



WiFi Testing – In the real world

September, 2016
CWNP WIFITREK

Today's agenda

- Understanding the environment
 - Pillars of Carrier Grade WiFi
 - Deployment types
- Test requirements
 - What to test
- Tools selection
 - Characterize the network performance
 - Baseline the environment
 - Logs & Analysis
- Test kit
- Samples of output & results

Understanding the environment

Testing of Comcast Carrier Network

Pillars of Carrier Grade WiFi



Large Coverage Footprint

- Outdoor
- SMB (cafes, shops, restaurants, etc.)
- Venues



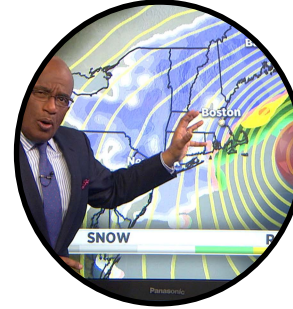
Good Bandwidth / Speeds

- Home internet speeds on the go



Security

- 802.1X support
- Federated Access
- Seamless network selection



Reliable

- Ability to connect
- Good RF coverage
- Supporting fast handoffs (mobility)



Easy to Use

- Rule of 6s

Pillars of Carrier Grade WiFi



Large Coverage Footprint

- Outdoor
- SMB (cafes, shops, restaurants, etc.)
- Venues



Good Bandwidth / Speeds

- Home internet speeds on the go



Security

- 802.1X support
- Federated Access
- Seamless network selection



Reliable

- Ability to connect
- Good RF coverage
- Supporting fast handoffs (mobility)



Easy to Use

- Rule of 6s

WiFi deployment approach

Build WiFi coverage in locations where users most likely want to connect



Outdoor

- Aerial strand
- Main streets
- Shop, dine, relax, wait, commute



SMB

- Small business
- Seating areas
- Waiting areas



Residential

- WG CPE
- Home network
- XFINITY WiFi



Venues

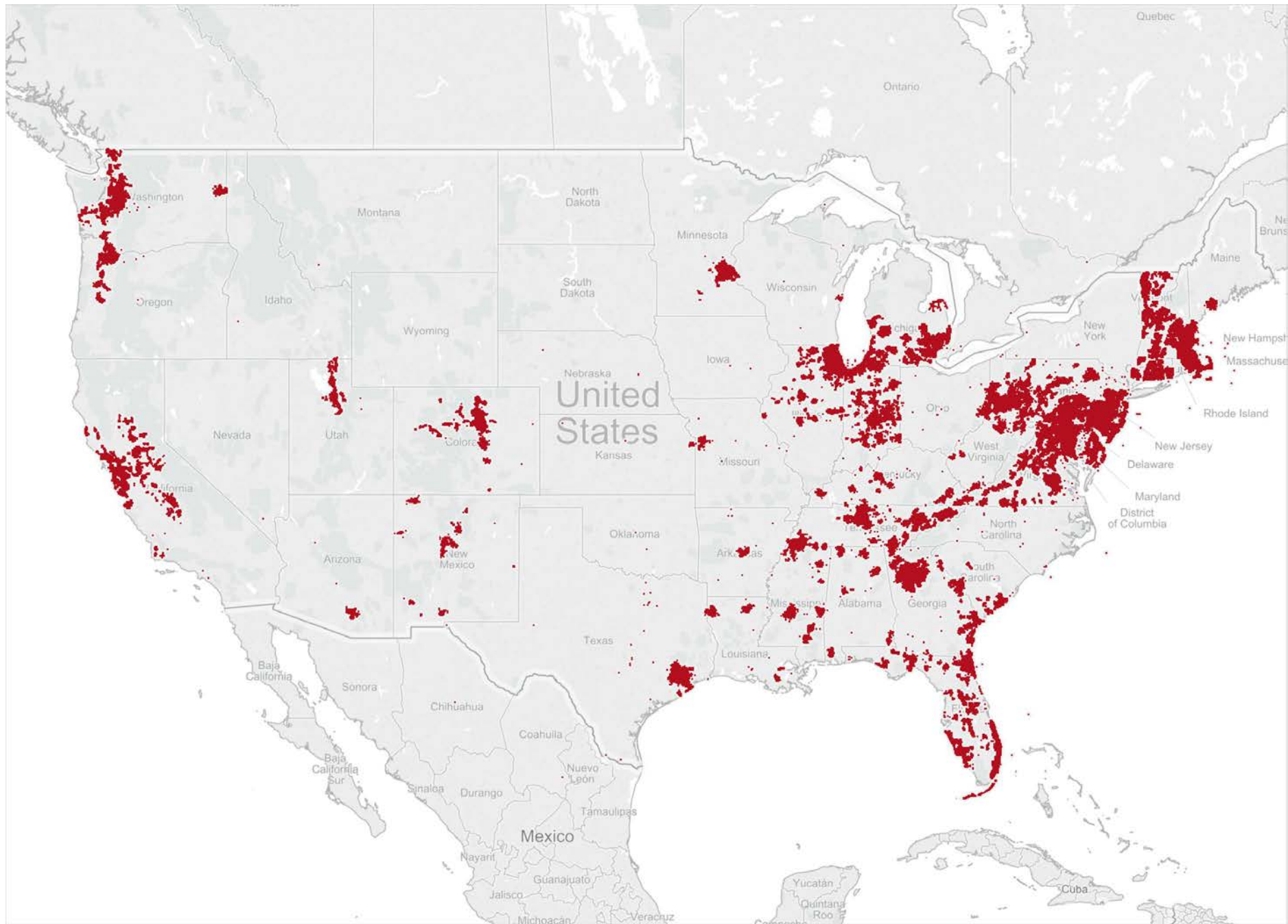
- High traffic
- Strategic venue
- ROI targets



CableWiFi

- 5 largest MSOs
- Partner sites
- Federations

Each vertical has unique use cases and user base



Dynamic Environment

- No control over buildings, people, materials, ...
- I can “see” 30 networks and can’t connect



Test Requirements

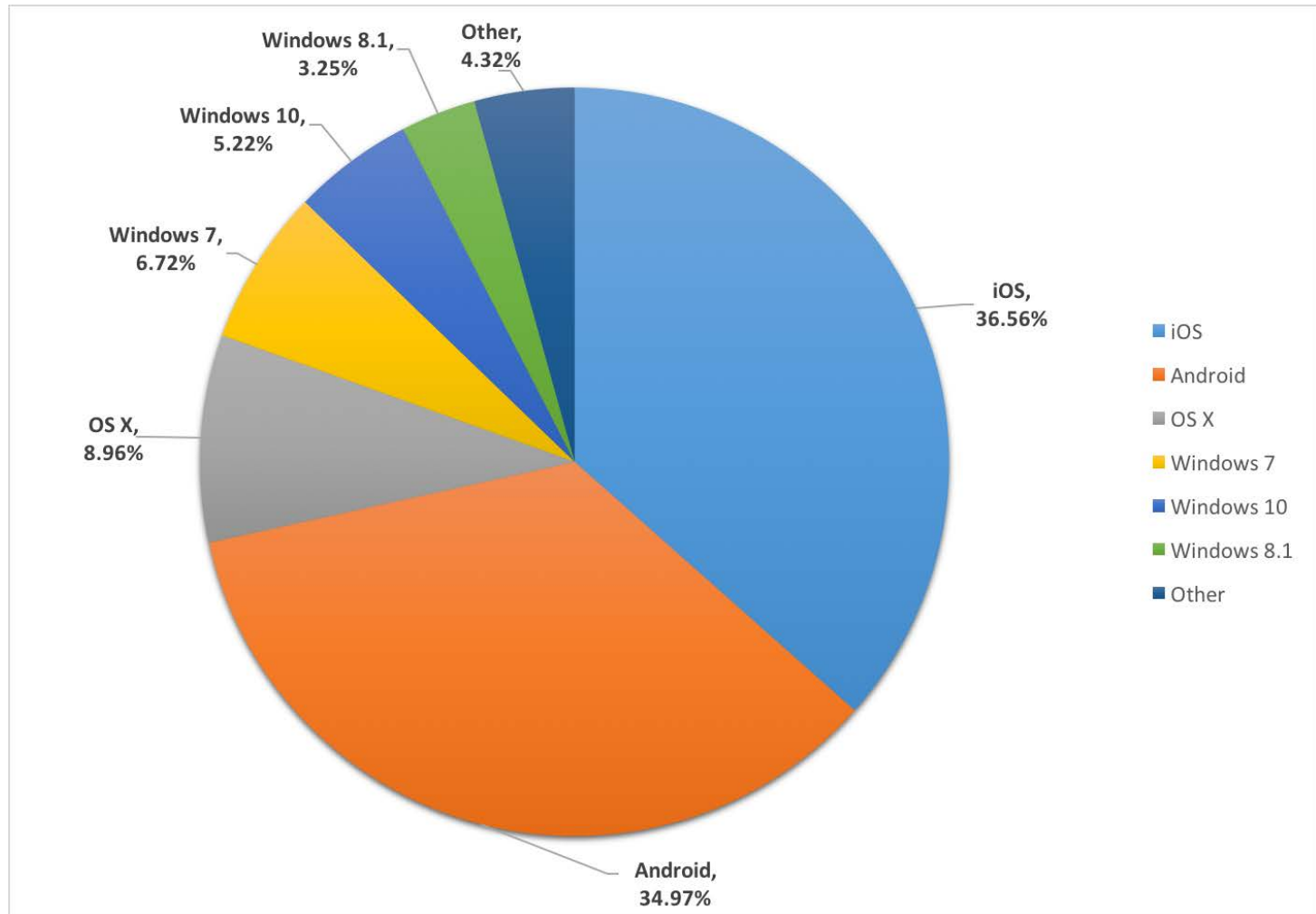
Test Requirements

- All testing must be done from as a client would use the network
 - Real client handsets
 - Real client applications
 - Captures must be able to support client information
 - Tests must be repeatable
 - Tests must be measurable

Device Support



Authenticated Device type distribution



Tools selection

Tool Selection – Characterize the network performance

The first objective when characterizing any network is to have tools that provide empirical data. We needed something that would operate on the mobile platforms our customers are using and provide details into more than just upstream & download speeds.

Ideally we wanted the following:

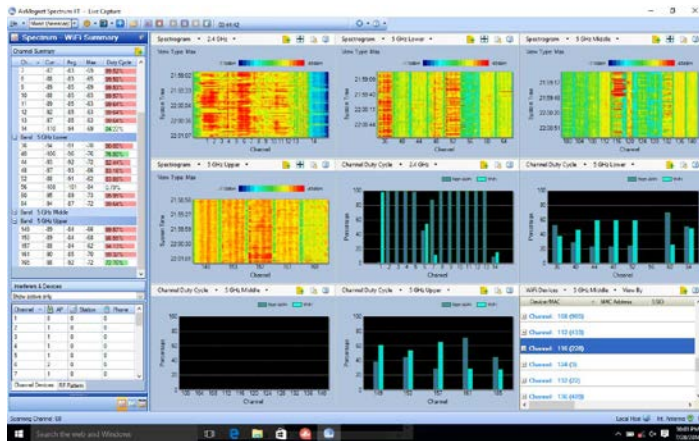
- Timing associations (start of association -> DHCP address)
- Upload / Download Speed
- Measure video performance
- Measure browsing performance
- Measure VoIP performance
- Roaming Performance

After researching numerous tools, timing for associations and roaming performance are not exposed or available on mobile platforms. nPerf was able to achieve 3 of the remaining 4 items and was selected as a result.

Tool Selection – Baseline the environment

Our next object was to baseline the environments we are in. We wanted to baseline the RF environment from a spectrum usage, number of AP's, and AP capability standpoint. We needed a solution that was mobile and could capture enough data that we could replicate environments in the lab. For AP information, the Fluke AirCheck seemed like a no brainer.

Many tools were looked reviewed; however, AirMagnet Spectrum XT was locked in for the spectrum captures. Ekahau's rebranded version of MetaGeek's Wi-Spy DBx was also purchased for collecting data over the map. Spectrum XT is easier to read, in my opinion. Samples below:



Tool Selection – Logs and Analysis

The last thing we needed were logs and packets to round out our ability to see the big picture. Many different packet capture capabilities are out there, OmniPeek and WireShark most frequently used. We selected OmniPeek due to the packet aggregation function being easy to use and the Netgear A6120 being a very inexpensive adapter. When one breaks replacing it is pretty easy and they will break in the field.

We also look at what hooks iOS and Android had available in the OS. Android has the debug shell and Apple has special access for developer accounts. For more information check this out:

<https://developer.apple.com/bug-reporting/profiles-and-logs/>

Find the Wi-Fi for iOS, read the instructions and install the profile. You will be glad you did

Wi-Fi for iOS

 Instructions

 Profile



Test Kit

Full Kit - Testing Devices & Tools

- Test devices will be the most popular mobile hand held devices used on the network.
 - iPhone 6(s)
 - Galaxy S6(edge)
 - iPad Air
- Applications used during testing
 - nPerf, SpeedTest.Net, WiFiPerf (Venues only)
 - xfinity TV (TV GO), You Tube
 - Network & Ping utilities
 - Network diagnostics & debug logs where available
- Capture tools
 - Fluke Aircheck
 - Fluke Spectrum XT & Ekahau Spectrum Analyzer
 - OmniPeak for packet captures

Test equipment, apps, and tools will be updated annually. Client devices constant change drives this requirement. Initial testing will create roadmap requirements for future testing tools

Kit Prep



Testing in Action



Sample Outputs

Mobility 2_1 – Edge

No.	Time	Source	Destination	Protocol	Length	Info
18	36:48:786660	22:86:8C:E5:E9:7E	5F:3E:01:89:8C	802.11	30	Deauth
19	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
20	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
21	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
22	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
23	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
24	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
25	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
26	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
27	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
28	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
29	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
30	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
31	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
32	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
33	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
34	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
35	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
36	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
37	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
38	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
39	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
40	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
41	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
42	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
43	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
44	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
45	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
46	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
47	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
48	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
49	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
50	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
51	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
52	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
53	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
54	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
55	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
56	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
57	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
58	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
59	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
60	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
61	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
62	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
63	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
64	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
65	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
66	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
67	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
68	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
69	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
70	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
71	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
72	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
73	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
74	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
75	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
76	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
77	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
78	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
79	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
80	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
81	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
82	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
83	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
84	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
85	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
86	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
87	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
88	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
89	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
90	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
91	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
92	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
93	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
94	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
95	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
96	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
97	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
98	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
99	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp
100	36:48:786660	5F:3E:01:89:8C	22:86:8C:E5:E9:7E	802.11	30	Probe Rsp

```

Frame Control Flags: 00000000 [1]
  0... .. Non-strict order
  .0... .. Non-Protected Frame
  ..0... .. No More Data
  ...0... .. Power Management - active mode
  ....0... This is not a Re-Transmission
  ....0... Last or Unfragmented Frame
  ....0... Not an Exit from the Distribution System
  ....0... Not to the Distribution System
Duration: 60 Microseconds [2-3]
Destination: 22:86:8C:E5:E9:7E [4-9]
Source: AC:5F:3E:01:89:8C [10-15]
BSSID: 22:86:8C:E5:E9:7E [16-21]
Seq Number: 2013 [22-23 Mask 0xFFFF0]
Frag Number: 0 [22 Mask 0x0F]
802.11 Management - Deauthentication
  Deauthentication Reason Code: 7 Class 3 frame received from nonassociated station [
FCS - Frame Check Sequence
  FCS: 0x9C6826C0 [26-29]
0000: C0 00 3C 00 22 86 8C E5 E9 7E AC 5F 3E 01 89 8C 22 86 8C E5 E9
0021: 7E D0 7D 07 00 9C 68 26 C0
  ..<.....>.....
  ..})...h&
  
```

It seems as if the AP is allowing your client to Authenticate and Associate, and then a moment later, when the client starts sending real data traffic ("Class 3 frames"), the AP acts as if the client wasn't associated, and kicks it off the network (deauthenticates it).

Mobility 2_1 – Edge continued

Start Page 0601_CE2_walk21.pkt x

addr(ethernet:AC:5F:3E:01:89:8C)

Source	Destination	BSSID	F..	Chan...	Signal ...	Data R...	Noise dBm	Absolute Time	Protocol
.. 22:86:8C:D9:AF:06	AC:5F:3E:01:89:8C	22:86:8C:D9:AF:06	*	40	-89	6.0	-97	18:34:36.290306	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	22:86:8C:D9:AF:06		#	40	-57	6.0	-89	18:34:36.290355	802.11 Ack
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-39	6.0	-93	18:34:36.309930	802.11 Probe Req
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-39	6.0	-93	18:34:36.330129	802.11 Probe Req
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*+	40	-87	6.0	-90	18:34:36.331946	802.11 Probe Rsp
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*+	40	-88	6.0	-90	18:34:36.332375	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-39	6.0	-81	18:34:36.349963	802.11 Probe Req
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*	40	-87	6.0	-84	18:34:36.350964	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2		#	40	-39	6.0	-84	18:34:36.351440	802.11 Ack
.. 0C:54:A5:6E:D7:CA	AC:5F:3E:01:89:8C	0C:54:A5:6E:D7:CA	*	40	-90	6.0	-84	18:34:36.351965	802.11 Disassoc
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-39	6.0	-92	18:34:36.369332	802.11 Probe Req
.. 22:86:8C:D9:AF:06	AC:5F:3E:01:89:8C	22:86:8C:D9:AF:06	*	40	-88	6.0	-92	18:34:36.369990	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	22:86:8C:D9:AF:06		#	40	-38	6.0	-92	18:34:36.370014	802.11 Ack
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*	40	-88	6.0	-95	18:34:36.370436	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2		#	40	-38	6.0	-95	18:34:36.370511	802.11 Ack
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-38	6.0	-93	18:34:36.389017	802.11 Probe Req
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*C	40	-88	6.0	-92	18:34:36.390038	802.11 Probe Rsp
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*+	40	-89	6.0	-93	18:34:36.392218	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2		#	40	-38	6.0	-93	18:34:36.392234	802.11 Ack
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-38	6.0	-93	18:34:36.409235	802.11 Probe Req
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*	40	-87	6.0	-91	18:34:36.410060	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2		#	40	-37	6.0	-91	18:34:36.410076	802.11 Ack
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-37	6.0	-106	18:34:36.430083	802.11 Probe Req
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*	40	-87	6.0	-98	18:34:36.431127	802.11 Probe Rsp
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*+	40	-88	6.0	-84	18:34:36.432413	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-37	6.0	-91	18:34:36.449520	802.11 Probe Req
.. 22:86:8C:D9:AF:06	AC:5F:3E:01:89:8C	22:86:8C:D9:AF:06	*	40	-87	6.0	-94	18:34:36.450178	802.11 Probe Rsp
.. 00:0D:67:7B:81:E2	AC:5F:3E:01:89:8C	00:0D:67:7B:81:E2	*	40	-88	6.0	-92	18:34:36.451061	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-37	6.0	-90	18:34:36.470078	802.11 Probe Req
.. 0C:54:A5:6E:D7:CA	AC:5F:3E:01:89:8C	0C:54:A5:6E:D7:CA	*	40	-90	6.0	-92	18:34:36.472201	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-37	6.0	-89	18:34:36.490097	802.11 Probe Req
.. 22:86:8C:D9:AF:06	AC:5F:3E:01:89:8C	22:86:8C:D9:AF:06	*	40	-88	6.0	-96	18:34:36.490549	802.11 Probe Rsp
.. AC:5F:3E:01:89:8C	FF:FF:FF:FF:FF:FF	FF:FF:FF:FF:FF:FF	*	40	-37	6.0	-95	18:34:36.509878	802.11 Probe Req
.. 0C:54:A5:6E:D7:CA	AC:5F:3E:01:89:8C	0C:54:A5:6E:D7:CA	*+	40	-91	6.0	-93	18:34:36.511752	802.11 Probe Rsp
.. 0C:54:A5:6E:D7:CA	AC:5F:3E:01:89:8C	0C:54:A5:6E:D7:CA	*+	40	-91	6.0	-93	18:34:36.512018	802.11 Probe Rsp

Also before the Authentication took place, UE was not able to associate on the network. It send multiple Probe requests, but didn't receive any response. Also as seen from the screenshot the RSSI in downlink is very low. Indicating that the UE was in poor coverage area.

CE17 Loc 2 - Nperf – iPhone6s – Weak Indoor Signal

The screenshot shows a Wireshark interface with a packet list table and a packet details pane. The packet list table contains the following data:

Packet	Source	Destination	Flags	Ch...	Signal dBm	Data Rate	Noise dBm	Size	Absolute Time	Protocol	Application	Expert
1337853	172.20.20.20	17.155.127.223	A	153	-41	6.5	-110	82	12:59:38.166040	UDP	UDP	
1337854	84:00:2D:43:4F:71	00:56:CD:03:52:3A	#	153	-79	6.0	-101	32	12:59:38.166178	802.11 BA		
1337967	00:56:CD:03:52:3A	84:00:2D:43:4F:71	C	153	-42	24.0	-95	28	12:59:38.228290	802.11 Null Data		
1338117	172.20.20.20	75.75.75.75	+A	153	-42	6.5	-94	108	12:59:38.305011	DNS	DNS	
1338118	84:00:2D:43:4F:71	00:56:CD:03:52:3A	#	153	-80	6.0	-84	14	12:59:38.305049	802.11 Ack		
1338119	84:00:2D:43:4F:71	00:56:CD:03:52:3A	#	153	-80	6.0	-84	14	12:59:38.305684	802.11 Ack		
1338120	172.20.20.20	75.75.75.75	+A	153	-42	6.5	-84	93	12:59:38.306255	DNS	DNS	
1338121	00:56:CD:03:52:3A	84:00:2D:43:4F:71		153	-43	24.0	-84	28	12:59:38.306691	802.11 Null Data		
1338123	172.20.20.20	75.75.75.75	+A	153	-43	6.5	-83	114	12:59:38.307034	DNS	DNS	
1338124	84:00:2D:43:4F:71	00:56:CD:03:52:3A	#	153	-80	6.0	-84	14	12:59:38.307059	802.11 Ack		
1338126	00:56:CD:03:52:3A	00:56:CD:03:52:3A	#	153	-80	6.0	-85	14	12:59:38.307684	802.11 Ack		
1338129	172.20.20.20	75.75.75.75	+A	153	-43	6.5	-95	109	12:59:38.308311	DNS	DNS	
1338183	172.20.20.20	75.75.75.75	+A	153	-43	6.5	-85	97	12:59:38.323434	DNS	DNS	
1338184	84:00:2D:43:4F:71	00:56:CD:03:52:3A	*	153	-78	6.0	-84	37	12:59:38.324133	802.11 Action		
1338185	00:56:CD:03:52:3A	84:00:2D:43:4F:71	*	153	-70	6.0	-84	37	12:59:38.324253	802.11 Action		
1338186	84:00:2D:43:4F:71	00:56:CD:03:52:3A	#	153	-80	6.0	-83	14	12:59:38.324261	802.11 Ack		

The packet details pane shows the following information for the selected packet (1338186):

- Packet Number: 1325363
- Flags: 0x00000000
- Status: 0x00000000
- Packet Length: 124
- Timestamp: 12:59:33.964152900 06/23/2016
- Data Rate: 2 1.0 Mbps
- Channel: 1 2412MHz 802.11b

The packet bytes pane shows the following hex data:

```
0000: 40 00 00 00 FF FF FF FF FF 00 56 CD 03 52 3A FF FF FF FF @.....V..R:....
0021: FF 80 EA 00 07 58 46 49 4E 49 54 59 01 04 02 04 0B 16 32 08 0C .....XFINITY.....2..
0042: 12 18 24 30 48 60 6C 03 01 01 2D 1A 21 00 17 FF 00 00 00 00 00 ..$0H'l...-!.....
0063: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0084: 08 84 00 00 00 40 6B 07 0F FF FF FF FF FF DD 08 00 50 F2 08 .....@.....P..
0105: 00 10 00 00 DD 09 00 10 18 02 00 00 10 00 00 11 BB B1 14 .....@.....
```

All devices worked fine, however performance could have been better, as this area had coverage from indoor routers, which were bleeding out on the street, outdoor AP signal was relatively weaker (below -80dBm). Slow performance is due to indoor signal weak coverage on the street.

Here we can see iphone6 (52:3A) and indoor router (4f:71) are communicating on channel 153, which has poor signal strength around (-80dBm) from router. Packets communication is happening well, however throughput is suffering due to low signal strength. This is the common reason seen across some devices which camped on ch. 153 from this indoor router. Root cause for poor Wifi performance at this location is weak indoor signal.



CE15 Loc 2 - Nperf – iPhone6s+ – Poor Channel Selection

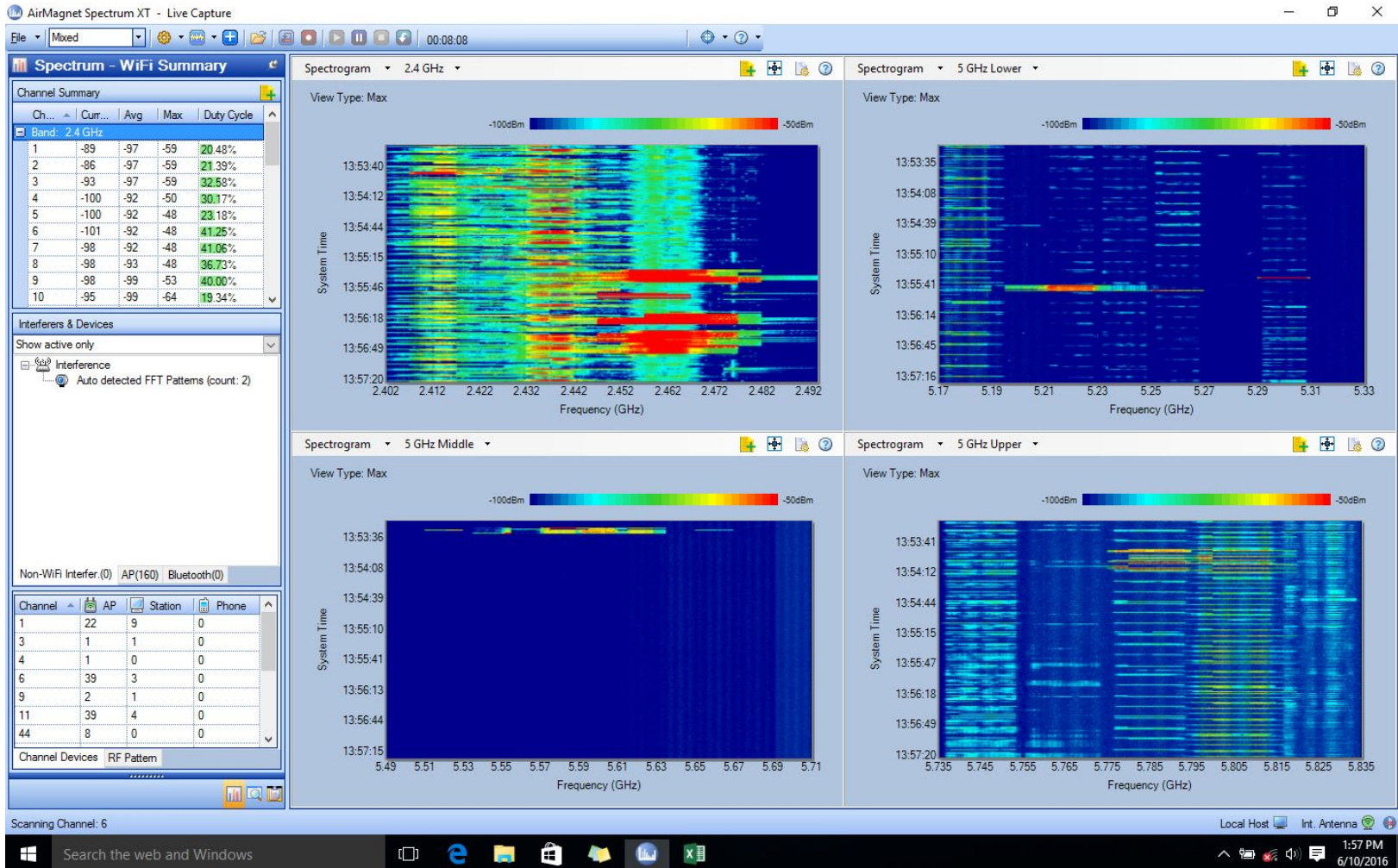
The screenshot shows a Wireshark capture of network traffic. The top pane displays a list of packets with columns for Packet, Source, Destination, Flags, Ch..., Signal dBm, Data Rate, Noise dBm, Size, Absolute Time, Protocol, Application, and Expert. The middle pane shows the details of the selected packet (802.11 MAC Header) with fields like Version, Type (Management), Subtype (Probe Request), and Frame Control Flags. The bottom pane shows the raw packet data in hexadecimal and ASCII.

Packet	Source	Destination	Flags	Ch...	Signal dBm	Data Rate	Noise dBm	Size	Absolute Time	Protocol	Application	Expert
249356	C0:7C:D1:D4:6E:7A	80:ED:2C:52:15:05	*	1	-63	1.0	-93	198	11:25:08.620341	802.11 Probe Rsp		
249357	80:ED:2C:52:15:05	C0:7C:D1:D4:6E:7A	#	1	-75	1.0	-104	14	11:25:08.620559	802.11 Ack		
249446	80:ED:2C:52:15:05	Ethernet Broadcast	*	1	-49	1.0	-91	128	11:25:08.685199	802.11 Probe Req		
249450	C0:7C:D1:D4:6E:7A	80:ED:2C:52:15:05	*	1	-63	1.0	-89	198	11:25:08.687284	802.11 Probe Rsp		
249453	C0:7C:D1:D4:6E:7A	80:ED:2C:52:15:05	*+	1	-64	1.0	-92	198	11:25:08.689281	802.11 Probe Rsp		Wireless AP - Too Many Retries
249455	C0:7C:D1:D4:6E:7A	80:ED:2C:52:15:05	*+	1	-62	1.0	-92	198	11:25:08.690554	802.11 Probe Rsp		
249461	C0:7C:D1:D4:6E:7A	80:ED:2C:52:15:05	*+	1	-64	1.0	-93	198	11:25:08.692616	802.11 Probe Rsp		
249572	80:ED:2C:52:15:05	Ethernet Broadcast	*	6	-50	1.0	-98	128	11:25:08.748520	802.11 Probe Req		
249598	80:ED:2C:52:15:05	Ethernet Broadcast	*	6	-49	1.0	-94	128	11:25:08.785505	802.11 Probe Req		
249600	00:71:C2:90:7A:52	80:ED:2C:52:15:05	*	6	-92	1.0	-92	182	11:25:08.787649	802.11 Probe Rsp		
249601	80:ED:2C:52:15:05	00:71:C2:90:7A:52	#	6	-50	1.0	-92	14	11:25:08.788000	802.11 Ack		
249606	00:71:C2:90:7A:52	80:ED:2C:52:15:05	*+	6	-73	1.0	-93	182	11:25:08.790871	802.11 Probe Rsp		
249607	80:ED:2C:52:15:05	00:71:C2:90:7A:52	#	6	-49	1.0	-93	14	11:25:08.791097	802.11 Ack		
249711	80:ED:2C:52:15:05	Ethernet Broadcast	*	11	-47	1.0	-90	128	11:25:08.940581	802.11 Probe Req		
249726	80:ED:2C:52:15:05	Ethernet Broadcast	*	11	-46	1.0	-83	128	11:25:08.954925	802.11 Probe Req		
249730	AE:34:26:16:0A:50	80:ED:2C:52:15:05	*	11	-76	1.0	-86	182	11:25:08.960931	802.11 Probe Rsp		
249732	AE:34:26:16:0A:50	80:ED:2C:52:15:05	*+	11	-72	1.0	-81	182	11:25:08.962991	802.11 Probe Rsp		Wireless AP - Too Many Retries
249734	AE:34:26:16:0A:50	80:ED:2C:52:15:05	*+	11	-73	1.0	-82	182	11:25:08.965176	802.11 Probe Rsp		

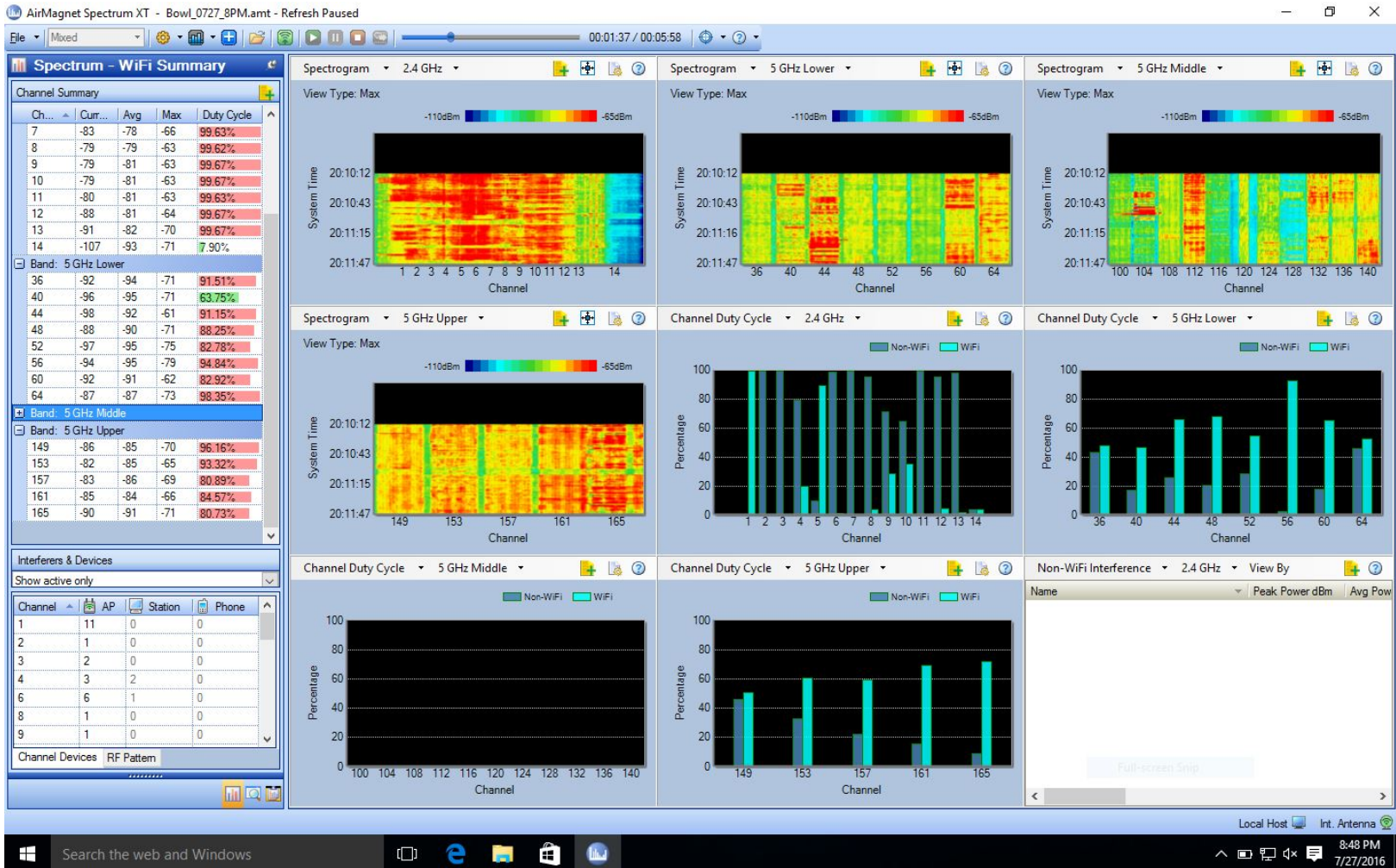
At this location, channel 11 and 157 are dominant channels as best server. However, device tried to connect to channel 1 which seems to be some indoor router coverage from above residential floors reaching inside shop, and it is not able to get the IP due to multiple probe requests on this channel. It is able to get probe response, but not able to get IP assigned. It will try to connect to other similar poor channel/AP (e.g. 6) as seen in attached screenshot in PPT. But it fails to connect to dominant channels ch. 11 and 157.

Here we can see iPhone6s+ (15:05) device was not able to get any authentication messages after getting probe response on channel 1 and then it tries to connect to channel 6 and other multiple channels, it was only this device which is trying to connect to channel 1 and it is not able to get the IP. So Poor channel selection is the reason.

Spectrum Sample – non-busy 5 GHz



Spectrum Sample – All channels full



Apple Logs Sample – Developer Account required

```
06/23/16 13:25:26.934 <NOTICE>: Attempting Apple80211ScanAsync on en0
06/23/16 13:25:27.203 <NOTICE>: __WiFiLQAMgrLogStats: Rssi: -86 Cca: 56 TxPer: 100.0% (3) BcnPer: 58.6% (29) RxFrms 0 TxRate: 13000 RxRate: 4294967295
06/23/16 13:25:27.203 <DEBUG>: Boolean __WiFiLQAMgrCheckTriggerDisconnect(WiFiLQAMgrRef, CFIndex, CFIndex):__WiFiLQAMgrCheckTriggerDisconnect: Better inf not available
06/23/16 13:25:29.604 <DEBUG>: Boolean __WiFiLQAMgrCheckTriggerDisconnect(WiFiLQAMgrRef, CFIndex, CFIndex):__WiFiLQAMgrCheckTriggerDisconnect: Better inf not available
06/23/16 13:25:30.557 <NOTICE>: Completed Apple80211ScanAsync on en0 (0x0)
06/23/16 13:25:30.576 <NOTICE>: Async scan request completed for "AirPort" (0)
06/23/16 13:25:31.810 <NOTICE>: Async scan requested by "AirPort" for 0 iterations with maxage=0 priority normal on en0
06/23/16 13:25:31.811 <NOTICE>: Enqueuing command type: "Scan" pending commands: 0
06/23/16 13:25:31.811 <NOTICE>: Dequeuing command type: "Scan" pending commands: 0
06/23/16 13:25:31.811 <NOTICE>: Attempting Apple80211ScanAsync on en0
06/23/16 13:25:32.204 <DEBUG>: Boolean __WiFiLQAMgrCheckTriggerDisconnect(WiFiLQAMgrRef, CFIndex, CFIndex):__WiFiLQAMgrCheckTriggerDisconnect: Better inf not available
06/23/16 13:25:35.427 <NOTICE>: Completed Apple80211ScanAsync on en0 (0x0)
06/23/16 13:25:35.448 <NOTICE>: Async scan request completed for "AirPort" (0)
06/23/16 13:25:36.841 <NOTICE>: Async scan requested by "AirPort" for 0 iterations with maxage=0 priority normal on en0
06/23/16 13:25:36.842 <NOTICE>: Enqueuing command type: "Scan" pending commands: 0
06/23/16 13:25:36.842 <NOTICE>: Dequeuing command type: "Scan" pending commands: 0
06/23/16 13:25:36.842 <NOTICE>: Attempting Apple80211ScanAsync on en0
06/23/16 13:25:37.210 <NOTICE>: __WiFiLQAMgrLogStats: Rssi: -80 Cca: 59 TxPer: 100.0% (3) BcnPer: 41.2% (34) RxFrms 0 TxRate: 13000 RxRate: 4294967295
06/23/16 13:25:37.210 <DEBUG>: Boolean __WiFiLQAMgrCheckTriggerDisconnect(WiFiLQAMgrRef, CFIndex, CFIndex):__WiFiLQAMgrCheckTriggerDisconnect: Better inf not available
06/23/16 13:25:40.469 <NOTICE>: Completed Apple80211ScanAsync on en0 (0x0)
06/23/16 13:25:40.486 <NOTICE>: Async scan request completed for "AirPort" (0)
06/23/16 13:25:41.386 <NOTICE>: Async scan requested by "AirPort" for 0 iterations with maxage=0 priority normal on en0
06/23/16 13:25:41.386 <NOTICE>: Enqueuing command type: "Scan" pending commands: 0
06/23/16 13:25:41.387 <NOTICE>: Dequeuing command type: "Scan" pending commands: 0
06/23/16 13:25:41.387 <NOTICE>: Attempting Apple80211ScanAsync on en0
06/23/16 13:25:42.215 <NOTICE>: __WiFiLQAMgrLogStats: Rssi: -80 Cca: 61 TxPer: 100.0% (3) BcnPer: 52.9% (17) RxFrms 0 TxRate: 6500 RxRate: 4294967295
06/23/16 13:25:42.216 <DEBUG>: Boolean __WiFiLQAMgrCheckTriggerDisconnect(WiFiLQAMgrRef, CFIndex, CFIndex):__WiFiLQAMgrCheckTriggerDisconnect: Better inf not available
06/23/16 13:25:45.007 <NOTICE>: Completed Apple80211ScanAsync on en0 (0x0)
06/23/16 13:25:45.035 <NOTICE>: Async scan request completed for "AirPort" (0)
06/23/16 13:25:46.235 <NOTICE>: Async scan requested by "AirPort" for 0 iterations with maxage=0 priority normal on en0
06/23/16 13:25:46.235 <NOTICE>: Enqueuing command type: "Scan" pending commands: 0
06/23/16 13:25:46.236 <NOTICE>: Dequeuing command type: "Scan" pending commands: 0
06/23/16 13:25:46.236 <NOTICE>: Attempting Apple80211ScanAsync on en0
06/23/16 13:25:47.217 <NOTICE>: __WiFiLQAMgrLogStats: Rssi: -80 Cca: 60 TxPer: 0.0% (0) BcnPer: 0.0% (0) RxFrms 0 TxRate: 0 RxRate: 0
06/23/16 13:25:47.217 <DEBUG>: Boolean __WiFiLQAMgrCheckTriggerDisconnect(WiFiLQAMgrRef, CFIndex, CFIndex):__WiFiLQAMgrCheckTriggerDisconnect: Better inf not available
06/23/16 13:25:49.845 <NOTICE>: Completed Apple80211ScanAsync on en0 (0x0)
06/23/16 13:25:49.864 <NOTICE>: Async scan request completed for "AirPort" (0)
```

Read more here by Ryan Adzima:

<https://community.arubanetworks.com/t5/Technology-Blog/Tools-for-Troubleshooting-from-the-Client-Revisited/bc-p/275482#M1183>

AirCheck Data

The screenshot displays the AirCheck Manager interface with the following components:

- Top Bar:** File, Edit, View, AirCheck, Help
- Left Panel:**
 - AirCheck:** Status: Disconnected; View: Profile, Date/Time
 - Local Disk:** C:\Users\kraq... \Fluke Aircheck

View	File	Profile	Date/Time
✓	C262F000	Default	8/30/2016...
✓	C262F150	Default	8/30/2016...
✓	C262F200	Default	8/30/2016...
✓	C262F250	Default	8/30/2016...
✓	C262S075	Default	8/30/2016...
✓	C262S100	Default	8/30/2016...
✓	C262S125	Default	8/30/2016...
- Main Panel: AutoTest Results**
 - Session Name: C262F000 | Profile: Default | Date/Time: 8/30/2016 4:30:55 PM
 - All Details:**
 - ✓ Air Quality
 - ⚠ Network Quality
 - ⚠ SSID: ATT7s2v317
 - ⚠ Coverage: No Access Points with acceptable signal quality
 - ✓ Interference: No interfering Access Points detected
 - ⊗ Security: No Access Points discovered
 - ⊗ Connection: Not Tested
 - ✓ SSID: xfinitywifi
 - ⚠ SSID: HOME-99EE
 - ⚠ Coverage: No Access Points with acceptable signal quality
 - ✓ Interference: No interfering Access Points detected
 - ⊗ Security: No Access Points discovered
 - ⊗ Connection: Not Tested
 - ⚠ SSID: HOME-9998
 - ⚠ Coverage: 1 Access Point(s) with marginal signal quality
 - ✓ Interference: No interfering Access Points detected
 - ⊗ Security: No Access Points discovered
 - ⊗ Connection: Not Tested
 - ✓ SSID: CPS
 - ⚠ SSID: CPSS1245
 - ⚠ Coverage: 3 Access Point(s) with marginal signal quality
 - ✓ Interference: No interfering Access Points detected
 - ⊗ Security: No Access Points discovered
 - ⊗ Connection: Not Tested
 - ⚠ SSID: HOME-744A-2.4
 - ⚠ Coverage: No Access Points with acceptable signal quality
 - ✓ Interference: No interfering Access Points detected
 - ⊗ Security: No Access Points discovered
 - ⊗ Connection: Not Tested
 - ⚠ SSID: CPSS8022
 - ⚠ Coverage: 2 Access Point(s) with marginal signal quality
 - ✓ Interference: No interfering Access Points detected
 - ⊗ Security: No Access Points discovered
 - ⊗ Connection: Not Tested
 - ⚠ SSID: ATT4z9w5h6
 - ⚠ Coverage: 1 Access Point(s) with marginal signal quality
 - ✓ Interference: No interfering Access Points detected
 - ⊗ Security: No Access Points discovered
 - ⊗ Connection: Not Tested
 - ⚠ SSID: HOME-64C2
 - ⚠ Coverage: No Access Points with acceptable signal quality
 - ✓ Interference: No interfering Access Points detected
 - ⊗ Security: No Access Points discovered
 - Summary:**
 - ✗ Fail: 0
 - ⚠ Warning: 22
 - Thresholds:**
 - 802.11 Channel Utilization:**
 - ✗ Fail: 802.11 > 85%
 - ⚠ Warning: 802.11 > 50%
 - ✓ Pass: 802.11 <= 50%
 - Non-802.11 Channel Utilization:**
 - ✗ Fail: Non-802.11 > 65%
 - ⚠ Warning: Non-802.11 > 30%
 - ✓ Pass: Non-802.11 <= 30%
 - Co-Channel Interference:**
 - ✗ Fail: More than 12 Access Point(s) with Signal Level >= -75 dBm on same channel
 - ⚠ Warning: More than 4 Access Point(s) with Signal Level >= -75 dBm on same channel
 - ✓ Pass: No more than 4 Access Point(s) with Signal Level >= -75 dBm on same channel
 - Network Coverage:**
 - ✗ Fail: No Access Points discovered or no Access Points with Signal Level >= -85 dBm and Signal Quality >= 10 dB
 - ⚠ Warning: At least one Access Point with Signal Level >= -85 dBm and Signal Quality >= 10 dB
 - ✓ Pass: At least 1 Access Point(s) with Signal Level >= -70 dBm and Signal Quality >= 25 dB
 - Network Co-Channel Interference:**
 - ✗ Fail: More than 10 Access Point(s) with Signal Level >= -75 dBm on same channel
 - ⚠ Warning: More than 3 Access Point(s) with Signal Level >= -75 dBm on same channel
 - ✓ Pass: No more than 3 Access Point(s) with Signal Level >= -75 dBm on same channel
 - Connection Retry Rate:**
 - ✗ Fail: Retry Rate > 50%
 - ⚠ Warning: Retry Rate > 40%
 - ✓ Pass: Retry Rate <= 40%
 - Connection Packet Rate:**
 - ✗ Fail: Actual Packet Rate < 10% of Access Point maximum supported Tx rate
 - ⚠ Warning: Actual Packet Rate < 30% of Access Point maximum supported Tx rate
 - ✓ Pass: Actual Packet Rate >= 30% of Access Point maximum supported Tx rate

AirCheck Data

The screenshot displays the Fluke Networks AirCheck Manager interface. The main window is titled "Channels" and shows a summary of channel utilization for session C262F000. The session details include: Name: C262F000, Profile: Default, Date/Time: 8/30/2016 4:30:52 PM.

Summary statistics for the selected channel (Channel 1, 2.412 GHz):

- Total Utilization (%): Last: 22, Average: 10
- 802.11 Utilization (%): Last: 21, Average: 10
- Non-802.11 Utilization (%): Last: 1, Average: 0

The "All Details" section contains a table with the following columns: Channel, Total (average %), Total (last %), 802.11 (average %), 802.11 (last %), Non-802.11 (average %), Non-802.11 (last %), Access Point Count, Client Count, Duplicate SSIDs, and Date/Time.

Channel	Total (average %)	Total (last %)	802.11 (average %)	802.11 (last %)	Non-802.11 (average %)	Non-802.11 (last %)	Access Point Count	Client Count	Duplicate SSIDs	Date/Time
1 (2.412GHz)	10	22	10	21	0	1	9	0	1	8/30/2016 4:30 PM
2 (2.417GHz)	7	10	6	10	1	0	0	0	0	8/30/2016 4:30 PM
3 (2.422GHz)	4	2	3	1	1	1	0	0	0	8/30/2016 4:30 PM
4 (2.427GHz)	7	3	5	1	2	2	0	0	0	8/30/2016 4:30 PM
5 (2.432GHz)	11	7	10	7	1	0	0	0	0	8/30/2016 4:30 PM
6 (2.437GHz)	36	50	34	46	2	4	15	0	2	8/30/2016 4:30 PM
7 (2.442GHz)	7	10	7	9	0	1	0	0	0	8/30/2016 4:30 PM
8 (2.447GHz)	0	1	0	0	0	1	0	0	0	8/30/2016 4:30 PM
9 (2.452GHz)	4	8	4	8	0	0	1	0	0	8/30/2016 4:30 PM
10 (2.457GHz)	3	4	3	4	0	0	0	0	0	8/30/2016 4:30 PM
11 (2.462GHz)	20	11	20	10	0	1	10	0	2	8/30/2016 4:30 PM
12 (2.467GHz)	5	11	5	11	0	0	0	0	0	8/30/2016 4:30 PM
13 (2.472GHz)	1	2	0	1	1	1	0	0	0	8/30/2016 4:30 PM
14 (2.484GHz)	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
34 (5.170GHz)	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
36 (5.180GHz)	0	0	0	0	0	0	1	0	0	8/30/2016 4:30 PM
38 (5.190GHz)	0	1	0	1	0	0	0	0	0	8/30/2016 4:30 PM
40 (5.200GHz)	0	0	0	0	0	0	1	0	0	8/30/2016 4:30 PM
42 (5.210GHz)	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
44 (5.220GHz)	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
46 (5.230GHz)	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
48 (5.240GHz)	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
52 (5.260GHz)	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
56 (5.280GHz)	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
60 (5.300GHz)	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
64 (5.320GHz)	0	0	0	0	0	0	1	0	0	8/30/2016 4:30 PM
100 (5.500G...	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
104 (5.520G...	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM
108 (5.540G...	0	0	0	0	0	0	0	0	0	8/30/2016 4:30 PM

AirCheck Data

Fluke Networks AirCheck Manager

File Edit View AirCheck Help

AirCheck Status: **Disconnected**

View File Profile Date/Time

Profile Setup Session Data

Session Details AutoTest Channels Access Points Clients Connection Details

Access Points

Access Point

SSID: 2_xfinitywifi_CU26-2 802.11 Types: b,g,n
 MAC: 00:0D:67:6F:72:BC Channel: 1 (2.412GHz)
 BSSID: 00:0D:67:6F:72:BC Extension Channel: N/A
 Vendor: Ericson Discovered Clients: 0
 Name: AP Reported Clients: --
 ACL: Unknown Supported Rates: 5 - 216 Mbps
 Mode: Infrastructure

Security: No Security

Notes

Associated Clients First Heard: 8/30/2016 4:30:24 PM

Last Signal Strength
 Signal Strength: -48 dBm SNR: 43 dB

Session Name: C262F000 Profile: Default Date/Time: 8/30/2016 4:30:52 PM

All Details Export

MAC	SSID	Vendor	Name	Authorization (ACL)	Channel	Mode	Type	Discover Clients	AP Reported Clients	First Heard	Last Signal Strength	Last SNR Level	Supported Rates	Extension Channel	Notes	Security	AP Cou Sett
00:0D:67:85:A5:F2	xfinitywifi	Ericson		Unknown	11	Infrastructure	b,g,n	0	--	8/30/2016 4:30 PM	-83 dBm	8 dB	5 - 216 Mbps	N/A		No Security	USO
EC:AA:A0:6C:C9:4A	xfinitywifi			Unknown	6	Infrastructure	b,g,n	0	--	8/30/2016 4:30 PM	-84 dBm	9 dB	1 - 216 Mbps	N/A		No Security	US
26:73:55:FE:64:C0	xfinitywifi	Arris		Unknown	11	Infrastructure	b,g,n	0	1	8/30/2016 4:30 PM	-85 dBm	7 dB	1 - 144 Mbps	N/A	40 MHz 802.11n is ...	No Security	US
06:1D:D6:00:02:60	xfinitywifi	Arris		Unknown	11	Infrastructure	b,g,n	0	2	8/30/2016 4:30 PM	-85 dBm	6 dB	1 - 144 Mbps	N/A	40 MHz 802.11n is ...	No Security	US
00:0D:67:6F:72:B4	xfinitywifi	Ericson		Unknown	161	Infrastructure	a,n	0	--	8/30/2016 4:30 PM	-40 dBm	55 dB	6 - 450 Mbps	157		No Security	USO
00:0D:67:6F:6F:4C	xfinitywifi	Ericson		Unknown	1	Infrastructure	b,g,n	0	--	8/30/2016 4:30 PM	-78 dBm	16 dB	5 - 216 Mbps	N/A		No Security	USO
00:0D:67:6F:7C:A0	xfinitywifi	Ericson		Unknown	161	Infrastructure	a,n	0	--	8/30/2016 4:30 PM	-86 dBm	9 dB	6 - 450 Mbps	157		No Security	USO
EC:AA:A0:8A:BD:CA	xfinitywifi			Unknown	6	Infrastructure	b,g,n	0	--	8/30/2016 4:30 PM	-88 dBm	9 dB	1 - 216 Mbps	N/A		No Security	US
00:0D:67:82:F2:AA	xfinitywifi	Ericson		Unknown	153	Infrastructure	a,n	0	--	8/30/2016 4:30 PM	-89 dBm	6 dB	6 - 450 Mbps	149		No Security	USO
00:0D:67:6F:6F:44	xfinitywifi	Ericson		Unknown	161	Infrastructure	a,n	0	--	8/30/2016 4:30 PM	-84 dBm	11 dB	6 - 450 Mbps	157		No Security	USO
CE:35:40:D7:C7:B1	xfinitywifi	Techni		Unknown	1	Infrastructure	b,g,n	0	--	8/30/2016 4:30 PM	-81 dBm	10 dB	1 - 216 Mbps	N/A		No Security	USO
00:0D:67:23:38:D2	xfinitywifi	Ericson		Unknown	153	Infrastructure	a,n	0	--	8/30/2016 4:30 PM	-88 dBm	7 dB	6 - 450 Mbps	149		No Security	USO
AE:34:26:9A:55:A8	xfinitywifi			Unknown	6	Infrastructure	b,g,n	0	--	8/30/2016 4:30 PM	-86 dBm	8 dB	1 - 216 Mbps	N/A		No Security	US
00:0D:67:75:9A:EE	xfinitywifi	Ericson		Unknown	161	Infrastructure	a,n	0	--	8/30/2016 4:30 PM	-87 dBm	8 dB	6 - 450 Mbps	157		No Security	USO
00:0D:67:75:9A:ED	xfinitywifi	Ericson		Unknown	161	Infrastructure	a,n	0	--	8/30/2016 4:30 PM	-88 dBm	7 dB	6 - 450 Mbps	157		WPA2-E(AES-CC...	USO
00:0D:67:82:F2:A9	XFINITY	Ericson		Unknown	153	Infrastructure	a,n	0	--	8/30/2016 4:30 PM	-91 dBm	4 dB	6 - 450 Mbps	149		WPA2-E(AES-CC...	USO
00:0D:67:6F:6F:4B	XFINITY			Unknown	1	Infrastructure	b,g,n	0	--	8/30/2016 4:30 PM	-80 dBm	14 dB	5 - 216 Mbps	N/A		WPA2-E(AES-CC...	USO

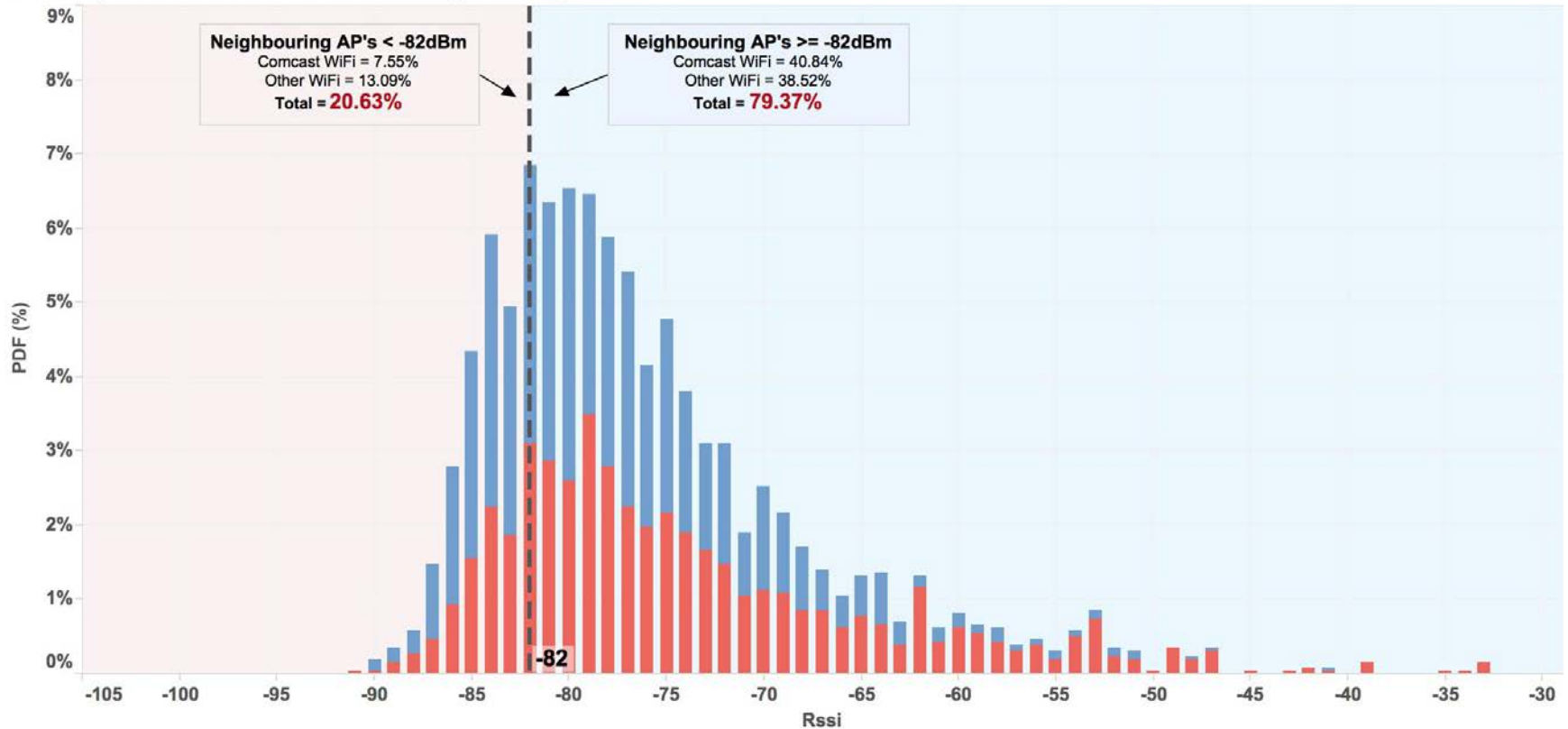
Local Disk C:\Users\kraq...Fluke Aircheck

View File Profile Date/Time

- C262F000 Default 8/30/2016...
- C262F150 Default 8/30/2016...
- C262F200 Default 8/30/2016...
- C262F250 Default 8/30/2016...
- C262S075 Default 8/30/2016...
- C262S100 Default 8/30/2016...
- C262S125 Default 8/30/2016...

Focus of control

RF Survey Scan of 2.4GHz Co-Channel Neighbouring BSSID's



WiFi Network Distribution
Other WiFi (Blue) Comcast WiFi (Red)



COMCAST