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Fecha: 16/05/2023

Curso: Redes

NRC: 4005

Homework 003

Answer the following questions.

1) Read the following Wireshark tutorial and use it to capture traffic from the following scenarios. Use screenshots to show your results.

a) Run 10 traceroute commands against google.com

The screenshot displays two windows. The left window is Wireshark, showing a packet capture on the 'Ethernet' interface. The filter is 'icmp'. The packet list shows ICMP Echo (ping) requests and replies. The packet details pane shows the selected packet's structure, including the ICMP Echo (ping) request. The packet bytes pane shows the raw data. The right window is a Windows Command Prompt, showing the output of the 'tracert google.com' command. The output shows the path from the local host to google.com, with the final destination being 172.217.28.110. The output also shows the IP addresses of the intermediate hops and the time taken for each hop.

No.	Time	Delta	Source	Destination	Protocol	Length	TCP Segmen	Info
143070	2202.901018	1.004090	192.168.1.1	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143071	2202.906250	0.005232	10.29.0.1	192.168.1.8	ICMP	70		Time-to-live exceeded (Time
143072	2202.909054	0.002804	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143073	2202.912576	0.003522	10.29.0.1	192.168.1.8	ICMP	70		Time-to-live exceeded (Time
143074	2202.912942	0.000366	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143075	2202.916907	0.003965	10.29.0.1	192.168.1.8	ICMP	70		Time-to-live exceeded (Time
143101	2203.920890	1.003983	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143102	2203.923925	0.003035	190.152.252.186	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143103	2203.924729	0.000804	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143104	2203.927669	0.002940	190.152.252.186	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143105	2203.928451	0.000782	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143106	2203.931470	0.003019	190.152.252.186	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143109	2204.932045	1.000575	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143110	2204.935752	0.003707	190.152.252.185	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143111	2204.936628	0.000876	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143112	2204.940309	0.003681	190.152.252.185	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143113	2204.940573	0.000264	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143114	2204.944169	0.003596	190.152.252.185	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143116	2205.955923	1.011754	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143117	2205.971921	0.015998	72.14.217.100	192.168.1.8	ICMP	134		Time-to-live exceeded (Time
143118	2205.973477	0.001556	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143119	2205.989160	0.015683	72.14.217.100	192.168.1.8	ICMP	134		Time-to-live exceeded (Time
143120	2205.989991	0.000831	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143121	2206.005442	0.015451	72.14.217.100	192.168.1.8	ICMP	134		Time-to-live exceeded (Time
143552	2211.964329	5.958887	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143553	2211.981037	0.016708	142.251.51.71	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143554	2211.982251	0.001214	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143555	2211.998825	0.016574	142.251.51.71	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143556	2212.000401	0.001576	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143557	2212.016914	0.016513	142.251.51.71	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143655	2217.956403	5.939489	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143656	2217.972853	0.016450	74.125.252.61	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143657	2217.975539	0.002686	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143658	2217.991766	0.016227	74.125.252.61	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143659	2217.992999	0.001233	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143660	2218.009226	0.016227	74.125.252.61	192.168.1.8	ICMP	110		Time-to-live exceeded (Time
143671	2223.948997	5.939771	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143672	2223.970851	0.021854	172.217.28.110	192.168.1.8	ICMP	106		Echo (ping) reply id=0xc
143673	2223.973229	0.002378	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143674	2223.995137	0.021908	172.217.28.110	192.168.1.8	ICMP	106		Echo (ping) reply id=0xc
143675	2223.997967	0.002830	192.168.1.8	172.217.28.110	ICMP	106		Echo (ping) request id=0xc
143676	2224.019860	0.021893	172.217.28.110	192.168.1.8	ICMP	106		Echo (ping) reply id=0xc

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1 <1 ms <1 ms <1 ms gpon.net [192.168.1.1]
2 4 ms 3 ms 3 ms 10.29.0.1 [10.29.0.1]
3 3 ms 3 ms 2 ms 186.252.152.190.static.anycast.cnt-grms.ec [190.152.252.186]
4 4 ms 3 ms 3 ms 185.252.152.190.static.anycast.cnt-grms.ec [190.152.252.185]
5 16 ms 15 ms 15 ms 72.14.217.100
6 16 ms 16 ms 16 ms 142.251.51.71
7 16 ms 16 ms 16 ms 74.125.252.61
8 22 ms 21 ms 21 ms gru06s09-in-f110.1e100.net [172.217.28.110]

Trace complete.

C:\Windows\System32>tracert google.com

Tracing route to google.com [172.217.28.110]
over a maximum of 30 hops:

 1  <1 ms <1 ms <1 ms gpon.net [192.168.1.1]
 2  4 ms 3 ms 3 ms 10.29.0.1 [10.29.0.1]
 3  3 ms 3 ms 2 ms 186.252.152.190.static.anycast.cnt-grms.ec [190.152.252.186]
 4  4 ms 3 ms 3 ms 185.252.152.190.static.anycast.cnt-grms.ec [190.152.252.185]
 5  16 ms 15 ms 15 ms 72.14.217.100
 6  16 ms 16 ms 16 ms 142.251.51.71
 7  16 ms 16 ms 16 ms 74.125.252.61
 8  22 ms 21 ms 21 ms gru06s09-in-f110.1e100.net [172.217.28.110]

Trace complete.

C:\Windows\System32>tracert google.com

Tracing route to google.com [172.217.28.110]
over a maximum of 30 hops:

 1  <1 ms <1 ms <1 ms gpon.net [192.168.1.1]
 2  5 ms 3 ms 4 ms 10.29.0.1 [10.29.0.1]
 3  3 ms 3 ms 3 ms 186.252.152.190.static.anycast.cnt-grms.ec [190.152.252.186]
 4  3 ms 3 ms 3 ms 185.252.152.190.static.anycast.cnt-grms.ec [190.152.252.185]
 5  15 ms 15 ms 15 ms 72.14.217.100
 6  17 ms 16 ms 16 ms 142.251.51.71
 7  16 ms 16 ms 16 ms 74.125.252.61
 8  22 ms 21 ms 21 ms gru06s09-in-f110.1e100.net [172.217.28.110]

Trace complete.

C:\Windows\System32>tracert google.com

Tracing route to google.com [172.217.28.110]
over a maximum of 30 hops:

 1  <1 ms <1 ms <1 ms gpon.net [192.168.1.1]
 2  5 ms 3 ms 4 ms 10.29.0.1 [10.29.0.1]
 3  3 ms 3 ms 3 ms 186.252.152.190.static.anycast.cnt-grms.ec [190.152.252.186]
 4  3 ms 3 ms 3 ms 185.252.152.190.static.anycast.cnt-grms.ec [190.152.252.185]
 5  15 ms 15 ms 15 ms 72.14.217.100
 6  16 ms 16 ms 16 ms 142.251.51.71
 7  16 ms 16 ms 16 ms 74.125.252.61
 8  22 ms 22 ms 22 ms gru06s09-in-f110.1e100.net [172.217.28.110]

Trace complete.

C:\Windows\System32>
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b) Watch a video from youtube.com. Capture the TCP handshake, and the congestion window.

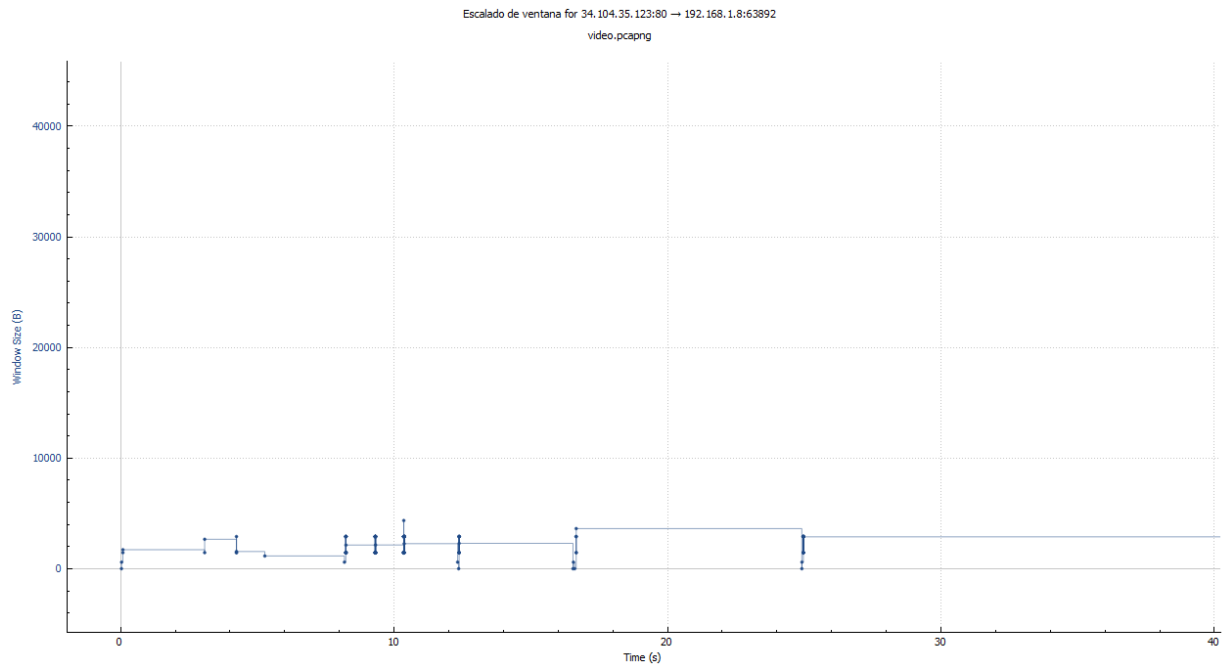
No.	Time	Delta	Source	Destination	Protocol	Length	TCP Segmen	Info
65748	46.845493	0.000202	192.168.1.8	52.1.33.175	TCP	54	0	63788 → 443 [FIN, ACK] Seq=2 Ack=79 Win=514 Len=0
65749	46.896039	0.050546	35.217.93.191	192.168.1.8	TCP	60	0	443 → 63890 [ACK] Seq=5114 Ack=1232 Win=64128 Len=0
65750	46.896039	0.000000	35.217.93.191	192.168.1.8	TCP	60	0	443 → 63890 [ACK] Seq=5114 Ack=1267 Win=64128 Len=0
65751	46.948114	0.052075	52.1.33.175	192.168.1.8	TCP	60	0	443 → 63788 [ACK] Seq=79 Ack=3 Win=394 Len=0
65754	47.942832	0.994718	192.168.1.8	142.250.78.131	TCP	55	1	[TCP Keep-Alive] 63806 → 443 [ACK] Seq=591 Ack=5443 Win=130304 Len=1
65755	47.958351	0.015519	142.250.78.131	192.168.1.8	TCP	66	0	[TCP Keep-Alive ACK] 443 → 63806 [ACK] Seq=5443 Ack=592 Win=66816 Len=0 SLE=591 SRE=592
65762	48.223757	0.265406	192.168.1.8	34.104.35.123	TCP	66	0	63892 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM
65763	48.239426	0.015669	34.104.35.123	192.168.1.8	TCP	66	0	80 → 63892 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1408 SACK_PERM WS=256
65764	48.239513	0.000087	192.168.1.8	34.104.35.123	TCP	54	0	63892 → 80 [ACK] Seq=1 Ack=1 Win=132352 Len=0
65765	48.239676	0.000163	192.168.1.8	34.104.35.123	HTTP	338	284	HEAD /edged1/release2/chrome_component/adhah2jgm6baja243ahr472t74za_392/1melglejhemegjinpboagddgdfbebgmp_392_all_ZZ_aco...
65766	48.255269	0.015593	34.104.35.123	192.168.1.8	TCP	60	0	80 → 63892 [ACK] Seq=1 Ack=285 Win=66816 Len=0
65767	48.259274	0.004005	34.104.35.123	192.168.1.8	HTTP	643	589	HTTP/1.1 200 OK
65768	48.287989	0.028715	192.168.1.8	34.104.35.123	HTTP	410	356	GET /edged1/release2/chrome_component/adhah2jgm6baja243ahr472t74za_392/1melglejhemegjinpboagddgdfbebgmp_392_all_ZZ_aco...
65769	48.307382	0.019393	34.104.35.123	192.168.1.8	TCP	1506	1452	80 → 63892 [ACK] Seq=590 Ack=641 Win=67840 Len=1452 [TCP segment of a reassembled PDU]
65770	48.307382	0.000000	34.104.35.123	192.168.1.8	HTTP	319	265	HTTP/1.1 206 Partial Content
65771	48.307444	0.000062	192.168.1.8	34.104.35.123	TCP	54	0	63892 → 80 [ACK] Seq=641 Ack=2307 Win=132352 Len=0
65783	48.890500	0.583056	192.168.1.8	142.250.78.174	TCP	55	1	[TCP Keep-Alive] 63811 → 443 [ACK] Seq=841 Ack=1335 Win=129794 Len=1
65784	48.905727	0.015227	142.250.78.174	192.168.1.8	TCP	66	0	[TCP Keep-Alive ACK] 443 → 63811 [ACK] Seq=1335 Ack=842 Win=67072 Len=0 SLE=841 SRE=842
66283	49.025289	0.119562	192.168.1.8	172.67.29.59	TCP	54	0	63790 → 443 [FIN, ACK] Seq=2 Ack=1 Win=511 Len=0
66284	49.025348	0.000059	192.168.1.8	172.217.28.110	TCP	54	0	63791 → 443 [FIN, ACK] Seq=2 Ack=1 Win=512 Len=0
66285	49.025372	0.000024	192.168.1.8	172.217.28.110	TCP	54	0	63787 → 443 [FIN, ACK] Seq=2 Ack=1 Win=512 Len=0
66286	49.025575	0.000203	2800:370:125:8e0:8408:B451:F8d...	2800:3f0:4005:406...	TCP	86	0	63893 → 443 [SYN] Seq=0 Win=64800 Len=0 MSS=1440 WS=256 SACK_PERM
66287	49.047144	0.021569	172.217.28.110	192.168.1.8	TCP	60	0	443 → 63791 [FIN, ACK] Seq=1 Ack=3 Win=261 Len=0
66288	49.047144	0.000000	172.217.28.110	192.168.1.8	TCP	60	0	443 → 63787 [FIN, ACK] Seq=1 Ack=3 Win=261 Len=0
66289	49.047181	0.000037	172.217.28.110	192.168.1.8	TCP	54	0	63791 → 443 [ACK] Seq=3 Ack=2 Win=512 Len=0
66290	49.047204	0.000023	192.168.1.8	172.217.28.110	TCP	54	0	63787 → 443 [ACK] Seq=3 Ack=2 Win=512 Len=0
66311	49.105835	0.058631	172.67.29.59	192.168.1.8	TCP	60	0	443 → 63790 [FIN, ACK] Seq=1 Ack=3 Win=8 Len=0

Se puede ver que el paquete 65762 es el inicio del handshake con el host que tiene la ip 34.104.35.123, la cual es perteneciente a Google.

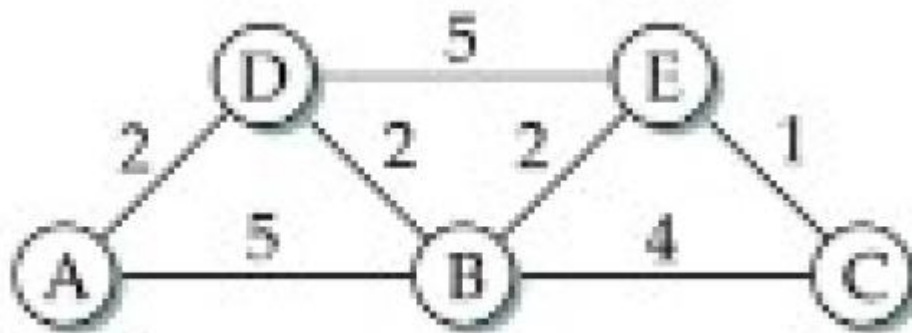
Y luego al hacer un “follow TCP stream” se obtiene esta versión filtrada de la conexión:

No.	Time	Delta	Source	Destination	Protocol	Length	TCP Segmen	Info
65762	48.223757	0.000000	192.168.1.8	34.104.35.123	TCP	66	0	63892 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM
65763	48.239426	0.015669	34.104.35.123	192.168.1.8	TCP	66	0	80 → 63892 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1408 SACK_PERM WS=256
65764	48.239513	0.000087	192.168.1.8	34.104.35.123	TCP	54	0	63892 → 80 [ACK] Seq=1 Ack=1 Win=132352 Len=0
65765	48.239676	0.000163	192.168.1.8	34.104.35.123	HTTP	338	284	HEAD /edged1/release2/chrome_component/adhah2jgm6baja243ahr472t74za_392/1melglejhemegjinpboagddgdfbebgmp_392_all_ZZ_acono...
65766	48.255269	0.015593	34.104.35.123	192.168.1.8	TCP	60	0	80 → 63892 [ACK] Seq=1 Ack=285 Win=66816 Len=0
65767	48.259274	0.004005	34.104.35.123	192.168.1.8	HTTP	643	589	HTTP/1.1 200 OK
65768	48.287989	0.028715	192.168.1.8	34.104.35.123	HTTP	410	356	GET /edged1/release2/chrome_component/adhah2jgm6baja243ahr472t74za_392/1melglejhemegjinpboagddgdfbebgmp_392_all_ZZ_acono...
65769	48.307382	0.019393	34.104.35.123	192.168.1.8	TCP	1506	1452	80 → 63892 [ACK] Seq=590 Ack=641 Win=67840 Len=1452 [TCP segment of a reassembled PDU]
65770	48.307382	0.000000	34.104.35.123	192.168.1.8	HTTP	319	265	HTTP/1.1 206 Partial Content
65771	48.307444	0.000062	192.168.1.8	34.104.35.123	TCP	54	0	63892 → 80 [ACK] Seq=641 Ack=2307 Win=132352 Len=0
66360	51.277415	2.969971	192.168.1.8	34.104.35.123	HTTP	413	359	GET /edged1/release2/chrome_component/adhah2jgm6baja243ahr472t74za_392/1melglejhemegjinpboagddgdfbebgmp_392_all_ZZ_acono...
66361	51.297599	0.020184	34.104.35.123	192.168.1.8	TCP	1506	1452	80 → 63892 [ACK] Seq=2307 Ack=1000 Win=68864 Len=1452 [TCP segment of a reassembled PDU]
66362	51.297599	0.000000	34.104.35.123	192.168.1.8	HTTP	1261	1207	HTTP/1.1 206 Partial Content
66363	51.297679	0.000000	192.168.1.8	34.104.35.123	TCP	54	0	63892 → 80 [ACK] Seq=1000 Ack=4966 Win=132352 Len=0
66422	52.441152	1.143473	192.168.1.8	34.104.35.123	HTTP	413	359	GET /edged1/release2/chrome_component/adhah2jgm6baja243ahr472t74za_392/1melglejhemegjinpboagddgdfbebgmp_392_all_ZZ_acono...
66423	52.461103	0.019951	34.104.35.123	192.168.1.8	TCP	1506	1452	80 → 63892 [ACK] Seq=4966 Ack=1359 Win=69888 Len=1452 [TCP segment of a reassembled PDU]
66424	52.461199	0.000096	34.104.35.123	192.168.1.8	TCP	1506	1452	80 → 63892 [PSH, ACK] Seq=6418 Ack=1359 Win=69888 Len=1452 [TCP segment of a reassembled PDU]
66425	52.461232	0.000033	192.168.1.8	34.104.35.123	TCP	54	0	63892 → 80 [ACK] Seq=1359 Ack=7870 Win=132352 Len=0
66426	52.461251	0.000019	34.104.35.123	192.168.1.8	TCP	1506	1452	80 → 63892 [ACK] Seq=7870 Ack=1359 Win=69888 Len=1452 [TCP segment of a reassembled PDU]
66427	52.461251	0.000000	34.104.35.123	192.168.1.8	HTTP	155	101	HTTP/1.1 206 Partial Content
66428	52.461272	0.000021	192.168.1.8	34.104.35.123	TCP	54	0	63892 → 80 [ACK] Seq=1359 Ack=9423 Win=132352 Len=0
66436	53.478815	1.017543	192.168.1.8	34.104.35.123	HTTP	413	359	GET /edged1/release2/chrome_component/adhah2jgm6baja243ahr472t74za_392/1melglejhemegjinpboagddgdfbebgmp_392_all_ZZ_acono...
66438	53.498235	0.019420	34.104.35.123	192.168.1.8	HTTP	1206	1152	HTTP/1.1 206 Partial Content
66441	53.539734	0.041499	192.168.1.8	34.104.35.123	TCP	54	0	63892 → 80 [ACK] Seq=1718 Ack=10575 Win=131072 Len=0
66689	56.389641	2.849907	192.168.1.8	34.104.35.123	HTTP	333	279	HEAD /edged1/release2/chrome_component/acafegrh72civrzom6ks24ksb7ua_590/efniojlnjndmcblieegkicadnoecjjeff_590_all_cr6cdatf...
66691	56.409347	0.019706	34.104.35.123	192.168.1.8	HTTP	645	591	HTTP/1.1 200 OK
66692	56.440562	0.031215	192.168.1.8	34.104.35.123	HTTP	406	352	GET /edged1/release2/chrome_component/acafegrh72civrzom6ks24ksb7ua_590/efniojlnjndmcblieegkicadnoecjjeff_590_all_cr6cdatf...
66693	56.450816	0.019254	34.104.35.123	192.168.1.8	TCP	1506	1452	80 → 63892 [ACK] Seq=11166 Ack=2349 Win=73216 Len=1452 [TCP segment of a reassembled PDU]

Y la congestion Window se ve algo así:

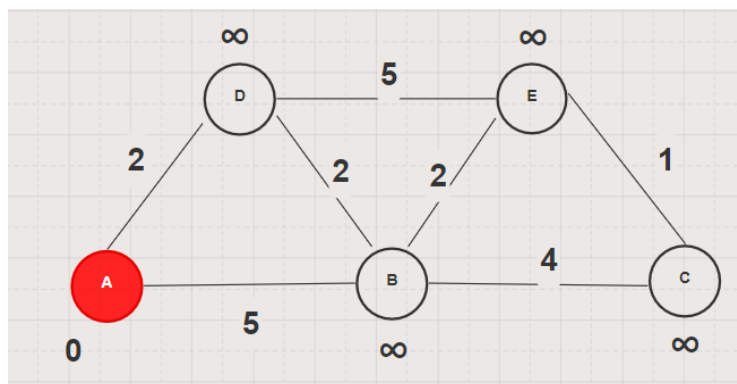


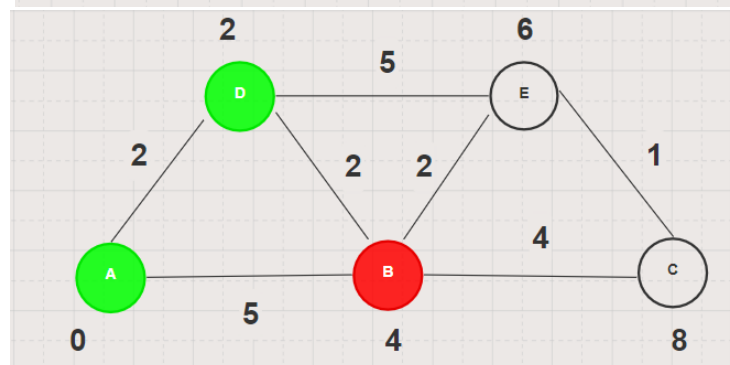
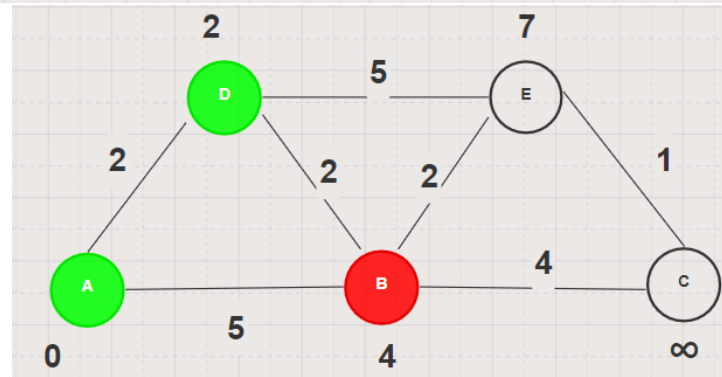
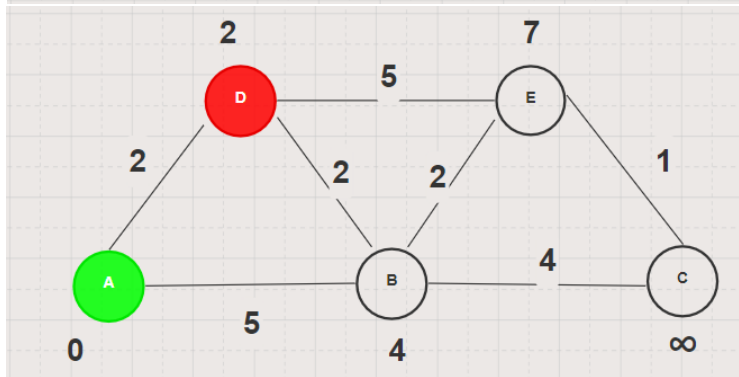
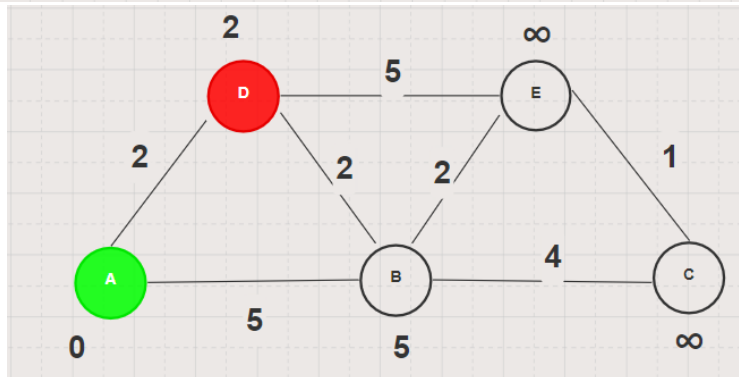
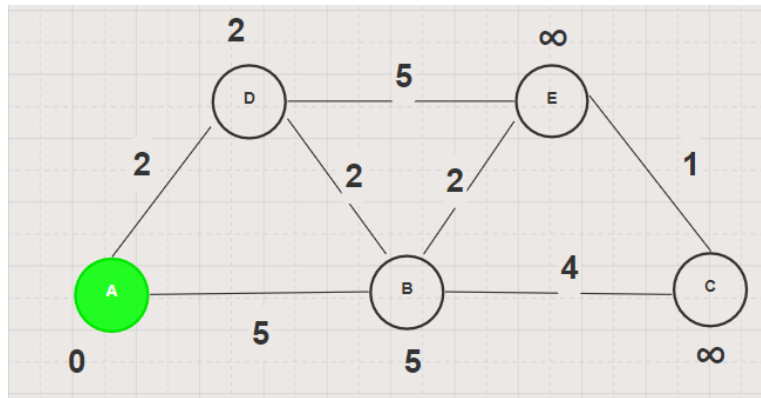
2) Use Dijkstra's to get the routing tables for nodes A, B and E.

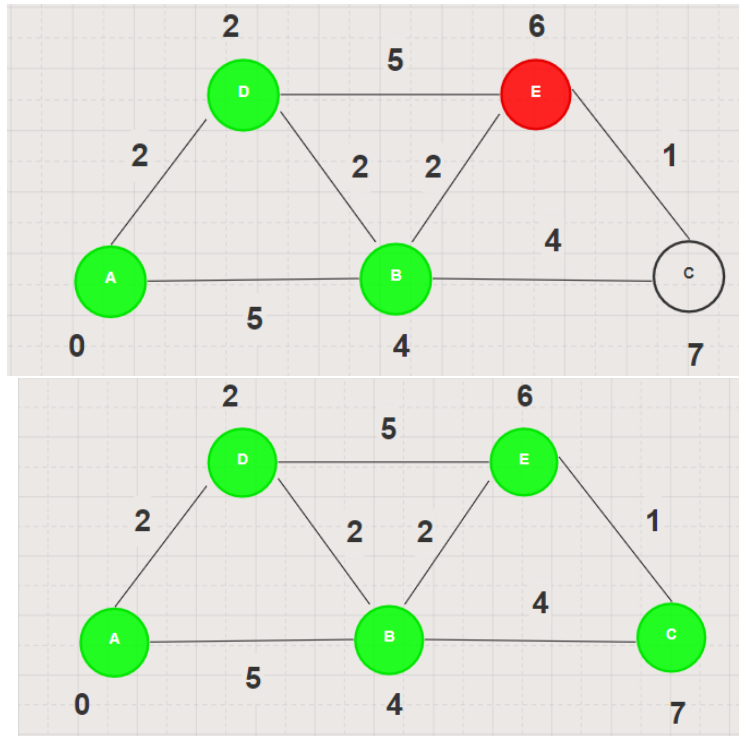


Nodo A

Se van a exponer los pasos del Algoritmo de Dijkstra. Los nodos visitados serán pintados con verde y los tentativos son los rojos



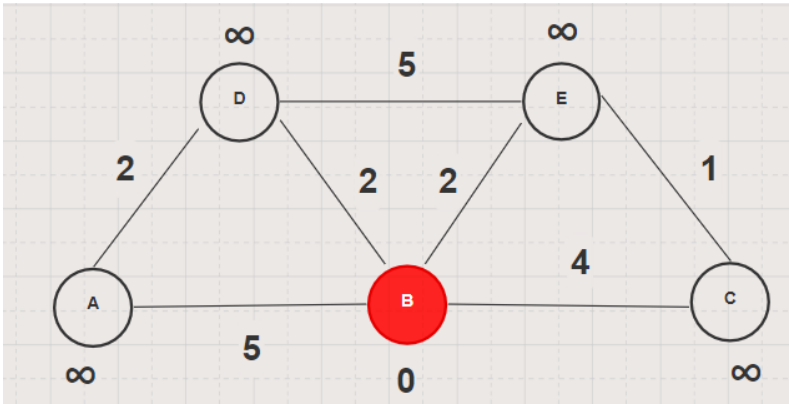


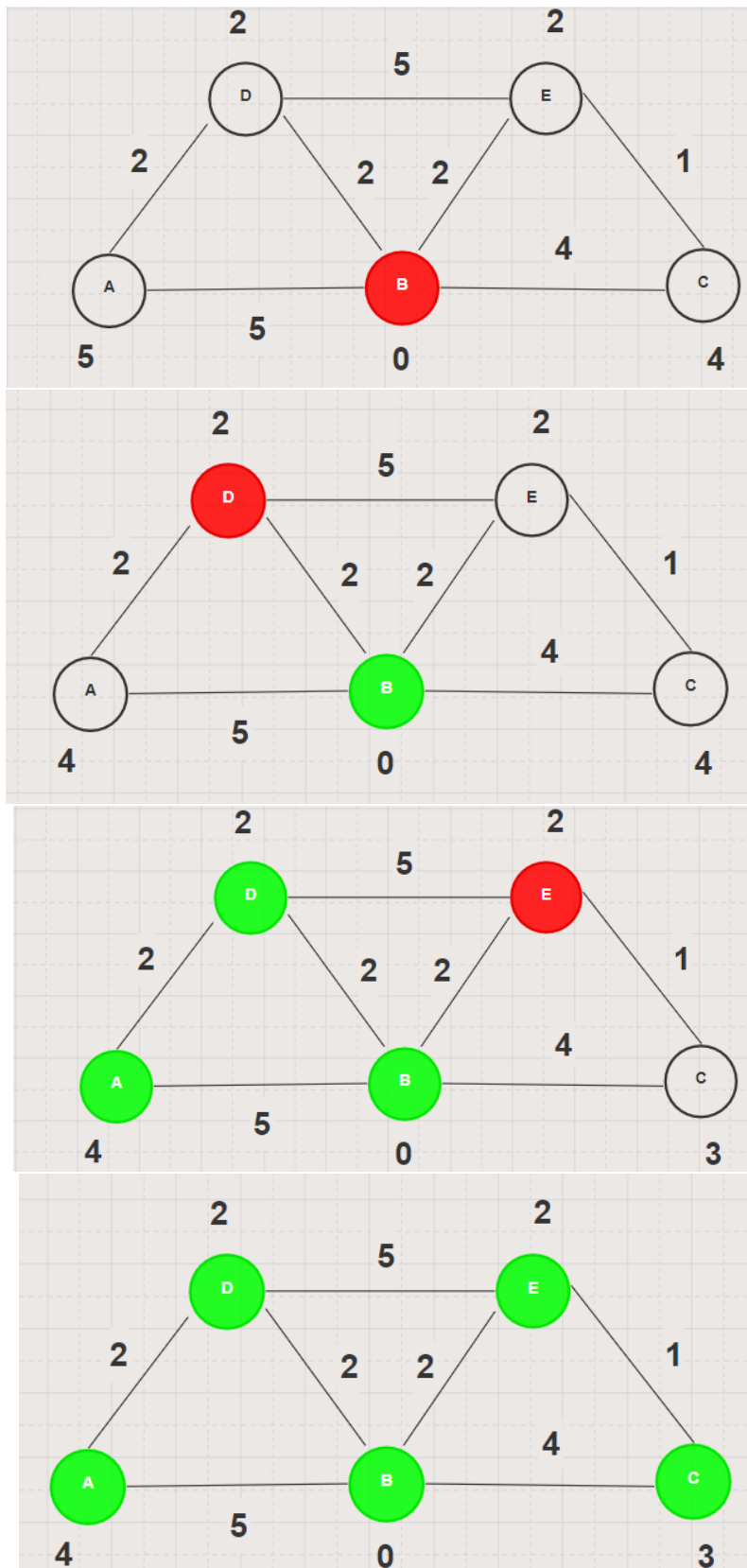


Entonces la forwarding table es la siguiente:

Destination	Next Hop	Cost
B	D	4
D	D	2
E	D	6
C	D	7

Nodo B

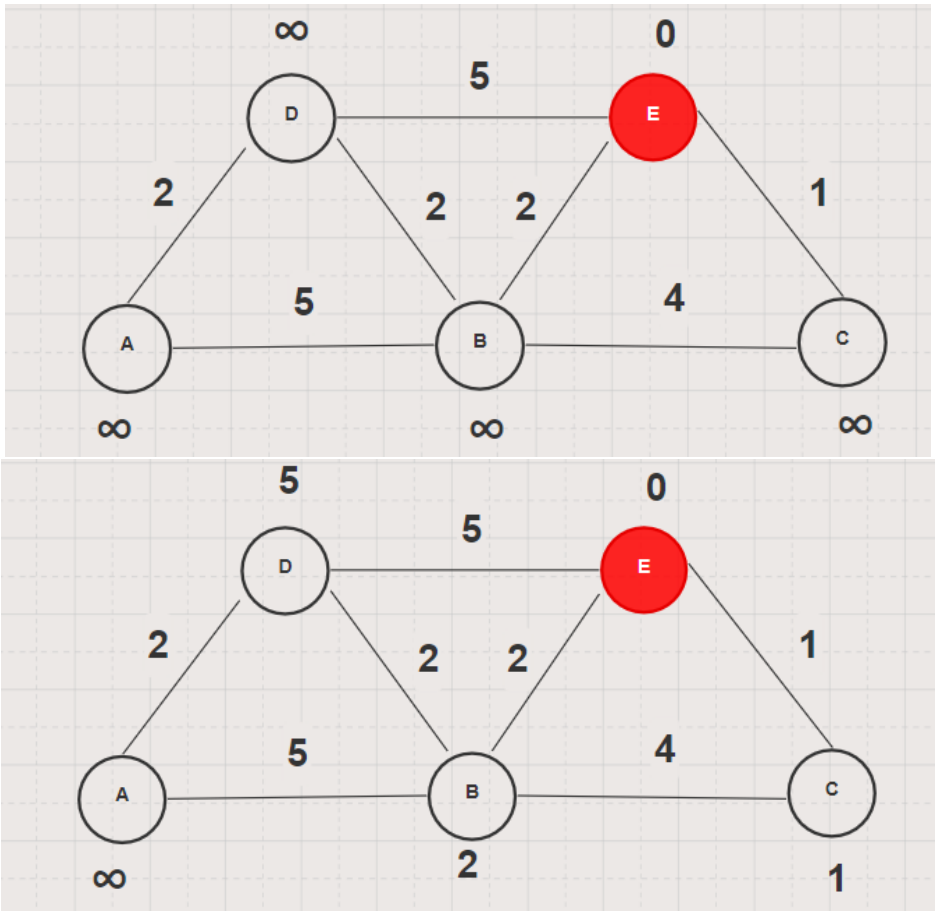


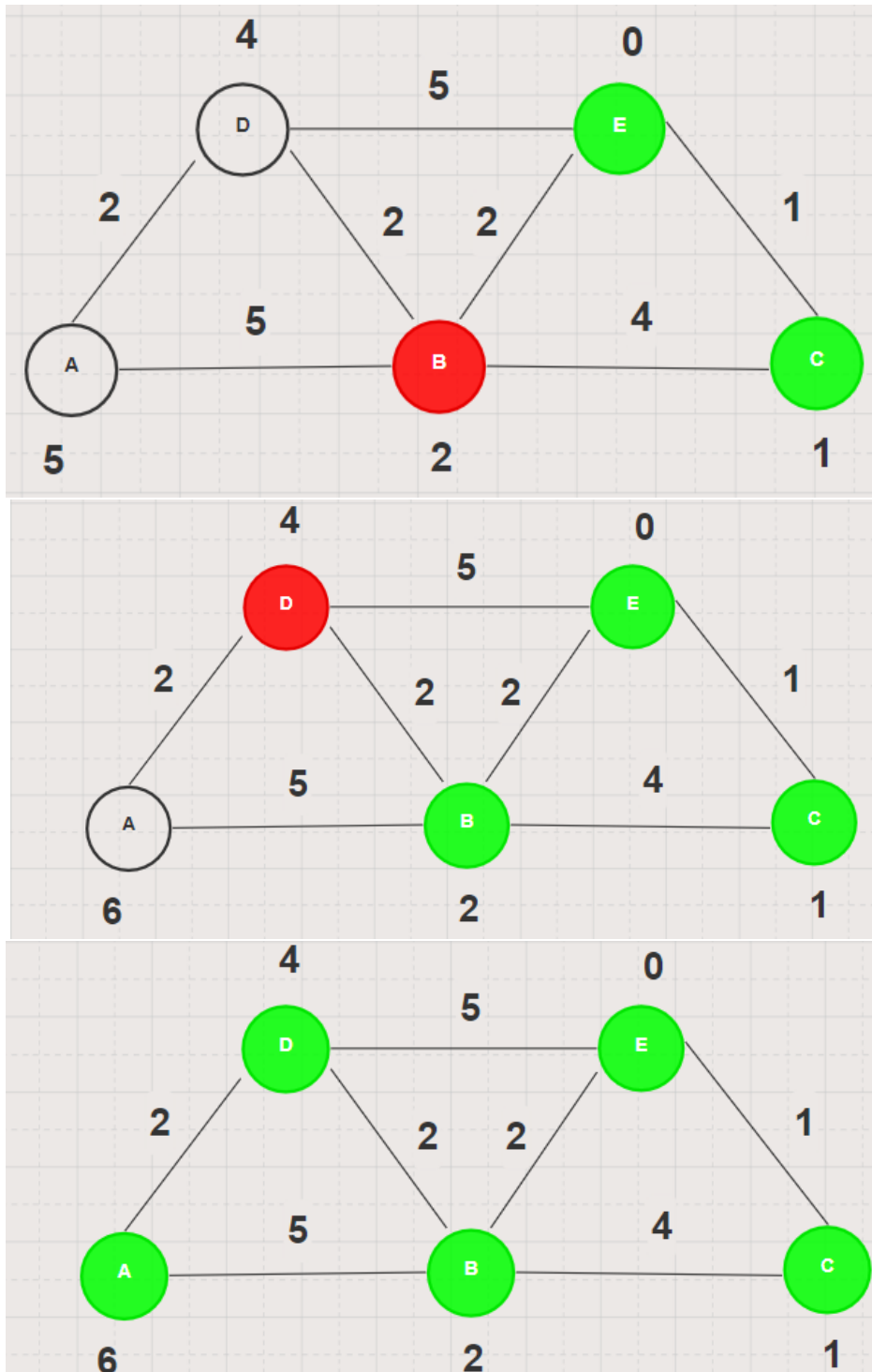


Y la forwarding table sería:

Destination	Next Hop	Cost
A	D	4
D	D	2
E	E	2
C	E	3

Nodo E





Y el forwarding table sería:

Destination	Next Hop	Cost
A	B	6
D	B	4
C	C	1

B	B	2
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3) Suppose a host wants to establish the reliability of a link by sending packets and measuring the percentage that are received; routers, for example, do this. Explain the difficulty of doing this over a TCP connection.

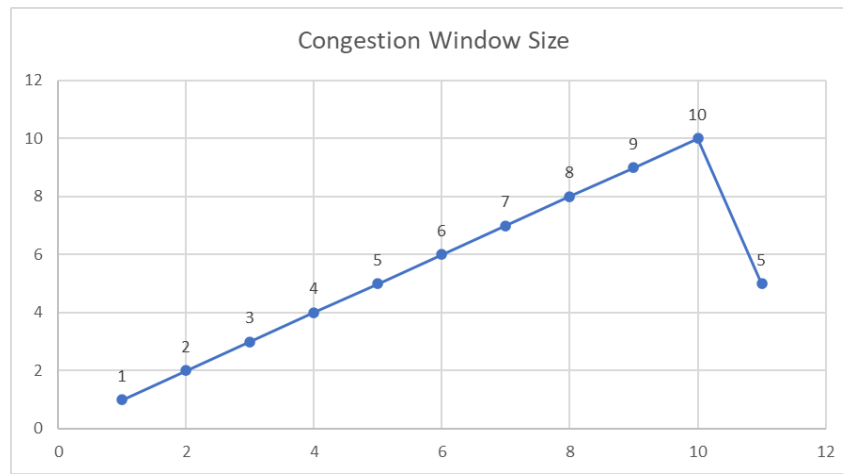
Los problemas de intentar establecer la fiabilidad de la red con una conexión de TCP es que al tener medios para reenviar paquetes por si no se reciben acknowledgments tales como los time outs o los métodos existentes en el sliding window protocol, se puede de alguna manera “cubrir” que está habiendo una pérdida de paquetes en la red. Además de que con el control de congestión de TCP pueden haber confusiones entre perder paquetes por deficiencias de una conexión, o perderlos por que hay demasiados paquetes y no entran en el congestion window.

4) Consider a simple congestion control algorithm that uses linear increase and multiplicative decrease (no slow start). Assume the congestion window size is in units of packets rather than bytes, and it is one packet initially.

a) Give a detailed sketch of this algorithm.

Ya que se considera un algoritmo simple, se van a especificar los valor de los factores de adición y multiplicación como: 1 para el linear increase y 2 para el multiplicative decrease. Con esto se puede describir el funcionamiento del algoritmo cómo:

1. Se empieza la Congestion Window con 1 paquete
2. Si se recibe el ACK del paquete se aumenta el tamaño de la Congestion Window en 1, ahora siendo de 2 paquetes.
3. Se envían dos paquetes y si se reciben los dos ACKS, se aumenta el tamaño de la Congestion Window en 1, ahora siendo de 3.
4. El algoritmo continúa añadiendo 1 paquete al Congestion Window por cada vez que se reciben todos los ACKs de los paquetes que se enviaron.
5. Si en algún momento, no se recibe un paquete ya sea porque pasó el tiempo de timeout o se perdió el ACK, se divide el número de paquetes del Congestion Window para 2. Por ejemplo, si la ventana era de tamaño 10, ahora pasa a ser de tamaño 5.



b) Assume the delay is latency only, and that when a group of packets is sent, only a single ACK is returned.

Si solo se recibe un ACK por grupo de paquetes enviados, no hay efectos negativos en el incremento lineal del algoritmo, ya que realmente no importa la cantidad de ACKs que llegan, sino, si llega el ack que significa que hubo éxito en enviar los paquetes. El problema surge cuando se pierde un paquete. Ya que no se tiene ACKs individuales, si no llega un ACK, se va a suponer que todo el grupo de paquetes debe ser reenviado, y se disminuye el tamaño del Congestion Window a la mitad. Por lo que esto lo vuelve menos eficiente.

c) Plot the congestion window as a function of RTT for the situation in which the following packets are lost: 9, 25, 30, 38 and 50. For simplicity, assume a perfect timeout mechanism that detects a lost packet exactly 1 RTT after it is transmitted.

Se va a realizar una tabla para mostrar cómo cambia el tamaño de la congestion window en función del RTT y los paquetes que se pierden

RTT	Paquetes enviados	Congestion window Size
1	1	1
2	2,3	2
3	4,5,6	3
4	7,8,9,10	4
5	9,10	2
6	11,12,13	3
7	14,15,16,17	4
8	18,19,20,21,22	5
9	23,24,25,26,27,28	6
10	25,26,27	3
11	28,29,30,31	4
12	30,31	2
13	32,33,34	3
14	35,36,37,38	4
15	38,39	2
16	40,41,42	3

17	43,44,45,46	4
18	47,48,49,50,51	5
19	50,51	2

