Wednesday 2 February 2022

ELEC-C7420 Basic Principles in Networking Spring 2022

Assignment 1 - Wi-Fi measurement

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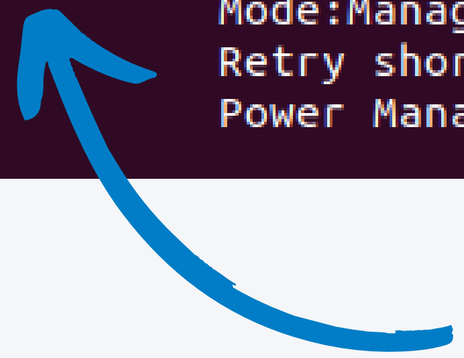
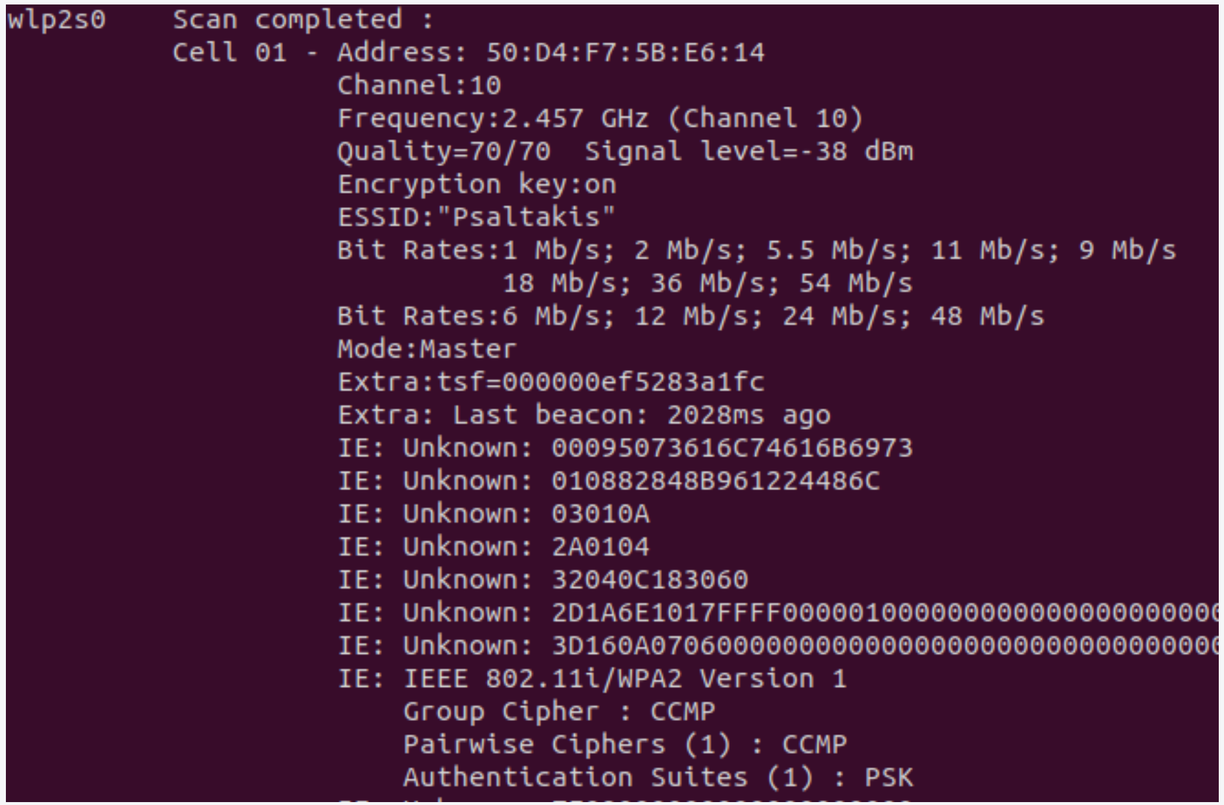
Check the configuration of the Wi-Fi network interface on your own computer.

```
researcher@YX-LAB20:~$ iwconfig
lo        no wireless extensions.

enp0s31f6  no wireless extensions.

wlp2s0    IEEE 802.11  ESSID:off/any
          Mode:Managed  Access Point: Not-Associated   Tx-Power=22 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Power Management:on
```



Wifi Network Interface

Use command line to scan the Wi-Fi access points and record information of all the APs you observe from one location, including SSID, BSSID, used channel, band, network protocol (e.g. 802.11g/n/ac), supported data rates, signal strength and anything else you can get.



- SSID — Psaltakis
- BSSID — 50:D4:F7:5B:E6:14
- Used channel — 10
- Band — 2.457GHZ
- Network protocol — 802.11i/WPA2
- Supported data rates — 1,2,5.5,6,11,12,9,18,36, 54,24,48
- Signal strength — -38DB

Observe the changes in signal strength when moving around, and analyze the impact of distance and obstacles on wireless signal strength.

```
researcher@YX-LAB20:~$ sudo iwconfig wlp2s0
wlp2s0    IEEE 802.11  ESSID:"Psaltakis"
          Mode:Managed  Frequency:2.457 GHz  Access Point: 50:D4:F7:5B:E6:14
          Bit Rate=300 Mb/s   Tx-Power=22 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:on
          Link Quality=70/70  Signal level=-32 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:20   Missed beacon:0
```

Refference Point. Distance Near AP -32dB

```
researcher@YX-LAB20:~$ sudo iwconfig wlp2s0
wlp2s0    IEEE 802.11  ESSID:"Psaltakis"
          Mode:Managed  Frequency:2.457 GHz  Access Point: 50:D4:F7:5B:E6:14
          Bit Rate=300 Mb/s   Tx-Power=22 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:on
          Link Quality=70/70  Signal level=-37 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:20   Missed beacon:0
```

Same Distance with Door Obstacle -37dB

```
researcher@YX-LAB20:~$ sudo iwconfig wlp2s0
wlp2s0    IEEE 802.11  ESSID:"Psaltakis"
          Mode:Managed  Frequency:2.457 GHz  Access Point: 50:D4:F7:5B:E6:14
          Bit Rate=300 Mb/s   Tx-Power=22 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:on
          Link Quality=61/70  Signal level=-49 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:22   Missed beacon:0
```

Further Away with Open Door (Obstacles wall) -49dB

```
researcher@YX-LAB20:~$ sudo iwconfig wlp2s0
wlp2s0    IEEE 802.11  ESSID:"Psaltakis"
          Mode:Managed  Frequency:2.457 GHz  Access Point: 50:D4:F7:5B:E6:14
          Bit Rate=300 Mb/s   Tx-Power=22 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:on
          Link Quality=52/70  Signal level=-58 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:22   Missed beacon:0
```

Further Away with Closed Door (Obstacles wall) -58dB

```
researcher@YX-LAB20:~$ sudo iwconfig wlp2s0
wlp2s0    IEEE 802.11  ESSID:"Psaltakis"
          Mode:Managed  Frequency:2.457 GHz  Access Point: 50:D4:F7:5B:E6:14
          Bit Rate=1 Mb/s   Tx-Power=22 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:on
          Link Quality=46/70  Signal level=-64 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:1   Missed beacon:0
```

Outside Apartment Two doors/walls Obstacles -64dB

Associate your phone or laptop with one Wi-Fi AP, and parse the beacon frames.

Check Network For Association

```
researcher@YX-LAB20:~$ iwconfig wlp2s0
wlp2s0    IEEE 802.11  ESSID:"Psaltakis"
          Mode:Managed  Access Point: Not-Associated   Tx-Power=22 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Power Management:on
```

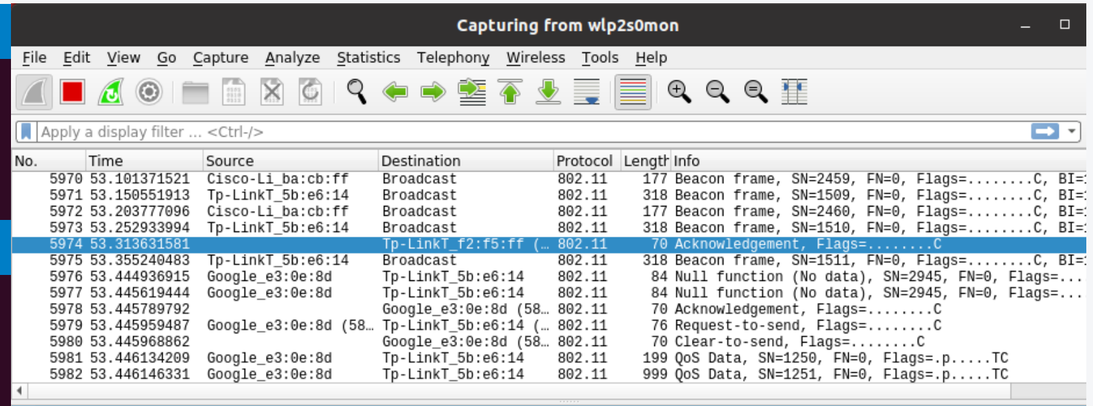
Associate my laptop since its not associated with the AP

```
researcher@YX-LAB20:~$ sudo iwconfig wlp2s0 essid Psaltakis
researcher@YX-LAB20:~$ iwconfig wlp2s0
wlp2s0    IEEE 802.11  ESSID:"Psaltakis"
          Mode:Managed  Frequency:2.457 GHz  Access Point: 50:D4:F7:5B:E6:14
          Bit Rate=300 Mb/s   Tx-Power=22 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Power Management:on
          Link Quality=70/70  Signal level=-38 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:15   Missed beacon:0
```

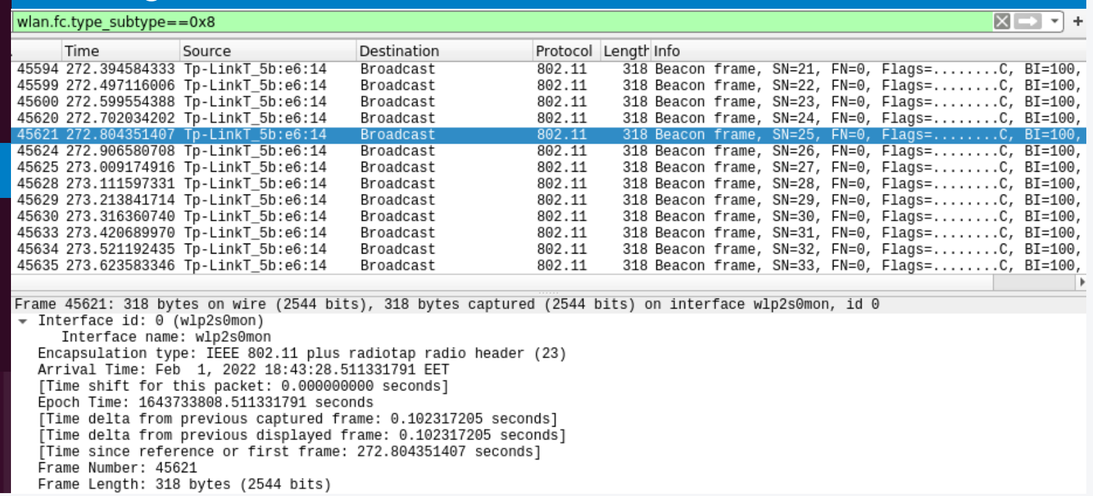
Beggining Monitor for AP and Opening Wireshark

```
PHY     Interface       Driver          Chipset

phy0    wlp2s0          iwlwifi         Intel Corporation Wireless 8265 / 8275 (rev 78)

                (mac80211 monitor mode vif enabled for [phy0]wlp2s0 on [phy0]wlp2s0mon)
                (mac80211 station mode vif disabled for [phy0]wlp2s0)
```

```
researcher@YX-LAB20:~$ wireshark
researcher@YX-LAB20:~$ sudo wireshark
18:38:34.739     Main Warn QStandardPaths: XDG_RUNTIME_DIR not set, defaulting t
o '/tmp/runtime-root'
```



Adding Filter For Wireshark to show and Parse Beacon



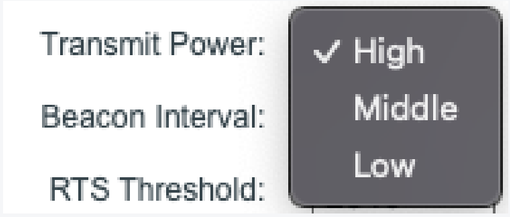
Send data from one station to another one connected to the same AP (check BSSID), and measure data rate.

Using Iperf and connecting Macbook with my Linux laptop. Listening on Mac, Found IP adress from Router settings and adding details on linux including the port and the ip adresse we found. Data Rate is 47 mb/s

```
researcher@YX-LAB20:~$ iperf -c 192.168.0.102 -p 5201
------------------------------------------------------------
Client connecting to 192.168.0.102, TCP port 5201
TCP window size: 85.0 KByte (default)
------------------------------------------------------------
[  3] local 192.168.0.104 port 47706 connected with 192.168.0.102 port 5201
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.0 sec  56.1 MBytes  47.0 Mbits/sec
researcher@YX-LAB20:~$
```

```
georgepsaltakis@Georges-MacBook-Air ~ % /Applications/iperf3 -s
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
```

Analyze the impact on data rate from signal strength. You can measure the data rate with three different levels of signal strength.



Went on the router advanced settings and adjusted the transmission power in three intregals

Did the same as above for the three different transmission powers

```
researcher@YX-LAB20:~$ iperf -c 192.168.0.102 -p 5201
------------------------------------------------------------
Client connecting to 192.168.0.102, TCP port 5201
TCP window size: 85.0 KByte (default)
------------------------------------------------------------
[  3] local 192.168.0.104 port 47792 connected with 192.168.0.102 port 5201
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.2 sec  51.4 MBytes  42.3 Mbits/sec
```

High Power 42.3 Mb/s transmission rate is high as expected

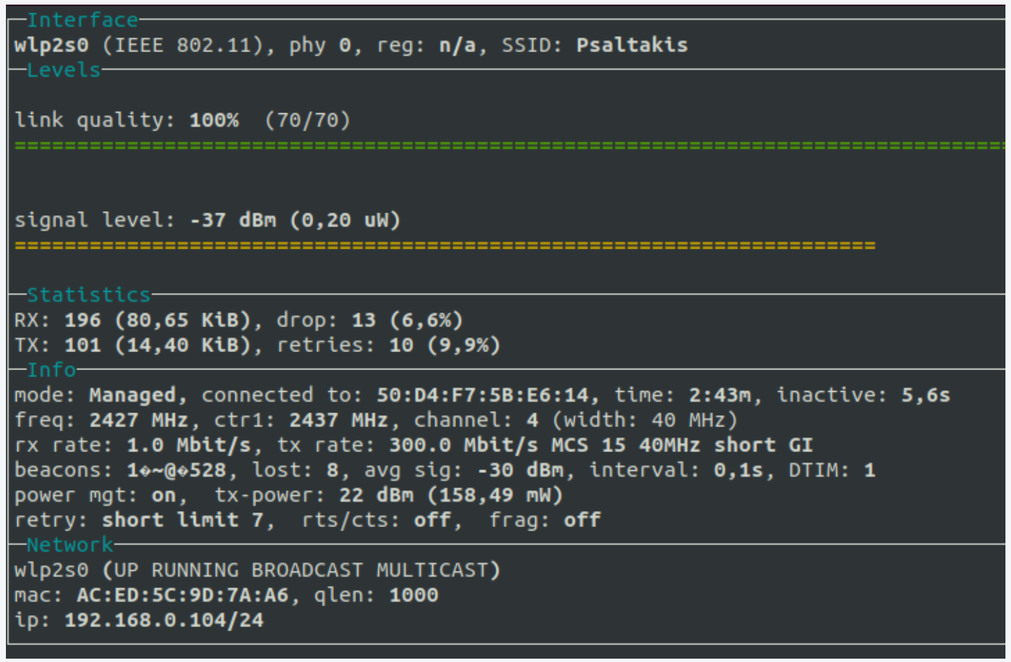
Middle Power 37.2 Mb/s transmission rate is lower in comparison to the full strenght

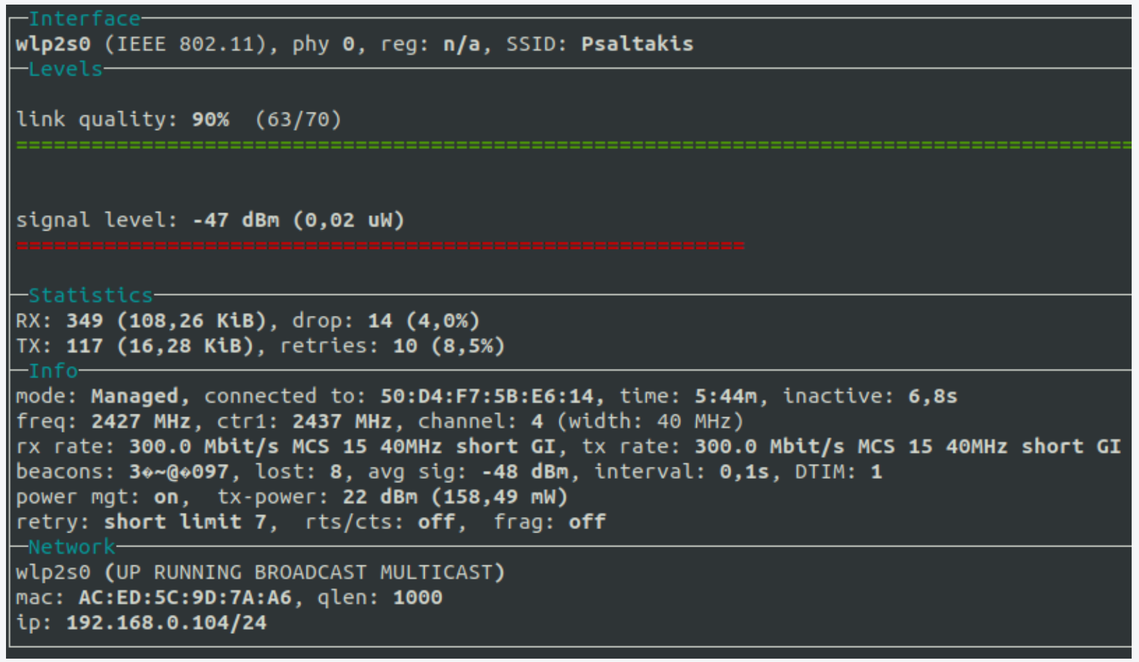
```
researcher@YX-LAB20:~$ iperf -c 192.168.0.102 -p 5201
------------------------------------------------------------
Client connecting to 192.168.0.102, TCP port 5201
TCP window size: 85.0 KByte (default)
------------------------------------------------------------
[  3] local 192.168.0.104 port 47798 connected with 192.168.0.102 port 5201
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.1 sec  44.6 MBytes  37.2 Mbits/sec
```

```
researcher@YX-LAB20:~$ iperf -c 192.168.0.102 -p 5201
------------------------------------------------------------
Client connecting to 192.168.0.102, TCP port 5201
TCP window size: 85.0 KByte (default)
------------------------------------------------------------
[  3] local 192.168.0.104 port 47796 connected with 192.168.0.102 port 5201
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.2 sec  39.8 MBytes  32.8 Mbits/sec
```

Low Power 32.8 Mb/s transmission rate is significant lower in comparison to the full strenght

Generate interference and monitor noise level and signal-to-noise ratio. Analyze the impact of interference on throughput. Repeat the experiment to compare the impact from different levels of interference. Bonus (2p): Also measure and analyse MAC retransmission rate in your measurement

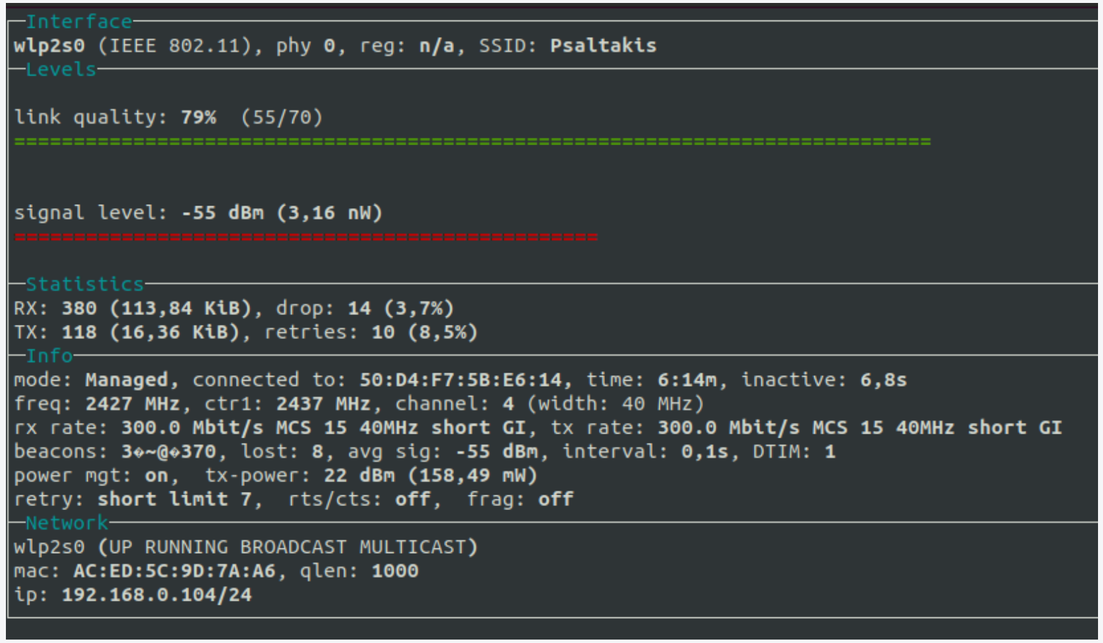


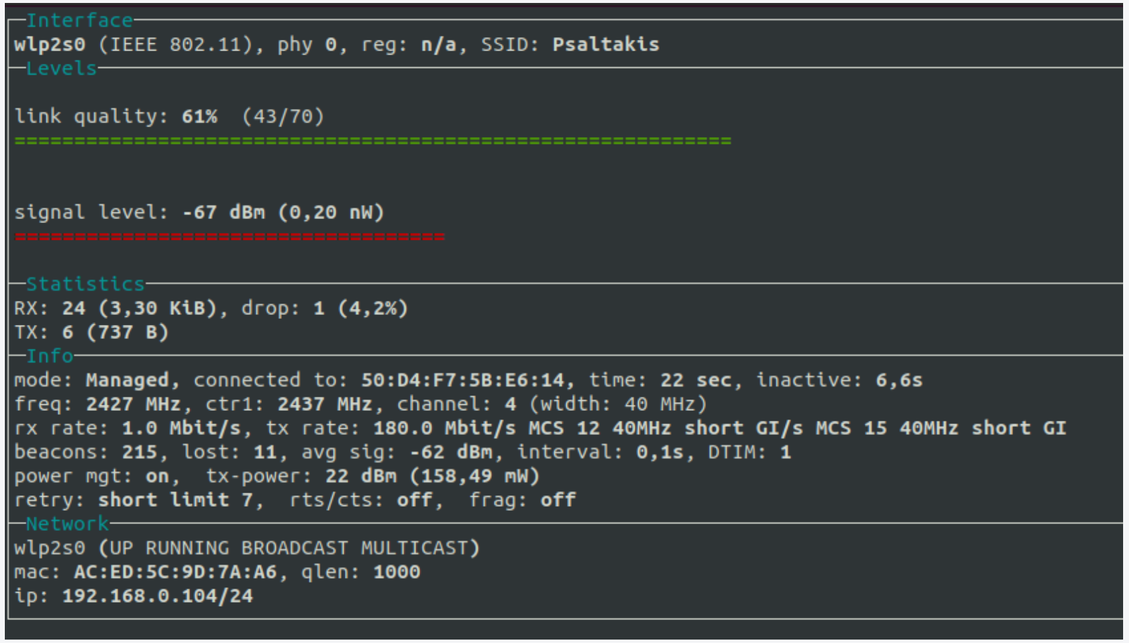


Quality of signal (similar to signal to noise) 70/70
Signal: -37dB
Retransmission Rate (drop/retries):13(6.6%),10(9.9%)

Quality of signal (similar to signal to noise) 63/70
Signal: -47dB
Retransmission Rate (drop/retries): 14(4%),10(8.5%)

Used a "Faraday Cage" (A Deep Metal Bowl Covering Some percentage of the access point to almost completely on three integrals) to create interference





Quality of signal (similar to signal to noise) 55/70
Signal: -55dB
Retransmission Rate (drop/retries):14(3.7%),10(8.5%)

Quality of signal (similar to signal to noise) 43/70
Signal: -67dB
Retransmission Rate (drop/retries): 1(4.2%)

Tried with every tool available exact noice level in db cannot be calculated due to hardware limitations of either the wifi card of the laptop or the AP (Signal/Noise Ratio = Signal-Level (db) - Noise Level (db)) Quality is the closest we can measure to SNR.