Evolution of WiFi Testing

But Mostly Practical Advice

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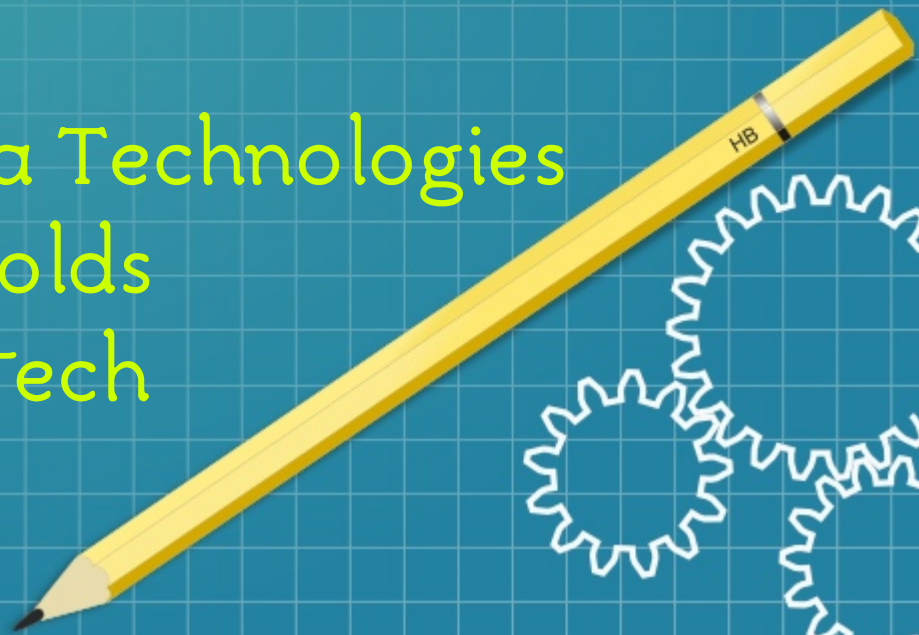


Topics and Interests

Like, what's really on your mind?

Get that on the whiteboard at the start

Past Present Future

- The Past of WiFi testing
  - WiFi standards
  - Signal strength, placement, site mapping
- The Present of WiFi testing
  - You are my density!
  - Ensuring fairness
- The Future of WiFi testing
  - Efficiency at density, battery life

What is WiFi Testing?

- What are we testing?
- Signal Strength, Availability
- Speed test
- Number of devices
- Stability
- Quality of Connection

Number of Devices

- Home
- Public Venue
- Enterprise
- Sensor Network

Stability

- How reliable is your connection
- What interrupts it?
  - Downstream interference
  - Upstream congestion
- Your channel plan

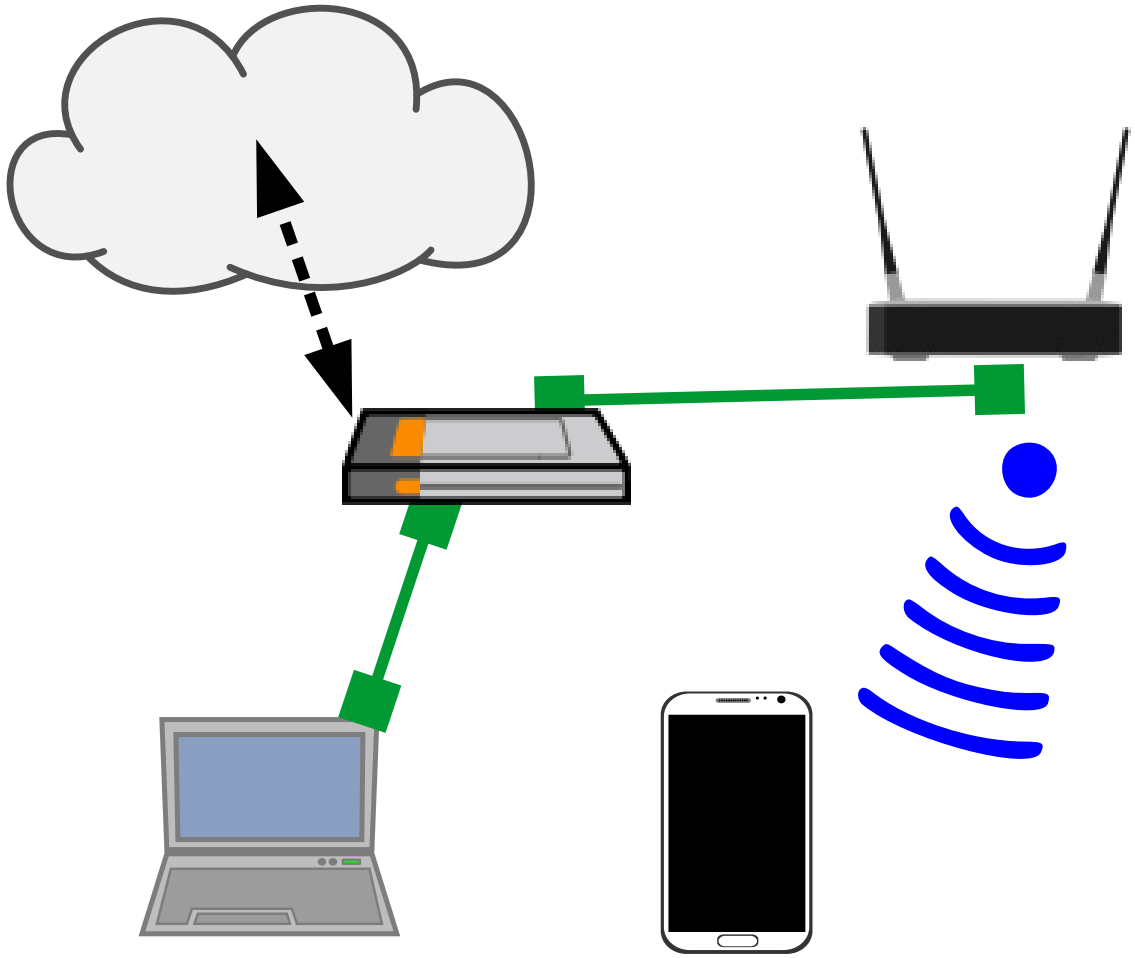
Quality of Connection

- Is it responsive?
  - Measure DNS times
- Is it fast enough?
  - Download test
- Does it allow enough users?
- Are they getting equitable bandwidth?

What is a speed test?

- Speedtest.net
  - A good idea?
- Wired speed
- Wireless speed
- Isolate what you're testing
- Be your own upstream

Basic Network



Being an Upstream Endpoint

- Wired endpoint
- On same LAN as AP
- Running a better chipset
- PC, NAS, or OpenWRT on AP itself

Your tools

On Linux, they are all based on:

- Intel wireless tools (iw, iwlist)
- WPA Supplicant (station mode)
- HostAPd (AP mode)
- IPRoute2 package

Effect of Your Hardware

- Different devices have different radios
  - 1x1 or 2x2 radios are common
- Different upstreams have different CPUs
  - Rpi Ethernet ...100Mbps on USB bus
  - Odroid C1 Ethernet 1000Mbps
  - Thinkpad T420 Ethernet 1000Mbps on PCIe2

Traffic Generation

- Android Iperf
  - Magic iPerf
  - MyPerf Server
  - HE.net
- Android SCP or Samba:
  - X-plore

What is your wifi card?

- Linux Settings
- **$ ip a show wlp1s0**

```
wlp1s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc
noqueue state UP group default qlen 1000
    link/ether b0:52:16:07:4c:8f
    inet 192.168.45.118/24 brd 192.168.45.255
```

- Android Settings

  - many items in Play store

Your connection is...?

```
$ iwlist wlp1s0 scan
wlp1s0     Scan completed :
  Cell 01 - Address: 60:E3:27:6F:D9:BA
    Channel:11
    Frequency:2.462 GHz (Channel 11)
    Quality=70/70  Signal level=-31 dBm
    Encryption key:on
    ESSID:"cyrus-n"
    Bit Rates:1 Mb/s; 2 Mb/s; 5.5 Mb/s; 11 Mb/s; 6 Mb/s
              9 Mb/s; 12 Mb/s; 18 Mb/s
    Bit Rates:24 Mb/s; 36 Mb/s; 48 Mb/s; 54 Mb/s
```

Connection Quality

- Signal Strength
- Available Airtime
  - Co-Channel interference
  - Only one thing can transmit at once
- Side-Channel interference
  - 2.4GHz: 1, 6, 11 !!!
  - 5GHz: 80, 40, or 20MHz?
  - DFS (radar) (52-144)

Tests use Scripting

- Laptop and Linux!
- Iperf
- Netburn
- Scp

Setting up iPerf server

- $ apt install iperf3
- $ ufw status; ufw disable
- $ iperf3 -s
- Laptop—ethernet plugged in?

Using iPerf client

- Many Android iPerf apps
  - Iperf2 != Iperf3
- HE.net iperf3

Netburn

- Github: jimsalterjrs/network-testing
- webserver on LAN
- Attack a page:

```
$ netburn -u http://server/disc.iso
```

Other CLI Tools

- Iftop (cli meter)
- Netperf
- Complicated options:
  - Flowgrind
  - Flent (uses netperf, bufferbloat)
  - Mgen (navy.mil)

Most of your tools

...have only changed a little. Are based on:

- Intel wireless tools (iw, iwlist)
- WPA Supplicant (station mode)
- HostAPd (AP mode)
- IPRoute2 package

Professional Tools

- Site Survey Tools
  - Ekahau Site Survey/Sidekick
  - Tamograph
  - Airmagnet
- Traffic Emulation Platforms
  - LANforge
    - Multi UE testing solutions
  - Ixia
    - Testing and reporting platform

802.11b (WiFi 1)

Much wifi was 802.11b

- 2, 5.5 and 11Mbps
- Two antennas
- These APs are long gone
- Endpoint devices will never leave us

More Resources

- WlanPro Resources:
  - www.wlanpi.com
- Laminate this:
  - bit.ly/2UGhvpz
- Wlanpros Lending library
  - bit.ly/2UOTHQs
- WLANPi:
  - www.wlanpi.com

802.11a (WiFi 2)

6, 9, 12, 18, 24, 36, 48 and 54 Mbps

Not compatibe with 11b

OFDM

802.11g (WiFi 3)

6, 9, 12, 18, 24, 36, 48 and 54 Mbps; can revert to 1, 2, 5.5, and 11 Mbps using DSSS and CCK.

compatible with 11b

OFDM

802.11n (WiFi 4)

1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, 54 Mbps

OFDM

MIMO

Channel Bonding

3 2.4Ghz channels

12 5Ghz channels

.11n MIMO

- 1x1 20Mhz 1x1 40Mhz
- 2x2 20Mhz 2x2 40Mhz
- 3x3 20Mhz 3x3 40Mhz

Spatial Streams

Antenna Diversity

Multipath Interference

Compensates for Fading

802.11ac wave1 (WiFi 5)

- High Efficiency, MIMO
- 24 5Ghz channels
- 1x1 40 MHz 200 Mbps
- 2x2 40 MHz 400 Mbps
- 1x1 80 MHz 433 Mbps
- 2x2 80 MHz 866 Mbps
- Many UE radios are dual-band .11n/.11ac to gain 2.4Ghz channels

802.11ac wave2 (WiFi 5)

- Higher performance
- Introduces MU-MIMO
- 2 5Ghz 160Mhz channels (866Mbps)

3x3 MIMO

802.11ax (WiFi 6)

- High efficiency
- Crowded environments
- No rate increases
- Multiple subchannels
- Emphasizes hardware sleep states with colors and Time to Wake