NET 363
Introduction to LANs

IPv4 Addresses and DHCPv4

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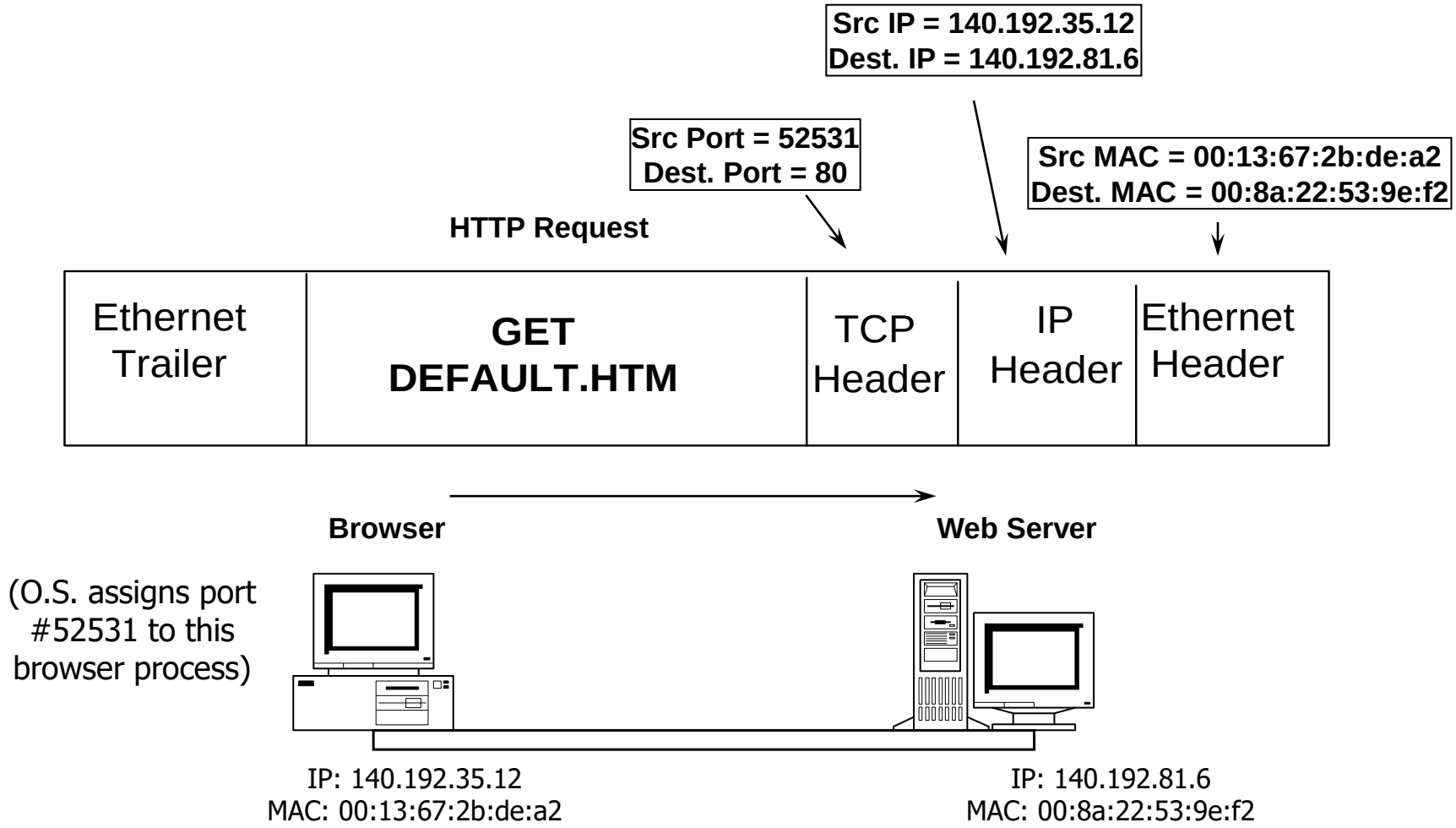
Packet Headers and Addresses

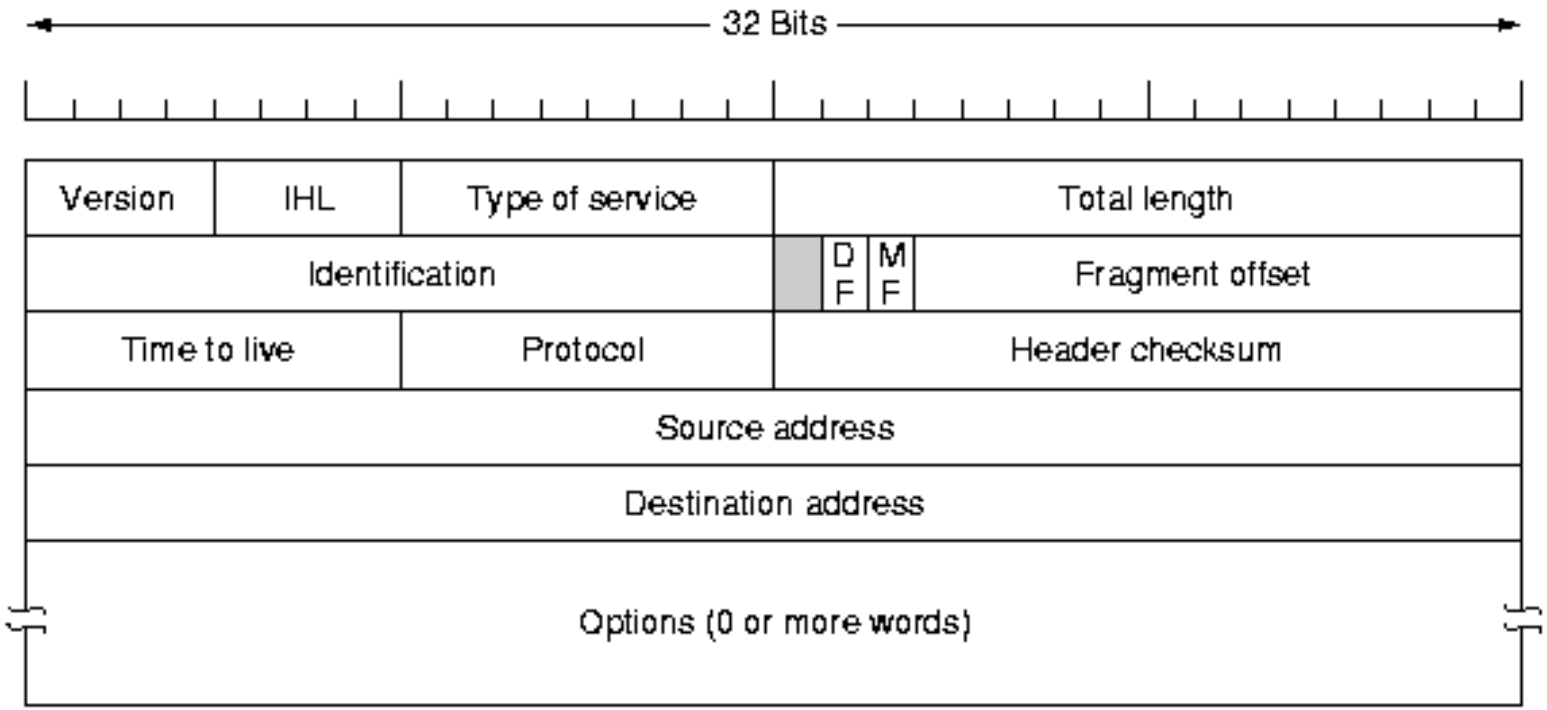


In Response packet, Src and Dest values will be swapped in IP and TCP headers

IPv4 Header

- IPv4 adds 20 bytes of ***IPv4 Header*** to every data packet
- These 20 bytes include all information required by IP routers to direct this packet to its destination.

IPv4 Header


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

IPv4 Header Fields

- **Version**: IP protocol version. Value = "4" for IPv4 header.
- **IP Header Length**: Length of IP header in 32-bit words
- **Type of Service**: Indicates whether this packet should be low or high priority
- **Total Length**: Length of IP packet in bytes

IP Header Fields

- **Identification / Fragment Offset**: used to identify and reassemble ***fragments*** that are formed when routers break IP packets into smaller packets
- **Time to Live**: Max. number of routers this IP packet may pass through. If exceeded, packet will be discarded.
- **Protocol**: Identifies the protocol carried inside the *next header* after this IPv4 header – typically TCP or UDP.

IP Header Fields

- **Header Checksum**: Allows error checking of IP packets
- **Source Address**: 4-byte IPv4 source address for this packet
- **Destination Address**: 4-byte IPv4 destination address for this packet

IP Address Allocation

- IPv4 address allocation controlled by **Internet Assigned Numbers Authority (www.iana.org)**
- IANA allocates "/8 blocks" (all IP addresses with a fixed value in 1st byte) to **Regional IP Registries (RIRs)** who control IP address allocation for a part of the globe*.

The Five RIRs

Registry	Area Covered
AfriNIC	Africa Region
APNIC	Asia/Pacific Region
ARIN	North America Region
LACNIC	Latin America and some Caribbean Islands
RIPE NCC	Europe, the Middle East, and Central Asia

* RIR allocations: http://www.iana.org/assignments/ipv4-address-space/ipv4-address-space.xml

IP Address Allocation

- **RIRs** then allocate blocks of IP addresses to **ISPs** and **Large Organizations.** ISPs then allocate smaller blocks of IP addresses to their customers as needed.
- In 1980s/early 1990s, **Classful IP Address Allocation** was used, where each address block allocated by an RIR was a **Class A, Class B or Class C** block (/8, /16 or /24, respectively).
- After mid-1990s, RIRs and ISPs use **Classless IP Address Allocation**, where they now allocate address blocks of size 2^x for any value of x <= 24.

IPv4 Address Classes

- **Class A block (unicast)**
  - Value of first bit = 0.
  - Result: Class A **1st byte** range = 1 to 127.
- **Class B block (unicast)**
  - Value of first 2 bits = 10.
  - Result: Class B **1st byte** range = 128 to 191.
- **Class C block (unicast)**
  - Value of first 3 bits = 110.
  - Result: Class C **1st byte** range = 192 to 223.
- **Class D block (multicast)**
  - Value of first 4 bits = 1110.
  - Result: Class D **1st byte** range = 224 to 239.

Special IP Addresses

- **0.0.0.0** = Current host
- **255.255.255.255** = IP broadcast within current subnet.
- **127.0.0.0/8** = Loopback address
- Private IP addresses – see next slide.

Private IP Addresses

- Some IP Address networks were set aside for private use by the IANA.
- Private IP Networks :
  - Class A: 10.0.0.0/8
  - Class B: 172.16.0.0/16 to 172.31.0.0/16
  - Class C: 192.168.0.0/24 to 192.168.255.0/24
- These addresses can be used in private networks, but cannot be used in any IP packets on the public Internet backbone.

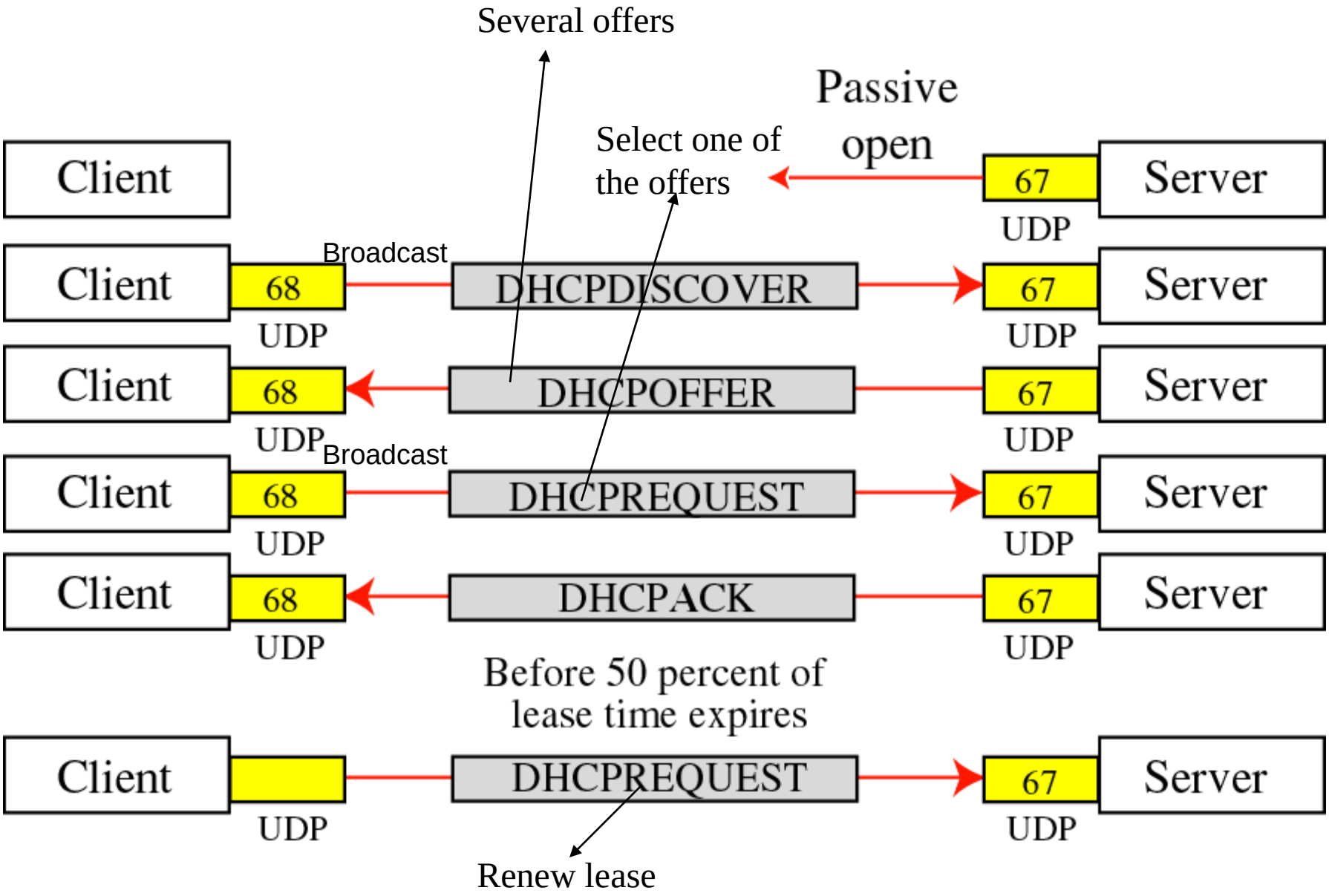
DHCP

- A device that has just powered up can use DHCP (Dynamic Host Configuration Protocol) service to obtain the **IP bootstrap values** required to send IP data**:**
  - IP Address
  - Subnet Mask
  - Default gateway address (router interface on same subnet)
  - DNS server address
- DHCP server(s) maintain pools of free IP addresses for each subnet and allocate with a *lease time*.

DHCP Protocol

- DHCP uses UDP port 67 (server) and port 68 (client)
- Client broadcasts DHCPDISCOVER request
- Server(s) respond with DHCPOFFER(s)
- Client broadcasts DHCPREQUEST, identifying one OFFER accepted.
- Server responds with DHCPACK.
- When 50% of Lease Time expires, Client sends DHCPREQUEST to renew IP address.

Figure 18.9 Exchanging messages (Part I)



DHCP Relay Service

- A router can forward DHCP Requests if the admin enables the **Relay Agent** service: **ip helper-address <DHCP Server IP>.**
- When this router receives DHCP Discover or DHCP Request, it stores the incoming interface IP into the Gateway IP Addr field of the DHCP msg and forwards it to the DHCP Server.
- DHCP Server receives and allocates an unused IP address for the subnet containing the Gateway IP Address in packet.
- When sending the offer back to the client, the DHCP server sends the DHCPOffer message directly to the Relay Agent router (to the Gateway IP Address).
- Once received by the Relay Agent, the Gateway IP Address is used to determine the interface out which the DHCPOffer message will be forwarded.