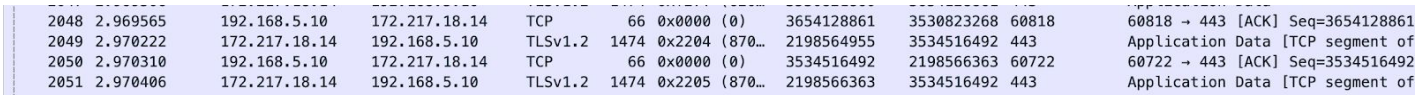
Part A Explanation - Host Specified

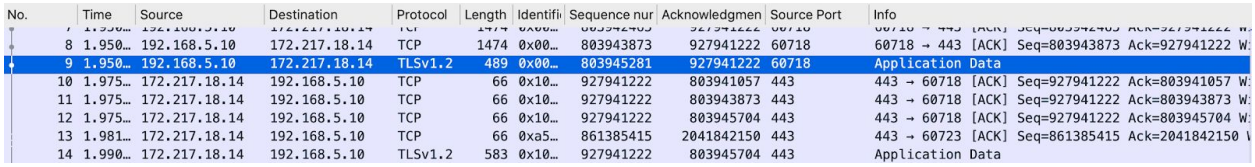
A. A laptop that connects to a WiFi network.

a. Youtube



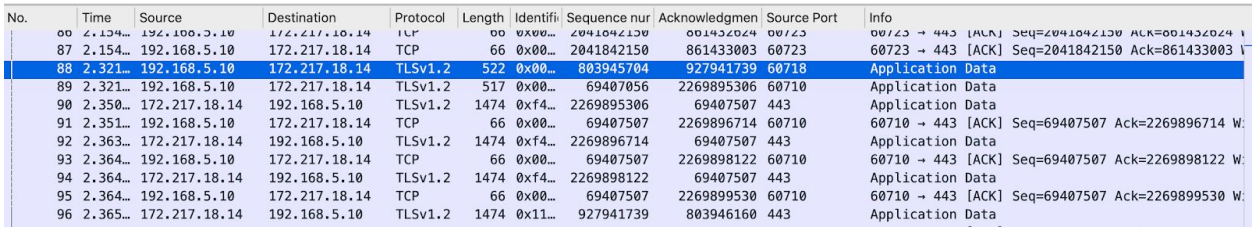
2048	2.969565	192.168.5.10	172.217.18.14	TCP	66	0x0000 (0)	3654128861	3530823268	60818	60818 → 443 [ACK] Seq=3654128861
2049	2.970222	172.217.18.14	192.168.5.10	TLSv1.2	1474	0x2204 (870…	2198564955	3534516492	443	Application Data [TCP segment of
2050	2.970310	192.168.5.10	172.217.18.14	TCP	66	0x0000 (0)	3534516492	2198566363	60722	60722 → 443 [ACK] Seq=3534516492
2051	2.970406	172.217.18.14	192.168.5.10	TLSv1.2	1474	0x2205 (870…	2198566363	3534516492	443	Application Data [TCP segment of

From the image, you can see that there are two ports in which packets are being exchanged from, port 60818 and port 60722. In order to exchange between several ports, several tcp connections must be established.



No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
8	1.950…	192.168.5.10	172.217.18.14	TCP	1474	0x00…	803943873	927941222	60718	60718 → 443 [ACK] Seq=803943873 Ack=927941222 W
9	1.950…	192.168.5.10	172.217.18.14	TLSv1.2	489	0x00…	803945281	927941222	60718	Application Data
10	1.975…	172.217.18.14	192.168.5.10	TCP	66	0x10…	927941222	803941057	443	443 → 60718 [ACK] Seq=927941222 Ack=803941057 W
11	1.975…	172.217.18.14	192.168.5.10	TCP	66	0x10…	927941222	803943873	443	443 → 60718 [ACK] Seq=927941222 Ack=803943873 W
12	1.975…	172.217.18.14	192.168.5.10	TCP	66	0x10…	927941222	803945704	443	443 → 60718 [ACK] Seq=927941222 Ack=803945704 W
13	1.981…	172.217.18.14	192.168.5.10	TCP	66	0xa5…	861385415	2041842150	443	443 → 60723 [ACK] Seq=861385415 Ack=2041842150
14	1.990…	172.217.18.14	192.168.5.10	TLSv1.2	583	0x10…	927941222	803945704	443	Application Data

From this image, you can see that application data is sent from port 60718 (client) to port 443 (server) at packet 9. As indicated by the ack number, the server responds with packet number 10.



No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
87	2.154…	192.168.5.10	172.217.18.14	TCP	66	0x00…	2041842150	861433003	60723	60723 → 443 [ACK] Seq=2041842150 Ack=861433003
88	2.321…	192.168.5.10	172.217.18.14	TLSv1.2	522	0x00…	803945704	927941739	60718	Application Data
89	2.321…	192.168.5.10	172.217.18.14	TLSv1.2	517	0x00…	69407056	2269895306	60710	Application Data
90	2.350…	172.217.18.14	192.168.5.10	TLSv1.2	1474	0xf4…	2269895306	69407507	443	Application Data
91	2.351…	192.168.5.10	172.217.18.14	TCP	66	0x00…	69407507	2269896714	60710	60710 → 443 [ACK] Seq=69407507 Ack=2269896714 W
92	2.363…	172.217.18.14	192.168.5.10	TLSv1.2	1474	0xf4…	2269896714	69407507	443	Application Data
93	2.364…	192.168.5.10	172.217.18.14	TCP	66	0x00…	69407507	2269898122	60710	60710 → 443 [ACK] Seq=69407507 Ack=2269898122 W
94	2.364…	172.217.18.14	192.168.5.10	TLSv1.2	1474	0xf4…	2269898122	69407507	443	Application Data
95	2.364…	192.168.5.10	172.217.18.14	TCP	66	0x00…	69407507	2269899530	60710	60710 → 443 [ACK] Seq=69407507 Ack=2269899530 W
96	2.365…	172.217.18.14	192.168.5.10	TLSv1.2	1474	0x11…	927941739	803946160	443	Application Data

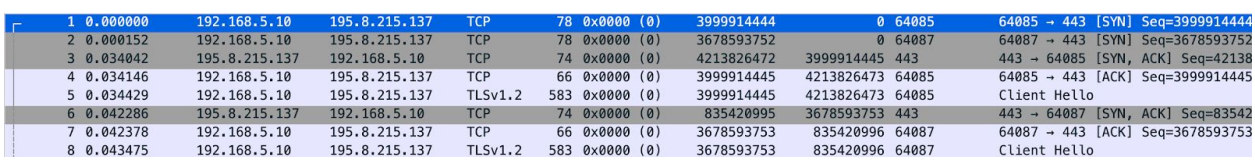
From this image, we see that application data is once again sent from port 60718 (client) to port 443 (server) at packet 88. As indicated by the ack number, the server responds with packet number 96.

The previous two images represent two client server exchanges. This can be considered a persistent connection because if it were not, then the port would close after the first exchange.

i. Persistent/Nonpersistent: **Persistent**

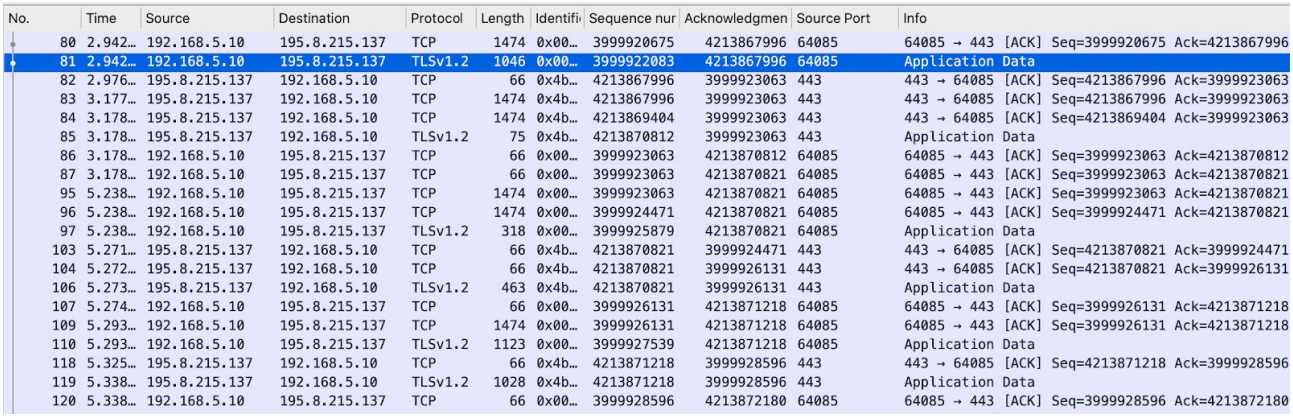
ii. Multiple TCP Connections/One TCP Connection: **Multiple TCP Connections**

b. DailyMotion



1	0.000000	192.168.5.10	195.8.215.137	TCP	78	0x0000 (0)	3999914444	0	64085	64085 → 443 [SYN] Seq=3999914444
2	0.000152	192.168.5.10	195.8.215.137	TCP	78	0x0000 (0)	3678593752	0	64087	64087 → 443 [SYN] Seq=3678593752
3	0.034042	195.8.215.137	192.168.5.10	TCP	74	0x0000 (0)	4213826472	3999914445	443	443 → 64085 [SYN, ACK] Seq=42138
4	0.034146	192.168.5.10	195.8.215.137	TCP	66	0x0000 (0)	3999914445	4213826473	64085	64085 → 443 [ACK] Seq=3999914445
5	0.034429	192.168.5.10	195.8.215.137	TLSv1.2	583	0x0000 (0)	3999914445	4213826473	64085	Client Hello
6	0.042286	195.8.215.137	192.168.5.10	TCP	74	0x0000 (0)	835420995	3678593753	443	443 → 64087 [SYN, ACK] Seq=83542
7	0.042378	192.168.5.10	195.8.215.137	TCP	66	0x0000 (0)	3678593753	835420996	64087	64087 → 443 [ACK] Seq=3678593753
8	0.043475	192.168.5.10	195.8.215.137	TLSv1.2	583	0x0000 (0)	3678593753	835420996	64087	Client Hello

From this image, you can see that multiple TCP connections are initiated from their respective SYN flags being set, these are the beginnings of their three way handshakes. Therefore, this server has multiple TCP connections.

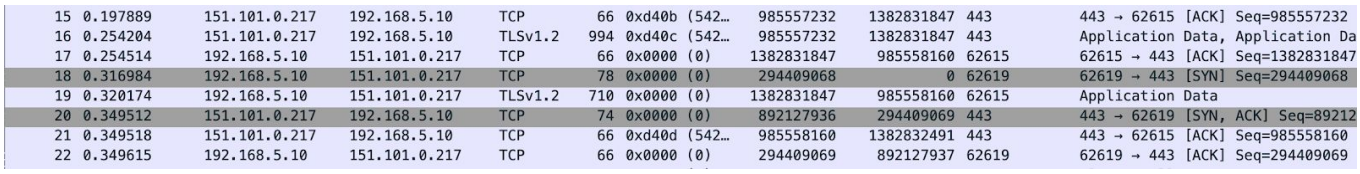


No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
80	2.942…	192.168.5.10	195.8.215.137	TCP	1474	0x00…	3999920675	4213867996	64085	64085 → 443 [ACK] Seq=3999920675 Ack=4213867996
81	2.942…	192.168.5.10	195.8.215.137	TLSv1.2	1046	0x00…	3999922083	4213867996	64085	Application Data
82	2.976…	195.8.215.137	192.168.5.10	TCP	66	0x4b…	4213867996	3999923063	443	443 → 64085 [ACK] Seq=4213867996 Ack=3999923063
83	3.177…	195.8.215.137	192.168.5.10	TCP	1474	0x4b…	4213867996	3999923063	443	443 → 64085 [ACK] Seq=4213867996 Ack=3999923063
84	3.178…	195.8.215.137	192.168.5.10	TCP	1474	0x4b…	4213869404	3999923063	443	443 → 64085 [ACK] Seq=4213869404 Ack=3999923063
85	3.178…	195.8.215.137	192.168.5.10	TLSv1.2	75	0x4b…	4213870812	3999923063	443	Application Data
86	3.178…	192.168.5.10	195.8.215.137	TCP	66	0x00…	3999923063	4213870812	64085	64085 → 443 [ACK] Seq=3999923063 Ack=4213870812
87	3.178…	192.168.5.10	195.8.215.137	TCP	66	0x00…	3999923063	4213870821	64085	64085 → 443 [ACK] Seq=3999923063 Ack=4213870821
95	5.238…	192.168.5.10	195.8.215.137	TCP	1474	0x00…	3999923063	4213870821	64085	64085 → 443 [ACK] Seq=3999923063 Ack=4213870821
96	5.238…	192.168.5.10	195.8.215.137	TCP	1474	0x00…	3999924471	4213870821	64085	64085 → 443 [ACK] Seq=3999924471 Ack=4213870821
97	5.238…	192.168.5.10	195.8.215.137	TLSv1.2	318	0x00…	3999925879	4213870821	64085	Application Data
103	5.271…	195.8.215.137	192.168.5.10	TCP	66	0x4b…	4213870821	3999924471	443	443 → 64085 [ACK] Seq=4213870821 Ack=3999924471
104	5.272…	195.8.215.137	192.168.5.10	TCP	66	0x4b…	4213870821	3999926131	443	443 → 64085 [ACK] Seq=4213870821 Ack=3999926131
106	5.273…	195.8.215.137	192.168.5.10	TLSv1.2	463	0x4b…	4213870821	3999926131	443	Application Data
107	5.274…	192.168.5.10	195.8.215.137	TCP	66	0x00…	3999926131	4213871218	64085	64085 → 443 [ACK] Seq=3999926131 Ack=4213871218
109	5.293…	192.168.5.10	195.8.215.137	TCP	1474	0x00…	3999926131	4213871218	64085	64085 → 443 [ACK] Seq=3999926131 Ack=4213871218
110	5.293…	192.168.5.10	195.8.215.137	TLSv1.2	1123	0x00…	3999927539	4213871218	64085	Application Data
118	5.325…	195.8.215.137	192.168.5.10	TCP	66	0x4b…	4213871218	3999928596	443	443 → 64085 [ACK] Seq=4213871218 Ack=3999928596
119	5.338…	195.8.215.137	192.168.5.10	TLSv1.2	1028	0x4b…	4213871218	3999928596	443	Application Data
120	5.338…	192.168.5.10	195.8.215.137	TCP	66	0x00…	3999928596	4213872180	64085	64085 → 443 [ACK] Seq=3999928596 Ack=4213872180

From this image, you can see that packet 81 is sent from the client (located at port 64085) to the server (located at port 443). Once the server receives the packet, presumably a request packet, it responds with an ack (packet 82 and 83) as indicated by the sequence number of 4213867996, which matches the ack of packet 81. Later, at packet 110, another packet is sent from the client to the server. This packet is once again acknowledged by the server (at packet 118 and 119). This is a persistent connection because if it were not, then the connection would be immediately closed after the acknowledgement of the first packet.

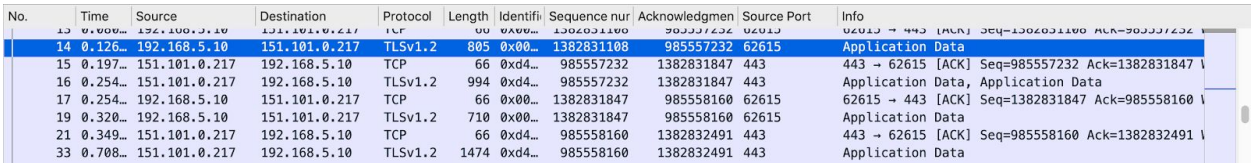
i. Persistent/Nonpersistent: **Persistent**
ii. Multiple TCP Connections/One TCP Connection: **Multiple TCP Connections**

c. Vimeo



15	0.197889	151.101.0.217	192.168.5.10	TCP	66	0xd40b (542…	985557232	1382831847	443	443 → 62615 [ACK] Seq=985557232
16	0.254204	151.101.0.217	192.168.5.10	TLSv1.2	994	0xd40c (542…	985557232	1382831847	443	Application Data, Application Da
17	0.254514	192.168.5.10	151.101.0.217	TCP	66	0x0000 (0)	1382831847	985558160	62615	62615 → 443 [ACK] Seq=1382831847
18	0.316984	192.168.5.10	151.101.0.217	TCP	78	0x0000 (0)	294409068	0	62619	62619 → 443 [SYN] Seq=294409068
19	0.320174	192.168.5.10	151.101.0.217	TLSv1.2	710	0x0000 (0)	1382831847	985558160	62615	Application Data
20	0.349512	151.101.0.217	192.168.5.10	TCP	74	0x0000 (0)	892127936	294409069	443	443 → 62619 [SYN, ACK] Seq=89212
21	0.349518	151.101.0.217	192.168.5.10	TCP	66	0xd40d (542…	985558160	1382832491	443	443 → 62615 [ACK] Seq=985558160
22	0.349615	192.168.5.10	151.101.0.217	TCP	66	0x0000 (0)	294409069	892127937	62619	62619 → 443 [ACK] Seq=294409069

From this image, you can see that there is an already established TCP connection at port 62615, when another TCP connection is established (at port 62619). This is marked by the SYN flag being set, indicating the start of the TCP three way handshake. Therefore, there are multiple TCP connections.



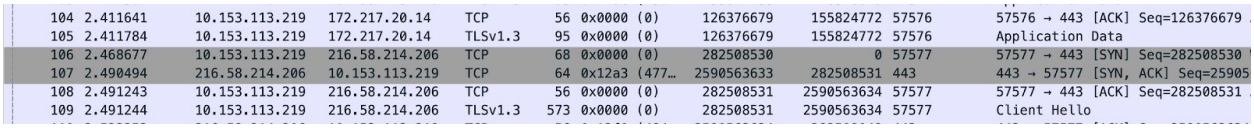
No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
14	0.126…	192.168.5.10	151.101.0.217	TLSv1.2	805	0x00…	1382831108	985557232	62615	Application Data
15	0.197…	151.101.0.217	192.168.5.10	TCP	66	0xd4…	985557232	1382831847	443	443 → 62615 [ACK] Seq=985557232 Ack=1382831847
16	0.254…	151.101.0.217	192.168.5.10	TLSv1.2	994	0xd4…	985557232	1382831847	443	Application Data, Application Data
17	0.254…	192.168.5.10	151.101.0.217	TCP	66	0x00…	1382831847	985558160	62615	62615 → 443 [ACK] Seq=1382831847 Ack=985558160
19	0.320…	192.168.5.10	151.101.0.217	TLSv1.2	710	0x00…	1382831847	985558160	62615	Application Data
21	0.349…	151.101.0.217	192.168.5.10	TCP	66	0xd4…	985558160	1382832491	443	443 → 62615 [ACK] Seq=985558160 Ack=1382832491
33	0.708…	151.101.0.217	192.168.5.10	TLSv1.2	1474	0xd4…	985558160	1382832491	443	Application Data

From this image, you can see that packet 14 is sent from the client (located at port 62615) to the server (located at port 443). Once the server receives the packet, presumably a request packet, it responds with an ack (packet 15) as indicated by the sequence number of 985557232, which matches the ack of packet 14. Later, at packet 19, another packet is sent from the client to the server. This packet is once again acknowledged by the server (at packet 21 and 33). This is a persistent connection because if it were not, then the connection would be immediately closed after the acknowledgement of the first packet.

i. Persistent/Nonpersistent: **Persistent**
ii. Multiple TCP Connections/One TCP Connection: **Multiple TCP Connections**

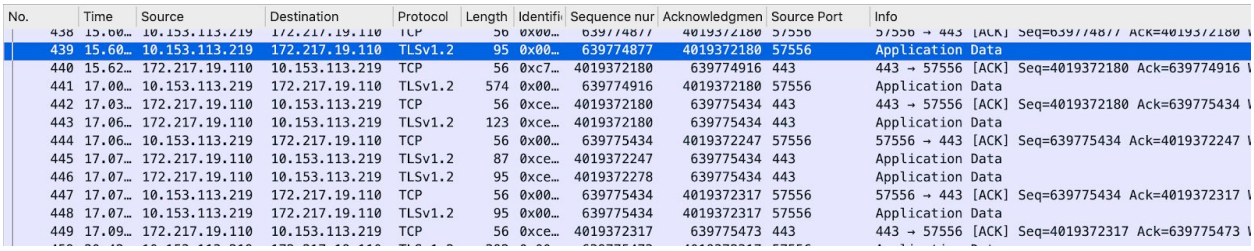
B. A smartphone that connects to a 4G cellular network.

a. Youtube



104	2.411641	10.153.113.219	172.217.20.14	TCP	56	0x0000 (0)	126376679	155824772	57576	57576 → 443 [ACK] Seq=126376679
105	2.411784	10.153.113.219	172.217.20.14	TLSv1.3	95	0x0000 (0)	126376679	155824772	57576	Application Data
106	2.468677	10.153.113.219	216.58.214.206	TCP	68	0x0000 (0)	282508530	0	57577	57577 → 443 [SYN] Seq=282508530
107	2.490494	216.58.214.206	10.153.113.219	TCP	64	0x12a3 (477…	2590563633	282508531	443	443 → 57577 [SYN, ACK] Seq=25905
108	2.491243	10.153.113.219	216.58.214.206	TCP	56	0x0000 (0)	282508531	2590563634	57577	57577 → 443 [ACK] Seq=282508531
109	2.491244	10.153.113.219	216.58.214.206	TLSv1.3	573	0x0000 (0)	282508531	2590563634	57577	Client Hello

From this image, you can see that there is an already established TCP connection at port 57576, when another TCP connection is established (at port 57577). This is marked by the SYN flag being set, indicating the start of the TCP three way handshake. Therefore, there are multiple TCP connections.



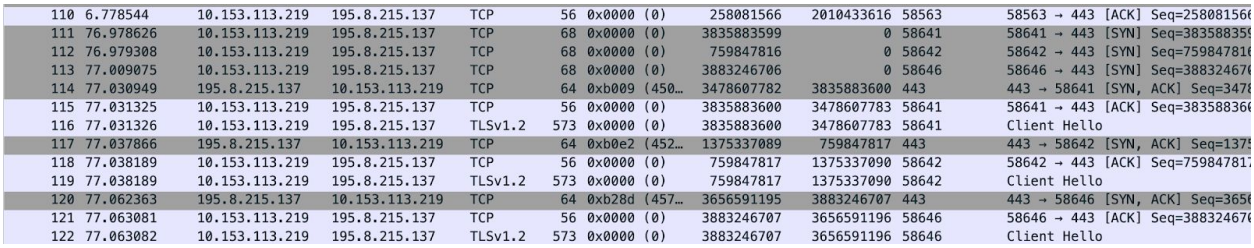
No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
439	15.60…	10.153.113.219	172.217.19.110	TLSv1.2	95	0x00…	639774877	4019372180	57556	Application Data
440	15.62…	172.217.19.110	10.153.113.219	TCP	56	0xc7…	4019372180	639774916	443	443 → 57556 [ACK] Seq=4019372180 Ack=639774916
441	17.00…	10.153.113.219	172.217.19.110	TLSv1.2	574	0x00…	639774916	4019372180	57556	Application Data
442	17.03…	172.217.19.110	10.153.113.219	TCP	56	0xce…	4019372180	639775434	443	443 → 57556 [ACK] Seq=4019372180 Ack=639775434
443	17.06…	172.217.19.110	10.153.113.219	TLSv1.2	123	0xce…	4019372180	639775434	443	Application Data
444	17.06…	10.153.113.219	172.217.19.110	TCP	56	0x00…	639775434	4019372247	57556	57556 → 443 [ACK] Seq=639775434 Ack=4019372247
445	17.07…	172.217.19.110	10.153.113.219	TLSv1.2	87	0xce…	4019372247	639775434	443	Application Data
446	17.07…	172.217.19.110	10.153.113.219	TLSv1.2	95	0xce…	4019372278	639775434	443	Application Data
447	17.07…	10.153.113.219	172.217.19.110	TCP	56	0x00…	639775434	4019372317	57556	57556 → 443 [ACK] Seq=639775434 Ack=4019372317
448	17.07…	10.153.113.219	172.217.19.110	TLSv1.2	95	0x00…	639775434	4019372317	57556	Application Data
449	17.09…	172.217.19.110	10.153.113.219	TCP	56	0xce…	4019372317	639775473	443	443 → 57556 [ACK] Seq=4019372317 Ack=639775473

From this image, you can see that packet 439 is sent from the client (located at port 57556) to the server (located at port 443). Once the server receives the packet, presumably a request packet, it responds with an ack (packet 440) as indicated by the sequence number of 4019372180, which matches the ack of packet 439. Later, at packet 448, another packet is sent from the client to the server. This packet is once again acknowledged by the server (at packet449). This is a persistent

connection because if it were not, then the connection would be immediately closed after the acknowledgement of the first packet.

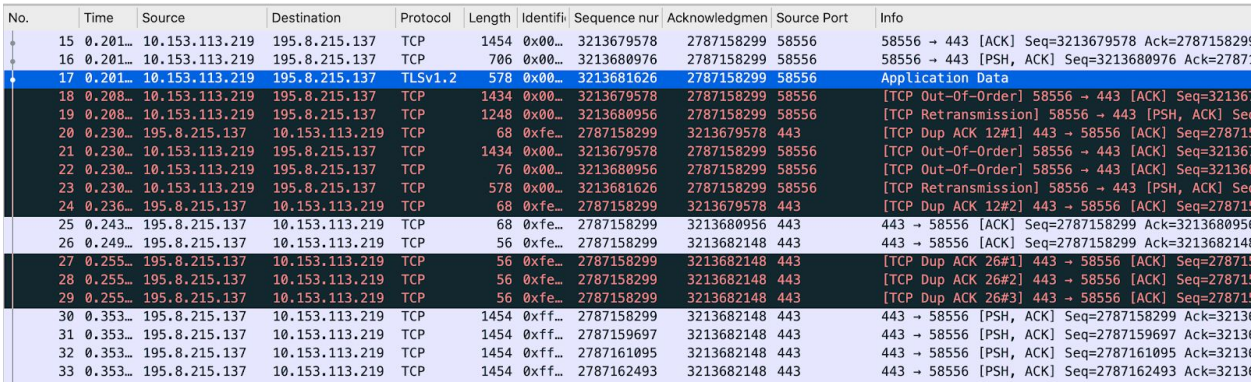
i. Persistent/Nonpersistent: **Persistent**
ii. Multiple TCP Connections/One TCP Connection:**Multiple TCP Connections**

b. DailyMotion

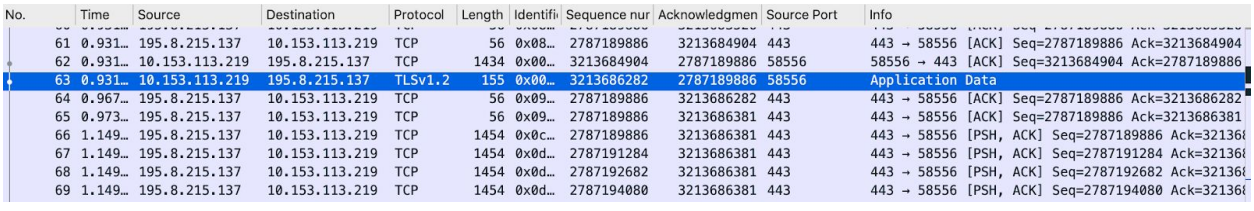


110	6.778544	10.153.113.219	195.8.215.137	TCP	56	0x0000 (0)	258081566	2010433616	58563	58563 → 443 [ACK] Seq=258081566
111	76.978626	10.153.113.219	195.8.215.137	TCP	68	0x0000 (0)	3835883599	0	58641	58641 → 443 [SYN] Seq=383588359
112	76.979308	10.153.113.219	195.8.215.137	TCP	68	0x0000 (0)	759847816	0	58642	58642 → 443 [SYN] Seq=759847816
113	77.009075	10.153.113.219	195.8.215.137	TCP	68	0x0000 (0)	3883246706	0	58646	58646 → 443 [SYN] Seq=388324670
114	77.030949	195.8.215.137	10.153.113.219	TCP	64	0xb009 (450…	3478607782	3835883600	443	443 → 58641 [SYN, ACK] Seq=3478
115	77.031325	10.153.113.219	195.8.215.137	TCP	56	0x0000 (0)	3835883600	3478607783	58641	58641 → 443 [ACK] Seq=383588360
116	77.031326	10.153.113.219	195.8.215.137	TLSv1.2	573	0x0000 (0)	3835883600	3478607783	58641	Client Hello
117	77.037866	195.8.215.137	10.153.113.219	TCP	64	0xb0e2 (452…	1375337089	759847817	443	443 → 58642 [SYN, ACK] Seq=1375
118	77.038189	10.153.113.219	195.8.215.137	TCP	56	0x0000 (0)	759847817	1375337090	58642	58642 → 443 [ACK] Seq=759847817
119	77.038189	10.153.113.219	195.8.215.137	TLSv1.2	573	0x0000 (0)	759847817	1375337090	58642	Client Hello
120	77.062363	195.8.215.137	10.153.113.219	TCP	64	0xb28d (457…	3656591195	3883246707	443	443 → 58646 [SYN, ACK] Seq=3656
121	77.063081	10.153.113.219	195.8.215.137	TCP	56	0x0000 (0)	3883246707	3656591196	58646	58646 → 443 [ACK] Seq=388324670
122	77.063082	10.153.113.219	195.8.215.137	TLSv1.2	573	0x0000 (0)	3883246707	3656591196	58646	Client Hello

From this image, you can see that several tcp connections are established (ports 58641, 58642 and 58646) as indicated by their SYN flags being set, marking the beginning of their three way handshake. Therefore, multiple tcp connections are established.



No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
15	0.201…	10.153.113.219	195.8.215.137	TCP	1454	0x00…	3213679578	2787158299	58556	58556 → 443 [ACK] Seq=3213679578 Ack=2787158299
16	0.201…	10.153.113.219	195.8.215.137	TCP	706	0x00…	3213680976	2787158299	58556	58556 → 443 [PSH, ACK] Seq=3213680976 Ack=2787
17	0.201…	10.153.113.219	195.8.215.137	TLSv1.2	578	0x00…	3213681626	2787158299	58556	Application Data
18	0.208…	10.153.113.219	195.8.215.137	TCP	1434	0x00…	3213679578	2787158299	58556	[TCP Out-Of-Order] 58556 → 443 [ACK] Seq=32136
19	0.208…	10.153.113.219	195.8.215.137	TCP	1248	0x00…	3213680956	2787158299	58556	[TCP Retransmission] 58556 → 443 [PSH, ACK] Se
20	0.230…	195.8.215.137	10.153.113.219	TCP	68	0xfe…	2787158299	3213679578	443	[TCP Dup ACK 12#1] 443 → 58556 [ACK] Seq=27871
21	0.230…	10.153.113.219	195.8.215.137	TCP	1434	0x00…	3213679578	2787158299	58556	[TCP Out-Of-Order] 58556 → 443 [ACK] Seq=32136
22	0.230…	10.153.113.219	195.8.215.137	TCP	76	0x00…	3213680956	2787158299	58556	[TCP Out-Of-Order] 58556 → 443 [ACK] Seq=32136
23	0.230…	10.153.113.219	195.8.215.137	TCP	578	0x00…	3213681626	2787158299	58556	[TCP Retransmission] 58556 → 443 [PSH, ACK] Se
24	0.236…	195.8.215.137	10.153.113.219	TCP	68	0xfe…	2787158299	3213679578	443	[TCP Dup ACK 12#2] 443 → 58556 [ACK] Seq=27871
25	0.243…	195.8.215.137	10.153.113.219	TCP	68	0xfe…	2787158299	3213680956	443	443 → 58556 [ACK] Seq=2787158299 Ack=321368095
26	0.249…	195.8.215.137	10.153.113.219	TCP	56	0xfe…	2787158299	3213682148	443	443 → 58556 [ACK] Seq=2787158299 Ack=3213682148
27	0.255…	195.8.215.137	10.153.113.219	TCP	56	0xfe…	2787158299	3213682148	443	[TCP Dup ACK 26#1] 443 → 58556 [ACK] Seq=27871
28	0.255…	195.8.215.137	10.153.113.219	TCP	56	0xfe…	2787158299	3213682148	443	[TCP Dup ACK 26#2] 443 → 58556 [ACK] Seq=27871
29	0.255…	195.8.215.137	10.153.113.219	TCP	56	0xfe…	2787158299	3213682148	443	[TCP Dup ACK 26#3] 443 → 58556 [ACK] Seq=27871
30	0.353…	195.8.215.137	10.153.113.219	TCP	1454	0xff…	2787158299	3213682148	443	443 → 58556 [PSH, ACK] Seq=2787158299 Ack=3213
31	0.353…	195.8.215.137	10.153.113.219	TCP	1454	0xff…	2787159697	3213682148	443	443 → 58556 [PSH, ACK] Seq=2787159697 Ack=3213
32	0.353…	195.8.215.137	10.153.113.219	TCP	1454	0xff…	2787161095	3213682148	443	443 → 58556 [PSH, ACK] Seq=2787161095 Ack=3213
33	0.353…	195.8.215.137	10.153.113.219	TCP	1454	0xff…	2787162493	3213682148	443	443 → 58556 [PSH, ACK] Seq=2787162493 Ack=3213

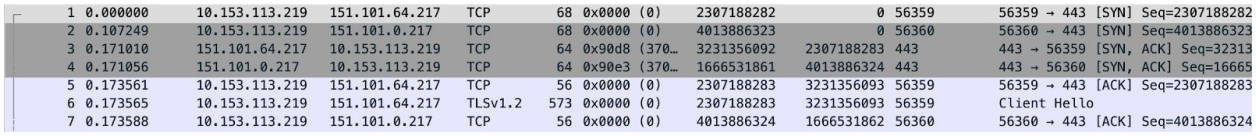


No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
61	0.931…	195.8.215.137	10.153.113.219	TCP	56	0x08…	2787189886	3213684904	443	443 → 58556 [ACK] Seq=2787189886 Ack=3213684904
62	0.931…	10.153.113.219	195.8.215.137	TCP	1434	0x00…	3213684904	2787189886	58556	58556 → 443 [ACK] Seq=3213684904 Ack=2787189886
63	0.931…	10.153.113.219	195.8.215.137	TLSv1.2	155	0x00…	3213686282	2787189886	58556	Application Data
64	0.967…	195.8.215.137	10.153.113.219	TCP	56	0x09…	2787189886	3213686282	443	443 → 58556 [ACK] Seq=2787189886 Ack=3213686282
65	0.973…	195.8.215.137	10.153.113.219	TCP	56	0x09…	2787189886	3213686381	443	443 → 58556 [ACK] Seq=2787189886 Ack=3213686381
66	1.149…	195.8.215.137	10.153.113.219	TCP	1454	0x0c…	2787189886	3213686381	443	443 → 58556 [PSH, ACK] Seq=2787189886 Ack=32136
67	1.149…	195.8.215.137	10.153.113.219	TCP	1454	0x0d…	2787191284	3213686381	443	443 → 58556 [PSH, ACK] Seq=2787191284 Ack=32136
68	1.149…	195.8.215.137	10.153.113.219	TCP	1454	0x0d…	2787192682	3213686381	443	443 → 58556 [PSH, ACK] Seq=2787192682 Ack=32136
69	1.149…	195.8.215.137	10.153.113.219	TCP	1454	0x0d…	2787194080	3213686381	443	443 → 58556 [PSH, ACK] Seq=2787194080 Ack=32136

From the first image, you can see that at packet 17 application data is sent from the source port of 58556 to the destination port of 443 (client to server). Although there are some errors in between, this is eventually acknowledged by the server. In the second image, you can see another packet, number 63, that is once again transmitting application data. The server once again responds with an acknowledgement. This is a persistent connection because if it were not, then the connection would have closed after the first exchange of data from client to server.

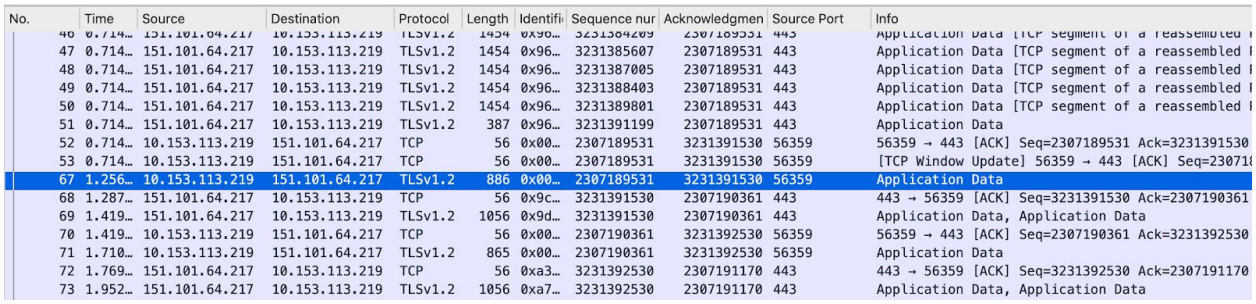
i. Persistent/Nonpersistent: **Persistent**
ii. Multiple TCP Connections/One TCP Connection:**Multiple TCP Connections**

c. Vimeo



No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
1	0.000000	10.153.113.219	151.101.64.217	TCP	68	0x0000 (0)	2307188282	0	56359	56359 → 443 [SYN] Seq=2307188282
2	0.107249	10.153.113.219	151.101.0.217	TCP	68	0x0000 (0)	4013886323	0	56360	56360 → 443 [SYN] Seq=4013886323
3	0.171010	151.101.64.217	10.153.113.219	TCP	64	0x90d8 (370…	3231356092	2307188283	443	443 → 56359 [SYN, ACK] Seq=32313
4	0.171056	151.101.0.217	10.153.113.219	TCP	64	0x90e3 (370…	1666531861	4013886324	443	443 → 56360 [SYN, ACK] Seq=16665
5	0.173561	10.153.113.219	151.101.64.217	TCP	56	0x0000 (0)	2307188283	3231356093	56359	56359 → 443 [ACK] Seq=2307188283
6	0.173565	10.153.113.219	151.101.64.217	TLSv1.2	573	0x0000 (0)	2307188283	3231356093	56359	Client Hello
7	0.173588	10.153.113.219	151.101.0.217	TCP	56	0x0000 (0)	4013886324	1666531862	56360	56360 → 443 [ACK] Seq=4013886324

From this image, you can see that several tcp connections are established (ports 56359, and 56360) as indicated by their SYN flags being set, marking the beginning of their three way handshake. Therefore, multiple tcp connections are established.



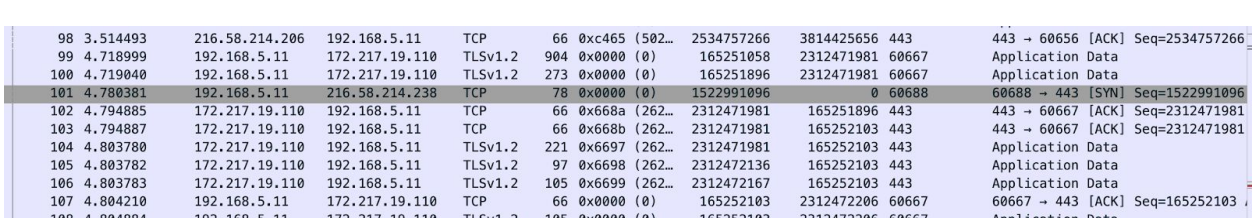
No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
47	0.714…	151.101.64.217	10.153.113.219	TLSv1.2	1454	0x96…	3231385607	2307189531	443	Application Data [TCP segment of a reassembled
48	0.714…	151.101.64.217	10.153.113.219	TLSv1.2	1454	0x96…	3231387005	2307189531	443	Application Data [TCP segment of a reassembled
49	0.714…	151.101.64.217	10.153.113.219	TLSv1.2	1454	0x96…	3231388403	2307189531	443	Application Data [TCP segment of a reassembled
50	0.714…	151.101.64.217	10.153.113.219	TLSv1.2	1454	0x96…	3231389801	2307189531	443	Application Data [TCP segment of a reassembled
51	0.714…	151.101.64.217	10.153.113.219	TLSv1.2	387	0x96…	3231391199	2307189531	443	Application Data
52	0.714…	10.153.113.219	151.101.64.217	TCP	56	0x00…	2307189531	3231391530	56359	56359 → 443 [ACK] Seq=2307189531 Ack=3231391530
53	0.714…	10.153.113.219	151.101.64.217	TCP	56	0x00…	2307189531	3231391530	56359	[TCP Window Update] 56359 → 443 [ACK] Seq=230718
67	1.256…	10.153.113.219	151.101.64.217	TLSv1.2	886	0x00…	2307189531	3231391530	56359	Application Data
68	1.287…	151.101.64.217	10.153.113.219	TCP	56	0x9c…	3231391530	2307190361	443	443 → 56359 [ACK] Seq=3231391530 Ack=2307190361
69	1.419…	151.101.64.217	10.153.113.219	TLSv1.2	1056	0x9d…	3231391530	2307190361	443	Application Data, Application Data
70	1.419…	10.153.113.219	151.101.64.217	TCP	56	0x00…	2307190361	3231392530	56359	56359 → 443 [ACK] Seq=2307190361 Ack=3231392530
71	1.710…	10.153.113.219	151.101.64.217	TLSv1.2	865	0x00…	2307190361	3231392530	56359	Application Data
72	1.769…	151.101.64.217	10.153.113.219	TCP	56	0xa3…	3231392530	2307191170	443	443 → 56359 [ACK] Seq=3231392530 Ack=2307191170
73	1.952…	151.101.64.217	10.153.113.219	TLSv1.2	1056	0xa7…	3231392530	2307191170	443	Application Data, Application Data

From this image, you can see that packet 67 is sent from the client (located at port 56359) to the server (located at port 443). Once the server receives the packet, presumably a request packet, it responds with an ack (packet 68) as indicated by the sequence number of 3231391530, which matches the ack of packet 67. Later, at packet 71, another packet is sent from the client to the server. This packet is once again acknowledged by the server (at packet 72 and 73). This is a persistent connection because if it were not, then the connection would be immediately closed after the acknowledgement of the first packet.

i. Persistent/Nonpersistent: **Persistent**
ii. Multiple TCP Connections/One TCP Connection: **Multiple TCP Connections**

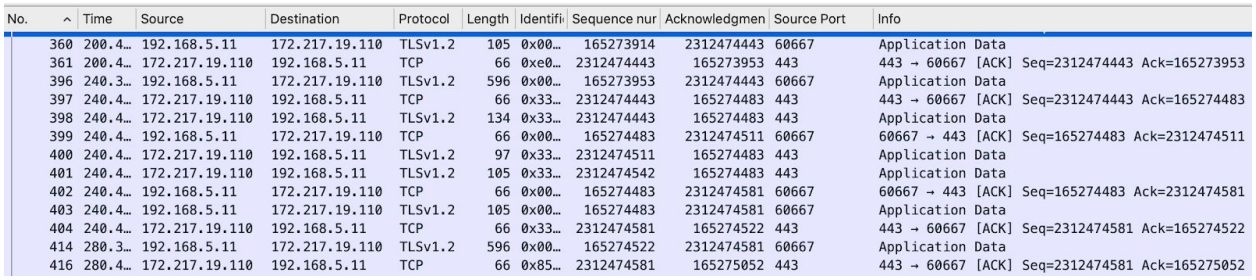
C. <u>A smartphone that connects to a WiFi network.</u>

a. Youtube



98	3.514493	216.58.214.206	192.168.5.11	TCP	66	0xc465 (502…	2534757266	3814425656	443	443 → 60656 [ACK] Seq=2534757266
99	4.718999	192.168.5.11	172.217.19.110	TLSv1.2	904	0x0000 (0)	165251058	2312471981	60667	Application Data
100	4.719040	192.168.5.11	172.217.19.110	TLSv1.2	273	0x0000 (0)	165251896	2312471981	60667	Application Data
101	4.780381	192.168.5.11	216.58.214.238	TCP	78	0x0000 (0)	1522991096	0	60688	60688 → 443 [SYN] Seq=1522991096
102	4.794885	172.217.19.110	192.168.5.11	TCP	66	0x668a (262…	2312471981	165251896	443	443 → 60667 [ACK] Seq=2312471981
103	4.794887	172.217.19.110	192.168.5.11	TCP	66	0x668b (262…	2312471981	165252103	443	443 → 60667 [ACK] Seq=2312471981
104	4.803780	172.217.19.110	192.168.5.11	TLSv1.2	221	0x6697 (262…	2312471981	165252103	443	Application Data
105	4.803782	172.217.19.110	192.168.5.11	TLSv1.2	97	0x6698 (262…	2312472136	165252103	443	Application Data
106	4.803783	172.217.19.110	192.168.5.11	TLSv1.2	105	0x6699 (262…	2312472167	165252103	443	Application Data
107	4.804210	192.168.5.11	172.217.19.110	TCP	66	0x0000 (0)	165252103	2312472206	60667	60667 → 443 [ACK] Seq=165252103

From this image, you can see that there is an already established TCP connection at port 60656, when another TCP connection is established (at port 60688). This is marked by the SYN flag being set, indicating the start of the TCP three way handshake. Therefore, there are multiple TCP connections.

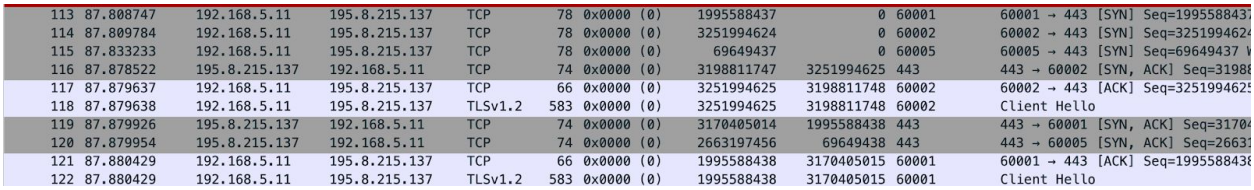


No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
360	200.4…	192.168.5.11	172.217.19.110	TLSv1.2	105	0x00…	165273914	2312474443	60667	Application Data
361	200.4…	172.217.19.110	192.168.5.11	TCP	66	0xe0…	2312474443	165273953	443	443 → 60667 [ACK] Seq=2312474443 Ack=165273953
396	240.3…	192.168.5.11	172.217.19.110	TLSv1.2	596	0x00…	165273953	2312474443	60667	Application Data
397	240.4…	172.217.19.110	192.168.5.11	TCP	66	0x33…	2312474443	165274483	443	443 → 60667 [ACK] Seq=2312474443 Ack=165274483
398	240.4…	172.217.19.110	192.168.5.11	TLSv1.2	134	0x33…	2312474443	165274483	443	Application Data
399	240.4…	192.168.5.11	172.217.19.110	TCP	66	0x00…	165274483	2312474511	60667	60667 → 443 [ACK] Seq=165274483 Ack=2312474511
400	240.4…	172.217.19.110	192.168.5.11	TLSv1.2	97	0x33…	2312474511	165274483	443	Application Data
401	240.4…	172.217.19.110	192.168.5.11	TLSv1.2	105	0x33…	2312474542	165274483	443	Application Data
402	240.4…	192.168.5.11	172.217.19.110	TCP	66	0x00…	165274483	2312474581	60667	60667 → 443 [ACK] Seq=165274483 Ack=2312474581
403	240.4…	192.168.5.11	172.217.19.110	TLSv1.2	105	0x00…	165274483	2312474581	60667	Application Data
404	240.4…	172.217.19.110	192.168.5.11	TCP	66	0x33…	2312474581	165274522	443	443 → 60667 [ACK] Seq=2312474581 Ack=165274522
414	280.3…	192.168.5.11	172.217.19.110	TLSv1.2	596	0x00…	165274522	2312474581	60667	Application Data
416	280.4…	172.217.19.110	192.168.5.11	TCP	66	0x85…	2312474581	165275052	443	443 → 60667 [ACK] Seq=2312474581 Ack=165275052

From this image, you can see that packet 360 is sent from the client (located at port 60667) to the server (located at port 443). Once the server receives the packet, presumably a request packet, it responds with an ack (packet 361) as indicated by the sequence number of 231247443, which matches the ack of packet 360. Later, at packet 403, another packet is sent from the client to the server. This packet is once again acknowledged by the server (at packet 416). This is a persistent connection because if it were not, then the connection would be immediately closed after the acknowledgement of the first packet.

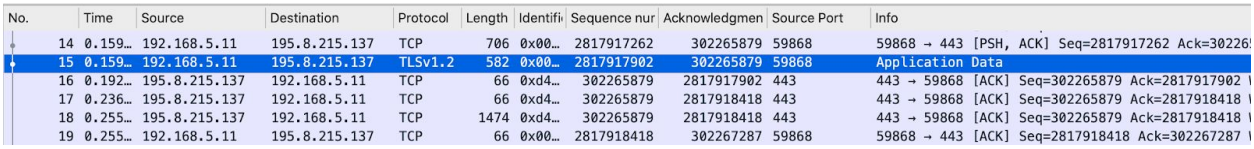
i. Persistent/Nonpersistent: **Persistent**
ii. Multiple TCP Connections/One TCP Connection: **Multiple TCP Connections**

b. DailyMotion

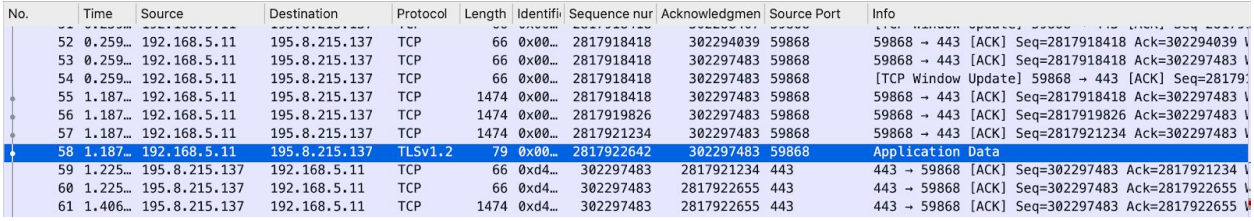


113	87.808747	192.168.5.11	195.8.215.137	TCP	78	0x0000 (0)	1995588437	0	60001	60001 → 443 [SYN] Seq=199558843
114	87.809784	192.168.5.11	195.8.215.137	TCP	78	0x0000 (0)	3251994624	0	60002	60002 → 443 [SYN] Seq=325199462
115	87.833233	192.168.5.11	195.8.215.137	TCP	78	0x0000 (0)	69649437	0	60005	60005 → 443 [SYN] Seq=69649437
116	87.878522	195.8.215.137	192.168.5.11	TCP	74	0x0000 (0)	3198811747	3251994625	443	443 → 60002 [SYN, ACK] Seq=3198
117	87.879637	192.168.5.11	195.8.215.137	TCP	66	0x0000 (0)	3251994625	3198811748	60002	60002 → 443 [ACK] Seq=325199462
118	87.879638	192.168.5.11	195.8.215.137	TLSv1.2	583	0x0000 (0)	3251994625	3198811748	60002	Client Hello
119	87.879926	195.8.215.137	192.168.5.11	TCP	74	0x0000 (0)	3170405014	1995588438	443	443 → 60001 [SYN, ACK] Seq=3170
120	87.879954	195.8.215.137	192.168.5.11	TCP	74	0x0000 (0)	2663197456	69649438	443	443 → 60005 [SYN, ACK] Seq=2663
121	87.880429	192.168.5.11	195.8.215.137	TCP	66	0x0000 (0)	1995588438	3170405015	60001	60001 → 443 [ACK] Seq=199558843
122	87.880429	192.168.5.11	195.8.215.137	TLSv1.2	583	0x0000 (0)	1995588438	3170405015	60001	Client Hello

From this image, you can see that several tcp connections are established (ports 60001, 60002, and 60005) as indicated by their SYN flags being set, marking the beginning of their three way handshake. Therefore, multiple tcp connections are established.



No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
14	0.159…	192.168.5.11	195.8.215.137	TCP	706	0x00…	2817917262	302265879	59868	59868 → 443 [PSH, ACK] Seq=2817917262 Ack=30226
15	0.159…	192.168.5.11	195.8.215.137	TLSv1.2	582	0x00…	2817917902	302265879	59868	Application Data
16	0.192…	195.8.215.137	192.168.5.11	TCP	66	0xd4…	302265879	2817917902	443	443 → 59868 [ACK] Seq=302265879 Ack=2817917902
17	0.236…	195.8.215.137	192.168.5.11	TCP	66	0xd4…	302265879	2817918418	443	443 → 59868 [ACK] Seq=302265879 Ack=2817918418
18	0.255…	195.8.215.137	192.168.5.11	TCP	1474	0xd4…	302265879	2817918418	443	443 → 59868 [ACK] Seq=302265879 Ack=2817918418
19	0.255…	192.168.5.11	195.8.215.137	TCP	66	0x00…	2817918418	302267287	59868	59868 → 443 [ACK] Seq=2817918418 Ack=302267287

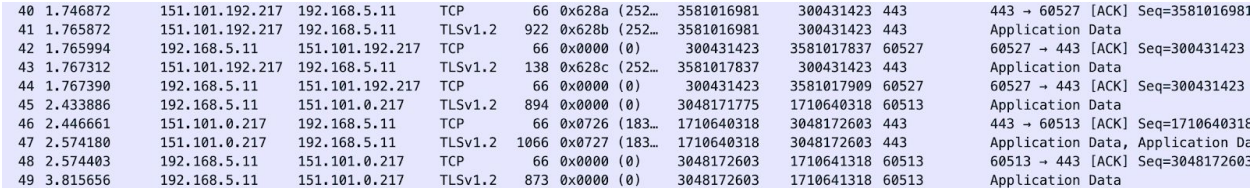


No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
52	0.259…	192.168.5.11	195.8.215.137	TCP	66	0x00…	2817918418	302294039	59868	59868 → 443 [ACK] Seq=2817918418 Ack=302294039
53	0.259…	192.168.5.11	195.8.215.137	TCP	66	0x00…	2817918418	302297483	59868	59868 → 443 [ACK] Seq=2817918418 Ack=302297483
54	0.259…	192.168.5.11	195.8.215.137	TCP	66	0x00…	2817918418	302297483	59868	[TCP Window Update] 59868 → 443 [ACK] Seq=28179
55	1.187…	192.168.5.11	195.8.215.137	TCP	1474	0x00…	2817918418	302297483	59868	59868 → 443 [ACK] Seq=2817918418 Ack=302297483
56	1.187…	192.168.5.11	195.8.215.137	TCP	1474	0x00…	2817919826	302297483	59868	59868 → 443 [ACK] Seq=2817919826 Ack=302297483
57	1.187…	192.168.5.11	195.8.215.137	TCP	1474	0x00…	2817921234	302297483	59868	59868 → 443 [ACK] Seq=2817921234 Ack=302297483
58	1.187…	192.168.5.11	195.8.215.137	TLSv1.2	79	0x00…	2817922642	302297483	59868	Application Data
59	1.225…	195.8.215.137	192.168.5.11	TCP	66	0xd4…	302297483	2817921234	443	443 → 59868 [ACK] Seq=302297483 Ack=2817921234
60	1.225…	195.8.215.137	192.168.5.11	TCP	66	0xd4…	302297483	2817922655	443	443 → 59868 [ACK] Seq=302297483 Ack=2817922655
61	1.406…	195.8.215.137	192.168.5.11	TCP	1474	0xd4…	302297483	2817922655	443	443 → 59868 [ACK] Seq=302297483 Ack=2817922655

From the first image, you can see that at packet 15, an application data packet is sent from port 59868 to port 443 (client to server). The server then acknowledges this with an ack packet. Later, as indicated by the second image, at packet number 58 another application data packet is sent from port 59868 to port 443 (client to server) and acknowledged by the server similarly. This can be considered a persistent connection, because if it were not, after the first exchange of data, the tcp connection would have closed and in order to send more data, a new connection would have had to be set up.

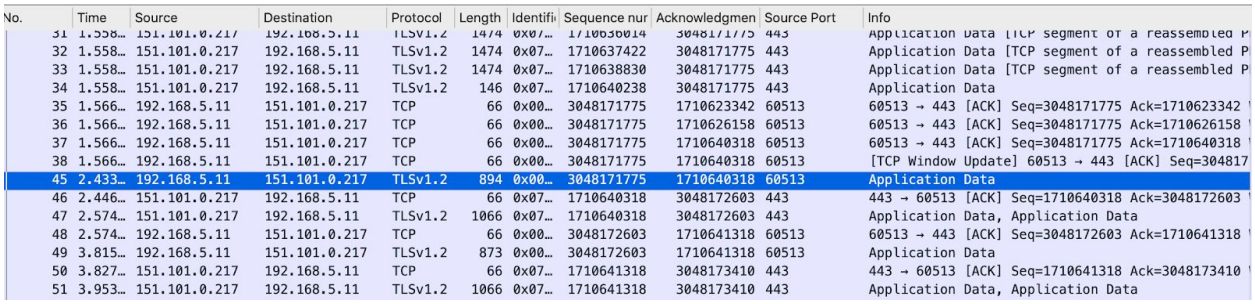
i. Persistent/Nonpersistent: **Persistent**
ii. Multiple TCP Connections/One TCP Connection: **Multiple TCP Connections**

c. Vimeo



40	1.746872	151.101.192.217	192.168.5.11	TCP	66	0x628a (252…	3581016981	300431423	443	443 → 60527 [ACK] Seq=3581016981
41	1.765872	151.101.192.217	192.168.5.11	TLSv1.2	922	0x628b (252…	3581016981	300431423	443	Application Data
42	1.765994	192.168.5.11	151.101.192.217	TCP	66	0x0000 (0)	300431423	3581017837	60527	60527 → 443 [ACK] Seq=300431423
43	1.767312	151.101.192.217	192.168.5.11	TLSv1.2	138	0x628c (252…	3581017837	300431423	443	Application Data
44	1.767390	192.168.5.11	151.101.192.217	TCP	66	0x0000 (0)	300431423	3581017909	60527	60527 → 443 [ACK] Seq=300431423
45	2.433886	192.168.5.11	151.101.0.217	TLSv1.2	894	0x0000 (0)	3048171775	1710640318	60513	Application Data
46	2.446661	151.101.0.217	192.168.5.11	TCP	66	0x0726 (183…	1710640318	3048172603	443	443 → 60513 [ACK] Seq=1710640318
47	2.574180	151.101.0.217	192.168.5.11	TLSv1.2	1066	0x0727 (183…	1710640318	3048172603	443	Application Data, Application Da
48	2.574403	192.168.5.11	151.101.0.217	TCP	66	0x0000 (0)	3048172603	1710641318	60513	60513 → 443 [ACK] Seq=3048172603
49	3.815656	192.168.5.11	151.101.0.217	TLSv1.2	873	0x0000 (0)	3048172603	1710641318	60513	Application Data

From the image, you can see that there are two ports in which packets are being exchanged from, port 60527 and port 60513. In order to exchange between several ports, several tcp connections must be established.



No.	Time	Source	Destination	Protocol	Length	Identifi	Sequence nur	Acknowledgmen	Source Port	Info
31	1.558…	151.101.0.217	192.168.5.11	TLSv1.2	1474	0x07…	1710636014	3048171775	443	Application Data [TCP segment of a reassembled P
32	1.558…	151.101.0.217	192.168.5.11	TLSv1.2	1474	0x07…	1710637422	3048171775	443	Application Data [TCP segment of a reassembled P
33	1.558…	151.101.0.217	192.168.5.11	TLSv1.2	1474	0x07…	1710638830	3048171775	443	Application Data [TCP segment of a reassembled P
34	1.558…	151.101.0.217	192.168.5.11	TLSv1.2	146	0x07…	1710640238	3048171775	443	Application Data
35	1.566…	192.168.5.11	151.101.0.217	TCP	66	0x00…	3048171775	1710623342	60513	60513 → 443 [ACK] Seq=3048171775 Ack=1710623342
36	1.566…	192.168.5.11	151.101.0.217	TCP	66	0x00…	3048171775	1710626158	60513	60513 → 443 [ACK] Seq=3048171775 Ack=1710626158
37	1.566…	192.168.5.11	151.101.0.217	TCP	66	0x00…	3048171775	1710640318	60513	60513 → 443 [ACK] Seq=3048171775 Ack=1710640318
38	1.566…	192.168.5.11	151.101.0.217	TCP	66	0x00…	3048171775	1710640318	60513	[TCP Window Update] 60513 → 443 [ACK] Seq=304817
45	2.433…	192.168.5.11	151.101.0.217	TLSv1.2	894	0x00…	3048171775	1710640318	60513	Application Data
46	2.446…	151.101.0.217	192.168.5.11	TCP	66	0x07…	1710640318	3048172603	443	443 → 60513 [ACK] Seq=1710640318 Ack=3048172603
47	2.574…	151.101.0.217	192.168.5.11	TLSv1.2	1066	0x07…	1710640318	3048172603	443	Application Data, Application Data
48	2.574…	192.168.5.11	151.101.0.217	TCP	66	0x00…	3048172603	1710641318	60513	60513 → 443 [ACK] Seq=3048172603 Ack=1710641318
49	3.815…	192.168.5.11	151.101.0.217	TLSv1.2	873	0x00…	3048172603	1710641318	60513	Application Data
50	3.827…	151.101.0.217	192.168.5.11	TCP	66	0x07…	1710641318	3048173410	443	443 → 60513 [ACK] Seq=1710641318 Ack=3048173410
51	3.953…	151.101.0.217	192.168.5.11	TLSv1.2	1066	0x07…	1710641318	3048173410	443	Application Data, Application Data

From this image, you can see that packet 45 is sent from the client (located at port 60513) to the server (located at port 443). Once the server receives the packet, presumably a request packet, it responds with an ack (packet 46) as indicated by the sequence number of 1710640318, which matches the ack of packet 45. Later, at packet 49, another packet is sent from the client to the server. This packet is once again acknowledged by the server (at packet 50). This is a persistent connection because if it were not, then the connection would be immediately closed after the acknowledgement of the first packet.

i. Persistent/Nonpersistent: **Persistent**
ii. Multiple TCP Connections/One TCP Connection: **Multiple TCP Connections**