end's HSM is received)*.



❖What happen when you create and use a socket?

3. Closing TCP Connection

- When the other end's close handshake message is arrived, an acknowledgment is sent and sate changes to ***Time-Wait.***

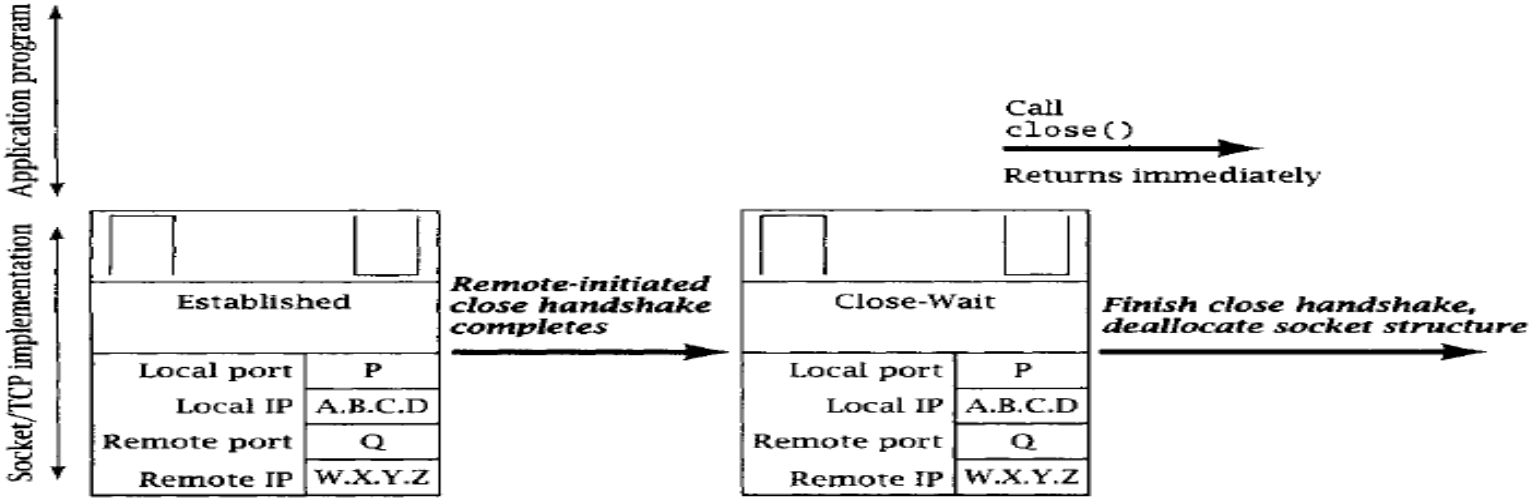


- Why ***Time-Wait*** state***?***
  - The possibility of a message being delayed in a network
  - Twice the time a packet can remain in a network.
  - It stays for anywhere from 30 second to 2 minutes

❖What happen when you create and use a socket?

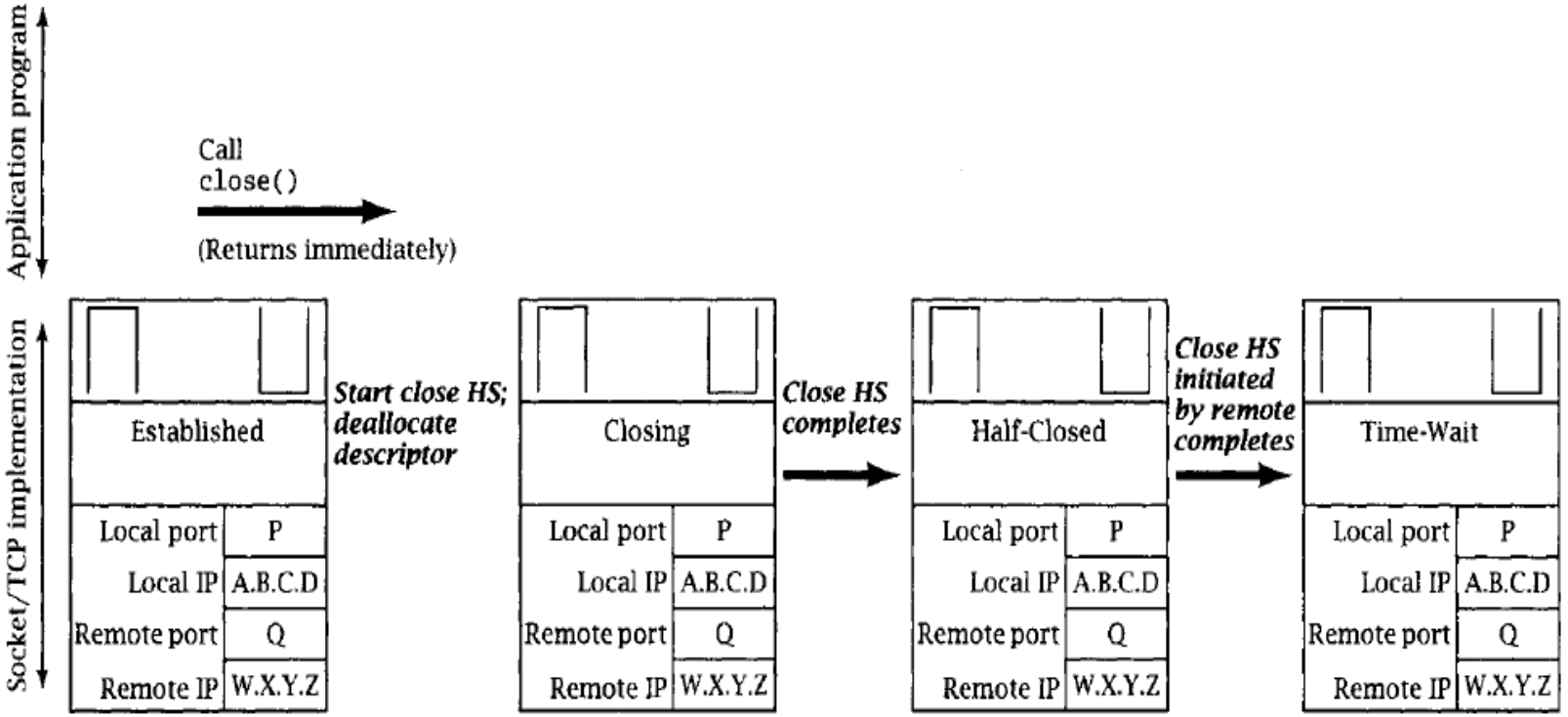
3. Closing TCP Connection

- What will happen to the end point that does not close first?
- When the closing handshake message arrives:
  1. An acknowledgement is sent immediately
  2. The connection state becomes Close-Wait
  3. When the application calls ***close()***:
     - Descriptor is deallocated
     - HSM initiated
     - Deallocate socket structure



❖What happen when you create and use a socket?

3. Closing TCP Connection: the whole process



Thank You

Reference

- Pocket Guide to TCP/IP Socket, by Michael J. Donahoo and Kenneth L. Calvert
- Beej's Guide to Network Programming Using Internet Sockets, by Brian "Beej" Hall. (http://www.cs.columbia.edu/~danr/courses/6761/Fall00/hw/pa1/6761-sockhelp.pdf)