

Introduzione

Tutti i file **.pcap** ed i file **.xml**, sono stati generati utilizzando il parametro “RngRun”, dato dalla somma delle nostre matricole, che è pari a 7783477.

Task 1

Q1) Tutti i frame ricevono l'acknowledgement? Spiegare perché.

A1) Analizzando la sequenza di pacchetti con il programma NetAnim è possibile verificare che tutti i pacchetti UDP ed ARP (tranne quelli broadcast) sono seguiti da un ACK di ricezione dal destinatario [\[immagine 1\]](#). Abbiamo infatti usato una connessione CSMA/CA con lo standard IEEE 802.11g, che prevede l'attesa dell'ACK da parte della stazione ricevente in un tempo SIFS (Short Inter Frame Space). Osservando lo scambio di pacchetti su Wireshark, notiamo che sia il nodo n_1 che n_2 ricevono i pacchetti scambiati tra n_0 , n_3 ed n_4 . Infatti, si trovano tutti nel range di copertura di ogni dispositivo [\[immagine 2\]](#).

No.	Time	Source	Destination	Protocol	Length	Duration	Retrv	Info
1	0.000000	00:00:00_00:00:05	Broadcast	ARP	64	0	0	Frame is not being retransmitted
2	0.000754	00:00:00_00:00:01	00:00:00_00:00:05	ARP	64	314	0	Frame is not being retransmitted
3	0.001068	00:00:00_00:00:01	00:00:00_00:00:05	802.11	14	0	0	Frame is not being retransmitted
4	0.000018	192.168.1.5	192.168.1.1	UDP	576	314	0	Frame is not being retransmitted
5	0.000332	00:00:00_00:00:05	00:00:00_00:00:05	802.11	14	0	0	Frame is not being retransmitted
6	0.014772	00:00:00_00:00:01	Broadcast	ARP	64	0	0	Frame is not being retransmitted
7	0.015520	00:00:00_00:00:05	00:00:00_00:00:01	ARP	64	314	0	Frame is not being retransmitted
8	0.015040	00:00:00_00:00:05	00:00:00_00:00:05	802.11	14	0	0	Frame is not being retransmitted
9	0.020710	192.168.1.1	192.168.1.5	UDP	576	314	0	Frame is not being retransmitted
10	0.021024	00:00:00_00:00:01	00:00:00_00:00:05	802.11	14	0	0	Frame is not being retransmitted
11	1.000096	192.168.1.5	192.168.1.1	UDP	576	314	0	Frame is not being retransmitted
12	1.000410	00:00:00_00:00:05	00:00:00_00:00:05	802.11	14	0	0	Frame is not being retransmitted
13	1.005260	192.168.1.1	192.168.1.5	UDP	576	314	0	Frame is not being retransmitted
14	1.005574	00:00:00_00:00:01	00:00:00_00:00:05	802.11	14	0	0	Frame is not being retransmitted
15	1.000400	00:00:00_00:00:04	Broadcast	ARP	64	0	0	Frame is not being retransmitted
16	1.007162	00:00:00_00:00:01	00:00:00_00:00:04	ARP	64	314	0	Frame is not being retransmitted
17	1.007476	00:00:00_00:00:01	00:00:00_00:00:01	802.11	14	0	0	Frame is not being retransmitted
18	1.012466	192.168.1.4	192.168.1.1	UDP	576	314	0	Frame is not being retransmitted
19	1.012780	00:00:00_00:00:04	00:00:00_00:00:04	802.11	14	0	0	Frame is not being retransmitted
20	1.021220	00:00:00_00:00:01	Broadcast	ARP	64	0	0	Frame is not being retransmitted
21	1.021974	00:00:00_00:00:04	00:00:00_00:00:01	ARP	64	314	0	Frame is not being retransmitted
22	1.022288	00:00:00_00:00:04	00:00:00_00:00:04	802.11	14	0	0	Frame is not being retransmitted
23	1.027198	192.168.1.1	192.168.1.4	UDP	576	314	0	Frame is not being retransmitted
24	1.027512	00:00:00_00:00:01	00:00:00_00:00:05	802.11	14	0	0	Frame is not being retransmitted
25	3.000096	192.168.1.4	192.168.1.1	UDP	576	314	0	Frame is not being retransmitted
26	3.000410	00:00:00_00:00:04	00:00:00_00:00:04	802.11	14	0	0	Frame is not being retransmitted
27	3.005260	192.168.1.1	192.168.1.4	UDP	576	314	0	Frame is not being retransmitted
28	3.005574	00:00:00_00:00:01	00:00:00_00:00:05	802.11	14	0	0	Frame is not being retransmitted

Immagine 1 (task1-n2-off.pcap)

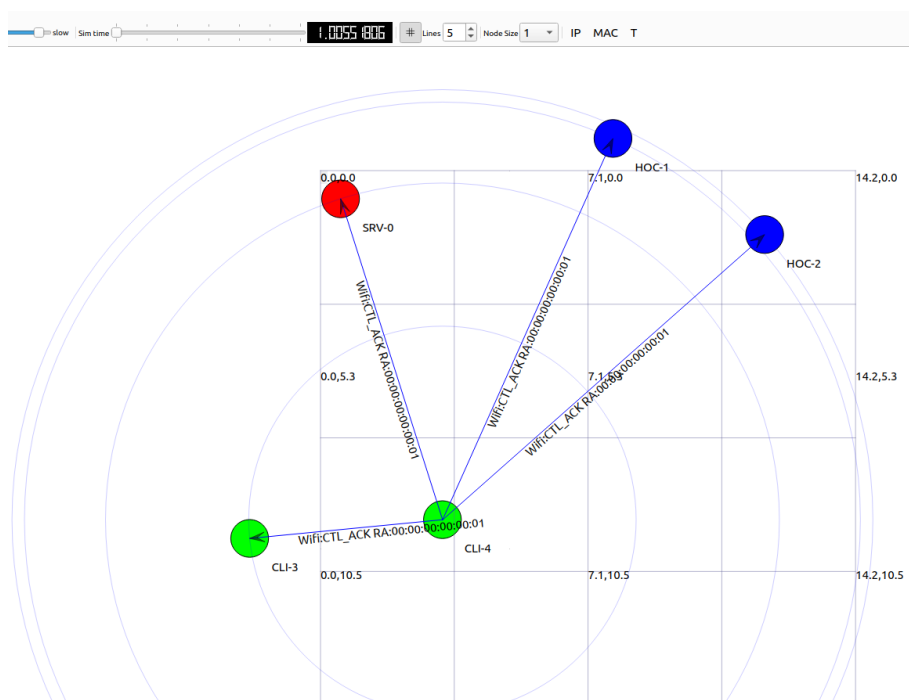


Immagine 2 (wireless-task1-rtts-off.xml)

Q2) Vi sono delle collisioni nella rete? Spiegare perché. Come sei arrivato a questa conclusione?

A2) Non sono presenti collisioni in quanto non sono presenti ritrasmissioni di pacchetti. Questo si può verificare nella sezione “IEEE 802.11 Data, Flags > Frame control field > Flags > Retry” di Wireshark. Questo parametro è 0 per tutta la durata della simulazione, che implica “**Frame is not being retransmitted**” [\[immagine 3\]](#). Inoltre, l’unico momento possibile in cui potrebbe avvenire una collisione è al tempo $t = 2s$, poiché sia n_3 sia n_4 desiderano inviare il proprio pacchetto. Grazie all’uso del “**Collision Avoidance**”, i due nodi sono in grado di rilevare il canale occupato e si mettono in attesa di un tempo casuale, nella speranza che i due tempi siano diversi per creare una sequenzialità [\[immagine 4\]](#).

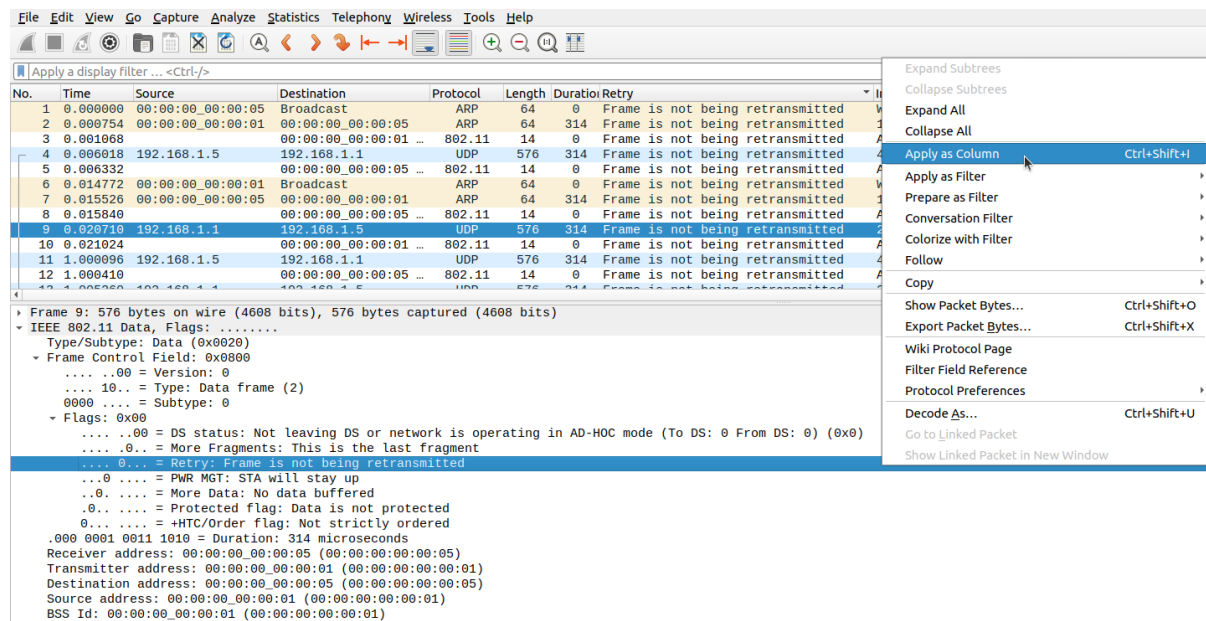


Immagine 3 (task1-n2-off.pcap)

	From Id	To Id	Tx	Meta
1	4	3	2.00005	UDP 49153 > 20
2	4	0	2.00005	UDP 49153 > 20
3	0	3	2.00486	Wifi CTL_ACK RA:00:00:00:00:00:05
4	0	4	2.00486	Wifi CTL_ACK RA:00:00:00:00:00:05
5	0	3	2.00521	UDP 20 > 49153
6	0	4	2.00521	UDP 20 > 49153
7	4	3	2.01002	Wifi CTL_ACK RA:00:00:00:00:00:01
8	4	0	2.01002	Wifi CTL_ACK RA:00:00:00:00:00:01
9	3	4	2.01046	Arp request SMac: 00:00:00:00:00:04 DMac: ff:ff:ff:ff:ff:ff Srcip : 192.168.1.4 Dstip : 192.168.1.1
10	3	0	2.01046	Arp request SMac: 00:00:00:00:00:04 DMac: ff:ff:ff:ff:ff:ff Srcip : 192.168.1.4 Dstip : 192.168.1.1
11	0	3	2.01121	Arp reply SMac: 00:00:00:00:00:01 DMac: 00:00:00:00:00:04 Srcip : 192.168.1.1 Dstip : 192.168.1.4
12	0	4	2.01121	Arp reply SMac: 00:00:00:00:00:01 DMac: 00:00:00:00:00:04 Srcip : 192.168.1.1 Dstip : 192.168.1.4
13	3	4	2.01193	Wifi CTL_ACK RA:00:00:00:00:00:01
14	3	0	2.01193	Wifi CTL_ACK RA:00:00:00:00:00:01
15	3	4	2.01242	UDP 49153 > 20
16	3	0	2.01242	UDP 49153 > 20
17	0	3	2.01723	Wifi CTL_ACK RA:00:00:00:00:00:04
18	0	4	2.01723	Wifi CTL_ACK RA:00:00:00:00:00:04
19	0	3	2.02527	Arp request SMac: 00:00:00:00:00:01 DMac: ff:ff:ff:ff:ff:ff Srcip : 192.168.1.1 Dstip : 192.168.1.4
20	0	4	2.02527	Arp request SMac: 00:00:00:00:00:01 DMac: ff:ff:ff:ff:ff:ff Srcip : 192.168.1.1 Dstip : 192.168.1.4
21	3	4	2.02602	Arp reply SMac: 00:00:00:00:00:04 DMac: 00:00:00:00:00:01 Srcip : 192.168.1.4 Dstip : 192.168.1.1
22	3	0	2.02602	Arp reply SMac: 00:00:00:00:00:04 DMac: 00:00:00:00:00:01 Srcip : 192.168.1.4 Dstip : 192.168.1.1
23	0	3	2.02674	Wifi CTL_ACK RA:00:00:00:00:00:04
24	0	4	2.02674	Wifi CTL_ACK RA:00:00:00:00:00:04
25	0	3	2.02715	UDP 20 > 49153
26	0	4	2.02715	UDP 20 > 49153
27	3	4	2.03196	Wifi CTL_ACK RA:00:00:00:00:00:01
28	3	0	2.03196	Wifi CTL_ACK RA:00:00:00:00:00:01

Immagine 4 (wireless-task1-rts-off.xml)

Q3) Come si può forzare i nodi ad utilizzare la procedura di handshake RTS/CTS vista in classe? Qual è il ragionamento dietro questa procedura?

A3) È possibile forzare l'uso di RTS/CTS impostando un “**threshold limit**”, in modo che il protocollo si applichi solamente ai pacchetti scambiati con una dimensione maggiore del suddetto limite. Avendolo impostato a 100, sono solo i pacchetti UDP, con dimensione 512bytes, ad essere colpiti dal cambiamento [\[immagine 5\]](#). L'RTS/CTS è una tecnica di trasmissione che prevede l'invio ulteriore di due pacchetti prima di mandare un messaggio. Inizialmente viene inviato il pacchetto RTS che indica la durata della trasmissione, in risposta viene inviato un pacchetto CTS che impedisce agli altri nodi di inviare messaggi. A questo scambio è seguito il messaggio UDP [\[immagine 6\]](#).

task1-on-2.pcap

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No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	00:00:00_00:00:05	Broadcast	ARP	64	Who has 192.168.1.1? Tell 192.168.1.5
2	0.000754	00:00:00_00:00:01	00:00:00_00:00:05	ARP	64	192.168.1.1 is at 00:00:00:00:00:01
3	0.001068	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Acknowledgement, Flags=.....
4	0.001570	00:00:00_00:00:05	00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	20	Request-to-send, Flags=.....
5	0.001884	00:00:00_00:00:05	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	14	Clear-to-send, Flags=.....
6	0.006694	192.168.1.5	192.168.1.1	UDP	576	49153 → 20 Len=512
7	0.007088	00:00:00_00:00:05	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	14	Acknowledgement, Flags=.....
8	0.015448	00:00:00_00:00:01	Broadcast	ARP	64	Who has 192.168.1.5? Tell 192.168.1.1
9	0.016202	00:00:00_00:00:05	00:00:00_00:00:01	ARP	64	192.168.1.5 is at 00:00:00:00:00:05
10	0.016516	00:00:00_00:00:05	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	14	Acknowledgement, Flags=.....
11	0.016938	00:00:00_00:00:01	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	20	Request-to-send, Flags=.....
12	0.017252	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Clear-to-send, Flags=.....
13	0.022062	192.168.1.1	192.168.1.5	UDP	576	20 → 49153 Len=512
14	0.022376	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Acknowledgement, Flags=.....
15	0.095648	00:00:00_00:00:05	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	20	Request-to-send, Flags=.....
16	0.095962	00:00:00_00:00:05	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	14	Clear-to-send, Flags=.....
17	1.000772	192.168.1.5	192.168.1.1	UDP	576	49153 → 20 Len=512
18	1.001086	00:00:00_00:00:05	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	14	Acknowledgement, Flags=.....
19	1.001488	00:00:00_00:00:01	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	20	Request-to-send, Flags=.....
20	1.001802	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Clear-to-send, Flags=.....
21	1.006612	192.168.1.1	192.168.1.5	UDP	576	20 → 49153 Len=512
22	1.006926	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Acknowledgement, Flags=.....
23	1.007760	00:00:00_00:00:04	Broadcast	ARP	64	Who has 192.168.1.1? Tell 192.168.1.4
24	1.008514	00:00:00_00:00:01	00:00:00_00:00:04	ARP	64	192.168.1.1 is at 00:00:00:00:00:01
25	1.008828	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Acknowledgement, Flags=.....
26	1.009370	00:00:00_00:00:04	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	20	Request-to-send, Flags=.....
27	1.009684	00:00:00_00:00:04	00:00:00:00:00:04 (00:00:00:00:00:04) (RA)	802.11	14	Clear-to-send, Flags=.....
28	1.014494	192.168.1.4	192.168.1.1	UDP	576	49153 → 20 Len=512
29	1.014898	00:00:00_00:00:04	00:00:00:00:00:04 (00:00:00:00:00:04) (RA)	802.11	14	Acknowledgement, Flags=.....
30	1.023248	00:00:00_00:00:01	Broadcast	ARP	64	Who has 192.168.1.4? Tell 192.168.1.1
31	1.024002	00:00:00_00:00:04	00:00:00_00:00:01	ARP	64	192.168.1.4 is at 00:00:00:00:00:04

Immagine 5 (task1-n2-on.pcap)

task1-on-2.pcap

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wlan.fc.type_subtype == 0x001c || wlan.fc.type_subtype == 0x001b || udp

No.	Time	Source	Destination	Protocol	Length	Info
4	0.001570	00:00:00_00:00:05	00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	20	Request-to-send, Flags=.....
5	0.001884	00:00:00_00:00:05	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	14	Clear-to-send, Flags=.....
6	0.006694	192.168.1.5	192.168.1.1	UDP	576	49153 → 20 Len=512
11	0.016938	00:00:00_00:00:01	00:00:00_00:00:05 (00:00:00:00:00:05) (RA)	802.11	20	Request-to-send, Flags=.....
12	0.017252	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Clear-to-send, Flags=.....
13	0.022062	192.168.1.1	192.168.1.5	UDP	576	20 → 49153 Len=512
15	0.095648	00:00:00_00:00:05	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	20	Request-to-send, Flags=.....
16	0.095962	00:00:00_00:00:05	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	14	Clear-to-send, Flags=.....
17	1.000772	192.168.1.5	192.168.1.1	UDP	576	49153 → 20 Len=512
19	1.001488	00:00:00_00:00:01	00:00:00:00:00:05 (00:00:00:00:00:05) (RA)	802.11	20	Request-to-send, Flags=.....
20	1.001802	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Clear-to-send, Flags=.....
21	1.006612	192.168.1.1	192.168.1.5	UDP	576	20 → 49153 Len=512
26	1.009370	00:00:00_00:00:04	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	20	Request-to-send, Flags=.....
27	1.009684	00:00:00_00:00:04	00:00:00:00:00:04 (00:00:00:00:00:04) (RA)	802.11	14	Clear-to-send, Flags=.....
28	1.014494	192.168.1.4	192.168.1.1	UDP	576	49153 → 20 Len=512
33	1.024778	00:00:00_00:00:01	00:00:00:00:00:04 (00:00:00:00:00:04) (RA)	802.11	20	Request-to-send, Flags=.....
34	1.025092	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Clear-to-send, Flags=.....
35	1.029902	192.168.1.1	192.168.1.4	UDP	576	20 → 49153 Len=512
37	2.995648	00:00:00_00:00:04	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	20	Request-to-send, Flags=.....
38	2.995962	00:00:00_00:00:04	00:00:00:00:00:04 (00:00:00:00:00:04) (RA)	802.11	14	Clear-to-send, Flags=.....
39	3.000772	192.168.1.4	192.168.1.1	UDP	576	49153 → 20 Len=512
41	3.001488	00:00:00_00:00:01	00:00:00:00:00:04 (00:00:00:00:00:04) (RA)	802.11	20	Request-to-send, Flags=.....
42	3.001802	00:00:00_00:00:01	00:00:00:00:00:01 (00:00:00:00:00:01) (RA)	802.11	14	Clear-to-send, Flags=.....
43	3.006612	192.168.1.1	192.168.1.4	UDP	576	20 → 49153 Len=512

Immagine 6 (task1-n2-off.pcap)

Q4) Forzare l'uso di RTS/CTS nella rete utilizzando il parametro useRtsCts:

- Ci sono delle collisioni adesso?
- Quali sono i benefici di RTS/CTS?
- Dove si può trovare ed analizzare le informazioni relative al Network Allocation Vector?

A4) In questa configurazione non ci sono collisioni dato l'uso del protocollo RTS/CTS. Il beneficio principale è infatti quello di diminuire la probabilità di collisioni attraverso una prenotazione del canale per una trasmissione sicura del pacchetto. Così facendo, viene risparmiato il tempo di una eventuale ritrasmissione; questo metodo viene spesso usato per pacchetti di grandi dimensioni. In Wireshark è possibile trovare il parametro **NAV** all'interno dell'header MAC, guardando la sezione "IEEE 802.11 Data > Frame Control Field > Duration" [\[immagine 7\]](#). Questo valore indica la durata effettiva della comunicazione, includendo l'invio del messaggio e la ricezione del pacchetto ACK.

The screenshot shows the Wireshark interface with the following details:

- Packet List:**
 - No. 6: 0.006694 192.168.1.5 → 192.168.1.1, UDP, 576 bytes, Info: 49153 → 20 Len=512
 - No. 7: 0.007008 00:00:00:00:00:05 → 00:00:00:00:00:05 (00:00:00:00:00:05) (RA), 802.11, 14 bytes, Info: Acknowledgement, Flags=.....
 - No. 8: 0.015448 00:00:00:00:00:01 Broadcast, ARP, 64 bytes, Info: Who has 192.168.1.1?
 - No. 9: 0.016202 00:00:00:00:00:05 00:00:00:00:00:01 (00:00:00:00:00:05) (RA), ARP, 64 bytes, Info: 192.168.1.5 is at 00:00:00:00:00:01
 - No. 10: 0.016516 00:00:00:00:00:05 00:00:00:00:00:05 (00:00:00:00:00:05) (RA), 802.11, 14 bytes, Info: Acknowledgement
 - No. 11: 0.016938 00:00:00:00:00:01 00:00:00:00:00:05 (00:00:00:00:00:05) (RA), 802.11, 20 bytes, Info: Request-to-send, Flags=.....
 - No. 12: 0.017252 00:00:00:00:00:01 00:00:00:00:00:01 (00:00:00:00:00:01) (RA), 802.11, 14 bytes, Info: Clear-to-send, Flags=.....
 - No. 13: 0.022062 192.168.1.1 → 192.168.1.5, UDP, 576 bytes, Info: 20 → 49153 Len=512
 - No. 14: 0.022376 00:00:00:00:00:01 00:00:00:00:00:05 (00:00:00:00:00:05) (RA), 802.11, 14 bytes, Info: Acknowledgement
 - No. 15: 0.095648 00:00:00:00:00:05 00:00:00:00:00:01 (00:00:00:00:00:01) (RA), 802.11, 20 bytes, Info: Request-to-send, Flags=.....
 - No. 16: 0.095962 00:00:00:00:00:05 00:00:00:00:00:05 (00:00:00:00:00:05) (RA), 802.11, 14 bytes, Info: Clear-to-send, Flags=.....
 - No. 17: 1.000772 192.168.1.5 → 192.168.1.1, UDP, 576 bytes, Info: 49153 → 20 Len=512
 - No. 18: 1.001086 00:00:00:00:00:05 00:00:00:00:00:05 (00:00:00:00:00:05) (RA), 802.11, 14 bytes, Info: Acknowledgement
 - No. 19: 1.001488 00:00:00:00:00:01 00:00:00:00:00:05 (00:00:00:00:00:05) (RA), 802.11, 20 bytes, Info: Request-to-send, Flags=.....
 - No. 20: 1.001802 00:00:00:00:00:01 00:00:00:00:00:01 (00:00:00:00:00:01) (RA), 802.11, 14 bytes, Info: Clear-to-send, Flags=.....
 - No. 21: 1.006612 192.168.1.1 → 192.168.1.5, UDP, 576 bytes, Info: 20 → 49153 Len=512
 - No. 22: 1.006926 00:00:00:00:00:01 00:00:00:00:00:05 (00:00:00:00:00:05) (RA), 802.11, 14 bytes, Info: Acknowledgement
 - No. 23: 1.007760 00:00:00:00:00:04 Broadcast, ARP, 64 bytes, Info: Who has 192.168.1.1?
 - No. 24: 1.008514 00:00:00:00:00:01 00:00:00:00:00:04 (00:00:00:00:00:04) (RA), ARP, 64 bytes, Info: 192.168.1.1 is at 00:00:00:00:00:04
 - No. 25: 1.008828 00:00:00:00:00:01 00:00:00:00:00:01 (00:00:00:00:00:01) (RA), 802.11, 14 bytes, Info: Acknowledgement
- Packet Details:**
 - Frame 6: 576 bytes on wire (4608 bits), 576 bytes captured (4608 bits) on interface 0
 - IEEE 802.11 Data, Flags:
 - Type/Subtype: Data (0x0020)
 - Frame Control Field: 0x0000
 -00 = Version: 0
 -10.. = Type: Data frame (2)
 - 0000 = Subtype: 0
 - Flags: 0x00
 - Duration: 314 microseconds
 - Receiver address: 00:00:00:00:00:01 (00:00:00:00:00:01)
 - Transmitter address: 00:00:00:00:00:05 (00:00:00:00:00:05)
 - Destination address: 00:00:00:00:00:01 (00:00:00:00:00:01)
 - Source address: 00:00:00:00:00:05 (00:00:00:00:00:05)
 - BSS Id: 00:00:00:00:00:05 (00:00:00:00:00:05)

Immagine 7 (task1-n2-off.pcap)

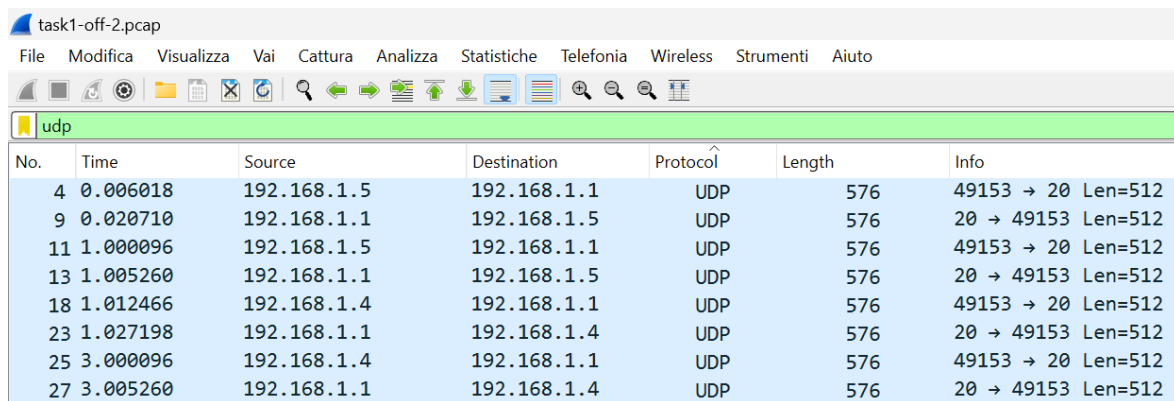
Q5) Calcolare il throughput medio complessivo delle applicazioni

A5) Il Throughput a livello di applicazione riguarda esclusivamente i messaggi UDP, che sono composti da **512bytes** di dati e **64bytes** di header. Il throughput è la dimensione totale dei pacchetti inviati sul tempo totale della trasmissione, ovvero il tempo dall'invio del primo messaggio UDP fino alla ricezione dell'ultimo ACK. Consideriamo i due casi con e senza procedura RTS/CTS, analizzando solo i pacchetti UDP [\[immagine 8\]](#) senza tener conto dell'header dato che consideriamo il throughput delle applicazioni.

$$RTS/CTS\ OFF = 1'365,535\text{bytes/s} = 10'924,283\text{bps} = 10,92\text{kbit/s}$$

$$RTS/CTS\ ON = 1'365,228\text{bytes/s} = 10'921,829\text{bits/s} = 10,92\text{kbit/s}$$

Come previsto il throughput con RTS/CTS è leggermente minore, visto che viene speso del tempo per garantire una trasmissione sicura.



No.	Time	Source	Destination	Protocol	Length	Info
4	0.006018	192.168.1.5	192.168.1.1	UDP	576	49153 → 20 Len=512
9	0.020710	192.168.1.1	192.168.1.5	UDP	576	20 → 49153 Len=512
11	1.000096	192.168.1.5	192.168.1.1	UDP	576	49153 → 20 Len=512
13	1.005260	192.168.1.1	192.168.1.5	UDP	576	20 → 49153 Len=512
18	1.012466	192.168.1.4	192.168.1.1	UDP	576	49153 → 20 Len=512
23	1.027198	192.168.1.1	192.168.1.4	UDP	576	20 → 49153 Len=512
25	3.000096	192.168.1.4	192.168.1.1	UDP	576	49153 → 20 Len=512
27	3.005260	192.168.1.1	192.168.1.4	UDP	576	20 → 49153 Len=512

Immagine 8 (task1-off-2.pcap)

Task2

Q1) Spiegare il comportamento dell'AP. Cosa succede fin dal primo momento dell'inizio della simulazione?

A1) L'Access Point ha una posizione fissa nello spazio e gestisce lo scambio di dati Client/Server e le richieste ARP, aggiornando la rispettiva tabella [\[immagine 9\]](#). Come previsto dallo standard IEEE 802.11g, l'AP trasmette frame beacon in broadcast ad intervalli regolari di **0.102s**, come si può verificare con i programmi Wireshark e NetAnim. Il frame beacon serve a segnalare la sua presenza agli altri nodi e per sincronizzare le operazioni dei nodi connessi. Seguono i messaggi di associazione tra i vari nodi con l'AP: all'invio del frame di "Association Request" da parte di un nodo, l'Access Point risponde con un frame di "Association Response", necessario per stabilire delle connessioni logiche.

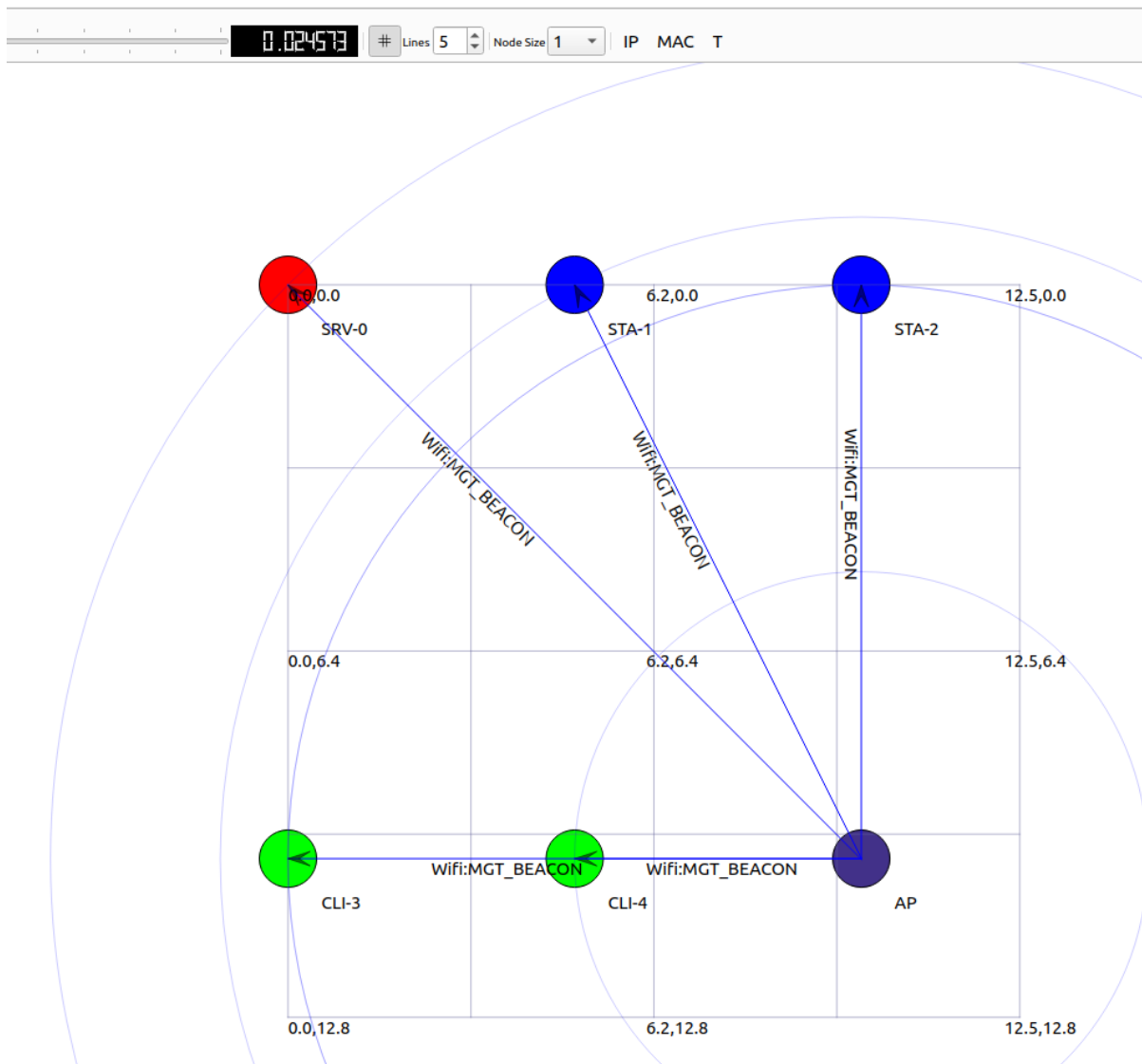


Immagine 9 (wireless-task2-rts-off.xml)

Q2) Analizzare il beacon frame. Quali sono le sue parti più rilevanti? Specificare il filtro Wireshark ed il file utilizzati per l'analisi.

A3) Il file analizzato è “task2-off-4.pcap”, mentre il filtro utilizzato su Wireshark è “wlan.fc.type_subtype == 0x08” [\[immagine 10\]](#). I campi significativi nel corpo di un frame beacon sono i seguenti:

1. **Timestamp:** tempo (in microsecondi) in cui l'AP è attivo. Questo risulta utile per la sincronizzazione tra tutte le stazioni connesse allo stesso AP;
2. **Beacon Interval:** intervallo di tempo tra due trasmissioni di frame beacon consecutive;
3. **Capability Information:** informazioni sulla capacità della rete o del dispositivo. Verifica se il tipo di rete in uso è una rete ad hoc o una rete infrastrutturale;
4. **Service Set Identifiers:** codice identificativo di una LAN wireless;
5. **Supported rates:** indica i bit rate che sono supportati.

wlan.fc.type_subtype == 0x08							
No.	Time	Source	Destination	Protocol	Length	Info	
29	0.614389	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=11, FN=0, Flags=.....	BI=100, SSID=7783477
30	0.716789	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=12, FN=0, Flags=.....	BI=100, SSID=7783477
31	0.819189	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=13, FN=0, Flags=.....	BI=100, SSID=7783477
32	0.921589	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=14, FN=0, Flags=.....	BI=100, SSID=7783477
55	1.023989	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=21, FN=0, Flags=.....	BI=100, SSID=7783477
56	1.126389	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=22, FN=0, Flags=.....	BI=100, SSID=7783477
57	1.228789	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=23, FN=0, Flags=.....	BI=100, SSID=7783477
58	1.331189	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=24, FN=0, Flags=.....	BI=100, SSID=7783477
59	1.433589	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=25, FN=0, Flags=.....	BI=100, SSID=7783477
60	1.535989	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=26, FN=0, Flags=.....	BI=100, SSID=7783477
61	1.638389	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=27, FN=0, Flags=.....	BI=100, SSID=7783477
62	1.740789	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=28, FN=0, Flags=.....	BI=100, SSID=7783477
63	1.843189	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=29, FN=0, Flags=.....	BI=100, SSID=7783477
64	1.945589	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=30, FN=0, Flags=.....	BI=100, SSID=7783477
94	2.047989	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=39, FN=0, Flags=.....	BI=100, SSID=7783477
95	2.150389	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=40, FN=0, Flags=.....	BI=100, SSID=7783477
96	2.252789	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=41, FN=0, Flags=.....	BI=100, SSID=7783477
97	2.355189	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=42, FN=0, Flags=.....	BI=100, SSID=7783477
98	2.457589	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=43, FN=0, Flags=.....	BI=100, SSID=7783477
99	2.559989	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=44, FN=0, Flags=.....	BI=100, SSID=7783477
100	2.662389	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=45, FN=0, Flags=.....	BI=100, SSID=7783477
101	2.764789	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=46, FN=0, Flags=.....	BI=100, SSID=7783477
102	2.867189	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=47, FN=0, Flags=.....	BI=100, SSID=7783477
103	2.969589	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=48, FN=0, Flags=.....	BI=100, SSID=7783477
104	3.071989	00:00:00:00:00:01	Broadcast	802.11	71	Beacon frame, SN=49, FN=0, Flags=.....	BI=100, SSID=7783477
Frame 61: 71 bytes on wire (568 bits), 71 bytes captured (568 bits)							
IEEE 802.11 Beacon frame, Flags:							
IEEE 802.11 Wireless Management							
Fixed parameters (12 bytes)							
Timestamp: 1662943							
Beacon Interval: 0.102400 [Seconds]							
Capabilities Information: 0x0401							
Tagged parameters (35 bytes)							
Tag: SSID parameter set: 7783477							
Tag: Supported Rates 1(B), 2(B), 5.5, 11, 6(B), 9, 12(B), 18, [Mbit/sec]							
Tag: DS Parameter set: Current Channel: 1							
Tag: ERP Information							
Tag: Extended Supported Rates 24(B), 36, 48, 54, [Mbit/sec]							
Tag: SSID parameter set: Undecoded							
Tag: SSID parameter set: Undecoded							

Immagine 10 (task2-off-5.pcap)

Q3) Come per il Task 1, forzare l'uso di RTS/CTS nella rete utilizzando il parametro “useRtsCts”: ci sono delle collisioni adesso? Spiegare il perché.

A3) Senza l'uso di RTS/CTS sono presenti potenziali collisioni durante la fase di associazione dei dispositivi con l'AP [immagine 11](#). Durante l'invio del pacchetto UDP n°121 al secondo $t = 4.002s$, notiamo che il suddetto viene ritrasmesso: il flag “**Frame is being retransmitted**” ne è una conferma [immagine 12](#). Applicando RTS/CTS la sequenza di messaggi è più ordinata ed i pacchetti vengono ritrasmessi data l'assenza di collisioni. Questo avviene solo per i pacchetti UDP! Dato che gli altri hanno dimensione inferiore del “threshold limit”, non traggono beneficio dal RTS/CTS [immagine 13](#). Grazie a questo protocollo è facile osservare una grande differenza in termini di efficacia, data l'assenza di collisioni per pacchetti di grandi dimensioni.

No.	Time	Source	Destination	Protocol	Length	Retry	Info
1	0.000000	00:00:00:00:00:01	Broadcast	802.11	71		Frame is not being retransmitted Beacon frame, SN=0, FN=0, Flags=....., BI=100, SSID=7783477
2	0.097853	00:00:00:00:00:04	00:00:00:00:00:01	802.11	57		Frame is being retransmitted Association Request, SN=0, FN=0, Flags=....R..., SSID=7783477
3	0.097863	00:00:00:00:00:04	(00:00:00:00:00:04) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
4	0.097395	00:00:00:00:00:01	00:00:00:00:00:04	802.11	53		Frame is not being retransmitted Association Response, SN=1, FN=0, Flags=....., SSID=Wildcard
5	0.098325	00:00:00:00:00:06	00:00:00:00:00:01	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
6	0.098910	00:00:00:00:00:06	00:00:00:00:00:01	802.11	57		Frame is being retransmitted Association Request, SN=0, FN=0, Flags=....R..., SSID=7783477
7	0.099820	00:00:00:00:00:06	00:00:00:00:00:06	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
8	0.099442	00:00:00:00:00:01	00:00:00:00:00:06	802.11	53		Frame is not being retransmitted Association Response, SN=2, FN=0, Flags=....., SSID=Wildcard
9	0.100003	00:00:00:00:00:03	00:00:00:00:00:01	802.11	57		Frame is being retransmitted Association Request, SN=0, FN=0, Flags=....R..., SSID=7783477
10	0.100093	00:00:00:00:00:03	(00:00:00:00:00:03) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
11	0.101936	00:00:00:00:00:02	00:00:00:00:00:01	802.11	57		Frame is being retransmitted Association Request, SN=0, FN=0, Flags=....R..., SSID=7783477
12	0.101946	00:00:00:00:00:02	(00:00:00:00:00:02) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
13	0.102971	00:00:00:00:00:05	00:00:00:00:00:01	802.11	57		Frame is being retransmitted Association Request, SN=0, FN=0, Flags=....R..., SSID=7783477
14	0.102981	00:00:00:00:00:05	(00:00:00:00:00:05) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
15	0.103304	00:00:00:00:00:01	Broadcast	802.11	71		Frame is not being retransmitted Beacon frame, SN=3, FN=0, Flags=....., BI=100, SSID=7783477
16	0.104245	00:00:00:00:00:01	00:00:00:00:00:06	802.11	53		Frame is being retransmitted Association Response, SN=2, FN=0, Flags=....R..., SSID=Wildcard
17	0.105175	00:00:00:00:00:01	(00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
18	0.105248	00:00:00:00:00:01	00:00:00:00:00:03	802.11	53		Frame is not being retransmitted Association Response, SN=4, FN=0, Flags=....., SSID=Wildcard
19	0.106178	00:00:00:00:00:01	(00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
20	0.106305	00:00:00:00:00:01	00:00:00:00:00:02	802.11	53		Frame is not being retransmitted Association Response, SN=5, FN=0, Flags=....., SSID=Wildcard
21	0.107235	00:00:00:00:00:01	(00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
22	0.107362	00:00:00:00:00:01	00:00:00:00:00:05	802.11	53		Frame is not being retransmitted Association Response, SN=6, FN=0, Flags=....., SSID=Wildcard
23	0.108292	00:00:00:00:00:01	(00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
24	0.204789	00:00:00:00:00:01	Broadcast	802.11	71		Frame is not being retransmitted Beacon frame, SN=7, FN=0, Flags=....., BI=100, SSID=7783477

Immagine 11 (task2-on-5.pcap)

No.	Time	Source	Destination	Protocol	Length	Retry	Info
111	3.891189	00:00:00:00:00:01	Broadcast	802.11	71		Frame is not being retransmitted Beacon frame, SN=57, FN=0, Flags=....
112	3.980255	192.168.1.6	192.168.1.2	UDP	576		Frame is not being retransmitted 49153 - 21 Len=512
113	3.980265	00:00:00:00:00:06	(00:00:00:00:00:06) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
114	3.980597	192.168.1.6	192.168.1.2	UDP	576		Frame is not being retransmitted 49153 - 21 Len=512
115	3.985711	00:00:00:00:00:01	(00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
116	3.990539	192.168.1.6	192.168.1.2	UDP	576		Frame is not being retransmitted 21 - 49153 Len=512
117	3.990549	00:00:00:00:00:02	(00:00:00:00:00:02) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
118	3.990998	192.168.1.6	192.168.1.2	UDP	576		Frame is not being retransmitted 21 - 49153 Len=512
119	3.996022	00:00:00:00:00:01	(00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
120	3.996041	00:00:00:00:00:01	Broadcast	802.11	71		Frame is not being retransmitted Beacon frame, SN=60, FN=0, Flags=....
121	4.001791	192.168.1.5	192.168.1.2	UDP	576		Frame is being retransmitted 49153 - 21 Len=512
122	4.001881	00:00:00:00:00:05	(00:00:00:00:00:05) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
123	4.002133	192.168.1.5	192.168.1.2	UDP	576		Frame is not being retransmitted 49153 - 21 Len=512
124	4.007247	00:00:00:00:00:01	(00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
125	4.012075	192.168.1.5	192.168.1.2	UDP	576		Frame is not being retransmitted 21 - 49153 Len=512
126	4.012085	00:00:00:00:00:02	(00:00:00:00:00:02) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
127	4.012417	192.168.1.5	192.168.1.2	UDP	576		Frame is not being retransmitted 21 - 49153 Len=512
128	4.017531	00:00:00:00:00:01	(00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....

Immagine 12 (task2-off-5.pcap)

task2-on-5.pcap

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frame.time_relative < 4.09 && frame.time_relative > 3.89

No.	Time	Source	Destination	Protocol	Length	Retry	Info
127	3.891189	00:00:00_00:00:01	Broadcast	802.11	71		Frame is not being retransmitted Beacon frame, SN=57, FN=0, Flags=...
128	3.975897	00:00:00_00:00:06...	00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	20		Frame is not being retransmitted Request-to-send, Flags=.....
129	3.975817		00:00:00_00:00:06 (00:00:00:00:00:06) (RA)	802.11	14		Frame is not being retransmitted Clear-to-send, Flags=.....
130	3.980931	192.168.1.6	192.168.1.2	UDP	576		Frame is not being retransmitted 49153 - 21 Len=512
131	3.980941		00:00:00_00:00:06 (00:00:00:00:00:06) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
132	3.981273	00:00:00_00:00:01...	00:00:00_00:00:02 (00:00:00:00:00:02) (RA)	802.11	20		Frame is not being retransmitted Request-to-send, Flags=.....
133	3.981939		00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Clear-to-send, Flags=.....
134	3.981949	192.168.1.6	192.168.1.2	UDP	576		Frame is not being retransmitted 49153 - 21 Len=512
135	3.987063		00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
136	3.987443	00:00:00_00:00:02...	00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	20		Frame is not being retransmitted Request-to-send, Flags=.....
137	3.987453		00:00:00_00:00:02 (00:00:00:00:00:02) (RA)	802.11	14		Frame is not being retransmitted Clear-to-send, Flags=.....
138	3.992567	192.168.1.2	192.168.1.6	UDP	576		Frame is not being retransmitted 21 - 49153 Len=512
139	3.992577		00:00:00_00:00:02 (00:00:00:00:00:02) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
140	3.992936	00:00:00_00:00:01...	00:00:00_00:00:06 (00:00:00:00:00:06) (RA)	802.11	20		Frame is not being retransmitted Request-to-send, Flags=.....
141	3.993082		00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Clear-to-send, Flags=.....
142	3.993612	192.168.1.2	192.168.1.6	UDP	576		Frame is not being retransmitted 21 - 49153 Len=512
143	3.998726		00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
144	3.998745	00:00:00_00:00:01	Broadcast	802.11	71		Frame is not being retransmitted Beacon frame, SN=60, FN=0, Flags=...
145	4.000047	00:00:00_00:00:05...	00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	20		Frame is not being retransmitted Request-to-send, Flags=.....
146	4.000057		00:00:00_00:00:05 (00:00:00:00:00:05) (RA)	802.11	14		Frame is not being retransmitted Clear-to-send, Flags=.....
147	4.005171	192.168.1.5	192.168.1.2	UDP	576		Frame is not being retransmitted 49153 - 21 Len=512
148	4.005181		00:00:00_00:00:05 (00:00:00:00:00:05) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
149	4.005513	00:00:00_00:00:01...	00:00:00_00:00:02 (00:00:00:00:00:02) (RA)	802.11	20		Frame is not being retransmitted Request-to-send, Flags=.....
150	4.006179		00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Clear-to-send, Flags=.....
151	4.006189	192.168.1.5	192.168.1.2	UDP	576		Frame is not being retransmitted 49153 - 21 Len=512
152	4.011383		00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
153	4.011683	00:00:00_00:00:02...	00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	20		Frame is not being retransmitted Request-to-send, Flags=.....
154	4.011693		00:00:00_00:00:02 (00:00:00:00:00:02) (RA)	802.11	14		Frame is not being retransmitted Clear-to-send, Flags=.....
155	4.016807	192.168.1.2	192.168.1.5	UDP	576		Frame is not being retransmitted 21 - 49153 Len=512
156	4.016817		00:00:00_00:00:02 (00:00:00:00:00:02) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....
157	4.017149	00:00:00_00:00:01...	00:00:00_00:00:05 (00:00:00:00:00:05) (RA)	802.11	20		Frame is not being retransmitted Request-to-send, Flags=.....
158	4.017815		00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Clear-to-send, Flags=.....
159	4.017825	192.168.1.2	192.168.1.5	UDP	576		Frame is not being retransmitted 21 - 49153 Len=512
160	4.022940		00:00:00_00:00:01 (00:00:00:00:00:01) (RA)	802.11	14		Frame is not being retransmitted Acknowledgement, Flags=.....

Imagine 13 (task2-on-5.pcap)

Team 25

Lavoro compiuto dal Team 25, composto da:

- Simone Federico Laganà – 1946083
- Filippo Guerra – 1931976
- Giulio Di Gregorio – 1943235
- Marika Fuccio – 1962183