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FACULTY OF SCIENCE AGRICULTURE AND ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE
ASSIGNMENT COVER SHEET

MODULE TITLE	Wireless Networks	
MODULE CODE	4CPS504	
ASSIGNMENT TOPIC	Exploring Wi-Fi Raw Packets	
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DUE DATE	9 May 2025	
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Question 1

The Devices :

The two machines was used in creating or generating the capture files:

- **Linux Machine (desktop)** : The Linux system with a Wi-Fi network interface working in

monitor mode

• **Windows Machine (Laptop)** : A Windows 10 system with a Wi-Fi network interface working in managed mode.

Wi-Fi Network :

The Linux and window devices was operating or working within the same WiFi network or connected to the same WiFi network which was set up using Access points (AP), The access point functioned as the central hub in an infrastructure mode WiFi network, permitting the wireless communication between devices and providing internet or LAN access

Windows computer : The windows computer's managed mode network interface was used to record the Wi-Fi frames. Wireshark which was installed on the windows computer made the capture process easier.

Capture files

The capture files "connectingAndDisconnecting-Dlink-fakeEthernetFrames-windows10Managed.pcapng" was created on the windows computer and includes Wi-Fi frames that have been contained within Ethernet frames. The row Wi-Fi frames collected by the network interface running in monitor mode are contained in the "connectingAndDisconnecting-Dlink-WifiFrames-LinuxMonitor.pcapng" capture file, which was created on the Linux computer

Capture method :

Linux machine : The Linux machine's network interface, running in a monitored was used to record the Wi-Fi frames. In a similar manner, packets have been captured on Linux systems using wireshark

Question 2

"connectingAndDisconnecting-Dlink-FakeEthernetFrames-Windows10Managed.pcapng":

>This capture file was created on a Windows 10 controlled system and seems to involve a D-Link device

>The Wi-Fi frames that were captured and included in this file are displayed as fake Ethernet frames and this implies that they were encased within Ethernet frames for testing or compatibility reasons.

>Examining how the Windows 10 management system manages Wi-Fi connections and disconnections with D-link equipment is the main goal of this capture file.

> The Wi-Fi interface mode is the managed mode

>it only displays or show Ethernet frames at the data link layer which are derived from higher-layer protocols like as TCP, DHCP, IP and so on.

> it fails to record real 802.11 Wi-Fi frames

"connectingAndDisconnecting-Dlink-WifiFrames-linuxMonitor.pcapng":

>This capture file was created on Linux system running in a monitor mode but it is also included a D-link device

>The capture file offers more through details on Wi-Fi specific parameters by containing raw Wi-Fi frames that were recorded by the network card when it was in monitored mode.

>The Wi-Fi frames that were captured and included in this file are displayed as original Ethernet frames

>The Wi-Fi interface mode is the monitor mode

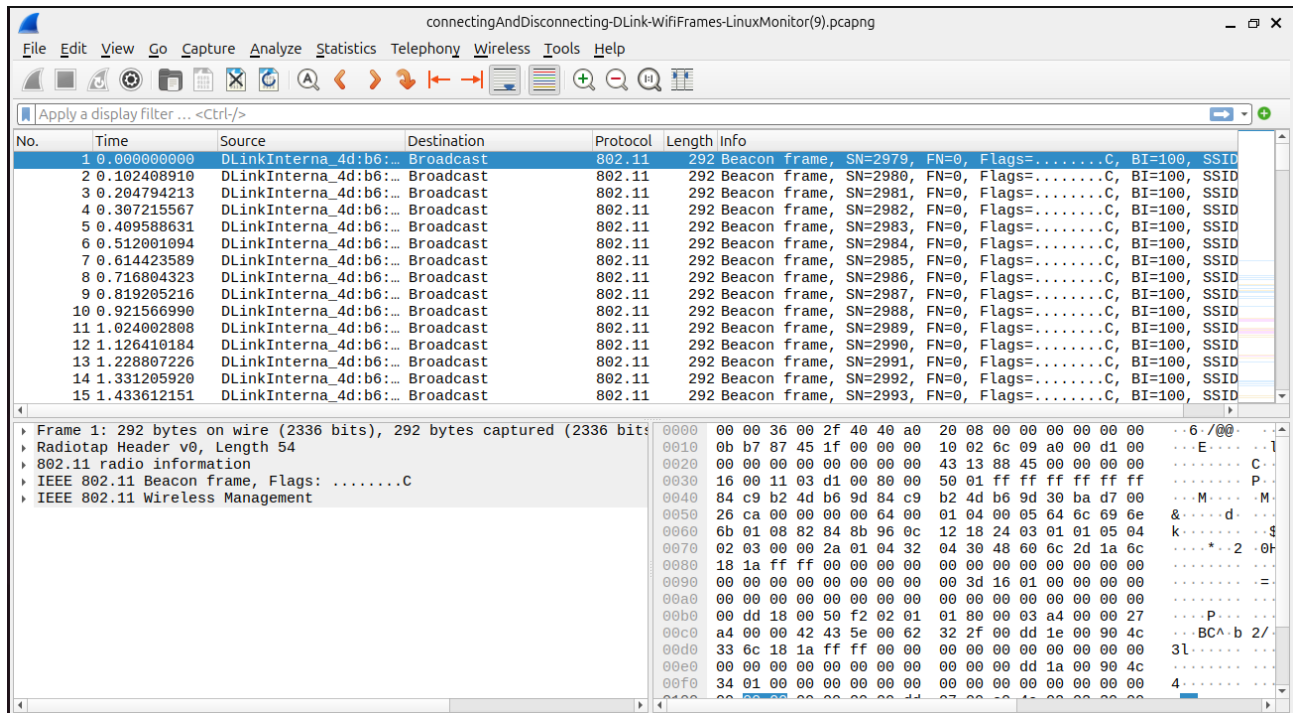
> it records unprocessed or raw 802.11 Wi-Fi frames such as the Beacon frames, retransmissions and many more.

Question 3

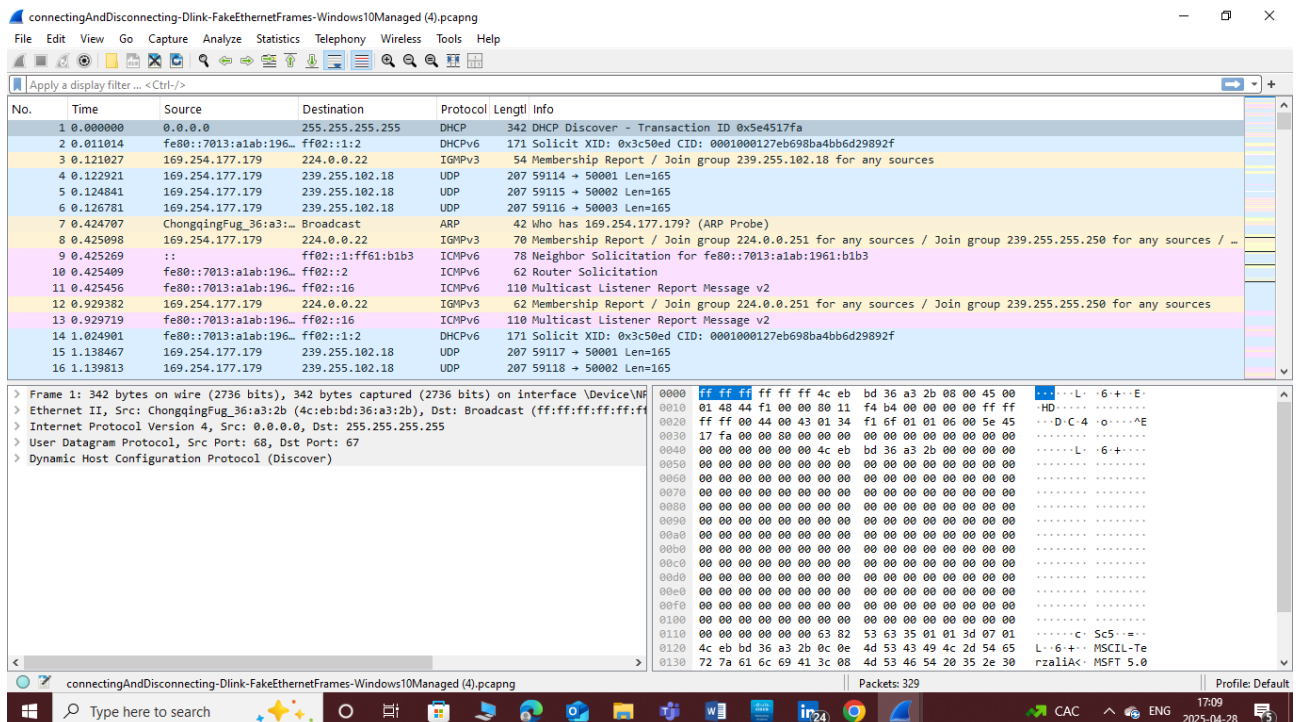
Aligning the packets in both capture files according to the same events is the main aim of synchronization. To put it another way, we must locate a packet that corresponds to the same event and shows up in both capture files. After locating such a packet, we may synchronize the two capture files by using its timestamps to ascertain the time shift between them.

step-by-step approach that I followed to synchronize the capture files :

"connectingAndDisconnecting-DLink-WifiFrames-LinuxMonitor.pcapng"



"connectingAndDisconnecting-Dlink-FakeEthernetFrames-Windows10Managed.pcapng"



I applied the display filter on both files to display only the ICMP packets.

For Linux machine :

connectingAndDisconnecting-DLink-WifiFrames-LinuxMonitor(10).pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

dhcp

No.	Time	Source	Destination	Protocol	Length	Info
683	18.971536204	0.0.0.0	255.255.255.255	DHCP	424	DHCP Discover - Transaction ID 0x5e4517fa
687	18.972937327	0.0.0.0	255.255.255.255	DHCP	424	DHCP Discover - Transaction ID 0x5e4517fa
689	18.976089421	0.0.0.0	255.255.255.255	DHCP	418	DHCP Discover - Transaction ID 0x5e4517fa
699	19.258528859	192.168.0.50	255.255.255.255	DHCP	666	DHCP Offer - Transaction ID 0x5e4517fa
1036	26.996612839	0.0.0.0	255.255.255.255	DHCP	424	DHCP Discover - Transaction ID 0x5e4517fa
1040	26.997969333	0.0.0.0	255.255.255.255	DHCP	424	DHCP Discover - Transaction ID 0x5e4517fa
1042	27.001102468	0.0.0.0	255.255.255.255	DHCP	418	DHCP Discover - Transaction ID 0x5e4517fa
1043	27.026114311	192.168.0.50	255.255.255.255	DHCP	666	DHCP Offer - Transaction ID 0x5e4517fa
1054	27.149269409	0.0.0.0	255.255.255.255	DHCP	464	DHCP Request - Transaction ID 0x5e4517fa
1056	27.153408614	0.0.0.0	255.255.255.255	DHCP	458	DHCP Request - Transaction ID 0x5e4517fa
1060	27.245830236	192.168.0.50	255.255.255.255	DHCP	666	DHCP ACK - Transaction ID 0x5e4517fa
1161	30.011260890	0.0.0.0	255.255.255.255	DHCP	464	DHCP Request - Transaction ID 0x5e4517fa
1163	30.015540938	0.0.0.0	255.255.255.255	DHCP	458	DHCP Request - Transaction ID 0x5e4517fa
1164	30.045895107	192.168.0.50	255.255.255.255	DHCP	666	DHCP ACK - Transaction ID 0x5e4517fa

Frame 147: 416 bytes on wire (3328 bits), 416 bytes captured (3328 b) on interface 0

Ethernet II, Src: Realtek (08:00:00:00:00:00), Dst: 255.255.255.255

Internet Protocol Version 4, Src: 0.0.0.0, Dst: 255.255.255.255

User Datagram Protocol, Src Port: 68, Dst Port: 67

Dynamic Host Configuration Protocol (Discover)

0000 00 00 32 00 2a 40 48 a8 20 08 00 00 10 00 6c 09 ..@H..7..

0010 00 04 e3 00 00 00 37 00 04 00 00 00 00 00 00 ..7F..

0020 e2 8b 37 46 00 00 00 00 16 00 11 03 02 00 50 04 ..7F..

0030 e3 00 08 01 2c 00 84 c9 b2 4d b6 9d 4c eb bd 36 ..M..

0040 a3 2b ff ff ff ff ff ff 00 00 00 00 aa 03 00 ..+.....

0050 00 00 08 00 45 00 01 48 44 f1 00 00 80 11 f4 b4 ..E..H D..

0060 00 00 00 00 ff ff ff ff 00 44 00 43 01 34 f1 6f ..D..

0070 01 01 06 00 5e 45 17 fa 00 00 00 00 00 00 00 ..^E..

0080 00 00 00 00 00 00 00 00 00 00 00 00 4c eb bd 36 ..+.....

0090 a3 2b 00 00 00 00 00 00 00 00 00 00 00 00 00 ..+.....

00a0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ..+.....

00b0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ..+.....

00c0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ..+.....

00d0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ..+.....

00e0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ..+.....

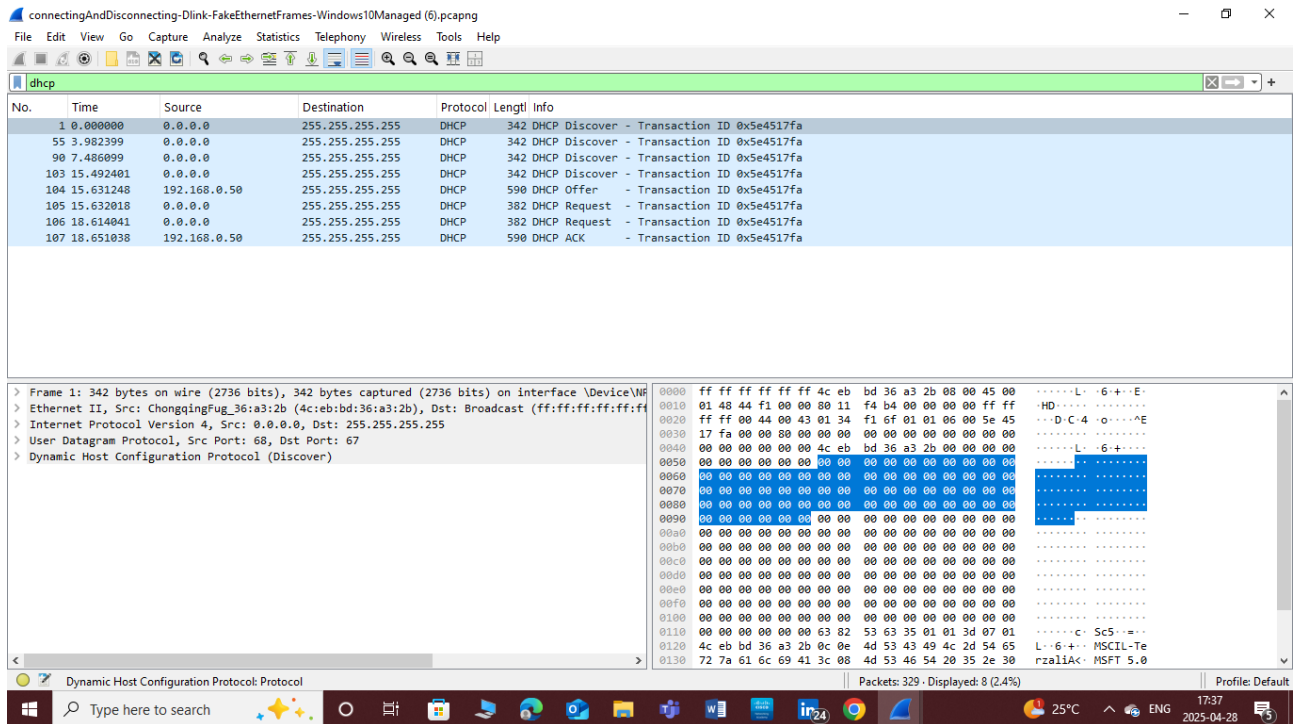
00f0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ..+.....

Dynamic Host Configuration Protocol: Protocol

Packets: 2554 · Displayed: 20 (0.8%)

Profile: Default

for window machine



>I identified the packet that appears in both capture files and represents the same event. This can serve as a reference point for synchronization.

"connectingAndDisconnecting-Dlink-WifiFrames-LinuxMonitor.pcapng"

1164	30.045895107	192.168.0.50	255.255.255.255	DHCP	666	DHCP ACK	- Transaction ID 0x5e4517fa
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"connectingAndDisconnecting-Dlink-FakeEthernetFrames-Windows10Managed.pcapng"

107	18.651038	192.168.0.50	255.255.255.255	DHCP	590	DHCP ACK	- Transaction ID 0x5e4517fa
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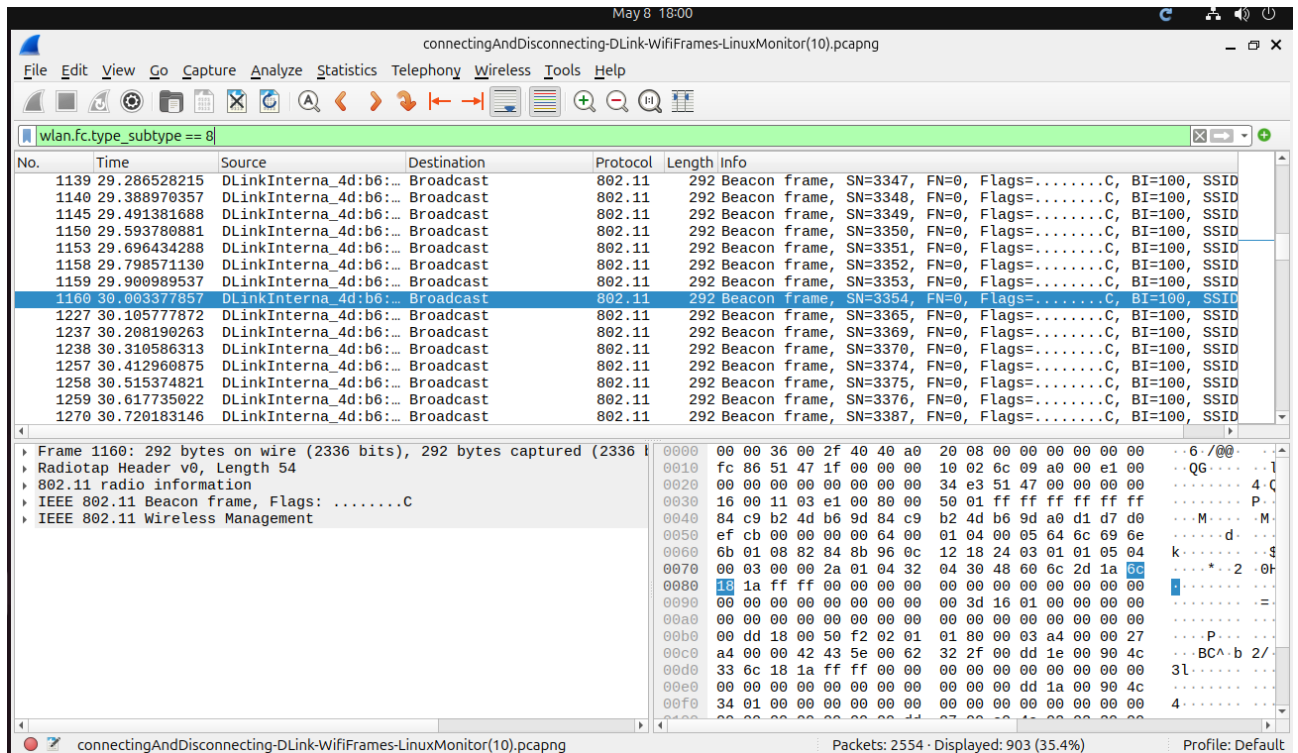
The aforementioned packets can be regarded as representing the same event because they are part of the same protocol, their source and destination addresses match, and they contain the same transaction.

We take note of the timestamp of the common ICMP packet in each capture file. In the file with fake Ethernet frame, the timestamp is 11.3958,

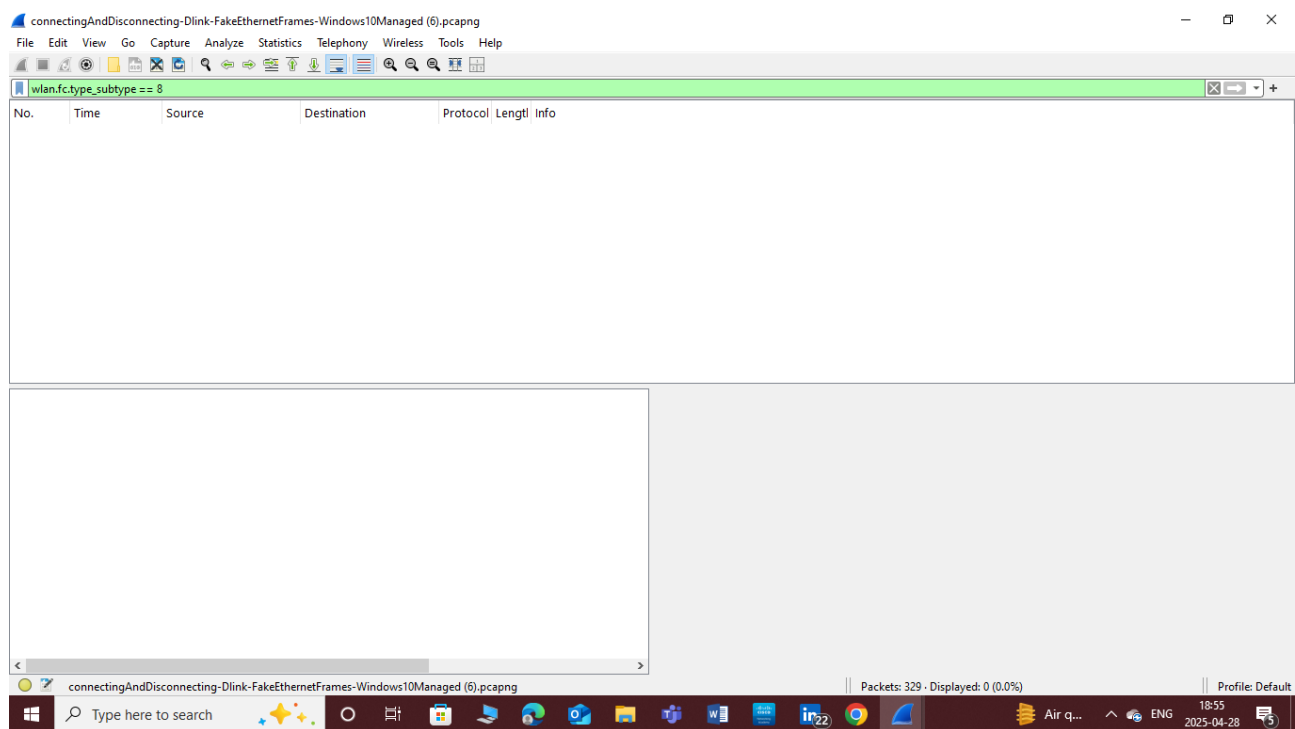
for linux machine : time = 1164 30.045895107
for window machine : time = 107 18.651038

Question 4

I opened the two files in Wireshark which are "connectingAndDisconnecting-DLink-FakeEthernetFrames-Windows10Managed.pcapng" and "connectingAndDisconnecting-DLink-WifiFrames-LinuxMonitor.pcapng". Then I applied a display filter to show only beacon packets. I used the display filter 'wlan.fc.type_subtype == 8' to filter and display only beacon frames.



"connectingAndDisconnecting-DLink-FakeEthernetFrames-Windows10Managed.pcapng"



Because the Windows computer is a fake Ethernet frame, the beacon frames are only present for Wi-Fi frames that are running on Linux computer or machine.

In the Linux capture file, the beacon frames' sequence numbers gradually increases by 1.

By detecting beacon packets, examining their sequence numbers, and measuring the time gaps between them, we can gain insights into how the access point (AP) transmits beacons. This analysis helps us better understand the network's functioning and the timing and order in which the AP sends beacon frames.

question 5

Association Dialog :

The **Association Dialog** is a crucial part of how a wireless client connects to a Wi-Fi network. After detecting a network either through beacon frames sent by the access point (AP) or by actively probing for available networks the client first performs an authentication step, which is often a simple handshake in open networks. Once authenticated, the client initiates the association process by sending an **Association Request** frame to the AP. This request includes information such as the network name (SSID), supported data rates, and the client's capabilities. The AP processes this request and replies with an **Association Response** frame, which either accepts or rejects the request. If accepted, the response includes an association ID and confirms the parameters for the connection. Once this exchange is complete, the client is considered associated with the AP and can proceed to obtain an IP address and start data communication. This dialog ensures that both the client and AP agree on connection settings before allowing network access

Disassociation Dialog :

The **Disassociation Dialog** is the formal process by which a wireless client or an access point (AP) terminates an established connection in a Wi-Fi network. This communication occurs through the exchange of **Disassociation frames**. When a client decides to leave the network such as when the user turns off Wi-Fi, moves out of range, or switches to another network it sends a Disassociation frame to the AP to inform it that the session is ending. Conversely, the AP can also initiate disassociation if, for example, the client violates network policies, experiences signal issues, or the AP is shutting down. The Disassociation frame includes a reason code explaining why the connection is being terminated. This process allows both the AP and the client to gracefully release network resources, update their connection tables, and prepare for either reconnection or a clean disconnection. It helps maintain stability and proper resource management in the wireless network.

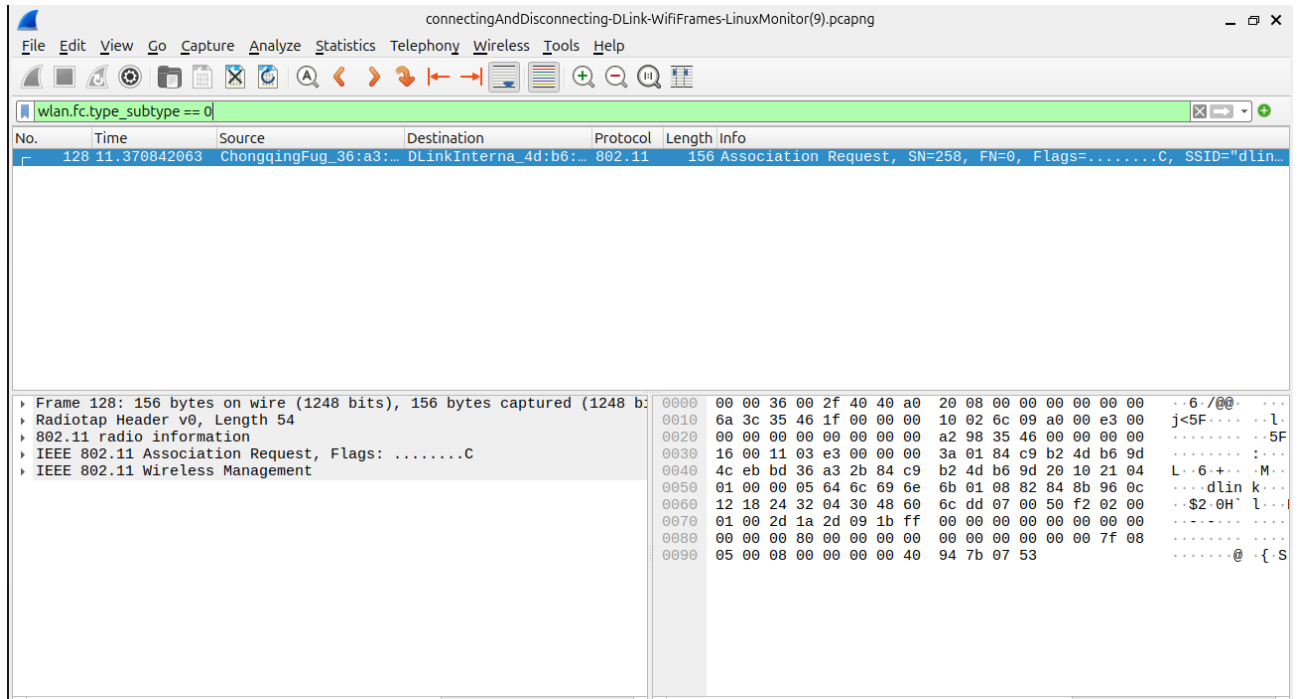
Steps to find the association and disassociation dialog in the two given files, I started by opening the two files on wireshark

>Both capture file which is "connectingAndDisconnecting-Dlink-WifiFrames-LinuxMonitor.pcapng" and "connectingAndDisconnecting-

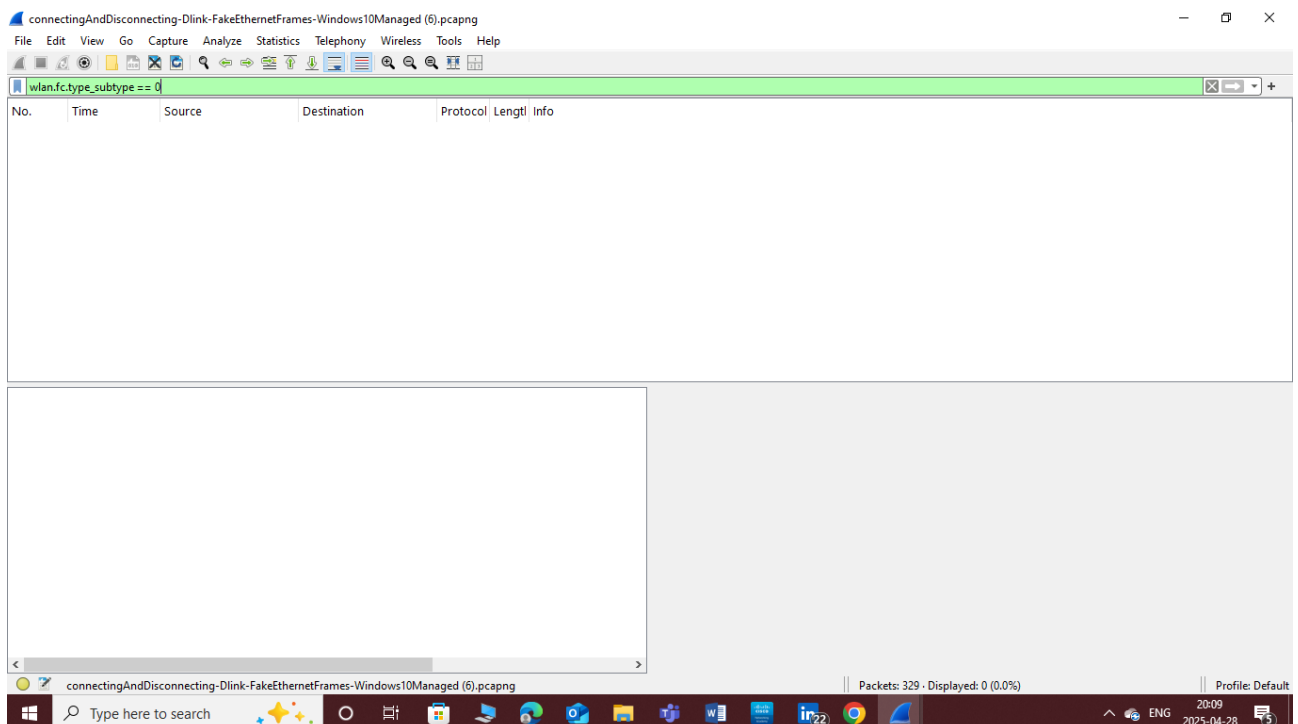
Dlink-FakeEthernetFrames-Windows10Managed.pcapng" was opened in wireshark. I applied the display filter to show only association and disassociation packets. I then applied the filter wlan.fc.type_subtype == 0 to filter and only display association and disassociation packets.

The screen short are as below for both Linux and windows machines :

For Linux machine :



for windows machine



The two screen short above shows the two capture files that was opened on wireshark after applying the display filter to show the association and disassociation packets. And it can be observed that the association and disassociation packets only present on

the"connectingAndDisconnecting-DLink-WifiFrames-LinuxMonitor.pcapng" capture file only, it not present on the windows machine as proven in the above screen short.

Question 6

screen short for Linux machine

The screenshot shows a Wireshark capture of an IEEE 802.11 Beacon frame. The packet list on the left shows a single packet of 292 bytes. The packet details pane on the right shows the frame structure, including the MAC timestamp, Flags, Data rate, Channel frequency, Channel flags, Antenna signal, and Antenna. The frame control field is expanded, showing the Type/Subtype (Beacon frame), Duration (336 microseconds), Receiver address (Broadcast), Destination address (Broadcast), Transmitter address (DLinkInterna_4d:b6:9d), Source address (DLinkInterna_4d:b6:9d), BSS Id (DLinkInterna_4d:b6:9d), and Fragment number (0). The frame check sequence is 0xdddb43d2 [unverified]. The WLAN Flags are shown as [WLAN Flags:C].

for window machine

The screenshot shows a Wireshark capture of an Ethernet II frame. The packet list on the left shows a single packet of 342 bytes. The packet details pane on the right shows the frame structure, including the Time to Live, Protocol, Header Checksum, Source Address, Destination Address, User Datagram Protocol, Source Port, Destination Port, Length, Destination Address (ip.dst) = 255.255.255.255, and Payload.

In the first packet captured on the Windows machine (in Managed mode), only two MAC addresses are present because the wireless network interface presents the data in a simplified, Ethernet-like format. In this mode, the network adapter strips away the 802.11-specific header information, leaving only the source and destination MAC addresses. This is sufficient for normal Ethernet-style communication because the access point (AP) handles the wireless routing and acts as a transparent bridge between the client and the broader network. As a result, there's no need to explicitly include the BSSID (the MAC address of the AP) in each packet the AP is assumed to be part of the infrastructure behind the scenes.

In contrast, the second packet captured on the Linux machine (in Monitor mode) includes three MAC addresses because it retains the

full 802.11 frame structure. In Wi-Fi infrastructure mode, these three addresses are essential to properly route the frame through the wireless network. The frame must include the **transmitter address** (the device physically sending the frame), the **receiver address** (the intended recipient), and the **BSSID** (the identifier of the access point managing the connection). This extra address helps distinguish between the source of the data and the network infrastructure relaying it a crucial detail in wireless communication where multiple devices may share the same medium through a central AP. Thus, three addresses are required in Monitor mode to fully represent the structure and routing context of the wireless frame.

Question 7

No.	Time	Source	Destination	Protocol	Length	Info
138	11.398571345	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3102, FN=0, Flags=...R...C, Dialog Token=1
139	11.399173724	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3102, FN=0, Flags=...R...C, Dialog Token=1
140	11.399742458	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3102, FN=0, Flags=...R...C, Dialog Token=1
141	11.400380550	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3102, FN=0, Flags=...R...C, Dialog Token=1
142	11.400968740	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3102, FN=0, Flags=...R...C, Dialog Token=1
143	11.401638125	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3102, FN=0, Flags=...R...C, Dialog Token=1
166	11.529908241	00:00:00:70:9a:f4	b2:fe:09:d2:99:92	LLC	289	U P, func=SNRME; DSAP 0x70 Group, SSAP 0xe6 Command
167	11.532009997	00:00:00:f0:01:8d	17:cc:0f:64:d9:0f	LLC	289	I, N(R)=3, N(S)=46; DSAP 0x70 Individual, SSAP 0xf6 Resp...
168	11.536503770	169.254.177.179	239.255.102.18	UDP	289	59116 → 50003 Len=165
170	11.541492405	169.254.177.179	239.255.102.18	UDP	289	59116 → 50003 Len=165
172	11.542955790	00:00:00:f0:53:b2		LLC	289	I, N(R)=53, N(S)=28; DSAP 0x5e Individual, SSAP 0x2a Com...
178	11.554228124	169.254.177.179	239.255.102.18	UDP	289	59116 → 50003 Len=165
195	11.824062910	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3111, FN=0, Flags=...R...C, Dialog Token=1
196	11.825331158	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3111, FN=0, Flags=...R...C, Dialog Token=1
197	11.825914405	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3111, FN=0, Flags=...R...C, Dialog Token=1
198	11.826502144	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3111, FN=0, Flags=...R...C, Dialog Token=1
199	11.827149493	DLinkInterna_4d:b6...	ChongqingFug_36:a3...	802.11	91	Action, SN=3111, FN=0, Flags=...R...C, Dialog Token=1
202	11.828374747	169.254.177.179	224.0.0.22	IGMPv3	152	Membership Report / Join group 224.0.0.251 for any sourc...
203	11.828383225	::	ff02::1:ff61:b1b3	ICMPv6	160	Neighbor Solicitation for fe80::7013:a1ab:1961:b1b3
204	11.828386060	fe80::7013:a1ab:196...	ff02::2	ICMPv6	144	Router Solicitation
205	11.828389429	fe80::7013:a1ab:196...	ff02::16	ICMPv6	192	Multicast Listener Report Message v2
258	12.538633362	169.254.177.179	239.255.102.18	UDP	289	59119 → 50003 Len=165
438	14.914782101	fe80::7013:a1ab:196...	ff02::16	ICMPv6	172	Multicast Listener Report Message v2
439	14.914790597	169.254.177.179	224.0.0.22	IGMPv3	136	Membership Report / Leave group 224.0.0.252
440	14.914793892	fe80::7013:a1ab:196...	ff02::16	ICMPv6	172	Multicast Listener Report Message v2
441	14.914797104	169.254.177.179	224.0.0.22	IGMPv3	136	Membership Report / Join group 224.0.0.252 for any sourc...
442	14.914800068	169.254.177.179	224.0.0.251	MDNS	162	Standard query 0x0000 ANY MSCIL-TerzaliA.local, "QM" que...
443	14.914802739	fe80::7013:a1ab:196...	ff02::fb	MDNS	182	Standard query 0x0000 ANY MSCIL-TerzaliA.local, "QM" que...
444	14.914806178	fe80::7013:a1ab:196...	ff02::fb	MDNS	220	Standard query response 0x0000 AAAA fe80::7013:a1ab:1961...
445	14.914808713	fe80::7013:a1ab:196...	ff02::1:3	LLMNR	176	Standard query 0xf682 ANY MSCIL-TerzaliA

Frame 166: 289 bytes on wire (2312 bits), 289 bytes captured (2312) on interface 0, 289 bytes from 00:00:00:70:9a:f4 to b2:fe:09:d2:99:92

Radiotap Header v0, Length 58

connectingAndDisconnecting-DLink-WifiFrames-LinuxMonitor(8).pcapng

Packets: 2554 · Displayed: 147 (5.8%)

Profile: Default

In the provided screenshot from the Wireshark capture file `connectingAndDisconnecting-DLink-WifiFrames-LinuxMonitor(8).pcapng`, we can observe a sequence of retransmissions that is indicative of typical wireless communication behavior when acknowledgments (ACKs) are delayed or lost.

Focusing on frame 166, we see that the frame originates from `00:00:00:70:9a:f4` and is being transmitted to `b2:fe:09:d2:99:92`, using the LLC protocol. It has a length of 289 bytes and includes a field marked `wlan.fc.retry = 1`, which is a clear indicator that this is a retransmission of an earlier frame that did not receive an acknowledgment. This retry bit being set suggests that the same data frame has been sent before and is now being sent again because the sender did not receive an ACK from the receiver. Following this, the surrounding frames (such as frames 167 and beyond) do not appear to be direct ACKs (they are different in protocol or source/destination), indicating that the retransmission sequence may still be ongoing at that point in the capture. The retransmission sequence will eventually end when an ACK is received.

Question 8

The data packets appear to be unencrypted. When viewing the packet contents in Wireshark, the information is clearly visible and lacks the typical features of encrypted data, such as random or unreadable patterns. This strongly suggests that the transmission is in plaintext. Moreover, examining the frame control field reveals that the "Protected Frame bit" or "protected flag" which usually indicates encryption is not active. This absence further supports the conclusion that the data has not been encrypted. Therefore, based on the clear readability of the payload and the lack of encryption markers, it is evident that the packets were sent without encryption.