Internetworking, the Internet

CS158a

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Outline

- Issues in Internetworking
- The Internet

Internetworking

- Until now we have assumed our network was homogeneous
- Real world, we have several different network layers out there: IP, SNA, ATM, NCP/IPX, Appletalk.
- These have differences at each of the layers.
- At the network layer, may differ in addressing, packet size, connectionless versus connection-oriented, QoS, flow, and congestion control.
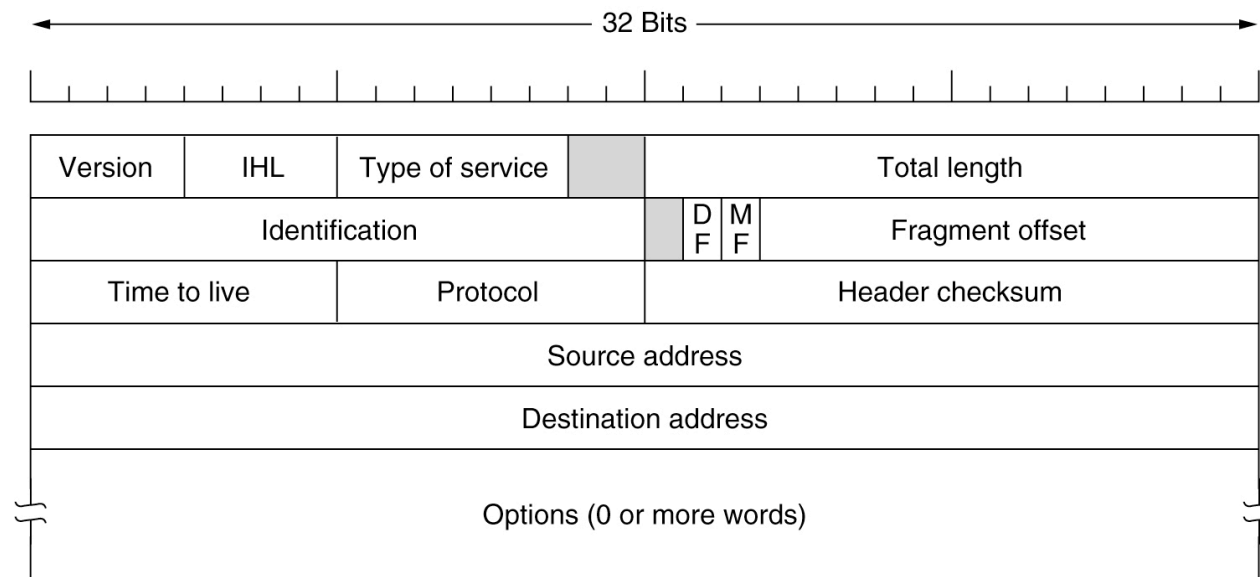
How Networks Can be Connected

- Routers that can handle multiple network layer protocols, (**multiprotocol routers**) can be used
- At the transport layer, might have transport gateways.
- At the the application layer, might have gateways that convert between things like X.400 and RFC 822 e-mail.
- Two common approaches to internetworking are:
  - **Concatenated Virtual Circuits** -- set up a sequence of virtual circuit within each network in path from source to destination. (frame relay, SNA, 80216, ATM).
  - **Connectionless Internetworking**: some approaches -- try to translate packets (not common), try to encapsulate or **(tunnel packets),** try to maintain tables at gateway machines between two different addressing schemes

Internetwork Routing

- As indicated the connectionless approach might have several problems to overcome.
- Usually apply either distance vector routing or link state routing in a hierarchal fashion:
- Use one as an **interior gateway protocol** with a given network, then use another at a higher level called an **exterior gateway protocol** between networks.
- Each network at the higher level is independent of each other and is sometimes referred to as an **Autonomous System**.
- To make sure that a packet can go through each system, when it hits a gateway at which smaller packets may be required it is typically split up into smaller packets in a process called **fragmentation**. Packet 0 might be split into 0.0, 0.1, etc. 0.1 might be further split into 0.1.0, 0.1.1, etc.
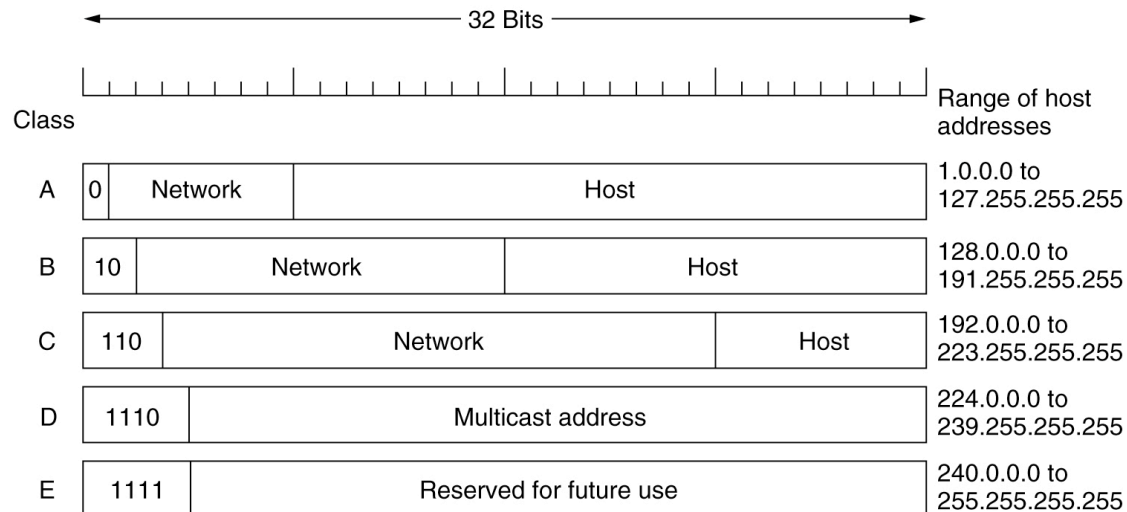- Recombination may occur at other gateway or destination.

IP Protocol

- We now look at the **Internet Protocol (IP)** which is the glue which holds together the network layer of the actual internet.

- It supports packets up to 64Kb, but most are typically 1500 bytes.

- An IPv4 packet header looks like:

← 32 Bits →				
Version	IHL	Type of service		Total length
Identification			DF MF	Fragment offset
Time to live		Protocol		Header checksum
Source address				
Destination address				
Options (0 or more words)				

IP Addresses

- Every host or router on the internet has at least one IP address.

- This is a 32 bit number which is typically split into a network part and a host part.

- Addresses as 4 bytes separated by dots: 127.1.0.1. They can also be written in binary or in hex (as a eight digit number).

- Originally, addressing was done in a **classful way** with 5 classes of networks:

		32 Bits	Range of host addresses
Class			
A	0	Network / Host	1.0.0.0 to 127.255.255.255
B	10	Network / Host	128.0.0.0 to 191.255.255.255
C	110	Network / Host	192.0.0.0 to 223.255.255.255
D	1110	Multicast address	224.0.0.0 to 239.255.255.255
E	1111	Reserved for future use	240.0.0.0 to 255.255.255.255

Subnets

- Classful addressing caused problems because most organizations were two big to use class C networks. On the other hand, they could use all of the 65,000ish addresses of a class B network. So many addresses were wasted.

- To solve this problem today subnetting is used **(Classless Interdomain Routing--CIDR).** IP addresses are often written as Address/#lead on bits in the mask. Masks are 32 bits with the lead bits on, the rest off. For example, we might write the IP address as: 194.24.0.0/21

- A router entry consists of a triple, (IP address, subnet mask, outgoing line).

- When a packet arrives at a router. Its destination IP address is extracted, this is matched to a router entry, by first ANDing it with the entry mask then comparing to the IP address. If it matches the corresponding line is used.

- At the subnet router, (for instance, have a 32 bit mask) routing to individual hosts might happen.