



Wifi Lab

Division C



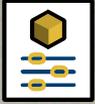
Event Basics

Teams build (prior to competition) an antenna to transmit/receive a standard 2.4 ghz Wifi signal, and complete a test about electromagnetic waves.

Team Members - 2

Impound - No

Eye Protection - No



What to Bring to the Event

Three Ring Binder

Containing any information from any source

Writing Utensils

2 Calculators

Of any type

Team Device

Design Log

Bonus points if in a labeled box

Graphs & Charts



The Antenna

Must completely fit within a 15cm^3 cube

Must include a SMA Male connector

Must not damage the SMA female connector or backplane

Must not use commercial antenna parts or magnets

Must not use an external power source



Design Log

Materials used for device construction

A labeled diagram or picture of the device

Device graphs or charts

Information about software and hardware used

- If a 3D printer, CNC machine etc. was used. Include information about the source of any files used

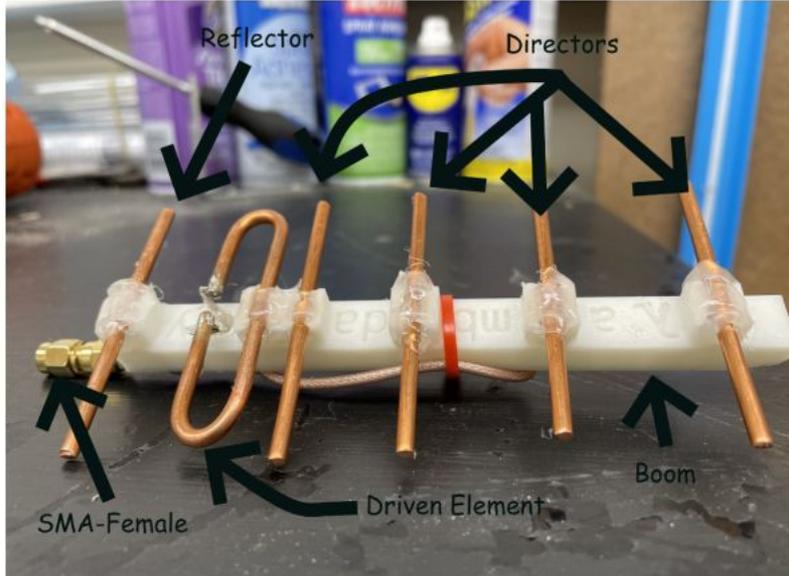
Socorro High School Team C19

Elias Zheng
Cody Johnston

Materials:

- 8 Gauge Copper Wire
- Sma Cable with adapters
- 3d Printed Antenna Boom
- Hot Glue
- Zip Tie
- Wooden Dowel
- Rosin Core Solder

Labeled Diagram



Socorro High School Team C19

Elias Zheng
Cody Johnston

Driven Element Specification Calculations

Connect here

Frequency (MHz) 2400 Length units mm inch

Length A Length Gap

Length B Radius R

Length C Rod Diameter

Length D Total Length

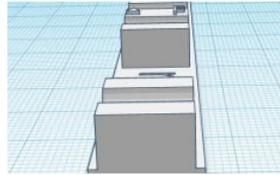
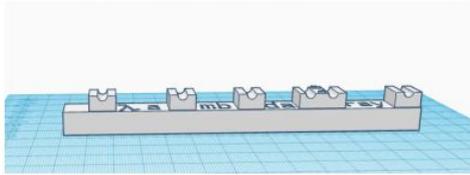
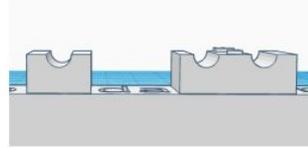
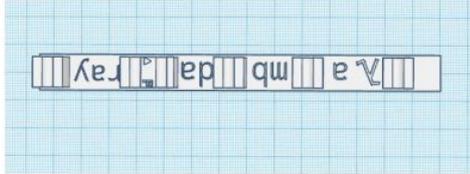
CALCULATE

Antenna Element Length and Spacing

Element	Length (mm)	Distance from reflector (mm)
Reflector		
Driven Element		
Director 1		
Director 2		
Director 3		
Director 4		

Socorro High School Team C19

Elias Zheng
Cody Johnston

Boom File Designed in tinkercad (final product of 4 iterations and dubbed the Hamdaray)**Bend Guide Designed in tinkercad**

Socorro High School Team C19

Elias Zheng
Cody Johnston

Construction

1. Copper Wires were cut to length and straightened using a pair of pliers
2. The Boom was printed with Abs with a infill density of 15% and a zig zag infill pattern
3. The copper wires were centered and fixed with hot glue
4. The driven element was soldered to the sma cable, one part to the inner cable and the other to the coating
5. The remaining sma cable was zip tied to the base
6. A dowel was affixed to the bottom of the boom with hot glue to sturdy the antenna



Charts and Graphs

For Full Points

Data must span at least 5m in distance

Data must have at least 10 data points

Graphs and Charts must be properly labeled

Have at least 4 distinct charts and/or graphs

- Different runs with the same variables count as a different charts/graphs

Design Log Must be Complete



Signal Strength of Antenna over a Distance

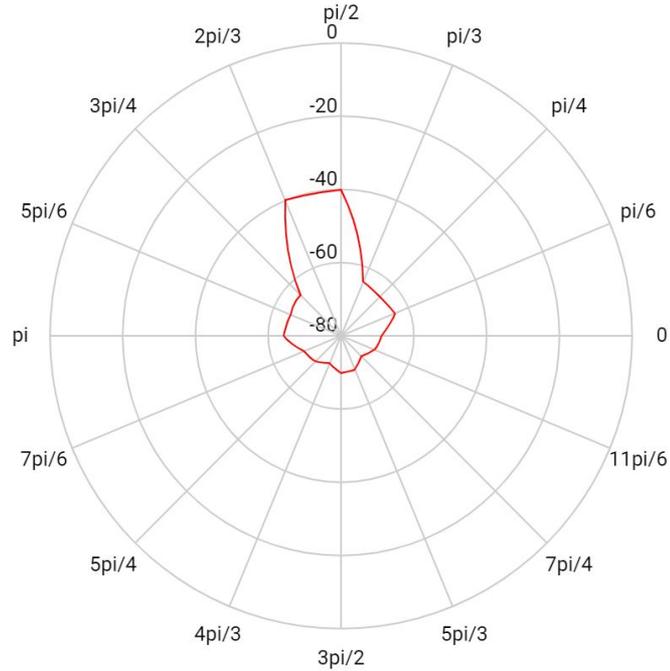
Meters from antenna	iPhone 12 (dbm)	Galaxy Note 10 (dbm)	Inspiron 1410 (dbm)
1	-50	-43	-49
2	-55	-50	-52
3	-53	-55	-57
4	-59	-53	-56
5	-57	-57	-58
6	-62	-56	-59
...
21	-65	-64	-59
22	-68	-62	-60
23	-64	-63	-62
24	-66	-62	-70
25	-69	-58	-60
26	-67	-61	-68
27	-65	-61	-66



Signal Strength of Antenna around a Circle (r=3m)

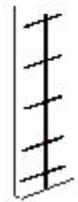
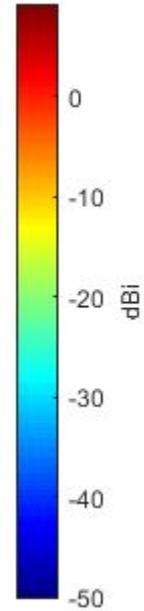
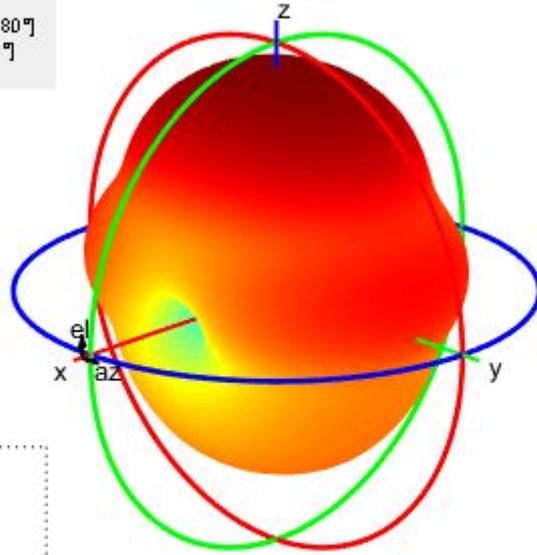
Angle	Dbm
$\pi/2$	-40
$\pi/3$	-64
$\pi/4$	-65
$\pi/6$	-64
0	-69
$11\pi/6$	-70
$7\pi/4$	-72
$5\pi/3$	-70
$3\pi/2$	-70
$4\pi/3$	-72
$5\pi/4$	-70
$7\pi/6$	-69
π	-64
$5\pi/6$	-65
$3\pi/4$	-64
$2\pi/3$	-40

Yagi Uda Radiation Pattern



3D Radiation Pattern Using MatLab

Output : Directivity
Frequency : 2.4 GHz
Max value : 9.29 dBi
Min value : -50.1 dBi
Azimuth : [-180°, 180°]
Elevation : [-90°, 90°]



Show Antenna





The Written Test

At least 5 questions from each of the following

- The Electromagnetic Spectrum, radio waves, and EM wave propagation
- Relating velocity, wavelength, and frequency for waves
- Common antenna designs, compare/contrast different types of antennas



The Written Test Cont.

At least 5 question from each of the following

For State and Nationals Only:

- Mathematical questions involving common antenna designs
- Gain patterns, the radar equation, impedance, bandwidth, noise, and information

Device Testing



- The event supervisor will provide a 30cm x 30cm x .5cm non conductive backplane on a tripod with an SMA female connector in the center
- The event supervisor will measure the dBm of a 3.1 cm monopole antenna at 3m to determine the minimum connection threshold
- The transmitter and receiver will be placed at equal heights of at least 50 cm

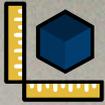


Building your Antenna

Research and pick your antenna type

Design your antenna

Build, Debug, Improve



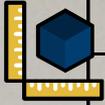
Collecting Data

For a Wifi signal the signal strength is measured in decibels per milliwatt (dBm), on a scale of -100 (weakest) to 0 (strongest)

Connect your antenna to a transmitter

When using a router make sure the other antenna (if any) are disconnected

Measure the dBm at several distances by moving the receiving device

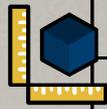


Windows

WifiInfoView

Extract the Zip file and run "WifiInfoView.exe"

--	--	--	--	--	--	--	--	--



Windows

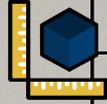
WifiInfoView

WifiInfoView - Full Details Mode

File Edit View Options Help

SSID	MAC Address	PHY Type	RSSI	Signal Quality	Average Signal...	Frequency	Channel	Information Size	Elements Count	Compa
MyWifiLabRouter	D8-EC-5E-20-8B-27	802.11g/n	-34	96	95.7	2.422	3	456	17	Belkin

1 item(s) NirSoft Freeware. <https://www.nirsoft.net>

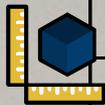


Windows

WifiInfoView

SSID	MAC Address	PHY Type	RSSI	Signal Quality	Average Signal...	Frequency	Channel	Information Size	Elements Count	Compa
MyWifiLabRouter	D8-EC-5E-20-8B-27	802.11g/n	-34	96	95.7	2.422	3	456	17	Belkin

1 item(s) NirSoft Freeware. <https://www.nirsoft.net>

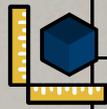


Windows

WifiInfoView

SSID	MAC Address	PHY Type	RSSI	Signal Quality	Average Signal...	Frequency	Channel	Information Size	Elements Count	Company Name
MyWifiLabRouter	D8-EC-5E-20-8B-27	802.11g/n	-34	96	95.7	2.422	3	456	17	Belkin

1 item(s) NirSoft Freeware. <https://www.nirsoft.net>



Windows WifiInfoView

WifiInfoView - Full Details Mode

File Edit View Options Help

SSID	MAC Address	PHY Type	RSSI	Signal Quality	Average Signal...	Frequency	Channel	Information Size	Elements Count	Compa
MyWifiLabRouter	D8-EC-5E-20-8B-27	802.11g/n	-34	96	95.7	2.422	3	456	17	Belkin

1 item(s) NirSoft Freeware. <https://www.nirsoft.net>

Windows

WifiInfoView

WifiInfoView - Full Details Mode

File Edit View Options Help

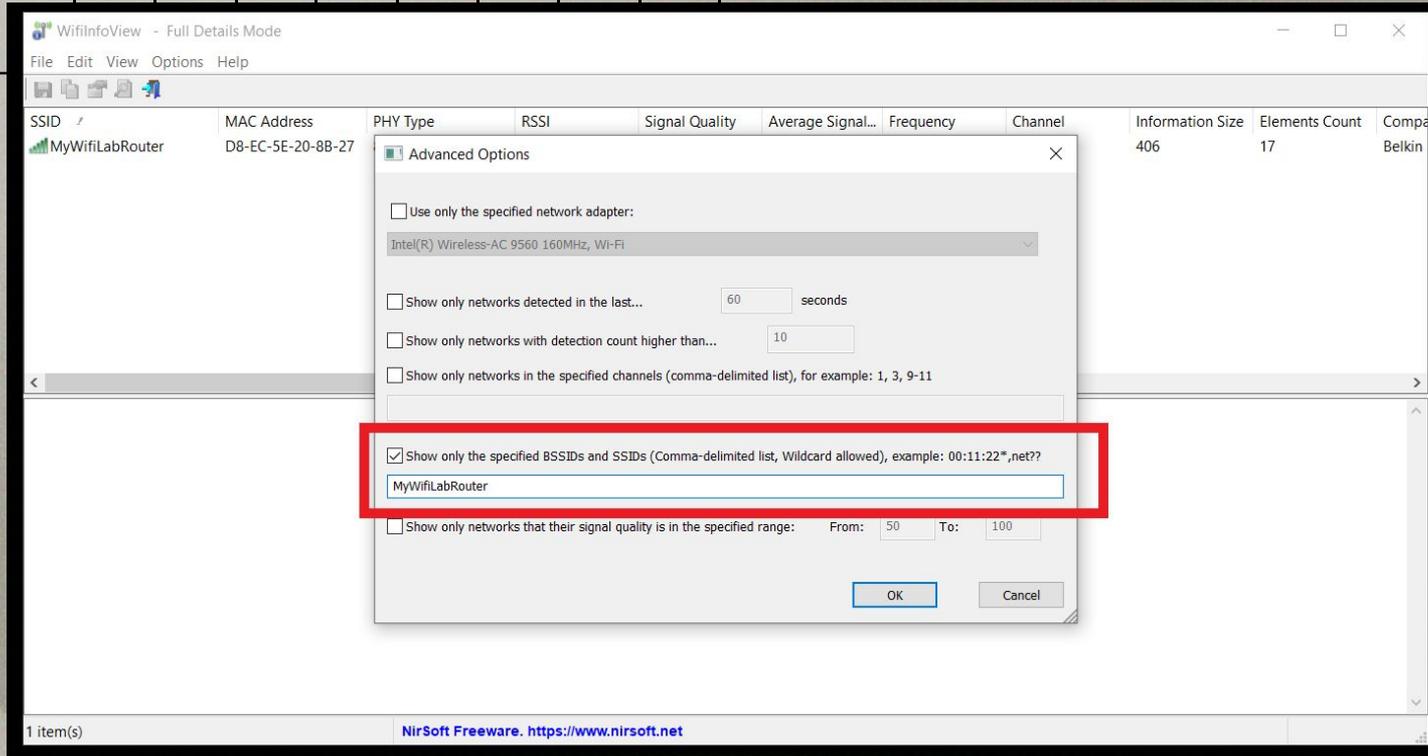
MAC Address Format >
Update Rate >
SSID Encoding >
Full Details Mode
Channels Summary Mode
Companies Summary Mode
PHY Types Summary Mode
Max Speed Summary Mode
Router Model Summary Mode
Router Name Summary Mode
Signal Quality Summary Mode
BSS Type Summary Mode
Security Summary Mode
WPS Summary Mode
Company-Router Model Summary Mode
Affected Channels Summary Mode
Sort On Every Update
Automatically Scroll Down On New Item
Put Icon On Tray
Align Numeric Columns To Right
Select Another Font
Use Default Font
MAC Addresses List Ctrl+F8
Advanced Options F9

Signal Quality	Average Signal...	Frequency	Channel	Information Size	Elements Count	Comp
97	95.1	2.422	3	406	17	Belkin

1 item(s) NirSoft Freeware. <https://www.nirsoft.net>

Windows

WifiInfoView



WifiInfoView - Full Details Mode

File Edit View Options Help

SSID	MAC Address	PHY Type	RSSI	Signal Quality	Average Signal...	Frequency	Channel	Information Size	Elements Count	Comp
MyWifiLabRouter	D8-EC-5E-20-8B-27							406	17	Belkin

Advanced Options

Use only the specified network adapter:
Intel(R) Wireless-AC 9560 160MHz, Wi-Fi

Show only networks detected in the last... 60 seconds

Show only networks with detection count higher than... 10

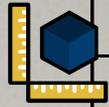
Show only networks in the specified channels (comma-delimited list), for example: 1, 3, 9-11

Show only the specified BSSIDs and SSIDs (Comma-delimited list, Wildcard allowed), example: 00:11:22*,.net??
MyWifiLabRouter

Show only networks that their signal quality is in the specified range: From: 50 To: 100

OK Cancel

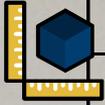
1 item(s) NirSoft Freeware. <https://www.nirsoft.net>



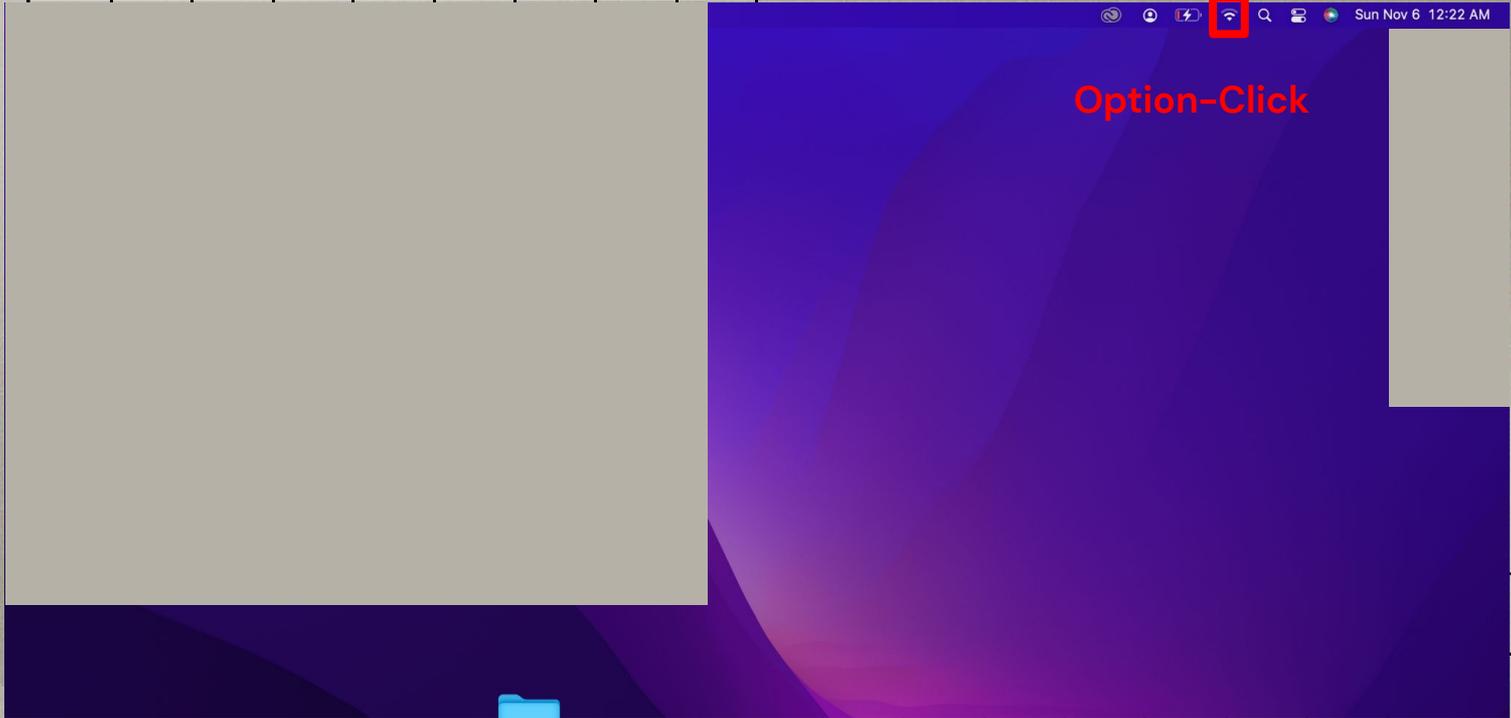
Native on Mac OS

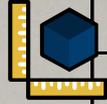
Mac

Wifi Diagnostics



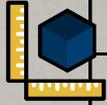
Mac Wifi Diagnostics



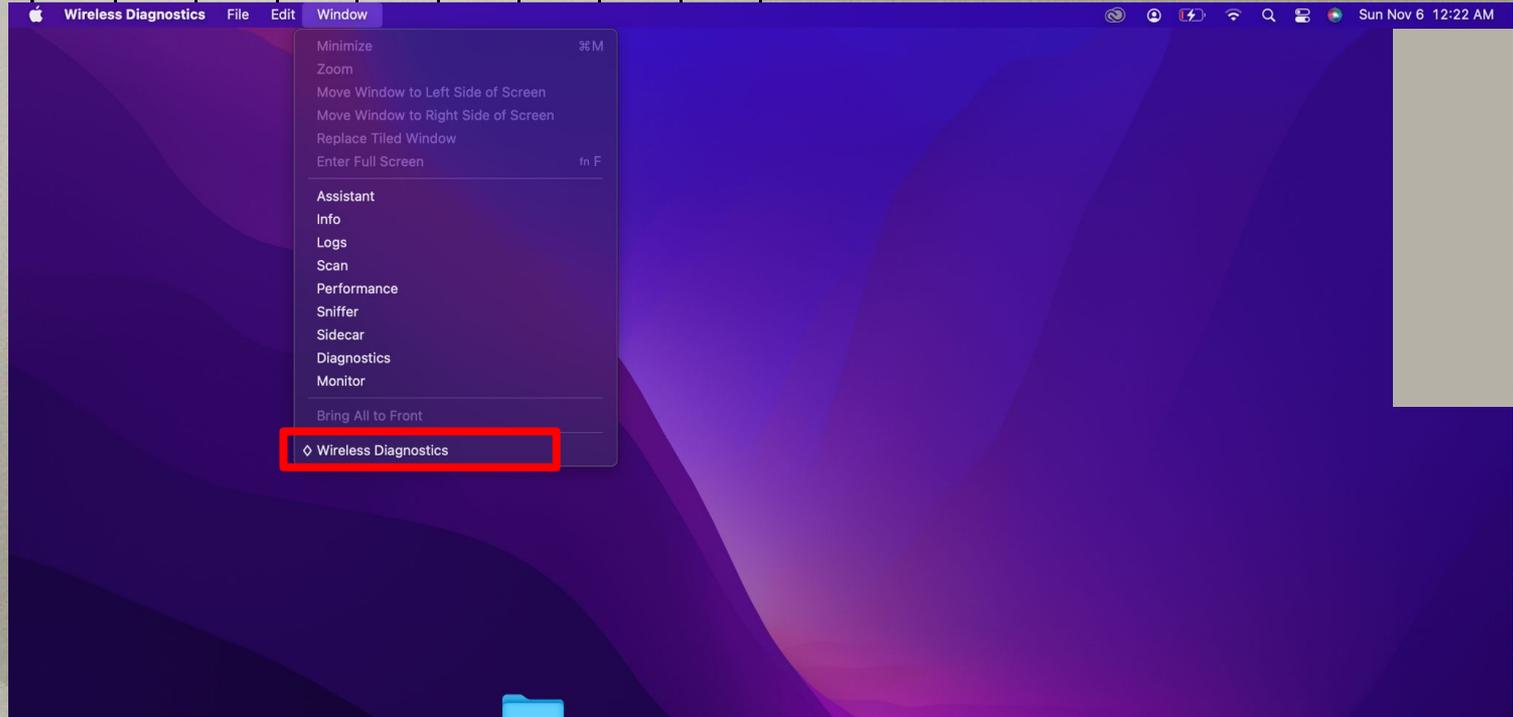


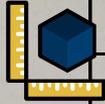
Mac Wifi Diagnostics

The screenshot shows a Mac desktop with a purple and blue abstract background. At the top, the menu bar includes 'Finder', 'File', 'Edit', 'View', 'Go', 'Window', and 'Help'. On the right side of the menu bar, there are icons for network, security, battery, Wi-Fi, search, and system status, along with the date and time: 'Sun Nov 6 12:20 AM'. The Wi-Fi system status menu is open, showing the 'Wi-Fi' toggle switch turned on. Below the toggle, there are three options: 'Disable Wi-Fi Logging', 'Create Diagnostics Report...', and 'Open Wireless Diagnostics...'. The 'Open Wireless Diagnostics...' option is highlighted with a red rectangle. Underneath, the 'Preferred Networks' section is visible, showing a list of networks with their respective signal strength icons and lock status. Below the preferred networks, technical details are listed: 'Channel: 11 (2.4 GHz, 20 MHz)', 'Country Code: US', 'RSSI: -78 dBm', 'Noise: -94 dBm', 'Tx Rate: 28 Mbps', 'PHY Mode: 802.11n', 'MCS Index: 3', and 'NSS: 1'. At the bottom of the menu, there are 'Other Networks' and 'Network Preferences...' options.



Mac Wifi Diagnostics





Mac Wifi Diagnostics

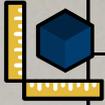
The screenshot shows the Mac Wireless Diagnostics application window. The title bar reads "Wireless Diagnostics" with menu options "File", "Edit", and "Window". The system status bar at the top right shows "Sun Nov 6 12:23 AM".

The main window displays a "Scan" window with a summary table on the left and a list of detected networks on the right.

Summary	
Total	8
2.4GHz Count	8
5GHz Count	0
Current Channel Count	3
Best 2.4GHz	1
Best 5GHz	161

Network Name	BSSID	Security	Protocol	RSSI
		WPA2 Personal	802.11b/g/n	-78
		WPA2 Personal	802.11b/g/n	-86
		WPA2 Personal	802.11b/g/n	-62
		WPA2 Personal	802.11b/g/n	-72
		WPA2 Personal	802.11b/g/n	-80
MyWifiLabRouter	d8:ec:5e:20:8b:27	WPA2 Personal	802.11b/g/n	-35
		WPA2 Personal	802.11ax	-76

A "Scan Now" button is located at the bottom right of the scan window.

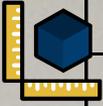


Android and iOS

Network Analyzer

<https://apps.apple.com/us/app/network-analyzer/id562315041>

<https://play.google.com/store/apps/details?id=net.techet.netanalyzerlite.an>



Wi-Fi Signal

2.4 GHZ SETTINGS

- 3** MyWifiLabRouter -47 dBm
d8:ec:5e:20:8b:27 WPA2 (AES)
Belkin International Inc. 40 MHz, WPS
b11/g54/n300(2)
- [Redacted] -64 dBm
WPA2/WPA (AES/TKIP)
20 MHz, WPS
- [Redacted] -80 dBm
WPA2 (AES)
20 MHz, WPS
- [Redacted] -81 dBm
WPA2/WPA (AES/TKIP)
20 MHz
- [Redacted] -87 dBm
WPA2 (AES)
20 MHz, WPS
- [Redacted] -91 dBm
20 MHz

Android and iOS

Network Analyzer

