Talaria TWO™ (INP2045)

Ultra-Low Power Multi-Protocol Wireless Platform SoC

IEEE 802.11 b/g/n, BLE 5.0

User Guide for Talaria TWO MPD Demo Tool – iPerf3 & Scan Modes

Release: 09-29-2022

Revision History

Version	Date	Comments
1.0	07-07-2022	First release.
2.0	09-06-2022	Updated to reflect the appropriate Max_Listen_Time for Standard Scan.
2.1	10-04-2022	Updated with the latest logs for the tool.

Contents

Figures

Tables

Terms & Definitions

AP	Access Point
ARP	Address Resolution Protocol
COM	Composite Device Driver
ELF	Extensible Linking Format
EVK	Evaluation Kit
FTDI	Future Technology Devices International
GARP	Gratuitous Address Resolution Protocol
GUI	Graphical User Interface
HTTP	Hyper Text Transfer Protocol
HTTPS	Hyper Text Transfer Protocol Secure
iPerf	Internet Performance Working Group
MPD	Multipurpose Demo
MQTT	Message Queuing Telemetry Transport
SSID	Service Set Identifier
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
URL	Uniform Resource Locator
USB	Universal Serial Bus

Introduction

This document describes the different modes in which the iPerf3 and Scan applications can be used with the Demo tool GUI.

iPerf3

Select the iPerf3 tab on the Demo tool GUI to automatically load the signed firmware image for iPerf3 application.

The following sections provide information on the different modes in which the iPerf3 application can be used along with their respective outputs.

UDP Throughput Test Downlink

Console output of UDP Downlink test:

```
Y-BOOT 208ef13 2019-07-22 12:26:54 -0500 790da1-b-7

ROM yoda-h0-rom-16-0-gd5a8e586

FLASH:PNWWWWWAEBuild $Id: git-e31bdbe13 $

krn.gpio=--K suspend=1 np_conf_path=/data/nprofile.json ssid=InnoPhase
          passphrase=43083191

addr e0:69:3a:00:2c:42

[0.690,936] CONNECT:b0:39:56:93:83:31 Channel:6 rssi:-47 dBm

[0.732,813] MYIP 192.168.1.131

[0.732,977] IPv6 [fe80::e269:3aff:fe00:2c42]-link

IPerf3 server @ 192.168.1.131

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

Iperf3 TCP/UDP server listening on 5201

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

Accepted connection from 192.168.1.124 port 47552

[  1] local 192.168.1.131 port 20756 connected to 192.168.1.124 port 34976

RSSI start: -46 dBm

RSSI end:   -48 dBm

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

[ ID]           Interval        Transfer     Bitrate
```

```
[  1] iperf3[S-RX-udp]: 0.0-30 sec 106.4 MBytes 29.7 Mbits/sec

User: 23606574 (78%)

IRQ:  2906897 (9%)

Idle: 3489850 (11%)
```

Windows console output:

```
C:\Users\InnoP\Downloads\iperf-3.1.3-win64\iperf-3.1.3-win64>iperf3 -c 192.168.1.131 -u
-b30M -i1 -t30

Connecting to host 192.168.1.131, port 5201

[  5] local 192.168.1.124 port 34976 connected to 192.168.1.131 port 5201

[ ID] Interval           Transfer     Bitrate         Total Datagrams

[  5]   0.00-1.00   sec  3.57 MBytes  30.0 Mbits/sec  2567

[  5]   1.00-2.00   sec  3.58 MBytes  30.0 Mbits/sec  2568

[  5]   2.00-3.00   sec  3.58 MBytes  30.0 Mbits/sec  2569

[  5]   3.00-4.00   sec  3.58 MBytes  30.0 Mbits/sec  2568

.

.

.

.

.

[  5]  24.00-25.00  sec  3.58 MBytes  30.0 Mbits/sec  2569

[  5]  25.00-26.00  sec  3.58 MBytes  30.0 Mbits/sec  2568

[  5]  26.00-27.00  sec  3.58 MBytes  30.0 Mbits/sec  2569

[  5]  27.00-28.00  sec  3.58 MBytes  30.0 Mbits/sec  2568
```

```
[  5]  28.00-29.00  sec  3.58 MBytes  30.0 Mbits/sec  2569

[  5]  29.00-30.00  sec  3.58 MBytes  30.0 Mbits/sec  2569

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

[ ID] Interval           Transfer     Bitrate        Jitter     Lost/Total Datagrams

[  5]   0.00-30.00  sec   107 MBytes  30.0 Mbits/sec  0.000 ms  0/77054 (0%)   sender

[  5]   0.00-30.00  sec   106 MBytes  29.8 Mbits/sec  0.000 ms  634/77054 (0.82%)
receiver


iperf Done.
```

UDP Throughput Test Uplink

Console output for UDP throughput uplink test:

```
----------------------------------------

Iperf3 TCP/UDP server listening on 5201


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

Accepted connection from 192.168.1.124 port 47568

[  1] local 192.168.1.131 port 20756 connected to 192.168.1.124 port 39126

RSSI start: -47 dBm

RSSI end:   -49 dBm

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

[ ID]          Interval        Transfer     Bitrate

[  1] iperf3[S-TX-udp]: 0.0-30 sec 48.8 MBytes 13.6 Mbits/sec

User: 10874781 (36%)

IRQ:  1501611 (5%)

Idle: 17631727 (58%)
```

Windows console output:

```
C:\Users\InnoP\Downloads\iperf-3.1.3-win64\iperf-3.1.3-win64> iperf3 -c 192.168.1.131 -

u -b30M -i1 -t30 -R

Connecting to host 192.168.1.131, port 5201

Reverse mode, remote host 192.168.1.131 is sending

[  5] local 192.168.1.124 port 39126 connected to 192.168.1.131 port 5201

[ ID] Interval           Transfer     Bitrate         Jitter    Lost/Total Datagrams

[  5]   0.00-1.00   sec  2.62 MBytes  22.0 Mbits/sec  0.605 ms  0/1881 (0%)

[  5]   1.00-2.00   sec  2.62 MBytes  21.9 Mbits/sec  1.475 ms  0/1879 (0%)

[  5]   2.00-3.00   sec  1.26 MBytes  10.6 Mbits/sec  1.434 ms  0/907 (0%)

[  5]   3.00-4.00   sec  1.74 MBytes  14.6 Mbits/sec  0.773 ms  0/1247 (0%)

[  5]   4.00-5.00   sec  1.36 MBytes  11.4 Mbits/sec  0.828 ms  0/976 (0%)

[  5]   5.00-6.00   sec  1.76 MBytes  14.7 Mbits/sec  1.314 ms  0/1262 (0%)

[  5]   6.00-7.00   sec  1.63 MBytes  13.7 Mbits/sec  0.931 ms  0/1173 (0%)

.

.

.

[  5]  26.00-27.00  sec  1.53 MBytes  12.8 Mbits/sec  1.512 ms  0/1096 (0%)

[  5]  27.00-28.00  sec  1.59 MBytes  13.3 Mbits/sec  1.299 ms  0/1142 (0%)

[  5]  28.00-29.00  sec  1.53 MBytes  12.8 Mbits/sec  1.160 ms  0/1097 (0%)

[  5]  29.00-30.00  sec  1.57 MBytes  13.2 Mbits/sec  1.988 ms  0/1128 (0%)
```

```
- - - - - - - - - - - - - - - - - - - - - - - - - -

[ ID] Interval           Transfer     Bitrate         Jitter    Lost/Total Datagrams

[  5]   0.00-30.00  sec  48.9 MBytes  13.7 Mbits/sec  0.000 ms  0/35102 (0%)   sender

[  5]   0.00-30.00  sec  48.8 MBytes  13.6 Mbits/sec  1.988 ms  0/35022 (0%)   receiver



iperf Done.
```

TCP Throughput Test Downlink

Console output of TCP Throughput Downlink test:

```
----------------------------------------

Iperf3 TCP/UDP server listening on 5201


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

Accepted connection from 192.168.1.124 port 47556

[  1] local 192.168.1.131 port 5201 connected to 192.168.1.124 port 47558

RSSI start: -47 dBm

RSSI end:   -48 dBm

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

[ ID]             Interval         Transfer     Bitrate

[  1] iperf3[S-RX-tcp]: 0.0-30 sec 84.8 MBytes 23.7 Mbits/sec

User: 26877186 (88%)

IRQ:  3241560 (10%)

Idle: 124208 (0%)
```

Windows console output:

```
C:\Users\InnoP\Downloads\iperf-3.1.3-win64\iperf-3.1.3-win64>iperf3 -c 192.168.1.131  -
          i1 -t30

Connecting to host 192.168.1.131, port 5201

[  5] local 192.168.1.124 port 47558 connected to 192.168.1.131 port 5201

[ ID] Interval           Transfer     Bitrate         Retr  Cwnd

[  5]   0.00-1.00   sec  3.14 MBytes  26.3 Mbits/sec    0   67.0 KBytes

[  5]   1.00-2.00   sec  2.91 MBytes  24.4 Mbits/sec    0   67.0 KBytes

[  5]   2.00-3.00   sec  2.79 MBytes  23.4 Mbits/sec    0   67.0 KBytes

[  5]   3.00-4.00   sec  2.91 MBytes  24.4 Mbits/sec    0   67.0 KBytes

[  5]   4.00-5.00   sec  2.91 MBytes  24.4 Mbits/sec   10   47.1 KBytes

[  5]   5.00-6.00   sec  2.76 MBytes  23.1 Mbits/sec   21   17.1 KBytes

[  5]   6.00-7.00   sec  2.91 MBytes  24.4 Mbits/sec   20   34.2 KBytes

[  5]   7.00-8.00   sec  2.76 MBytes  23.1 Mbits/sec    9   28.5 KBytes

.

.

.

.

[  5]  23.00-24.00  sec  2.79 MBytes  23.4 Mbits/sec    0   67.0 KBytes

[  5]  24.00-25.00  sec  2.91 MBytes  24.4 Mbits/sec   22   14.3 KBytes

[  5]  25.00-26.00  sec  2.76 MBytes  23.1 Mbits/sec   28   15.7 KBytes
```

```
[  5]   26.00-27.00  sec  2.76 MBytes  23.1 Mbits/sec   22   24.2 KBytes

[  5]   27.00-28.00  sec  2.91 MBytes  24.4 Mbits/sec    9   29.9 KBytes

[  5]   28.00-29.00  sec  2.79 MBytes  23.4 Mbits/sec    7   14.3 KBytes

[  5]   29.00-30.00  sec  2.94 MBytes  24.7 Mbits/sec    8   32.8 KBytes

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

[ ID] Interval           Transfer     Bitrate         Retr

[  5]    0.00-30.00  sec  84.8 MBytes  23.7 Mbits/sec  296              sender

[  5]    0.00-30.00  sec  84.8 MBytes  23.7 Mbits/sec                   receiver


iperf Done.

--------
```

TCP Throughput Test Uplink

Console output of TCP Throughput Uplink test.

```
----------------------------------------

Iperf3 TCP/UDP server listening on 5201


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

Accepted connection from 192.168.1.124 port 47564

[  1] local 192.168.1.131 port 5201 connected to 192.168.1.124 port 47566

RSSI start: -47 dBm

RSSI end:   -48 dBm

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

[ ID]            Interval        Transfer    Bitrate

[  1] iperf3[S-TX-tcp]: 0.0-30 sec 48.7 MBytes 13.6 Mbits/sec

User: 13556511 (45%)

IRQ:  1300291 (4%)

Idle: 15148431 (50%)
```

Windows console output:

```
C:\Users\InnoP\Downloads\iperf-3.1.3-win64\iperf-3.1.3-win64> iperf3 -c 192.168.1.131

-i1 -t30 -R

Connecting to host 192.168.1.131, port 5201

Reverse mode, remote host 192.168.1.131 is sending

[  5] local 192.168.1.124 port 47566 connected to 192.168.1.131 port 5201

[ ID] Interval           Transfer     Bitrate

[  5]   0.00-1.00   sec  2.03 MBytes  17.0 Mbits/sec

[  5]   1.00-2.00   sec  2.43 MBytes  20.4 Mbits/sec

[  5]   2.00-3.00   sec  2.48 MBytes  20.8 Mbits/sec

[  5]   3.00-4.00   sec  2.46 MBytes  20.6 Mbits/sec

[  5]   4.00-5.00   sec  2.51 MBytes  21.0 Mbits/sec

[  5]   5.00-6.00   sec  1.87 MBytes  15.7 Mbits/sec

.

.

.

[  5]  27.00-28.00  sec  1.31 MBytes  11.0 Mbits/sec

[  5]  28.00-29.00  sec  1.35 MBytes  11.3 Mbits/sec

[  5]  29.00-30.00  sec  1.38 MBytes  11.6 Mbits/sec

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

[ ID] Interval           Transfer     Bitrate         Retr

[  5]   0.00-30.00  sec  48.8 MBytes  13.6 Mbits/sec    0             sender
```

```
[  5]   0.00-30.00  sec  48.7 MBytes  13.6 Mbits/sec                    receiver


iperf Done.
```

Scan

Select the Scan tab on the Demo tool GUI to actively scan for nearby Access Points. The user can choose between the following scan types:

1. Standard Wi-Fi Scan
2. Low Power Wi-Fi Smart Scan

For more information on the different scan parameters and the procedure to configure them, refer document: `UG_MPD_Demo_Tool_Part_1_Overview.pdf` (*sdk_x.y\pc_tools\MPD\doc*).

Note: x and y in sdk_x.y refer to the SDK release version.

Default values of parameters for `Standard Wi-Fi` and `Low-Power Wi-Fi` scan are shown in Table 1. Depending on the user's choice of the scanning scheme, respective default values will be set to corresponding parameters.

Default Value			
Parameters	Standard Wi-Fi scan	Low-Power Wi-Fi Scan	Remark
No_of_Probes	2	1	Configurable
Ide_Slots	3	3	Configurable
Select the Required Probe Rate	11b_1Mbps	11b_6Mbps	Configurable
NAP Enable	No	Yes	Hard coded

Table 1: Default values for Standard Wi-Fi and Low-Power Wi-Fi Scan

Case 1: Standard Wi-Fi Scan

1. In this mode of scan, Talaria TWO will dwell 40ms on each channel.
2. Hence, to scan all 2Ghz channels, it will take ~520ms in clean environment.
3. In a crowded environment, it will take additional time to complete full scan based on the channel condition.

Console output for Standard Scan Scheme:

```
UART:SNWWWWWAEBuild $Id: git-ba65998b7 $

mpd.proto=scan wifi.scan_num_probes=2 wifi.scan_idleslots=3 wifi.scan_min_listen_time=8

wifi.scan_max_listen_time=40 wifi.scan_wait_time=0 wifi.nap_scan=0

mpd.scan.dt_iterations=10 wifi.probe_rate=0x00 wifi.scan_channel_mask=0x7ff

mpd.regdomain=FCC mpd.suspend=1

$App:git-73e7f910

SDK Ver: SDK_2.6

T2 Multipurpose Demp App Version 0.12

Suspend Enabled.

Regdomain=FCC

addr e0:69:3a:00:13:90

Applying reg domain: 1-11@20

MPD scan mode.

Channels to be scanned=1,2,3,4,5,6,7,8,9,10,11

Enabling suspend.

period=10

Round:1 Found 9 nets:

00:5f:67:cd:c5:a6 on channel 11 @ -60 'InnoPhase' 'WPA2-PSK'
```

```
b0:a7:b9:73:8e:51 on channel  4 @ -73 'Lakshmi pg 2nd floor 2g' 'WPA2-PSK'

ba:6b:ad:62:6d:8b on channel 11 @ -79 'DESKTOP-9B1DNVC 1786' 'WPA2-PSK'

e4:a7:c5:d4:ea:86 on channel  6 @ -82 'Airtel-E5573-EA86' 'WPA2-PSK'

d8:47:32:2e:e1:e0 on channel 11 @ -83 'GPMH' 'WPA2-PSK'

3c:1e:04:2d:c1:01 on channel 11 @ -85 'Lakshmi pg 1st floor' 'WPA-PSK/WPA2-PSK Mixed
Mode'

34:e8:94:be:16:9b on channel  1 @ -88 'InfecteD v2.4' 'WPA2-PSK'

dc:71:37:56:91:b0 on channel  8 @ -90 'Hathway_Raghuram' 'WPA-PSK/WPA2-PSK Mixed Mode'

50:2b:73:98:0f:51 on channel  9 @ -92 'SharmaShesCheatingonYou' 'WPA-PSK/WPA2-PSK Mixed
Mode'
------------------------
Round:2 Found 7 nets:

00:5f:67:cd:c5:a6 on channel 11 @ -52 'InnoPhase' 'WPA2-PSK'

34:0a:33:70:f3:a2 on channel  1 @ -78 'Siddusm' 'WPA2-PSK'

90:8d:78:fa:54:60 on channel 10 @ -79 'LAKSHMI PG 4TH FLOOR' 'WPA2-PSK'

e4:a7:c5:d4:ea:86 on channel  6 @ -82 'Airtel-E5573-EA86' 'WPA2-PSK'

70:4f:57:77:7e:d4 on channel  2 @ -84 'Rahul' 'WPA2-PSK'

dc:71:37:56:91:b0 on channel  8 @ -84 'Hathway_Raghuram' 'WPA-PSK/WPA2-PSK Mixed Mode'

aa:74:84:e0:c9:a0 on channel  4 @ -94 'SUMAIYA' 'WPA-PSK/WPA2-PSK Mixed Mode'
------------------------
Round:3 Found 2 nets:

00:5f:67:cd:c5:a6 on channel 11 @ -60 'InnoPhase' 'WPA2-PSK'
```

```
e4:a7:c5:d4:ea:86 on channel  6 @ -79 'Airtel-E5573-EA86' 'WPA2-PSK'

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

Round:4 Found 3 nets:

34:0a:33:70:f3:a2 on channel  1 @ -80 'Siddusm' 'WPA2-PSK'

e4:a7:c5:d4:ea:86 on channel  6 @ -80 'Airtel-E5573-EA86' 'WPA2-PSK'

34:e8:94:be:16:9b on channel  1 @ -90 'InfecteD v2.4' 'WPA2-PSK'
```

Expected Result: Depending on the scan specifications, available networks are identified and displayed.

Otii log: Shows an average current consumption of 43.7mA for 99.950ms scan duration, here the FCC regulatory domain is enabled.
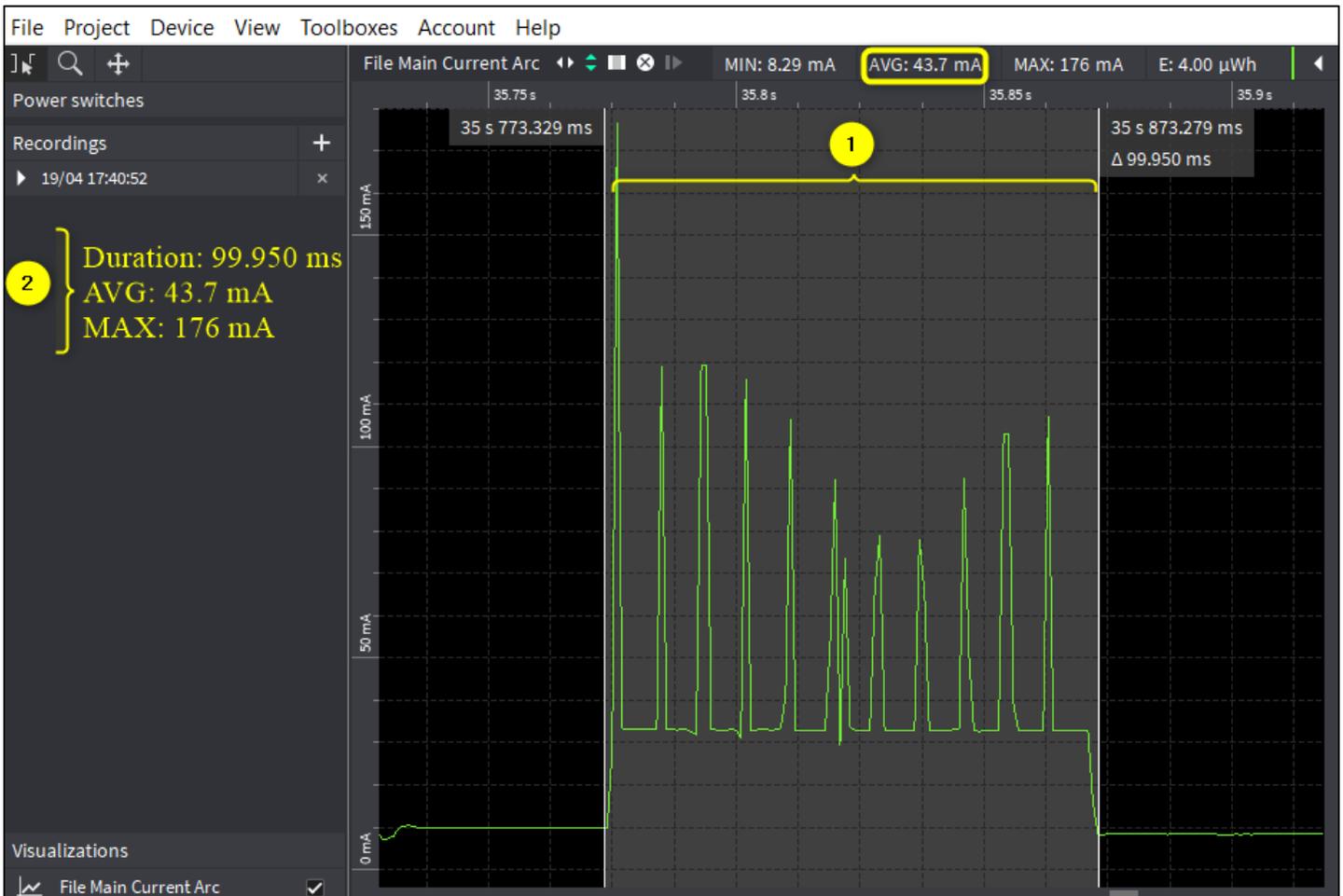
Figure 1: Case 1 - Standard scan - Otii log

Case 2: Low Power Wi-Fi Smart Scan

Overall current consumption can be reduced by one of the following methods:

1. Dynamic dwelling
   a. Based on the channel condition, Talaria TWO can stay minimum channel time or maximum channel time.
   b. Normally, minimum channel time is configured to 8ms, and maximum channel time is configured to 24ms.
   c. While scanning, Talaria TWO will decide after every minimum channel time, whether to stay on channel or move to next channel.
   d. Staying in the channel is based on channel condition. Talaria TWO will identify this by number of idle slots at the end of minimum channel time.
2. Napping
   a. After probe, if Talaria TWO receives packet other than the Probe response and Beacon, Talaria TWO will take a NAP based on the duration of packet received.

Console output for `Low Power` scan scheme:

```
UART:SNWWWWWAEBuild $Id: git-ba65998b7 $

mpd.proto=lpscan wifi.scan_num_probes=1 wifi.scan_idleslots=3

wifi.scan_min_listen_time=8 wifi.scan_max_listen_time=24 wifi.nap_scan=1

mpd.lpscan.ap_logging=1 mpd.lpscan.dt_iterations=10 mpd.lpscan.rate=0x100

wifi.scan_channel_mask=0x7ff mpd.regdomain=FCC mpd.suspend=1

$App:git-73e7f910

SDK Ver: SDK_2.6

T2 Multipurpose Demp App Version 0.12

Suspend Enabled.

Multicast reception Disabled.

Regdomain=FCC

addr e0:69:3a:00:13:90

Applying reg domain: 1-11@20

MPD lpscan mode.
```

```
Enabling suspend.

[1.718,157] Round:1 Found 3 nets:

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

[1.718,817] 00:5f:67:cd:c5:a6 on channel 11 @ -45 'InnoPhase' 'WPA2-PSK'

[1.718,929] b0:a7:b9:73:8e:51 on channel  4 @ -70 'Lakshmi pg 2nd floor 2g' 'WPA2-PSK'

[1.719,042] 34:0a:33:70:f3:a2 on channel  1 @ -77 'Siddusm' 'WPA2-PSK'

[11.698,197] Round:2 Found 3 nets:

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

[11.698,286] ba:6b:ad:62:6d:8b on channel 11 @ -67 'DESKTOP-9B1DNVC 1786' 'WPA2-PSK'

[11.698,401] b0:a7:b9:73:8e:51 on channel  4 @ -71 'Lakshmi pg 2nd floor 2g' 'WPA2-PSK'

[11.698,517] d8:47:32:2e:e1:e0 on channel 11 @ -79 'GPMH' 'WPA2-PSK'

[21.693,819] Round:3 Found 2 nets:

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

[21.693,903] 34:0a:33:70:f3:a2 on channel  1 @ -78 'Siddusm' 'WPA2-PSK'

[21.694,019] 30:b6:2d:94:37:a0 on channel  1 @ -86 'JioPrivateNet' 'WPA2/WPA3-
Enterprise'

[31.684,572] Round:4 Found 2 nets:

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

[31.684,656] 00:5f:67:cd:c5:a6 on channel 11 @ -47 'InnoPhase' 'WPA2-PSK'

[31.684,769] f8:c4:f3:18:2e:08 on channel  2 @ -91 'Shiva_Airtel' 'WPA2-PSK'

[41.702,628] Round:5 Found 3 nets:

------------------------
```

```
[41.702,713] 00:5f:67:cd:c5:a6 on channel 11 @ -57 'InnoPhase' 'WPA2-PSK'

[41.702,828] ba:6b:ad:62:6d:8b on channel 11 @ -66 'DESKTOP-9B1DNVC 1786' 'WPA2-PSK'

[41.702,943] 70:4f:57:77:7e:d4 on channel  2 @ -85 'Rahul' 'WPA2-PSK'
```

Otii log: Shows an average current consumption of 32.8mA for 96.032ms scan duration for low power Wi-Fi smart scan, here FCC regulatory domain is enabled.

Note: The capture is taken in a clean environment.
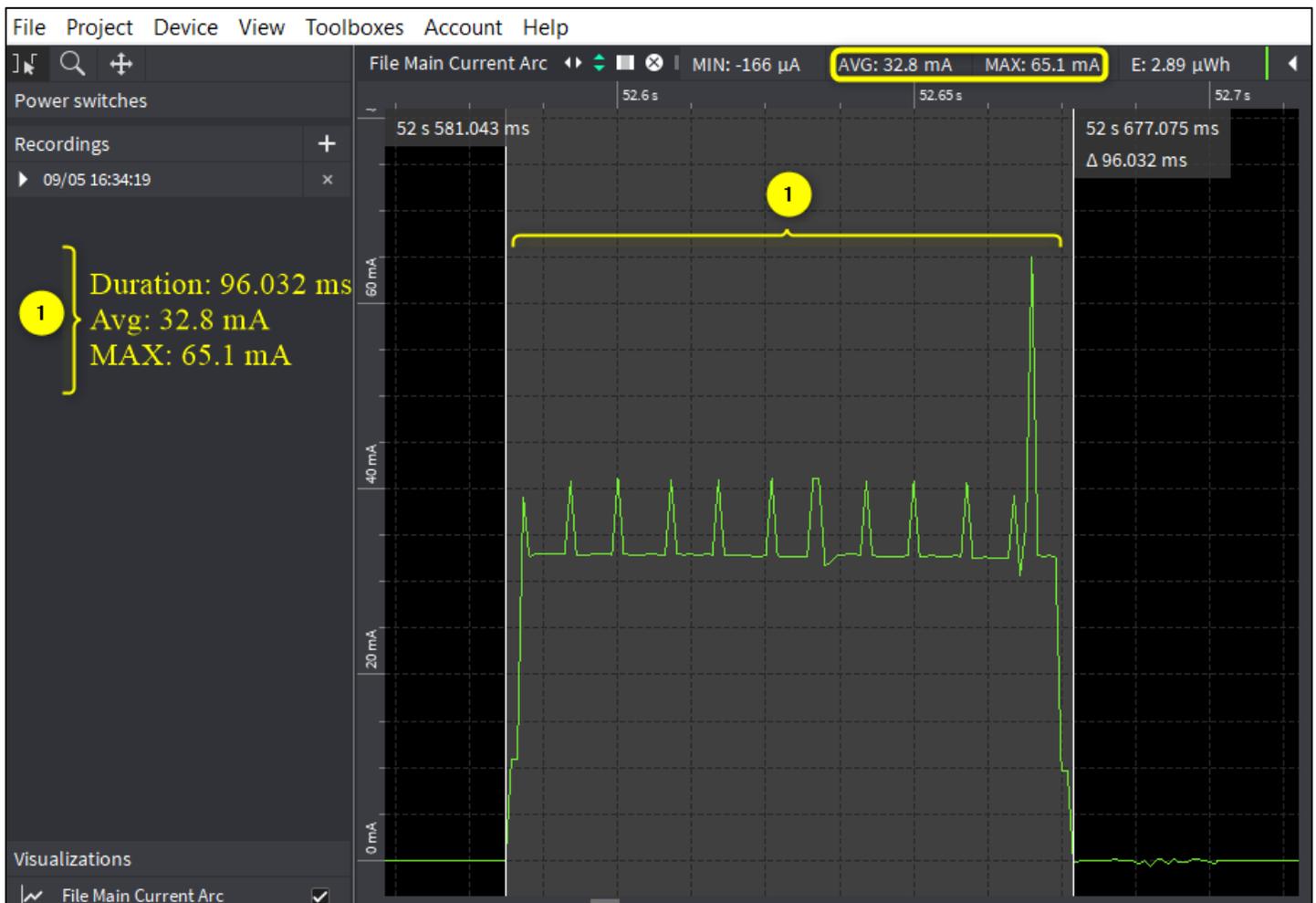
Figure 2: Low power Wi-Fi smart scan - Otti log

Note: Following are some of the use cases that can be configured manually by the user on the MPD GUI scan tab, which is applicable for both Standard and Low Power Smart scan:

1. The Scan tab allows the user to actively scan for nearby Access Points by default parameters.
2. Regulatory Domain: Depending on the user's geographical location, any one of the listed Regulatory Domains can be selected.
3. Channel_list: Set the Wi-Fi channels to be used.
   For example: Set `1-11,13` to use channels 1 to 11 and 13, depending on the selected Regulatory Domain.
4. Prob_rate: The rate as defined by `rate_t` is used to transmit the probe request. If this field is set to `0xffff`, no probes will be sent and the scan will only be passive.

5. Setting the SSID.
   SSID (Service Set Identifier) is the name of the user's wireless network, also known as Network ID. If the SSID of the network is provided and the BSSID field is kept empty, it scans for the network as per the provided SSID and gives the following details:
   a. BSSID
   b. Channel
   c. RSSI Range
   d. Mode
6. Setting the BSSID.
   BSSID recognizes the AP or router as it has a unique address which creates the wireless network. To set the BSSID of a network, enter the BSSID in the provided field and click on `Start`.

Support

1. Sales Support: Contact an InnoPhase sales representative via email – sales@innophaseiot.com
2. Technical Support:
    a. Visit: https://innophaseiot.com/contact/
    b. Also Visit: https://innophaseiot.com/talaria-two-modules/
    c. Contact: support@innophaseiot.com

InnoPhase is working diligently to provide customers outstanding support to all customers.

Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, InnoPhase IoT Incorporated does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and assumes no liability associated with the use of such information. InnoPhase IoT Incorporated takes no responsibility for the content in this document if provided by an information source outside of InnoPhase IoT Incorporated.

InnoPhase IoT Incorporated disclaims liability for any indirect, incidental, punitive, special or consequential damages associated with the use of this document, applications and any products associated with information in this document, whether or not such damages are based on tort (including negligence), warranty, including warranty of merchantability, warranty of fitness for a particular purpose, breach of contract or any other legal theory. Further, InnoPhase IoT Incorporated accepts no liability and makes no warranty, express or implied, for any assistance given with respect to any applications described herein or customer product design, or the application or use by any customer's third-party customer(s).

Notwithstanding any damages that a customer might incur for any reason whatsoever, InnoPhase IoT Incorporated' aggregate and cumulative liability for the products described herein shall be limited in accordance with the Terms and Conditions of identified in the commercial sale documentation for such InnoPhase IoT Incorporated products.

Right to make changes — InnoPhase IoT Incorporated reserves the right to make changes to information published in this document, including, without limitation, changes to any specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — InnoPhase IoT Incorporated products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an InnoPhase IoT Incorporated product can reasonably be expected to result in personal injury, death or severe property or environmental damage. InnoPhase IoT Incorporated and its suppliers accept no liability for inclusion and/or use of InnoPhase IoT Incorporated products in such equipment or applications and such inclusion and/or use is at the customer's own risk.

All trademarks, trade names and registered trademarks mentioned in this document are property of their respective owners and are hereby acknowledged.