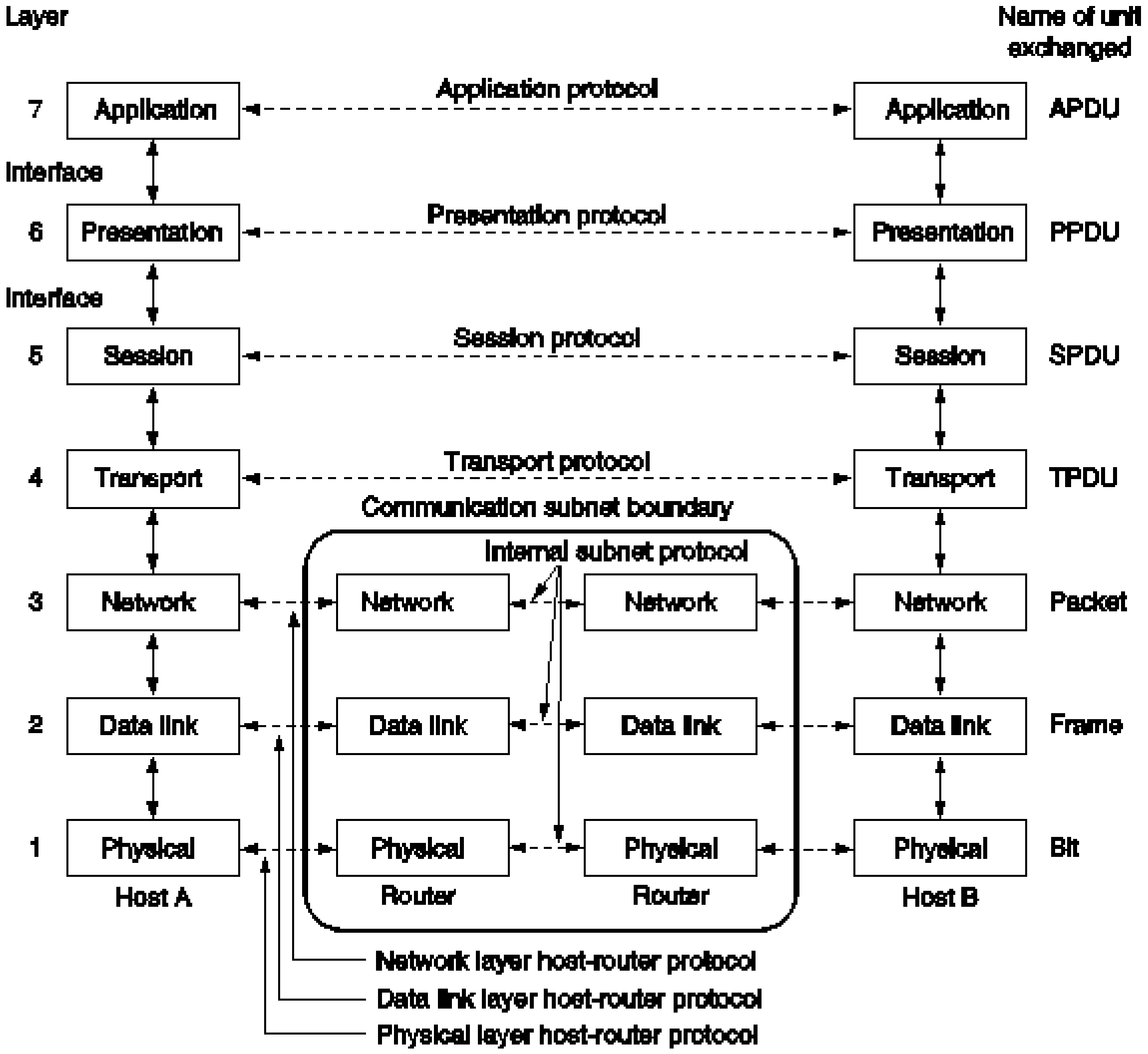
CO650 Advanced Programming - C++ Sockets

Sockets were initially developed for Unix. Windows developed their own version of the sockets called Winsock. On Windows systems, the core components of the socket come in the form of a dll file. (ws2_32.dll)

7 Layers of OSI model (Open Systems Interconnection)



The OSI model describes seven layers that computer systems use to communicate over a network. This is what happens underneath the surface when we send data from one machine to another over a network.

Architecture

- In order for connection to take place between two devices via the network, the data has to be sent from the application layer and descend down to the physical layer on a device sending data, and then ascend from the physical layer to the application layer on the device receiving the data.
- The connection is always between two devices, and each side uses its own IP and port number. Usually one side is called the **client**, the other side the **server**
- The server is continually waiting for incoming connections. This is called **listening** which is always done on a certain IP and port number.

IP addresses

- BOth the server and client use an IP and port number.
- THe IP address of both server and client is configured during Network setup unless it is allocated dynamically.
- A machine may have more than one network interface card(NIC), in which case it may have more than one IP address.
- When developing Network Programs the port number of the server is usually specified within the code, whereas the client port number is allocated by the O/S.
- The **Loopback address** 127.0.0.1 refers to the current machine. This can be used during development to test both client and server on a single machine.

Ports

- Port numbers (16 bit address) can be any integer between 1 and 65.535.
- Ports 1…1023 are described as well known ports and are reserved for specific applications (port 21 FTP).
- It is recommended to choose a number over 1024. To be sure that your desired port isn't already in use

Sockets

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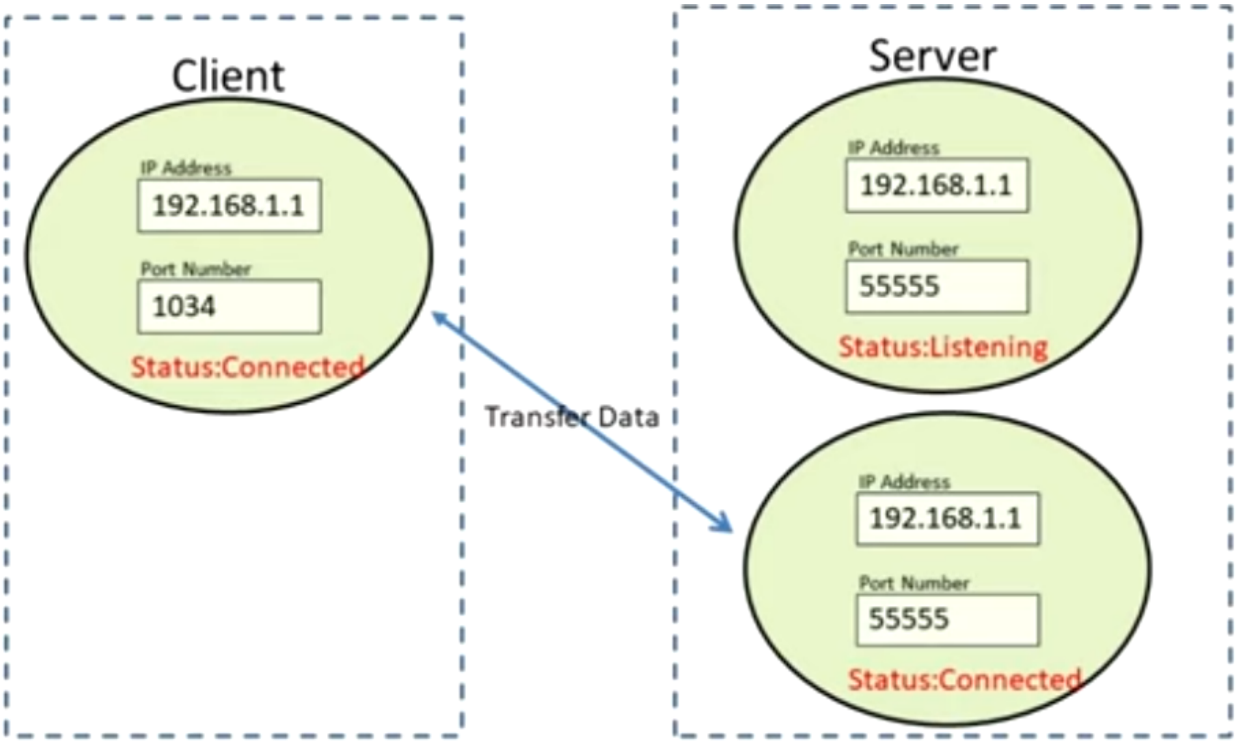
- Definition "A pipe between two computers on a network through which data flows" (Mulholland 2004).
- Almost all Winsock functions operate on a socket, as it's your handle to the connection. Both sides of the connection use a socket.
- Sockets are also two-way, data can be both sent and received on a socket.
- There are two common types of socket
  - Streaming socket (SOCK_STREAM) TCP
  - Datagram socket (SOCK_DGRAM) UDP

Request a Connection

The client socket tries to connect to the known IP address of the server.

Once it's been bound, the client puts out a request for a connection to a server. Once the request has been accepted by the server, the server duplicates the socket to enable the connection between them. It is creating a new socket bound to its own IP address and valid port. From this point, the client socket and the server connection socket just created will be able to communicate, while the listening socket will keep listening for other connections.



Server Functions

1. Initialize WSA - WSAStartup().
2. Create a socket - socket().
3. Bind the socket - bind().
4. Listen on the socket - listen().
5. Accept a connection - accept(), connect().
6. Send and receive data - recv(), send(), recvfrom(), sendto().
7. Disconnect - closesocket().

Client Functions

1. Initialize WSA - WSAStartup().
2. Create a socket - socket().

3. Connect to the server - connect().
4. Send and receive data - recv(), send(), recvfrom(), sendto().
5. Disconnect - closesocket().

The Server Code

- The server must load the DLL by invoking WSAStartup
- It then creates a socket specifying the protocol to be used
- It binds the server’s IP address to the socket
- Then listens for clients trying to establish connections
- On a client connecting the server creates a new socket to handle the client server communication

Initializing the DLL

Winsock DLL can be initiated by following:

```
int WSAStartup(WORD wVersionRequested, LPWSADATA lpWSAData);
```

wVersionRequested	The highest version of Windows Sockets specification that the caller can use. The high-order byte specifies the minor version number; the low-order byte specifies the major version number
lpWSAData	A pointer to the LPWSADATA data structure that is to receive details of the Windows Sockets implementation

If successful, the WSAStartup function returns zero.

The Socket Function

- The socket function creates a socket that is bound to a specific transport service provider

```
SOCKET WSAAPI socket (int af, int type, int protocol);
```

af	The address family specification (AF_INET for UDP or TCP).
type	The type specification for the new socket (SOCK_STREAM for TCP and SOCK_DGRAM for UDP).
protocol	THe protocol to be used (IPPROTO_TCP for TCP)

Deregister Winsock2 DLL

- The WSA Cleanup function terminates use of Winsock 2 DLL
- The return value is zero if the operation was successful. Otherwise, the value SOCKET_ERROR is returned

```
int WSACleanup(void);
```

- When it has completed the use of WIndows Sockets, the application or DLL must call WSACleanup to deregister itself from a Windows Sockets
- Multiple applications may share a DLL. Windows tracks the number of applications using each DLL and will only remove the DLL from system memory when it is no longer required.

Close Socket

- Closes the socket passed as an argument
- The socket must have previously been opened through a call to socket

```
int closesocket(Socket s);
```