IP Networking

The internet is a network of connected networks.

(Draw connected networks with hosts and routers/gateways here.)

Every computer/host has a unique IP address.
The IP address is divided into network address and host address by the netmask.

**IP Address Assignment**

IP addresses can be assigned statically (by an administrator) or dynamically by a DHCP server. When the host boots it broadcasts a request for a DHCP server. The DHCP server responds with IP, NETMASK, GATEWAY IP, DNS IP.

Routers are used to connect networks. Routers are connected to multiple networks and have IP addresses (and interface cards) on all networks.

A host can tell from the IP address if a destination is on the local network or on a different network. If the destination is local the packet is sent directly to the destination. If it is on a different network the packet is sent to the router/gateway.

**DNS**

We (humans) specify host by names instead of IP numbers. When you type a host name in your web browser or click on a link. The application (web browser) translates the name into an IP address by contacting a DNS server. The DNS server returns the IP address corresponding to the remote host name.

**Localhost**

Every computer has a localhost IP address of 127.0.0.1 on a virtual 127.0.0.0 address. You can write network communication software that communicates using this address even if you don't have a network card.

**Netburner**

We will use a private LAN with statically assigned IP numbers to communicate with the Netburner initially.

<table>
<thead>
<tr>
<th>Computer</th>
<th>IP=192.168.100.1</th>
<th>NETMASK=255.255.255.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netburner</td>
<td>IP=192.168.100.2</td>
<td>NETMASK=255.255.255.0</td>
</tr>
</tbody>
</table>

**Ethernet**

IP addressing works regardless of how the computers on the local network (LAN) are connected physically. The most common physical network in use today is Ethernet. Packets on the local network are Ethernet packets containing Ethernet addresses of the source and destination. ARP is used to find the Ethernet address of a host on the local network from its IP address.

**TCP**

TCP takes care of routing the packets from source to destination. TCP allows you to have multiple (virtual) connections between the same two computers. Applications on both sides bind to particular ports. IP packets contain source/dest IP addresses as well as source/dest TCP port numbers.
TCP also takes care of error detection and correction. This is done automatically by TCP. The programmer does not have to worry about it.

Services
Server applications bind/listen on well-known ports (HTTP: 80, FTP: 21, SSH: 22, SMTP: 25, Telnet: 23). Clients send data to these particular ports to initiate communication. Elevated privileges are required to run an application that binds to a well-known port (ports with port number < 1024).

UDP
UDP is another transport protocol similar to TCP, but it does not provide error correction.

Sockets
The sockets API is the most common API for network programming. Support for TCP/IP and UDP/IP communication is provided. The sockets API is a general API for intertask comm. In addition to TCP/IP sockets, you can also create UNIX (local) sockets for comm between processes running on the same computer.

Name to IP Resolution
/etc/hosts file
DNS

IP to MAC Resolution
/etc/ethers file (obsolete)
ARP
arp command

IP Assignment
static
DHCP

Layer 1 (Physical)
Ethernet Physical (10BASE-T, 100BASE-T, 1000BASE-T, 10BASE-2, 10BASE-5)
WiFi (IEEE 802.11)
LocalTalk, Telephone modems, IRDA, Serial, Parallel, USB, Bluetooth,
 T1 et al, ISDN, DSL, CAN, SONET, ...

Layer 2 (Data Link)
Ethernet
WiFi, WiMAX, PPP, SLIP, Token Ring, FDDI, Frame Relay, ...

Layer 2.5 (Network Topology)
ARP
RARP, ATM, X.25, ...

Layer 3 (Network)
IPV4, IPV6
IPSec, ICMP, IGRP, EGP
IPX, DDP, AppleTalk DDN, ...

Layer 4 (Transport)
TCP, UDP, SSL
SPX, ...

Layer 5 (Session)
Sockets
NFS, SMB, NetBIOS, NetBEUI, NCP
Layer 6 (Presentation)
    TLS
Layer 7 (Application)
    HTTP, HTTPS, SSH, BitTorrent
    DNS, DHCP, FTP, Telnet, rlogin, IMAP, POP3, NTP, NNTP, ...

Layers 5-7 are combined in the TCP/IP model.

Protocol Suites
    IP Suite (TCP/IP)
        IPX/SPX, AppleTalk, DECnet, Xerox

TCP/IP

    Application
    /  \
   |   |
  TCP  UDP
  |   |
 /   /
 |   |
 IP
 /  \
 |   |
Ethernet  WiFi

IP - Internetworking Protocol
DHCP - Dynamic Host Control Protocol
DNS - Domain Name Services
TCP - Transport Control Protocol
UDP - User Datagram Protocol
ARP - Address Resolution Protocol
NAT - Network Address Translation