TCP/IP Internetworking I Assignment

Answer all of the following questions.

1. a) Which two layers standardize Ethernet and Wi-Fi operation? **Data link and physical layers**

b) Which two layers standardize most of the Internet's operation? **Internet and transport layers**

c) What do IP, TCP, and UDP govern? **IP governs addressing and routing, TCP govern reliability and connection oriented, and UDP governs fast and connectionless.**

d) What do TCP/IP supervisory protocols govern? **They manage errors, address resolution, and network operations.**

2. a) What are interfaces? **Network connection points**

b) Explain the network adage "Switch where you can; route where you must." **Switching is faster with in networks, but routing is needed between networks.**

3. a) What are the three parts of an IPv4 address? **Network part, subnet part, and host part**

b) How long is each part? **Depends on the subnet mask.**

c) What is the total length of an IPv4 address? **32 bits**

d) In the IPv4 address, 10.11.13.13, what is the network part? **10**

e) If you see an IPv4 address, what do you know for certain? **It is a 32-bit address for a device that is online in a network**

4. a) Connecting different networks is the main job of what type of router? **Border router**

b) What type of router connects different subnets? **Internal router**

5. a) How many bits are there in an IPv4 mask? **32 bits**

b) What do the 1s in an IPv4 network mask correspond to in IPv4 addresses? **Network part**

c) What do the 1s in an IPv4 subnet mask correspond to in IPv4 addresses? Think carefully! **Network/subnet parts**

d) When a network mask is applied to any IPv4 address on the network, what is the result? **Network identifier**

6. a) A mask has eight 1s, followed by 0s. Express this mask in dotted decimal notation. **255.0.0.0**

b) Express this mask in prefix notation. **/8**

c) In prefix notation, a mask is /16. Express this mask in dotted decimal notation.
255.255.0.0

d) Express the mask /18 in dotted decimal notation. (You will need a calculator for this.) **255.255.192.0**

7. Why are routing tables more complex than Ethernet switching tables? Give a detailed answer. **They are more complex because they store much more, including metrics and network prefixes. Switching tables only store MAC-port mappings.**

8. a) In a routing table, what does a row represent? **A route to a network**

b) Do Ethernet switches have a row for each individual Ethernet address? **No**

c) Do routers have a row for each individual IPv4 address? **No**

d) What is the advantage of the answer to the previous subparts of this question?
They reduce memory and overhead processing.

9. a) In Figure 8-11, how will a router test whether Row 3 matches the IPv4 address 60.168.6.7? **Router applies the subnet mask to the destination IP and the result matches the destination network in row 3.**

Packet arrives with destination IP address 128.171.17.13

1. Find all row matches

2. Select the best-match row

3. Decide how to send the packet back out

Row	Destination Network or Subnet	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
1	128.171.0.0	255.255.0.0 (/16)	47	2	G
2	172.30.33.0	255.255.255.0 (/24)	0	1	Local
3	60.168.6.0	255.255.255.0 (/24)	12	2	G
4	123.0.0.0	255.0.0.0 (/8)	33	2	G
5	172.29.8.0	255.255.255.0 (/24)	34	1	F
6	172.40.6.0	255.255.255.0 (/24)	47	3	H
7	128.171.17.0	255.255.255.0 (/24)	55	3	H
8	172.29.8.0	255.255.255.0 (/24)	20	3	H
9	172.12.6.0	255.255.255.0 (/24)	23	1	F
10	172.30.12.0	255.255.255.0 (/24)	9	2	G
11	172.30.12.0	255.255.255.0 (/24)	3	3	H
12	60.168.0.0	255.255.0.0 (/16)	16	2	G
13	0.0.0.0	0.0.0.0 (/0)	5	3	H

FIGURE 8-11 Routing Table

b) Is the row a match? **Yes**

c) Why is the last row called the default row? **It matches any IP address if no other match is found.**

d) Why must a router look at all rows in a routing table? **To find all the POTENTIAL matches, then select the best one**

e) Which rows in Figure 8-11match 172.30.17.6? (Don't forget the default row.) Show your calculations for rows that match. **Row 10 (172.30.12.0/24): No match (172.30.17.6 is outside 172.30.12.0/24). Row 11 (172.30.17.0/24): Matches (172.30.17.6 falls within 172.30.17.0 - 172.30.17.255). Row 13 (0.0.0.0/0): Matches by default. Best match is Row 11.**

f) Which rows match 60.168.7.32? Show your calculations for rows that match. **Row 3 (60.168.6.0/24): No match (60.168.7.32 is outside 60.168.6.0/24). Row 12 (60.168.0.0/16): Matches (60.168.7.32 falls within 60.168.0.0 - 60.168.255.255). Row 13 (0.0.0.0/0): Matches by default. Best match is Row 12.**

g) Which rows in Figure 8-11 match 128.171.17.13? (Show your calculations for rows that match.) **Row 1 (128.171.0.0/16): Matches (128.171.17.13 falls within 128.171.0.0 - 128.171.255.255). Row 7 (128.171.17.0/24): Matches (128.171.17.13 falls within 128.171.17.0 - 128.171.17.255). Row 13 (0.0.0.0/0): Matches by default. Best match is Row 7.**

10. a) Distinguish between Step 1 and Step 2 in the routing process. **Step one is all about finding all the matches with the destination IP, and step 2 is all about finding the best match.**

b) If any row other than the default row matches an IPv4 address, why will the router never choose the default row? **The default row is only used when no other row matches.**

c) Which rows in Figure 8-11 match 128.171.17.13? (Don't forget the default row.) **Row 1 (128.171.0.0/16) → Match Row 7 (128.171.17.0/24) → Match (more specific) Row 13 (0.0.0.0/0) → Default match**

d) Which of these is the best-match row? Justify your answer. **Row 7 because it has the longest prefix and is more specific than the others.**

e) What rows match 172.40.17.6? Show your calculations for rows that match. **Row 6 (172.40.6.0/24) → No match (172.40.17.6 is outside 172.40.6.0/24). Row 13 (0.0.0.0/0) → Matches by default.**

f) Which of these is the best-match row? Justify your answer. **Row 13 because there is no specific match that exists.**

g) Which rows match 172.30.12.47? Show your calculations for rows that match. **Row 10 (172.30.12.0/24) → Matches (172.30.12.47 is within 172.30.12.0 - 172.30.12.255). Row 13 (0.0.0.0/0) → Matches by default.**

h) Which of these is the best-match row? Justify your answer. **Row 10 because it has the longest prefix match.**

i) How would your previous answer change if the metric had been reliability? **The row that had the highest reliability score would be preferred over the lowest metric score.**

11. a) Distinguish between Step 2 and Step 3 in routing. **Step 2 is about choosing the best match row, and step 3 is about forwarding the packet to the next router/device.**

b) What are router ports called? **Interfaces**

c) If the router selects Row 13 as the best-match row, what interface will the router send the packet out? **Interface 3**

d) To what device? **Next-hop router H**

e) Why is this router called the default router? (The answer is not in the text.) **It handles all traffic that has no specific route in the table.**

f) If the router selects Row 2 as the best-match row for packet 172.30.33.6, what interface will the router send the packet out? **Interface 0**

g) To what device? (Don't say, "the local device.") **Local network**

12. a) What should a router do if it receives several packets going to the same destination IPv4 address? **It should speed up the decision caching**

b) How would decision caching speed the routing decision for packets after the first one? **The router remembers the last decisions which means it does not have to check the routing table for every packet.**

c) Why is decision caching dangerous? **Routing condition changes can happen. For example, link failures and metric changes.**

13. An arriving packet has the destination IPv4 address 128.171.180.13. Row 86 has the destination value 128.171.160.0. The row's mask is 255.255.224.0. Does this row match the destination IPv4 address? Show your work. You can use the Windows Calculator if you have a Windows PC. In Windows Vista and earlier versions of Windows, choose scientific when you open the calculator. In the Windows 7 and Windows 10 calculator, choose programmer mode.

IPv4 Address (128.171.180.13):

10000000.10101011.10110100.00001101

Row Destination (128.171.160.0):

10000000.10101011.10100000.00000000

Subnet Mask (255.255.224.0):

11111111.11111111.11100000.00000000

10000000.10101011.10110100.00001101 (128.171.180.13) +

11111111.11111111.11100000.00000000 (255.255.224.0) =

10000000.10101011.10100000.00000000 (128.171.160.0)

The result (128.171.160.0) matches the row destination (128.171.160.0).

14. a) What is the main version of the Internet Protocol in use today? **IPV4**

<table>
<tr><td colspan="4">0</td><td colspan="2">31</td></tr>
<tr><td>Version (4 bits) 1010 (4)</td><td>Internet Header Length (4)</td><td>Differentiated Services Control Point (6)</td><td>ECN (2)</td><td colspan="2">Total Length (16)
Length in Octets</td></tr>
<tr><td colspan="4">Identification (16)</td><td>Flags (3)</td><td>Fragment Offset (13)</td></tr>
<tr><td colspan="2">Time to Live (8)</td><td colspan="2">Protocol (8)
Contents of the Data Field
1 = ICMP, 6 = TCP 17 = UDP</td><td colspan="2">Header Checksum (16)
If an error is found, receiver discards packet.
If it is correct, no acknowledgment is sent.
IP does error checking and discarding; it is not reliable.</td></tr>
<tr><td colspan="6">Source IPv4 Address (32)</td></tr>
<tr><td colspan="6">Destination IPv4 Address (32)</td></tr>
<tr><td colspan="4">Options if Any (Rare) (variable)</td><td colspan="2">Padding</td></tr>
<tr><td colspan="6">Data Field (variable)
TCP Segment, UDP Datagram, ICMP supervisory message, etc.</td></tr>
</table>

Differentiated Services Control Point: To request special services, such as priority.
ECN is Explicit Congestion Notification. To notify the receiver of congestion along the route.

FIGURE 8-15 IP Version 4 (IPv4) Packet Syntax

[5] The header length field gives the length of the header in 32-bit units. The length field gives the total length of the IPv4 packet in octets.

b) Which IPv4 header component can be used to specify quality of service? **Differentiated Services Field**

c) How can the ECN Field be used? **It marks packets that show network congestion so that the packets do not get dropped.**

15. a) Distinguish between application message fragmentation and packet fragmentation. **AMF: Done at application layer. PF: Done at network layer**

b) Under what circumstances would the identification, flags, and fragment offset fields be used in IP? **When a packet is too large and needs to be fragmented.**

c) Why did we not study them in detail? **Fragmentation is not efficient**

d) Does IPv6 allow packet fragmentation? **No**

16. a) What does a router do if it receives a packet with a TTL value of 2? **It decreases the TTL to 1 and forwards the packet**

b) What does the next router do? **Decreases the TTL to 0 and drops the packet**

c) What does the Protocol Field value tell the destination host? **Indicates the transport protocol**

d) What will the destination internet process do if it sees 17 in the Data Field? **Processes the packet as a UDP message**

17. What problem is caused by the way that IPv4 handles options? **They vary in length, which slows down routers**

18. a) What is the main problem with IPv4 that IPv6 was created to solve? **IPv4 address exhaustion**

b) How does IPv6 solve this problem? **128-bit addresses**

19. What has been holding back the adoption of IPv6? **Cost of upgrading networks, no immediate need, and compatibility issues with IPv4 systems**

20. a) Why are IPv6 addresses simplified? **They become shorter and easier to read**

b) Why must simplification rules be followed precisely? **To ensure consistency**

c) Are simplified IPv6 addresses written in uppercase or lowercase letters? **Lowercase**

d) Are simplified IPv6 addresses written with decimal or hexadecimal symbols? **Hexadecimal**

e) How many symbols are there in a field? **4**

f) How many bits are there in a field? **16**

g) How are fields separated? **Colons (:)**

h) How many fields are there in an IPv6 address? **8**

21. a) Write the following IPv6 address in canonical form using RFC 5952: 2001:0ed2:056b:00d3:000c:abcd:0bcd:0fe0. **2001:ed2:56b:d3:c:abcd:bcd:fe0**

b) Write the following IPv6 address in canonical form using RFC 5952: 2001:0002:0000:0000:0000:abcd:0bcd:0fe0. **2001:2::abcd:bcd:fe0**

c) Simplify the following IPv6 address using RFC 5952: 2001:0000:0000:00fe:0000:0000:0000:cdef. **2001:0:0:fe::cdef**

d) Simplify the following IPv6 address using RFC 5952: 2001:0000:0000:00fe:0000:0000:ba5a:cdef. **2001:0:0:fe::ba5a:cdef**

e) What is the advantage of simplifying IPv6 addresses according to strict rules? **Prevents multiple ways of writing the same address**

f) Which RFC is used to write IPv6 addresses in canonical form? **RFC 5952**

22. a) How do the Version Number Fields in IPv4 and IPv6 differ? **IPv4: version field is 4. IPv6: version field is 6**

<table>
<tr><td>Version (4)
0110
(6 in Binary)</td><td>Traffic Class (8)
Diffserv (6)
Congestion Notification (2)</td><td colspan="2">Flow Control (20)
Marks a packet as part of a specific flow of packets to be handled in a specified way.</td></tr>
<tr><td colspan="2">Payload ~~(Data Field)~~ Length (16)</td><td>Next Header (8)
Name of next header</td><td>Hop Limit (8)</td></tr>
<tr><td colspan="4">Source IPv6 Address (128)
There can be 2^{128} possible IPv6 addresses.</td></tr>
<tr><td colspan="4">Destination IPv6 Address (128)</td></tr>
<tr><td colspan="4">Extension Headers (Optional. There may be several.)</td></tr>
<tr><td colspan="4">Data Field (TCP segment, UDP datagram, etc.)
The extension headers plus the data field form the payload!</td></tr>
</table>

Traffic Class Field (8) has two parts: Diffserv and Congestion Notification

Differentiated Services (Diffserv) Field describes specific special (differentiated) services requested, such as priority.

Congestion Notification notifies the receiver that congestion has been experienced along the route.

FIGURE 8-18 IP Version 6 (IPv6) Packet Syntax with Main Header, Data Field, and Possibly Extension Headers (Next Headers)

b) What is the general purpose of the Diffserv subfield? **Specifying packet priority for QoS**

c) Of the Flow Label Field? **Identifies traffic flow**

d) In IPv6, how can the receiver tell the length of packet? **Check the Payload Length field**

e) Does the Payload Length Field include the lengths of any extension headers in the packet? **Yes**

f) How is the Hop Limit Field used? **Prevents infinite looping by decreasing by 1 at each router. At 0, the packet is discarded.**

g) Does IPv6 have a header checksum field? **No**

h) What is the consequence of this? **Faster processing**

23. a) Why is handling options the way that IPv4 does undesirable? **They store options in the main header which makes processing slower.**

b) Why is the approach of using optional extension headers desirable? **It keeps the base header simple**

c) What is often the only extension header that routers usually must consider? **Hop-by-Hop Options header**

Next Header Code (Value)	
Supervisory Header	Upper Layer Messages Header
Hop-by-Hop Options (0) Destination Options (60) Mobility Header (135) Encapsulating Security Payload Header (50)	TCP (6) UDP (17) ICMP (1) ICMPv6 (58)

FIGURE 8-20 IPv6 Next Header Values

d) How does the last extension header before a UDP datagram indicate that the UDP datagram comes next? **The next header field gets set to 17, which is the protocol for UDP**

e) If you see 0 in the Next Header Field of a header, what will follow this header? **No next header**

f) Why are the terms *payload* and *data field* **not** synonymous? **Payload includes the transport layer segment and the data field refers to the application data.**

24. a) How long are sequence and acknowledgment numbers? **32 bits**

b) How many flag fields do TCP headers have? **9**

c) If the ACK bit is set, what other field must have a value? **Acknowledgement number field**

25. a) What is a FIN segment? **TCP segment that is used to close a connection**

b) Distinguish between four-way closes and abrupt resets. **Four way close uses FIN and ACK, while abrupt resets use RST**

c) Why is a reset segment not acknowledged? **RST terminates the connection immediately**

d) What other type of segment is not acknowledged? **Pure SYN segments**

26. a) Why can TCP handle long application messages? **The packets are fragmented and then put back together to ensure reliable delivery**

b) Why can UDP not handle long application messages? **The packets are not fragmented or reassembled.**

c) What is the maximum application message size when UDP is used at the transport layer? **65,535 bytes**