TCP/IP and Inter-Networking

TCP/IP, a common protocol method used to interconnect computers together, and also serves as the default protocol for accessing information over the Internet.

Inter-Networking

UNIX systems are usually interconnected using TCP/IP (transmission control protocol, Internet protocol). This is a protocol mechanism that is widely used by large networks worldwide to interconnect computers of different types.

A protocol is a set of rules that govern how computers talk to each other.

TCP/IP is a widely used and very popular protocol. With TCP/IP, different computer systems can reliably exchange data on an interconnected network. It also provides a consistent set of application programming interfaces (API's) to support application development.

This means that software programs can use TCP/IP to exchange data. An example of this is web servers and web browsers, software applications which use TCP/IP to exchange data.

Features of TCP/IP

Below are a few of the common features of TCP/IP.

- **File Transfer**
  The file transfer protocol (FTP) applications let users transfer files between their computer systems.

- **Terminal Emulation**
  Telnet and rlogin provide a method for establishing an interactive connection between computer systems.

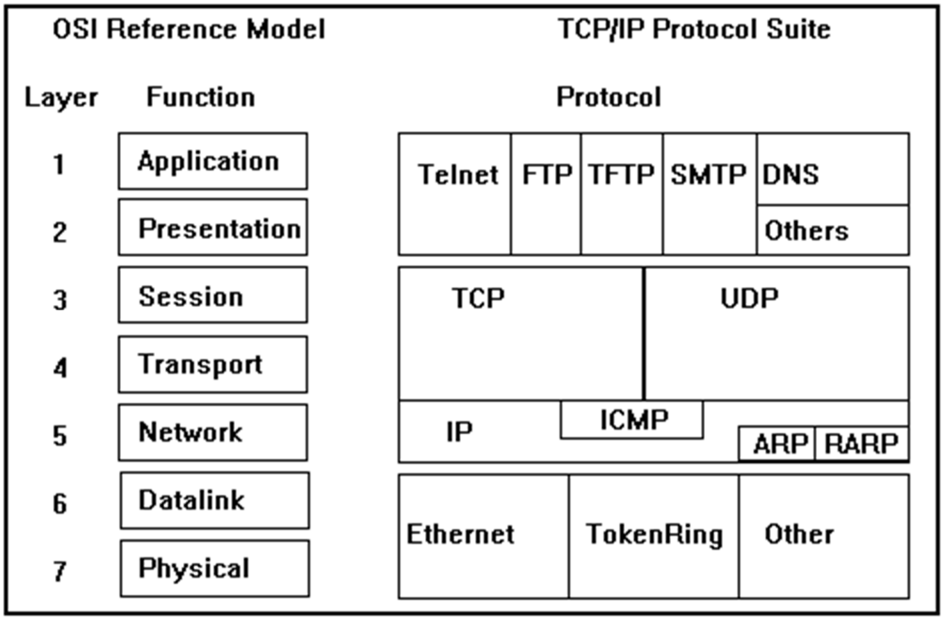
- **Transparent distributed file access and sharing**
  The Network File System (NFS) uses the IP protocol to extend the file system to support access to directories and disk on other computer systems.

- **Remote command execution**
  Using the remote shell (rsh) and remote execution (rexec) programs, users can run programs on remote computers and see the results on their own computer.

- **Remote Printing**
  The UNIX command lpr provides remote printing services.

TCP/IP and OSI

The protocols used closely resemble the OSI model. The Open Systems Inter-connect model is a model of 7 layers, which deal with the exchange of data from one computer to another.



Applications developed for TCP/IP generally use several of the protocols. The sum of the layers used is known as the **protocol stack.**

User Application programs communicate with the top layer in the protocol stack. This layer passes information to the next subsequent lower layer of the stack, and so on till the information is passed to the lowest layer, the physical layer, which transfers the information to the destination network.

The lower layer levels of the destination computer passes the received information to its higher levels, which in turn passes the data to the destination application.

Each protocol layer performs various functions which are independent of the other layers.

Each layer communicates with equivalent layers on another computer, e.g., the session layer of two different computers interact.

An application program, transferring files using TCP/IP, performs the following,

The **Application layer** passes the data to the transport layer of the source computer.

The **Transport layer** divides the data into TCP segments, adds a header with a sequence number to each TCP segment passes the TCP segments to the IP layer

The **IP layer** creates a packet with a data portion containing the TCP segment, adds a packet header containing the source and destination IP addresses, determines the physical address of the destination computer passes the packet and destination physical address to the data link layer.

The **Data link layer** transmits the IP packet in the data portion of a frame the destination computers. Data link layer discards the data link header and passes the IP packet to the IP layer.

Physical Addresses and Internet Addresses

Each networked computer is assigned a **physical address,** which takes different forms on different networks. For ETHERNET networks, the physical address is a 6 byte numeric (or 12 digit hexadecimal) value (e.g. 080BF0AFDC09).

Each computers Ethernet address is unique, and corresponds to the address of the physical network card installed in the computer.

Internet addresses are **logical addresses**, and are independent of any particular hardware or network component.

The TCP/IP protocol implements a logical network numbering, stored in configuration files, which a machine identifies itself as. This logical numbering is important in sending information to other users at other networks, or accessing machines remotely.

Internet addresses are logical addresses, and are independent of any particular hardware or network component. It consists of a 4 byte (32-bit) numeric value which identifies the network number and the device number on the network.

The 4 byte IP address is represented in dotted decimal notation, where each byte represents a value between 0 and 255, e.g., 127.46.6.11

When a computer wants to exchange data with another computer using TCP/IP, it first translates the destination IP address into a physical address in order to send packets to other computers on the network, this is called **Address resolution Protocol(ARP)**.

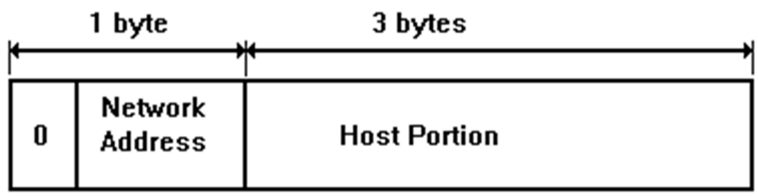
When a client computer wishes to communicate with the host computer, it must translate its logical name into its IP address. Once the IP address is known, an address resolution is performed to return the physical address of the computer.

The IP logical numbering is comprised of a network number and a local number. For sites connected to the Internet, the network portion is assigned by applying to a company responsible for maintaining the Internet Domain Names.

The construction of an IP address is divided into three classes. Which class is used by an organization depends upon the maximum number of work stations that is required by that organization. Each node or computer using TCP/IP within the organization MUST HAVE a unique host part of the IP address.

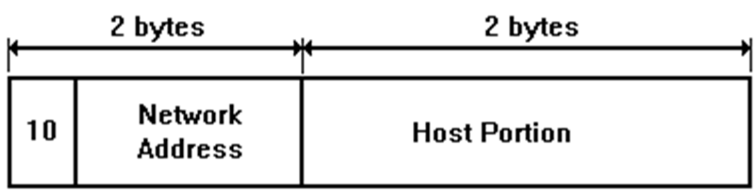
Class A Addressing

- first byte specifies the network portion
- remaining bytes specify the host portion
- the highest order bit of the network byte is always 0
- network values of 0 and 127 are reserved
- there are 126 class A networks
- there are more than 16 million host values for each class A network



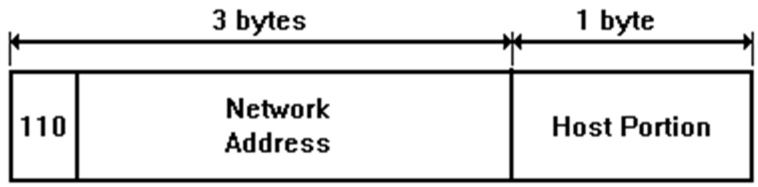
Class B Addressing

- the first two bytes specify the network portion
- the last two bytes specify the host portion
- the highest order bits 6 and 7 of the network portion are 10
- there are more than 16 thousand class B networks
- there are 65 thousand nodes in each class B network

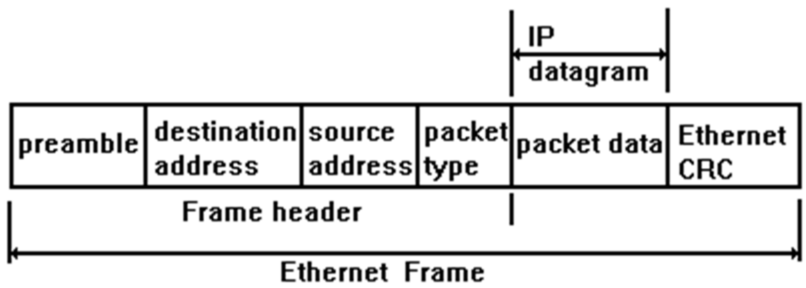


Class C Addressing

- the first three bytes specify the network portion
- the last byte specifies the host portion
- the highest order bits 5, 6 and 7 of the network portion are 110
- there are more than 2 million class C networks
- there are 254 nodes in each class C network

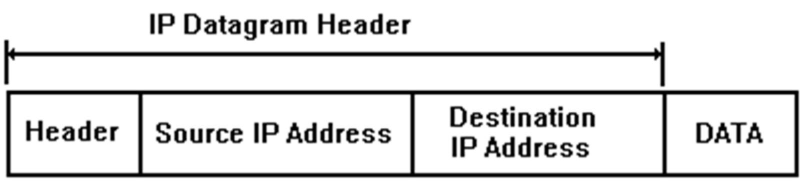


Internet to Physical Address Translation
When an IP packet is sent, it is encapsulated (enclosed) within the physical frame used by the network. The IP address is mapped onto the physical address using the Address Resolution Protocol (ARP) for networks such as Ethernet, token-ring.



When a node wants to send an IP packet, it determines the physical address of the destination node by first broadcasting an ARP packet which contains the destination IP address. The destination node responds by sending its physical address back to the requesting node.

The Internet Protocol (IP)
This defines the format of the packets and how to handle them when sending or receiving. The form of the packets is called an *IP datagram*.



Summary
TCP/IP is the protocol used by computers on the Internet. Each computer has an IP address, which is a set of four digits joined using dots, and a logical name, which identifies it.

Many applications can be built on top of TCP/IP, such as file transfer (FTP) and Web services (WWW). In an organization which is connected to the Internet using TCP/IP, a domain name server resolves logical names of host computers to IP addresses.