

# Proactive WiFi Testing and Monitoring

(aka Continuous Validation Testing)

Zaib Kaleem  
@WLANBook  
Work at @AccessAgility

zaib@accessagility.com  
703-870-3949 ext 140



IT Professional Wi-Fi Trek 2016



# Agenda

-  Design
-  Survey
-  Install

1



Verify: Validation Testing  
From Client Perspective

2



Verify: Automated Validation Testing  
Using Software Agents

3



# WiFi Survey Rig / AP on a Stick Setup Anyone?



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# Our Typical Design / Survey Process

## Design Based On

- # of users
- # and types of devices
- Applications
- Use cases
- Floor plans
- Existing network details
- Model Network / AP Placement

## Site / RF Survey

- Usually performed once before install
- Verify floor plan
- Verify building materials
- Verify RF characteristics
- Perform RF site survey (AP on a Stick)
- Access point mounting options
- Cable paths
- Data closet locations
- Measure spectrum



# Install Plan



Design

+



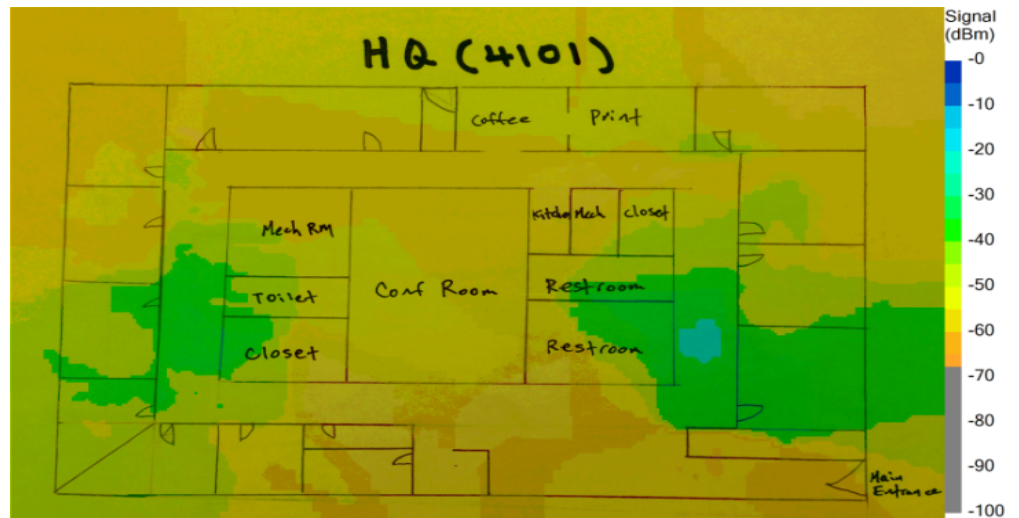
Survey

=



Install Plan

- Take the design, tweak it with survey information and observations, in order to create the install plan.



Early on our own best practices was to design, survey, and collect RF validation and limited or no client testing.



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## Why Validation Is Needed: Confirm Install Will Meet Performance Requirements

### Ideal

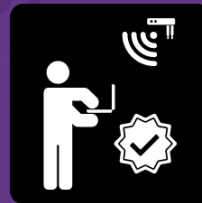
- Use all Design/Survey recommendations
- Equipment type
- Equipment quantity
- Equipment location
- Mounting types
- Access to all areas
- Perfect software models
- Unlimited budget!!!
- Clients behave the same as laptop/survey tool and USB adapter

### Actual

- Adjust design and survey for install limitations
- Can't use that room!
- This wall wasn't in floor plan
- Data closet issues - space, power, switch ports, etc
- Customer special requests (dont mount that over my desk!)
- Installers didn't follow install plan
- Software modeling not 100% reliable
- Budget ☹️
- **Client behavior can be very different compared to survey / design tools**



# Validation Testing From Client Perspective



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# Client Perspective – Why Is It Important?

- Test with what will be used on network
  - Laptop / Mobile
  - Device model
  - OS type and version
  - Client power
  - Chipset capability

5 Minute Avg. RSSI Measurement

Test Device	Min	Max	Diff	Avg
NetScout AirCheck	56	57	1	56.5
Proxim 8494	53	63	10	58
Macbook 12" - Windows Bootcamp	58	62	4	60
Macbook 12" - OS X	59	67	8	63
iPad Pro 9.7"	60	67	7	63.5
Macbook Air 11" - OS X	64	70	6	67
Samsung Tablet	68	71	3	69.5
iPad Mini	67	73	6	70
GoogleFi Phone	69	72	3	70.5
iPhone 6+	71	78	7	74.5

Table from <http://www.wlanpros.com/compensatenotcalibrate/>



## Validate Network & Clients

- Signal/RSSI is a must
  - Measure client hears AP
  - Measure how AP hears client
    - `show controllers dot1 radio 1 | begin RSSI**`
  - Next step is to collect actual network performance measurements
    - Latency
    - Speed up/down
    - DNS
    - Voice Quality



Cisco command line protip and image  
credit George Stefanick @wirelessguru



# Laptop + Utilities for Validation Testing

- Utilities / Apps for measuring validation metrics
  - Operating system adapter info
  - Ping
  - DHCPing
  - Speed Testers
  - DNS Query Tool
  - WiFi Scanners (\$)
  - Survey Apps (\$\$\$)



Selected 2013 Retina MacBook Pro for this presentation

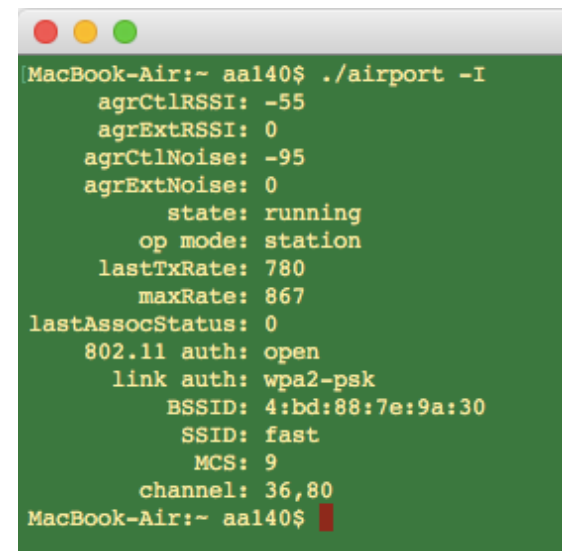
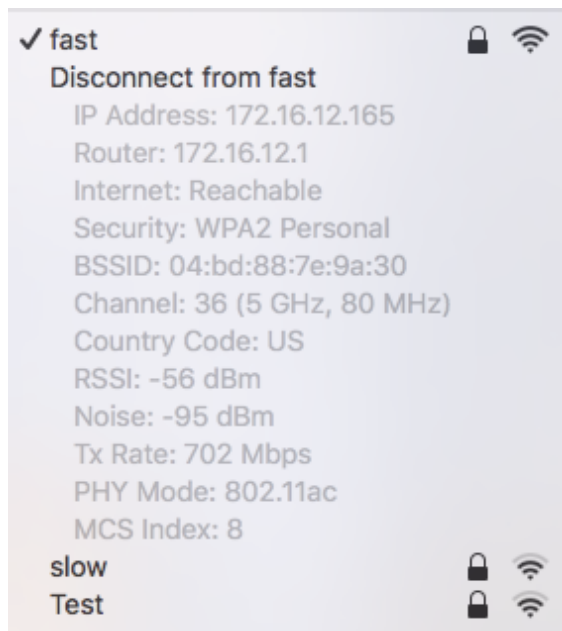
- Built in WiFi Cards
- Easy to find tools for testing
- Audience will be able to duplicate results at work / home



# Connected Client Network Measurements

MacBook Pro airport icon drop down information or airport command

- Signal Strength
- Connected BSSID
- Connected Channel
- Noise level
- Windows netsh command
- WiFi Scanner app (\$)
- Airport utility iOS



# LAN/WAN Reachability and Predict VoIP Quality

- Impact Voice Quality
  - Latency
  - Jitter
  - Packet Loss
- MOS (Mean Opinion Score)
  - 1 poor, 5 excellent
  - 4.2 – 4.4 very good and expected for good networks
  - can be estimated from ping results because we know latency, jitter, packet loss

```
MacBook-Air:~ aal40$ ping -c 5 172.16.12.1
PING 172.16.12.1 (172.16.12.1): 56 data bytes
64 bytes from 172.16.12.1: icmp_seq=0 ttl=64 time=2.121 ms
64 bytes from 172.16.12.1: icmp_seq=1 ttl=64 time=2.080 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=64 time=2.126 ms
64 bytes from 172.16.12.1: icmp_seq=3 ttl=64 time=1.694 ms
64 bytes from 172.16.12.1: icmp_seq=4 ttl=64 time=1.473 ms

--- 172.16.12.1 ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 1.473/1.899/2.126/0.267 ms
MacBook-Air:~ aal40$
```

```
MacBook-Air:~ aal40$ ping -c 5 google.com
PING google.com (172.217.4.238): 56 data bytes
64 bytes from 172.217.4.238: icmp_seq=0 ttl=57 time=23.333 ms
64 bytes from 172.217.4.238: icmp_seq=1 ttl=57 time=25.426 ms
64 bytes from 172.217.4.238: icmp_seq=2 ttl=57 time=24.929 ms
64 bytes from 172.217.4.238: icmp_seq=3 ttl=57 time=24.918 ms
64 bytes from 172.217.4.238: icmp_seq=4 ttl=57 time=24.438 ms

--- google.com ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 23.333/24.609/25.426/0.710 ms
MacBook-Air:~ aal40$
```



# DNS Performance Measurement

- Dig command - dig (domain information groper) is a network administration command-line tool for querying Domain Name System (DNS) servers.
- Basic lookup
- **dig google.com** returns IP address of hostname and query time

```
aa140 ~ -bash - 80x24
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 41554
;; flags: qr rd ra; QUERY: 1, ANSWER: 8, AUTHORITY: 0, ADDITIONAL: 0

;; QUESTION SECTION:
;google.com.                IN      A

;; ANSWER SECTION:
google.com.                251     IN      A      63.88.73.24
google.com.                251     IN      A      63.88.73.20
google.com.                251     IN      A      63.88.73.21
google.com.                251     IN      A      63.88.73.27
google.com.                251     IN      A      63.88.73.23
google.com.                251     IN      A      63.88.73.26
google.com.                251     IN      A      63.88.73.25
google.com.                251     IN      A      63.88.73.22

;; Query time: 21 msec
;; SERVER: 172.16.12.1#53(172.16.12.1)
;; WHEN: Sun Sep 25 21:06:14 2016
;; MSG SIZE rcvd: 156

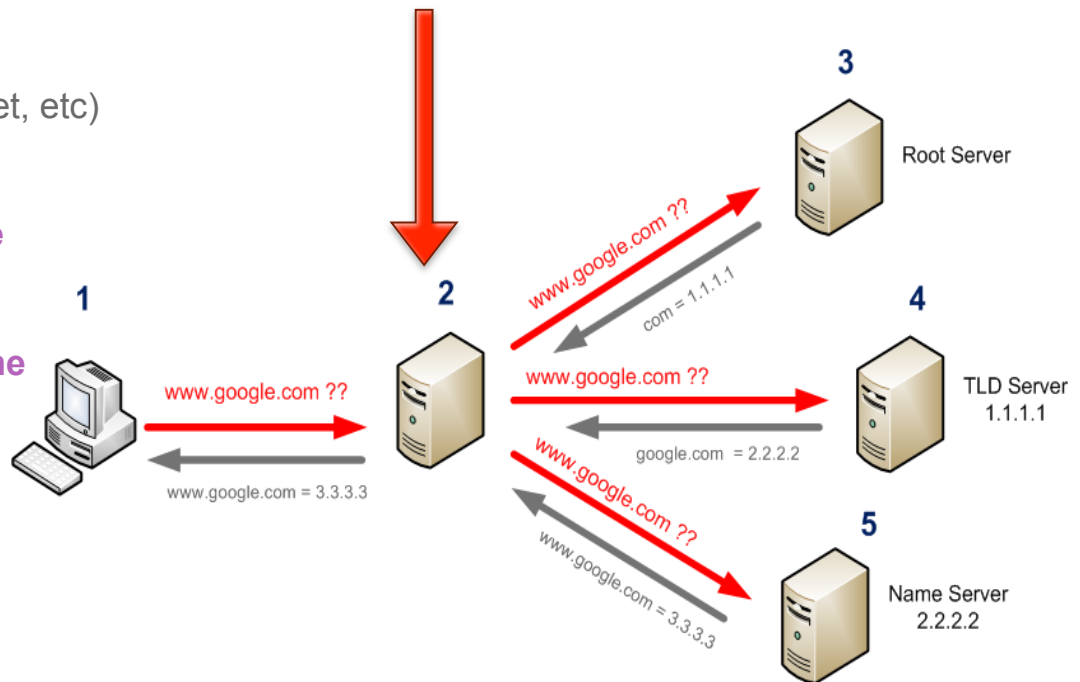
MacBook-Air:~ aa140$
```



# DNS Hostname Recursive Lookup Process

1. Client
2. Local DNS / ISP DNS Server
3. Root Server
4. Top Level Domain Server (.com, .net, etc)
5. domain name server (domain.com)

99% of the time end user experience is based on performance of server #2 and how well it returns future lookups after initial lookup and cache



# DHCP Server Availability / Performance Measurement

- **dhcping** – sends a DHCP request to DHCP server to see if it is up and running
  1. Find DHCP server on your network
  2. DHCP response time

```
MacBook-Air:~ aal40$ sudo dhcping -s 255.255.255.255 -r -v
Got answer from: 172.16.12.1
received from 172.16.12.1, expected from 255.255.255.255
no answer
MacBook-Air:~ aal40$
```

```
MacBook-Air:~ aal40$ time sudo dhcping -s 172.16.12.1
Got answer from: 172.16.12.1

real    0m0.111s
user    0m0.008s
sys     0m0.011s
MacBook-Air:~ aal40$
```



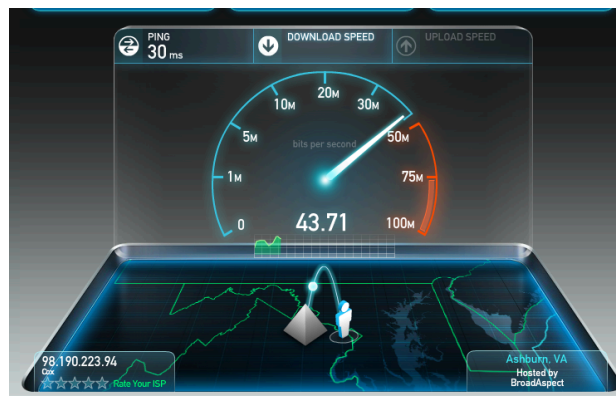


# Speed Tests

- Download
- Upload

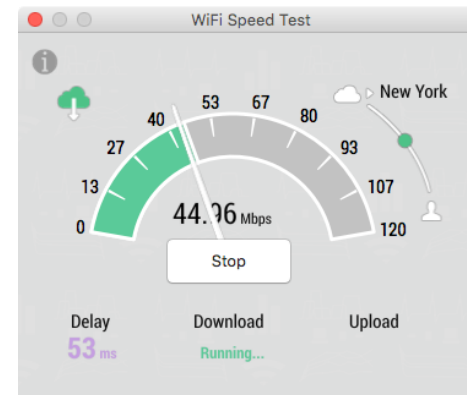
Make sure you understand how speed test site / service operates and calculates results.

Speedtest.net



Speedtest.net opens multiple connections to test servers which are located at ISP close to your Internet gateway

WiFi Speed Test App on Mac App Store



WiFi Speed Test app supports local LAN speed testing (requires configuring php script for up/down speed testing)



# Scale Manual Process to Validate Entire Network



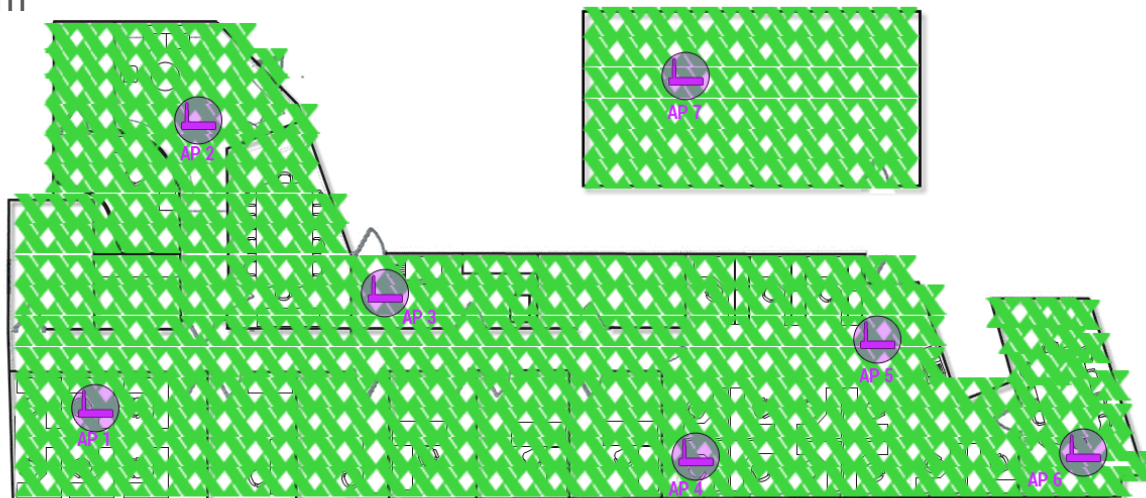
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Certirek

# Ideal Validation Conditions



= testing location

- Unlimited number of tests
- Unlimited locations to test from (every last inch...)
- Constant data to account for the variations that occur
- Test in peak usage times
- Test with every device
- Nothing in the building ever changes

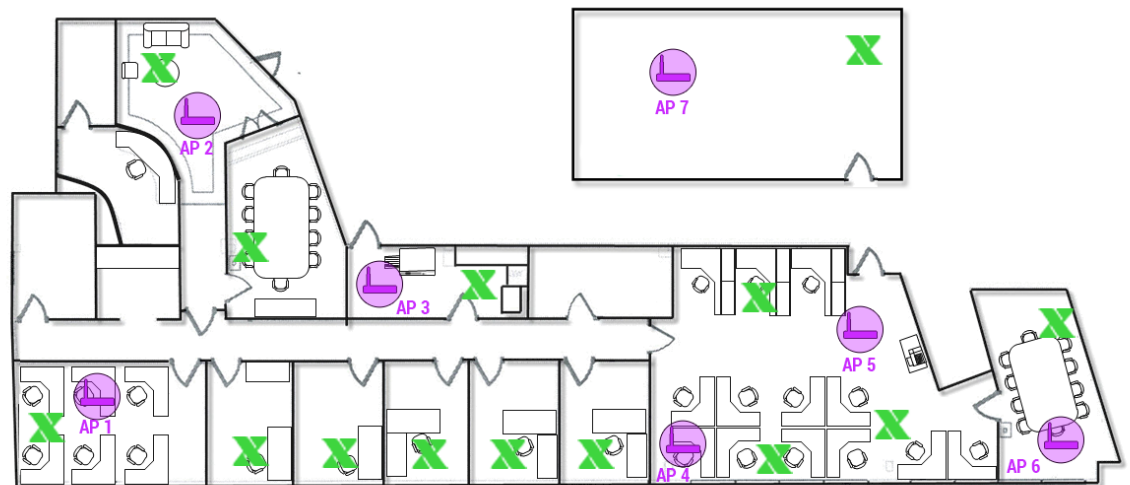


# Practical Validation Conditions

Choose your validation spots wisely to maximize the benefits of the results

- Possible problem areas?
- Roaming points between APs?
- High volume areas?
- Important rooms?

We chose 14 spot locations for the 7 APs in this small office.



# Record WiFi Network Validation Measurements

- Signal Coverage
- Noise
- Channel Plan
- Local and Internet Speed Test
- LAN / WAN Delay
- DNS Performance
- DHCP Server Availability
- Application Testing

	A	B	C	D	E	F	G	H	I	J	K
1	Client	Location	BSSID	Channel	Signal	Noise	LAN Ping	WAN Ping	DNS	Download	Upload
2	MacBook Pro	Front Cubes	02:18:5A:5A:64:61	149	-38	-88	1.322	96.723	36	41.93	35.87
3							6.849	97.073	97	42.61	15.88
4							3.848	98.648	42	44.6	28.39
5							1.363	96.103	154	39.72	31.78
6							12.365	93.809	43	40.87	17.01
7											
8	MacBook Pro	Conference Room	02:18:5A:5A:64:61	149	-61	-91	131.988	19.685	75	42.11	25.47
9							1.288	19.736	88	39.83	19.73
10							1.368	19.697	44	43.14	12.74
11							3.961	19.965	44	38.14	24.91
12							1.406	134.873	198	42.91	27.13
13											
14	MacBook Pro	Back Cubes	02:18:5A:5A:35:F1	100	-48	-88	53.746	19.9	41	43.67	37.26
15							104.202	20.608	43	43.68	24.41
16							1.444	19.781	46	41	24.61
17							1.175	22.305	48	43.55	24.42
18							4.054	22.419	43	43.76	29.14



# Set Thresholds

- Acceptable, Warning, Unacceptable
- Are you happy with Signal strength and coverage?
- Are the speeds you found reasonable/expected?
- Any outliers?
- Did they mostly fall within your “Acceptable” range?

These thresholds are set by you or your client. They act as the baseline of what you want the network to accomplish.

	Acceptable	Warning	Unacceptable
<b>Network Threshold</b>			
<b>Signal Strength</b>			
65 dBm	-66 dBm to -80 dBm		81 dBm
<b>LAN Ping</b>			
<b>Latency(Avg) :</b>		50 ms to 150 ms	
49 ms			151 ms
<b>Jitter :</b>		50 ms to 150 ms	
49 ms			151 ms
<b>Packet Loss :</b>		20 % to 45 %	
19 %			46 %
<b>MOS :</b>		3.4 to 2.1	
3.5			2.0
<b>WAN Ping</b>			
google.com			
<b>Latency(Avg) :</b>		50 ms to 150 ms	
49 ms			151 ms



# Drawing Conclusions Using Network Thresholds

- Acceptable, Warning, Unacceptable
- What met your expectations?

We used excel formulas tweaked to our thresholds to show what was acceptable, warnings, and unacceptable.

	A	B	C	D	E	F	G	H	I	J	K
1	Client	Location	BSSID	Channel	Signal	Noise	LAN Ping	WAN Ping	DNS	Download	Upload
2	MacBook Pro	Front Cubes	02:18:5A:5A:64:61	149	-38	-88	1.322	96.723	36	41.93	35.87
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16							1.444	19.781	46	41	24.61
17							1.175	22.305	48	43.55	24.42
18							4.054	22.419	43	43.76	29.14



# Drawing Conclusions

- Are the thresholds OK for this network?
  - Is WiFi network meeting expectations?
  - Are there anomalies in the results?
  - How efficient was the process?
  - How long did this take? Is this a scalable practice?
  - What if validation tests could be automated and proactive?
- Small office building:
    - 6,000 sq ft.
    - 7 APs
    - 14 “spot” locations for validation tests
    - 2 minutes running tests and recording information at each location
    - 28 minutes
  - 1,000,000 sq ft = over 77.5 hours ☹️ (analysis and sorting through information not included)





# Scaling and Automating Validation Testing

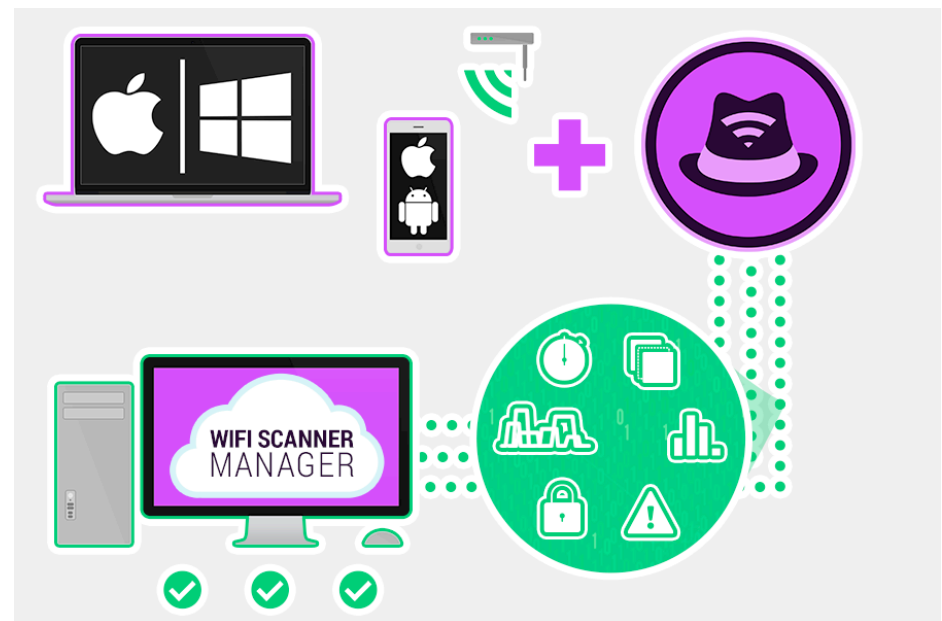


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# WiFi Scanner Manager (WFSM): Proactive Testing and Monitoring

- Ready to deploy software for all major OSes: Mac, Windows, Android, iOS
- Load software on existing equipment, and turn them into WFS Agents
- WFS Agents collect network metrics in the background and feeds them to a WiFi Scanner Manager account.
- WFS Agents also run on demand tests initiated by client or from manager.



WIFI Scanner Manager

https://manage.wifiscanner.com/apphome.jsp#

Dashboard | WIFI Scanner | Performance | Configuration | Account | Last Updated: 17:16:31 | Download Agents

Agents

- 6SOUKA
  - MacBookAir-zk-main
  - iPhone-zk-6s
  - WINDOWS3AQH1BN
  - DESKTOP-mini
  - aa140-mba-spare
  - AAZAIBSSP3
  - googleNexus 7

WIFI Scanner

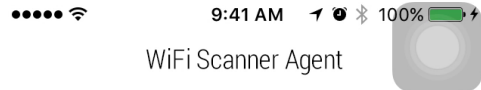
where SSID is: Any and Channel is: Any and Channel Band is: Any and Signal is: Stronger Than: -60 Filter

SSID	BSSID / MAC ...	Vendor OUI	Signal	Channel	Channel Band	Channel Width	Max Rate	Ad-Hoc	Last Seen	AP Name
PSAV_Event_S...	2C:36:F8:43:F...	Cisco Systems Inc	-56	165	5 GHz	20 MHz	144 Mbps	No	1 minute ago	4117-AP62-Chart
IT Admin	2C:36:F8:61:B...	Cisco Systems Inc	-42	11	2.4 GHz	20 MHz	144 Mbps	No	1 minute ago	4117-AP63-Chart
PSAV_Event_So...	2C:36:F8:61:B...	Cisco Systems Inc	-49	116	5 GHz	20 MHz	144 Mbps	No	1 minute ago	4117-AP63-Chart
IT Admin	0C:27:24:E6:9...	Cisco Systems Inc	-55	1	2.4 GHz	20 MHz	144 Mbps	No	1 minute ago	4117-AP64-Chart
PSAV_Event_So...	0C:27:24:E6:9...	Cisco Systems Inc	-53	132	5 GHz	20 MHz	144 Mbps	No	1 minute ago	4117-AP64-Chart
TT73378	A0:39:F7:2B:1...	Lg Electronics m...	-54	11	2.4 GHz	20 MHz	64.8 Mbps	No	1 minute ago	4117-AP64-Chart
IT Admin	2C:36:F8:43:3F...	Cisco Systems Inc	-48	6	2.4 GHz	20 MHz	144 Mbps	No	1 minute ago	4117-AP62-Chart
T-Mobile Broad...	A8:A6:68:DD:C...	Zte Corporation	-59	11	2.4 GHz	20 MHz	144 Mbps	No	4 minutes ago	4117-AP62-Chart
PSAV_Event_So...	2C:36:F8:43:3F...	Cisco Systems Inc	-47	6	2.4 GHz	20 MHz	144 Mbps	No	11 minutes a...	4117-AP62-Chart
PSAV_Event_So...	2C:36:F8:61:B...	Cisco Systems Inc	-46	11	2.4 GHz	20 MHz	144 Mbps	No	11 minutes a...	4117-AP63-Chart
PSAV_Event_So...	0C:27:24:E6:9...	Cisco Systems Inc	-55	1	2.4 GHz	20 MHz	144 Mbps	No	11 minutes a...	4117-AP64-Chart
Verizon-SM-N9...	2E:0E:3D:6D:4...	Unknown	-49	6	2.4 GHz	20 MHz	144 Mbps	No	14 minutes a...	4117-AP64-Chart
W2L3	CC:16:7E:52:B...	Cisco Systems Inc	-51	157	5 GHz	80 MHz	1300 Mb...	No	54 minutes a...	4117-AP64-Chart

SSID Details | RSSI vs. Time | 2.4 GHz | 5 GHz | Signal Rank



# How Do You Collect RSSI On IOS Devices?



Sign Out

Connected

Registered

Active

Tools

Agent Location: 38.929526,-77.243510

- Manually interface with Apple's Official Airport Utility + Our iOS Agent
  - Run WiFi Scan in Airport Utility
  - Share data with our iOS agent
  - Agent parses text file
  - Send data to manager for remote viewing
- Not background scanning but only way today without jail breaking



STAR  
TREK

CWNP  
Certitrek

WIFI Scanner Manager

https://manage.wifiscanner.com/apphome.jsp#

Dashboard | **WIFI Scanner** | Performance | Configuration | Account | Last Updated: 17:20:01 | Download Agents

Agents

- 6S0UKA
  - MacBookAir-zk-main
  - iPhone-zk-6s
  - WINDOWS3AQH1BN
  - DESKTOP-mini
  - aa140-mba-spare
  - AAZAIBSSP3
  - googleNexus 7

Test Profiles | Speed Tests | Pings | DNS

Default Test Profile

Agent Name	SSID	BSSID	Channel	Signal	Details	Time & Date																																
MacBookAir-zk-...	PSAV_Event_Solutions	2C:36:F8:61:B0:B0	11	-51	<table border="1"> <thead> <tr> <th>Test</th> <th>Latency</th> <th>Jitter</th> <th>Packet Loss</th> <th>MOS</th> <th>Host</th> </tr> </thead> <tbody> <tr> <td>LAN</td> <td>3.19 ms</td> <td>1.69 ms</td> <td>0%</td> <td>4.4</td> <td>10.190.112.1</td> </tr> <tr> <td>WAN</td> <td>78.58 ms</td> <td>19.9 ms</td> <td>0%</td> <td>4.34</td> <td>yahoo.com</td> </tr> <tr> <td></td> <td>Type</td> <td>Speed</td> <td>Location</td> <td colspan="2">Host</td> </tr> <tr> <td rowspan="2">Speed</td> <td>Down</td> <td>3.47 mbps</td> <td rowspan="2">104.131.178.169</td> <td colspan="2" rowspan="2">New York</td> </tr> <tr> <td>Up</td> <td>3.58 mbps</td> </tr> </tbody> </table>	Test	Latency	Jitter	Packet Loss	MOS	Host	LAN	3.19 ms	1.69 ms	0%	4.4	10.190.112.1	WAN	78.58 ms	19.9 ms	0%	4.34	yahoo.com		Type	Speed	Location	Host		Speed	Down	3.47 mbps	104.131.178.169	New York		Up	3.58 mbps	01:18 PM 09/28/2016
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	Type	Speed	Location	Host																																		
Speed	Down	3.47 mbps	104.131.178.169	New York																																		
	Up	3.58 mbps																																				

Speed Test Every 30 Min



manage.wifiscanner.com

WiFi Scanner Manager

Dashboard WiFi Scanner Performance Configuration Account Last Updated:11:37:56 Download Agents

Agents

- 6S0UKA
  - MacBookAir-zk-main
  - iPhone-zk-6s
  - WINDOWS3AQH1BN
  - DESKTOP-mini
  - aa140-mba-spore
  - AAZAIBSSP3
  - googleNexus 7

View Data By: Month Month: Sep 2016

DESKTOP-mini

Sep 2016						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

WINDOWS3AQH1BN

Sep 2016						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

aa140-mba-spore

Sep 2016						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

AAZAIBSSP3

Sep 2016						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
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googleNexus 7

Sep 2016						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

iPhone-zk-6s

Sep 2016						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
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MacBookAir-zk-main

Sep 2016						
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25	26	27	28	29	30	



manage.wifiscanner.com

WiFi Scanner Manager

Dashboard WiFi Scanner Performance Configuration Account Last Updated: 22:42:28 Download Agents

Agents Agent Status Charts

6S0UKA

- MacBookAir-zk-...
- iPhone-zk-6s
- WINDOWS3AQ...
- DESKTOP-mini
- aa140-mba-spare
- AAZAIBSSP3
- googleNexus 7

View Data By: Day Date: 09/26/2016

Agent	SSID	BSSID	9/25/2016 08:00 PM	9/26/2016 08:00 PM
DESKTOP-mini	fast	F0:5C:19:A1:1D:61	[Bar chart showing signal strength over time]	
WINDOWS3AQH1BN			[Bar chart showing signal strength over time]	
aa140-mba-spare	fast	94:B4:0F:49:2C:51	[Bar chart showing signal strength over time]	
AAZAIBSSP3	AA-Guest	02:18:5A:5A:64:61	[Bar chart showing signal strength over time]	
googleNexus 7	AA-Guest	02:18:5A:59:9D:31	[Bar chart showing signal strength over time]	
iPhone-zk-6s	AA-Guest	02:18:5A:5A:35:F1	[Bar chart showing signal strength over time]	
MacBookAir-zk-main	MAA-HQ	02:18:5A:5A:20:50	[Bar chart showing signal strength over time]	

MAA-HQ



manage.wifiscanner.com

WiFi Scanner Manager

Dashboard WiFi Scanner Performance Configuration Account Last Updated:22:45:43 Download Agents

Agents 6S0UKA

- MacBookAir-zk-main
- iPhone-zk-6s
- WINDOWS3AQH1BN
- DESKTOP-mini
- aa140-mba-spare
- AAZAIBSSP3
- googleNexus 7

Back

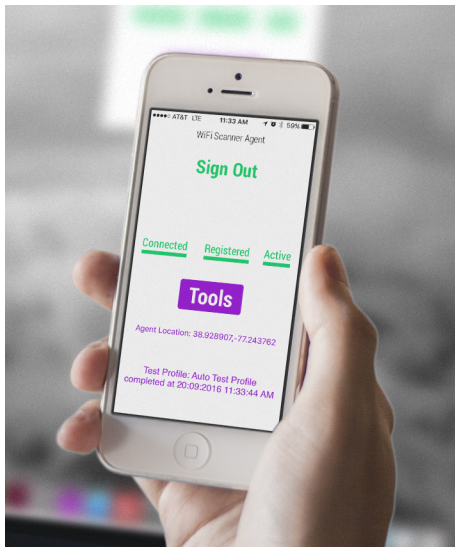
Mac MacBookAir-zk-main 09/26/2016 01:00 PM - 02:00 PM

Time	WiFi				LAN				WAN				Speed			Result
	SSID	BSSID	Channel	Signal	Latency	Jitter	Packet Loss	MOS	Latency	Jitter	Packet Loss	MOS	DNS	Download	Upload	
01:09 pm	MAA-HQ	02:18:5A:...	100	-46	10.69 ms	21.18 ms	0 %	4.38	41.28 ms	4.3 ms	0 %	4.38	51 ms			FAIL
01:10 pm	MAA-HQ	02:18:5A:...	100	-50	2.22 ms	1.43 ms	0 %	4.4	42.08 ms	5.13 ms	0 %	4.38	12 ms			PASS
01:11 pm	MAA-HQ	02:18:5A:...	100	-51	1.79 ms	0.91 ms	0 %	4.4	42.17 ms	5.9 ms	0 %	4.38	12 ms			PASS
01:12 pm	MAA-HQ	02:18:5A:...	100	-51	1.2 ms	0.22 ms	0 %	4.4	42.73 ms	5.22 ms	0 %	4.38	15 ms			PASS
01:13 pm	MAA-HQ	02:18:5A:...	100	-50	1.2 ms	0.18 ms	0 %	4.4	39.96 ms	1.1 ms	0 %	4.38	17 ms			PASS
01:14 pm	MAA-HQ	02:18:5A:...	100		1.49 ms	0.69 ms	0 %	4.4	46.07 ms	9.06 ms	0 %	4.37	14 ms			PASS
01:15 pm	MAA-HQ	02:18:5A:...	100	-51	1.16 ms	0.16 ms	0 %	4.4	43.99 ms	7.3 ms	0 %	4.37	18 ms			PASS
01:16 pm	MAA-HQ	02:18:5A:...	100	-51	1.48 ms	0.4 ms	0 %	4.4	40.31 ms	1.57 ms	0 %	4.38	17 ms			PASS
01:17 pm	MAA-HQ	02:18:5A:...	100	-51	1.57 ms	0.72 ms	0 %	4.4	98.06 ms	76.06 ms	0 %	3.99	102 ms			FAIL
01:18 pm	MAA-HQ	02:18:5A:...	52	-60	1.35 ms	0.18 ms	0 %	4.4	77.89 ms	0.2 ms	0 %	4.36	13 ms			FAIL





# Benefits for Network Operators and Consultants / Integrators



- Software Agents available with all major operating systems and all devices types (mobile, portable and even wired)
- Web based manager compatible with all major browsers.
- Minimal up front investment – software-as-a-service
- Leverage investment in existing client devices
- Track impact of network equipment and configuration changes in real-time or historical information
- Client / User level view of network performance
- Offer services to internal / external operators on performance optimization



[wifiscanner.com/cloud.html](http://wifiscanner.com/cloud.html)

Stop by AccessAgility Expo table  
for a demo and #WiFiStickers

Zaib Kaleem  
@WLANBook  
Work at @AccessAgility

zaib@accessagility.com  
703-870-3949 ext 140



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