

1. Near:

2.4G:

-20dBm

```
blast@blast-Ubuntu: ~  
wlp0s20f3 (IEEE 802.11), phy 0, reg: n/a, SSID: AoK_Blast-2.4G  
Link quality: 100% (70/70)  
Signal level: -20 dBm (0.01 mW)  
-----  
Statistics  
RX: 19,7294 (49.31 Mbit), drop: 59 (0.0%)  
TX: 1,8197 (468.37 Mbit), retries: 824 (4.5%)  
Info  
Mode: Managed, connected to: 08:15:31:6E:19:03, time: 8:05m, inactive: 1.2s  
Freq: 2452 MHz, ctrl: 2462 MHz, channel: 9 (width: 40 MHz)  
Rx rate: 150.0 Mbit/s MCS 7 40MHz short GI, tx rate: 300.0 Mbit/s MCS 15 40MHz short GI  
Beacons: 4619, avg sig: -17 dBm, interval: 0.1s, DTIM: 1  
Power mgt: on, tx power: 22 dBm (158.49 mW)  
Retry: short limit 7, rts/cts: off, frag: off  
Network  
wlp0s20f3 (UP RUNNING BROADCAST MULTICAST)  
mac: 2C:0B:07:07:3F:C8, qlen: 1000  
ip: 192.168.88.194/24
```

5G:

-34dBm

```
blast@blast-Ubuntu: ~  
wlp0s20f3 (IEEE 802.11), phy 0, reg: n/a, SSID: AoK_Blast-5G  
Link quality: 100% (70/70)  
Signal level: -34 dBm (0.40 uW)  
-----  
Statistics  
RX: 18,4907 (16.79 Mbit), drop: 28 (0.0%)  
TX: 8955 (509.37 Mbit), retries: 339 (3.8%)  
Info  
Mode: Managed, connected to: 08:15:31:6E:19:04, time: 34 sec, inactive: 0.1s  
Freq: 5220 MHz, ctrl: 5210 MHz, channel: 44 (width: 80 MHz)  
Rx rate: 433.3 Mbit/s VHT-MCS 9 80MHz short GI VHT-NSS 2, tx rate: 866.7 Mbit/s VHT-MCS 9 80MHz short GI VHT-NSS 2  
Beacons: 325, avg sig: -32 dBm, interval: 0.1s, DTIM: 1  
Power mgt: on, tx power: 22 dBm (158.49 mW)  
Retry: short limit 7, rts/cts: off, frag: off  
Network  
wlp0s20f3 (UP RUNNING BROADCAST MULTICAST)  
mac: 2C:0B:07:07:3F:C8, qlen: 1000  
ip: 192.168.88.194/24
```

Iperf 2.4->5G:

$$2.4G: \frac{162+159}{2} = 161.5 Mbit/s$$

$$5G: \frac{427+425}{2} = 426 Mbit/s$$

```
blast@blast-Ubuntu:~$ iperf3 --client 192.168.1.115 -p 5201
Connecting to host 192.168.1.115, port 5201
[ S] local 192.168.88.194 port 48740 connected to 192.168.1.115 port 5201
[ ID] Interval      Transfer      Bitrate      Retr  Cwnd
[ S] 0.00-1.00    sec 26.3 MBytes 170 Mbits/sec  0    813 KBytes
[ S] 1.00-2.00    sec 11.2 MBytes 94.4 Mbits/sec  1    1.00 MBytes
[ S] 2.00-3.00    sec 17.5 MBytes 147 Mbits/sec  0    1.18 MBytes
[ S] 3.00-4.00    sec 15.9 MBytes 126 Mbits/sec  1    1.49 MBytes
[ S] 4.00-5.00    sec 22.5 MBytes 189 Mbits/sec  0    1.49 MBytes
[ S] 5.00-6.00    sec 21.2 MBytes 178 Mbits/sec  0    1.57 MBytes
[ S] 6.00-7.00    sec 20.6 MBytes 168 Mbits/sec  0    1.67 MBytes
[ S] 7.00-8.00    sec 22.5 MBytes 189 Mbits/sec  0    1.94 MBytes
[ S] 8.00-9.00    sec 20.8 MBytes 168 Mbits/sec  0    1.94 MBytes
[ S] 9.00-10.00   sec 22.5 MBytes 189 Mbits/sec  0    2.04 MBytes
[ ID] Interval      Transfer      Bitrate      Retr  sender receiver
[ S] 0.00-10.00   sec 193 MBytes 162 Mbits/sec  2
[ S] 0.00-10.01   sec 198 MBytes 159 Mbits/sec  2
iperf Done.
blast@blast-Ubuntu:~$ iperf3 --client 192.168.1.115 -p 5201^C
blast@blast-Ubuntu:~$ iperf3 --server 192.168.1.115 -p 5201
Connecting to host 192.168.1.115, port 5201
[ S] local 192.168.88.194 port 48744 connected to 192.168.1.115 port 5201
[ ID] Interval      Transfer      Bitrate      Retr  Cwnd
[ S] 0.00-1.00    sec 56.1 MBytes 470 Mbits/sec  0    1.95 MBytes
[ S] 1.00-2.00    sec 60.0 MBytes 503 Mbits/sec  0    2.16 MBytes
[ S] 2.00-3.00    sec 52.5 MBytes 440 Mbits/sec  0    2.16 MBytes
[ S] 3.00-4.00    sec 47.5 MBytes 398 Mbits/sec  0    2.29 MBytes
[ S] 4.00-5.00    sec 50.0 MBytes 419 Mbits/sec  0    2.29 MBytes
[ S] 5.00-6.00    sec 46.2 MBytes 388 Mbits/sec  0    2.29 MBytes
[ S] 6.00-7.00    sec 43.8 MBytes 367 Mbits/sec  1    2.56 MBytes
[ S] 7.00-8.00    sec 52.5 MBytes 440 Mbits/sec  0    2.73 MBytes
[ S] 8.00-9.00    sec 46.2 MBytes 388 Mbits/sec  0    2.73 MBytes
[ S] 9.00-10.00   sec 53.8 MBytes 451 Mbits/sec  0    2.73 MBytes
[ ID] Interval      Transfer      Bitrate      Retr  sender receiver
[ S] 0.00-10.00   sec 589 MBytes 427 Mbits/sec  1
[ S] 0.00-10.02   sec 587 MBytes 425 Mbits/sec  1
iperf Done.
blast@blast-Ubuntu:~$
```

2.5m

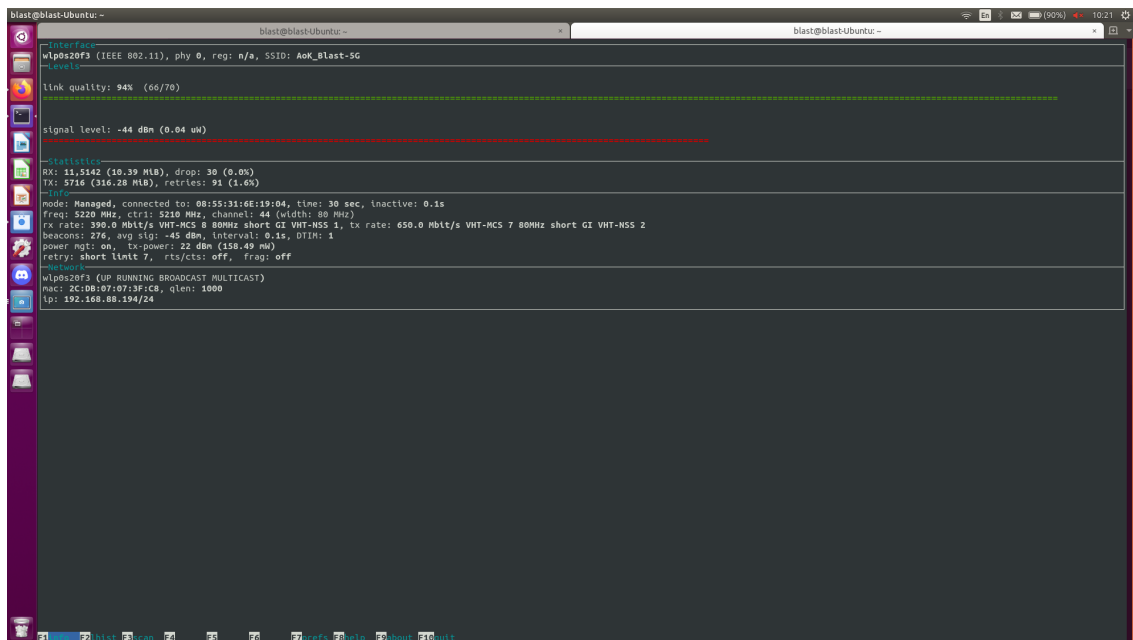
2.4G:

-33dBm

```
blast@blast-Ubuntu:~$ wpa_cli -i wlan0 -p /dev/null
Interface: wlan0 (IEEE 802.11), phy 0, reg: n/a, SSID: AoK_Blast-2.4G
Levels:
link quality: 100% (70/70)
-----
signal level: -33 dBm (0.50 uW)
-----
Statistics:
RX: 6.3421 (5.72 MIB), drop: 16 (0.0%)
TX: 4710 (179.73 MIB), retries: 353 (7.5%)
Info:
mode: Managed, connected to: 08:55:31:0E:19:03, time: 43 sec, inactive: 1.6s
freq: 2452 MHz, ctrl: 2462 MHz, channel: 9 (width: 40 MHz)
rx rate: 150.0 Mbit/s MCS 7 40MHz short GI, tx rate: 188.0 Mbit/s MCS 11 40MHz
beacons: 417, avg sig: -29 dBm, interval: 0.1s, DTIM: 1
power mgt: on, tx-power: 22 dBm (158.49 mW)
retry: short limit 7, rts/cts: off, frag: off
Help:
wlp0s20f3 (UP RUNNING BROADCAST MULTICAST)
HWaddr 2C:0B:07:07:3F:CE, qlen: 1000
ip: 192.168.88.194/24
```

5G:

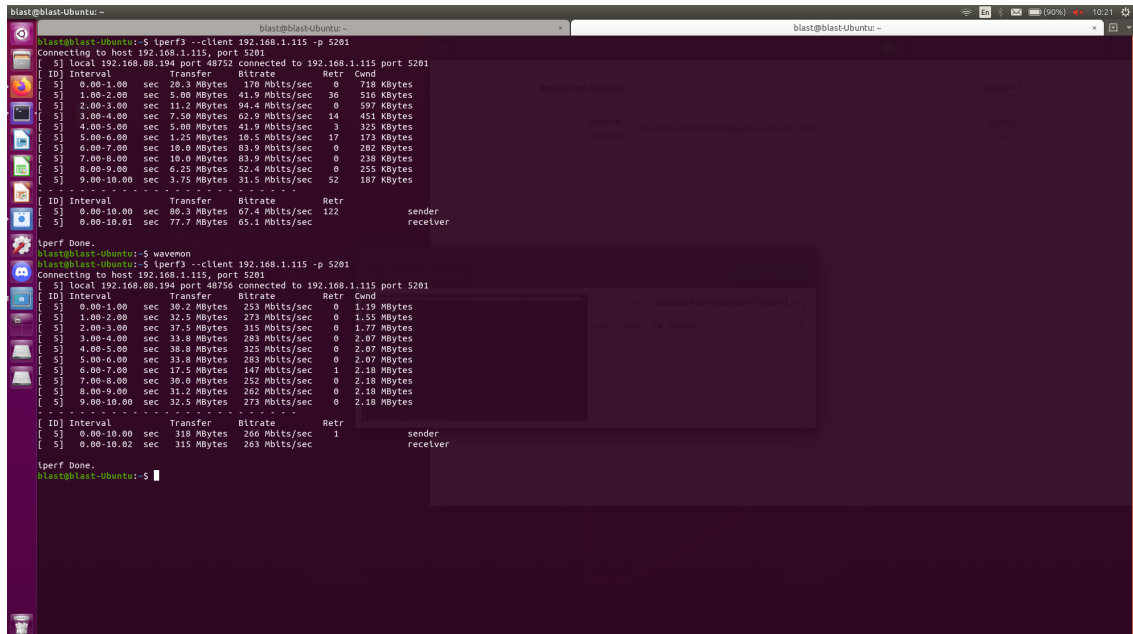
-44dBm



Iperf:

$$2.4G: \frac{67.4+65.1}{2} = 66.25 \text{ Mbit/s}$$

$$5G: \frac{266+263}{2} = 264.5 \text{ Mbit/s}$$



3. Wall

2.4G:

-35dBm

```

blast@blast-Ubuntu: ~
Interface:
wlp8s20f3 (IEEE 802.11), phy 0, reg: n/a, SSID: AoK_Blast-2.4G
Levels:
link quality: 100% (70/70)
signal level: -35 dBm (0.32 uW)
Statistics:
RX: 7.1272 (6.67 MMB), drops: 19 (0.0%)
TX: 8817 (202.47 MMB), retries: 1103 (12.5%)
Info:
node: Managed, connected to: 08:55:31:6E:19:03, time: 46 sec, inactive: 0.6s
freq: 2452 MHz, ctrl: 2462 MHz, channel: 9 (width: 40 MHz)
rx rate: 150.0 Mbit/s MCS 7 40MHz short GI, tx rate: 240.0 Mbit/s MCS 13 40MHz short GI
beacons: 446, avg sig: -29 dBm, interval: 0.1s, DTIM: 1
power mgt: on, tx-power: 22 dBm (158.49 mW)
retry: short limit 7, rts/cts: off, frag: off
wlp8s20f3 (UP RUNNING BROADCAST MULTICAST)
mac: 2C:08:07:07:3F:C8, qlen: 1000
ip: 192.168.88.194/24

```

5G:

-50dBm

```

blast@blast-Ubuntu: ~
Interface:
wlp8s20f3 (IEEE 802.11), phy 0, reg: n/a, SSID: AoK_Blast-5G
Levels:
link quality: 86% (60/70)
signal level: -50 dBm (0.01 uW)
Statistics:
RX: 22.4485 (23.14 MMB), drop: 32 (0.0%)
TX: 1.3260 (609.86 MMB), retries: 283 (2.1%)
Info:
node: Managed, connected to: 08:55:31:6E:19:04, time: 47 sec, inactive: 0.1s
freq: 5220 MHz, ctrl: 5210 MHz, channel: 44 (width: 80 MHz)
rx rate: 433.3 Mbit/s VHT-MCS 9 80MHz short GI VHT-NSS 1, tx rate: 866.7 Mbit/s VHT-MCS 9 80MHz short GI VHT-NSS 2
beacons: 446, avg sig: -50 dBm, interval: 0.1s, DTIM: 1
power mgt: on, tx-power: 22 dBm (158.49 mW)
retry: short limit 7, rts/cts: off, frag: off
wlp8s20f3 (UP RUNNING BROADCAST MULTICAST)
mac: 2C:08:07:07:3F:C8, qlen: 1000
ip: 192.168.88.194/24

```

lperf:

$$2.4G: \frac{65.4+64.6}{2} = 65Mbit/s$$

$$5G: \frac{510+510}{2} = 510Mbit/s$$

```
blast@blast-Ubuntu:~$ iperf3 --client 192.168.1.115 -p 5201
Connecting to host 192.168.1.115, port 5201
[ S] local 192.168.88.194 port 48764 connected to 192.168.1.115 port 5201
[ ID] Interval      Transfer      Bitrate      Retr  Cwnd
[ S] 0.00-1.00 sec  5.11 MBytes  42.0 Mbits/sec  0    73.5 KBytes
[ S] 1.00-2.00 sec  6.28 MBytes  52.7 Mbits/sec  0    119 KBytes
[ S] 2.00-3.00 sec  9.88 MBytes  82.9 Mbits/sec  0    171 KBytes
[ S] 3.00-4.00 sec  3.85 MBytes  32.3 Mbits/sec  16   62.2 KBytes
[ S] 4.00-5.00 sec  2.86 MBytes  24.0 Mbits/sec  12   15.6 KBytes
[ S] 5.00-6.00 sec  6.09 MBytes  51.1 Mbits/sec  23   110 KBytes
[ S] 6.00-7.00 sec  14.1 MBytes  118 Mbits/sec  0    184 KBytes
[ S] 7.00-8.00 sec  13.7 MBytes  115 Mbits/sec  0    235 KBytes
[ S] 8.00-9.00 sec  8.95 MBytes  75.1 Mbits/sec  0    268 KBytes
[ S] 9.00-10.00 sec  7.15 MBytes  60.0 Mbits/sec  1    216 KBytes
[ ID] Interval      Transfer      Bitrate      Retr  Cwnd
[ S] 0.00-10.00 sec  78.0 MBytes  65.4 Mbits/sec  60
[ S] 0.00-10.01 sec  77.1 MBytes  64.6 Mbits/sec  60
sender
receiver
Iperf Done.

blast@blast-Ubuntu:~$ wavemon
blast@blast-Ubuntu:~$ iperf3 --client 192.168.1.115 -p 5201
Connecting to host 192.168.1.115, port 5201
[ S] local 192.168.88.194 port 48768 connected to 192.168.1.115 port 5201
[ ID] Interval      Transfer      Bitrate      Retr  Cwnd
[ S] 0.00-1.00 sec  55.5 MBytes  466 Mbits/sec  0    1.65 MBytes
[ S] 1.00-2.00 sec  62.5 MBytes  524 Mbits/sec  0    2.09 MBytes
[ S] 2.00-3.00 sec  63.6 MBytes  535 Mbits/sec  0    2.09 MBytes
[ S] 3.00-4.00 sec  61.2 MBytes  514 Mbits/sec  0    2.32 MBytes
[ S] 4.00-5.00 sec  62.5 MBytes  524 Mbits/sec  0    2.32 MBytes
[ S] 5.00-6.00 sec  58.8 MBytes  493 Mbits/sec  0    2.32 MBytes
[ S] 6.00-7.00 sec  61.2 MBytes  514 Mbits/sec  0    2.45 MBytes
[ S] 7.00-8.00 sec  61.2 MBytes  514 Mbits/sec  0    2.45 MBytes
[ S] 8.00-9.00 sec  61.2 MBytes  514 Mbits/sec  0    2.68 MBytes
[ S] 9.00-10.00 sec  60.0 MBytes  503 Mbits/sec  0    2.74 MBytes
[ ID] Interval      Transfer      Bitrate      Retr  Cwnd
[ S] 0.00-10.00 sec  608 MBytes  510 Mbits/sec  0
[ S] 0.00-10.00 sec  607 MBytes  510 Mbits/sec  0
sender
receiver
Iperf Done.

blast@blast-Ubuntu:~$
```

## Analysis

Iperf Server在LAN用有線(1Gbps全雙工)接上，所以bottleneck只會在無線的訊號上。

在同環境下5G速度(功率)會大於2.4G，剛好符合Friis equation，波長小，功率大。

不同環境下的同頻率2.4G也會隨著距離跟障礙物變遠邊多，而功率變小，也是符合Friis equation(與距離的 $\alpha$ 次方成反比)。

不過我的5G隔牆反而比貼在旁邊測還要好，推測是因為牆壁厚度不夠而且距離過近導致穿透，且因為在其他無線接收端的反方向，不會有干擾。