TCP/IP Model

The first layered protocol model for internetwork communications was created in the early 1970s and is referred to as the Internet model. It defines four categories of functions that must occur for communications to be successful as shown in figure 1.

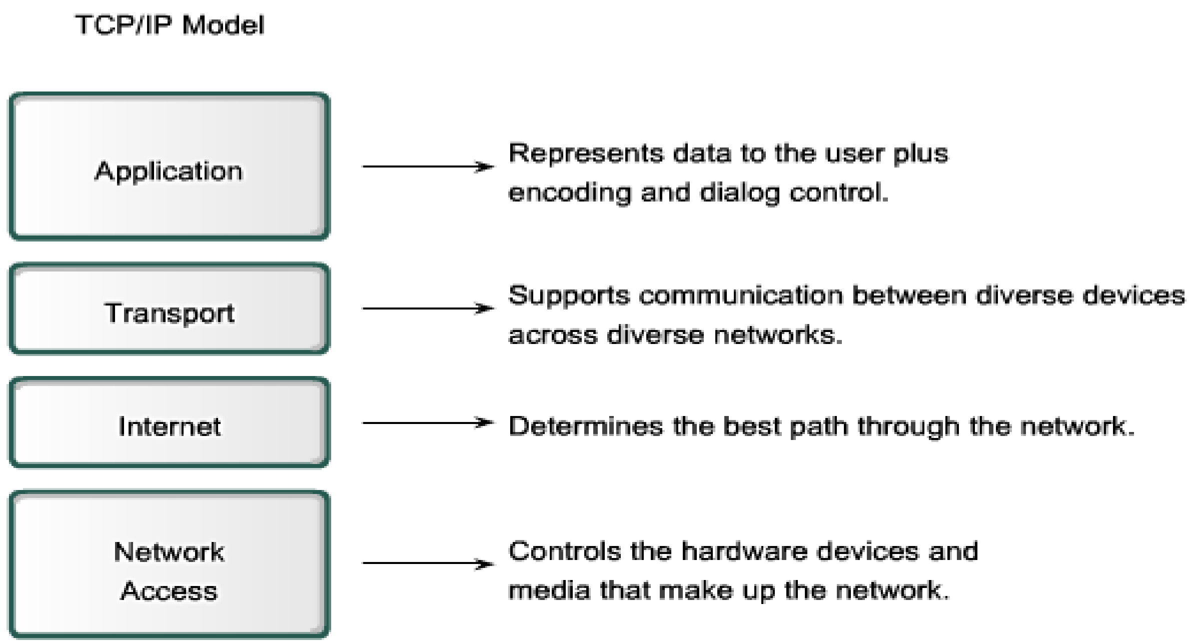

Figure 1: The four layers of TCP/IP Model

The Transmission Control Protocol / Internet Protocol (TCP/IP) was created by the Department of Defense (DoD) to make sure and protect data integrity, and also maintained communications in the time of disastrous war. However, if designed and deployed properly according to standard, a TCP/IP network can be a truly reliable and flexible one.

The Internet Protocol Suite, popularly known as the TCP/IP model, is a communication protocol that is used over the Internet. This model divides the entire networking functions into layers, where each layer performs a specific function.

This model gives a brief idea about the process of data formatting, transmission, and finally the reception. Each of these functions takes place in the layers, as described by the model. TCP/IP is a four-layered structure, with each layer having their individual protocol. Let us have a look at the four layers:

Network Access Layer (Link Layer)

As the name suggests, this layer includes the physical and logical connections from the host's link. It is also known as Network Access layer and Network Interface layer. It explains how the data is transmitted from the host, through the network. The physical connectors like the coaxial cables, twisted pair wires, the optical fiber, interface cards, etc., are a part of this layer. This layer can be used to connect different network types like Token ring, Ethernet, LAN, etc.

Internet Layer

This layer is also known as the Network Layer. The main function of this layer is to route the data to its destination. The data that is received by the link layer is made into data packets (IP datagrams). The data packets contain the source and the destination IP address or logical address. These packets are sent on any network and are delivered independently. This indicates that the data is not received in the same order as it was sent. The protocols at this layer are IP (Internet Protocol), ICMP (Internet Control Message Protocol), etc.

Transport Layer

This layer is responsible for providing datagram services to the Application layer. This layer allows the host and the destination devices to communicate with each other for exchanging messages, irrespective of the underlying network type.

Error control, congestion control, flow control, etc., are handled by the transport layer. The protocol that this layer uses is TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). TCP gives a reliable, end-to-end, connection-oriented data transfer, while UDP provides unreliable, connectionless data transfer between two computers.

Application Layer

It provides the user interface for communication. This is the layer where email, web browsers or FTP run. The protocols in this layer are FTP, SMTP, HTTP, etc Figure 2 shows the (OSI model, TCP/IP model, and the TCP/IP Internet protocol suite).

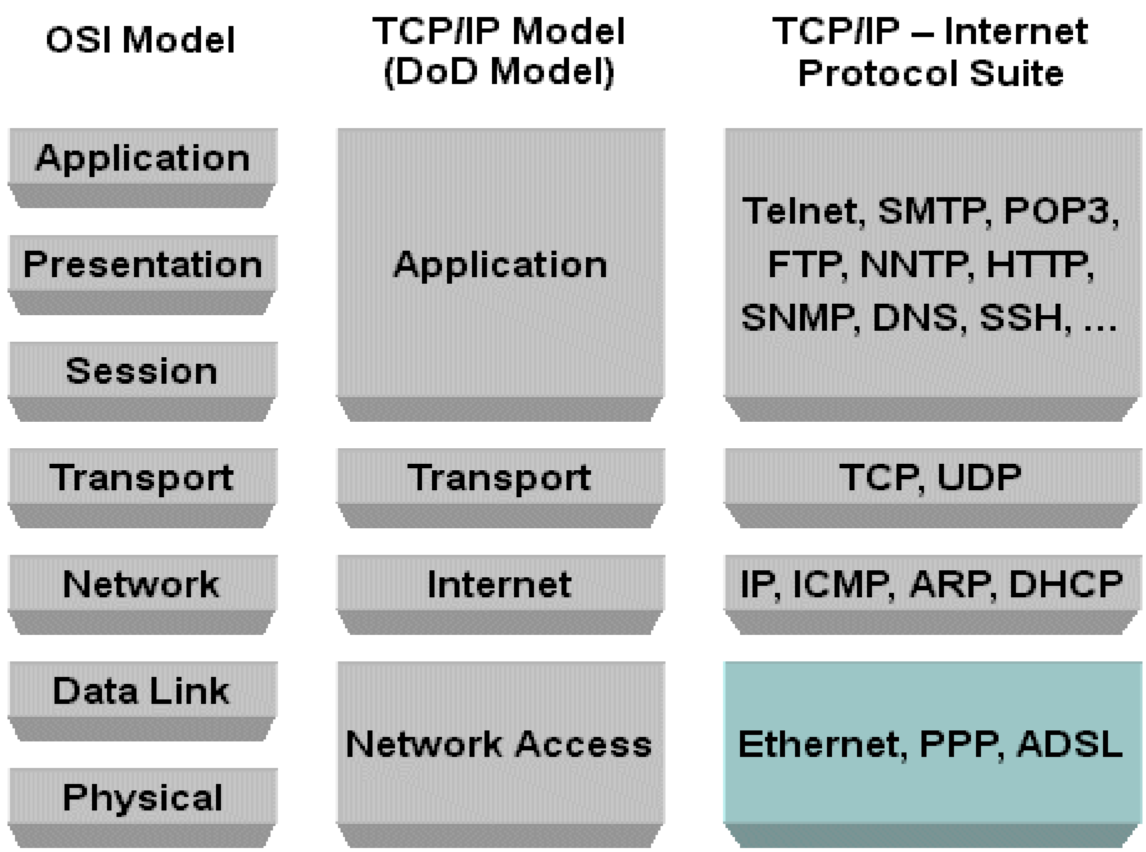

Figure 2 (OSI model, TCP/IP model, and the TCP/IP Internet protocol suite)

Encapsulation:

It's the process of adding information to application data at each level as is passed down the protocol stack on its way to be transmitted across the network media, see figure 3.

Protocol Data Unit (PDU):

It's the form that a piece of data takes at any layer.

At each stage of the process, a PDU has a different name to reflect its new appearance. The following points show the different naming of PDU:

- **Data -** The general term for the PDU used at the Application layer
- **Segment** - Transport Layer PDU
- **Packet** - Internetwork Layer PDU
- **Frame** - Network Access Layer PDU
- **Bits -** A PDU used when physically transmitting data over the medium

The Communication Process in TCP/IP Model

The TCP/IP model describes the functionality of the protocols that make up the TCP/IP protocol suite. These protocols, which are implemented on both the sending and receiving hosts (end devices), interact to provide end-to-end delivery of applications over a network. Figure 4 and 5 show the sending and receiving processes successively.

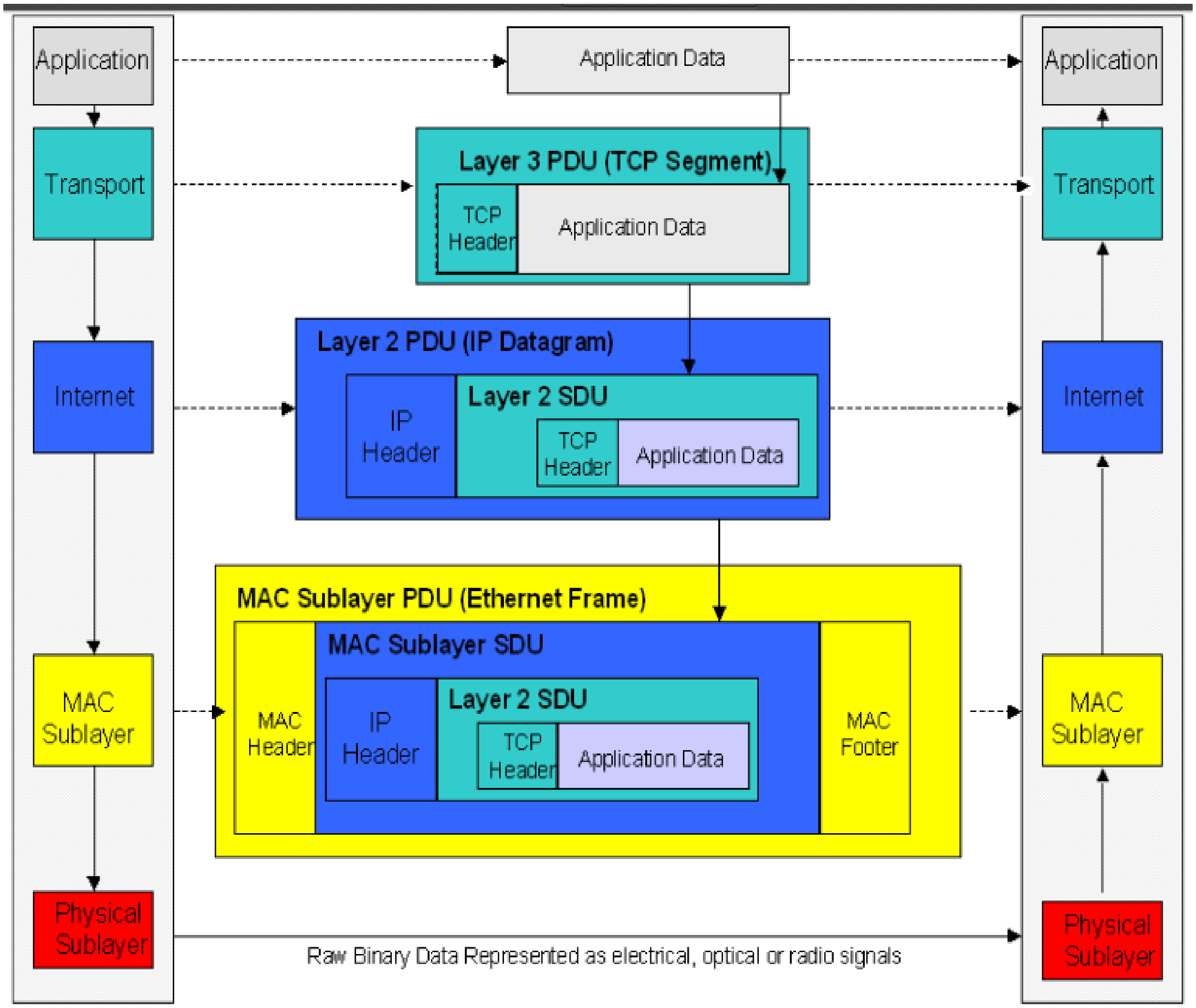

Figure 3: Encapsulation process

<u>A complete communication process includes the following steps:</u>

1. Creation of data at the application layer of the originating source end device.
2. Segmentation and encapsulation of data as it passes down the protocol stack in the source end device.
3. Generation of the data onto the media at the network access layer of the stack.
4. Transportation of the data through the internetwork, which consists of media and any intermediary devices.
5. Reception of the data at the network access layer of the destination end device.

6. Decapsulation and reassembly of the data as it passes up the stack in the destination device.
7. Passing this data to the destination application at the Application layer of the destination end device.

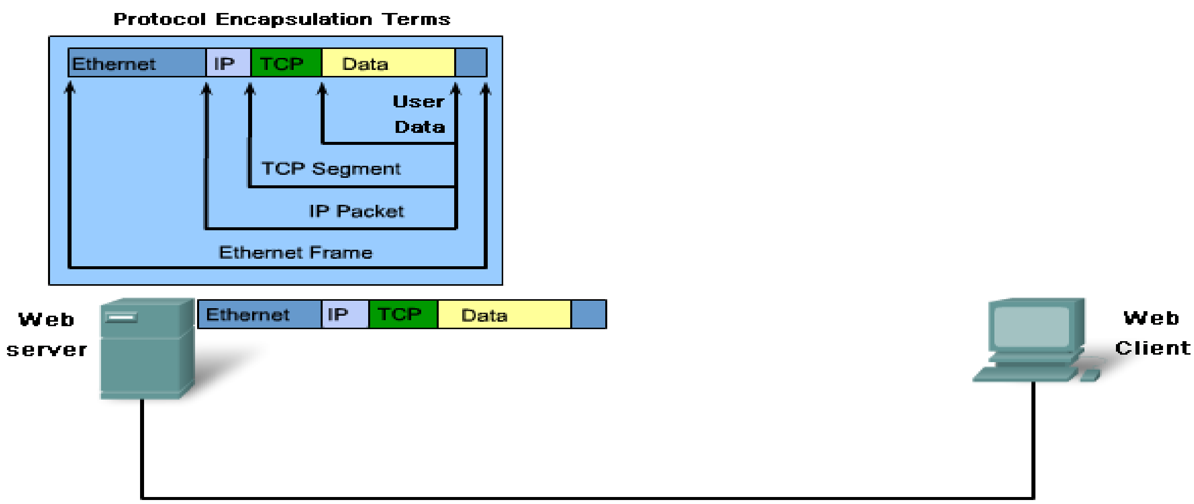

Figure 4: Protocol operation of sending a message

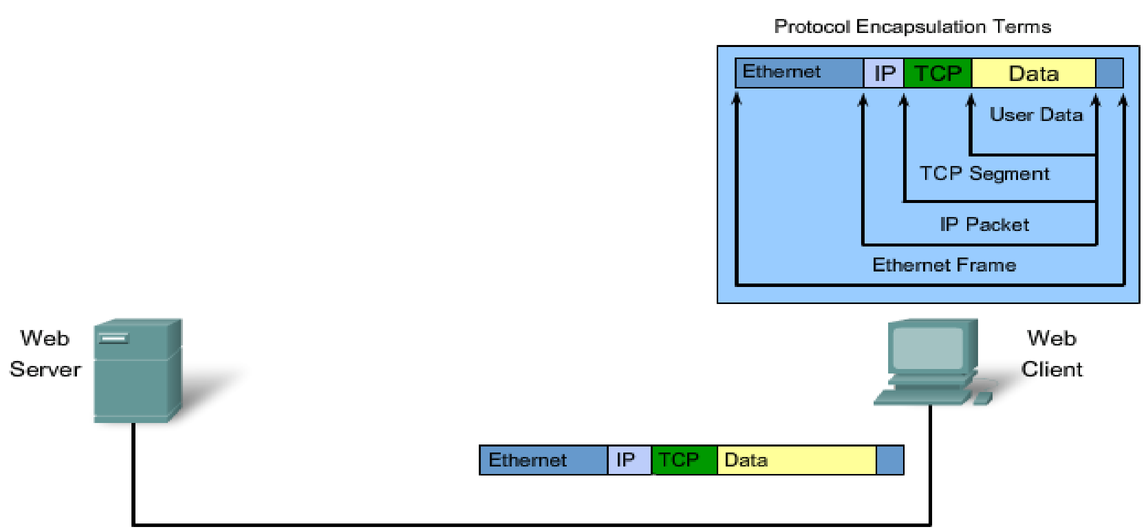

Figure 5: Protocol operation of receiving a message

The TCP/IP Protocols

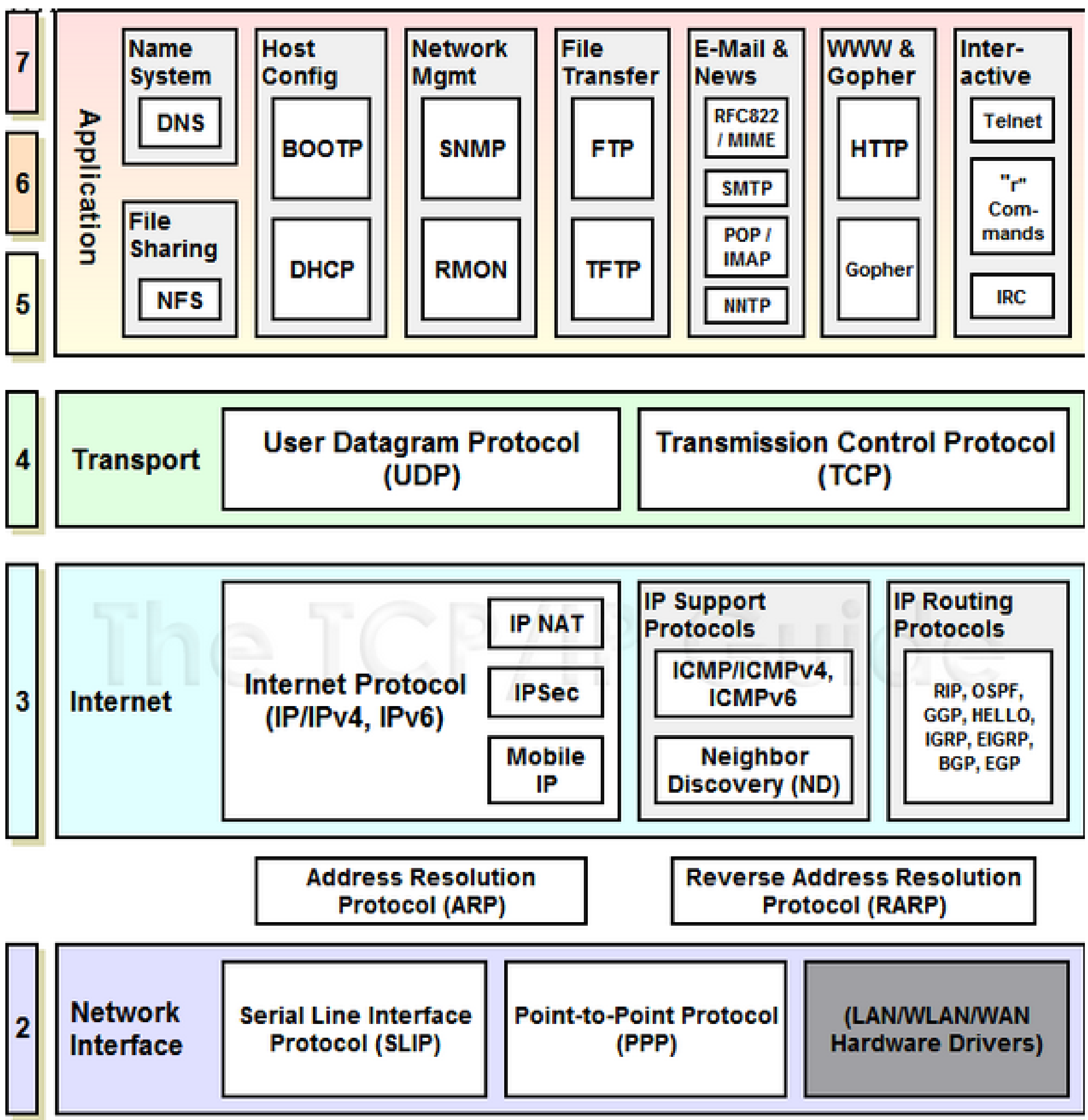

Figure 6: The TCP/IP Protocols

The TCP layer packages the data into packets. A header that's added to the data includes source and destination addresses, a sequence number, an acknowledgment number, a check sum for error detection and correction, and some other information *(Fig. 7)*. The header is 20 octets (octet = 8 bits) grouped in 32-bit increments. These bits are transmitted from left to right and top to bottom.

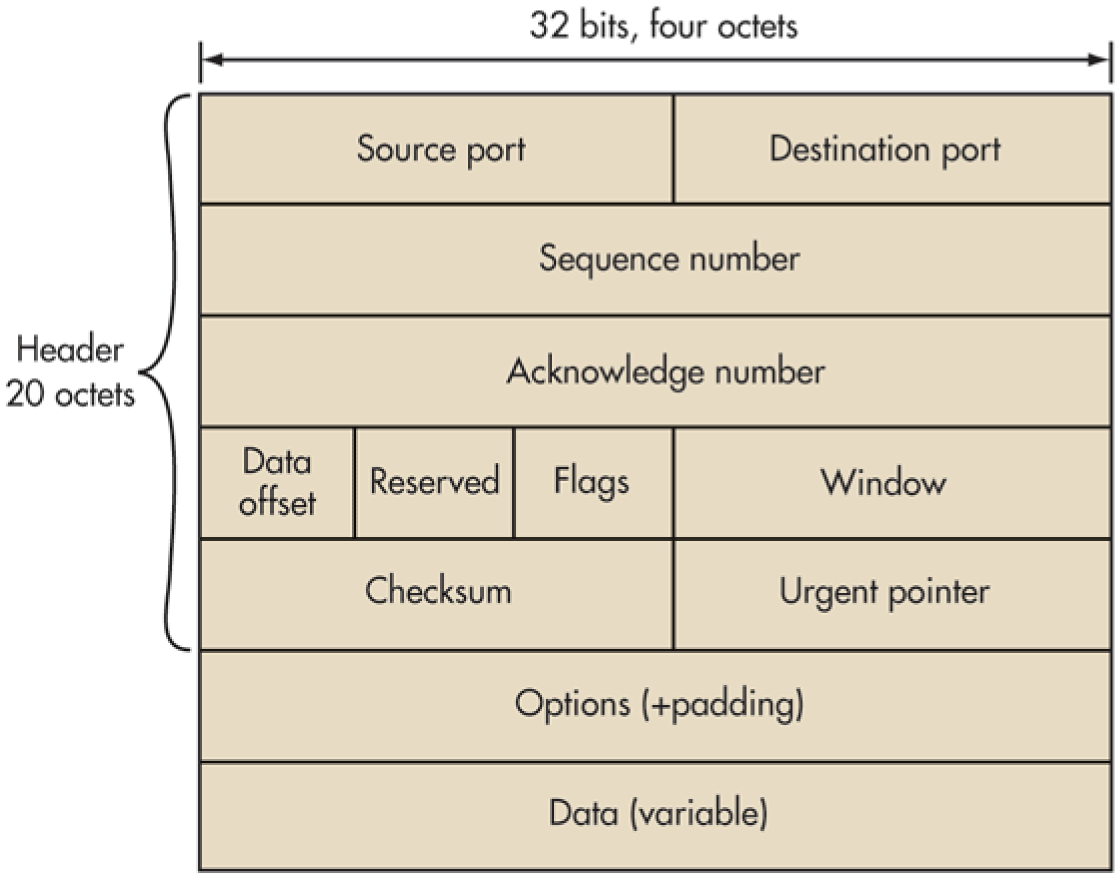

Figure7: The header is added and then removed during the encapsulation and de-encapsulation of the packet data at the TCP layer.

At the receiving end of the link, TCP reassembles the packets in the correct order and routes them up the stack to the application. TCP can retransmit a packet if an error occurs. In any case, TCP's main job is just to pack and unpack the data and

provide some assurance of the reliable transmission of error-free data. The IP layer actually transmits the TCP packet.

The IP layer transmits the data over the physical-layer connection. IP adds its own header to the packet *(Fig.8)*. The header comprises 32 octets again grouped in 32-bit words. Note the 32-bit source and destination addresses. These are the well-known IP addresses that we see in dotted decimal format (e.g., 197.45.204.36) where each 8-bit octet is expressed in its decimal value. This is the address assigned to the device by the Internet Assigned Numbers Authority (IANA).

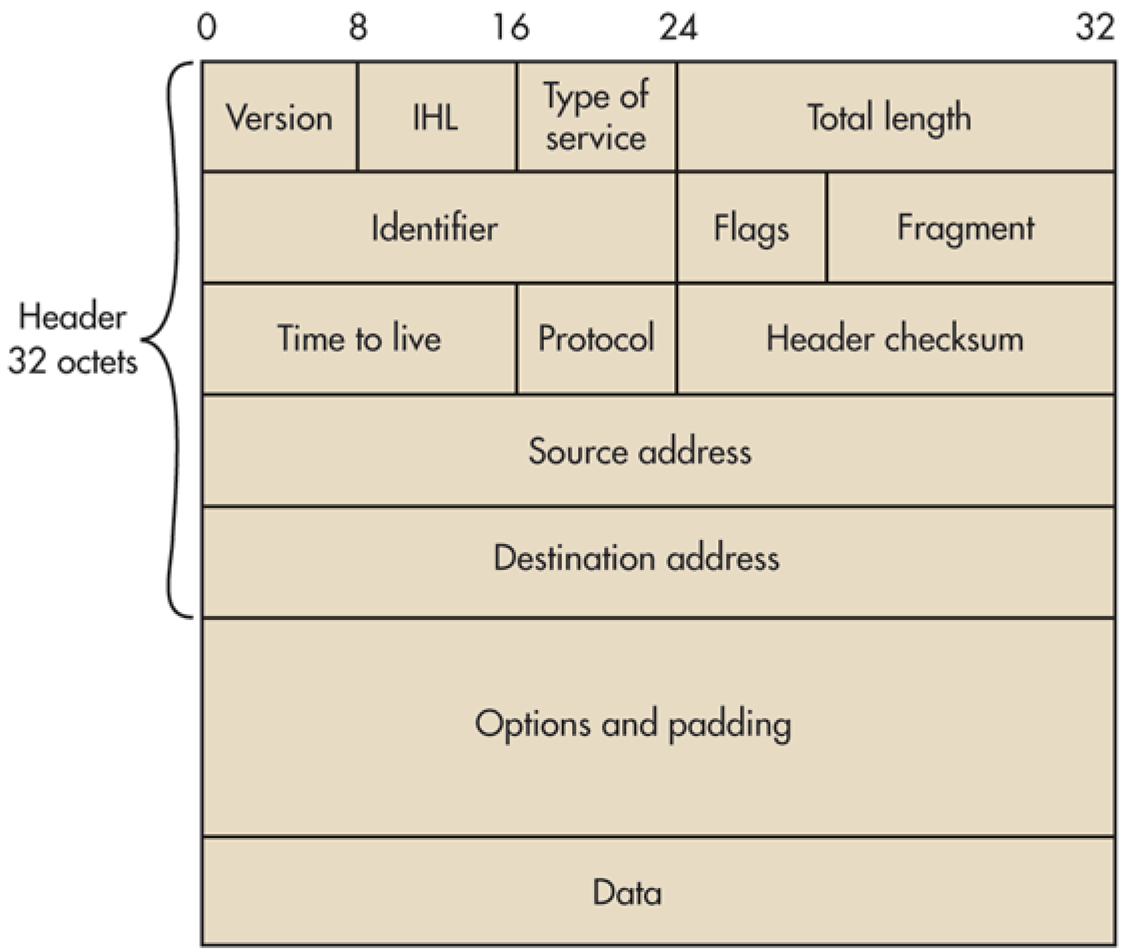

Figure 8: The IPv4 header is used during the Internet Protocol process in data transmission. Note that the source and destination addresses are 32-bit.

Note: OSI (Open Systems Interconnection) is a well-recognized model to describe the mechanisms used for computer systems and network devices to communicate and it is commonly used as a foundation to other networking protocols, such as TCP/IP.

The Similarities and Differences between OSI & TCP/IP

The main similarities between the two models include the following:

- **They share similar architecture**: Both of the models share a similar architecture. This can be illustrated by the fact that both of them are constructed with layers.
- **They share a common application layer**: Both of the models share a common "application layer". However in practice this layer includes different services depending upon each model.
- **Both models have comparable transport and network layers**: This can be illustrated by the fact that whatever functions are performed between the presentation and network layer of the OSI model similar functions are performed at the Transport layer of the TCP/IP model.
- **Knowledge of both models is required by networking professionals**: According to article obtained from the internet networking professionals "need to know both models". (Source:
- **Both models assume that packets are switched**: Basically this means that individual packets may take differing paths in order to reach the same destination.

The main differences between the two models are as follows:

- TCP/IP combines the presentation and session layer issues into its application layer.
- TCP/IP combines the OSI data link and physical layers into the network

access layer.

- TCP/IP appears to be a simpler model and this is mainly due to the fact that it has fewer layers.
- TCP/IP is considered to be a more credible model- This is mainly due to the fact because TCP/IP protocols are the standards around which the internet was developed therefore it mainly gains creditability due to this reason. Where as in contrast networks are not usually built around the OSI model as it is merely used as a guidance tool.
- The OSI model consists of 7 architectural layers whereas the TCP/IP only has 4 layers.

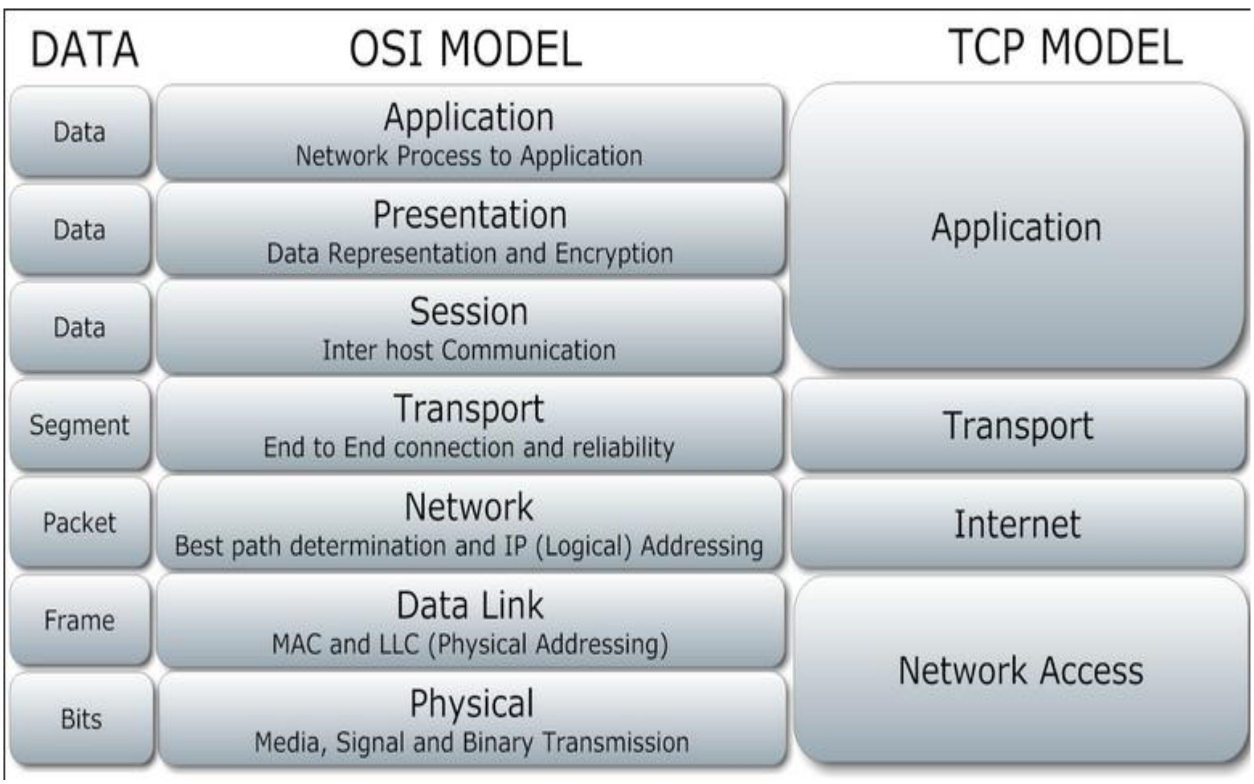

Figure 9: OSI & TCP model