CSC358H5: Principles of Computer Networking — Winter 2025

Worksheet 6: Internet Protocol (IP) Address, Prefix, and Forwarding

Q0 Knowledge Check (from Week 06 Lecture)

0.a **(True/False)** The IP protocol guarantees reliable data delivery.

0.b What happens when a router receives an IP packet with a destination IP address that is NOT in any of the IP prefixes in its routing table?

0.c In the context of routers, compare the two concepts **"Routing"** and **"Forwarding"**. Explain the key differences – the context/layer(s) they are defined at, protocol(s) they are related to, when/where they are used, etc.

- **Routing:**
  - The context/layer(s) it is defined at:
  - The protocol(s) it is related to:
  - When/where it is used/implemented:
  - Is it implemented locally or distributedly?
  - In at most 2-3 sentences, explain its purpose:

- **Forwarding:**
  - The context/layer(s) it is defined at:
  - The protocol(s) it is related to:
  - When/where it is used/implemented:
  - Is it implemented locally or distributedly?
  - In at most 2-3 sentences, explain its purpose:

0.d **(IP Prefix)** The following is the list of IP prefix of Networks 1, 2, and 3.

Network 1: 131.21.0.0/16 **Network 2:** 131.22.0.0/16 **Network 3:** 133.22.12.0/24

Consider the following hosts with IP addresses:

Host A: 131.21.12.19 **Host B:** 133.21.12.19 **Host C:** 133.22.11.19 **Host D:** 131.21.21.21

To which network do the different hosts belong? Are there any hosts that do not belong to any of the above networks?

- **Host A:** ☐ Network 1 ☐ Network 2 ☐ Network 3 ☐ None
- **Host B:** ☐ Network 1 ☐ Network 2 ☐ Network 3 ☐ None
- **Host C:** ☐ Network 1 ☐ Network 2 ☐ Network 3 ☐ None
- **Host D:** ☐ Network 1 ☐ Network 2 ☐ Network 3 ☐ None

0.e **(Routing Table and Maximum Prefix Matching)** Consider the routing table given in Table 1. Where does it send packets destined to 128.96.39.10, 128.96.40.12, 128.96.40.151, 192.4.153.17, and 192.4.153.90?

- Packet with destination 128.96.39.10:
- Packet with destination 128.96.40.12:
- Packet with destination 128.96.40.151:
- Packet with destination 192.4.153.17:
- Packet with destination 192.4.153.90:

Table 1: Routing Table

SubnetNumber	SubnetMask	NextHop
128.96.39.0	255.255.255.128	Interface 0
128.96.39.128	255.255.255.128	Interface 1
128.96.40.0	255.255.255.128	R2
192.4.153.0	255.255.255.192	R3
0.0.0.0	0.0.0.0	R4

0.f (IP Header) In lecture, we reviewed the list of tasks that packet headers are needed for:

A. Read packet correctly
B. Get the packet to the destination
C. Get responses to the packet back to source
D. Carry data
E. Tell host what to do with the packet once arrived
F. Specify any special network handling of the packet
G. Dealing with Header Corruption
H. Dealing with Loops
I. Dealing with Packets that are too large
J. Dealing with Payload Corruption

Consider the IPv4 headers shown in Figure 1. Each of these fields is devoted to a task. In Table 2, map between tasks listed above and the header fields. For your reference, we filled out the mapping for the first row in the table.

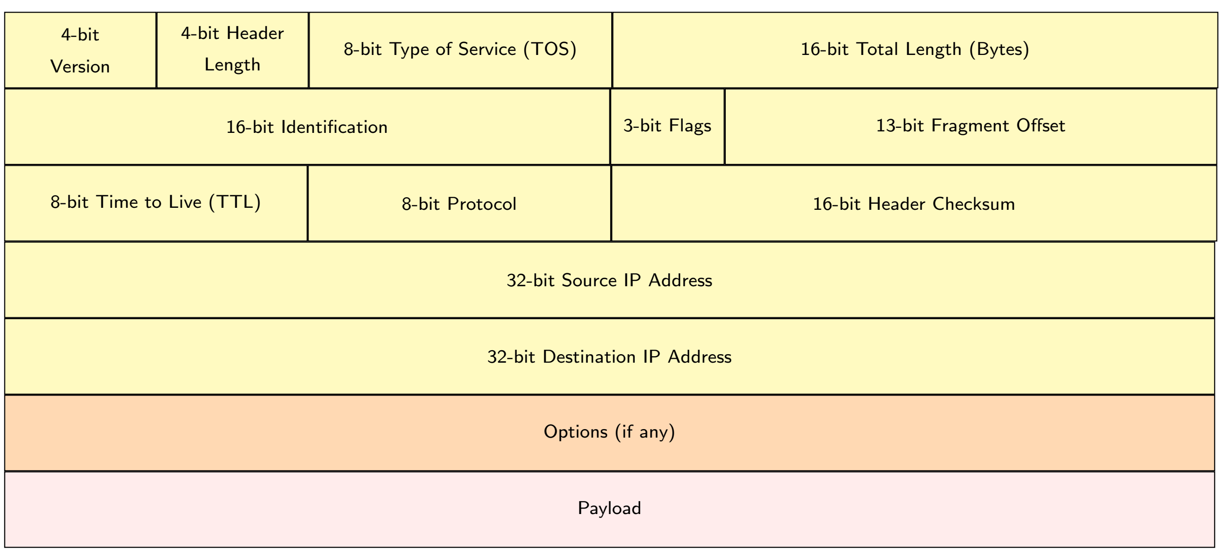

Figure 1: IPv4 headers.

Q1 (IP Fragmentation – Loss Probability)

Suppose an IP packet is fragmented into 10 fragments. Suppose that each fragments has (independent) loss probability of 1%.

1.a Find the probability of losing the whole packet. The whole packet is lost even if a single fragment is lost.

Table 2: Map between tasks listed above and the header fields.

Field(s)	Task
Payload	D
TTL	
Version number, Header length, and Total length	
Destination IP address	
Identification, Flags, Fragment Offset	
Type-of-Service, Options	
Source IP address	
Protocol	
Checksum	

1.b Find the probability of net loss of the whole packet if the packet is transmitted twice,

- **1.b. i** Assuming all fragments received must have been part of the same transmission?
- **1.b. ii** Assuming any given fragment may have been part of either transmission?

Q2 **(IP Fragmentation – MTU)** Suppose the following IP datagrams all pass through another router onto a link with a Maximum Transmission Unit (MTU) of 370 bytes.

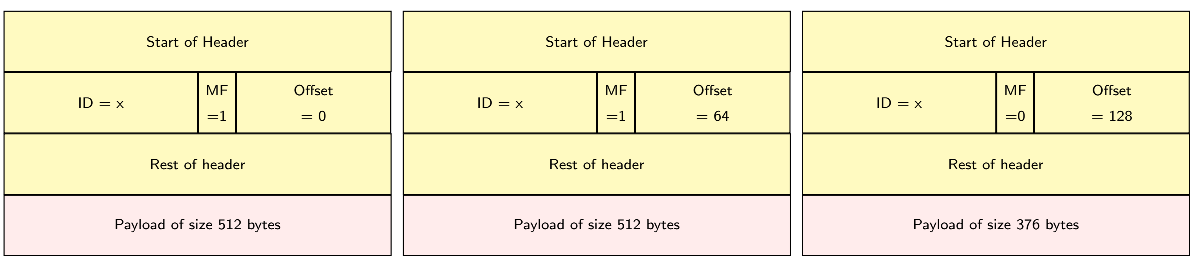

Figure 2: Three IPv4 packets and their header fields value.

2.a Considering the typical IP header size of 20 Bytes, show the IP fragments produced.

2.b If we had found the path MTU to be 370 and fragmented the data with respect to that, how many datagrams (*i.e.*, IP packets) would be produced by the sender?