Installation Tutorials

Reliability of IoT Network with Customer field Wi-Fi

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2. NS002 Wi-Fi Requirements:

2.1. Connectivity requirements

The NS002 sensor should have following minimum connectivity to assure proper data upload.

	NS002	*Smart Phone*
RSSI:	**> -75 dBm**	*> -68 dBm*
Upload speed:	**> 300 kbps**	*> 3 Mbps*

See chapter 6 for comprehensive study on NS002 vs smart phone

2.2. Wi-Fi & Security

Sensors support only 2.4GHz Wi-Fi network bandwidth.
NS002 can determine what type of security is required, be it WEP, WPA, or WPA2. It supports all of these 'consumer' security mechanisms.

2.3. Enterprise Wi-Fi

NS002 IS NOT compatible with enterprise-level Wi-Fi authentication, 802.1x, which requires logging in with a username and password.

2.4. Firewalls

NS002 uses the following ports which should be open for outgoing connection.

Port	TCP	UDP	Usage
31314	✓		Initial device-server connection
993	✓		Fallback device-server connection #1
443	✓		Fallback device-server connection #2
80	✓		Fetch device firmware
53		✓	Allow DNS look-ups — imps with non-default DNS settings

3. Wi-Fi connectivity check for NS002 using installed sensor

A start-up sequence is implemented in our standard sensor firmware which will prompt the sensor to upload additional data during the first hour after turned on for the first time. This will allow to verify in the dashboard the sensor connectivity statistics (RSSI and upload speed) to assure a proper and stable connection is available during commissioning.
If sensor is turned off and on again this sequence will repeat so changes can be made to sensor, modem or repeater locations to improve the connection.

Sensor start-up sequence:

1- Switch on the sensor and within 1 to 2 mins the sensor will establish a connection to the cloud, status LED will be blinking a combination of red and Amber. If the sensor finds the network and is **connected** to the internet the LED will blink green at least 2 times.
Unsuccessful connection: The sensor will only show Red or Amber for approximately 1 to 2 mins and then time out. This means the sensor is not able to connect to the internet.

2- The sensor will send a small set of data and a dark green light will be on during the first upload.

3- If the sensor is connected and the connection is good. The sensor will start uploading 1 set every 10 mins a total of 6 times. This data will be available on the dashboard as it gets received by the cloud.

At the end of the first hour sensor will upload a small set again with statistical information on connectivity which can be viewed in Loggly in case there was any data loss.

Note: the total number of sets in the first 1 hour is 8 sets [2 small set and 6 full sets]

4- After sending the above data the sensor will shift back to its normal measurement sequence and time.

5- The uploads for all the sensors can be analyzed during commissioning and after 1 hr of first turning the sensor on.

If the upload rate (No. of samples supposed to be received/No. of samples received > 80%), it is satisfactory connection.

4. Wi-Fi connectivity check for NS002 using smart phone

To check the reliability of IoT network with customer's field Wi-Fi using a smart phone please refer to the instructions below:

4.1. Speed test

Connect your smartphone to the field Wi-Fi. Make sure you get connected to the network successfully and NOT use data provided by your mobile network. Please switch off your mobile data to avoid any confusion with this. Here is a link for how to turn off the mobile data on the Android phone:

https://www.youtube.com/watch?v=rbNCyFF_mZI

Here is a link for how to turn off the mobile data for Apple iPhone:

https://www.youtube.com/watch?v=2auwdwrPZ3Q

Do a connection speed test by going to www.speedtest.net , or by downloading Speed Test by 'Ookla', available on both iOS app store and Android store.

1- Swipe up the below tab as shown in picture 1.

2- Click on Change Test Server and choose one of the servers in the San Jose, CA area.

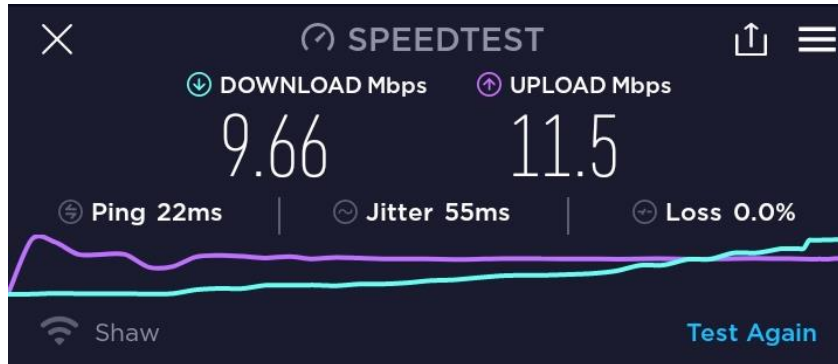3- Tap on the main screen and then click on GO to start the speed test.
[The speed test should be done near each installed sensor and using the same Wi-Fi network that the sensor is connected to].
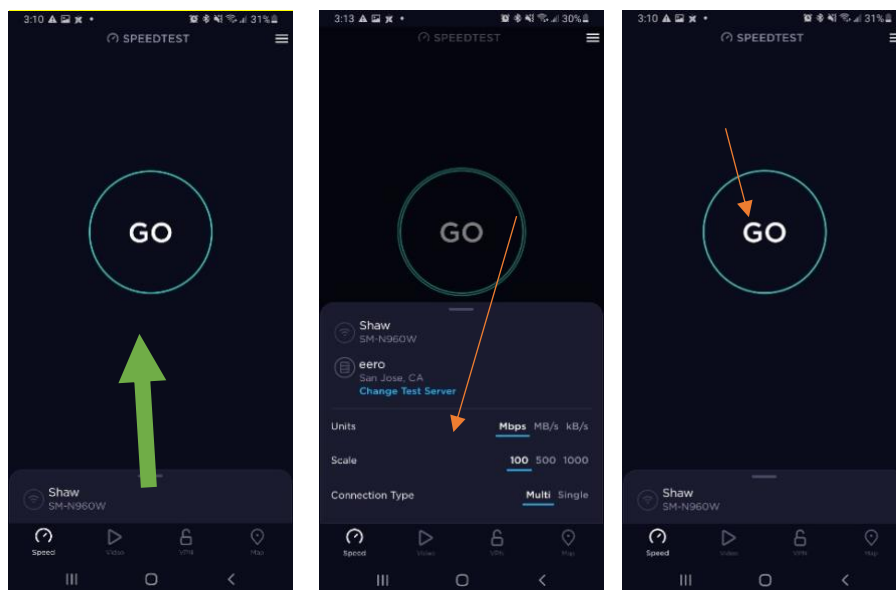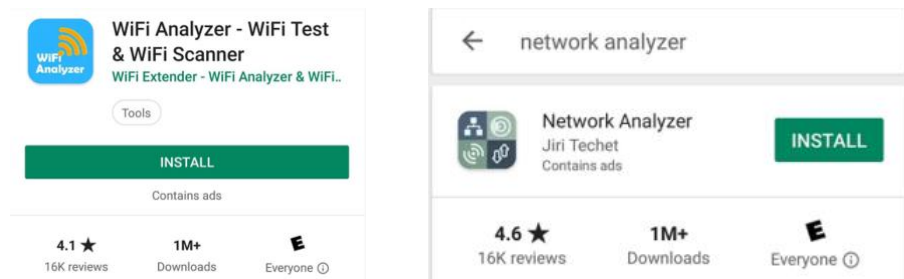
4- The speed test might take 1 to 2 mins to finish.

Please record the download speed, upload speed, and ping time for each test.

4.2. RSSI check for Android Phones

1. Download a Wi-Fi analyzing app onto your smartphone, like Wi-Fi Analyzer and Network Analyzer below, which is available through the Android Google Play Store®.

2. Enable the App location permission request, after which the Wi-Fi network SSID can be shown on the App dashboard.

3. Here we take "Wi-Fi Analyzer" as the example to show procedures of measuring RSSI (Received Signal Strength Indicator) in dBm. The Y-axis represents the RSSI of the network.
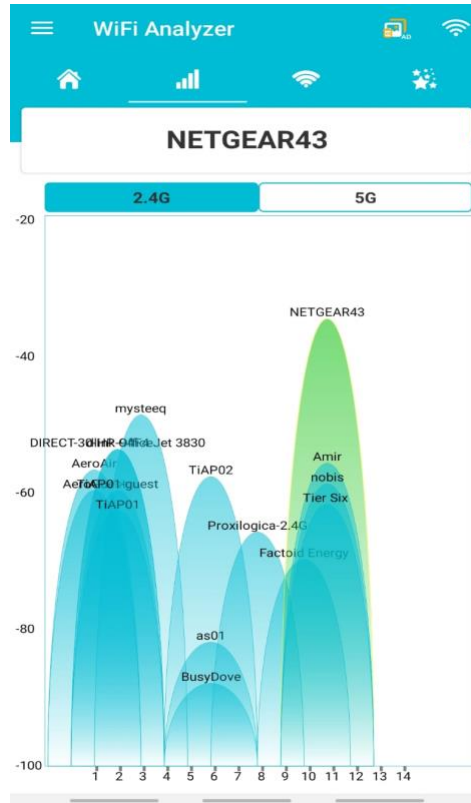
4. An ideal value for RSSI should be above -70 dBm, anything below -70dBm (on smart phone test) will not allow the sensor to send data seamlessly.
(See further for compared test between RSSI smart phone and sensor)

5. If the RSSI value is below -60, the router is far away from the sensors. To troubleshoot this problem, try to bring the router as close as possible to the sensors and/or to add repeaters nearby the sensors. Then run the RSSI test again.
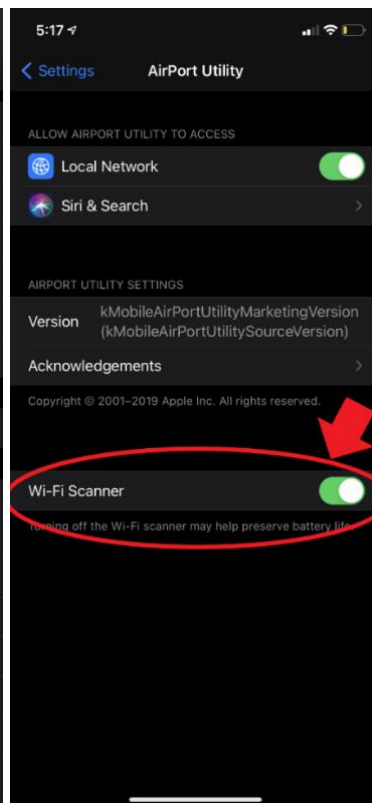
4.3. RSSI check for iPhone

1. Download Airport Utility from the Apple App Store. Link:
   https://apps.apple.com/ca/app/airport-utility/id427276530

2. Once downloaded and installed, go to settings app on iPhone and scroll till you see
   Airport Utility

3. Select Airport Utility and Enable Wi-Fi Scanner

4. Go to the Airport Utility App. Select Wi-Fi Scan
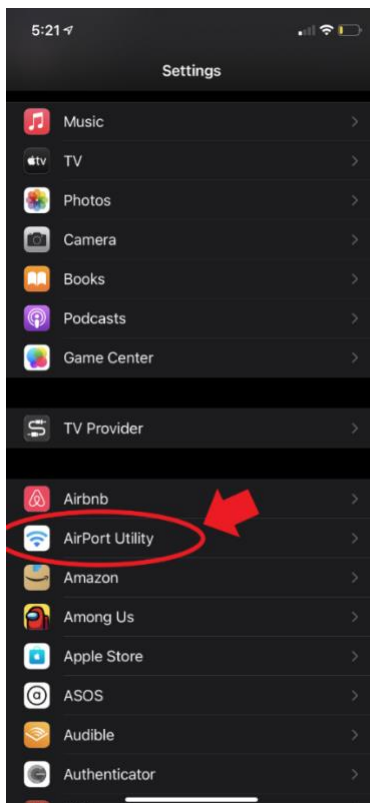
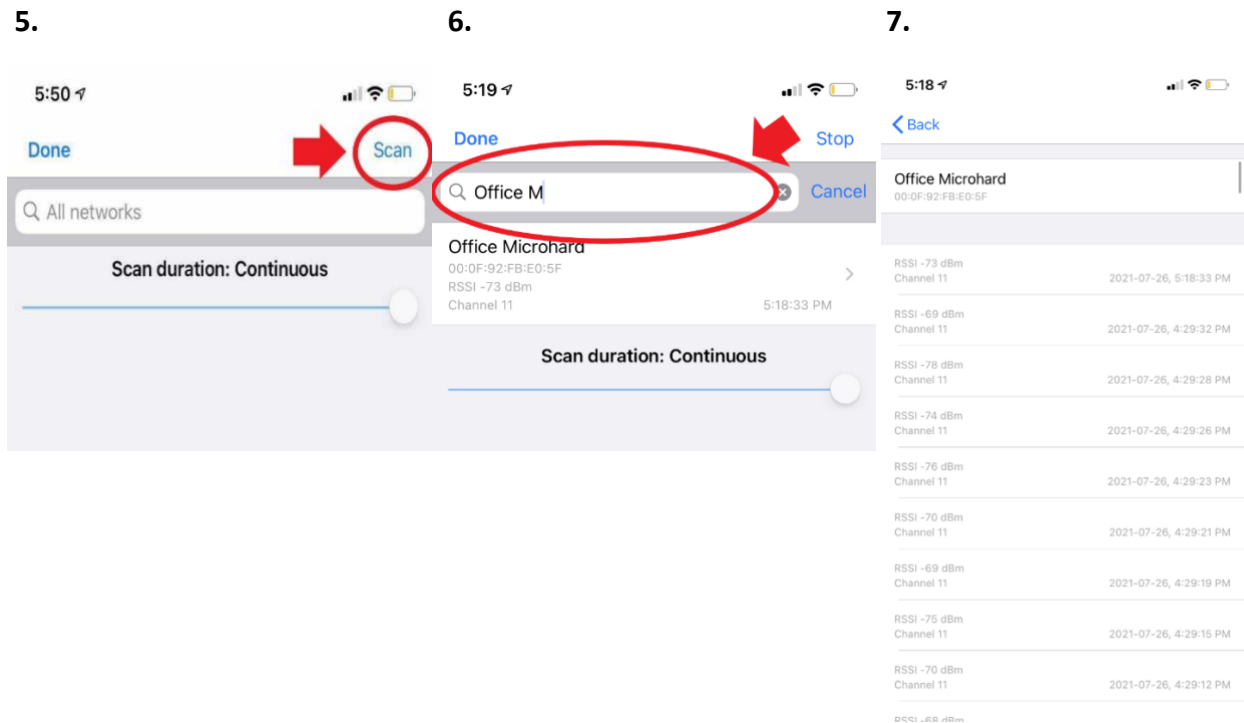**2.**   **3.**   **4.**

5. Select Scan in the next window.

6. When the scan is complete, type in the network SSID in the search bar and select it.

7. You should see RSSI logs as shown.

5.

6.

7.

Please refer to the link below:

https://iphone-tricks.com/tutorial/6941-using-airport-as-wi-fi-scanner-on-iphone

4.4. Conclusion

To have the best sensor performance all the below 5 things must be ensured:

1- Good RSSI above -68 dbM on a smartphone

2- Upload speed of at least 3 Mbps on the phone when connected to that Wi-Fi network (making sure that it is NOT connected to mobile network)

3- Ping time to any server nearby San Jose should be less than 80ms.

4- A good line of sight between a sensor and the internet access point

5- No thick metal cover or wall between the two points, even if there is one, the Point 1 & 2 need to be ensured on a higher side. This means RSSI of -60dbM and above 4 Mbps.

5. Wi-Fi connectivity check for NS002 using test sensor

A NS002 sensor can be configured as a connectivity test sensor, by deploying a special firmware, which can continuously present the connection status on the sensor agent page. **Important**: **This firmware will deplete the battery within 24h** (since it uploads every 5 seconds) and therefor should never be deployed on a sensor that will be used in production. Ideally a separate test sensor is used during installation only to perform the connectivity testing, or a new battery is installed after reverting to normal firmware.

Step 0: Provide the SensorTagId of test sensor to NanoPrecise so the special firmware can be loaded and a link to the agent interface provided (this link will expire after 48h or when reblinking sensor, contact Nanoprecise timely to get updated link)

Step 1: GO to the link that was provided for your test sensor, either on your mobile phone or on the laptop.

Step 2: Blink the test sensor to the appropriate Wi-Fi to which all the sensors need to be connected. Ensure the firewall requirements are met, refer to section 2.3 Firewalls.

Step 3: Please take the test sensor to every potential sensor location with the sensor switched off.
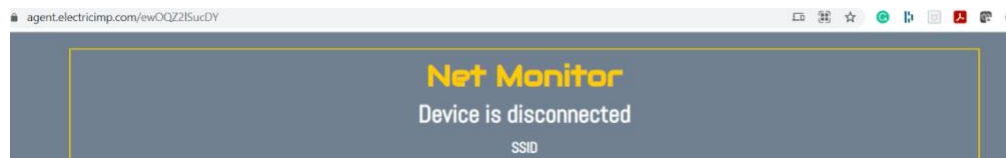
This is updated every 5 sec.

Switch on the sensor, within 5-10 sec or at max 20 sec depending upon internet speed at that time, the above status page will update to "Device is connected" and show following:
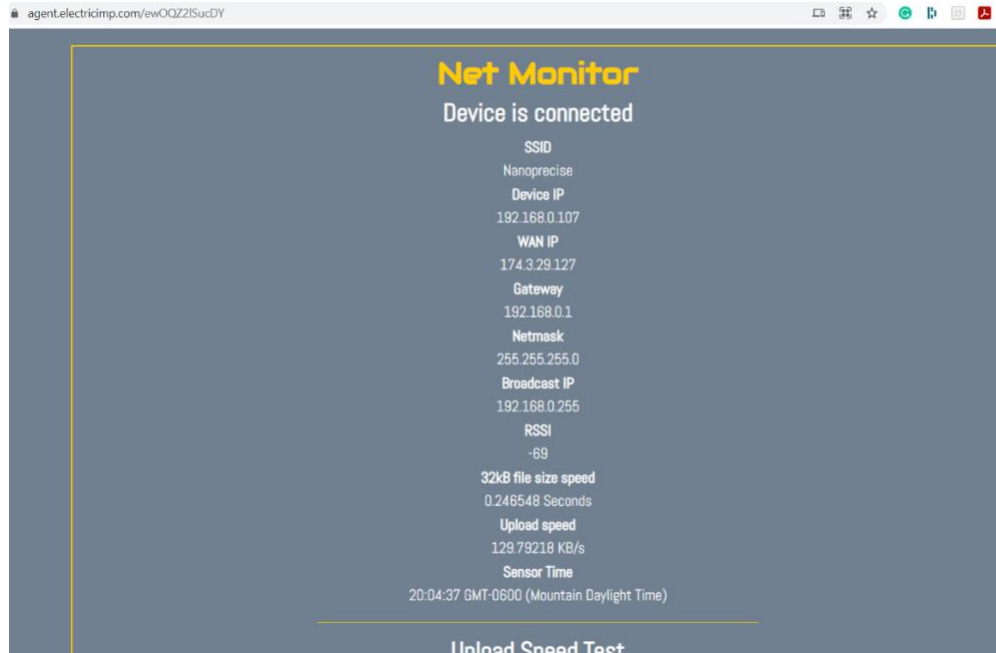
While the device is connected, you will notice the RSSI, and upload speed of the sensor is updated every 5 seconds.

If the sensor is not able to connect to the internet, the "Device is Disconnected" will prompt.

Repeat the test for each location you want to install a sensor and note down the RSSI and upload speed at each location. If needed the router or repeater can be moved or more routers or repeaters added to assure proper RSSI and upload speed at all planned sensor locations.

See the video here for demo on how NS002 can be used as connectivity test sensor:

https://www.dropbox.com/s/95ykxun9zaeiwd4/NS002%20as%20a%20Wifi%20Test%20Monitor.mp4?dl=0

6. Compare RSSI and Upload speed between Sensor and Smart Phone

An important thing to understand is that the RSSI and upload speed of the sensor are somewhat or entirely different than the RSSI and the upload speed of a smart phone connected to the same Wi-Fi network. Simply because this is different hardware, and that the Sensor will upload data through an encrypted TCP connection which is strongly influenced by latency.

Here is what the RSSI of the sensor vs smart phone looks like in ideal (line of sight) situation as we increase in distance every 5 meters:

RSSI (DBm vs meters)		
Distance(m)	NS002	Smart Phone
5	-58.8	-53
10	-70.4	-61.4
15	-72.4	-61
20	-77.2	-65.4
25	-79.6	-72
30	-83.2	-72
35	-81.8	-72
40	-82.4	-79
45	-84.2	-70.6
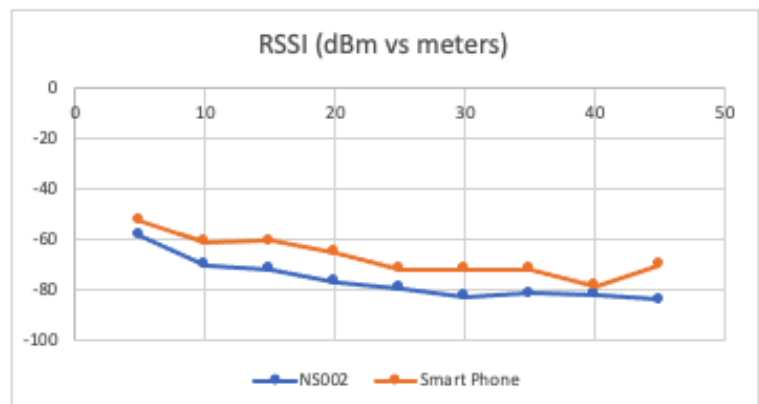
*Marked in Green indicate sensor seamlessly connected and uploaded data within 1 min connection and upload timeout.
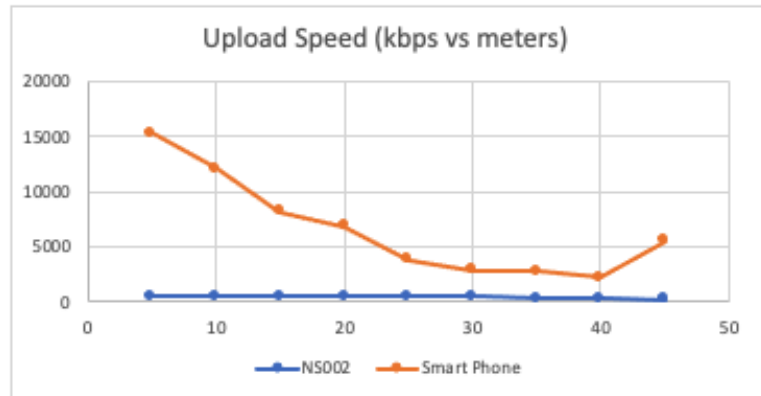
Correlation = 93%.

Thus, to ensure the RSSI of the sensor is good (>-75dBm), phone should at least have >-68dbM RSSI.

Below is what the upload speed of the sensor vs phone looks like as we increase in distance every 5 meters:

Upload Speed (Kbps vs meters)		
Distance(m)	NS002	Smart Phone
5	531	15300
10	472	12130
15	505	8230
20	527	6892
25	497	3822
30	472	2922
35	343	2752
40	286	2254
45	209	5544

*Marked in Green indicate sensor seamlessly connected and uploaded data within 1 min connection and upload timeout.

Correlation = 50%. (poor)

Thus, to ensure the upload speed of the sensor is good (>300kbps), phone should at least have upload speed of 3Mbps or higher.