Mojo Cognitive WiFi™
Feature Brief

Overview

Mojo Cognitive WiFi™ harnesses the intelligence of the Access Point (AP) at the edge and the power of the cloud with big data analytics and self-awareness automating WiFi management and troubleshooting to deliver the best experience to WiFi users and network administrators.

Cognitive WiFi, built on Mojo's deep domain expertise, transforms ~300 continuously monitored Key Performance Indicators (KPIs) into essential, actionable insights. It establishes a basis for a self-healing WLAN using machine learning, artificial intelligence, and cognitive computing.

What's Important

Cognitive WiFi was purpose built in the cloud with the user in mind to make WiFi reliable and easy to use and operate. It leverages an intelligent AP at the edge and the massive compute and storage resources of the cloud to take the pain out of WiFi use and management.
The user interface, designed by user experience (UX) experts and user tested, prominently presents the most important information and uses intuitive navigation workflows to quickly drill-in on details. When problems occur, the user interface highlights clear, concise, and actionable information for the most important issues. This client-first approach provides direct insight into WiFi users' network connectivity, performance, and application experience.

Baselines and Anomalies

Traditional network monitoring systems use thresholds to evaluate key health and performance metric. These thresholds are manually set and must be tuned because each network has different characteristics. Network managers typically disable threshold based warning messages based because they produce a significant number of false negatives and false positives.
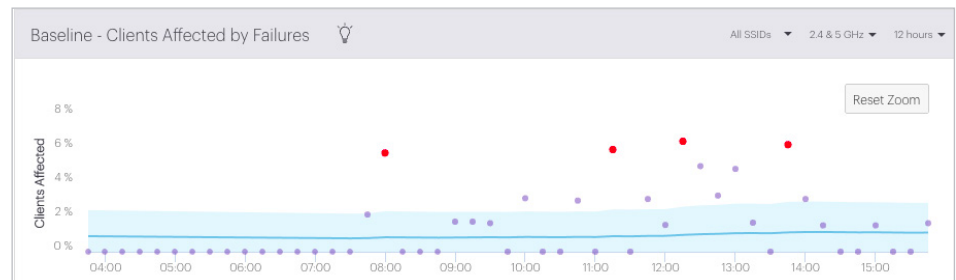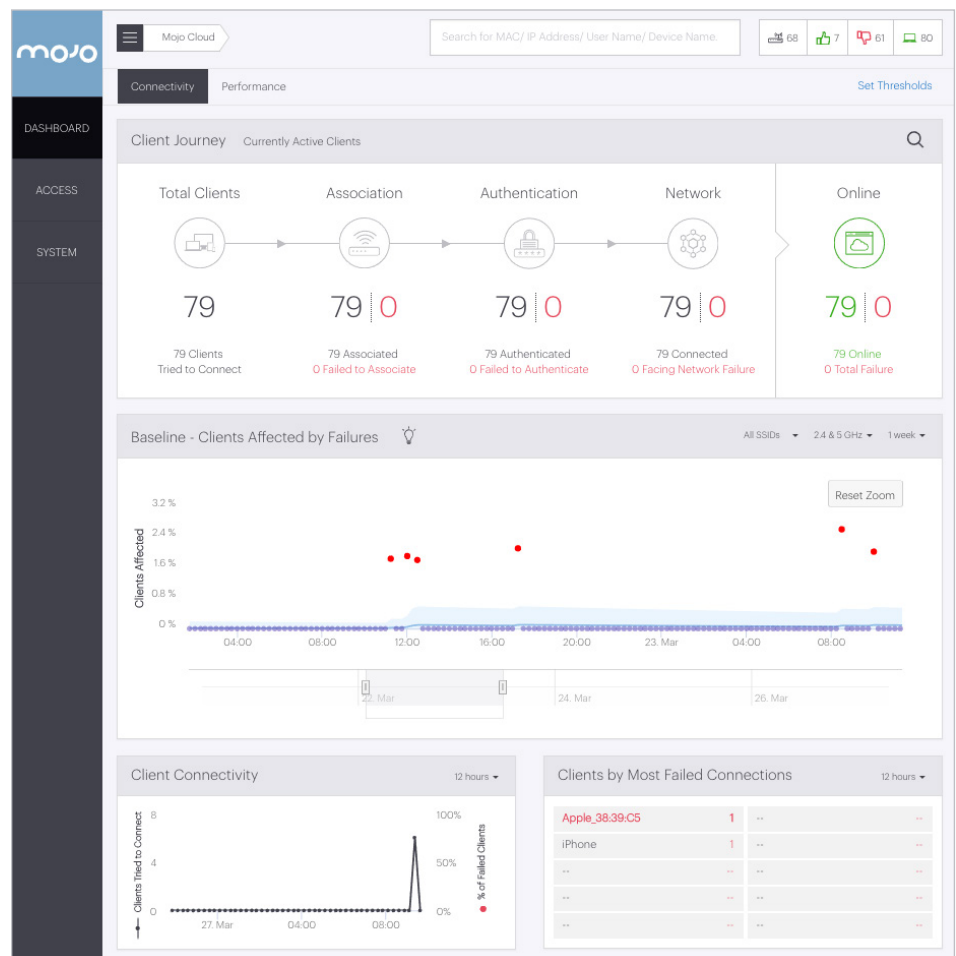

Mojo Cognitive WiFi uses a different approach. It monitors ~300 variables and determines what is normal for each environment, draws baselines for the behavior, and highlights anomalous behavior to focus on what is important. Baselines are provided for critical WiFi factors such as client connectivity, poor performance, data rates, latency, and applications.
Baselines are dynamic and adjust as the network characteristics change. Each baseline graph contains three components that make normal and unusual behavior easy to see:
• Baseline – blue line – weighted average that shows normal behavior
• Deviation range – blue area – normal range
• Anomalies – red dots – events significantly away from baseline

mojo Networks

Location-Based Information

Leveraging Mojo's hierarchy-based management, Cognitive WiFi evaluates and displays metrics at the level selected allowing views of the whole organization, site, or of a specific location.
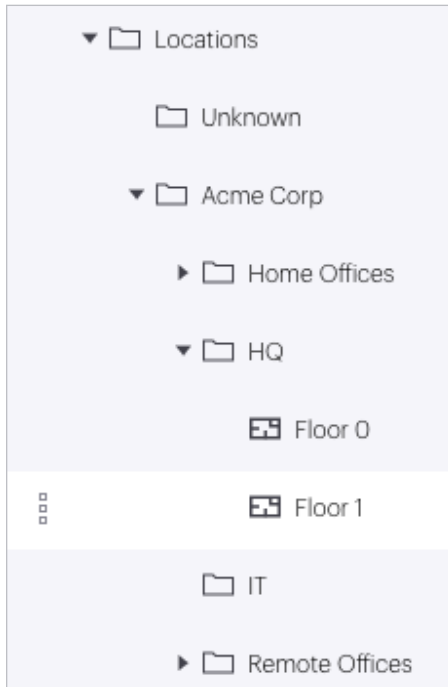
Cognitive WiFi with Cognitive Radio APs

Cognitive WiFi leverages intelligent APs and the power of the cloud to simplify, automate, and provide insights into all aspects of WiFi operations to provide an excellent user experience. The power of Cognitive WiFi is amplified when coupled with an intelligent AP with a cognitive 3rd radio. A cognitive 3rd radio frees the access radios from background tasks and allows them to focus on the most important function of the AP, servicing clients. In addition, the cognitive 3rd radio gathers RRM data and quickly detects interference and with more accuracy enabling the AP to perform advanced troubleshooting. Following are some of the advantages of having a cognitive 3rd radio:

- More accurate RRM information – the cognitive radio scans channels continuously
- Faster interference and security threat detection and response

- Spectrum analysis, WiFi packet capture on any channel, and on-demand & scheduled testing of neighboring AP without interrupting Access.
- Test neighboring AP for:
  - Connection
  - Network
  - VoIP
  - Application
 - Throughput – WiFi
  - Throughput - Internet

Evaluating Connections, Performance, and Applications

WiFi issues can be divided into two general categories:

- Connection problems - difficulty gaining access to the WLAN
- Poor performance - trouble with application after a successful connection

Depending on the type of application being used, poor network performance may not be detected by the end user. Real-time applications (voice and video) are especially sensitive to network performance issues and are easily noticed by users. Mojo's Cognitive WiFi detects real-time applications while in use and evaluates the user experience.

Mojo Aware, the interface into Cognitive WiFi, provides a dashboard to focus on each type of problem: Connectivity, Performance, and Applications.
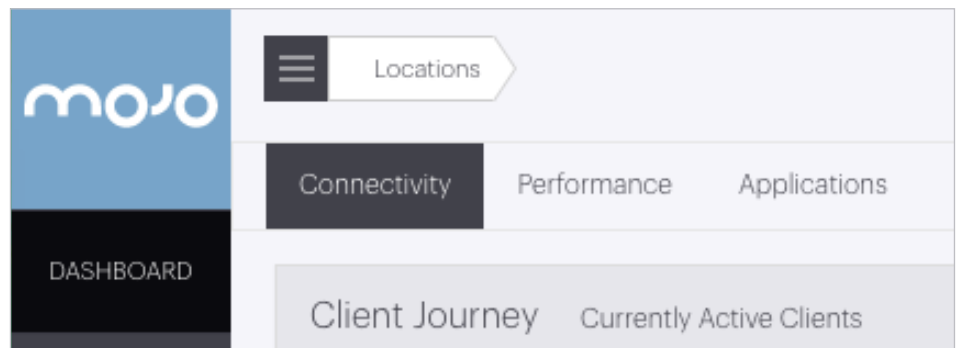
User Connections

The Connectivity dashboard summarizes and highlights problems that may degrade the WiFi user experience and require attention. It also builds a baseline of key metrics for each network and highlights anomalies that vary significantly from the baseline. Deeper insights can be found by a simple mouse-hover or by clicking and drilling down on specific WiFi clients, APs, applications, or charts.

Mojo APs intelligently monitor clients as they connect to the WiFi network. If problem occurs, the AP detects it, automatically captures the clients' packets, performs a root-cause-analysis, and delivers the root cause with the packet capture to Mojo Cloud. Client connection assessments (root cause analysis and packet capture) are available via the cloud within seconds of a failed connection attempt and are maintained historically for investigation if needed.

MOJO Networks

Client Journey for Location

The Client Journey is the main view of the Connectivity dashboard which provides a real-time overview of the network's client connection problems. It is segmented into the stages each client goes through to connect to the WLAN: Association, Authentication, and Network (DHCP and DNS).
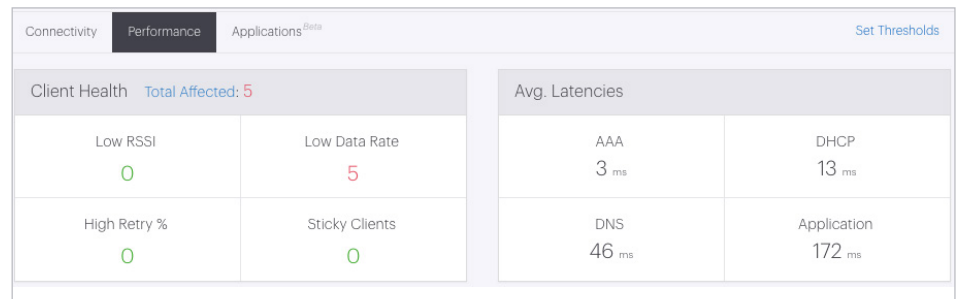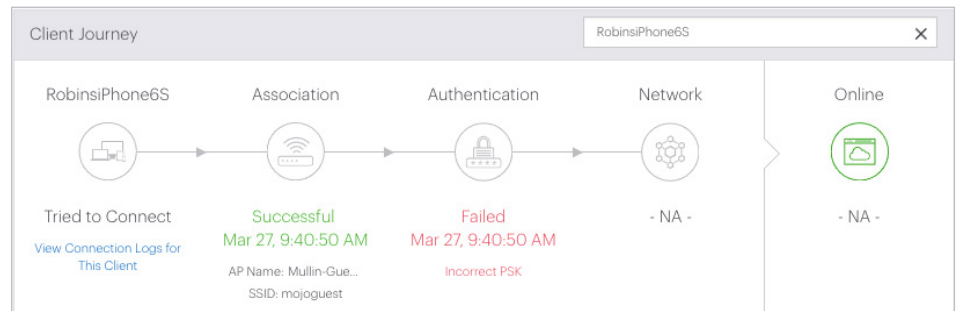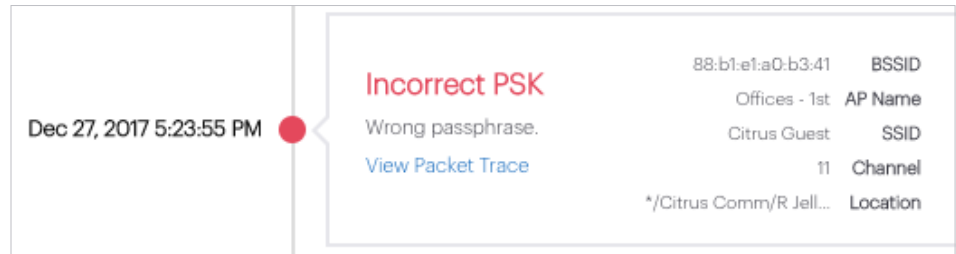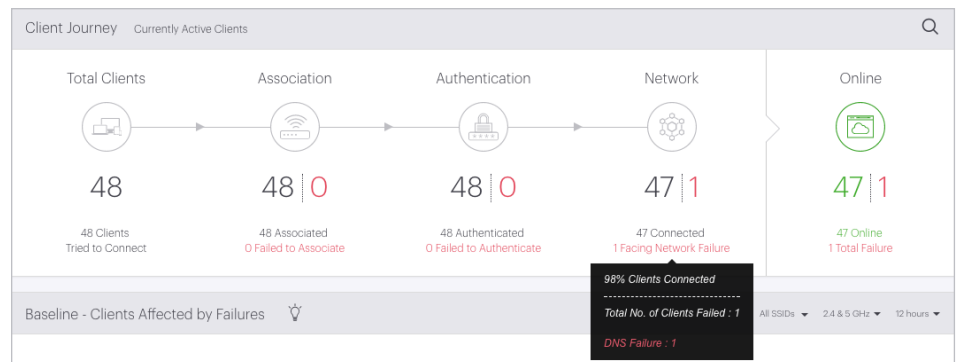
Each connection segment displays the number of clients that have succeeded or failed. Hovering over the failure (red) number in the stage summarizes the failures by root cause. Clicking drills down to provide more details on the clients. Clicking on a client drills deeper to show the connection logs. The packet trace of the event can be automatically opened in Mojo Packets for graphical analysis or downloaded locally for analysis in a packet analyzer like Wireshark. All of this is done within seconds of the connection problem occurring.

Client Journey of Individual Client

The Client Journey section has its own search function which can be used to quickly find and view the connection information of specific user. Search using MAC address, IP address, user name, or device name to see the details of the last connection. Click to drill down to view client's connection logs for the last month.
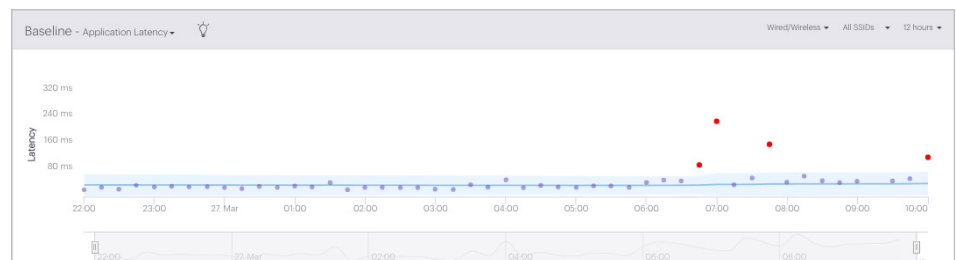
Performance

The user experience and application performance depends largely on the quality of a client's network health. Mojo Cognitive WiFi provides direct insight into clients' network health and reports on both WiFi and non-WiFI issues that may cause poor application performance and poor user experience.

Client Journey	Currently Active Clients				
Total Clients	Association	Authentication	Network		Online
48	48 0	48 0	47 1		47 1
48 Clients Tried to Connect	48 Associated 0 Failed to Associate	48 Authenticated 0 Failed to Authenticate	47 Connected 1 Facing Network Failure		47 Online 1 Total Failure

Baseline - Clients Affected by Failures   All SSIDs ▾   2.4 & 5 GHz ▾   12 hours ▾

98% Clients Connected

Total No. of Clients Failed : 1

DNS Failure : 1

Dec 27, 2017 5:23:55 PM   ●

Incorrect PSK
Wrong passphrase.
View Packet Trace

88:b1:e1:a0:b3:41	BSSID
Offices - 1st	AP Name
Citrus Guest	SSID
11	Channel
*/Citrus Comm/R Jell...	Location

Client Journey				RobinsiPhone6S ✕	
RobinsiPhone6S	Association	Authentication	Network		Online
Tried to Connect	Successful Mar 27, 9:40:50 AM	Failed Mar 27, 9:40:50 AM	- NA -		- NA -
View Connection Logs for This Client	AP Name: Mullin-Gue... SSID: mojoguest	Incorrect PSK			

Connectivity	**Performance**	Applications Beta		Set Thresholds
Client Health Total Affected: 5			**Avg. Latencies**	
Low RSSI 0	Low Data Rate 5		AAA 3 ms	DHCP 13 ms
High Retry % 0	Sticky Clients 0		DNS 46 ms	Application 172 ms

Application Latency

End-to-end application performance depends on both WiFi and wired networks over which packets traverse. Users often blame WiFi for performance problems when there could be a problem with wired side of the network.

Baseline - Application Latency ▾   Wired/Wireless ▾   All SSIDs ▾   12 hours ▾

320 ms	
240 ms	
160 ms	
80 ms	

22:00   23:00   27. Mar   01:00   02:00   03:00   04:00   05:00   06:00   07:00   08:00   09:00   10:00

mojo Networks

Using deep packet inspection (DPI), Mojo parses all TCP connections for the network and separates them into wired and wireless components. The Application Latency baseline graph displays the wired and wireless components of TCP latency. Comparing these baselines allows you to narrow down the troubleshooting focus to the wired or wireless part of the network.
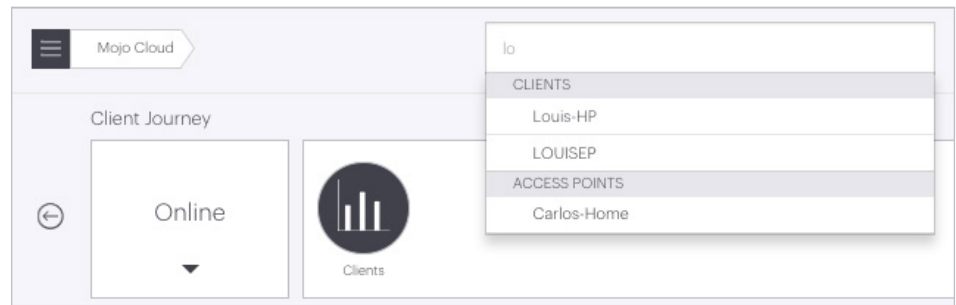
Troubleshooting

Traditionally, advanced WiFi troubleshooting is a painstaking process, often requiring personnel to travel to the site, set up test gear, attempt to reproduce the problem and collect relevant information. Even when everything goes as planned, it is tedious time-consuming process.

Mojo Cognitive WiFi takes the pain out of troubleshooting by automating detection and root cause analysis of failures and anomalies. Cognitive WiFi can even help when the problem is not a WiFi issue. If deeper analysis is necessary, Cognitive WiFi automatically captures the packet of connection problems and makes them available in Mojo Packets or for download.

Two of the WiFi troubleshooting features available with Cognitive WiFi are Auto Packet Capture and using an AP's 3rd radio as a client of a neighboring AP.

User Connections

The first step in troubleshooting a user-reported WiFi issue is locating the user's information. Mojo Cognitive WiFi minimizes the pain of finding a troubled client by providing global, dynamic search for clients on the network. The main search bar is readily accessible at the top of the dashboard and it dynamically searches for clients based on their MAC or IP address, or by user (802.1x) or device name. The search refines as information is entered, character by character.

Auto Packet Capture

Network troubleshooters often rely on capturing packet traces for advanced WiFi problem solving. Most of the time a packet capture tool is not running when a problem occurs so the administrator must coordinate with the user(s) that experienced the problem and seek their help to reproduce so that it can be captured in a packet trace. Special tools for WiFi packet capture and analysis, and presence of onsite WiFi experts is often needed.

Mojo Cognitive WiFi provides a smarter, automated way of capturing packet traces when it matters. Each Mojo AP captures packets for each client as it connects to the network. When a problem occurs, the AP detects the problem, perform root cause analysis, save the captured packets, and report all that information to the cloud.
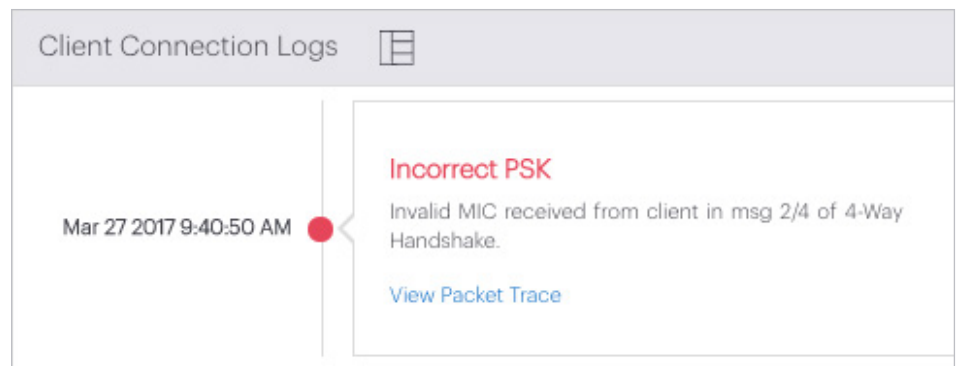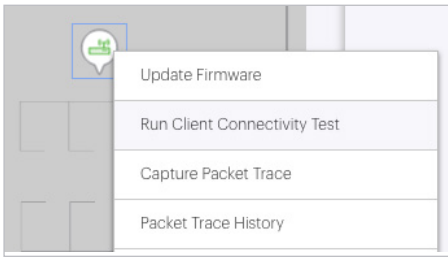

All necessary information is captured in real-time, as the problem occurs and available in the Mojo Cognitive WiFi UI within seconds. The packets are captured in the context of the troubled WiFi client that experienced the problem. The inconvenience of travel and problem reproduction is avoided.

Reviewing the trace is as easy as clicking which opens it in Mojo's graphical trace analysis tool, Mojo Packets.

3rd Radio as a Client Testing

Mojo Cognitive WiFi enables tri-radio APs (C-110 and C-130's) to connect as a client to a neighboring AP to evaluate WiFi connectivity and performance.

Tests can be run on-demand or can be scheduled and repeated. To run on-demand, right-click on the AP, select a test profile and frequency band, and the neighboring tri-radio AP to connect as a client. Each run tests WiFi, network, and Internet connectivity. Application, VoIP, and throughput tests can be included in the test template as desired.

MOJO Networks

Update Firmware
Run Client Connectivity Test
Capture Packet Trace
Packet Trace History

Test Results

Client Connectivity Test Results ⊗

SD: C-120-SD: C-130-Oct 30-16:45
Start Time: Oct 30 2017 4:45:42 PM   Stop Time: Oct 30 2017 4:55:06 PM

Access Point under Connectivity Test
AP Name : SD: C-120
Radio MAC : 00:11:74:F2:3D:A0
RSSI (dBm) : -42

Access Point acting as a Client
AP Name : SD: C-130
Radio MAC : 00:11:74:86:1C:7F

SSID : Acme Data
Frequency Band : 5 GHz
Connectivity Test Profile : 5 - Data - All Tests
Connectivity Test Profile Location : //Locations/Acme

▸ Association   ●
▸ Authentication   ●
▸ DHCP   ●
▸ Gateway   ●
▸ DNS   ●
▸ WAN Latency   ●

▾ Application Test   ●

| Productivity | Social | Communication | Custom |

Skype for Business   GotoMeeting
Successful   Successful
Latency : 9 ms   Latency : 21 ms

▾ VoIP Test   ●

VoIP Test : Successful

Mean Opinion Score (MOS) :
★★★★☆   4.40 / 5

▾ Throughput Test   ●

Internet : Successful

Upload	Download
24.734 Mbps	28.385 Mbps

Wi-Fi

Client and AP logs

AP Event Logs
A simple right-click on the AP on the floor plan provides a rich set of AP options including viewing the AP Event Logs. The AP logs show radio, network, and system level events for the last week.

68 Access Point Event Logs HQ - Floor-0 - C-100   1 week ▾   ▽

Category	Type	Description	Date
Radio	Alert	SSID Acme Guest (2.4 Ghz) is UP.	Dec 28, 2017 2:48:00 AM
Radio	Alert	AP changed channel to 1 with operating mode 11NG HT20.	Dec 28, 2017 2:48:00 AM
Radio	Alert	AP changed channel to 11 with operating mode 11NG HT20.	Dec 27, 2017 11:22:00 PM
Radio	Alert	SSID Acme Guest (2.4 Ghz) is UP.	Dec 27, 2017 11:22:00 PM
Network	Alert	DHCP lease expired on IPv4 VLAN 182.	Dec 27, 2017 3:30:00 AM
Network	Alert	DHCP lease expired on IPv4 VLAN 183.	Dec 27, 2017 3:30:00 AM
System	Info	AP rebooted because Ethernet speed degraded.	Dec 27, 2017 3:30:00 AM
Radio	Alert	SSID Acme 1x (5 Ghz) is UP.	Dec 27, 2017 3:30:00 AM
Network	Alert	DHCP lease expired on IPv4 VLAN 180.	Dec 27, 2017 3:30:00 AM

1 - 68 of 68 items   ◄   ►

Client Logging
Mojo Cognitive WiFi offers multiple options, from the high level connection successes and failures, to details of the events that happen during the connection, and to the lowest level of debugging. All logs are easily accessible from the intuitive portal regardless of where the client or the troubleshooter is located.

Client Connection Logs
At a high level, aware maintains a timeline of connection successes and failures for each client.

Client Connection Logs ▾   ☰

BSSID	AP Name	SSID	Chann...	Timestamp	Event
00:11:74:86:0b:a0	C130-Lobby	mnw	44	Dec 28, 2017 8:15:52 A...	● Successful
00:11:74:86:11:10	C130-Boardroom	mnw	157	Dec 27, 2017 3:41:58 PM	● Successful
00:11:74:86:11:10	C130-Boardroom	mnw	157	Dec 27, 2017 8:22:49 ...	● Successful
00:11:74:86:11:20	C130-Boardroom	mnw	11	Dec 22, 2017 3:13:53 P...	● Successful
00:11:74:86:0b:a0	C130-Lobby	mnw	40	Dec 22, 2017 2:36:43 ...	● Successful

MOJO Networks

Client Event Logs

Details of connection events are obtained quickly from the client view.

|	Client Event Logs ▾	⊟				Client MAC Address: 24:FO:94:A7:C3:30
BSSID	AP Name	SSID	Chann...	Timestamp ▾		Event
00:11:74:86:04:e0	C130-Corp-MNW-...	mnw	157	Aug 16 2017 4:38:00 ...	🟢	Successful
00:11:74:86:04:e0	C130-Corp-MNW-...	mnw	157	Aug 16 2017 4:38:00 ...	⚪	The client successfully received a response for its ...
00:11:74:86:04:e0	C130-Corp-MNW-...	mnw	157	Aug 16 2017 4:37:57 PM	⚪	Client has received IP address 192.168.201.100.
00:11:74:86:04:e0	C130-Corp-MNW-...	mnw	157	Aug 16 2017 4:37:57 PM	⚪	Client successfully (re)associated.
00:11:74:86:11:10	C130-Corp-Guest-...	mojoguest	161	Aug 16 2017 4:37:57 PM	⚪	The access point received disassociation from the ...
00:11:74:86:11:10	C130-Corp-Guest-...	mojoguest	161	Aug 16 2017 4:37:46 PM	🟢	Successful
00:11:74:86:11:10	C130-Corp-Guest-...	mojoguest	161	Aug 16 2017 4:37:46 PM	⚪	The client successfully received a response for its ...
00:11:74:86:11:10	C130-Corp-Guest-...	mojoguest	161	Aug 16 2017 4:37:43 PM	⚪	Client has received IP address 172.16.253.62.
00:11:74:86:11:10	C130-Corp-Guest-...	mojoguest	161	Aug 16 2017 4:37:42 PM	⚪	Client successfully (re)associated.
00:11:74:86:04:e0	C130-Corp-MNW-...	mnw	157	Aug 16 2017 4:37:25 PM	⚪	The access point received disassociation from the ...

Live Client Debugging

One of the most valuable tools in troubleshooting is getting details about what a client is doing as it moves around the WLAN. It is as easy as a right clicking on a client to start collecting debug logs in real-time while the client is live on the network.

```
Client MAC: 24:F0:94:A7:C3:30
SSID: mnw
BSSID    : 00:11:74:86:04:E0
AP NAME  : C130-Corp-MNW-Sales
Chan: 157
Time: 2017.08.16 18:37:25 (America/Chicago)
Tdiff(msec)     Timestamp          Event
        0       2017.08.16 18:37:25     Disassociation received from client because sending STA is leaving (or has left) BSS
        2       2017.08.16 18:37:25     Node Left
SSID: _MV-HS2.0
BSSID    : 00:11:74:86:11:11
AP NAME  : C130-Corp-Guest-Boardroom
Chan: 161
Time: 2017.08.16 18:37:37 (America/Chicago)
Tdiff(msec)     Timestamp          Event
        0       2017.08.16 18:37:37     HotSpot 2.0 GAS initial request received from client
        0       2017.08.16 18:37:37     HotSpot 2.0 GAS initial response sent to client
SSID: mojoguest
BSSID    : 00:11:74:86:11:10
AP NAME  : C130-Corp-Guest-Boardroom
Chan: 161
Time: 2017.08.16 18:37:42 (America/Chicago)
Tdiff(msec)     Timestamp          Event
        0       2017.08.16 18:37:42     AP received authentication request from client at [-54]db
        1       2017.08.16 18:37:42     Client successfully authenticated
        5       2017.08.16 18:37:42     AP received (re)association request from client
        5       2017.08.16 18:37:42     Signals a new WPA or WPA2 exchange
        6       2017.08.16 18:37:42     Client successfully (re)associated
        8       2017.08.16 18:37:42     Setting PMK from PSK as this is a WPA or WPA2 PSK authentication
        9       2017.08.16 18:37:42     First phase of WPA/WPA2 4-Way Handshake Completed
       12       2017.08.16 18:37:42     Second phase of WPA/WPA2 4-Way Handshake Completed
       12       2017.08.16 18:37:42     Third phase of WPA/WPA2 4-Way Handshake Completed
       26       2017.08.16 18:37:42     Node Authorized
       27       2017.08.16 18:37:42     Fourth phase of WPA/WPA2 4-Way Handshake Completed
      185       2017.08.16 18:37:42     Client sent DHCP DISCOVER
      192       2017.08.16 18:37:42     Client has received IP [fe80::84c:e7aa:e491:ef1c]
      970       2017.08.16 18:37:43     DHCP OFFER sent to Client from [172.16.253.1]
      970       2017.08.16 18:37:43     Client has received IP [172.16.253.62]
     1974       2017.08.16 18:37:44     Client sent DHCP REQUEST
     1978       2017.08.16 18:37:44     DHCP ACK sent to Client from [172.16.253.1]
    15534       2017.08.16 18:37:57     Disassociation received from client because sending STA is leaving (or has left) BSS
    15536       2017.08.16 18:37:57     Node Left
```
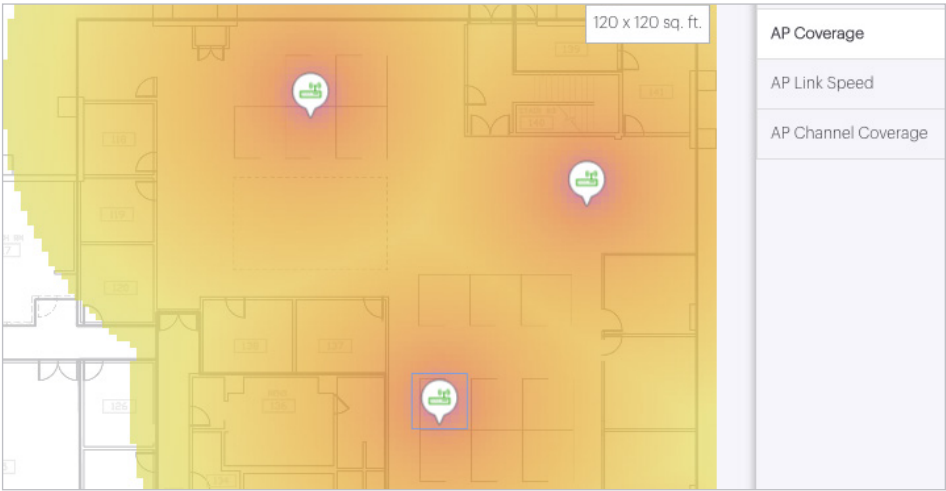
Floor Plans and RF Heatmaps

Standard image files of floor plans are easily imported for each location. Once added, a right-click on the AP provides all management and troubleshooting functions for each AP.
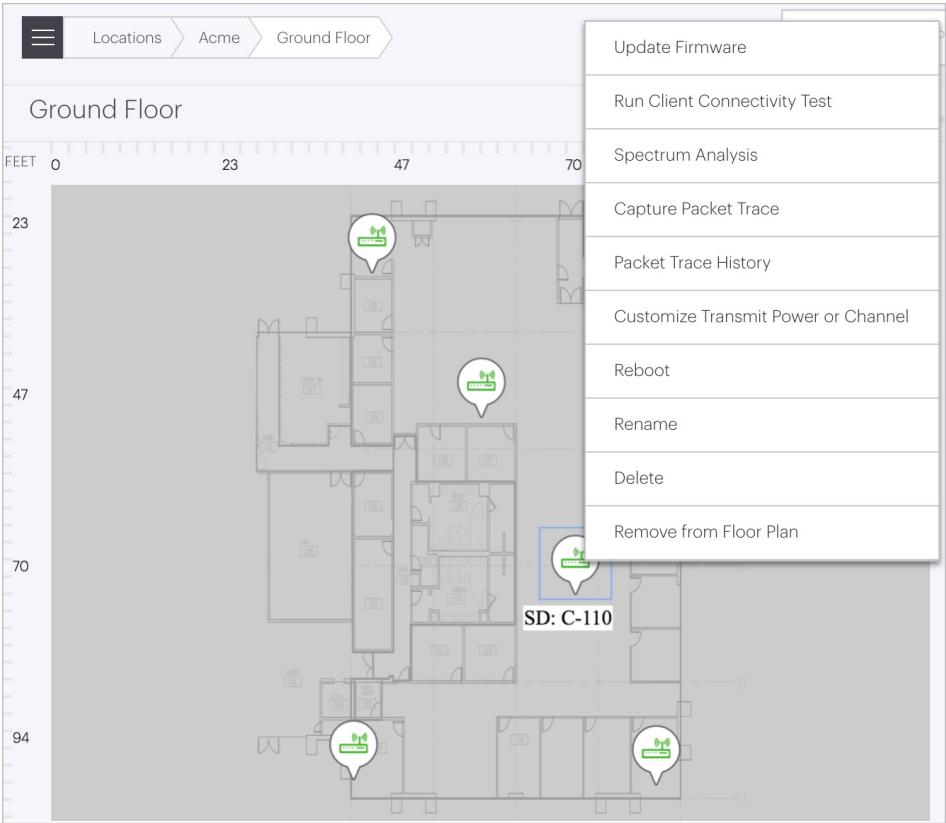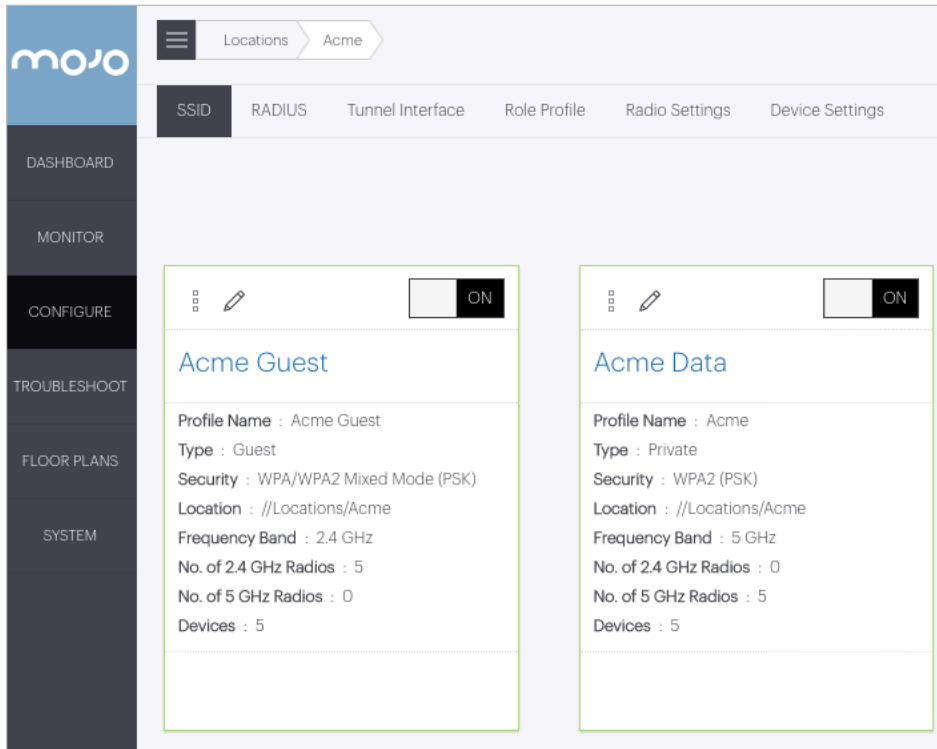

RF Heat Map

Heat maps show AP Coverage, Link Speed, and Channel Coverage. Each map can be viewed for 2.4, 5, or 2.4 & 5GHz bands.

Configuration

Setting up a WiFi network couldn't be easier. An SSID can be created and enabled in three easy steps:

- Configure SSID name.
- Setup Security.
- Configure the network settings.

Creating a guest SSID with a captive portal is done with the tick of a box, providing a rich set of access possibilities including, click-through and social media (Twitter, Facebook, LinkedIn, etc.) The portal can be configured for free and paid service with flexible time/payment tiers.
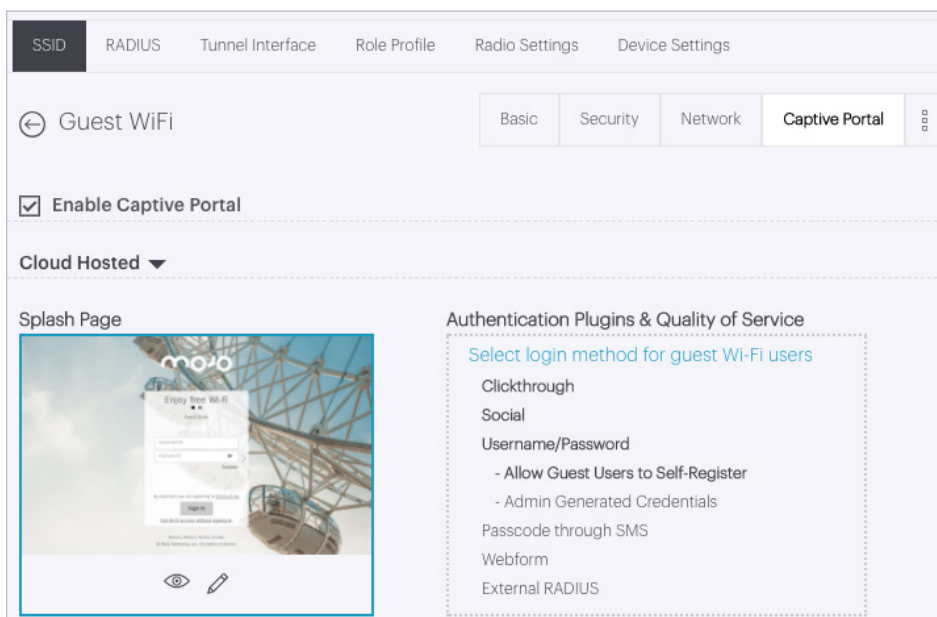
Conclusion

Mojo Networks' Cognitive WiFiTM harnesses the scale of the cloud and intelligent Access Points at the edge to create a powerful solution. Leveraging big data analytics, deep domain knowledge, and self-awareness, Cognitive WiFi automates to deliver the best possible user experience while minimizing WiFi administration.

Mojo's unique architecture enables Cognitive WiFi to continuously monitor ~300 KPIs and use state of the art machine learning, artificial intelligence, and cognitive computing to analyze and take action to tune and resolve issues before they impact users.

Cognitive WiFi kicks into overdrive when coupled with APs with a cognitive 3rd radio to secure, optimize, and perform advanced troubleshooting.

About Mojo Networks, Inc.

We are revolutionizing WiFi through the power of the cloud and open standards. We liberate networks from proprietary hardware and utilize the full power of the cloud to deliver cognitive WiFi: a self-driving network that makes things remarkably simple and reliable at massive scale. Mojo Networks' innovations empower IT with better user experiences, more options, and more velocity, all at much lower costs. Founded in 2003, Mojo Networks (formerly known as AirTight Networks), serves customers in the Fortune 500, Global 2000 and large carriers around the world. Request a free demo of Mojo Cloud managed WiFi at www.mojonetworks.com.