

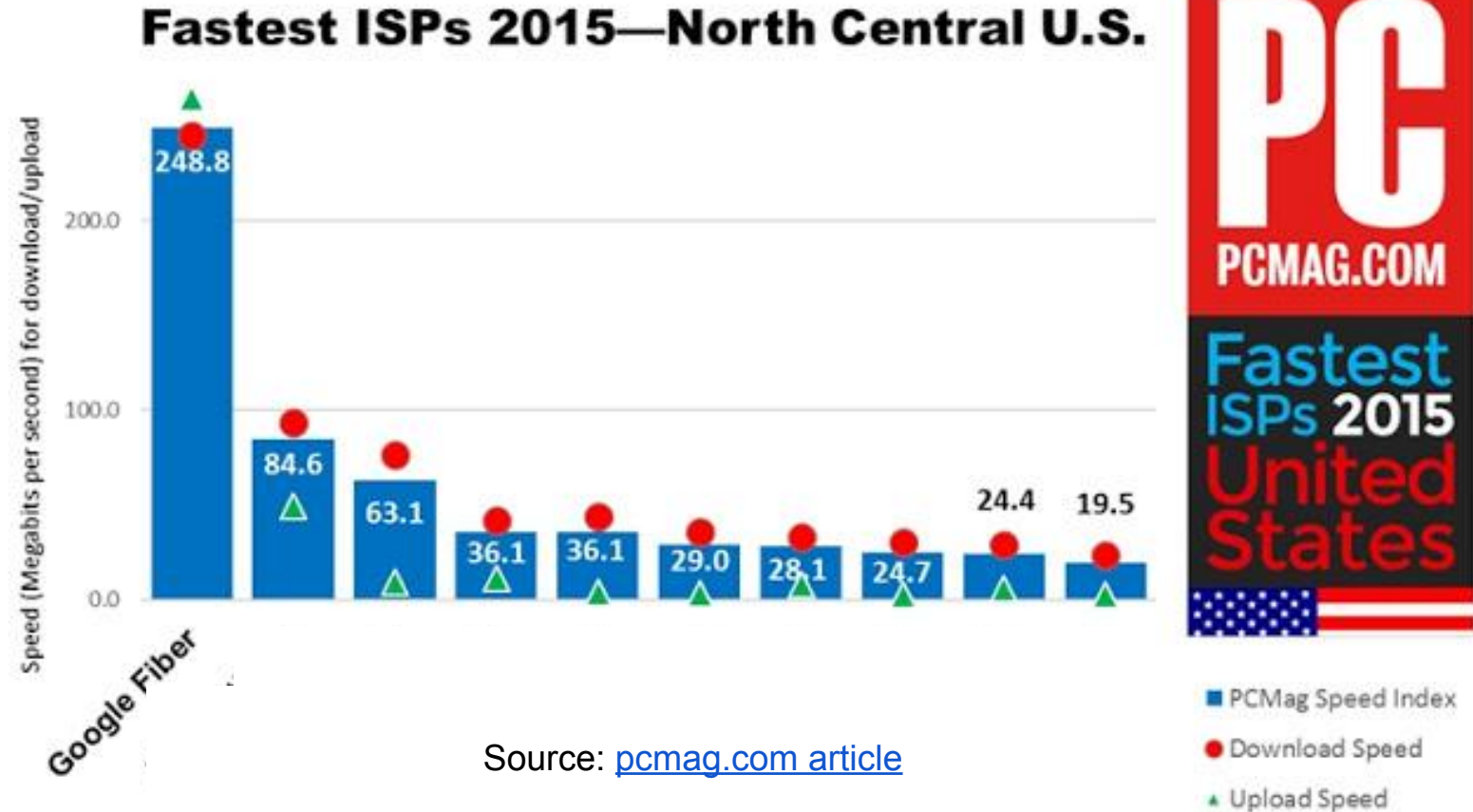
# GFiber Wifi Data

netdev1.1      Seville, Spain      Feb 2016

[apenwarr@google.com](mailto:apenwarr@google.com)

These are my personal opinions.  
They do not necessarily reflect the opinions of my employer.  
Not even a little.

# Who are we?

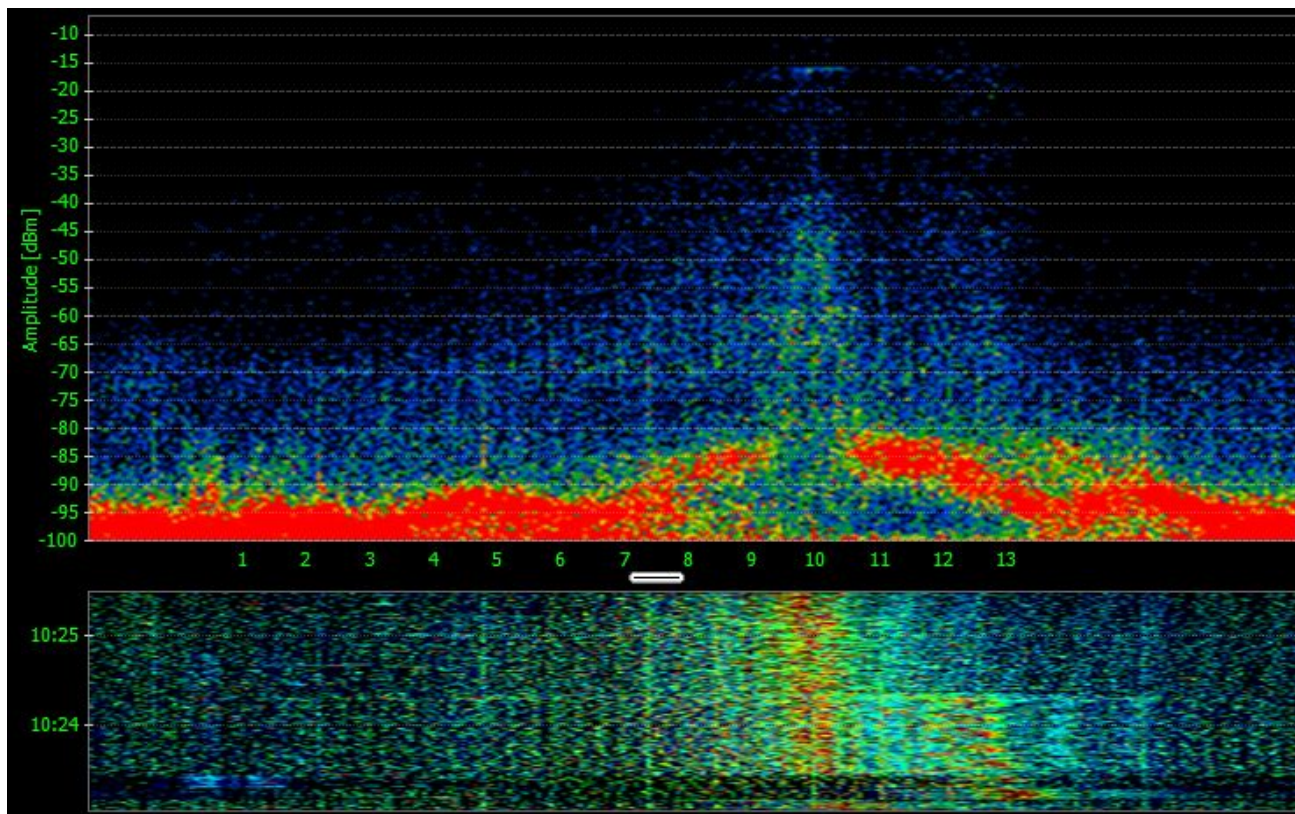




# A note on anonymity

- Privacy policy:
  - <https://fiber.google.com/legal/privacy.html>
- Data stored for a strictly limited time
- Just wifi stats:
  - Don't log content or Internet endpoints
- MAC addrs are anonymized and IP addrs removed
- Extremely strict access and aggregation controls

# Background spectrum analyzer

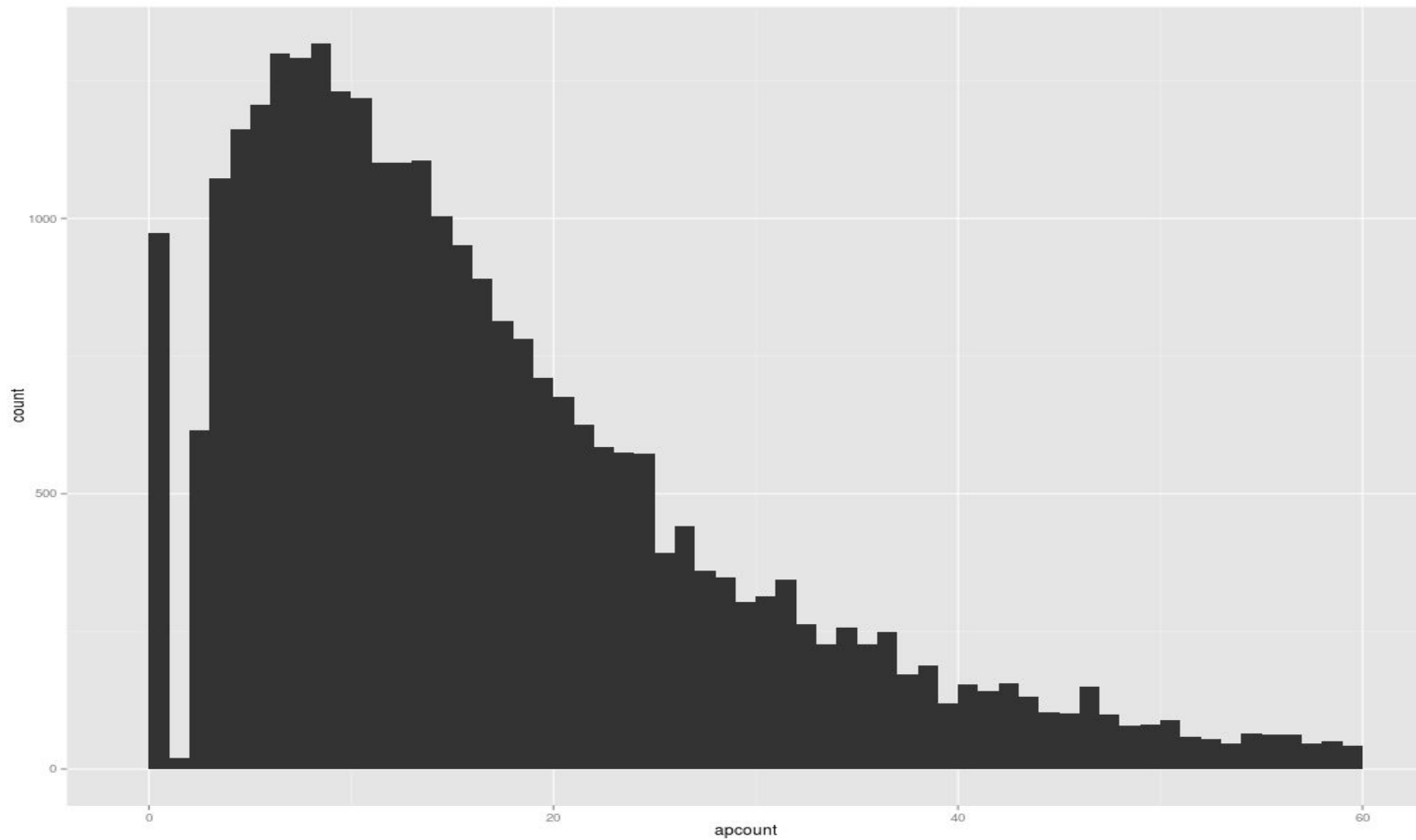


# Background spectrum analyzer

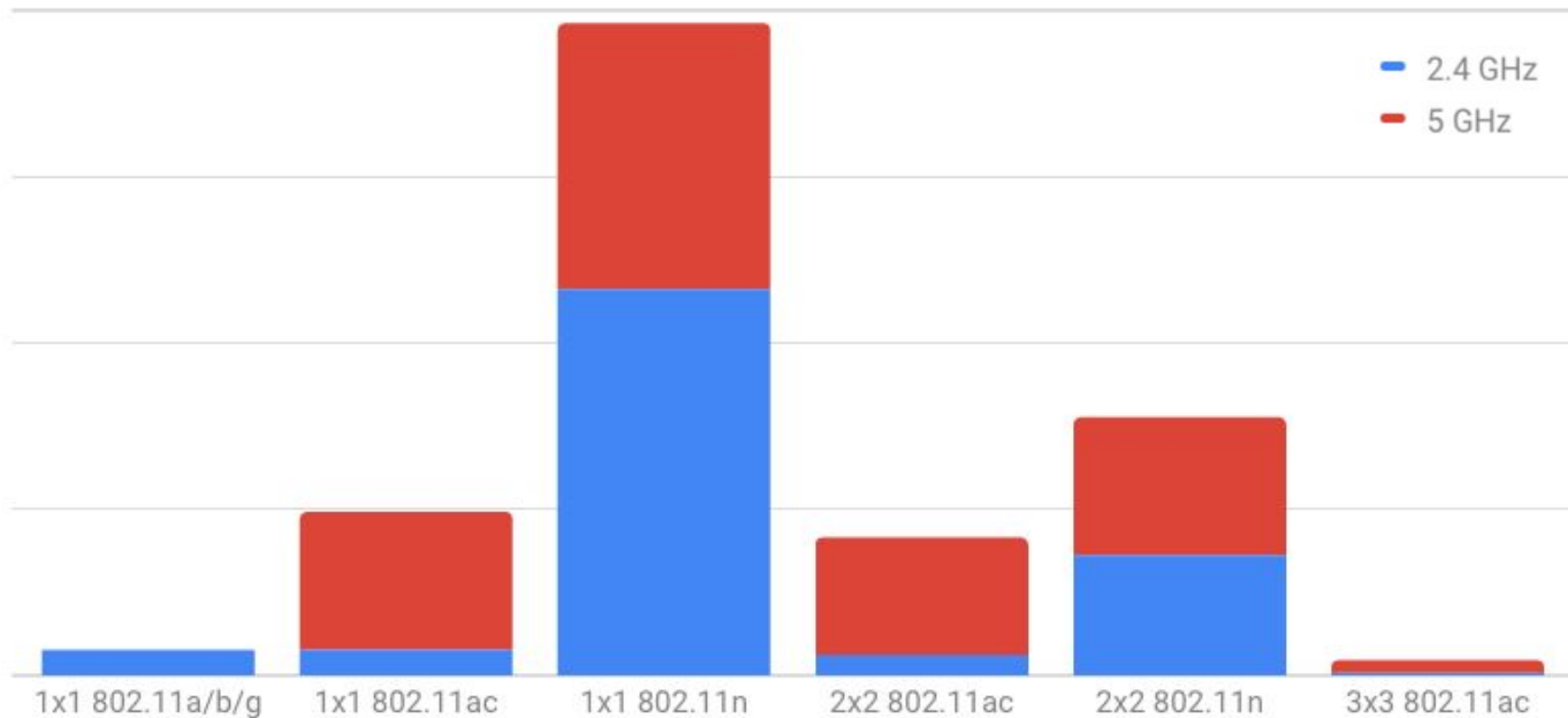
Open source: <https://gfiber.googleusercontent.com/vendor/google/platform/+master/spectralanalyzer/>

```
# period of low wifi traffic in a Google office
fft- 1:  94  2          1  1
fft- 2:  95  1
fft- 3:  95  1
fft- 4:  95  1          1
fft- 5:  95          1
fft- 6:  94          1      1
fft- 7:  94          1      1
fft- 8:  93  1  1          1      1
fft- 9:  92  1  2          1      1
fft-10:  91  3  3          1      1
fft-11:  89  4  4          1
```

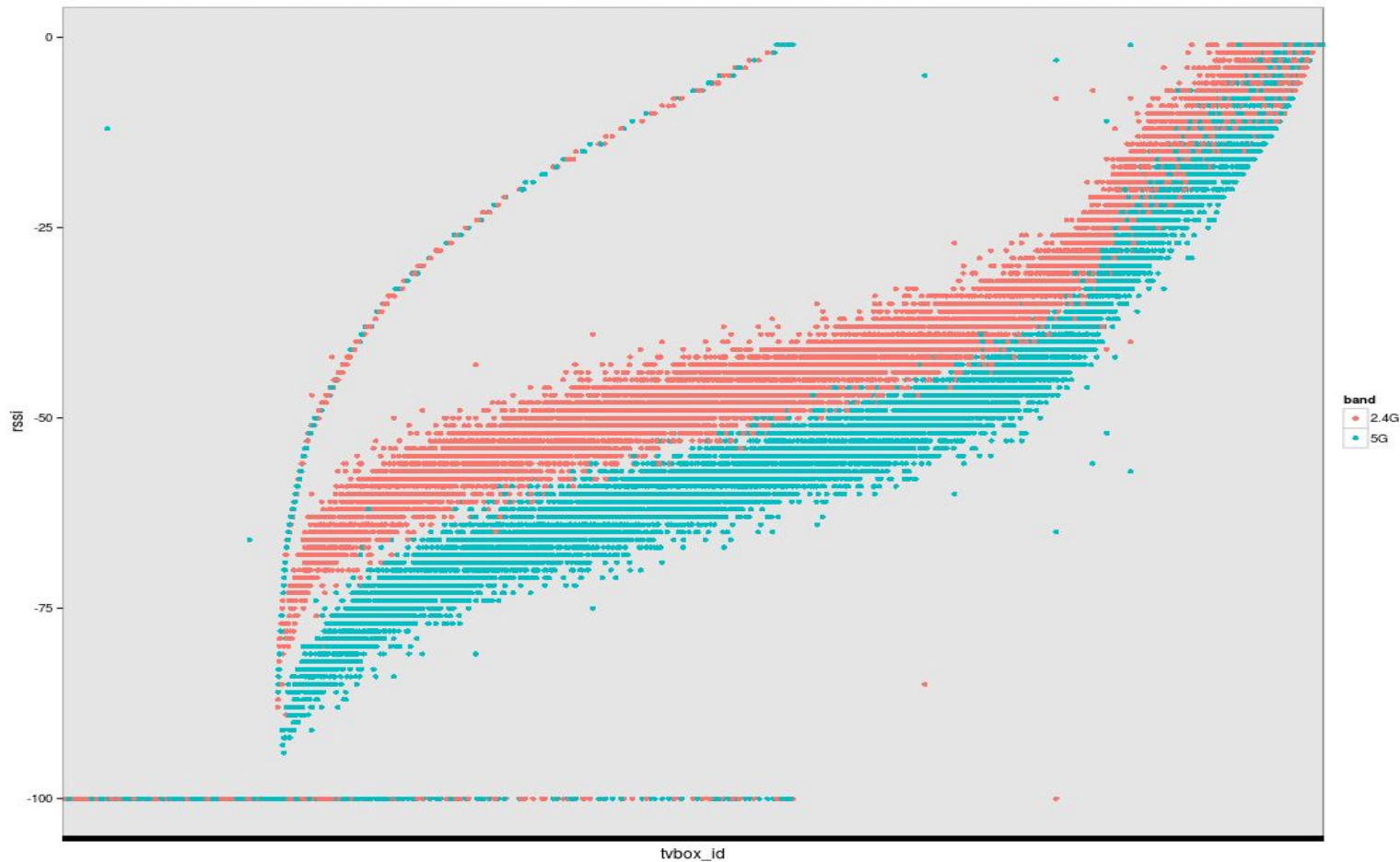
# Number of nearby visible access points



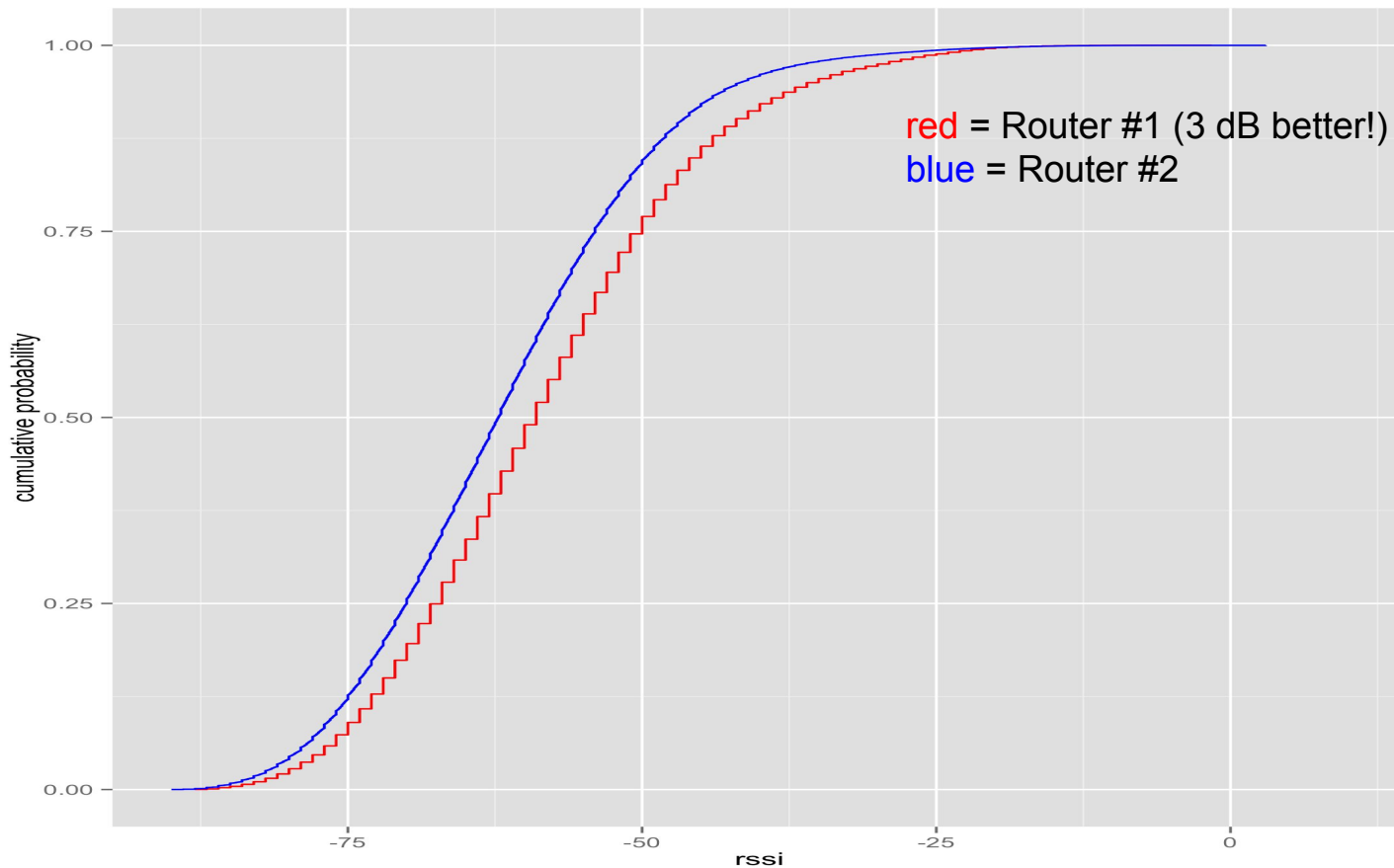
# Real-world device capabilities



# Distribution of RSSI samples for each TV box

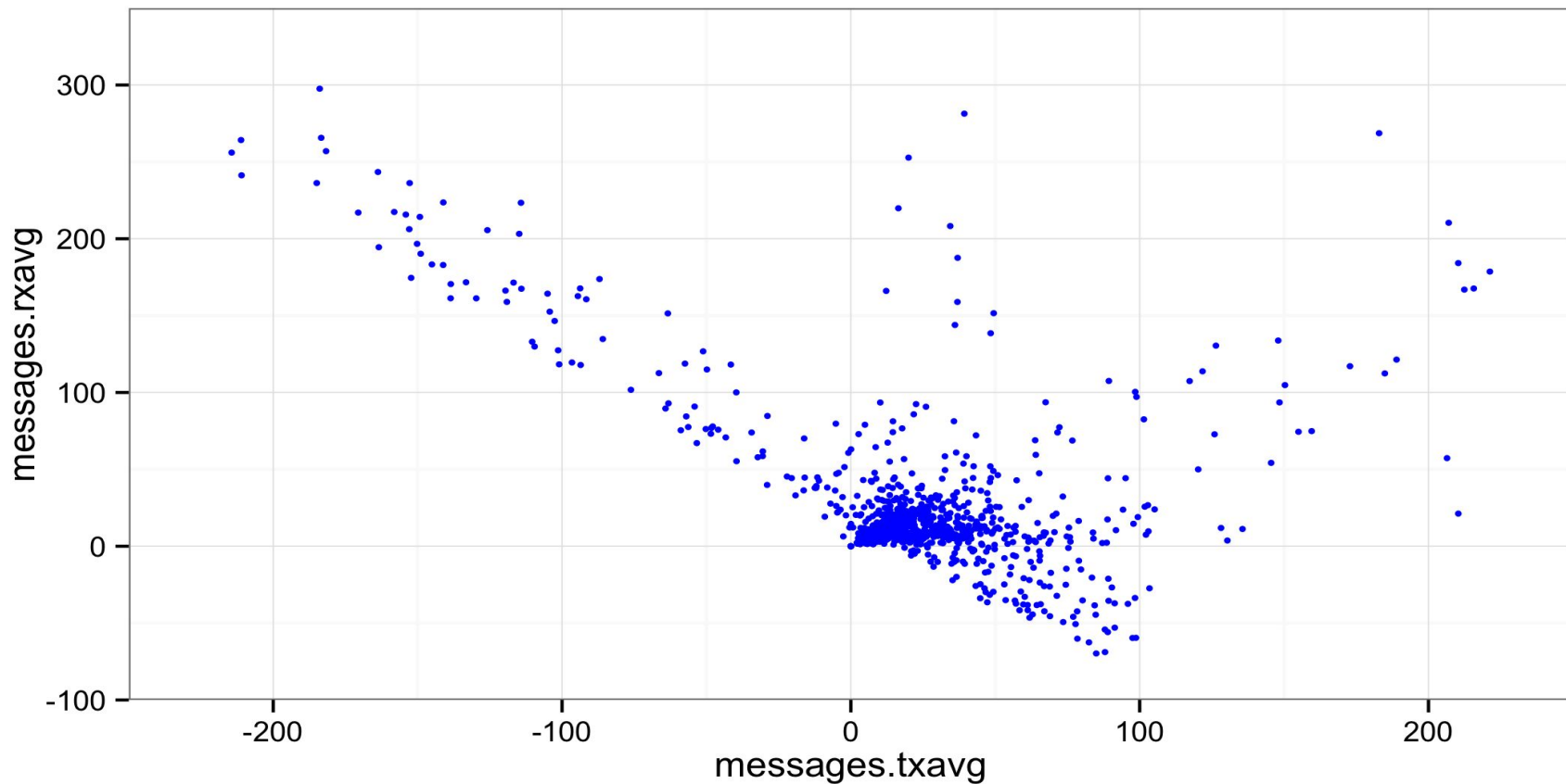


# Comparing signal reception on AP submodels



# Latency: isoping from GFiber android app

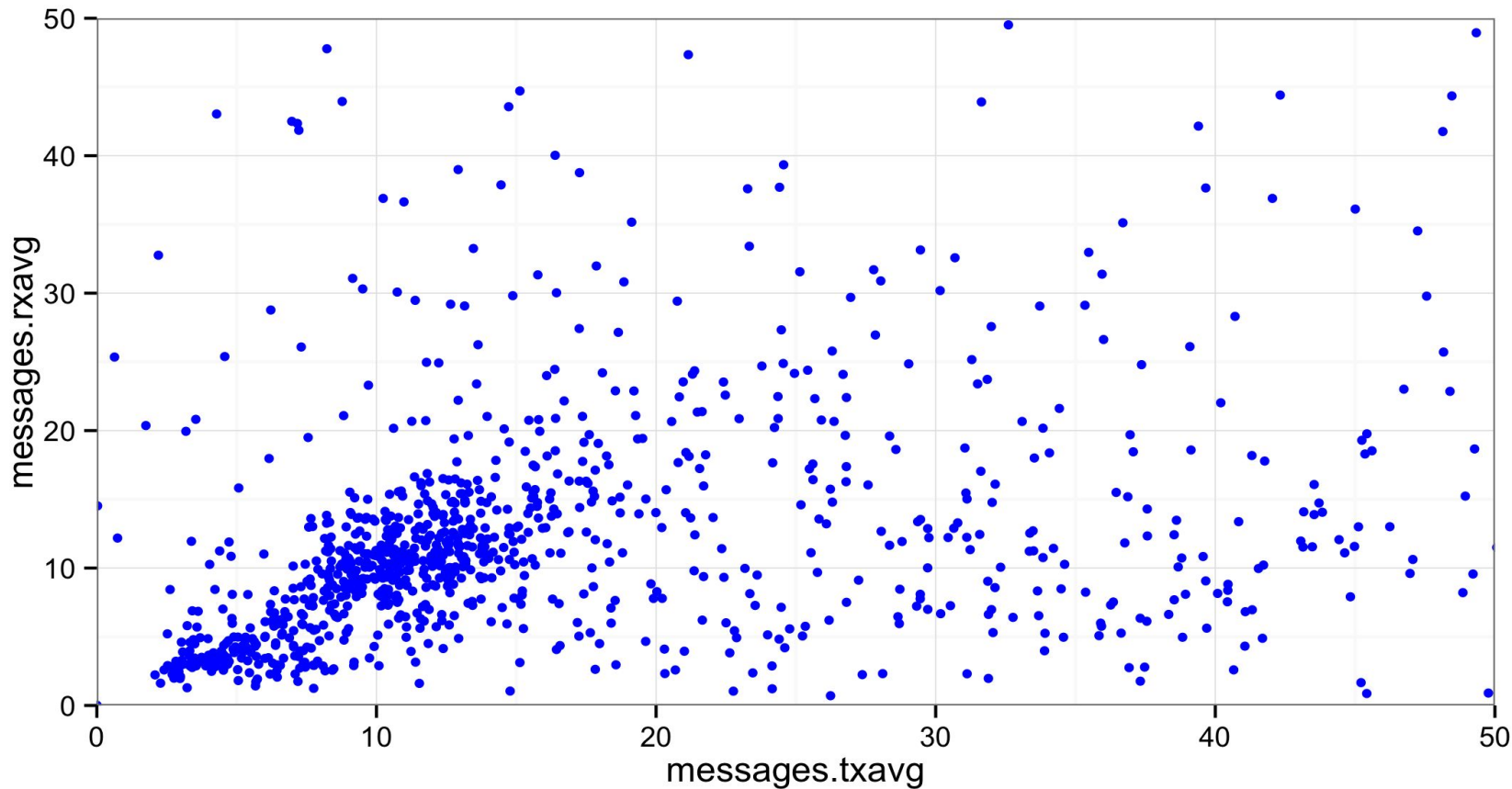
Open source: <https://gfiber.googleusercontent.com/vendor/google/platform/+master/cmds/isoping.c>





# Latency: isoping from GFiber android app (zoomed)

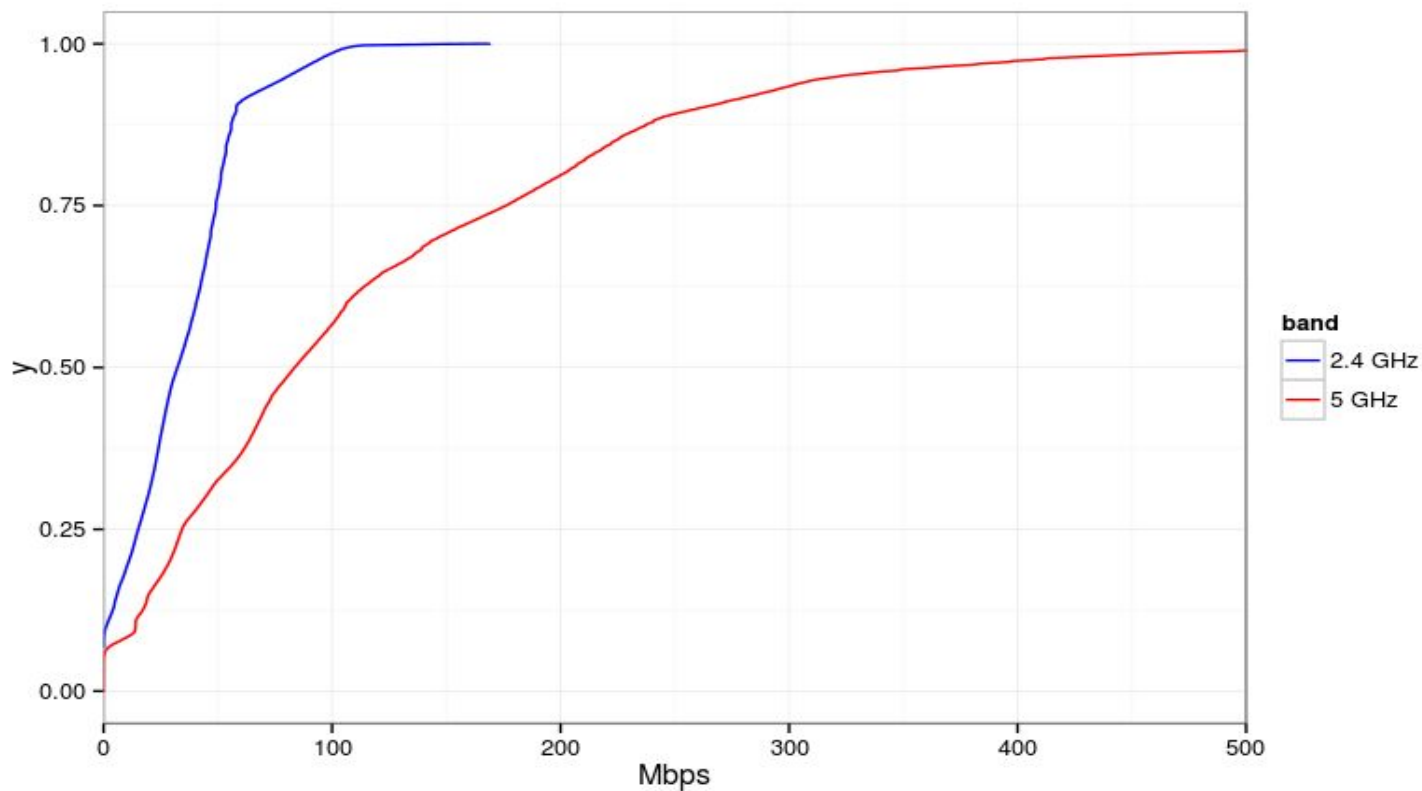
Open source: <https://gfiber.googlesource.com/vendor/google/platform/+master/cmds/isoping.c>



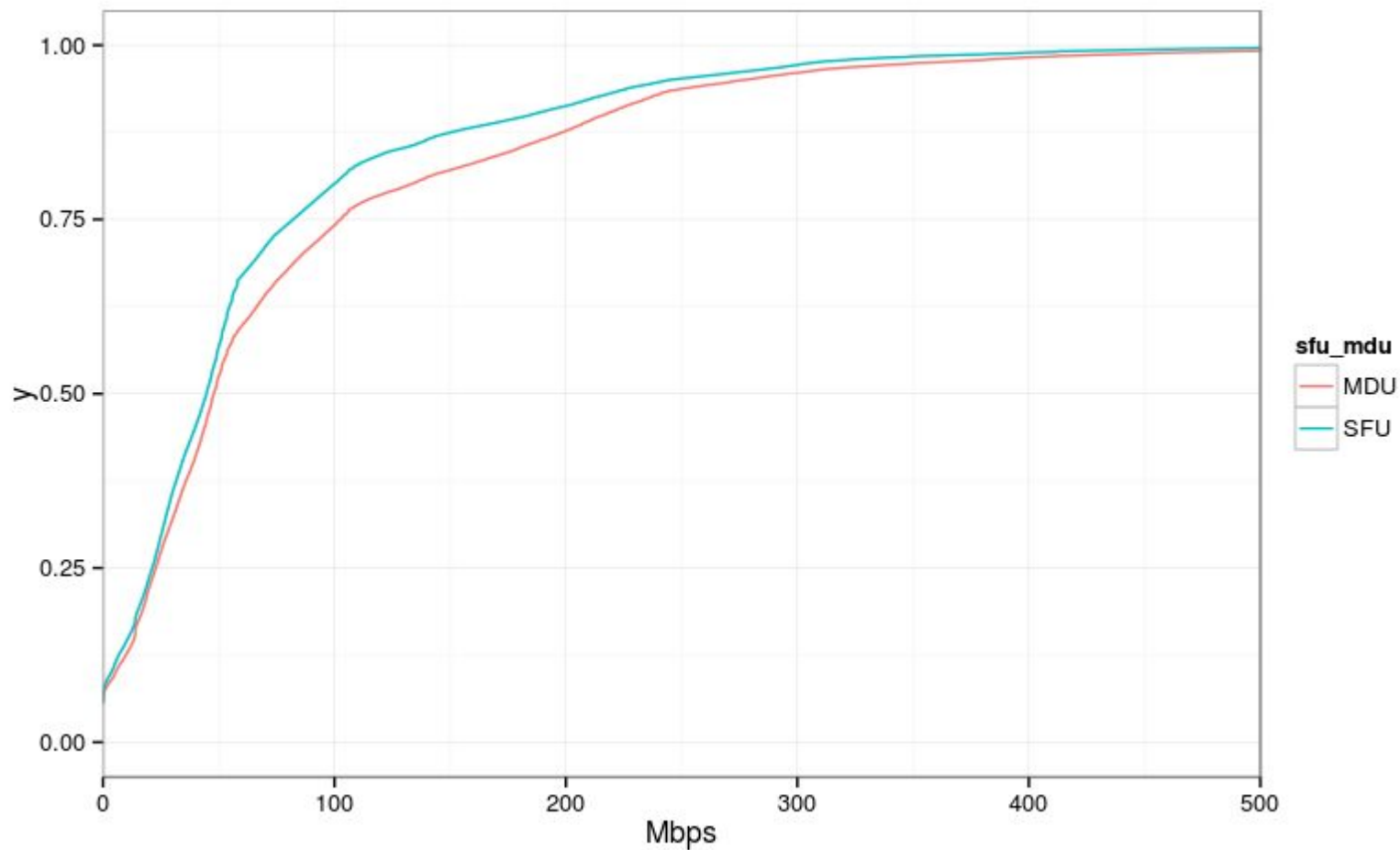
# Wifiblast: real world wifi speeds (cdf)

Open source: <https://gfiber.googlesource.com/vendor/google/platform/+master/wifiblast/>

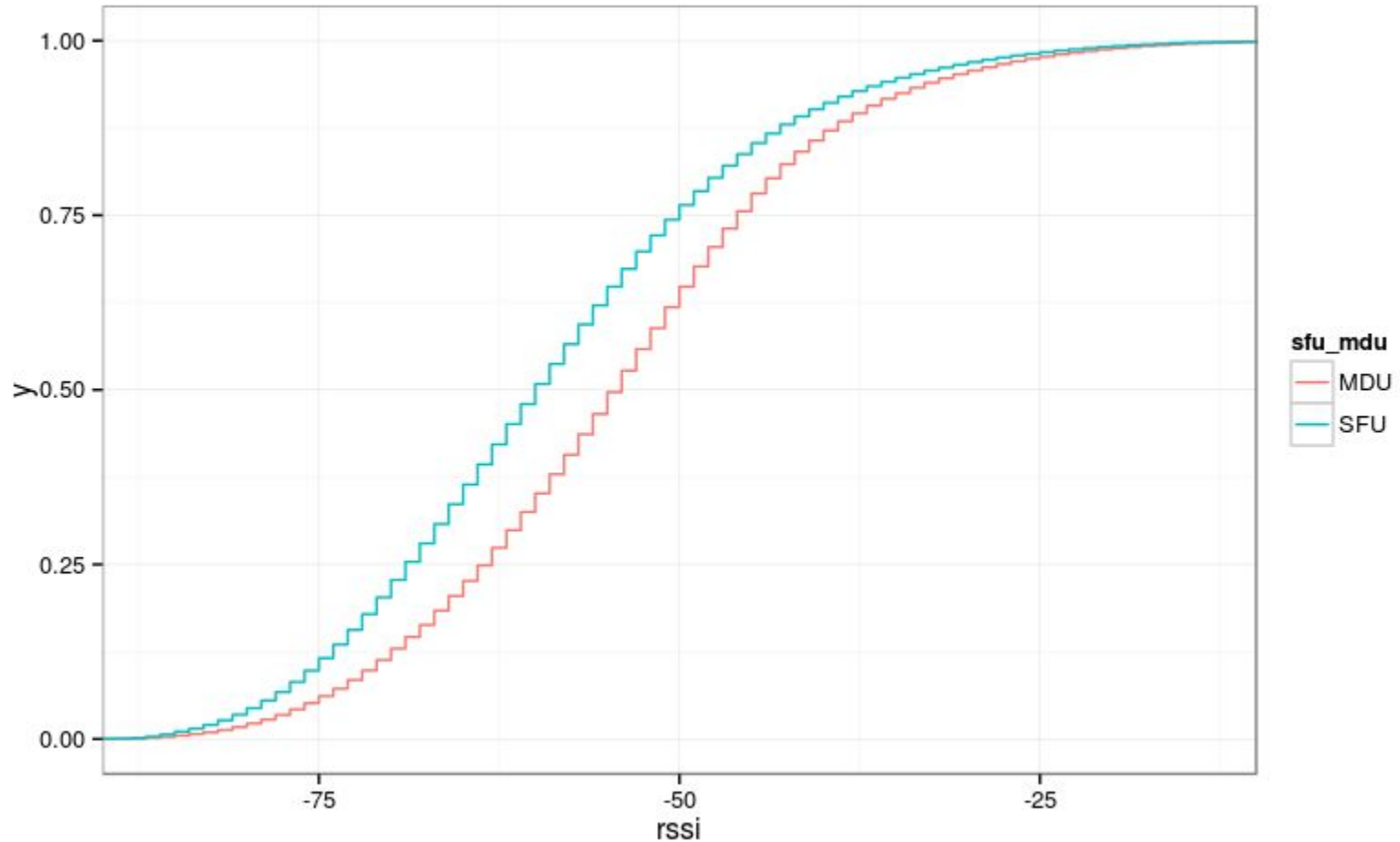
Lawyerized design doc: [http://www.tdcommons.org/dpubs\\_series/127/](http://www.tdcommons.org/dpubs_series/127/)



# Wifiblast: single-family vs multi-dwelling

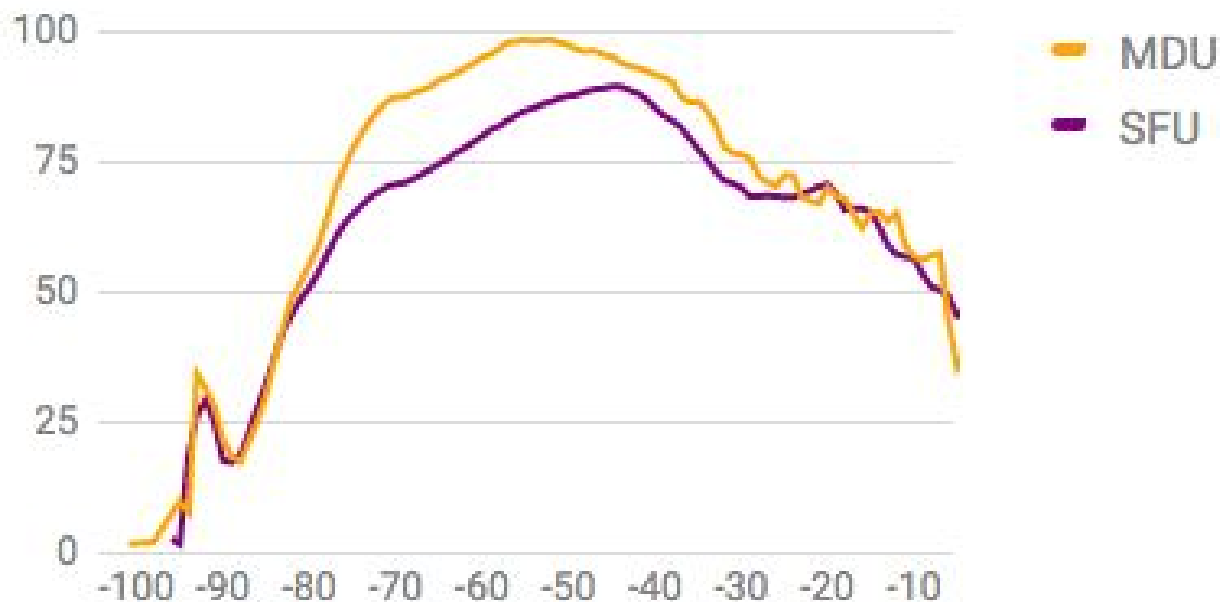


# Signal strength cdf, single-family vs multi-dwelling

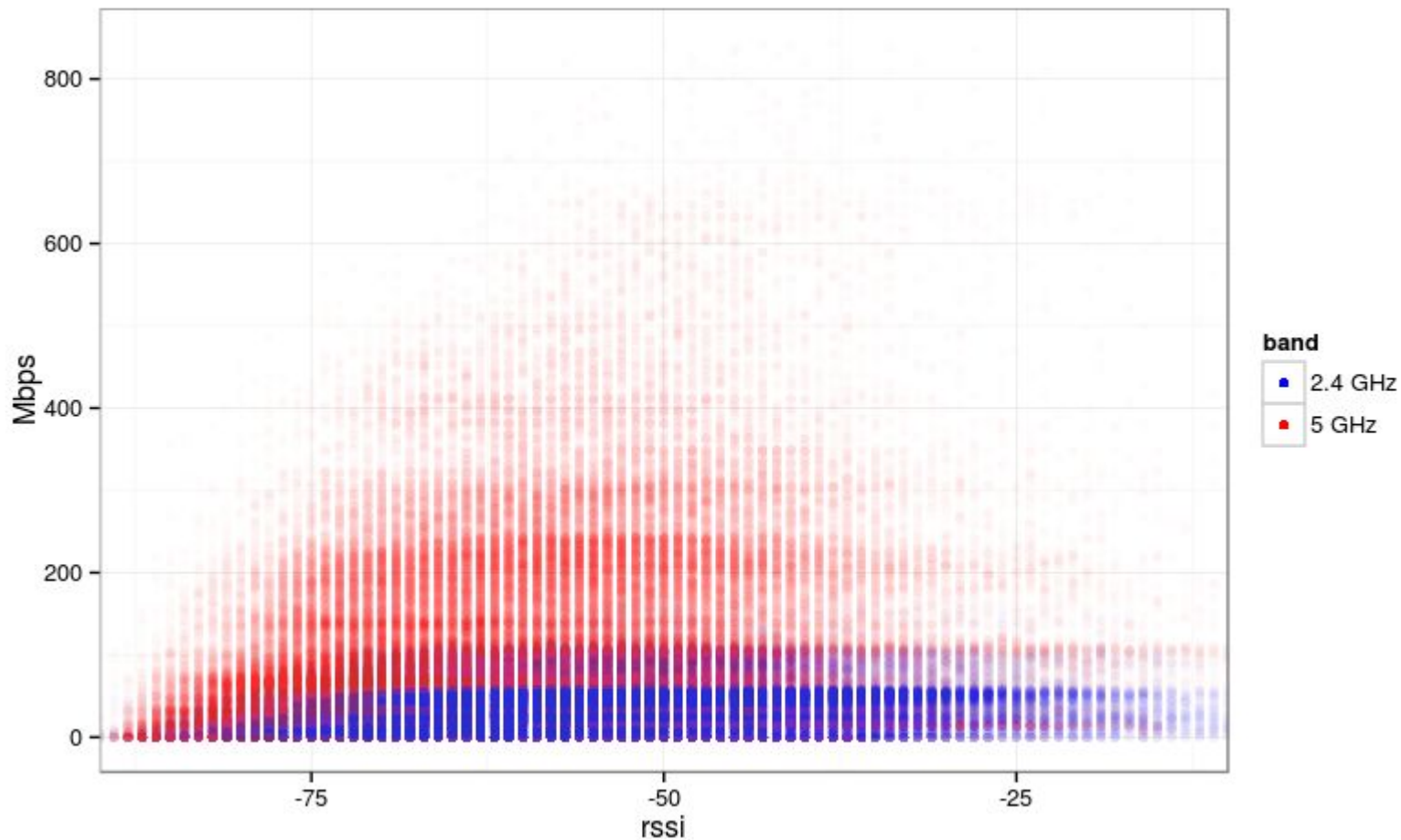


# Speed vs signal, single-family vs multi-dwelling

Avg Mbps at each RSSI, by home density

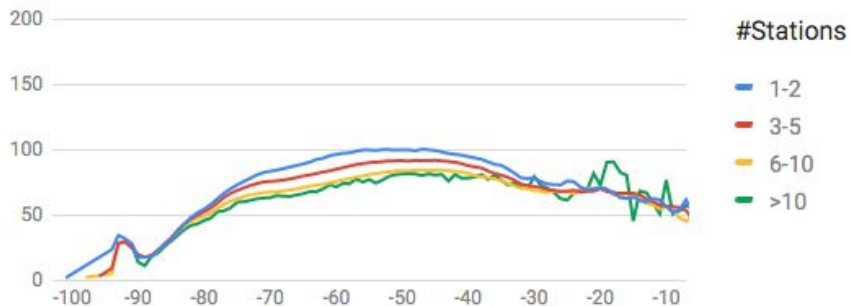


# RSSI vs Mbps (individual samples)

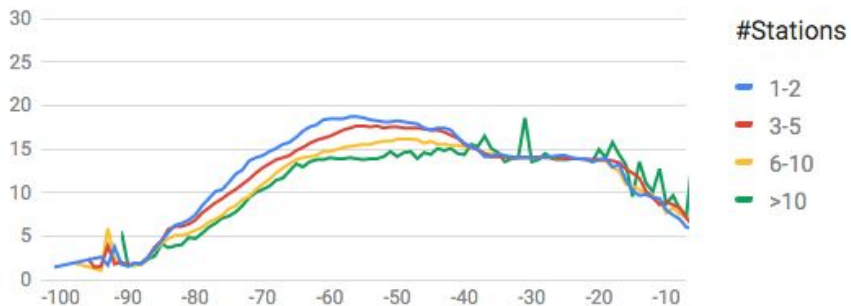


# Performance drop with more connected stations

Avg Mbps at each RSSI, by # Stations per AP

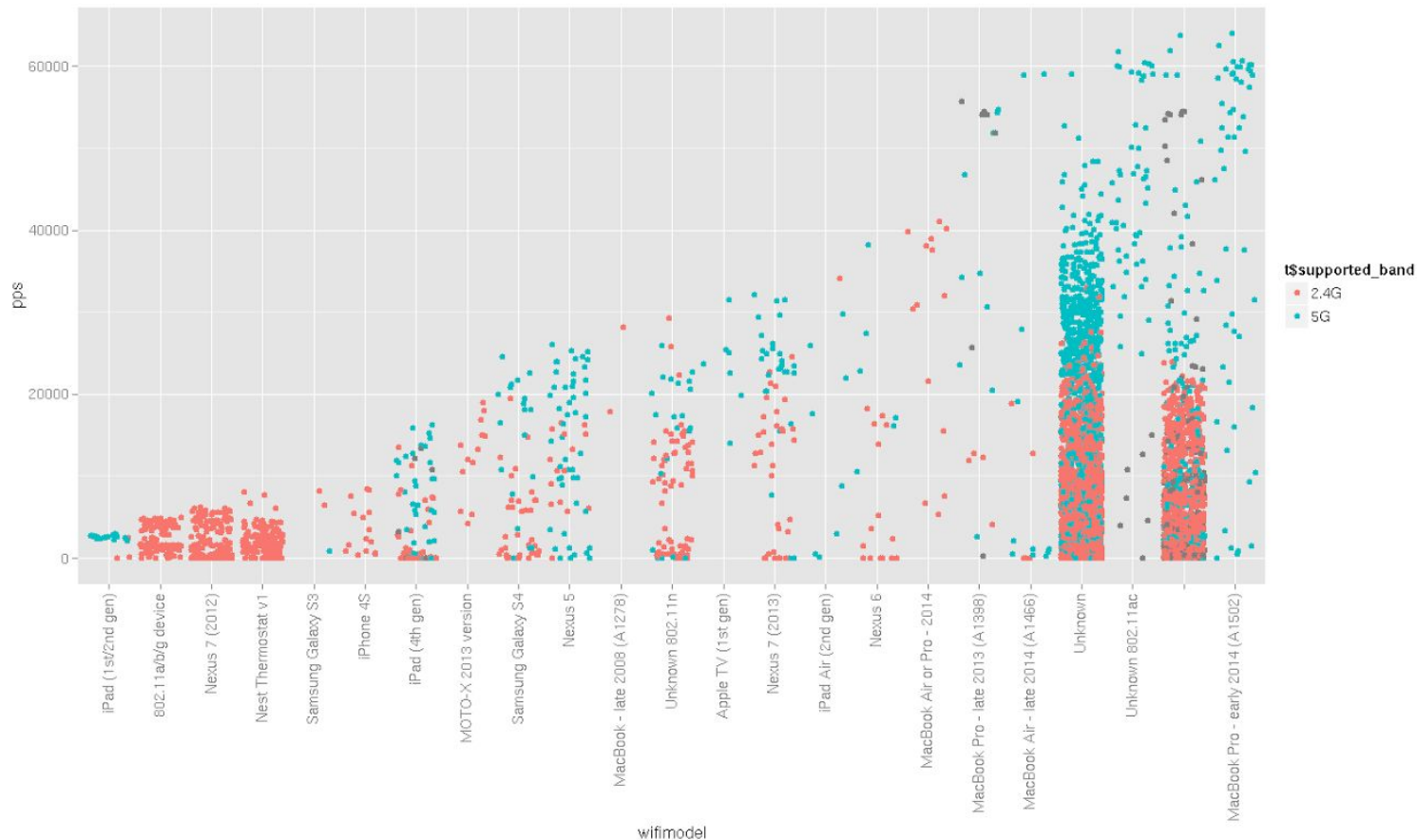


10th %ile Mbps at each RSSI, by # Stations per AP



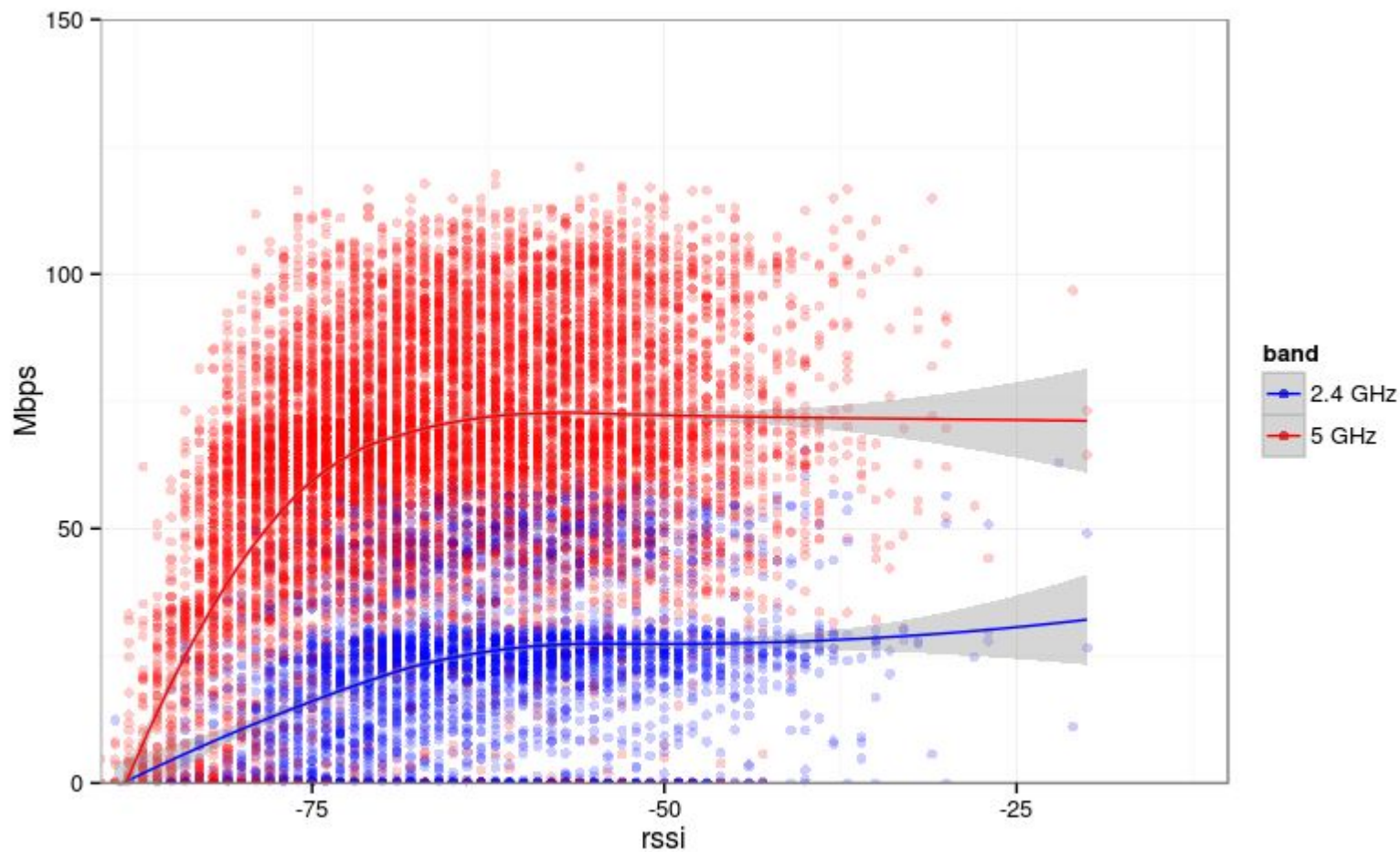
# Wifi “taxonomy” breakdowns

Open source: <https://gfiber.googleusercontent.com/vendor/google/platform/+/master/taxonomy/>



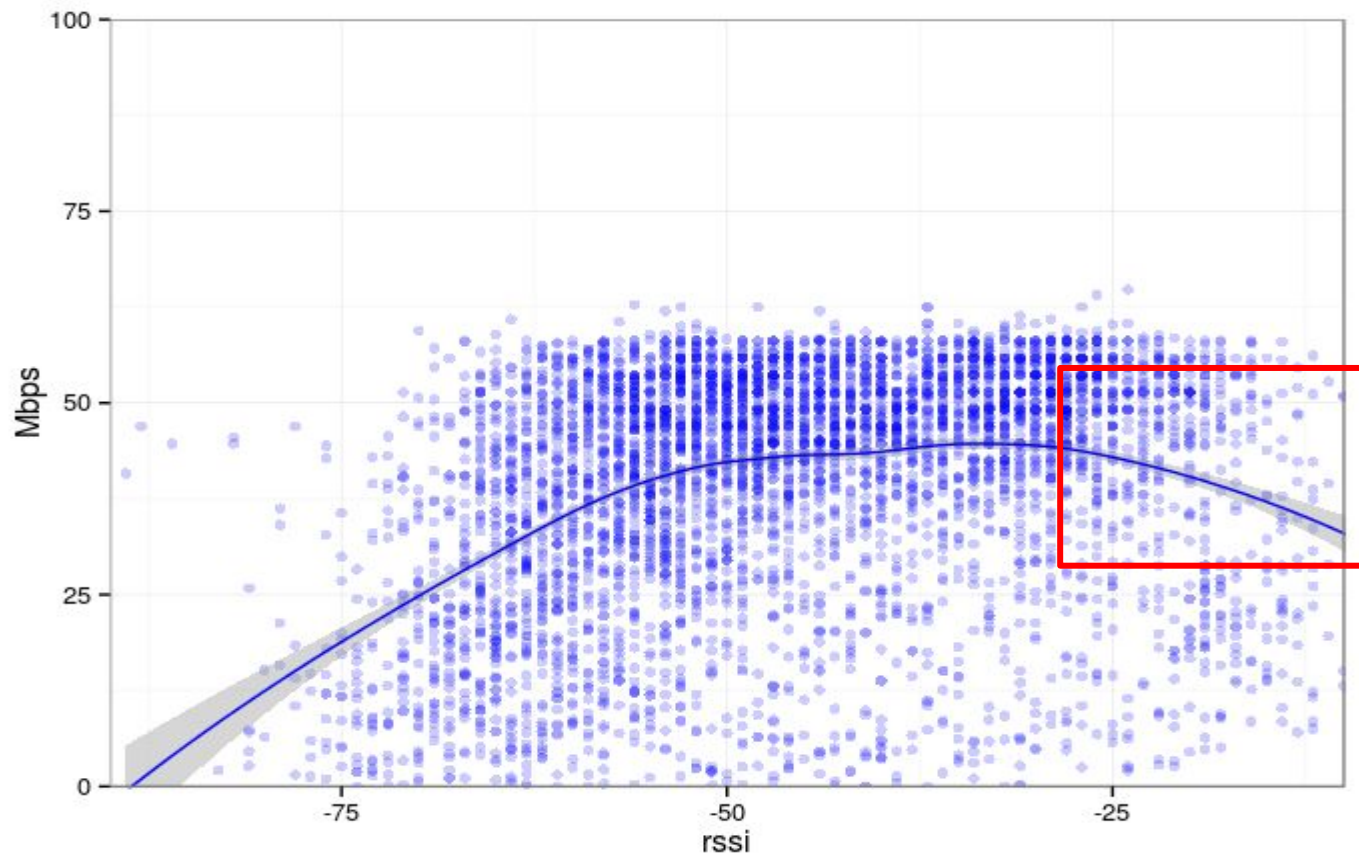


# Real world wifi speeds: particular phone model



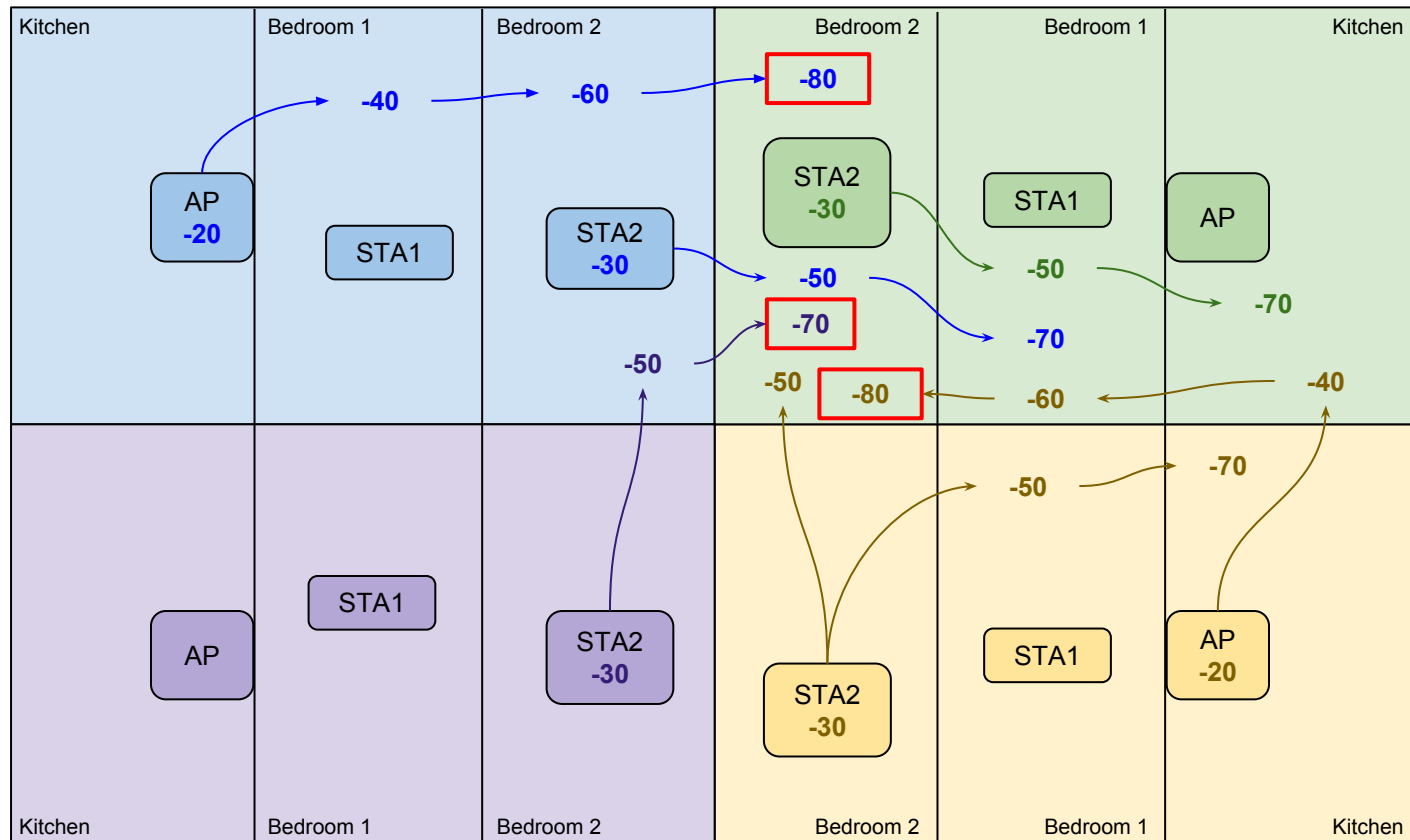
# Real world wifi: Chromecast (needs minstrel-blues?)

Minstrel-blues from Linux Plumbers Conf 2014: <http://www.linuxplumbersconf.net/2014/ocw/proposals/2439>



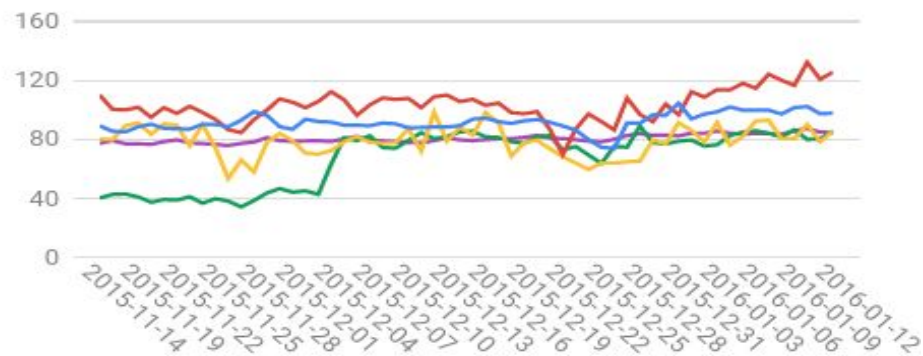
# Partial channel overlap in crowded environments

Open source channel selection: <https://gfiber.googleusercontent.com/vendor/google/platform/+master/waveguide/>

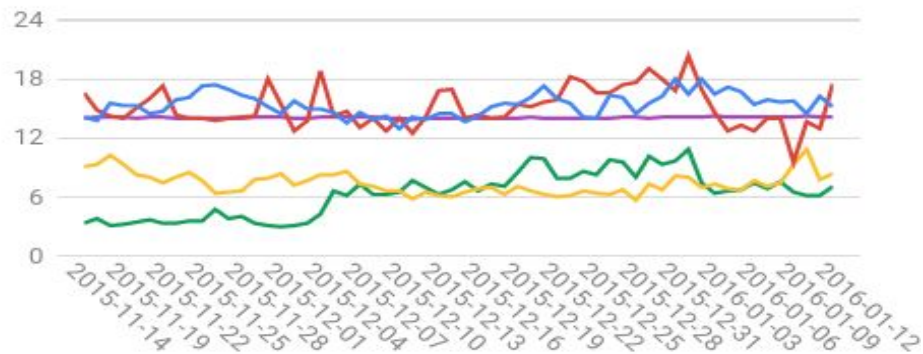


Channel  
overlap:  
before & after

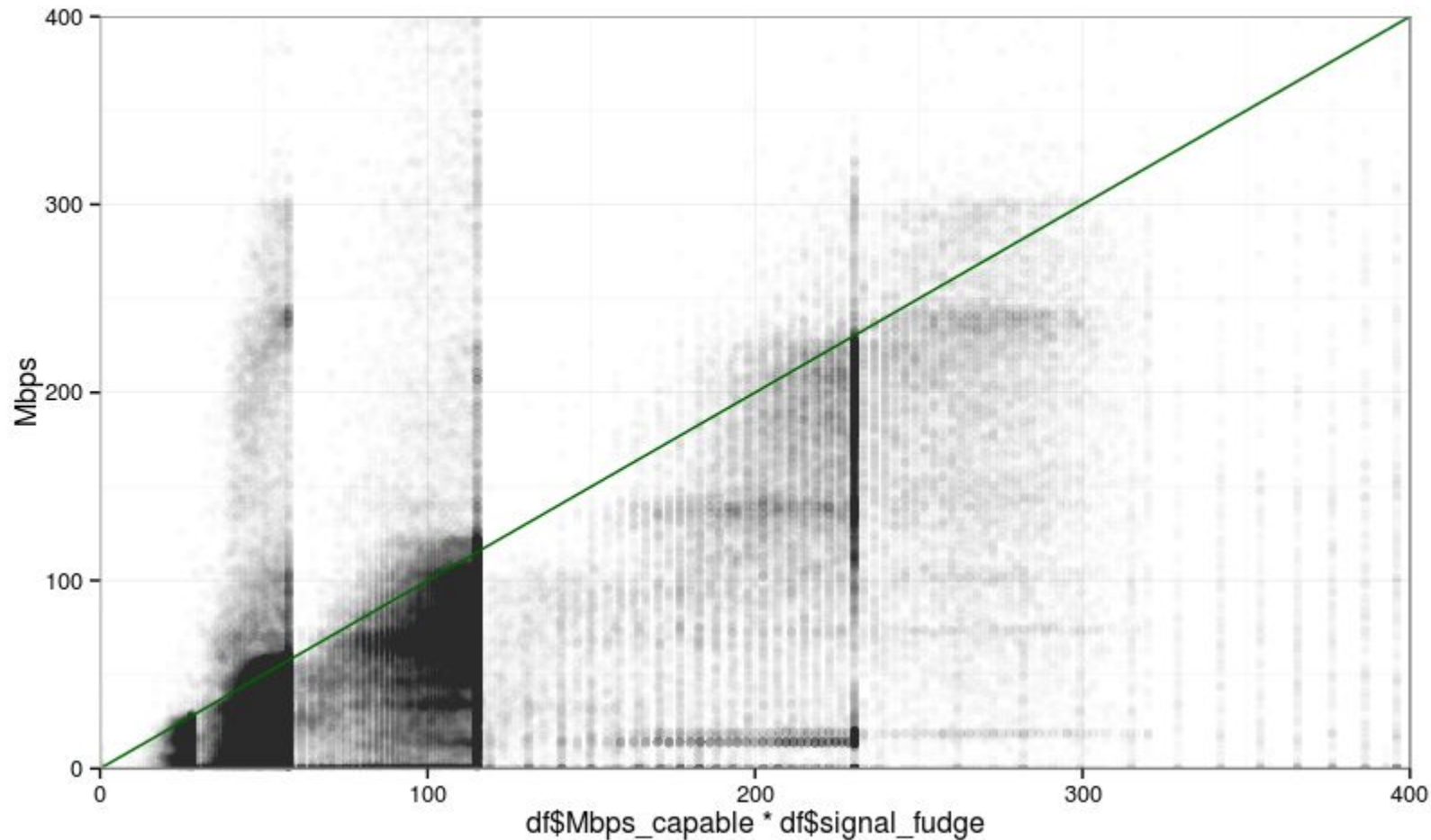
Avg Mbps at each Date, by Customer Group



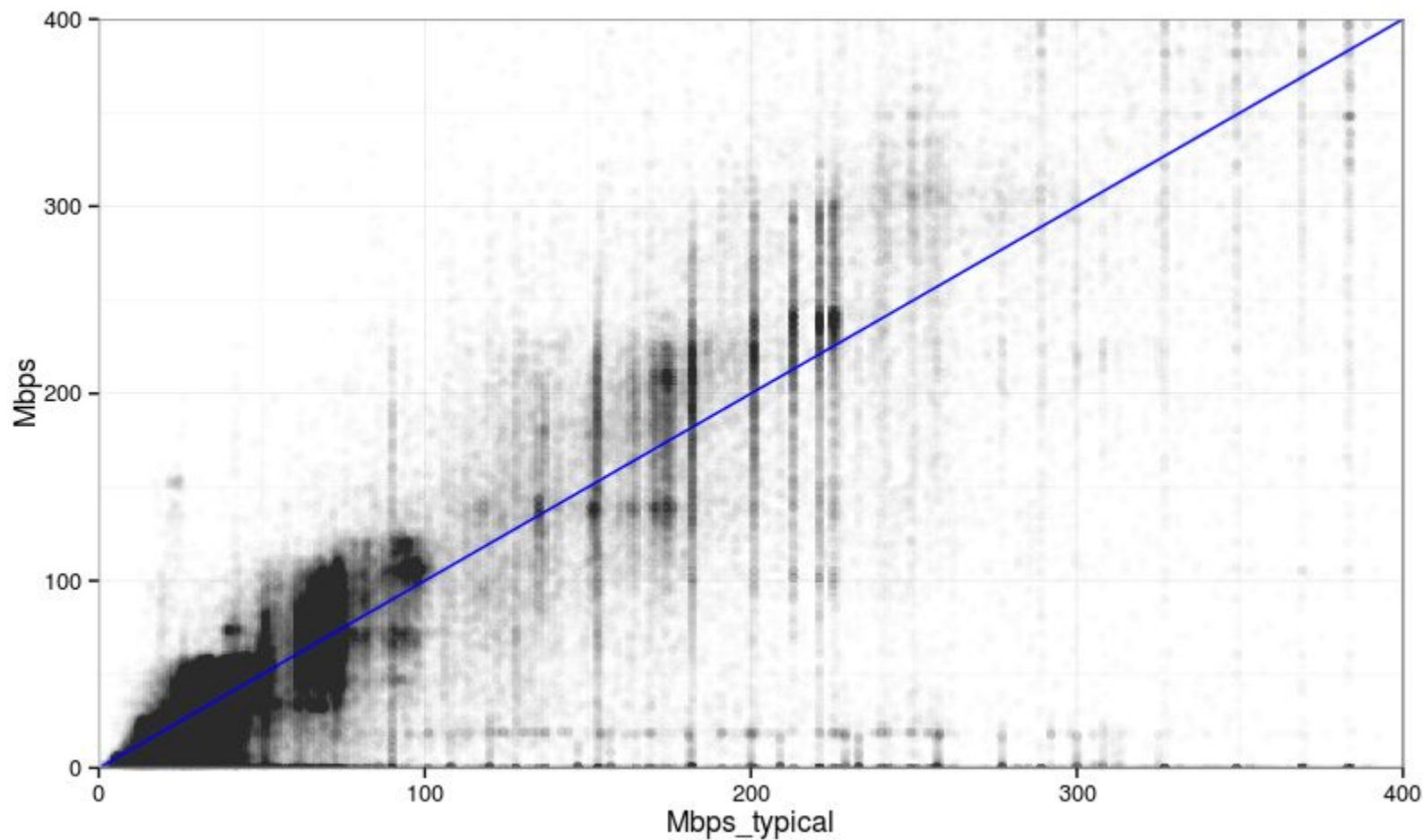
10th Percentile Mbps at each Date, by Customer Group



# Wifi speed prediction based on theory



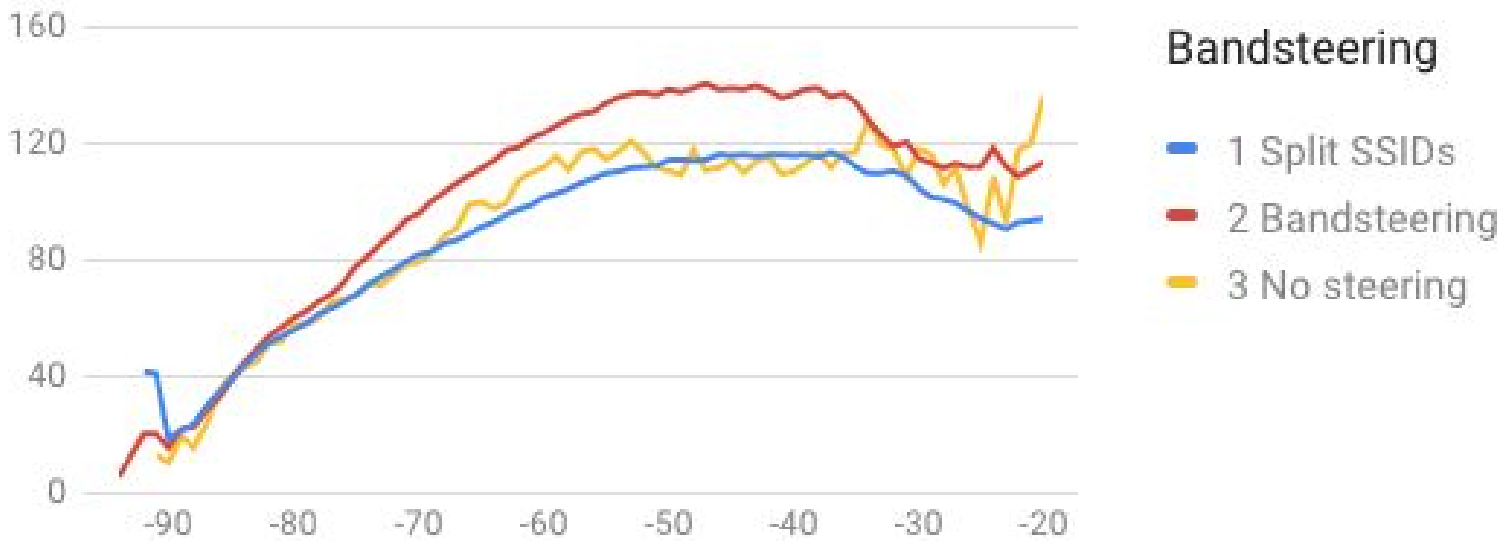
# Wifi speed prediction based on typical values



# Bandsteering (2.4 vs 5 GHz)

Bandsteering patches: <https://gfiber.googleusercontent.com/vendor/opensource/hostap/+/master>

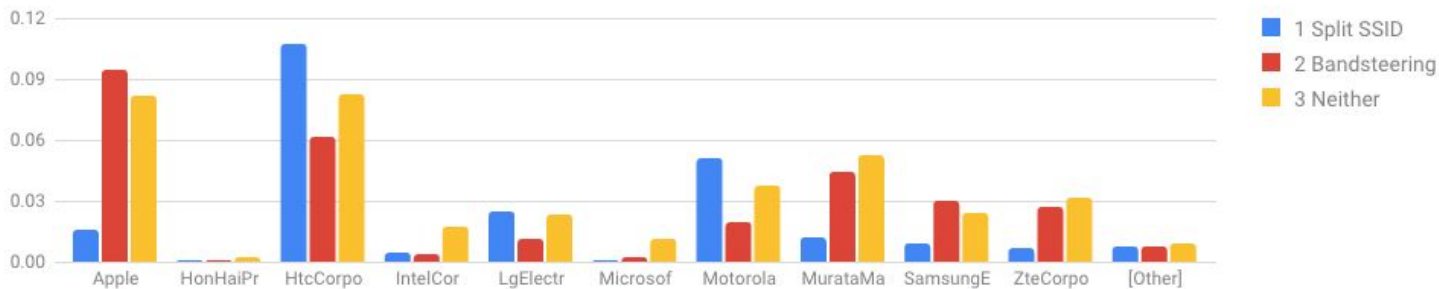
Dual-band, non-Apple devices only



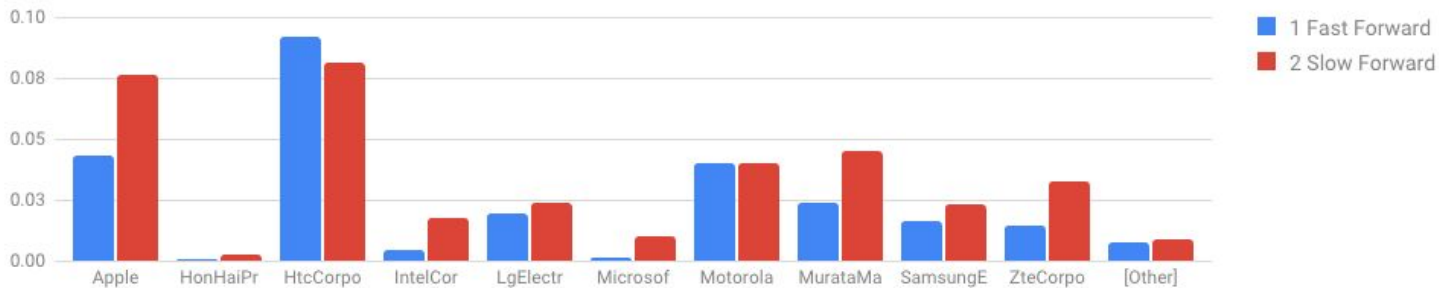


# Future: bounciness analysis

FracBouncy by Topvondor



FracBouncy by Topvondor

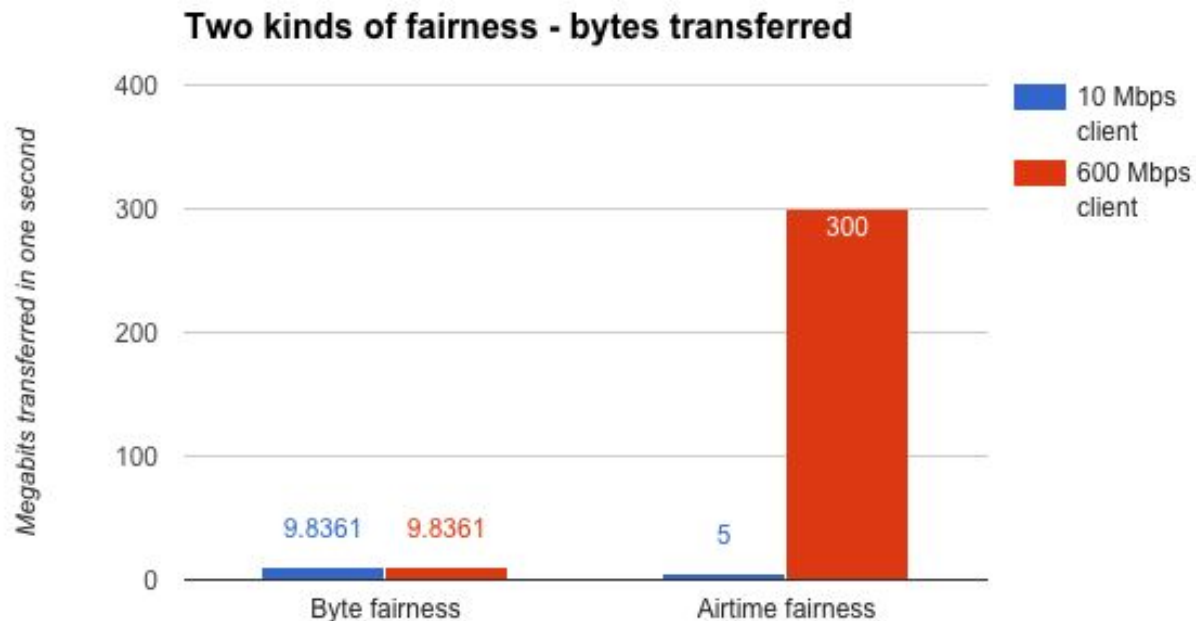




# Future: passive latency measurement

- Measure time delays:
  - SYN to SYN-ACK: Internet-facing RTT
  - SYN-ACK to ACK: wifi-facing RTT
- Allows measuring success of fq\_codel, per-station queuing, etc.

# Future: measuring effects of airtime fairness



\* Without airtime fairness, slow clients can ruin it for everyone. :(

# Yakthulhu

(and Questions?)

