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LANforge WiFi Testing Fast Roaming Stations with 802.11r

Goal: Use automated script to migrate stations between APs and report results.

Requires LANforge 5.2.11 or later. Configure Stations to use FT-EAP (802.11r) and associate them with an 802.11r AP network. Use the 'WiFi Mobility' LANforge-GUI Plugin to automate roaming the stations between the APs. The plugin will create graphs and other reports that can be saved to HTML. This example uses a LANforge CT523 system but the procedure should work on all CT520, CT523 and similar systems.

The two APs under test are on the same channel, so a single radio/NIC on LANforge can roam virtual stations between the APs. But, if the APs were on different channels, only a single station per radio would be supported. Multiple CT523 or other high-density systems can be used to migrate stations between APs on different channels.
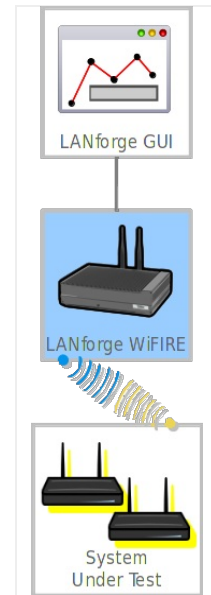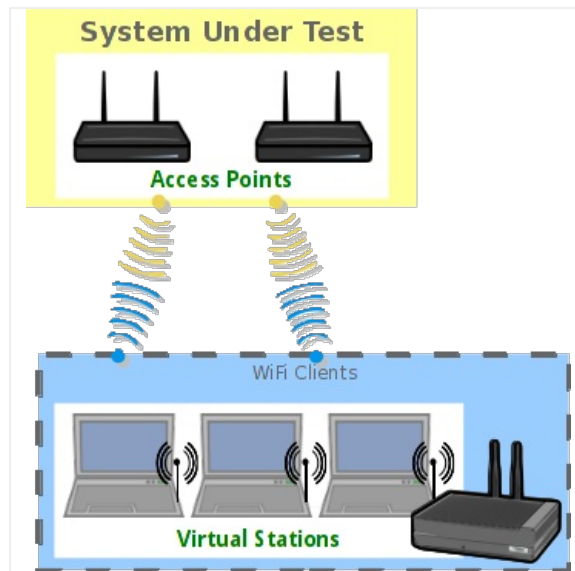
1. Configure stations to connect to APs configured for 802.11r. This requires special AP software support and usually an AP Controller (APC).
    A. Go to the Port Manager tab, select wiphy0 on proper resource, click Create, fill out appropriate information and create desired number of Station interfaces.

B. The new stations should appear in the Port-Mgr table. Double-click to modify one of them. Configure IP Address information, SSID and select WPA2:

sta1 (ct521−5359−F17x64) Configure Settings

Port Status Information
Current: LINK-UP GRO Authorized
Driver Info: Port Type: WIFI-STA   Parent: wiphy0

Port Configurables

| Standard Configuration | Advanced Configuration |

Enable
- ☑ Set IP Info
- ☑ Set IP6 Info
- ☐ Set IF Down
- ☐ Set MAC
- ☐ Set TX Q Len
- ☐ Set MTU
- ☐ Set Offload
- ☐ Set PROMISC

Services
- ☐ HTTP
- ☐ FTP

Low Level
- ☐ PROMISC
- ☐ TSO Enabled
- ☐ UFO Enabled
- ☐ GSO Enabled
- ☐ LRO Enabled
- ☑ GRO Enabled

General Interface Settings

☐ DHCP-IPv6 ☑ DHCP Release   ☐ Down   ☐ Aux-Mgt
☑ DHCP-IPv4   Secondary-IPs   DHCP Client ID: None

DNS Servers: 192.168.2.1   Peer IP: NA
IP Address: 0.0.0.0   Global IPv6: DELETED
IP Mask: 0.0.0.0   Link IPv6:   DELETED
Gateway IP: 0.0.0.0   IPv6 GW: DELETED
Alias: MTU: 1500
MAC Addr: 00:aa:aa:aa:aa:01 TX Q Len   1000
Rpt Timer: medium (8 s)   WiFi Bridge: NONE

WiFi Settings

SSID: aironet1-5   AP: DEFAULT
Key/Phrase: lanforge   Mode: 802.11abgn
Freq/Channel: 5180/36   Rate: OS Default
RTS: -1   Tx-Power: 17 dBm
AMPDU-Factor: OS Default   AMPDU-Density: OS Default
Max-AMSDU: OS Default   Bridge-IP: 0.0.0.0

☐ Use WPA ☑ Use WPA2 ☐ Use WEP ☐ Disable HT40 ☐ Disable SGI
☐ Scan Hidden ☐ Allow Migration

| Print | View Details | Probe | Display Scan | Sync | Apply | OK | Cancel |

C. Select the **Advanced Configuration** tab in the Port-Modify window and configure the Key Management, Private Key and other values needed to connect to the APs. Be sure to un-select the **Restart DHCP on Connect** checkbox so that DHCP is not refreshed each time a station roams:

D. Once the single station is connecting properly, use Batch-Modify to configure the rest of the stations to match the first.

For more information see LANforge User's Guide: Ports (Interfaces) , WiFi Station Cookbook

2. Create VOIP connections between the wired Ethernet eth1 interface and the stations. This will add realistic traffic load to the network under test and allow LANforge to report packet-loss statistics during roaming. The VOIP feature costs extra, so you may wish to use a normal Layer-3 UDP connection which should also provide good reports and a realistic traffic load. The steps below are for VOIP, but Layer-3 would be very similar.

A. Go to the VOIP/RTP tab, click Create, and configure a VOIP connection on eth1 and the first station:

B. Apply the configuration and make sure the call can complete. Then click Modify on the VOIP connection and use Batch-Create to create one connection for each of the WiFi stations.

C. Select the VOIP and/or Layer-3 connections and start traffic flow. For this example, the connections should remain running while the roaming takes place. It would also be valid to do roaming without any traffic if that is the desired test case.

3. Start the WiFi Migration script.

A. Go to the Port Manager tab, select the stations you wish to roam, right-click and choose the **WiFi Mobility** menu option.

WiFi Mobility

Refresh Interval (ms):	5000
Pause Between Commands (ms):	50
Pause after Show-Port (ms):	1000
Auto-Verify timer (ms):	1000
Maximum roam-time in graphs (ms):	250

WiFi Stations

Ports in Use
- 1.1.2 sta1
- 1.1.4 sta2
- 1.1.5 sta3
- 1.1.6 sta4
- 1.1.7 sta5
- 1.1.8 sta6
- 1.1.9 sta7

⟸ Add Station

Remove Station ⟹

Free Ports
- 1.1.10 sta8
- 1.1.11 sta9
- 1.1.12 sta10
- 1.1.13 sta11
- 1.1.14 sta12
- 1.1.15 sta13
- 1.1.16 sta14
- 1.1.17 sta15
- 1.1.18 sta16

Before roaming, you should first scan the proper frequencies.
Otherwise, the supplicant process may do an internal scan
which may significantly affect the connection time:
```
 do_cli scan 1 Resource STA NA 'trigger freq F1 F2'
```
To roam to a new Access Point, add a line in the text area with
the following format:
```
 roam Resource STA BSSID
```

- Resource: Station's resource ID number, often '1'
- STA: name of the station to roam: 'sta11'
- BSSID: the BSSID address of the AP: 00:01:02:03:04:05
- F1: the first frequency to scan: 5180
- F2: Optional second frequency to scan: 5300

After issuing ROAM commands, a pause should be added to let
the stations adjust (in seconds, floating-point allowed):
```
 sleep 20
```
To issue a generic LANforge CLI command, begin command with:
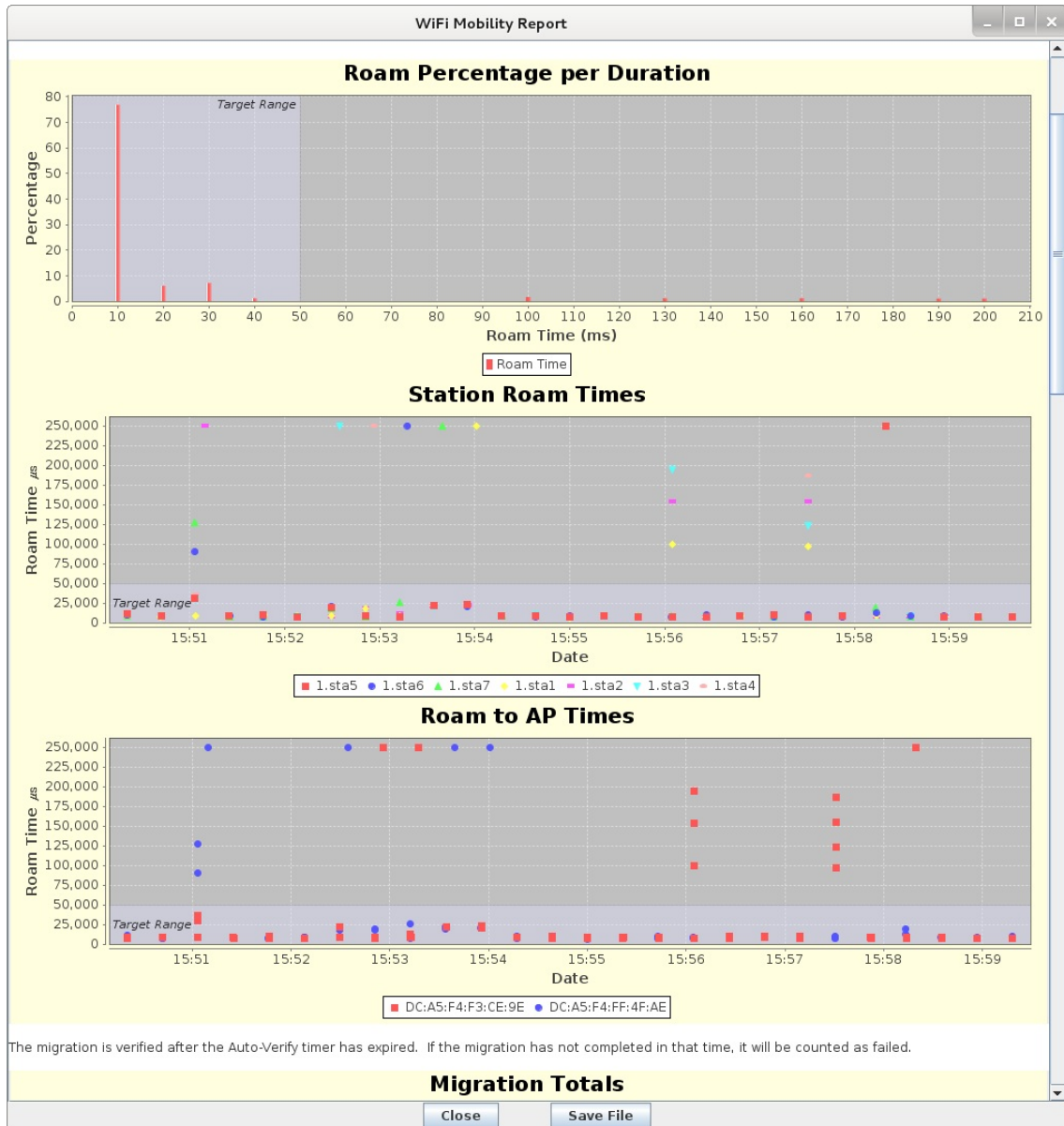```
 do_cli
```
Example:
```
 do_cli scan 1 1 sta1 NA 'trigger freq 5180 5300'
 sleep 1
 roam 1 sta1 dc:a5:f4:ff:4f:ae
 sleep 20
 do_cli scan 1 1 sta1 NA 'trigger freq 5180 5300'
 sleep 1
 roam 1 sta1 dc:a5:f4:f3:ce:9e
 sleep 20
```

```
do_cli scan 1 1 sta1 NA 'trigger freq 5180 5300'
sleep 1
roam 1 sta1 dc:a5:f4:ff:4f:ae
roam 1 sta2 dc:a5:f4:ff:4f:ae
roam 1 sta3 dc:a5:f4:ff:4f:ae
roam 1 sta4 dc:a5:f4:ff:4f:ae
roam 1 sta5 dc:a5:f4:f3:ce:9e
roam 1 sta6 dc:a5:f4:f3:ce:9e
roam 1 sta7 dc:a5:f4:f3:ce:9e
sleep 20
do_cli scan 1 1 sta1 NA 'trigger freq 5180 5300'
sleep 1
roam 1 sta7 dc:a5:f4:ff:4f:ae
roam 1 sta6 dc:a5:f4:ff:4f:ae
roam 1 sta5 dc:a5:f4:ff:4f:ae
roam 1 sta4 dc:a5:f4:f3:ce:9e
roam 1 sta3 dc:a5:f4:f3:ce:9e
roam 1 sta2 dc:a5:f4:f3:ce:9e
roam 1 sta1 dc:a5:f4:f3:ce:9e
sleep 20
```
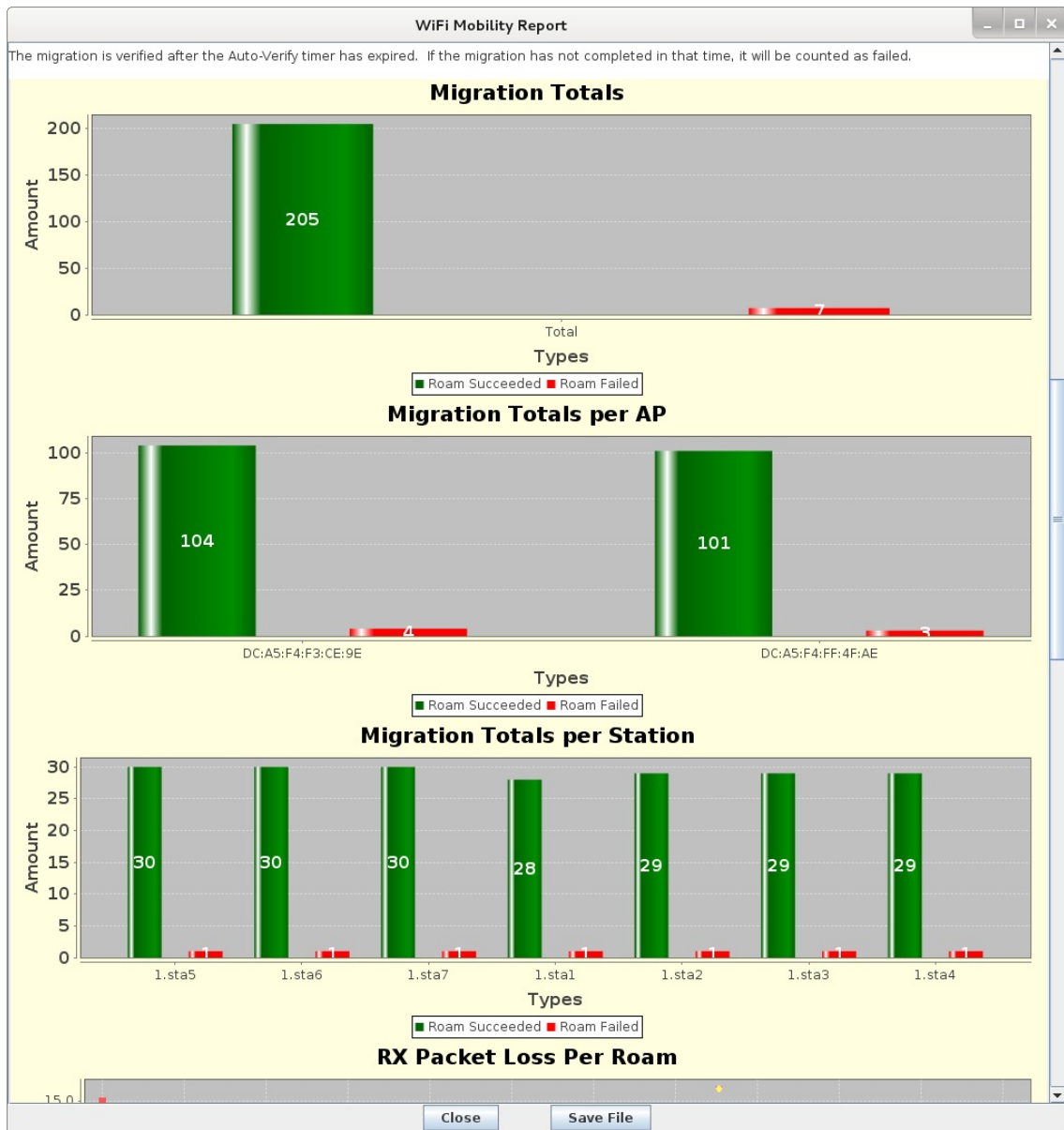
☑ Clear Counters on Start   ☑ Run Script in Loop   Start   Close

B. The options at the top default to common values and may not need to be changed. The ports will be automatically configured based on the selection on the Port Manager tab, and can be adjusted before starting the script. The Ports in Use should normally include all stations used in the script. The configuration requiring the most work from the user is the roaming script itself. There is a help section on the left, and a script-entry field on the right. Once the script is written, it should be saved in a text file on the user's PC so that it can easily be pasted into future WiFi Mobility scripts. Some key points are that you must scan about 1 second before roaming or the roam logic in the supplicant process will either fail or do it's own roaming. Either way, the results may be worse than if you do the roam properly in the script. It can take a bit of time for LANforge to get all of the data it needs to report on the roam attempt, so it is suggested that stations not roam more often that about once every 10-20 seconds. If reporting is less important, then the stations can roam more often.

C. Once the script is properly configured, click Start to start the roaming. A window will pop up that has live-updating graphs of various reports. A text log is at the bottom for more detailed analysis, and the whole thing can be saved as HTML. The graphs can be scaled and configured through right-click menus if desired. It will take 1-2 complete roam attempts before the graphs are able to show any useful information.

D.  Migration totals graphs.



WiFi Mobility Report

The migration is verified after the Auto-Verify timer has expired.  If the migration has not completed in that time, it will be counted as failed.

**Migration Totals**

205

7

Total

Types

■ Roam Succeeded ■ Roam Failed

**Migration Totals per AP**

104

101

4

3

DC:A5:F4:F3:CE:9E          DC:A5:F4:FF:4F:AE

Types

■ Roam Succeeded ■ Roam Failed

**Migration Totals per Station**

30      30      30      28      29      29      29

1.sta5    1.sta6    1.sta7    1.sta1    1.sta2    1.sta3    1.sta4

Types

■ Roam Succeeded ■ Roam Failed

**RX Packet Loss Per Roam**

Close          Save File

E. Packet Loss graphs.



WiFi Mobility Report

**RX Packet Loss Per Roam**

■ 1.sta5  ● 1.sta6  ▲ 1.sta7  ◆ 1.sta1  ■ 1.sta2  ▼ 1.sta3  ● 1.sta4

**Total RX Packet Loss Percentage**

— 1.sta5  — 1.sta6  — 1.sta7  — 1.sta1  — 1.sta2  — 1.sta3  — 1.sta4

Migration Script Contents:

```
do_cli scan 1 1 sta1 NA 'trigger freq 5180 5300'
sleep 1
roam 1 sta1 dc:a5:f4:ff:4f:ae
roam 1 sta2 dc:a5:f4:ff:4f:ae
roam 1 sta3 dc:a5:f4:ff:4f:ae
roam 1 sta4 dc:a5:f4:ff:4f:ae
roam 1 sta5 dc:a5:f4:f3:ce:9e
roam 1 sta6 dc:a5:f4:f3:ce:9e
roam 1 sta7 dc:a5:f4:f3:ce:9e
sleep 20
do_cli scan 1 1 sta1 NA 'trigger freq 5180 5300'
sleep 1
roam 1 sta7 dc:a5:f4:ff:4f:ae
roam 1 sta6 dc:a5:f4:ff:4f:ae
roam 1 sta5 dc:a5:f4:ff:4f:ae
roam 1 sta4 dc:a5:f4:f3:ce:9e
roam 1 sta3 dc:a5:f4:f3:ce:9e
roam 1 sta2 dc:a5:f4:f3:ce:9e
roam 1 sta1 dc:a5:f4:f3:ce:9e
sleep 20
```

Close   Save File

F. Text log with timestamps. Can be coorelated with wpa_supplicant logs and other log files to debug specific roam attempts.

WiFi Mobility Report

—1.sta5 —1.sta6 —1.sta7 1.sta1 —1.sta2 1.sta3 —1.sta4

```
Migration Script Contents:

do_cli scan 1 1 sta1 NA 'trigger freq 5180 5300'
sleep 1
roam 1 sta1 dc:a5:f4:ff:4f:ae
roam 1 sta2 dc:a5:f4:ff:4f:ae
roam 1 sta3 dc:a5:f4:ff:4f:ae
roam 1 sta4 dc:a5:f4:ff:4f:ae
roam 1 sta5 dc:a5:f4:f3:ce:9e
roam 1 sta6 dc:a5:f4:f3:ce:9e
roam 1 sta7 dc:a5:f4:f3:ce:9e
sleep 20
do_cli scan 1 1 sta1 NA 'trigger freq 5180 5300'
sleep 1
roam 1 sta7 dc:a5:f4:ff:4f:ae
roam 1 sta6 dc:a5:f4:ff:4f:ae
roam 1 sta5 dc:a5:f4:ff:4f:ae
roam 1 sta4 dc:a5:f4:f3:ce:9e
roam 1 sta3 dc:a5:f4:f3:ce:9e
roam 1 sta2 dc:a5:f4:f3:ce:9e
roam 1 sta1 dc:a5:f4:f3:ce:9e
sleep 20
```

```
1384905051.623 sta7: connected to: DC:A5:F4:F3:CE:9E in: 9,024 us
1384905062.111 CLI: scan 1 1 sta1 NA 'trigger freq 5180 5300'
1384905063.212 CLI: wifi_cli_cmd 1 1 sta7 'roam DC:A5:F4:FF:4F:AE'
1384905063.263 CLI: wifi_cli_cmd 1 1 sta6 'roam DC:A5:F4:FF:4F:AE'
1384905063.314 CLI: wifi_cli_cmd 1 1 sta5 'roam DC:A5:F4:FF:4F:AE'
1384905063.365 CLI: wifi_cli_cmd 1 1 sta4 'roam DC:A5:F4:F3:CE:9E'
1384905063.416 CLI: wifi_cli_cmd 1 1 sta3 'roam DC:A5:F4:F3:CE:9E'
1384905063.467 CLI: wifi_cli_cmd 1 1 sta2 'roam DC:A5:F4:F3:CE:9E'
1384905063.518 CLI: wifi_cli_cmd 1 1 sta1 'roam DC:A5:F4:F3:CE:9E'
1384905064.213 Detected: 0 dropped (rx) packets during roam attempt, station: 1.1.9(sta7), BSSID: DC:A5:F4:FF:4F:AE
1384905064.263 Detected: 6 dropped (rx) packets during roam attempt, station: 1.1.8(sta6), BSSID: DC:A5:F4:FF:4F:AE
1384905064.315 Detected: 0 dropped (rx) packets during roam attempt, station: 1.1.7(sta5), BSSID: DC:A5:F4:FF:4F:AE
1384905064.366 Detected: 2 dropped (rx) packets during roam attempt, station: 1.1.6(sta4), BSSID: DC:A5:F4:F3:CE:9E
1384905064.417 Detected: 2 dropped (rx) packets during roam attempt, station: 1.1.5(sta3), BSSID: DC:A5:F4:F3:CE:9E
1384905064.468 WARNING: Roam attempt did not work, station: 1.1.4(sta2), in VERIFY_ROAM task.
1384905064.468 WARNING: Requested BSSID: DC:A5:F4:F3:CE:9E Reported: DC:A5:F4:FF:4F:AE
1384905064.469 Detected: 0 dropped (rx) packets during roam attempt, station: 1.1.4(sta2), BSSID: DC:A5:F4:F3:CE:9E
1384905064.519 Detected: 1 dropped (rx) packets during roam attempt, station: 1.1.2(sta1), BSSID: DC:A5:F4:F3:CE:9E
1384905069.629 sta1: connected to: DC:A5:F4:F3:CE:9E in: 8,067 us
1384905069.631 sta3: connected to: DC:A5:F4:F3:CE:9E in: 29,865 us
1384905069.632 sta4: connected to: DC:A5:F4:F3:CE:9E in: 35,853 us
1384905069.634 sta5: connected to: DC:A5:F4:FF:4F:AE in: 30,478 us
1384905069.635 sta6: connected to: DC:A5:F4:FF:4F:AE in: 90,238 us
1384905069.636 sta7: connected to: DC:A5:F4:FF:4F:AE in: 127,157 us
1384905075.639 sta2: connected to: DC:A5:F4:FF:4F:AE in: 718,170 us
1384905083.619 CLI: scan 1 1 sta1 NA 'trigger freq 5180 5300'
1384905084.720 CLI: wifi_cli_cmd 1 1 sta1 'roam DC:A5:F4:FF:4F:AE'
1384905084.771 Skipping roam request for port: 1.sta2 because it is already associated with AP: DC:A5:F4:FF:4F:AE
1384905084.822 CLI: wifi_cli_cmd 1 1 sta3 'roam DC:A5:F4:FF:4F:AE'
1384905084.873 CLI: wifi_cli_cmd 1 1 sta4 'roam DC:A5:F4:FF:4F:AE'
1384905084.924 CLI: wifi_cli_cmd 1 1 sta5 'roam DC:A5:F4:F3:CE:9E'
1384905084.975 CLI: wifi_cli_cmd 1 1 sta6 'roam DC:A5:F4:F3:CE:9E'
1384905085.103 CLI: wifi_cli_cmd 1 1 sta7 'roam DC:A5:F4:F3:CE:9E'
1384905085.723 Detected: 0 dropped (rx) packets during roam attempt, station: 1.1.2(sta1), BSSID: DC:A5:F4:FF:4F:AE
1384905085.823 Detected: 2 dropped (rx) packets during roam attempt, station: 1.1.5(sta3), BSSID: DC:A5:F4:FF:4F:AE
1384905085.874 Detected: 1 dropped (rx) packets during roam attempt, station: 1.1.6(sta4), BSSID: DC:A5:F4:FF:4F:AE
1384905085.924 Detected: 1 dropped (rx) packets during roam attempt, station: 1.1.7(sta5), BSSID: DC:A5:F4:F3:CE:9E
1384905085.976 Detected: 2 dropped (rx) packets during roam attempt, station: 1.1.8(sta6), BSSID: DC:A5:F4:F3:CE:9E
1384905086.105 Detected: 0 dropped (rx) packets during roam attempt, station: 1.1.9(sta7), BSSID: DC:A5:F4:F3:CE:9E
1384905093.647 sta1: connected to: DC:A5:F4:FF:4F:AE in: 7,825 us
```

Close   Save File