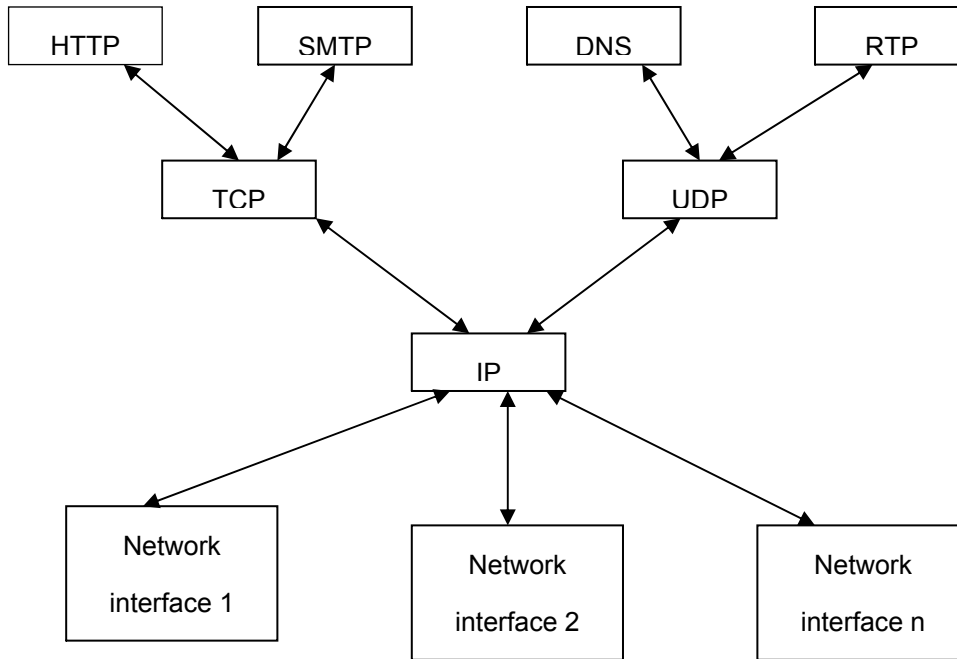**2.** (a) What universal set of communication services is provided by TCP/IP?

Solution:

The TCP/IP protocol stack provides two basic types of communications services through its two transport layer protocols: TCP provides reliable connection-oriented transfer of a byte stream; UDP provides for best-effort connectionless transfer of individual messages. TCP/IP provides with globally unique logical addressing that enables machines connected to the Internet to access these two services. The IP addressing scheme is very scalable because of its hierarchical structure.

2. (b) How is independence from underlying network technologies achieved?

Solution:

The two basic communications services provided by TCP and UDP are built on the connectionless packet transfer service provided by the Internet Protocol (IP). Many network interfaces are defined to support IP. The salient part of the above figure is that all of the higher layer protocols access the network interfaces through IP. This is what provides the ability to operate over multiple networks.

2. (c) What economies of scale result from (a) and (b)?

Solution:

Once a network interface for IP is defined for a given network technology, then hosts connected using the given network technology can connect to the Internet. This allows the reach of the Internet to grow rapidly, leveraging multiple coexisting networks technologies. Thus investment in new network technologies extends the reach of the Internet.

6. Which OSI layer is responsible for the following?

(a) Determining the best path to route packets.

The network layer is concerned with the selection of paths across the network.

(b) Providing end-to-end communications with reliable service.

The transport layer is concerned with providing reliable service on an end-to-end basis acro network.

(c) Providing node-to-node communications with reliable service.

The data link layer provides for the reliable transfer of information between adjacent nodes in a network.

10. Give two features that the data link layer and transport layer have in common. Give two features in which they differ. Hint: Compare what can go wrong to the PDUs that are handled by these layers.

Solution:

Features they have in common:
- Both layers can provide recovery from transmission errors.
- Both layers can provide flow control.
- Both layers can support multiplexing.

Features in which they differ:
- The transport layer is end to end and involves the interaction of peer processes across the network. The data link layer involves the interaction of peer-to-peer processes that are connected directly. In general, the time that elapses in traversing a data link is much smalle the time traversing a network, where packets can become trapped in temporary routing loops. Consequently, transport layer protocols must be able to deal with out-of-sequence PDUs and a much larger backlog of PDUs than data link layers.
- The data link layer is concerned with framing and the transport layer is not.
- The data link layer may be concerned with medium access control, the transport layer does not have this concern.

28. What is the difference between a physical address, a network address, and a domain name?

Solution:

The physical address is the unique hardware address that identifies an interface of a machine on a physical network such as a LAN. Physical addresses are used in the data link layer.

A network address is a machine's logical address on a network. The network address is used in the network layer. The network address used on the Internet is the IP address.

Domain names are used as an aid to identify hosts and networks in the Internet, since names are easier to remember than numbers. The DNS system is used to translate between domain names and IP addresses. The domain name for the network address 128.100.132.30 is toronto.edu.

32. Suppose a machine is attached to several physical networks. Why does it need a different IP address for each attachment?

Solution:

The IP address dictates through which network the packets are sent to and from the machine. Therefore each network connection must have a different address. The use of the IP address for the two attachments could also confuse nearby routers and introduce routing loops.

33. Suppose a computer is moved from one department to another. Does the physical address need to change? Does the IP address need to change? Does it make a difference if the computer is a laptop?

Solution:

The physical address does not change. It is globally unique to the computer's NIC card.

The IP address may need to be changed to reflect a new subnetwork id and host id.

The situation is the same for laptops.

43. Which of the TCP/IP transport protocol (UDP or TCP) would you select for the following applications: packet voice, file transfer, remote login, multicast communication (i.e., multiple destinations).

Solution:

Packet Voice - This example involves the transfer of a stream of information in real time across the network. At first, it may appear that TCP is suitable because of its connection orientation. However the acknowledgment and retransmission mechanisms in TCP introduce too much delay in the transfer of packets, and so UDP is the preferred approach to transferring a real-time voice stream across the network.

File Transfer - In general, file transfer requires reliable transfer and so TCP is preferred.

Remote Login - TCP is preferable because it provides for the reliable transfer of the stream of keystrokes that forms the basis for a remote login application.

Multicast Communication - In multicast services, a source sends information to a subset of destinations attached to the network. It is easy to imagine multicast applications that require reliable transfer of a stream of information to a set of destinations, and multicast applications that require only best effort transfer of individual messages. Therefore neither TCP nor UDP is preferred. A more pertinent point is that providing reliable multicast stream transfer service is quite difficult to implement, and TCP is not designed for this.

51. A denial-of-service attack involves loading a network resource to the point where it becomes non-functional.

  (a) Explain how PING can be used to carry out a denial-of-service attack.

Solution:

Using the PING program to send out a flood of packets to the network resource (for example, a server) increases the load on the server until it becomes nonfunctional.

  (b) On October 21, 2002 the 13 DNS root servers were subject to a distributed denial-of-service attack. Explain the impact of the attack on the operation of the Internet if some of the servers are brought down; if all of the servers are brought down.

Solution:

If all of the DNS root servers are brought down, then the root servers will not be available to handle the queries from local name servers resulting in severe disruption of the Internet. In practice, DNS servers make extensive use of caching and so can resolve a majority of queries without referring to the root servers.