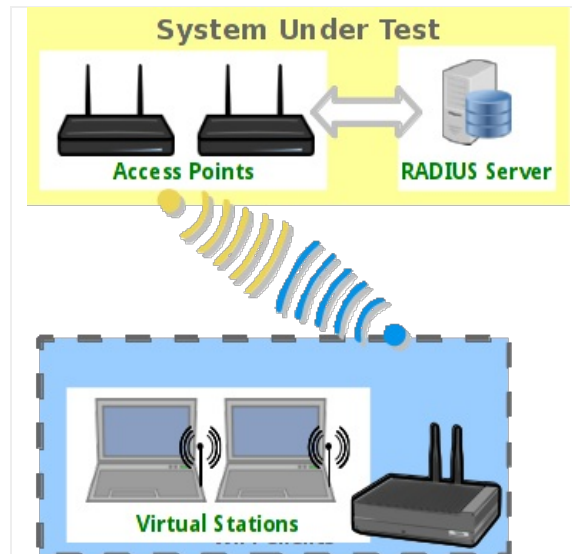


LANforge WiFi testing Roaming and HotSpot 2.0

Goal: Use automated script to reconnect stations to an AP and report results.

Requires LANforge 5.2.11 or later. Configure Stations to use HotSpot 2.0 (802.1x, 802.1u, etc) and associate them with a HotSpot 2.0 AP. Use the 'WiFi Mobility' LANforge-GUI Plugin to automate re-connecting to the AP and querying ANQP. The plugin will create graphs and other reports that can be saved to HTML. This example uses a LANforge CT520 system but the procedure should work on all CT521, CT522, CT523, CT525 and similar systems. The AP in this test is another LANforge machine, but it could be any AP that supports HotSpot 2.0. A similar test could roam between multiple APs. If the APs are all on the same channel there are no restrictions, but if the APs are on different channels, then only a single station can be configured per LANforge radio. In that case, multiple 3-radio CT523 or other high-density systems may be a good choice.



1. Configure stations to connect to an AP configured for HotSpot 2.0.
 - 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, set SSID to [BLANK] and select WPA2:

sta1 (ath9k-119) 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: 10.97.1.1 Peer IP: NA
- IP Address: 9.9.9.2 Global IPv6: AUTO
- IP Mask: 255.255.255.0 Link IPv6: AUTO
- Gateway IP: 0.0.0.0 IPv6 GW: AUTO
- Alias: MTU: 1500
- MAC Addr: 00:ab:cd:ef:01:02 TX Q Len: 1000
- Rpt Timer: medium (8 s) WiFi Bridge: NONE

WiFi Settings

- SSID: [BLANK] AP: DEFAULT
- Key/Phrase: 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, EAP Method, passwords, select **Use 802.1x**, **Enable 802.11u** and **HotSpot 2.0**. If you want to report on DHCP negotiation times, be sure to select the **Restart DHCP on Connect** checkbox. If you want to get packet-drop statistics during roam, Un-select **Restart DHCP on Connect**:

The screenshot shows the 'sta1 (ath9k-119) Configure Settings' window. At the top, it displays 'Port Status Information' with 'Current: LINK-UP GRO Authenticated' and 'Driver Info: Port Type: WIFI-STA Parent: wiphy0'. Below this is the 'Port Configurables' section, which has two tabs: 'Standard Configuration' and 'Advanced Configuration'. The 'Advanced Configuration' tab is active, showing 'Advanced WiFi Settings'. A note at the top of this section reads: 'Select 'WPA2' on the Standard Configuration screen to enable 802.1x and enable 802.1x to enable most of these. Enabling 802.11u enables others.' The settings are organized into two columns:

- Left Column:**
 - Key Management: WPA-EAP
 - Pairwise Ciphers: CCMP TKIP
 - Group Ciphers: All
 - WPA PSK: (empty)
 - EAP Methods: EAP-TTLS
 - EAP Identity: testuser
 - EAP Anon Identity: (empty)
 - EAP Password: testpasswd
 - EAP Pin: (empty)
 - Private Key: (empty)
 - CA Cert File: (empty)
 - Network Auth: (empty)
- Right Column:**
 - HESSID: 00:00:00:00:00:00
 - Realm: lanforge.org
 - Client Cert: (empty)
 - IMSI: (empty)
 - Milenage: (empty)
 - Domain: lanforge.org
 - Consortium: (empty)
 - Phase-1: (empty)
 - Phase-2: auth=MSCHAPV2
 - PK Password: (empty)
 - PAC File: (empty)

At the bottom of the 'Advanced WiFi Settings' section, there are several checkboxes:

- Use 802.1x
- PC/SC & SIM/USIM
- Enable 802.11u
- HotSpot 2.0
- Enable PKC
- Custom WPA Cfg
- WPA Cfg: (empty)
- Restart DHCP on Connect

At the very bottom of the window, there are buttons for 'Print', 'View Details', 'Probe', 'Display Scan', 'Sync', 'Apply', 'OK', and 'Cancel'.

- 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](#) , [WiFi HotSpot 2.0 Cookbook](#)

2. 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):

Pause Between Commands (ms):

Pause after Show-Port (ms):

Auto-Verify timer (ms):

Maximum roam-time in graphs (ms):

Skip Roam to current AP Run Script in Loop

Clear Counters on Start

WiFi Stations

Ports in Use		Free Ports
<div style="border: 1px solid gray; padding: 2px;"> 1.3.5 sta2 1.3.6 sta3 1.3.7 sta4 1.3.8 sta5 1.3.9 sta6 1.3.10 sta7 </div>	<input type="button" value="← Add Station"/> <input type="button" value="Remove Station →"/>	<div style="border: 1px solid gray; padding: 2px;"> 1.1.4 wlan0 1.1.5 wlan1 1.3.2 sta0 1.3.4 sta1 1.3.11 sta8 1.3.12 sta9 1.3.13 sta10 1.3.14 sta11 1.3.15 sta12 1.3.16 sta13 </div>

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:

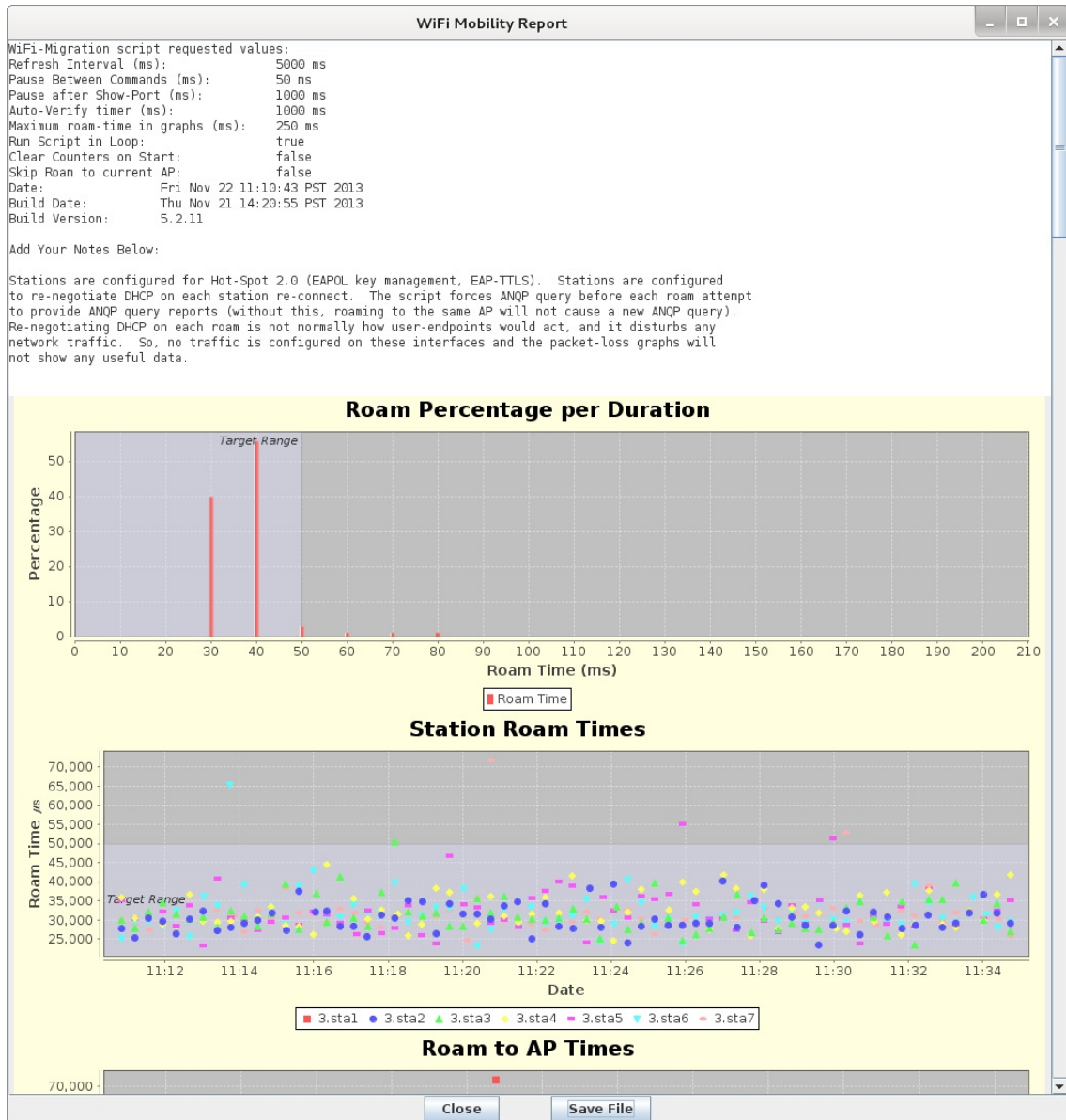
```
do_cli scan 1 1 stal NA 'trigger freq 5180 5300'
sleep 1
roam 1 stal dc:a5:f4:ff:4f:ae
sleep 20
do_cli scan 1 1 stal NA 'trigger freq 5180 5300'
sleep 1
roam 1 stal dc:a5:f4:f3:ce:9e
sleep 20
```

```
# When roaming to self, anqp is not normally done
# so this script forces an ANQP query so that we
# get some ANQP query report times to display.

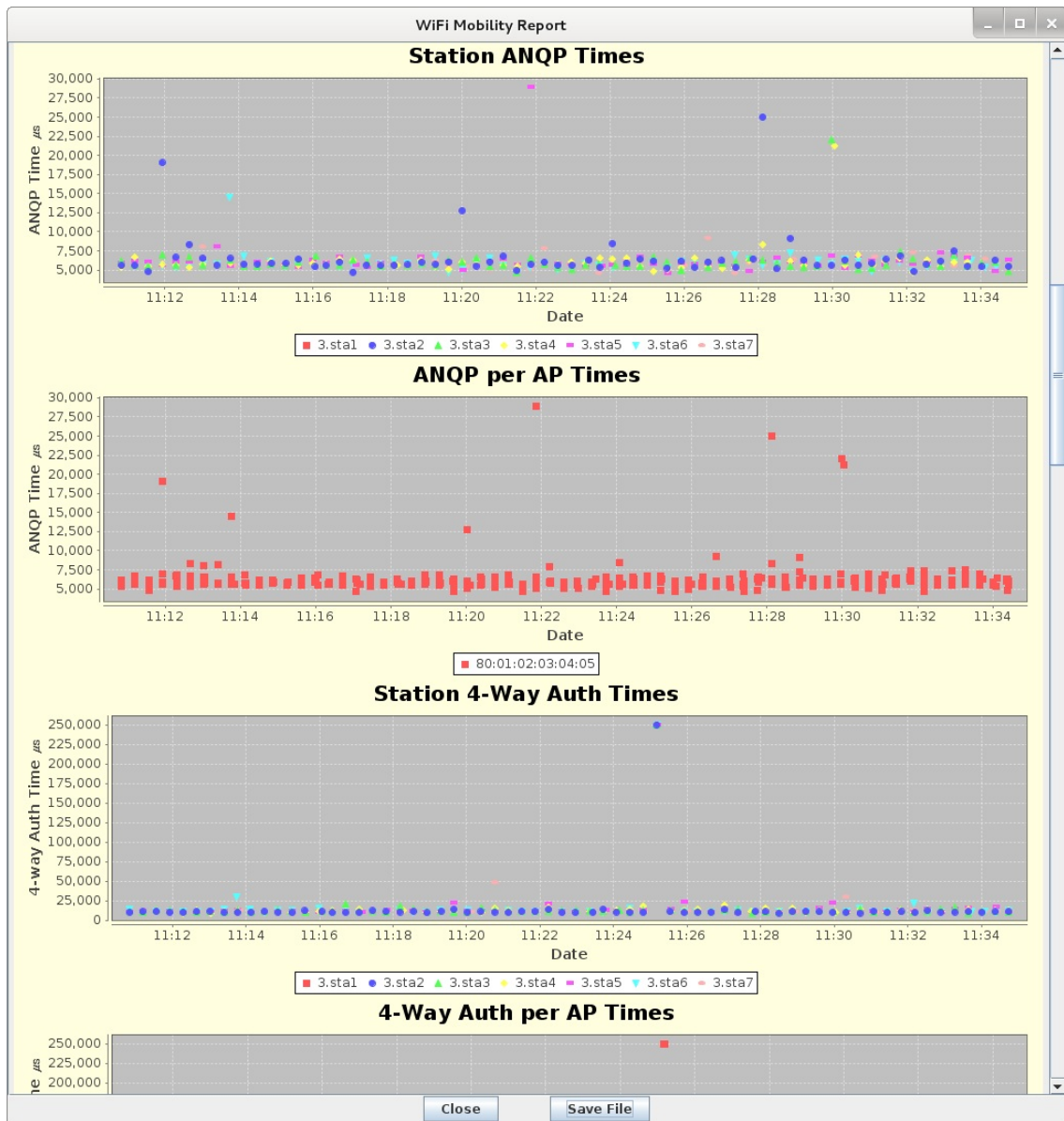
do_cli scan 1 3 sta1 NA 'trigger freq 5180 5300'
sleep 1
do_cli wifi_cli_cmd 1 3 sta1 'fetch_anqp'
roam 3 sta1 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta2 'fetch_anqp'
roam 3 sta2 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta3 'fetch_anqp'
roam 3 sta3 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta4 'fetch_anqp'
roam 3 sta4 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta5 'fetch_anqp'
roam 3 sta5 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta6 'fetch_anqp'
roam 3 sta6 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta7 'fetch_anqp'
roam 3 sta7 80:01:02:03:04:05
sleep 20
```

- B. The options at the top default to common values and most do not need to be changed. For this example, you must unselect **Skip Roam to current AP** because the script is requesting exactly that. The ports will be automatically configured based on the selection on the Port Manager tab, and may 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 its 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 than about once every 10-20 seconds. If reporting is less important, then the stations can roam more often.

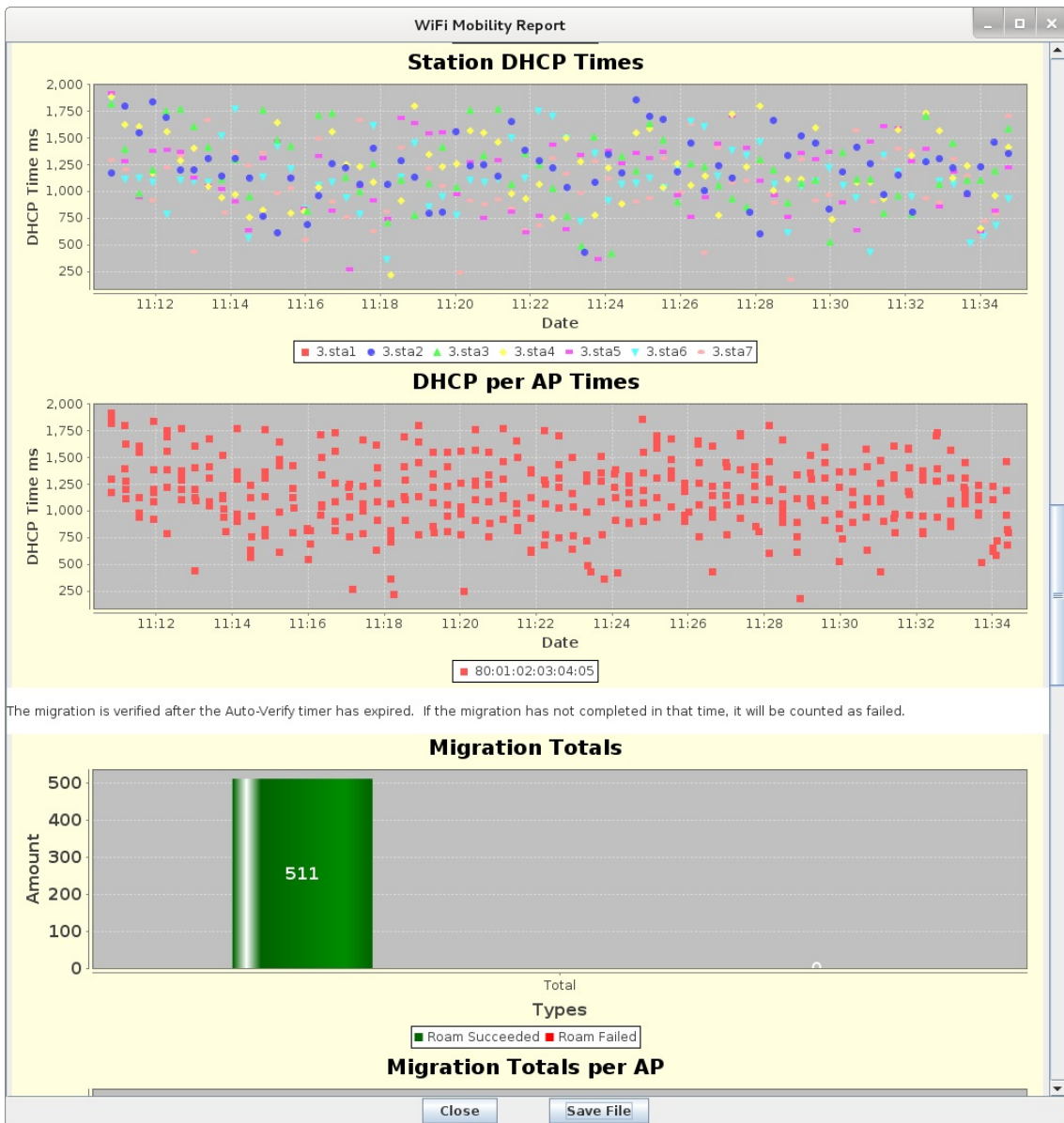
- C. Once the script is properly configured, click Start to start the roaming. A window will pop up that has live-updating graphs of various reports. A text log is at the bottom for more detailed analysis, and the whole thing can be saved as HTML. The graphs can be scaled and configured through right-click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



D. ANQP and 4-Way Authentication graphs.

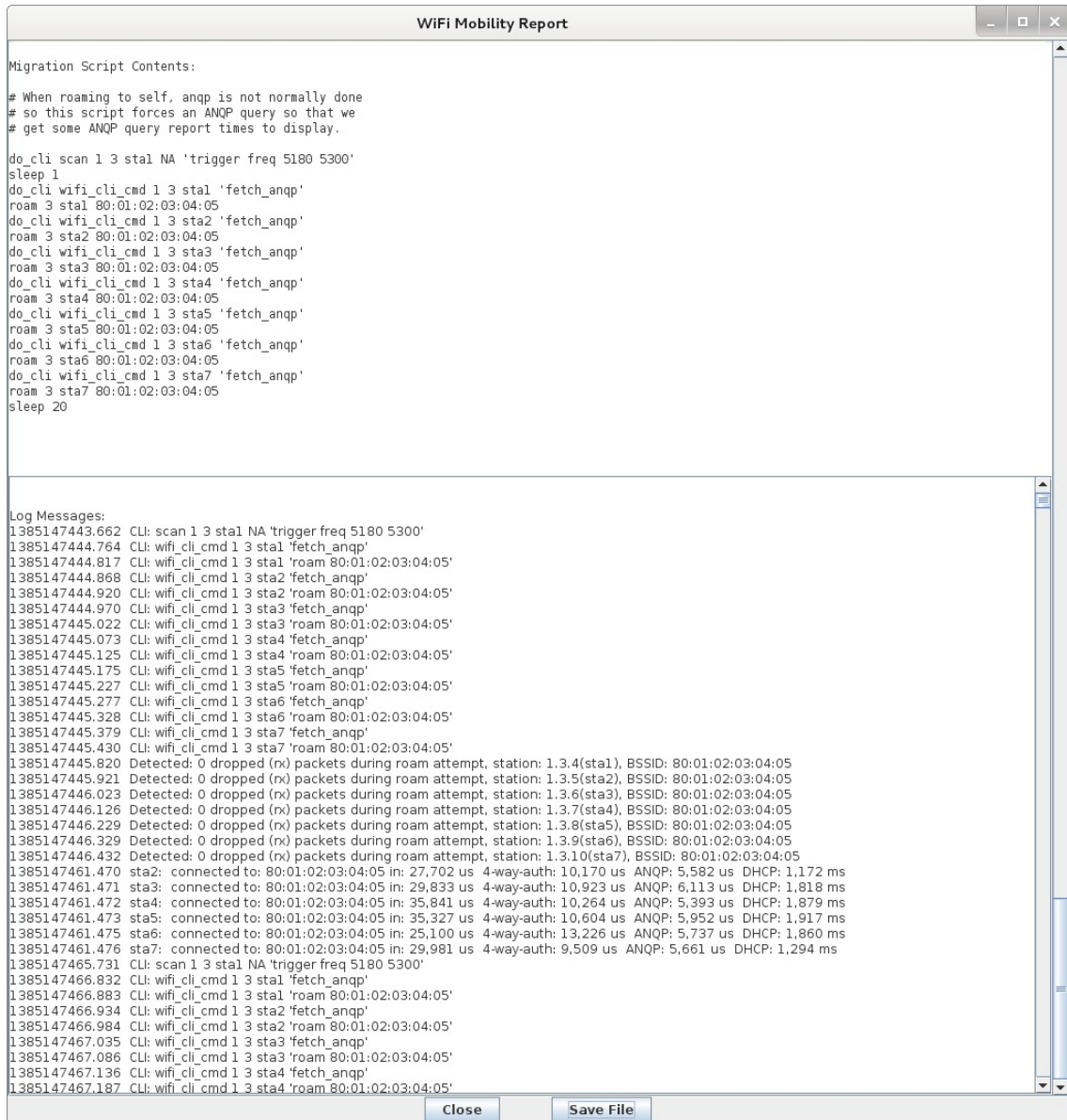


E. DHCP Negotiation and Migration Totals graphs.



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.

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



```
WiFi Mobility Report

Migration Script Contents:

# When roaming to self, anqp is not normally done
# so this script forces an ANQP query so that we
# get some ANQP query report times to display.

do_cli scan 1 3 sta1 NA 'trigger freq 5180 5300'
sleep 1
do_cli wifi_cli_cmd 1 3 sta1 'fetch_anqp'
roam 3 sta1 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta2 'fetch_anqp'
roam 3 sta2 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta3 'fetch_anqp'
roam 3 sta3 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta4 'fetch_anqp'
roam 3 sta4 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta5 'fetch_anqp'
roam 3 sta5 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta6 'fetch_anqp'
roam 3 sta6 80:01:02:03:04:05
do_cli wifi_cli_cmd 1 3 sta7 'fetch_anqp'
roam 3 sta7 80:01:02:03:04:05
sleep 20

Log Messages:
1385147443.662 CLI: scan 1 3 sta1 NA 'trigger freq 5180 5300'
1385147444.764 CLI: wifi_cli_cmd 1 3 sta1 'fetch_anqp'
1385147444.817 CLI: wifi_cli_cmd 1 3 sta1 'roam 80:01:02:03:04:05'
1385147444.868 CLI: wifi_cli_cmd 1 3 sta2 'fetch_anqp'
1385147444.920 CLI: wifi_cli_cmd 1 3 sta2 'roam 80:01:02:03:04:05'
1385147444.970 CLI: wifi_cli_cmd 1 3 sta3 'fetch_anqp'
1385147445.022 CLI: wifi_cli_cmd 1 3 sta3 'roam 80:01:02:03:04:05'
1385147445.073 CLI: wifi_cli_cmd 1 3 sta4 'fetch_anqp'
1385147445.125 CLI: wifi_cli_cmd 1 3 sta4 'roam 80:01:02:03:04:05'
1385147445.175 CLI: wifi_cli_cmd 1 3 sta5 'fetch_anqp'
1385147445.227 CLI: wifi_cli_cmd 1 3 sta5 'roam 80:01:02:03:04:05'
1385147445.277 CLI: wifi_cli_cmd 1 3 sta6 'fetch_anqp'
1385147445.328 CLI: wifi_cli_cmd 1 3 sta6 'roam 80:01:02:03:04:05'
1385147445.379 CLI: wifi_cli_cmd 1 3 sta7 'fetch_anqp'
1385147445.430 CLI: wifi_cli_cmd 1 3 sta7 'roam 80:01:02:03:04:05'
1385147445.820 Detected: 0 dropped (rx) packets during roam attempt, station: 1.3.4(sta1), BSSID: 80:01:02:03:04:05
1385147445.921 Detected: 0 dropped (rx) packets during roam attempt, station: 1.3.5(sta2), BSSID: 80:01:02:03:04:05
1385147446.023 Detected: 0 dropped (rx) packets during roam attempt, station: 1.3.6(sta3), BSSID: 80:01:02:03:04:05
1385147446.126 Detected: 0 dropped (rx) packets during roam attempt, station: 1.3.7(sta4), BSSID: 80:01:02:03:04:05
1385147446.229 Detected: 0 dropped (rx) packets during roam attempt, station: 1.3.8(sta5), BSSID: 80:01:02:03:04:05
1385147446.329 Detected: 0 dropped (rx) packets during roam attempt, station: 1.3.9(sta6), BSSID: 80:01:02:03:04:05
1385147446.432 Detected: 0 dropped (rx) packets during roam attempt, station: 1.3.10(sta7), BSSID: 80:01:02:03:04:05
1385147461.470 sta2: connected to: 80:01:02:03:04:05 in: 27,702 us 4-way-auth: 10,170 us ANQP: 5,582 us DHCP: 1,172 ms
1385147461.471 sta3: connected to: 80:01:02:03:04:05 in: 29,833 us 4-way-auth: 10,923 us ANQP: 6,113 us DHCP: 1,818 ms
1385147461.472 sta4: connected to: 80:01:02:03:04:05 in: 35,841 us 4-way-auth: 10,264 us ANQP: 5,393 us DHCP: 1,879 ms
1385147461.473 sta5: connected to: 80:01:02:03:04:05 in: 35,327 us 4-way-auth: 10,604 us ANQP: 5,952 us DHCP: 1,917 ms
1385147461.475 sta6: connected to: 80:01:02:03:04:05 in: 25,100 us 4-way-auth: 13,226 us ANQP: 5,737 us DHCP: 1,860 ms
1385147461.476 sta7: connected to: 80:01:02:03:04:05 in: 29,981 us 4-way-auth: 9,509 us ANQP: 5,661 us DHCP: 1,294 ms
1385147465.731 CLI: scan 1 3 sta1 NA 'trigger freq 5180 5300'
1385147466.832 CLI: wifi_cli_cmd 1 3 sta1 'fetch_anqp'
1385147466.883 CLI: wifi_cli_cmd 1 3 sta1 'roam 80:01:02:03:04:05'
1385147466.934 CLI: wifi_cli_cmd 1 3 sta2 'fetch_anqp'
1385147466.984 CLI: wifi_cli_cmd 1 3 sta2 'roam 80:01:02:03:04:05'
1385147467.035 CLI: wifi_cli_cmd 1 3 sta3 'fetch_anqp'
1385147467.086 CLI: wifi_cli_cmd 1 3 sta3 'roam 80:01:02:03:04:05'
1385147467.136 CLI: wifi_cli_cmd 1 3 sta4 'fetch_anqp'
1385147467.187 CLI: wifi_cli_cmd 1 3 sta4 'roam 80:01:02:03:04:05'
```

For more information see [Complete report for this test case](#)

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