Candela Technologies
Jed Reynolds
2015-02-06

Comparison of Station Association and Portal Login Scenarios

Summary Table

Tests performed on a pair of LANforge CT523 systems are summarized in the following table.

	5 simultaneous	10 simultaneous	20 simultaneous	30 simultaneous
DHCP Bring-Up, open WiFI	1	1.75	1.75	
DHCP Bring-Up, WPA2	1	1.75	1.75	
DHCP Bring-Up, 802.11x	1	1.75	1.75	
Static IP Bring-Up, open WiFi	1.0/sec	1.75/sec	1.75/sec	
Static IP Bring-Up, WPA2	1.25/sec	1.5-2.5/sec	1.3-4.6/sec	
Portal Login HTTP	16/sec	24/sec	32/sec	
Portal Login, HTTPS	16/sec	16/sec	12-18/sec	
Migration, WPA2	Yes	yes	yes	yes
Migration, WPA2 802.11x	yes	yes	yes	yes

What follows is technical discussion..

Summary Discussion

The LANforge CT523 three radio system can emulate at least 20 wireless users simultaneously logging in and logging out and 30 roaming. Simultaneous portal logins are fast, but ultimately limited by SSL key negotiation. We see a limiting range of 12-18 portal logins during 20 simultaneous station logins over HTTPS. HTTP is faster at 32 logins with 20 stations. This rate can probably be increased with scale-out of more LANforge client emulators.

Overt the air DHCP interface bring-up (DHCP, static IP, WPA2+RADIUS combinations) involve considerably more negotiation. Smaller simultaneous groups of stations do not associate faster than high numbers: groups of five stations associate between 0.5-3 stations a second. Both DHCP and WiFi negotiation incorporate timeouts and back-off strategies. DHCP tends to make association half as fast as a static IP assignment. At 20 simultaneous stations, a good DHCP+RADIUS association burst rate is 2.5 stations a second; a good static-ip and RADIUS association burst rate is 3. Open WiFi static-IP association is not much better, a good burst rate for Open WiFi static bring-up was a burst to 3.3 interfaces a second. The *average rate* for small simultaneous bring-up groups ranges between 0.5-0.75 event/second; for 10 and 20 stations we see an average of 0.75-2 events per second.

The association times we are seeing are not governed by encryption latency, rather the over the air method of station association. Actual captive portal speed or RADIUS authentication latencies below 100ms would not show any influence in this environment.

Roaming behavior is best if we let radios take turns. If we stampede all the stations from one radio to the other, performance and efficacy are poor. If we shuffle stations between BSSIDs so that station radios alternate and access points alternate, we get excellent results. Radio scan buffers also need to be taken into account. To reach 30 migrations a second, we can set a dwell time between commands of 32 milliseconds and ask for a roughly every 2500 milliseconds. This appears to avoid scan timeout related roaming failures.

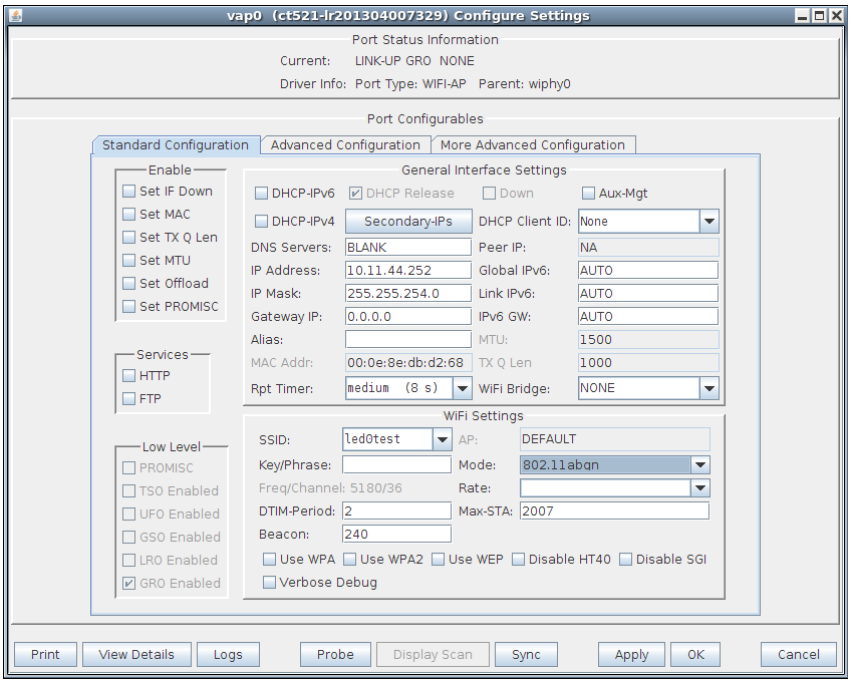
Portal Scenario Setup

These steps illustrate how to create the routing and test parameters. We start with the a 3 radio a/b/g/n system. Radio `wiphy0` is the virtal AP (`vap0`), and radios `wiphy1` and `wiphy2` host virtual stations. The name of the access point SSID is `led0test`. To emulate a login portal, another machine running Apache was hosting a very simple PHP page to behave like a login page. This login resource is called `portal-test`, at http://portal-test/, placed in the LANforge machine's /etc/host file (an IP could have been used as well).

1) Create virtual AP on radio 0:

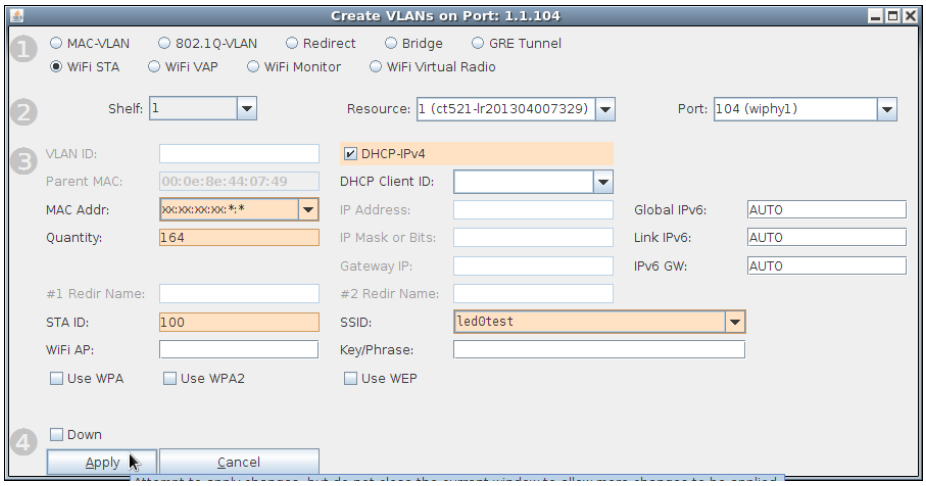
Select radio wiphy0 and click the **Create** button.

Set the *SSID* to led0test, the IP to 10.11.44.252, the subnet mask to 255.255.254.0, and the Mode to 802.11a/b/g/n.

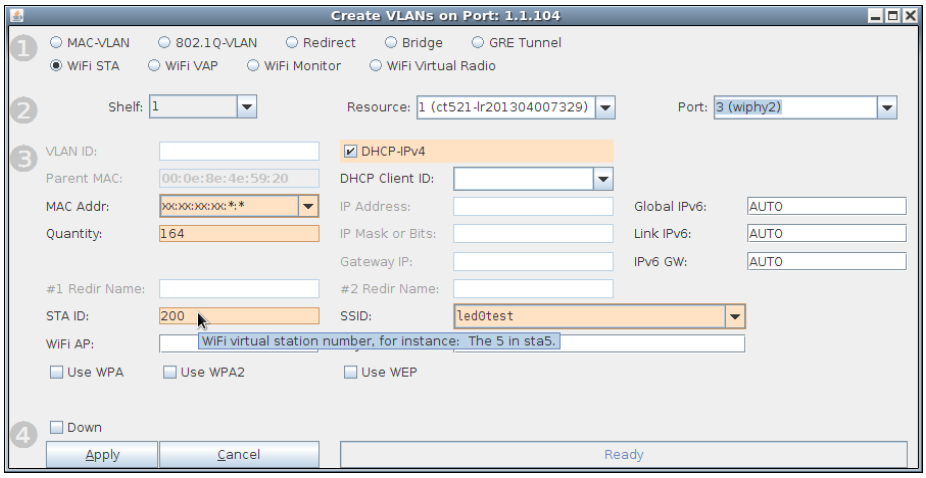


2) Create virtual stations on radio 1 and 2:

Create stations named sta100-164: set quantity to 164, Station ID 100, and SSID to led0test and check DHCP IPv4. Then click Apply.

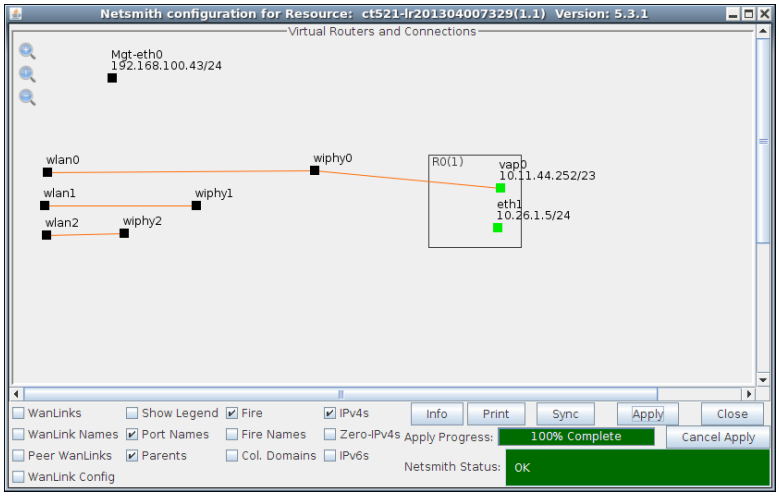


Create stations named sta300-464: Change the Port dropdown to wiphy2. Set station ID to 300. Then click Apply.

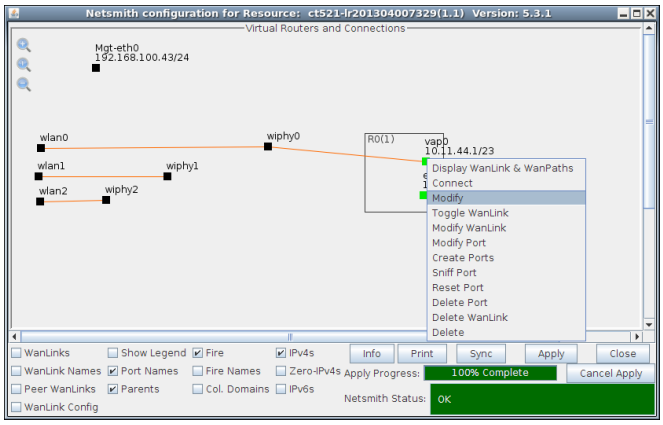


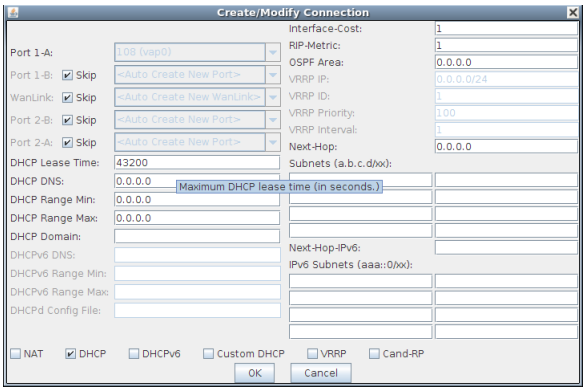
3) Configure DHCP on vap0

Open the Netsmith window, right click, select New Router. Click Apply. Drag vap0 into the Router. Click Apply. Drag eth1 into router. Click Apply.

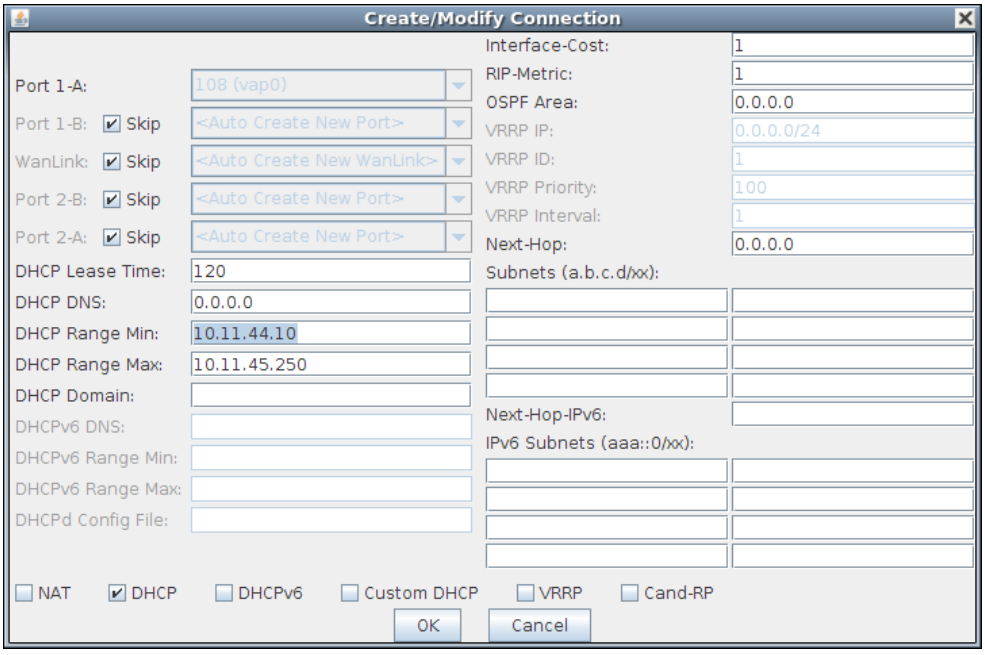


Right click on vap0 and select Modify.

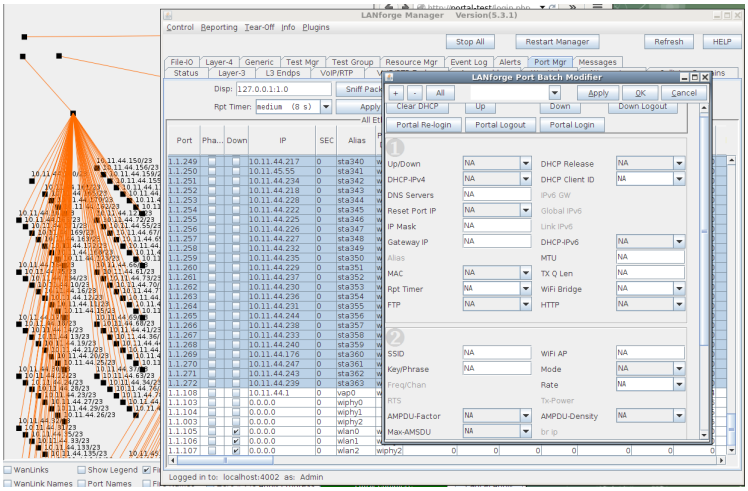




Select DHCP, configure DHCP Lease Time to 120 seconds, and the DHCP range from 10.11.44.10 to 10.11.45.250. Click OK.



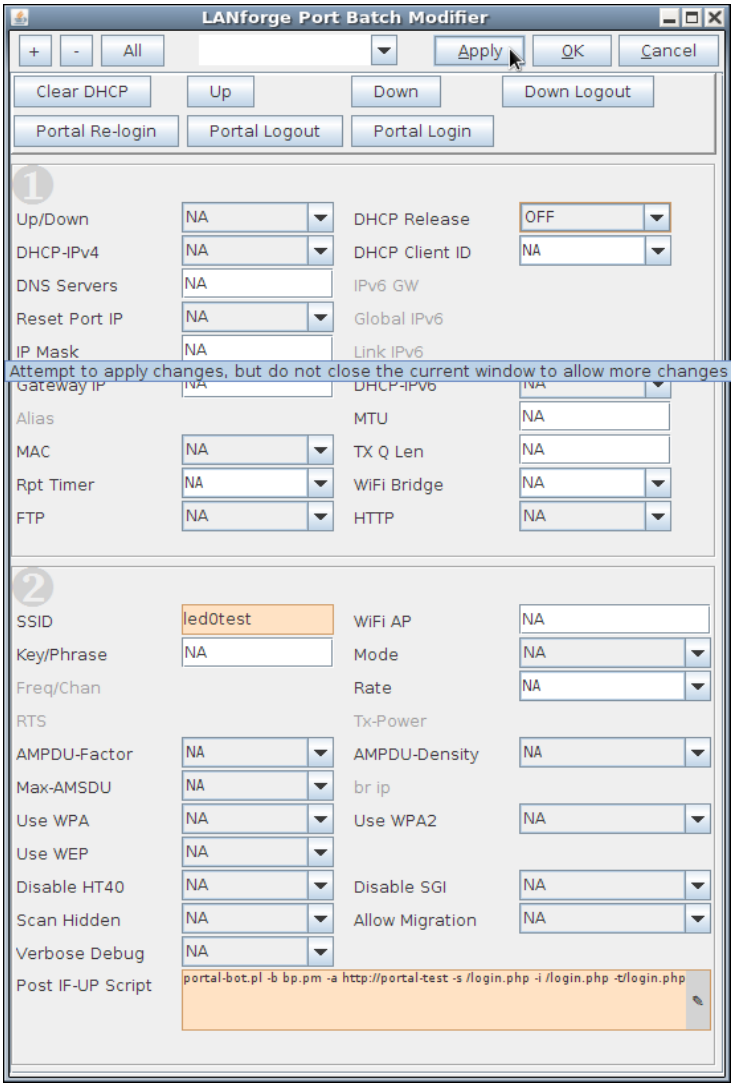
4) Configure DHCP Release on the stations. In the Ports tab, highlight all the stations, and click Batch Modify. Change DHCP Release to OFF. Click Apply.



5) Configure login scripts on stations

Set the Post IF-UP script to:

```
portal-bot.pl -b bp.pm -a http://portal-test/ -s http://portal-test/ -n login.php -o login.php -t login.php -u bob -p bob
```



Click OK.

6) Configure Apache and portal script

On the Apache machine, create a simple virtual host like so:

```
<VirtualHost portal-test:80>
   ServerName portal-test.candelatech.com
   ServerAlias portaltest portal-test
   ServerAdmin root@jed-shuttle.candelatech.com
   DocumentRoot /var/www/basic-portal

   <Directory /var/www/basic-portal>
      AllowOverride All
      Options +Indexes +ExecCGI +MultiViews +FollowSymLinks
      Require all granted
      DirectoryIndex index.php
   </Directory>
</VirtualHost>
```

We will also need an SSL version of the site. Create some self-signed keys:

```
openssl req -x509 -nodes -days 365 -newkey rsa:2048 -keyout /etc/ssl/private/portal-test.key
-out /etc/ssl/certs/portal-test.crt
```

Add another virtual host:

```
<VirtualHost portal-test:443>
   ServerName portal-test.candelatech.com
   ServerAlias portaltest portal-test
   ServerAdmin root@jed-shuttle.candelatech.com
   DocumentRoot /var/www/basic-portal

   SSLEngine on
   SSLCertificateFile      /etc/ssl/certs/portal-test.crt
   SSLCertificateKeyFile   /etc/ssl/private/portal-test.key

   <Directory /var/www/basic-portal>
      AllowOverride All
      Options +Indexes +ExecCGI +MultiViews +FollowSymLinks
      Require all granted
      DirectoryIndex index.php
   </Directory>
</VirtualHost>
```

Create a login script `/var/www/basic-portal/login.php`:

```
<!DOCTYPE html>
<html>
<head>
   <meta http-equiv="Content-Type" content="text/html; charset=utf-8" />
   <title>Login</title>
</head>
<body>
   <?php if ($_SERVER['REQUEST_METHOD'] == 'POST') { ?>
      <?= $_POST['username'] ?> access granted.
   <?php } else { ?>
      <form method="post" action="">
         Login:<input type="text" name="username" value="" /><br />
         <input type="submit" name="login" value="Login" />
      </form>
   <?php } ?>
</body>
```

```
</html>
```

This creates an effectively instant website interaction.

7) Configure routing between portal-test and virtual stations

First, configure the apache server to see a route to the stations gateway:

```
route add -net 10.11.44.0/23 gw 10.26.1.5
```

Possibly necessary: in Netsmith add route to eth1 in the virtual router. Highlight the eth1 port and click Modify. Under the Next Hop box, add the netmask for the stations: 10.11.44.0/23. Click Apply.

8) Verify the setup: we should be able to ping from stations to apache:

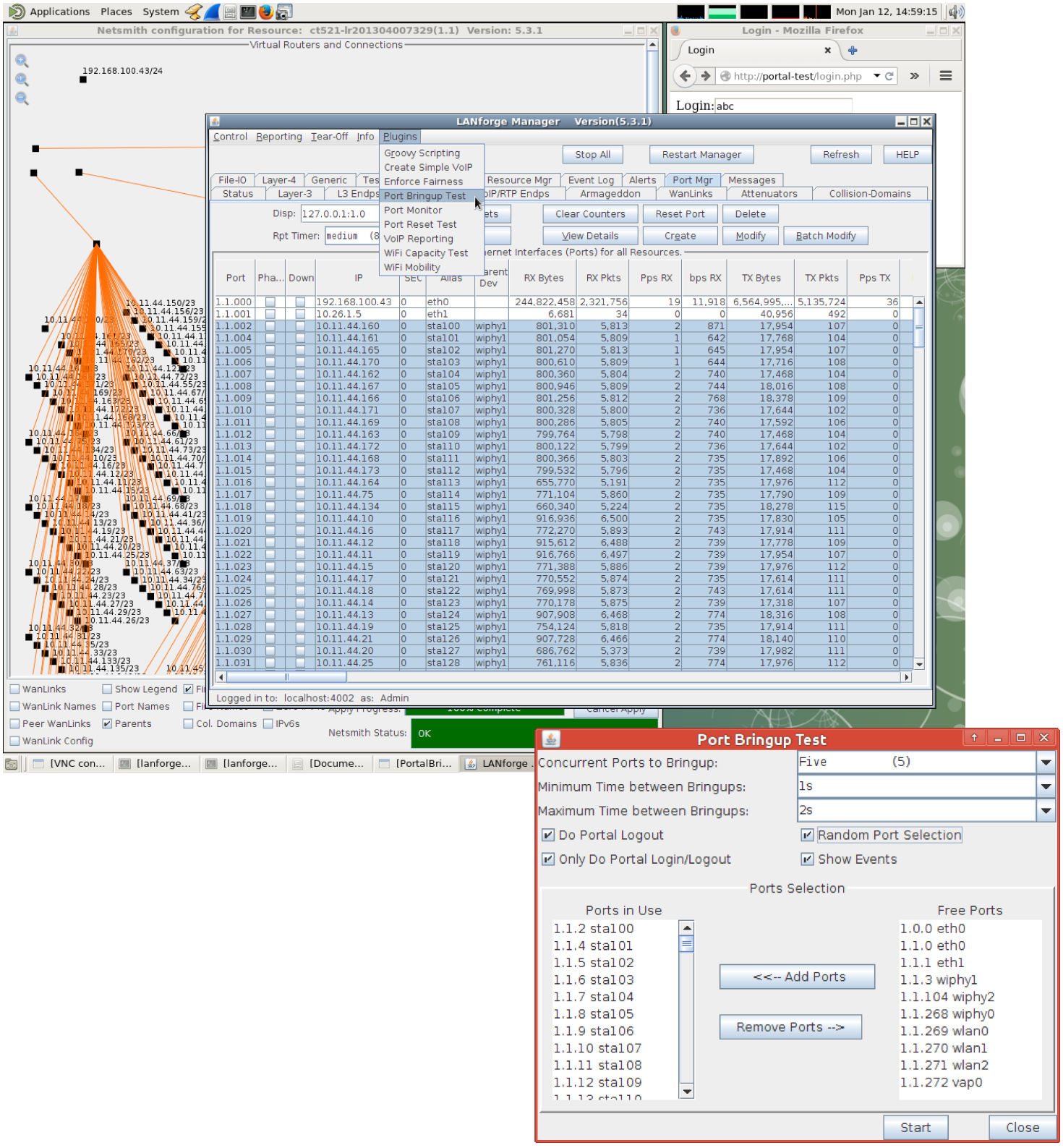
```
$ ping -I 10.11.44.160 10.26.1.254
```

We should be able to use a modified copy of `portal-bot.bash` from LANforge to exercise the login/logout commands:

```
PBOT_NOFORK=1 ./portal-bot.pl -i sta100 \
   -b    bp.pm \
   --ip4 10.11.44.160 \
   --dns 192.168.100.1 \
   --ip6 NA \
   --mgt /dev/null \
   -u    bob \
   -p    "secret" \
   -a    "http://portal-test/" \
   -s    "http://portal-test/" \
   -n    "login.php" \
   -o    "login.php" \
   -t    "login.php" \
   -v -d $*
```

Scenario: 5 simultaneous users, http transport

1) In the **Ports** tab, highlight all stations. From the top menu bar, select *Plugin->Port Bringup Test*.



In the **Port Bringup Test** window, Set *Concurrent Ports to Bringup* to 5 ports, *Minimum Time Between Bringups* to 5s, *Maximum Time Between Bringups* to 5s, select *Do Logout*, select *Only Do Portal Login/Logout*, select *Random Port Selection* and click **Start**.

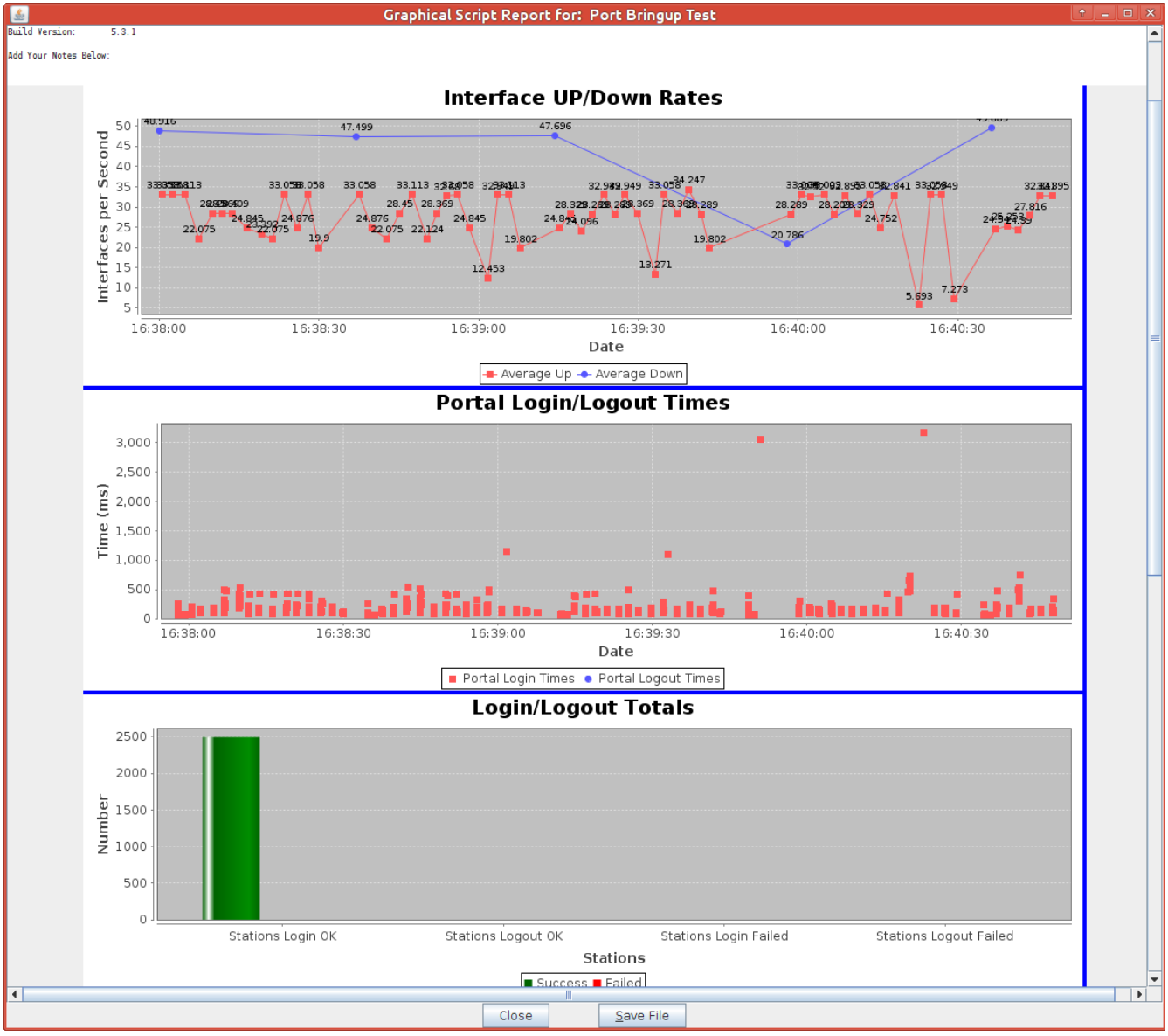
The results we see for this test are: about 16 interface events ave per second.

Scenario: 10 simultaneous users, HTTP portal

We change the batch size to ten. Average interface activity is now 24 events per second:

Scenario: 20 simultaneous users, HTTP portal

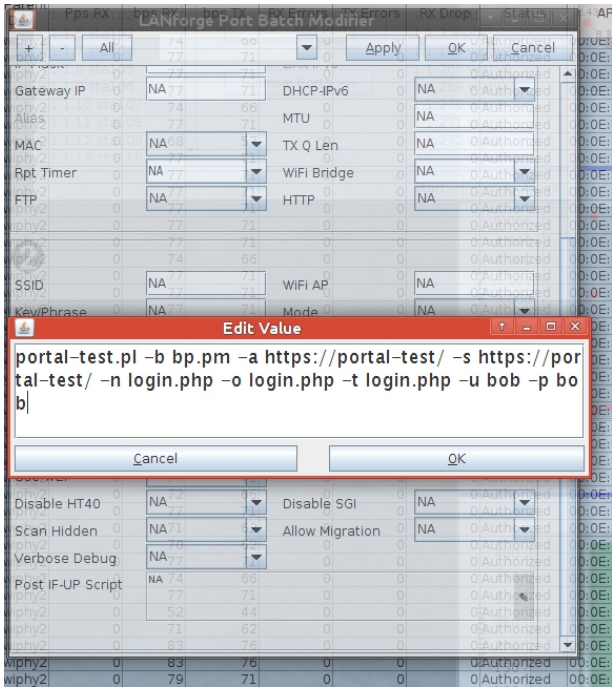
We set the batch size to 20 and we see an average of about 32 events per second:



Scenario: 5 simultaneous users, HTTP portal

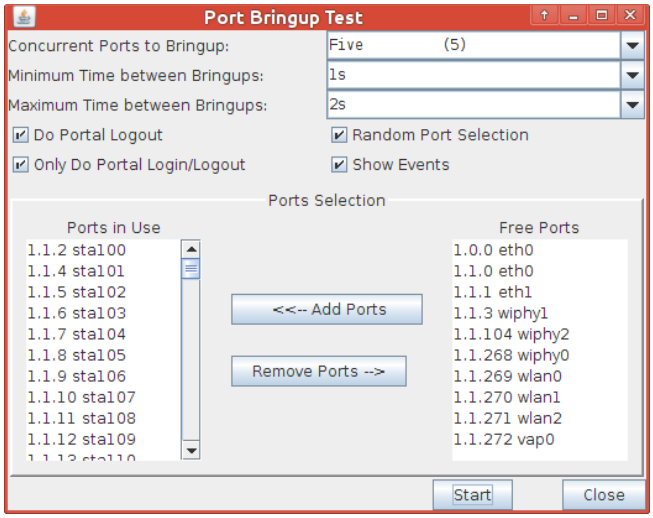
We need to modify the port settings to do https transport. In the **Ports** tab, highlight all stations, click **Batch Modify**, and edit the *Post IF-UP* text box to say:

```
portal-bot.pl -b bp.pm -a https://portal-test/
-s https://portal-test/ -n login.php -o
login.php -t login.php -u bob -p bob
```

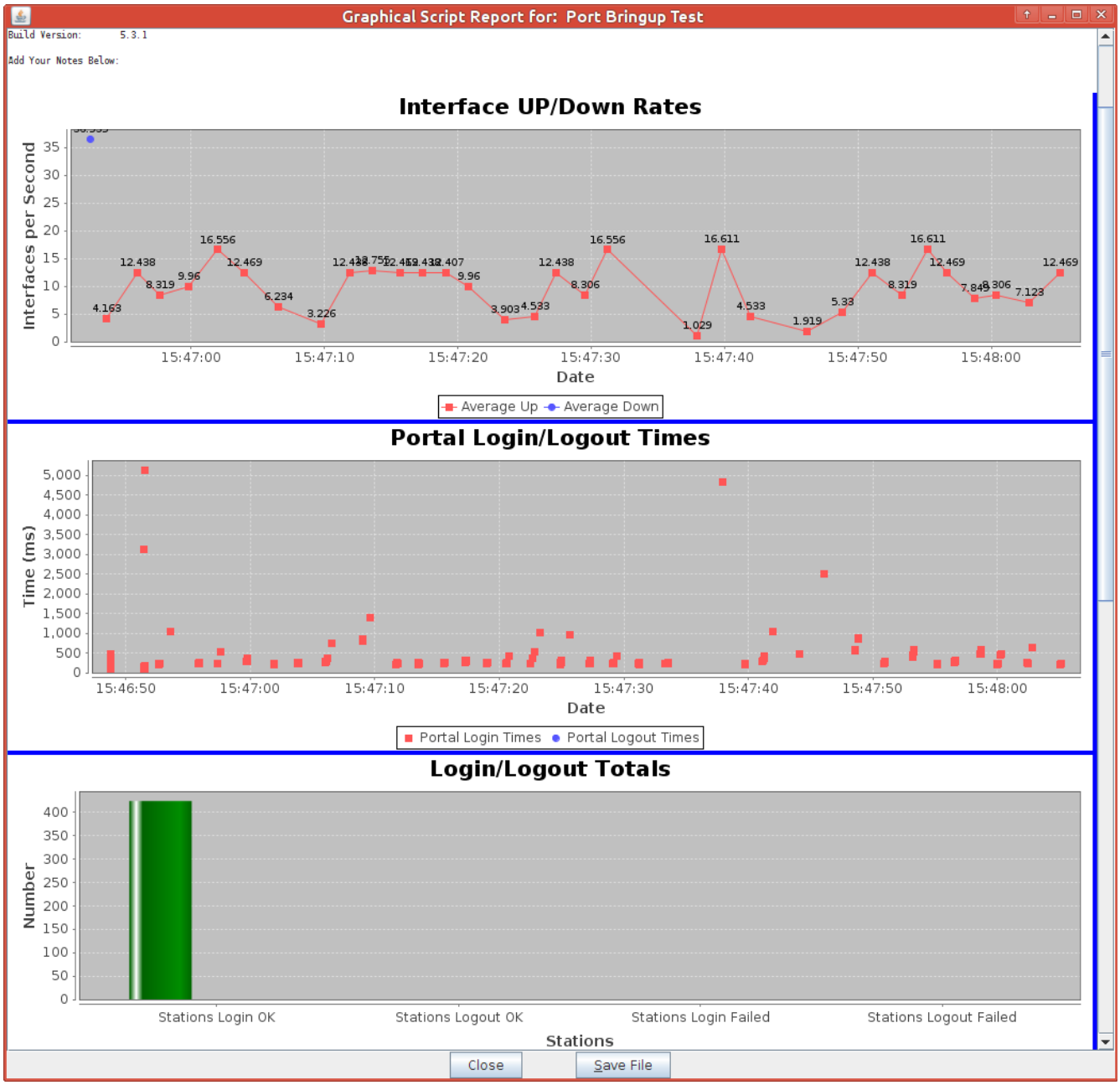


And click **OK**.

Leave the stations highlighted, and repeat the testing process with *Port Bringup Test*.



We will see up to 16 interface events per second in the graph.



Scenario: 10 simultaneous users, HTTPS portal

We will start the Portal Bringup Test with batch size of 10.

Our report will show average 16 events per second.

Scenario: 20 simultaneous users, HTTPS portal

We will start the Portal Bringup Test with batch size of 10.

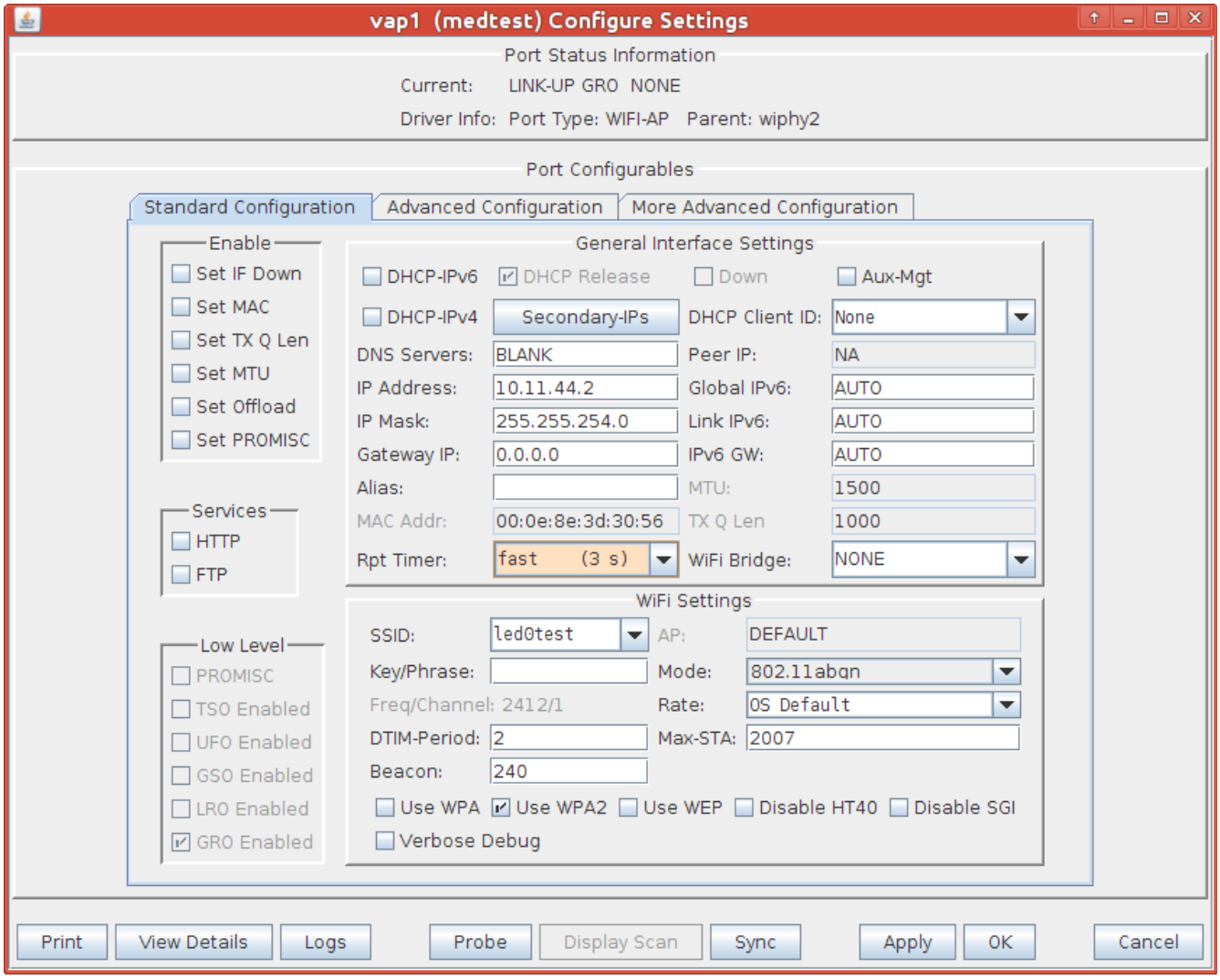
Our report will show an average of 12-18 events per second.

Scenario: 5 simultaneous users, DHCP, RADIUS (802.1x)

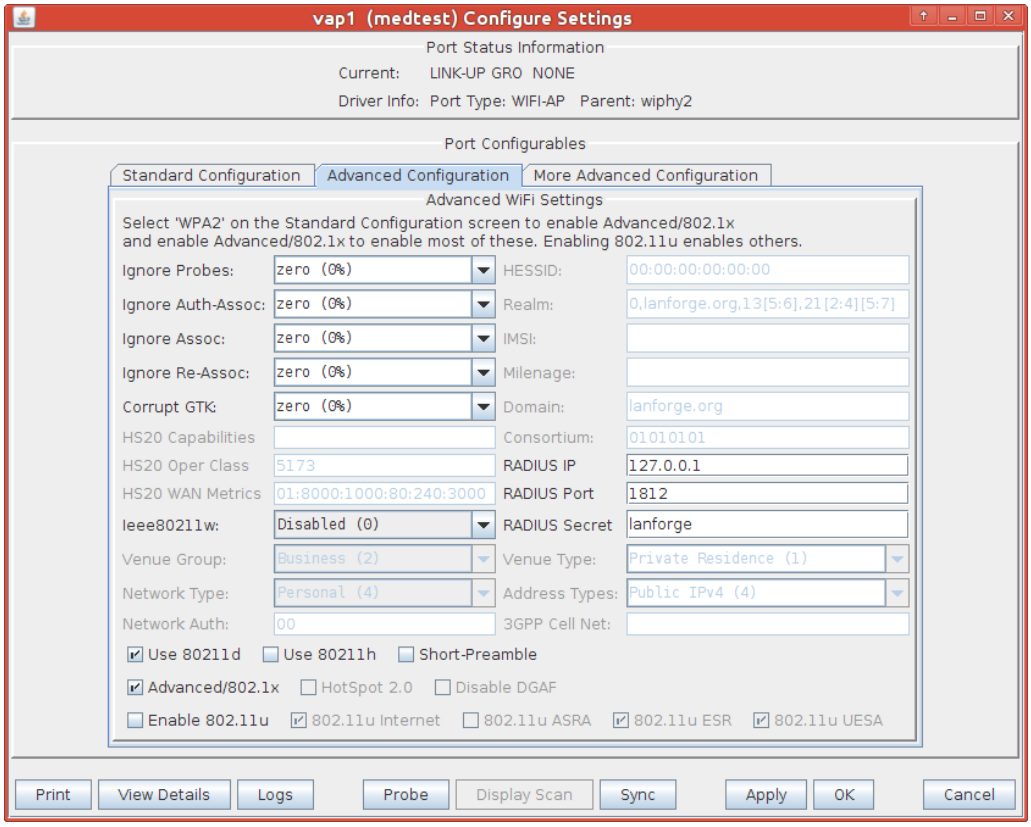
We do not use the portal services in this scenario because RADIUS is an authentication system. This radius authentication scenario is using WPA-EAP Key management but not HotSpot 2.0. Moving the virtual access point used for testing to a separate machine with the RADIUS service allows more processing power for the station emulation. We follow steps similar to To configure this authentication scenario, we follow these steps:

1) Delete the vap0 virtual access point on the first LANforge machine.

2) Create a vap1 virtual access point on a second LANforge machine. Configure the AP with the IP 10.11.44.2, netmask 255.255.254.0, SSID led0test, Mode 802.11abgn, check Use WPA2.



On the **Advanced** Tab, configure 80211w disabled, *RADIUS IP* to 127.0.0.1, *RADIUS port* to 1821, *RADIUS secret* to **lanforge**, check *Use 80211d*, check *Advanced/802.1x*. These settings provide the minimum necessary processing for WPA2 RADIUS authentication.

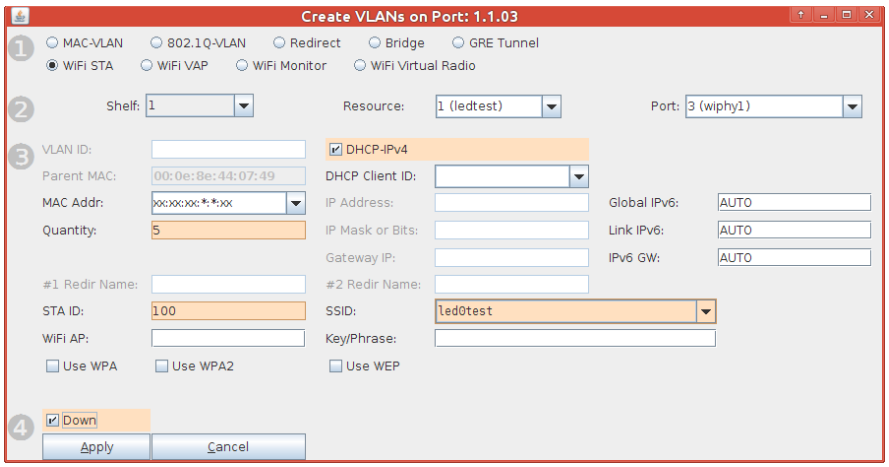


3) In the **Ports** tab, delete the previous virtual wifi stations.

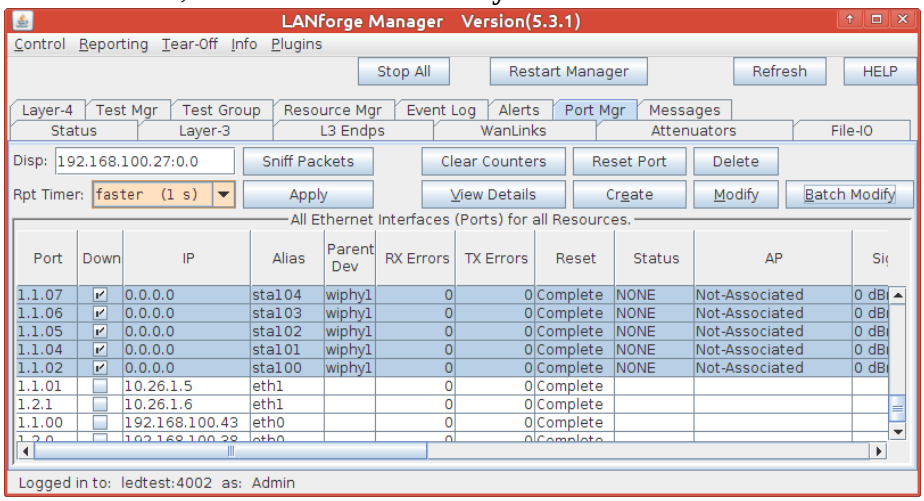
4) Create new virtual WiFi stations: Select radio ledtest wiphy1, click **Create.**

In the **Create** window, select *WiFi STA*, *Quantity* 164, check *DHCP-IPv4*, *Station ID* 100, check *Use WPA2*, check *Use WPA2*, check *Down*.

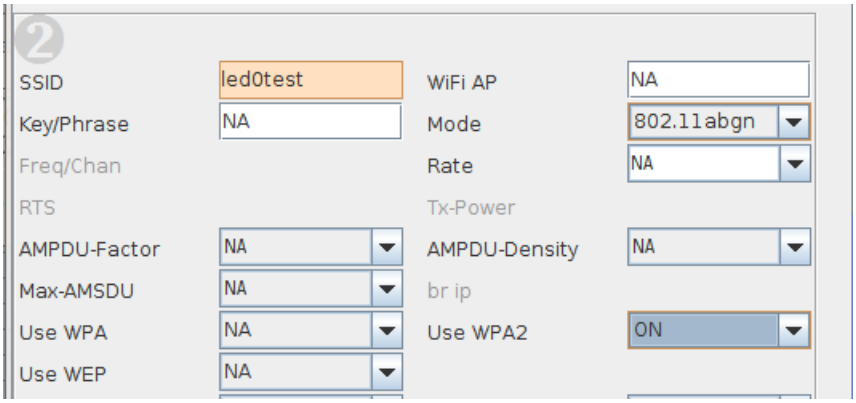
Then change the Port from wiphy1 to wiphy2 and create the next 164 stations. Start at station 300.



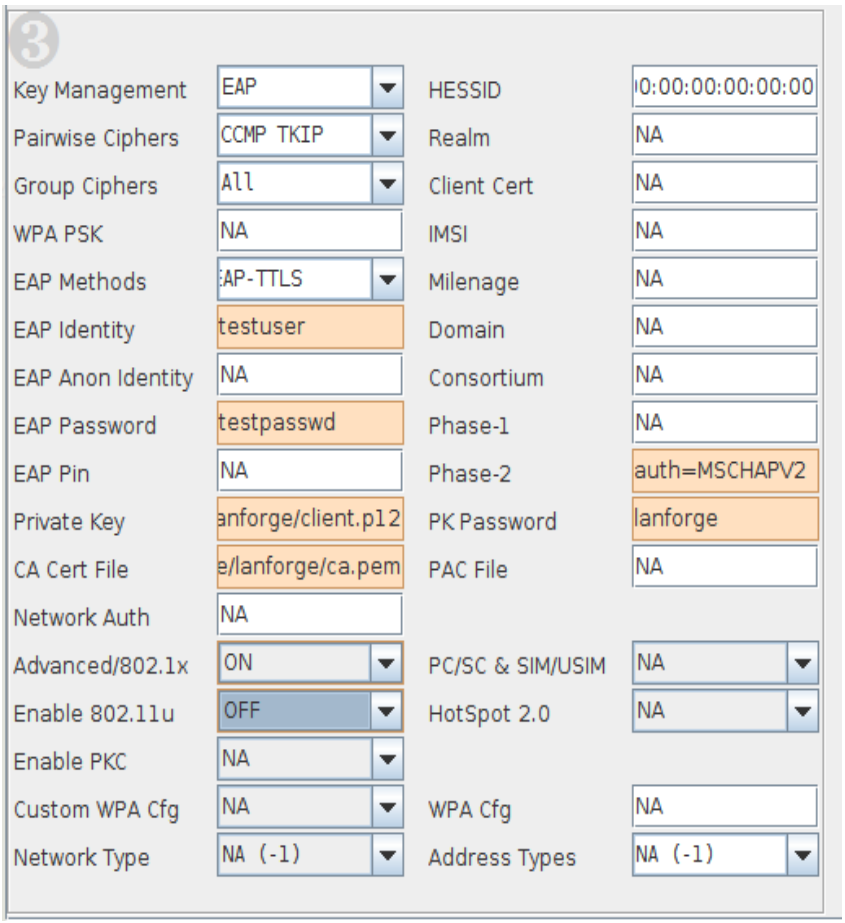
Highlight your new stations in the **Ports** tab, and click **Batch Modify**:



Click **Batch Modify.** Configure the stations to authenticate via RADIUS. In Box (2): set the *SSID* to led0test, set *Mode* to 80211abgn, set *Use WPA2* to ON.



In Box (3): set *Key Management* to EAP, set *Pairwise Ciphers* to CCMP TKIP, set *Group Ciphers* to ALL. Set *EAP Methods* to EAP-TTLS. The preconfigured user name and password in the preinstalled LANforge RADIUS server is next: set *EAP Identity* to **testuser** and *EAP Password* to **testpasswd**.



The RADIUS protocol is talking over TLS, so we need certificates. Set *Private Key* to:

```
/home/lanforge/client.p12
```

And set Client Cert to:

```
/home/lanforge/ca.pem
```

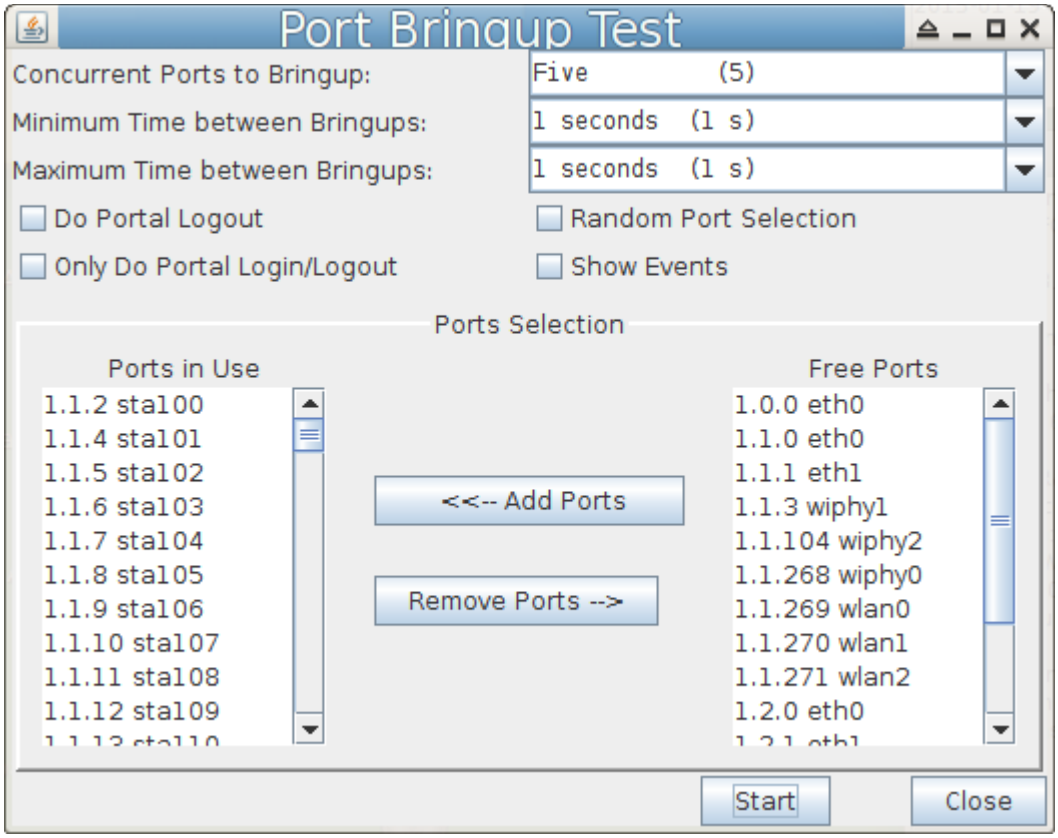
For our tests, we copied these files from `ledtest` to `medtest`; so they would be identical between AP and stations. When testing with your own AP, copy these files from your AP to your LANforge hosting virtual stations. Set *Phase 2* to auth=MSCHAPV2, and to use the private key file we need to set *PK Password* to **lanforge**.

We do not need 80211u for this test, so we make sure it is off. Set *Enable 802.11u* to OFF.

Click the **Apply** button to configure all the stations.

Scenario: DHCP, RADIUS Authentication, 5 simulateous users

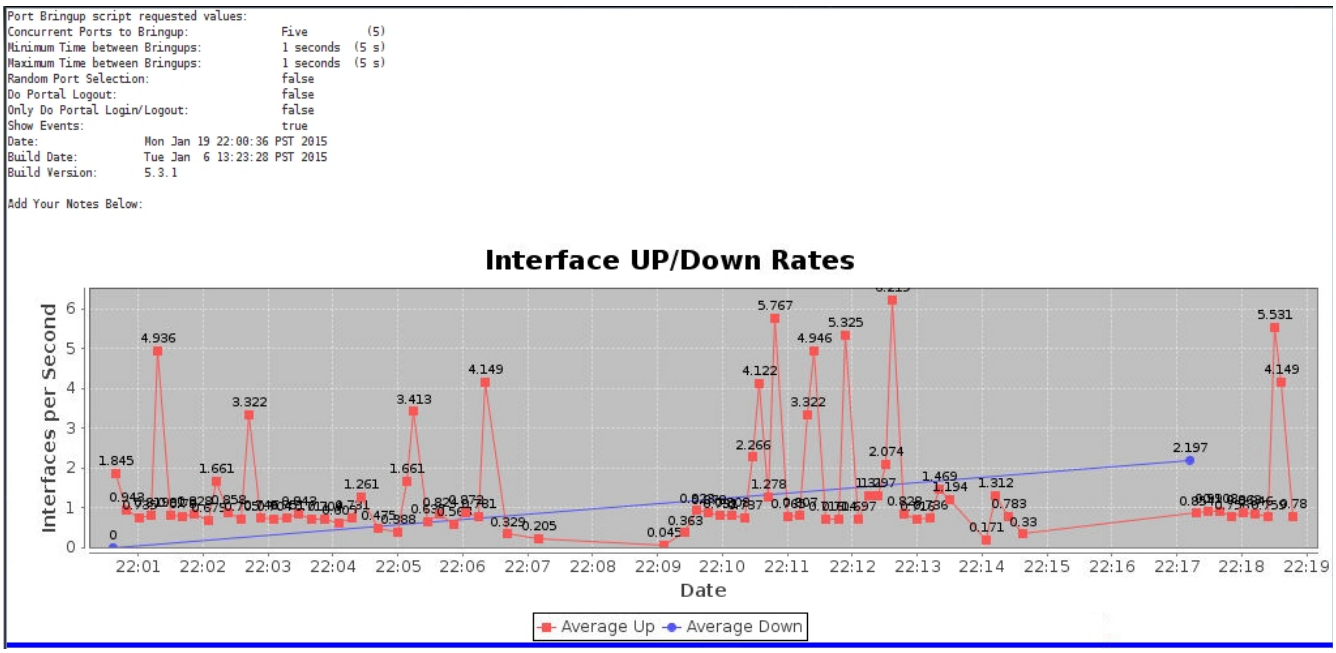
In the **Port** tab, highlight all stations. Open *Plugins->Port Bringup Test.* Set *Concurrent Ports to Bring Up* to 5, *Minimum Time Between Bringups* to 1s, and set *Maximum Time Between Bringups* to 1s. Check *Random Port Selection*. We will not use the "Do Portal Logout" or "Only Do Portal login/logout" feature because we are not doing captive portal authentication.

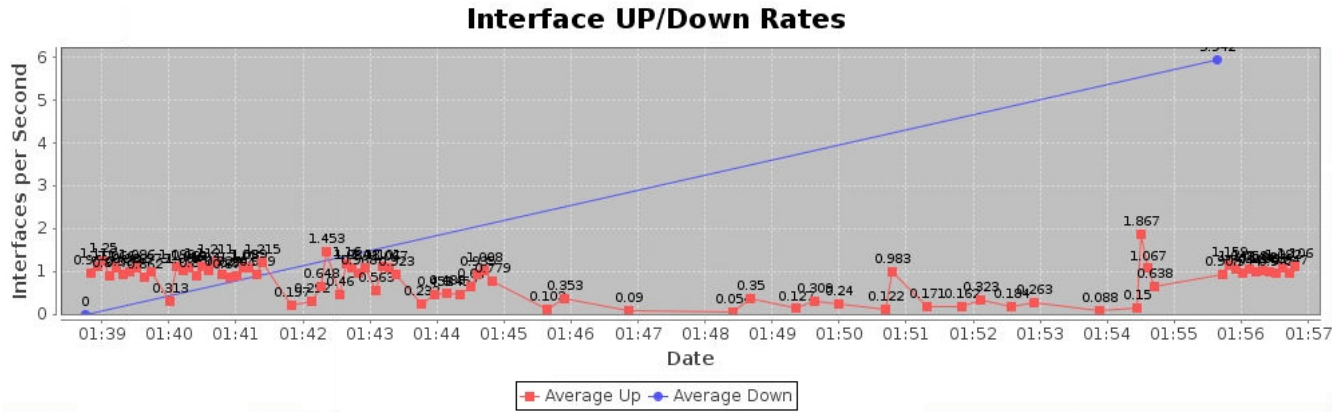


We see that the authentication rate is much slower, closer to 1interface event per second.

Testing the RADIUS server in this test from the command line, the average authentication time was 32ms. Analyzing the DHCP negotiation time, we saw about 23ms. So at best we have average 55ms accounted for. More investigation into this needs to be done.

Different behaviors can be seen during different runs. Some times there are long periods of timeouts and also some speedy bursts where we see up to 6 interface events per second.

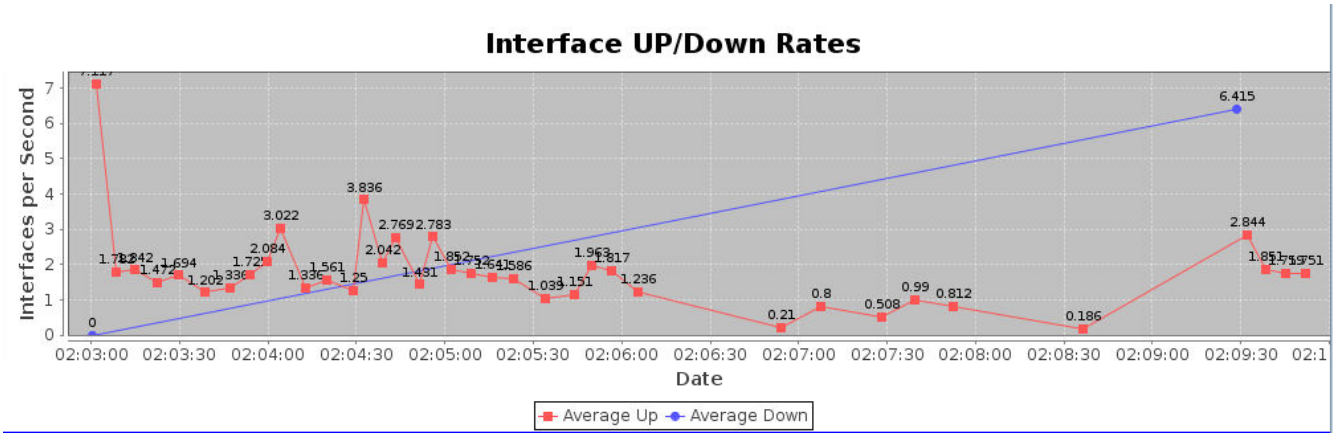




Scenario: DHCP, RADIUS, 10 simultaneous users.

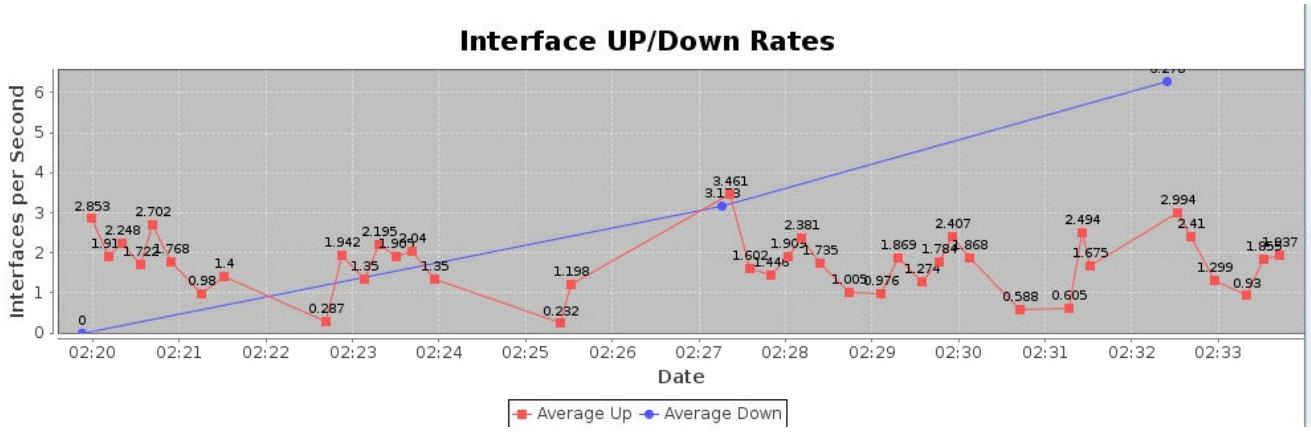
Set *Concurrent Ports to Bringup* to 10 and try the test again. We see slightly better results. This might be accounted by the increased probability of a DHCP retry occurring sooner with more stations trying simultaneously.

We see average closer to 1.3 interface events events a second, but we see groups at the start of the test associating between 2-4/sec. Near the end of the test we see laggard retry group of interfaces that have taken many retries to associate.



Scenario: DHCP, RADIUS, 20 simultaneous stations.

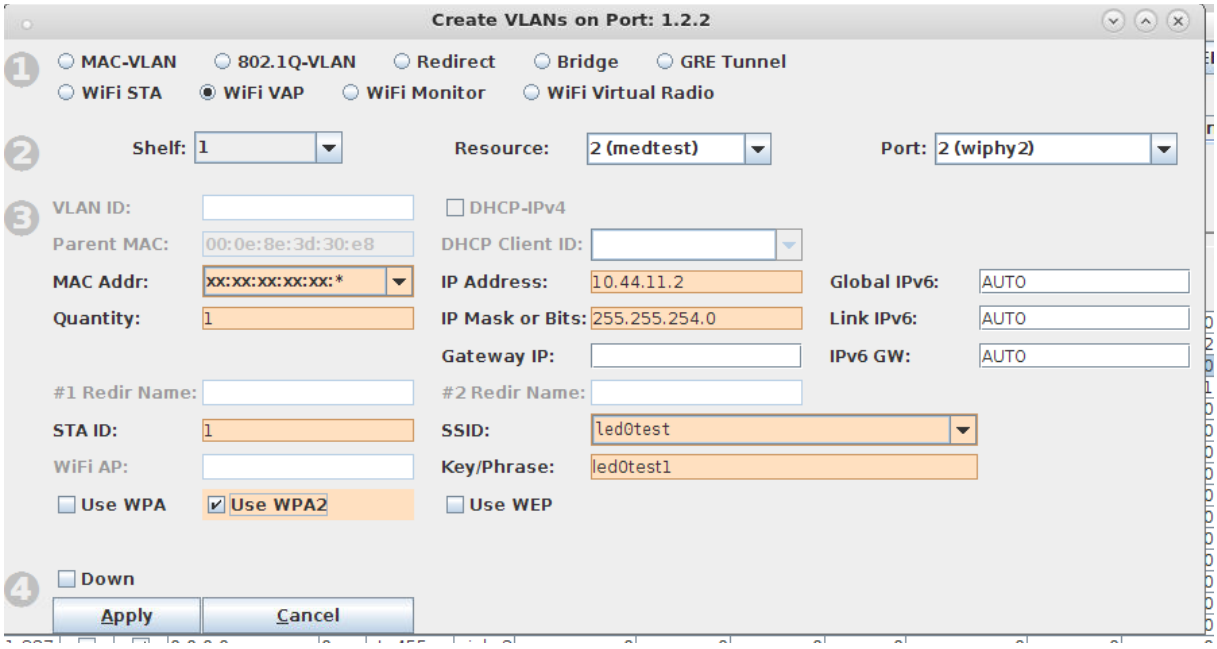
Set *Concurrant Ports to Bringup* to 20 and run the test again. We see association rates with a higher average this time.



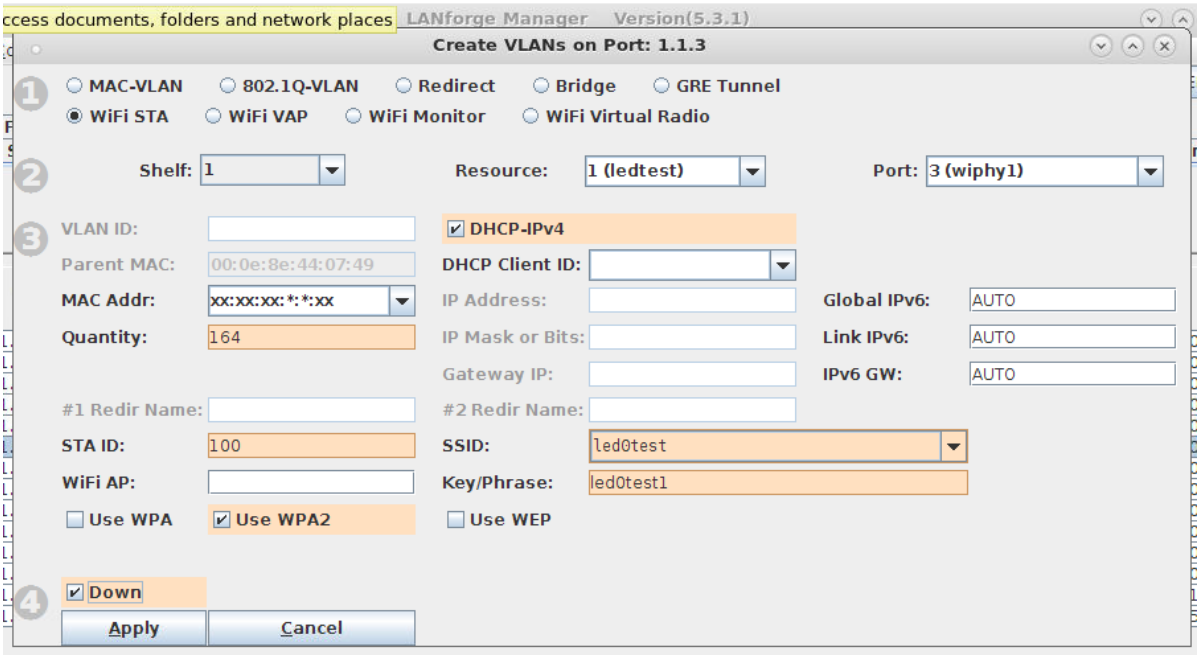
Scenario: DHCP, WPA2 auth, 5 simultaneous stations

The stations and virtual AP are deleted and recreated with only static WPA2 PSK authentication.

1) Create virtual access point on medtest radio wiphy2. Assign WPA2 and passphrase.



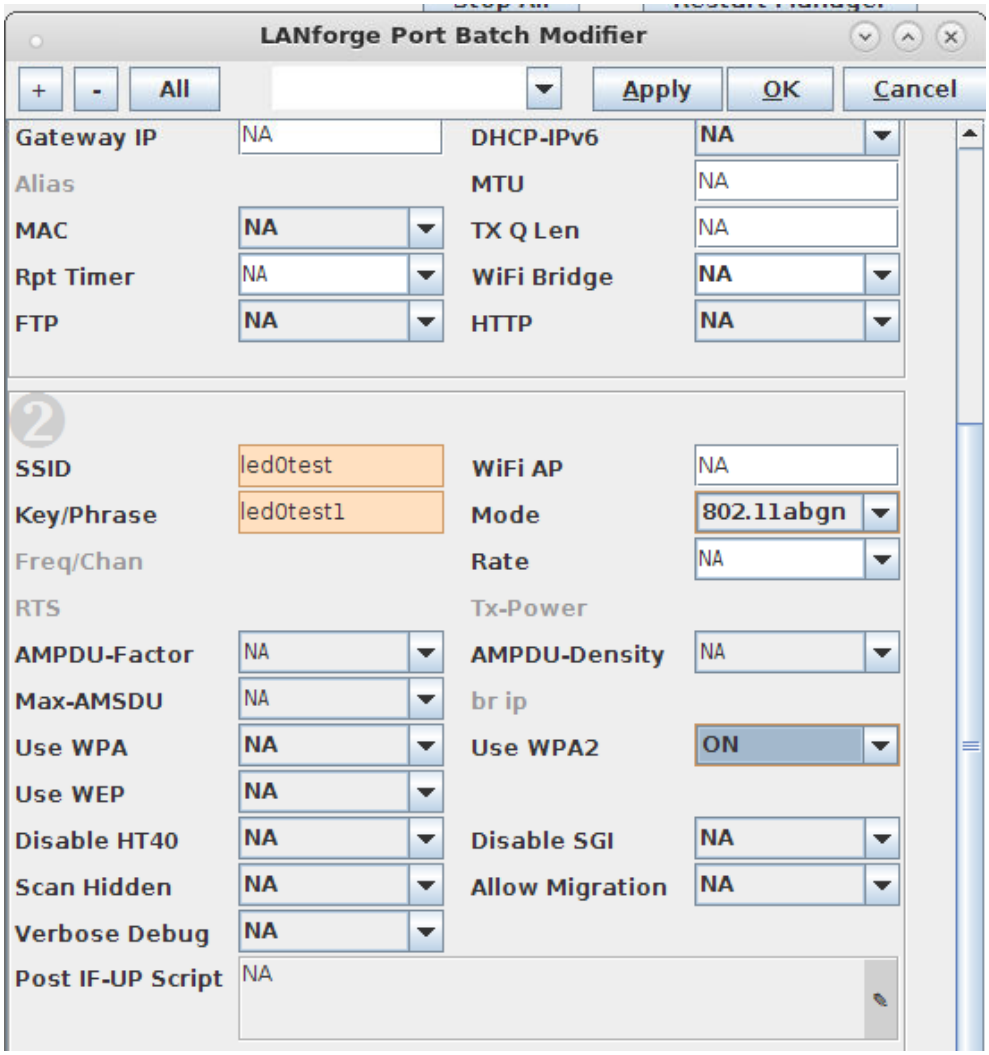
2) Create 164 stations on ledtest radio wiphy1 and another 164 stations on wiphy2. The first batch of Ids start at 100, the second batch start at 400. Stations are created in Down state for speed of configuration.



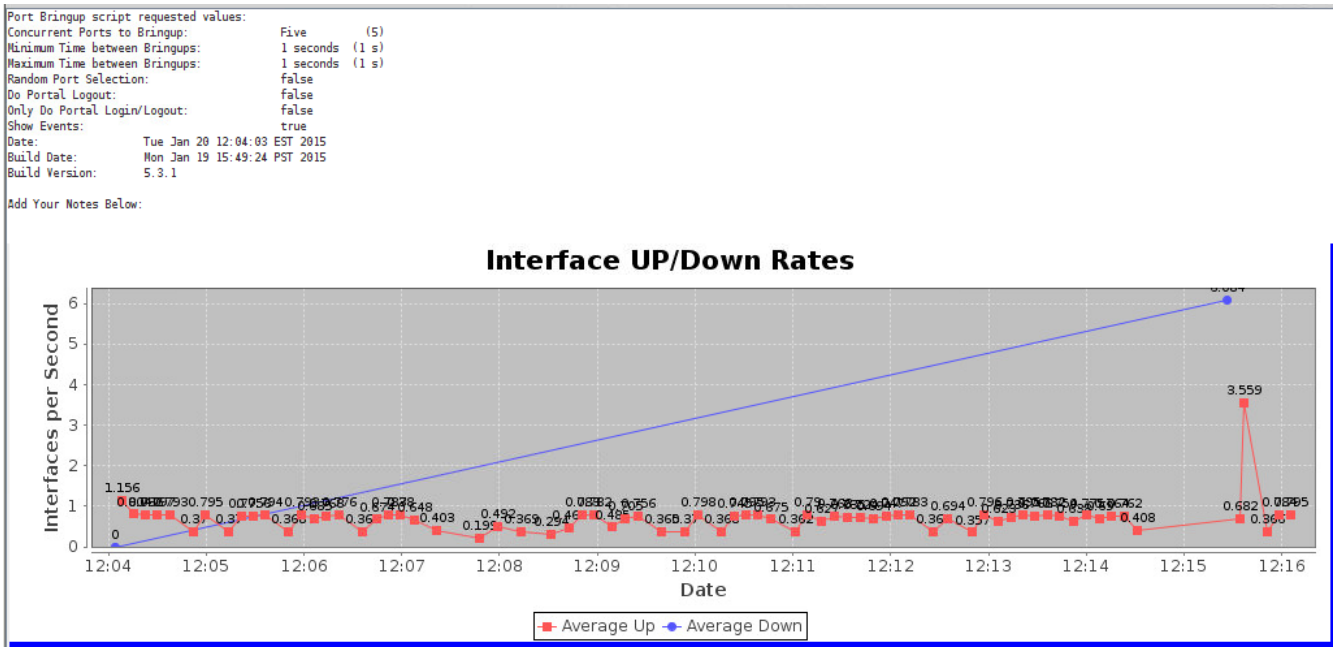
3) In the **Ports** tab, select all the stations and click **Batch Modify**. Assign them *Mode* **80211abgn**.

4) Click **Apply**.

5) Scroll to top and click the **Down** button to make sure none came up. This makes the start of the *Port Bringup Test* go faster.

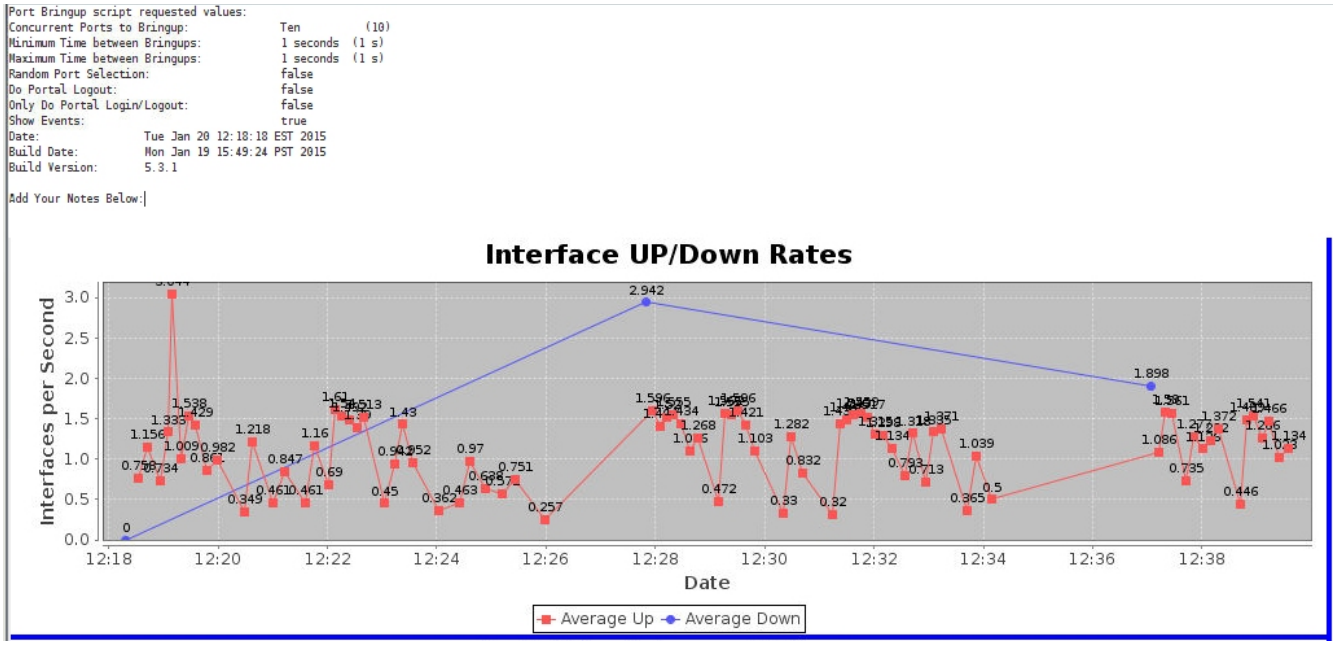


The results look very similar.



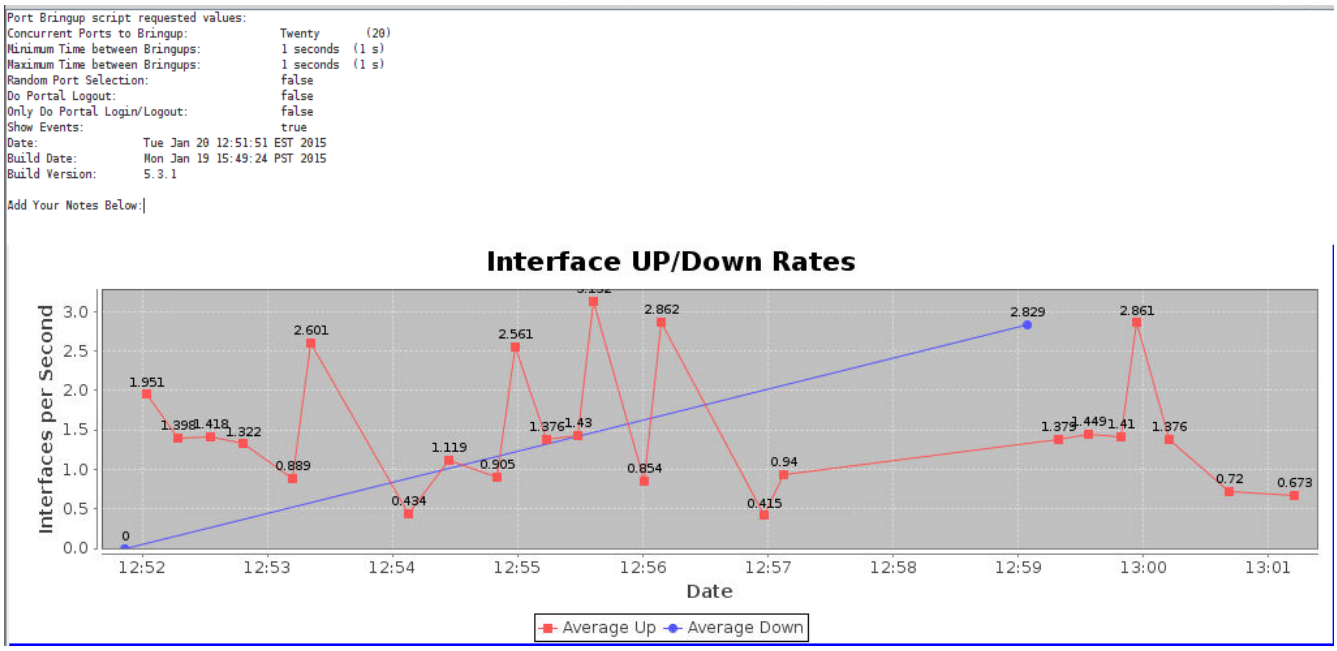
Scenario: DHCP, WPA2 auth, 10 simultaneous stations

Set Concurrent Ports to Bring Up to 10 and start the test again.



Scenario: DHCP, WPA2 auth, 20 simultaneous stations

Set the *Concurrent Ports to Bring Up* to 20 and start the test again.



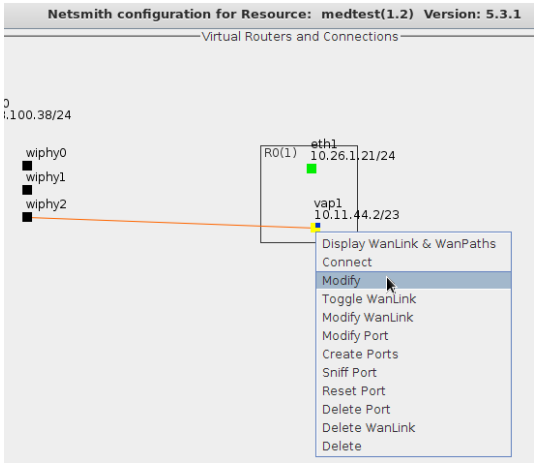
Scenario: WPA2 PSK, Static IP, 5 simultaneous stations

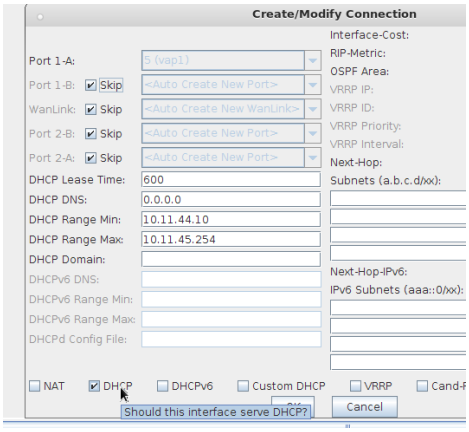
A lot of the bringup times for these previous events have been primarily influenced by DHCP. We will now perform a series of tests with static IP addresses in order more clearly see latency that might be brought on by authentication protocols.

We delete our previous set of stations and turn off the DHCP service on vap1. Next we create 128 stations on each radio with static IP addresses.

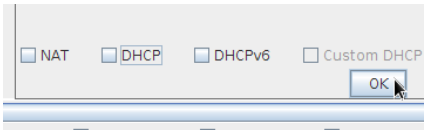
1) Delete stations in the ports tab.

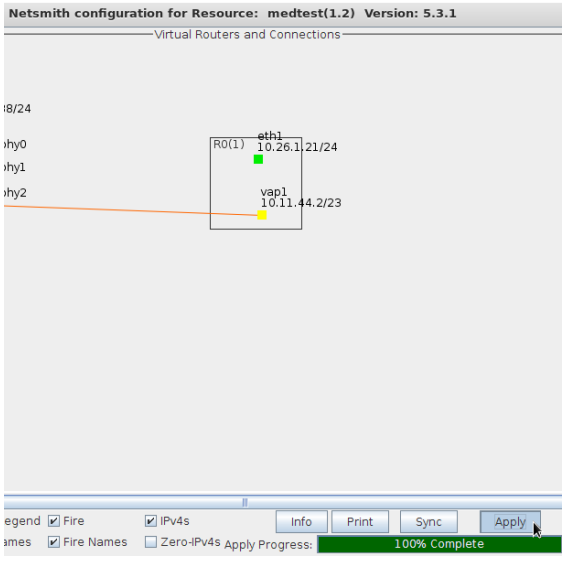
2) Go to vap1 in Netsmith and uncheck DHCP.

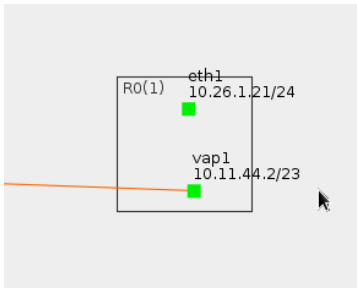




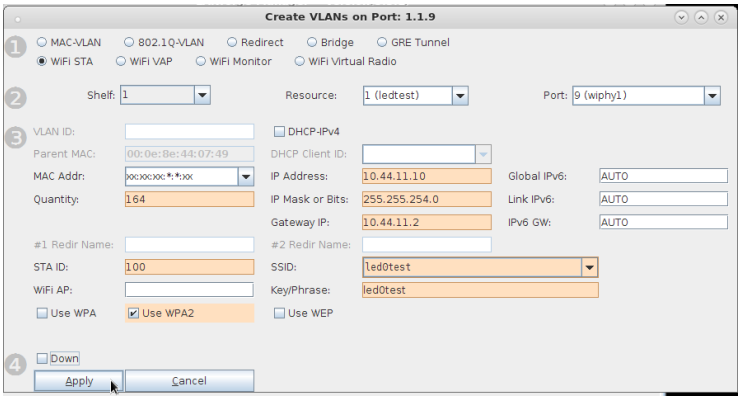
Click **OK** in the **Modify** window and **Apply** in the **Netsmith** window.



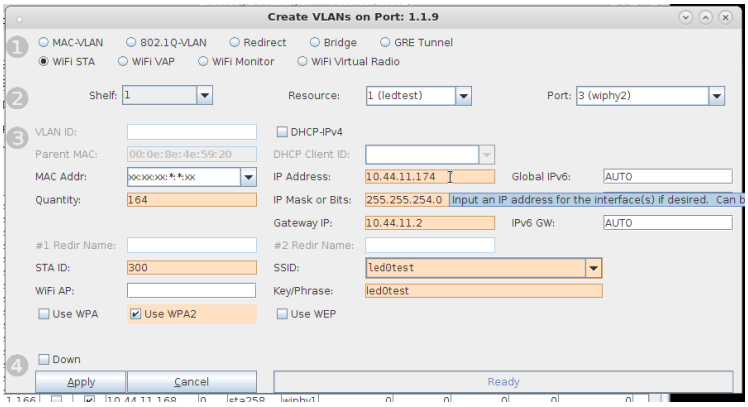




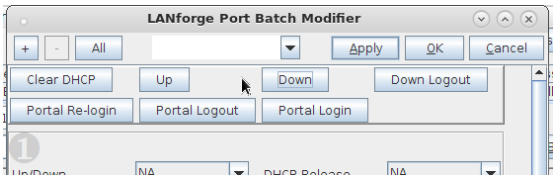
3) Create 164 stations on ledtest radio wiphy1. Set the *IP address* to 10.44.11.10, *netmask* 255.255.254.0, set *Quantity* 164, set *Gateway IP* to 10.44.11.2, the *STA ID* to 100, check *Use WPA2*, set *SSID* is **led0test**, set *Keyphrase* is **led0test1**. Click **Apply**.



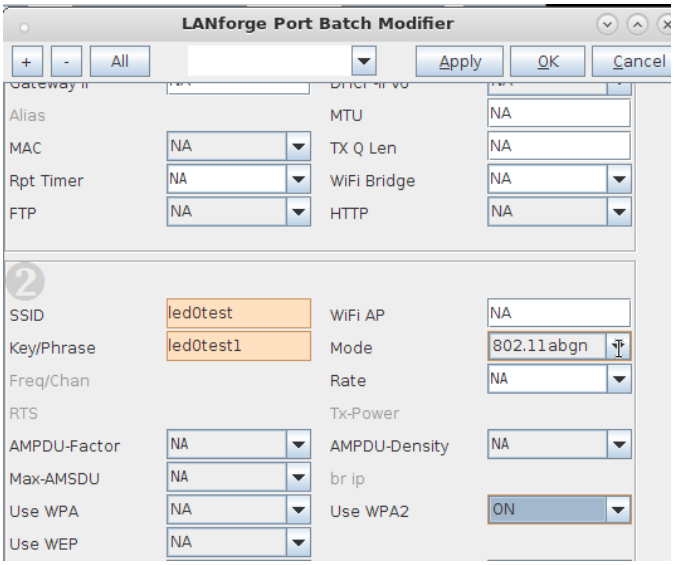
Change port to wiphy2, set STA ID to 300, change IP Address to 10.44.11.174, click **Apply**.



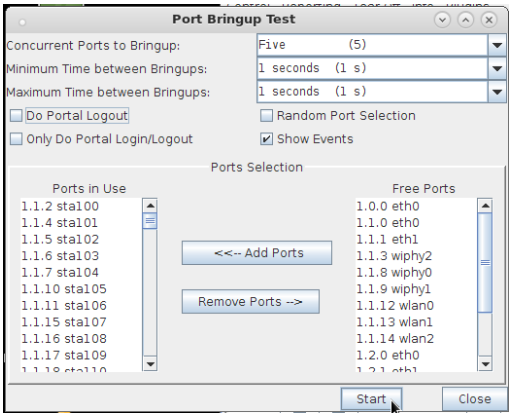
Next, down the ports and set the radio Mode to 80211abgn using the **Batch Modify** tool.



Click **apply**.



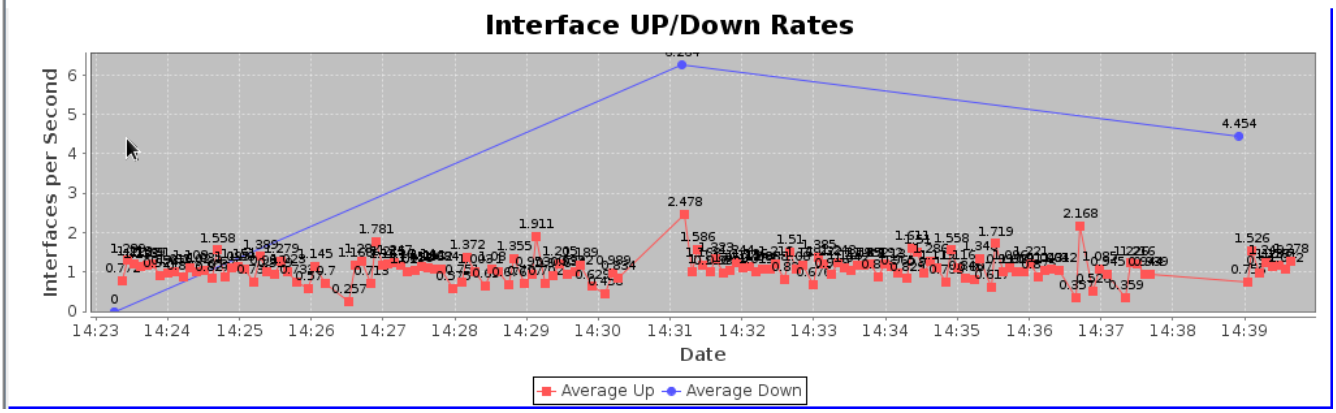
Use the *Port Bringup Test* to do a 5 concurrent port bringup, no login or logout:



The results appear to be about 1.25 interface events a second.

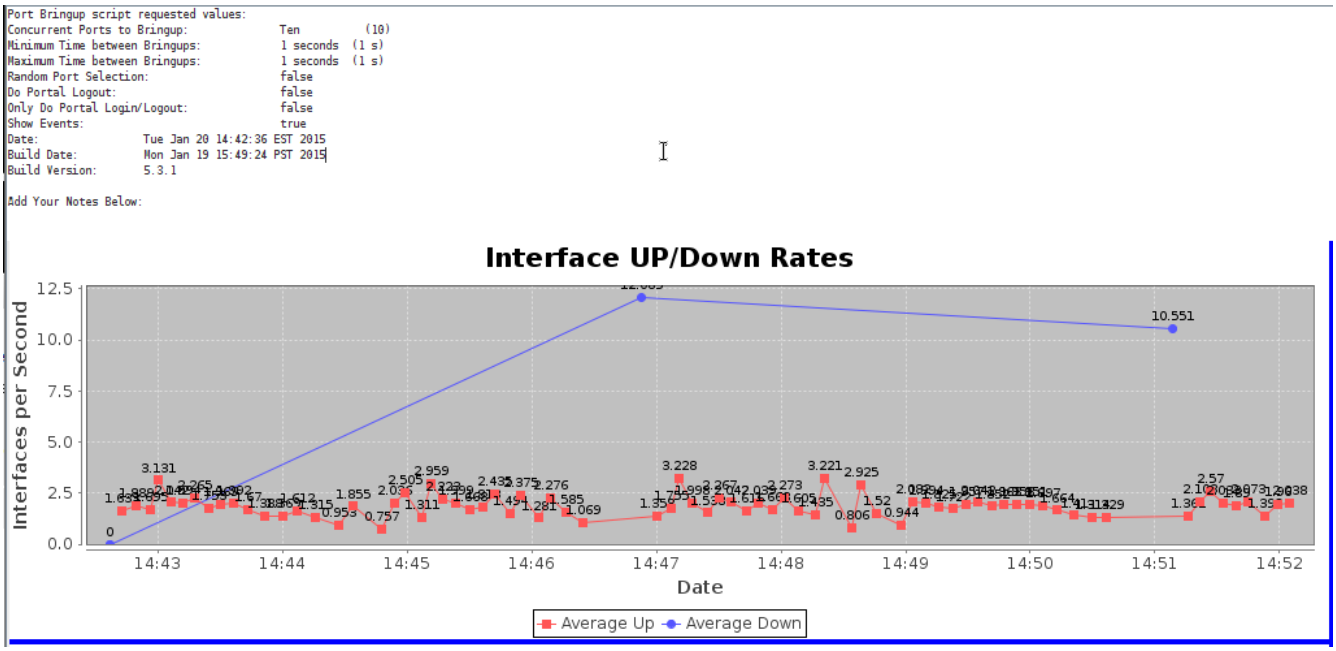
```
Port Bringup script requested values:
Concurrent Ports to Bringup:            Five        (5)
Minimum Time between Bringups:          1 seconds   (1 s)
Maximum Time between Bringups:          1 seconds   (1 s)
Random Port Selection:                  false
Do Portal Logout:                       false
Only Do Portal Login/Logout:            false
Show Events:                            true
Date:               Tue Jan 20 14:23:15 EST 2015
Build Date:         Mon Jan 19 15:49:24 PST 2015
Build Version:      5.3.1

Add Your Notes Below:
```



Scenario: WPA2 PSK, Static IP, 10 simultaneous stations

Set *Concurrent Ports to Bring Up* to 10 and run the test again.



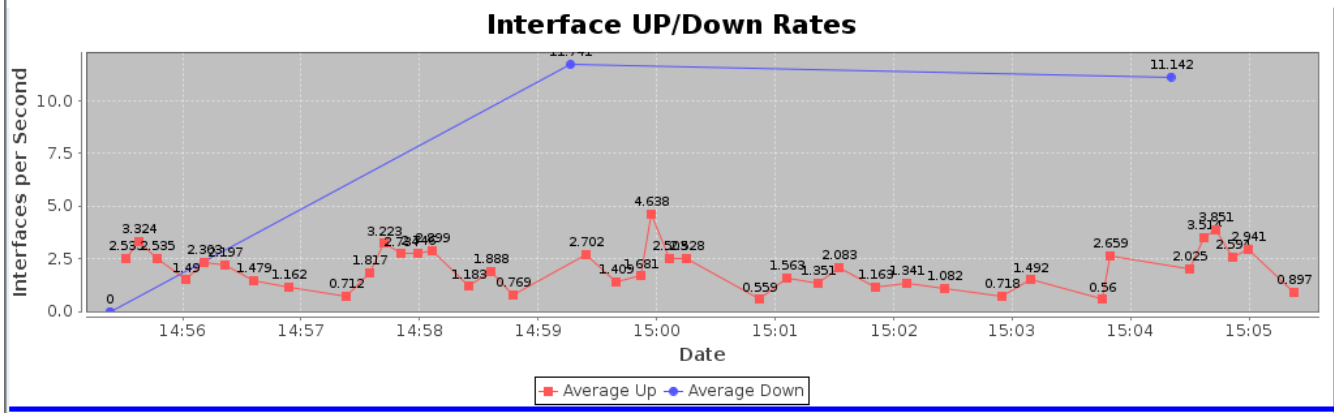
Looks like about 1.5-2.5 interface events per second.

Scenario: WPA2 PSK, Static IP, 20 simultaneous stations

Set *Concurrent Ports to Bring Up* to 20 and run the test again.

```
Port Bringup script requested values:
Concurrent Ports to Bringup:            Twenty      (20)
Minimum Time between Bringups:          1 seconds   (1 s)
Maximum Time between Bringups:          1 seconds   (1 s)
Random Port Selection:                  false
Do Portal Logout:                       false
Only Do Portal Login/Logout:            false
Show Events:                            true
Date:               Tue Jan 20 14:55:23 EST 2015
Build Date:         Mon Jan 19 15:49:24 PST 2015
Build Version:      5.3.1

Add Your Notes Below:
```



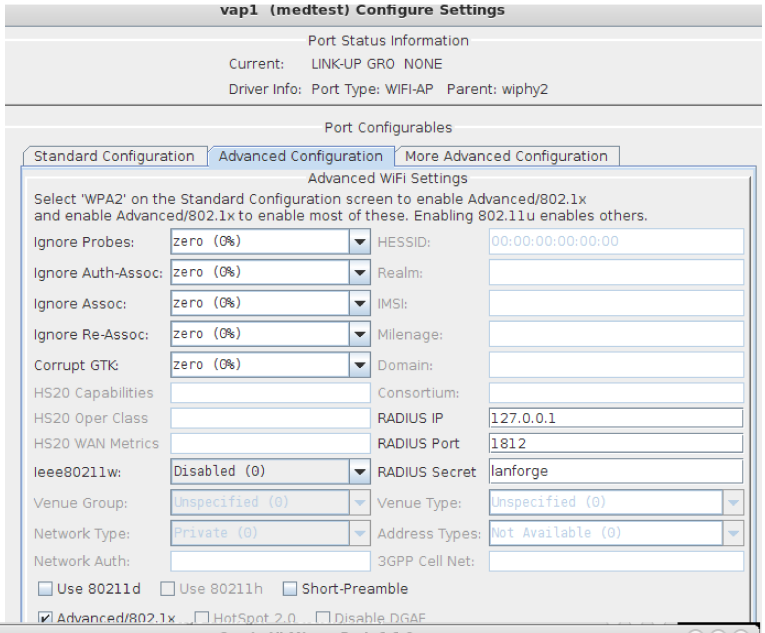
Looks minimums of 0.5 interfaces a second and bursts up to 4.6 interface a second.

Scenario: RADIUS dot1x, Static IP, 5 simultaneous stations

We will begin by deleting the previous stations and configure the VAP to have no key phrase, but to enable dot1x RADIUS authentication.

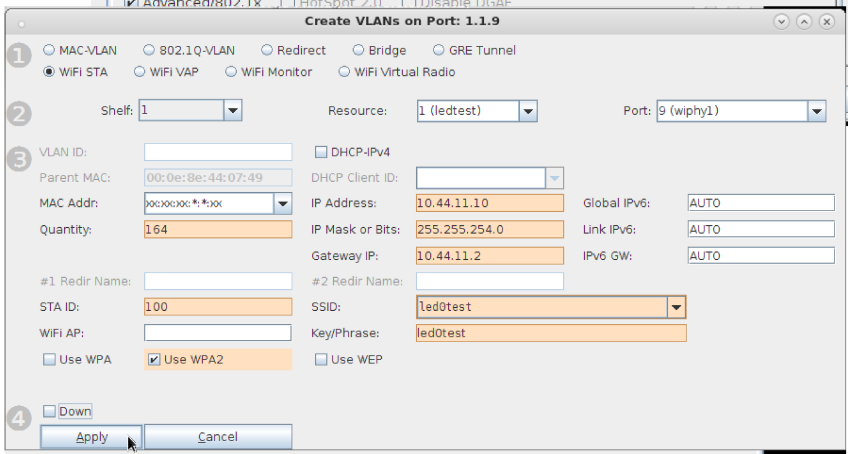
1) In the **Ports** tab, highlight all stations and delete them.

2) Double click the vap1 AP. We will keep the WPA2 settings. Click over to the **Advanced Configuration** tab: check Advanced/802.1x, set RADIUS secret to **lanforge**. Click **OK**.



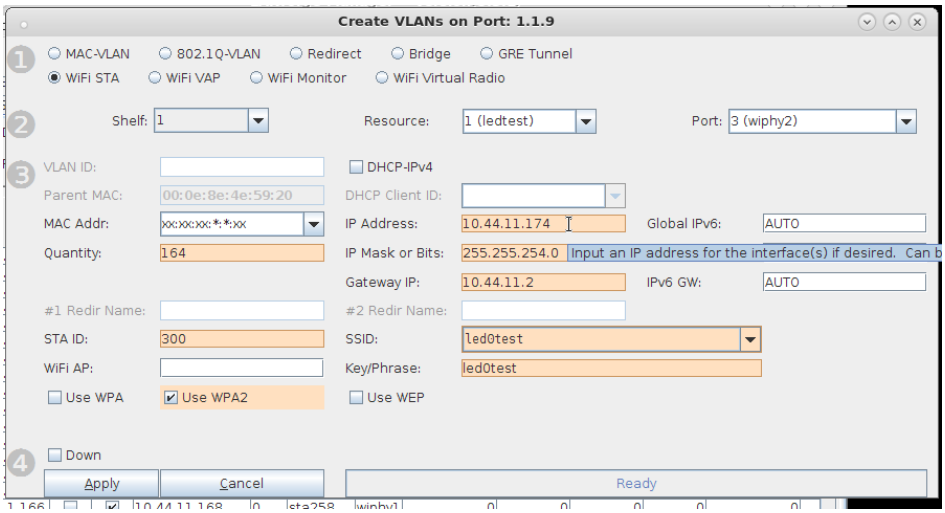
3) Create 164 wifi stations on ledtest **wiphy1**.

Start with *IP address* 10.44.11.10, *subnet mask* 255.255.254.0, *Gateway IP*

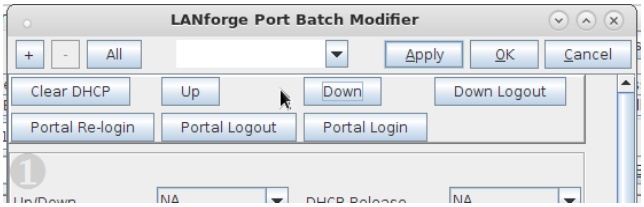


10.44.11.2, *STA ID* is 100, check *Use WPA2* and set *SSID* to **led0test** and *Key/Phrase* to **led0test1**. You can check Down.

4) create 128 more stations: set Port to **wiphy2**, Set the *IP Address* to 10.44.11.174, and the *STA ID* is 300. Click **Apply** then **Cancel**.

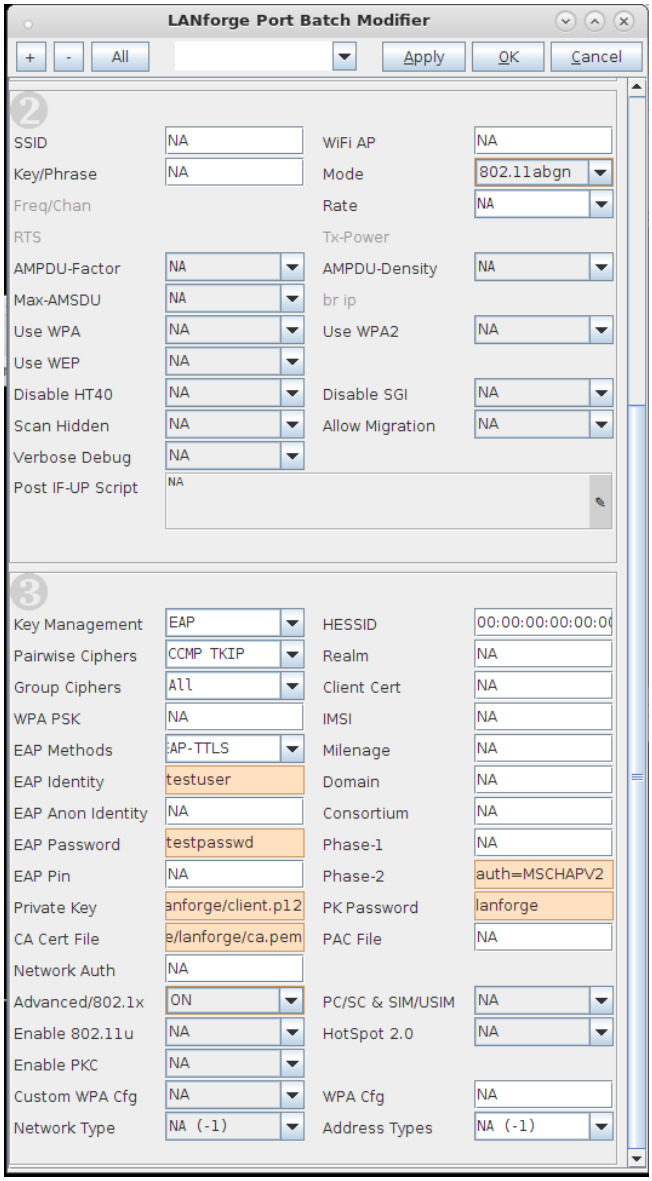


5) In the **Ports** tab, select all the stations. If the stations are not down, use **Batch Modify** to set them Down.



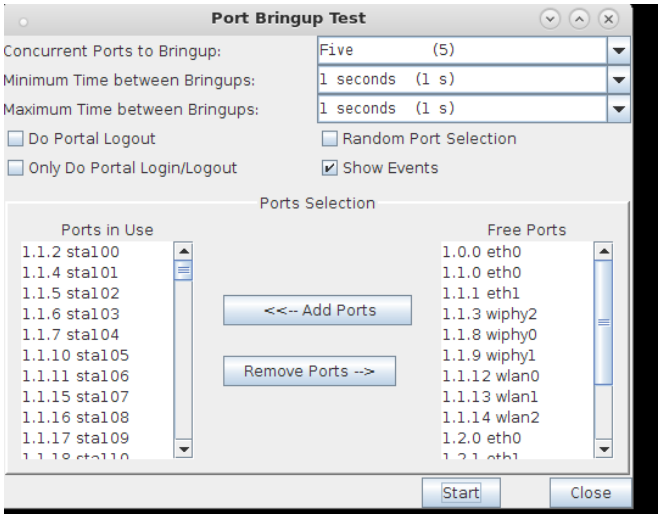
Next, in box **2**, set the **Mode** to 802.11abgn.

Continue to box **3** and set *Key Management* to **EAP**, *Pairwise Ciphers* to **CCMP TKIP**, *Group Ciphers* to ALL, *EAP Methods* to EAP-TTLS, *EAP Identity* to **testuser**, *EAP Password* to testpasswd, *Private Key* to /home/lanforge/client.pl2, *CA Cert File* to /home/lanforge/ca.pem, *Phase 2* to **auth=MSCHAPV2**, *Advanced 802.1x* to ON.

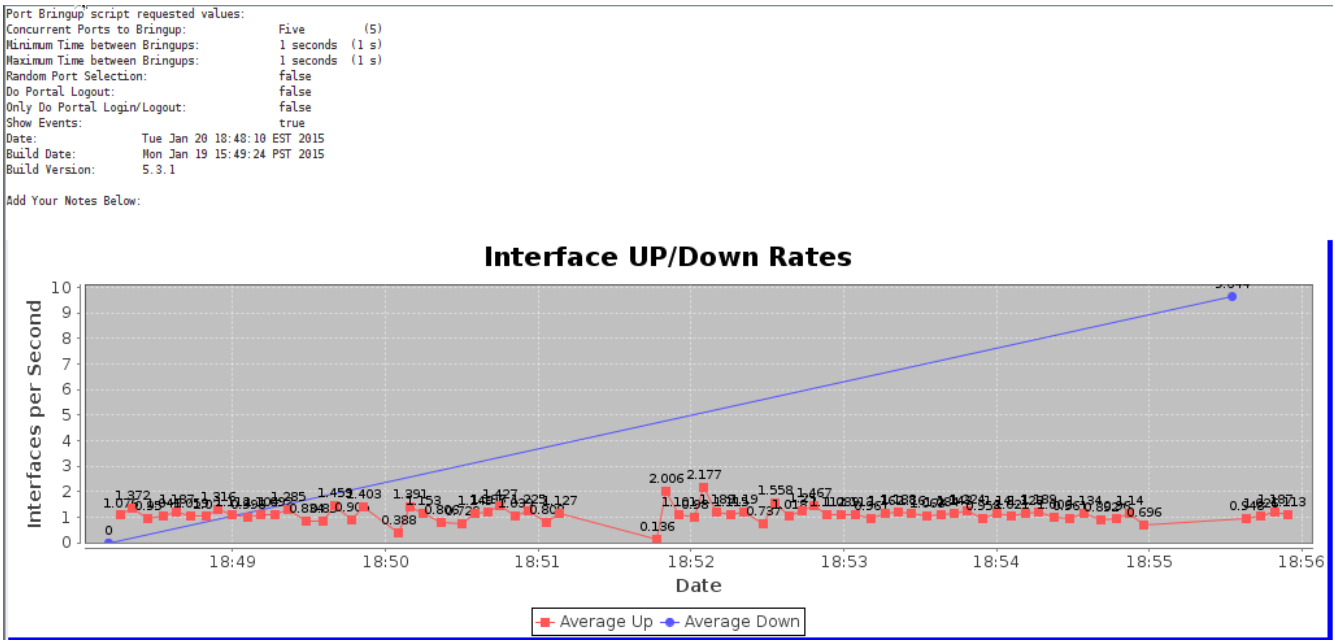


Click **OK** to apply the settings.

6) Leave all the stations highlighted. Open the *Plugins->Port Bring Up Test*, and set *Concurrent Ports to Bring Up* to **5**, turn off *Do Logout* and *Only Do Login/Logout*.

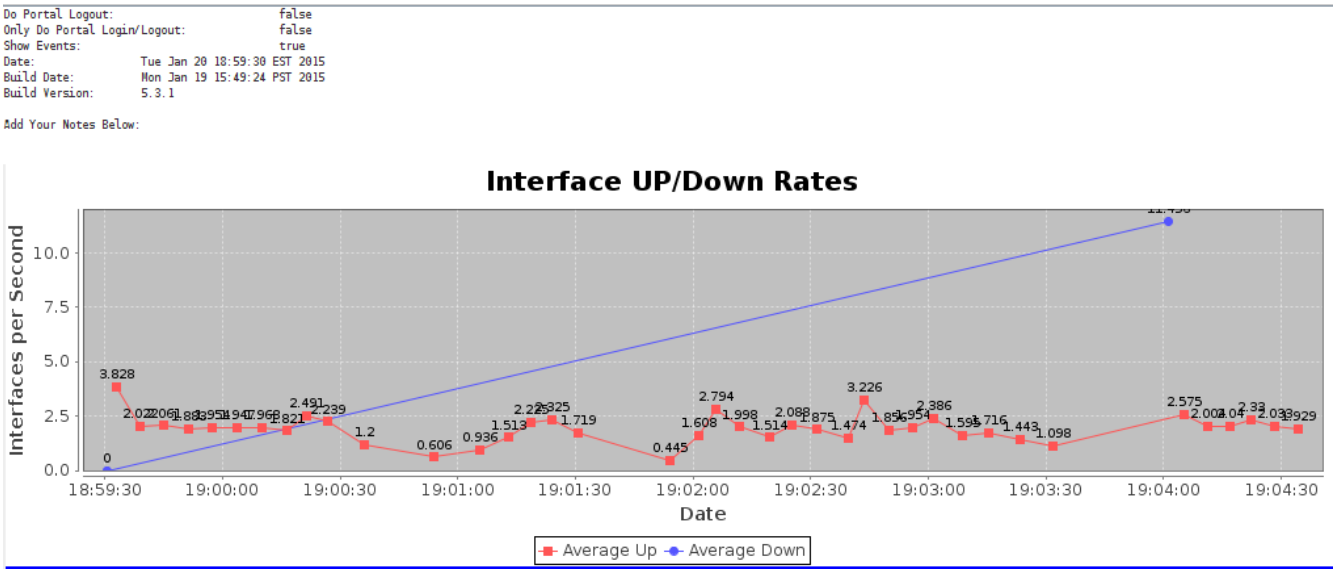


We will get about 1 interface a second.



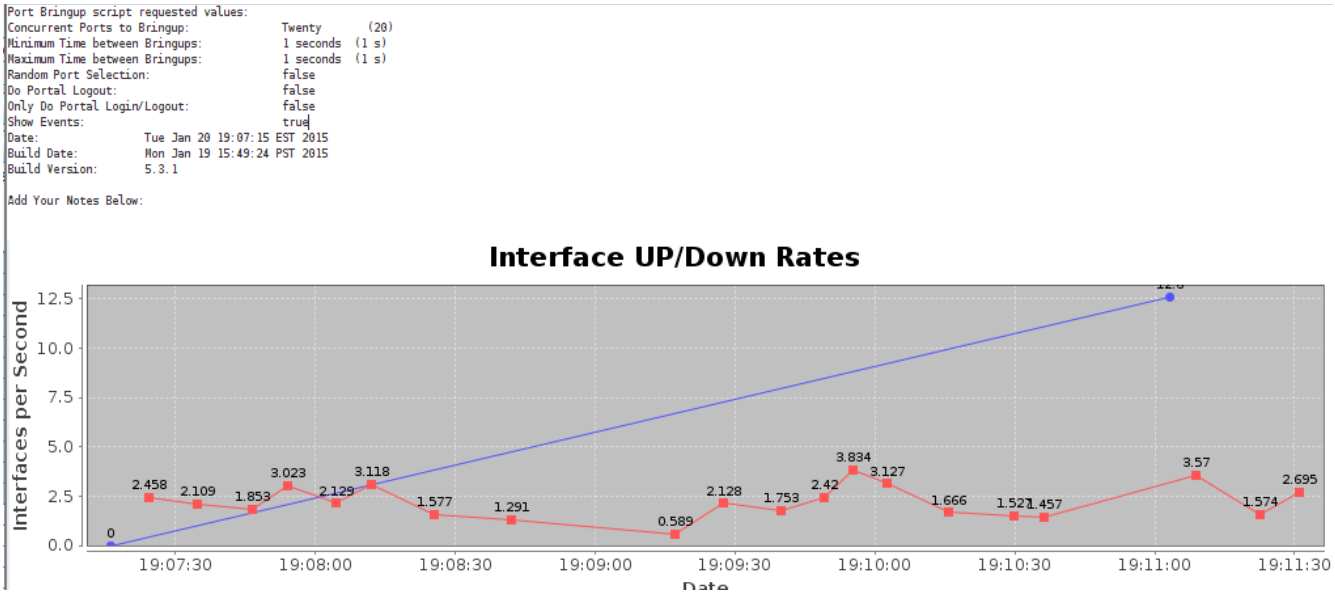
Scenario: RADIUS dot1x, Static IP, 10 simultaneous stations

Set *Concurrent Ports to Bring Up* to **10**, and start the test again.



We will get an average of about 1.75 interface events a second.

Scenario: RADIUS dot1x, Static IP, 20 simultaneous stations

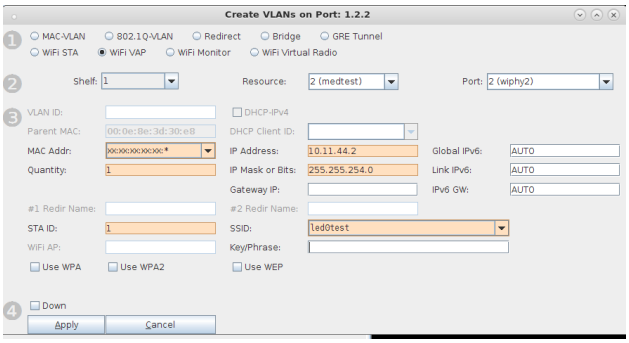


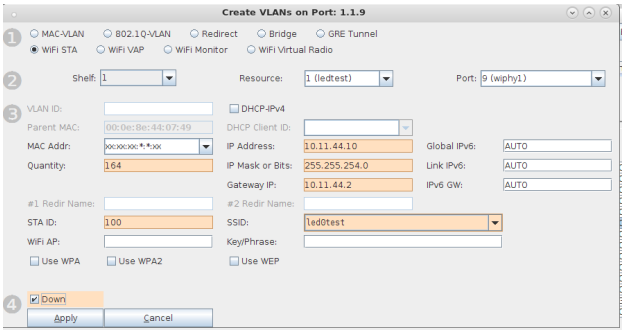
Set *Concurrent Ports to Bring Up* to **20**, and start the test again.

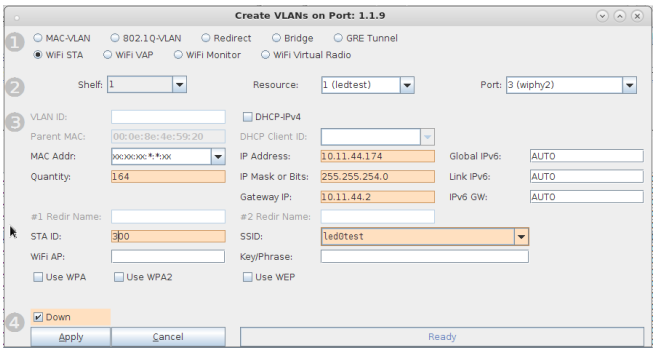
We will get an average of about 2 interface events a second.

Scenario: Open WiFi, 5 simultaneous stations

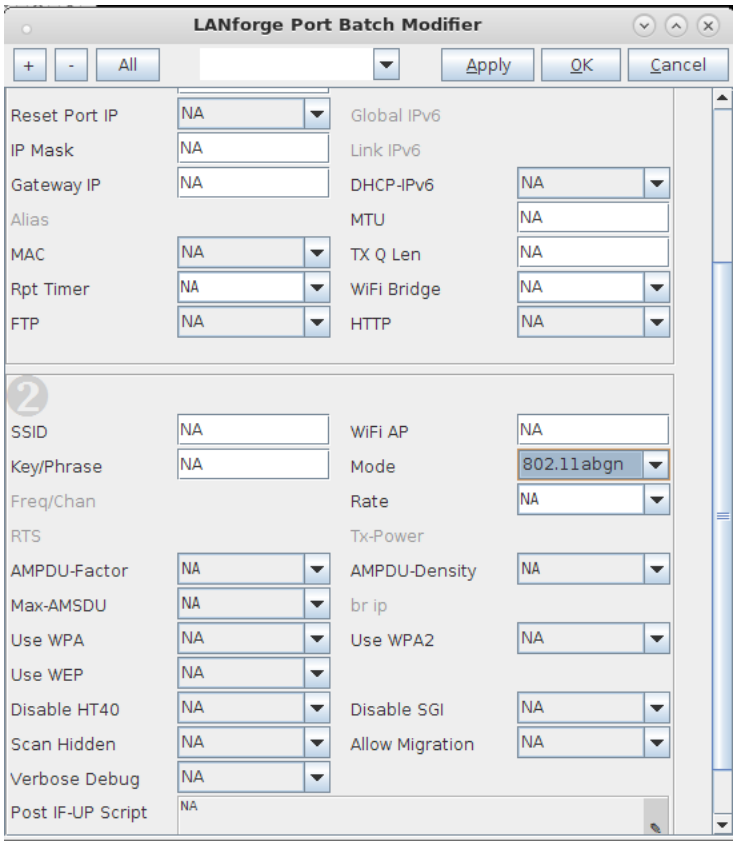
Creating an open WiFi spot is simple enough to do just by the pictures.



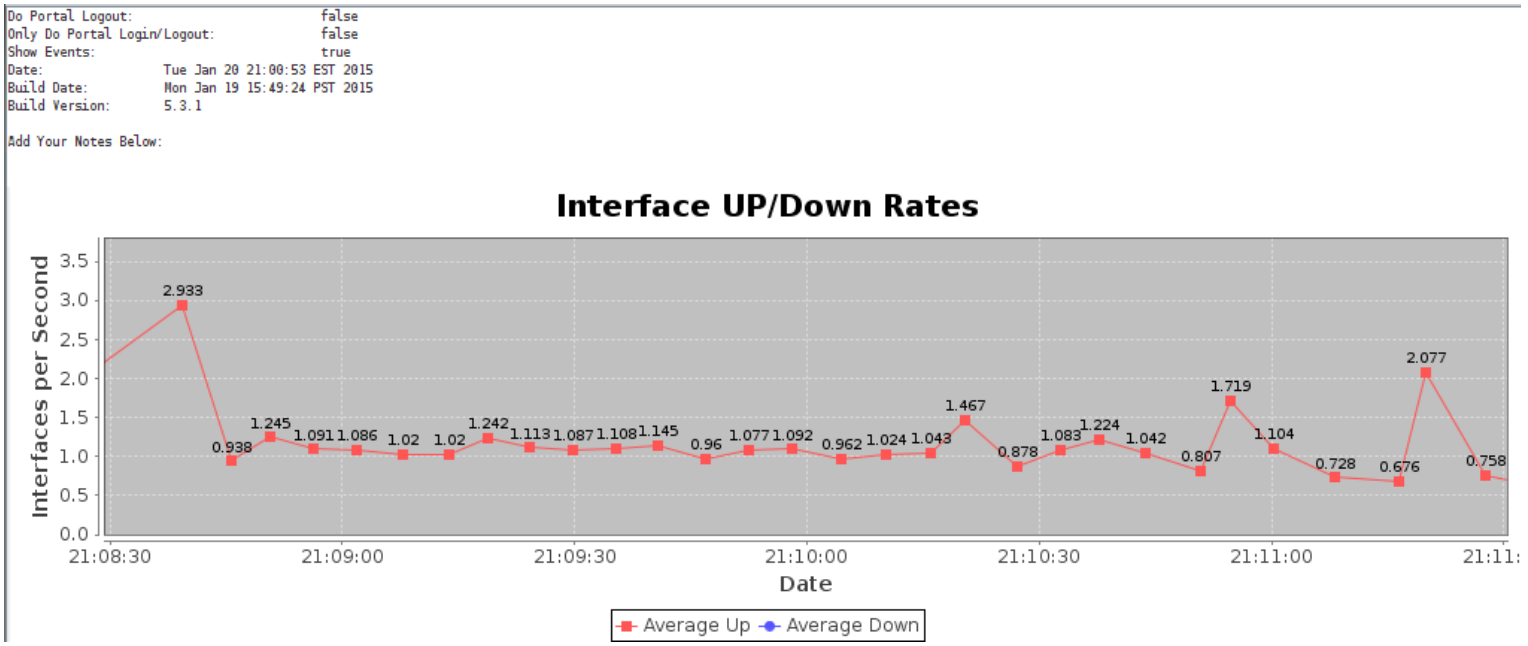




Just don't forget to highlightall the stations in the port tab and apply 80211abgn mode to them.

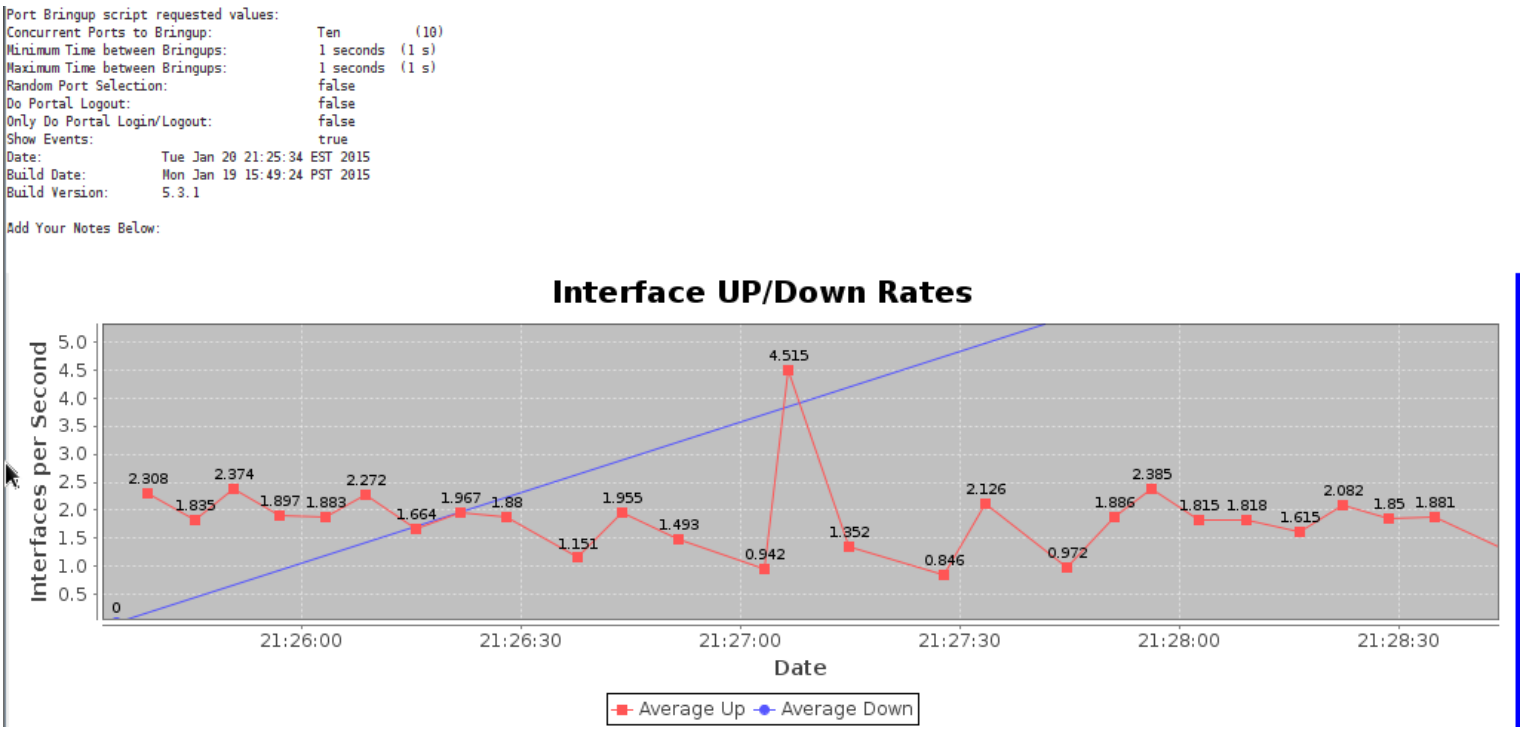


Next we do the Port Bring-Up Test with *Concurrent Ports to Bring Up* at 5. Ave appears to be 1.0.



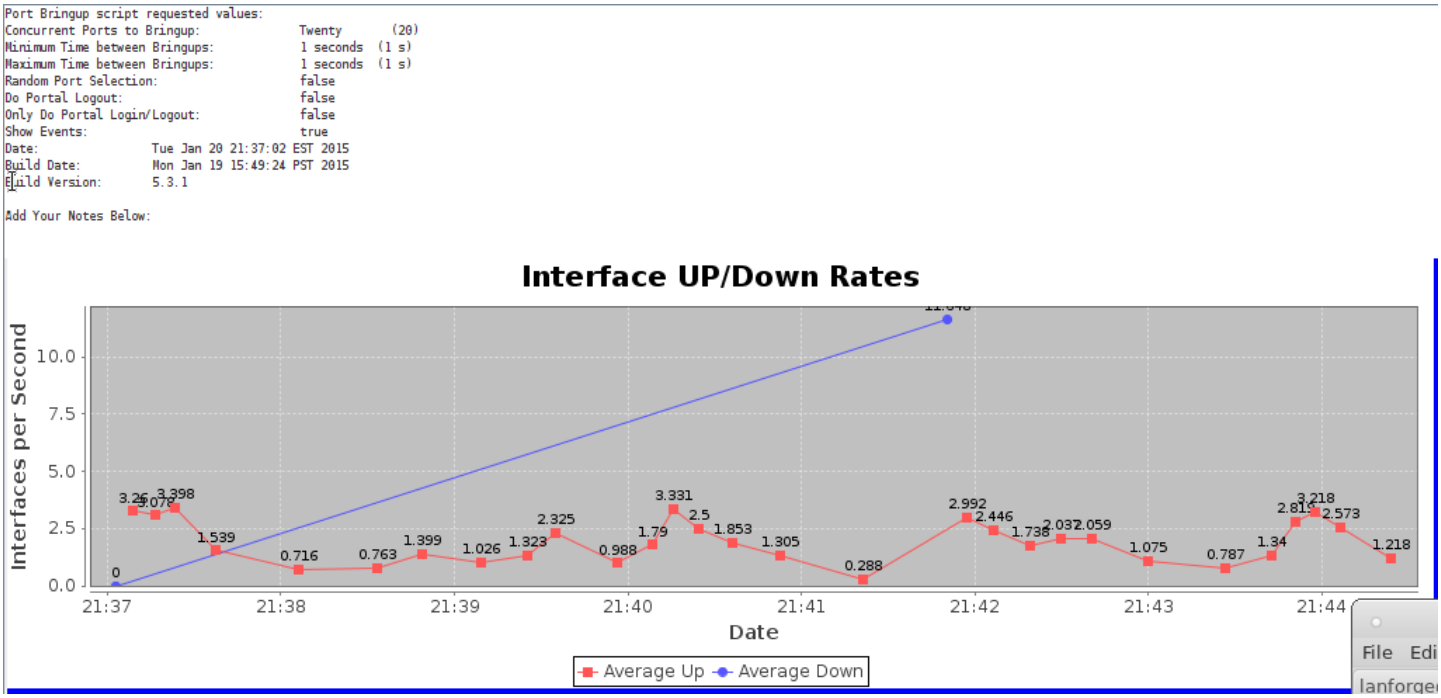
Scenario: Open WiFI, 10 simultaneous stations

Next we do the Port Bring-Up Test with *Concurrent Ports to Bring Up* at 10. Ave appears to be about 1.75.



Scenario: Open WiFI, 20 simultaneous stations

Next we do the Port Bringup Test with *Concurrent Ports to Bring Up* at 20. Ave appears to be 1.75.



Migration between two APs

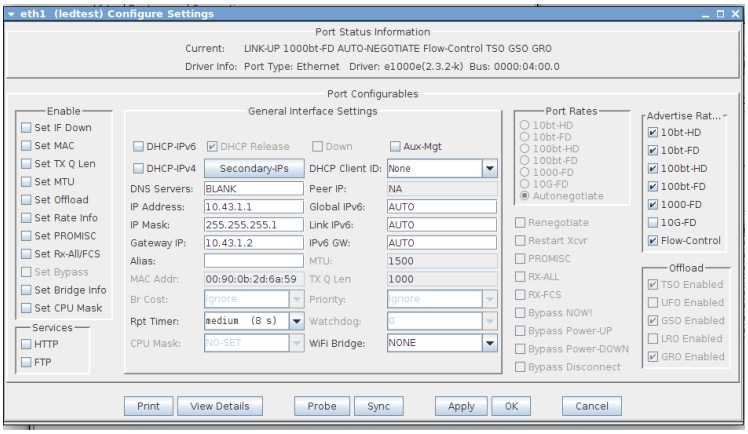
We expand the radio configuration for migration testing. We will setup the three radios on ledtest and one radio on medtest with these roles:

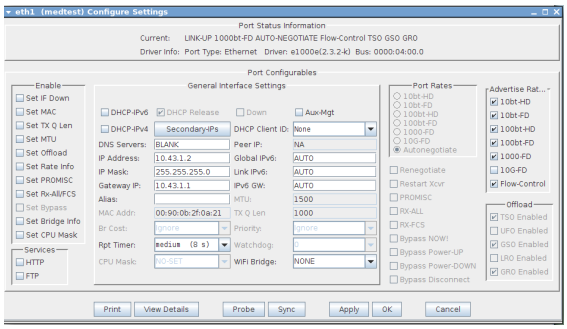
Computer	Radio	Role
Ledtest	Wiphy0	Virtual AP 0
Ledtest	Wiphy1	Virtual AP1
Ledtest	Wiphy2	Stations 100-263
Medtest	Wiphy2	Stations 300-463

The trick to migration is to not configure a stampede of stations from one AP to another. This will overload the radio drivers in the worst case and in best case roaming rates are very slow. Shuffling stations between radios works very well, and we easily drive 20 station migrations a second.

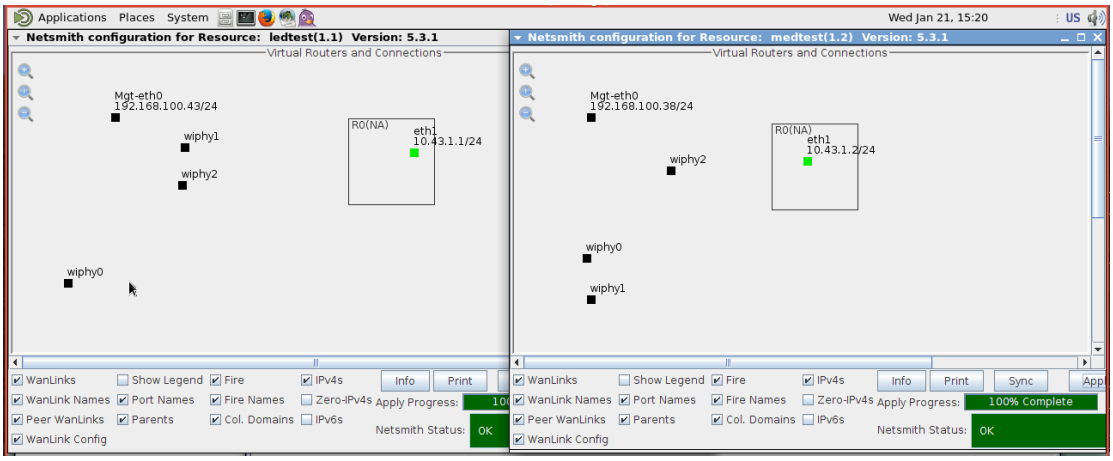
LANforge Configuration:

1) Configure the eth1 ports for each LANforge server to talk to each other.

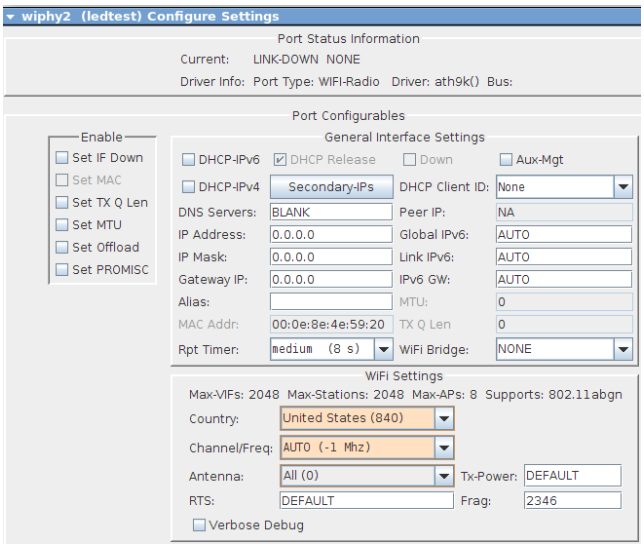


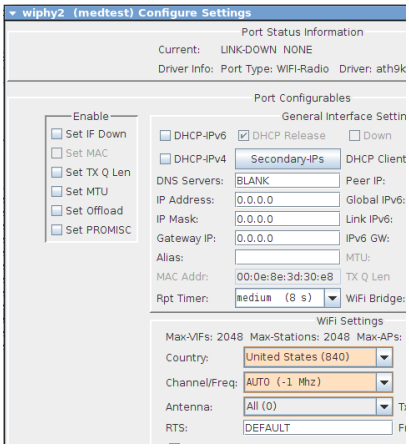


2) Place both ethernet ports in virtual routers

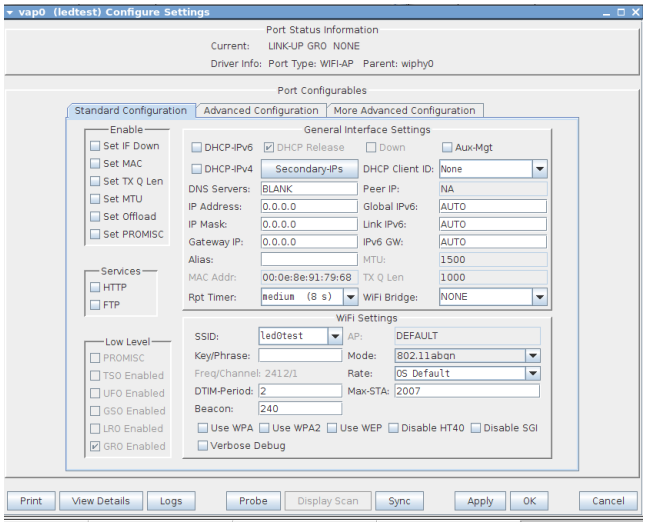


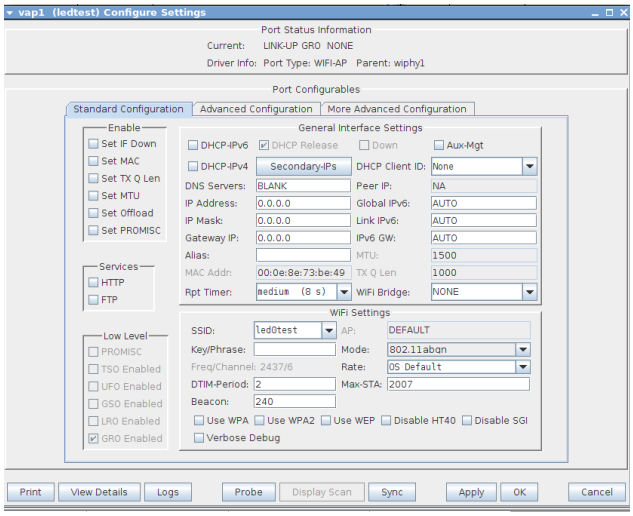
3)Create the virtual AP radios. Choose chanel 149 frequency 5745. Mode 802.11abgn for both ledtest wiphy0 and wiphy1.



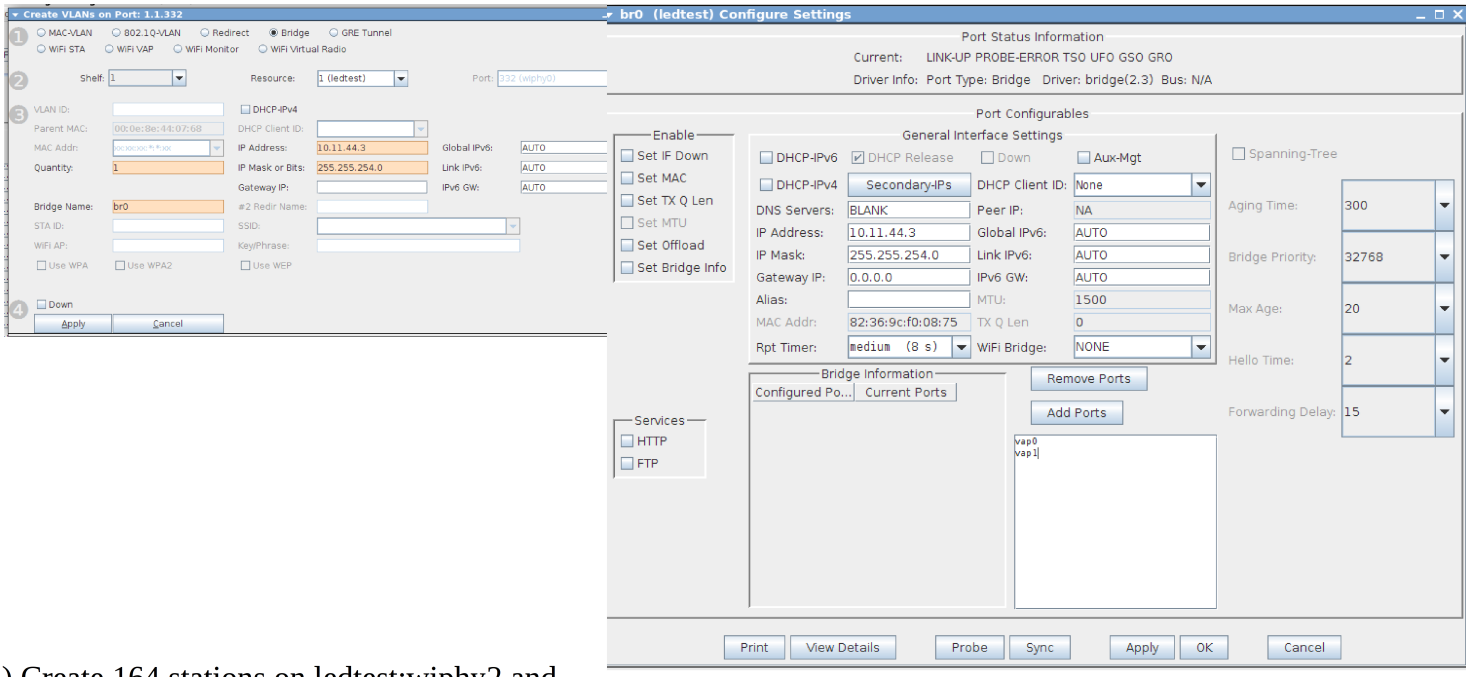


4) Create the two virtual APs: do not assign addresses to them, we will be adding them to a bridge.

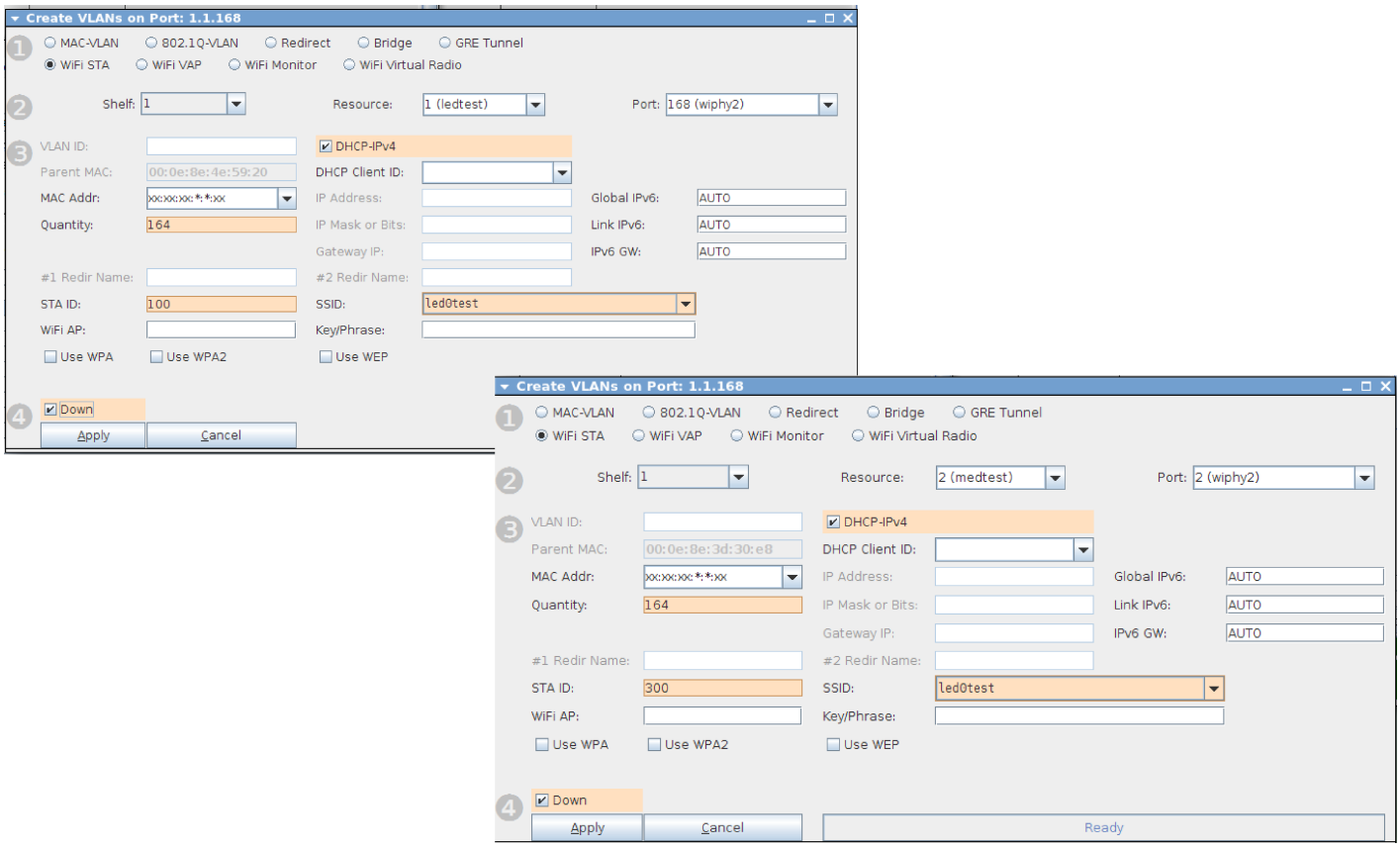




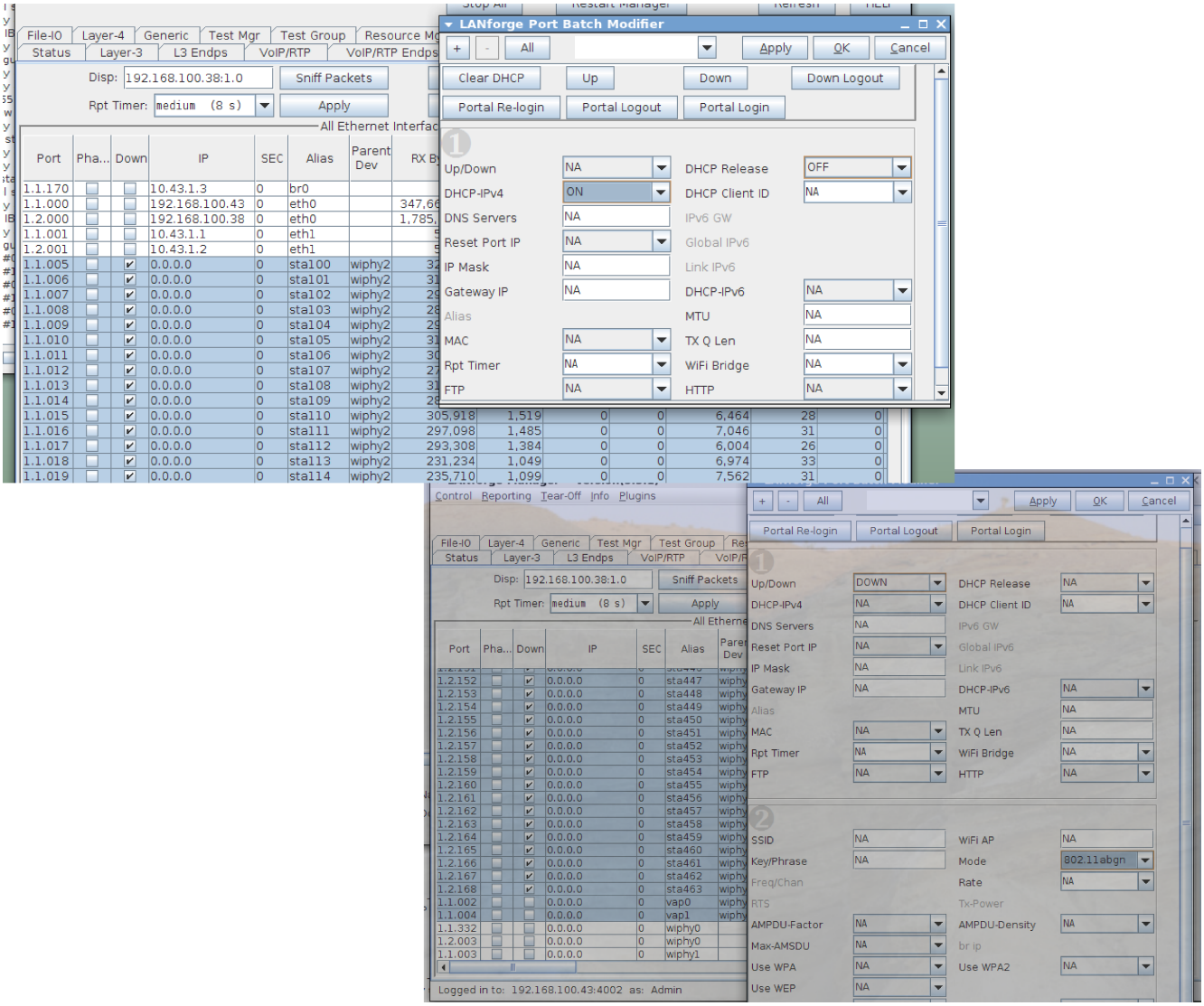
5) Create bridge br0. Add both vap0 and vap1 to the bridge. Assign an address to the bridge.



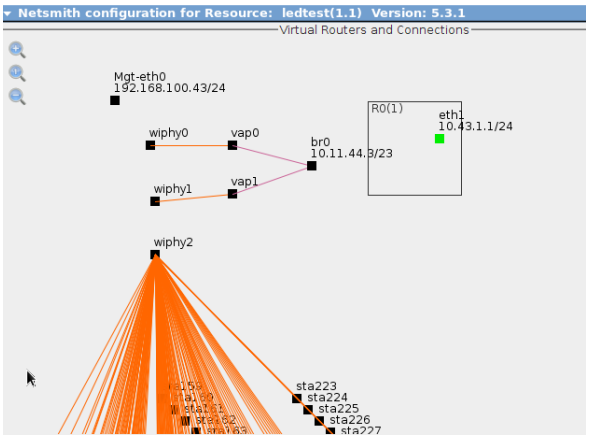
6) Create 164 stations on ledtest:wiphy2 and
164 stations on medtest:wiphy2. Set the SSID to **led0test**, the passphrase to **led0test1** and select **WPA2**.



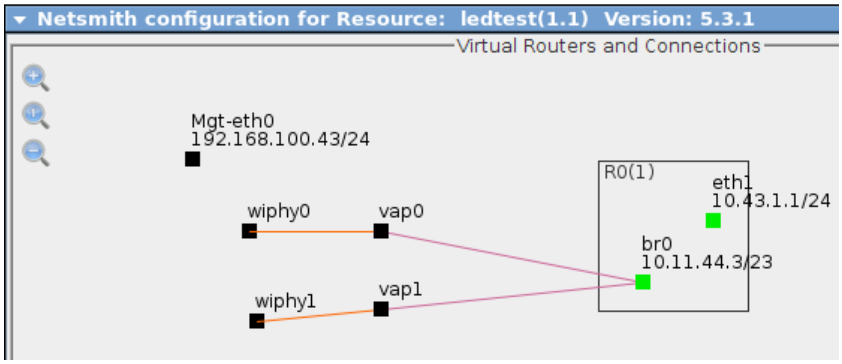
Highlight all the stations in the Ports tab. Set them down, **enable** DHCPv4, turn **off** DHCP Release, and set themto Mode **802.11abgn**.



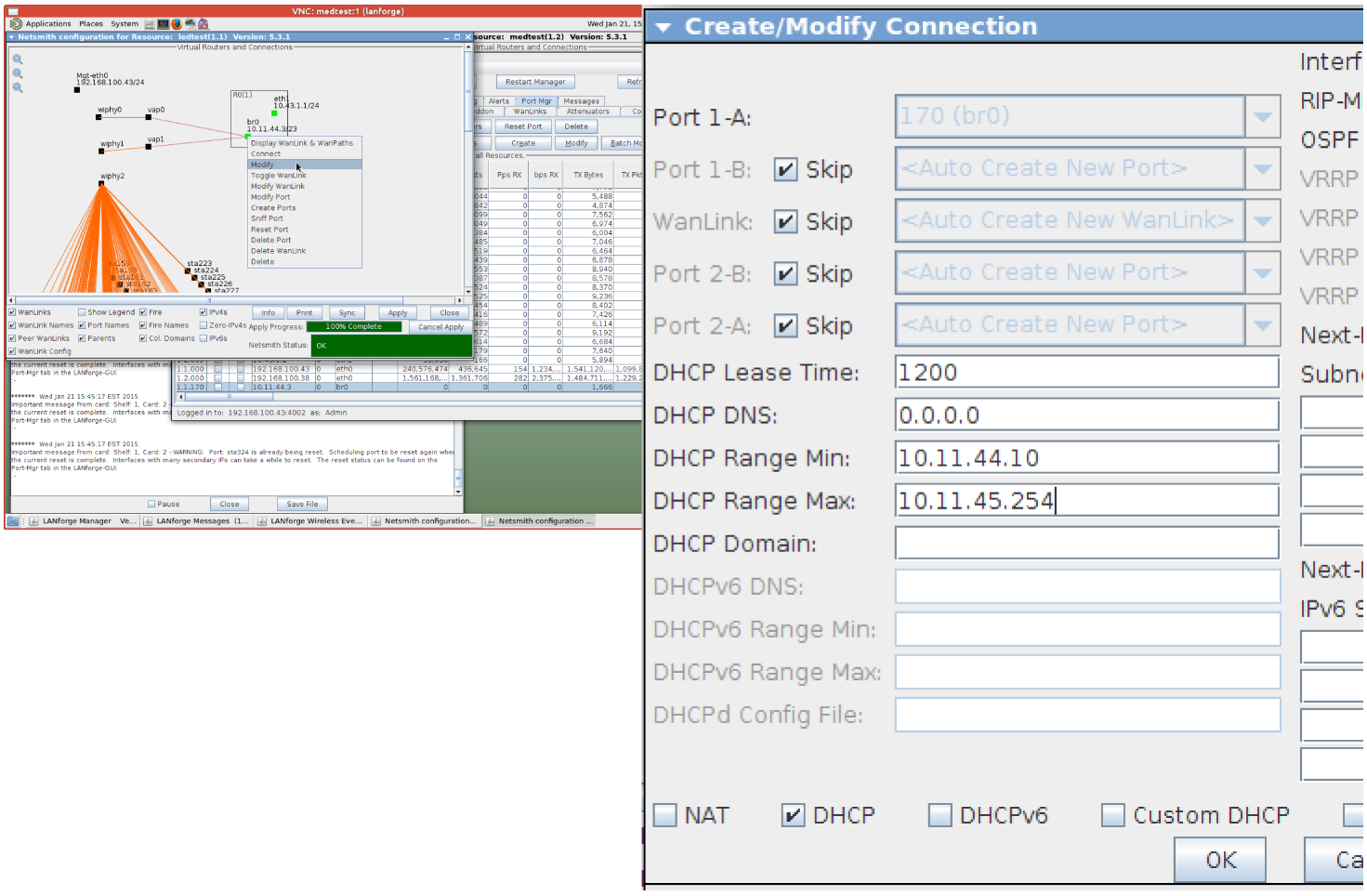
You should now see 164 stations in the ledtest Netsmith window.



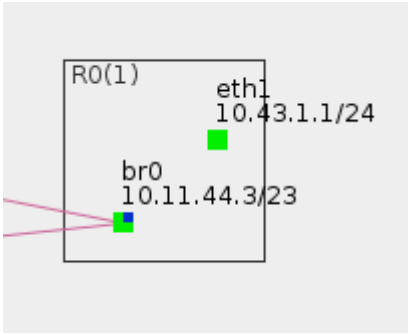
Drag the bridge into the Virtual Router. Click Apply.



Right click on br0, click Modify, and add a DHCP service to it. Grant lease time of 1200 seconds, and the range 10.11.44.10 – 10.11.45.254. Click OK.



When you are done with that, click Apply in the Netsmith window. You should see the **br0** port gain a blue rectangle.



7) Bring up all the stations and wait for them to complete their DHCP interaction. This might take a few minutes, be patient.

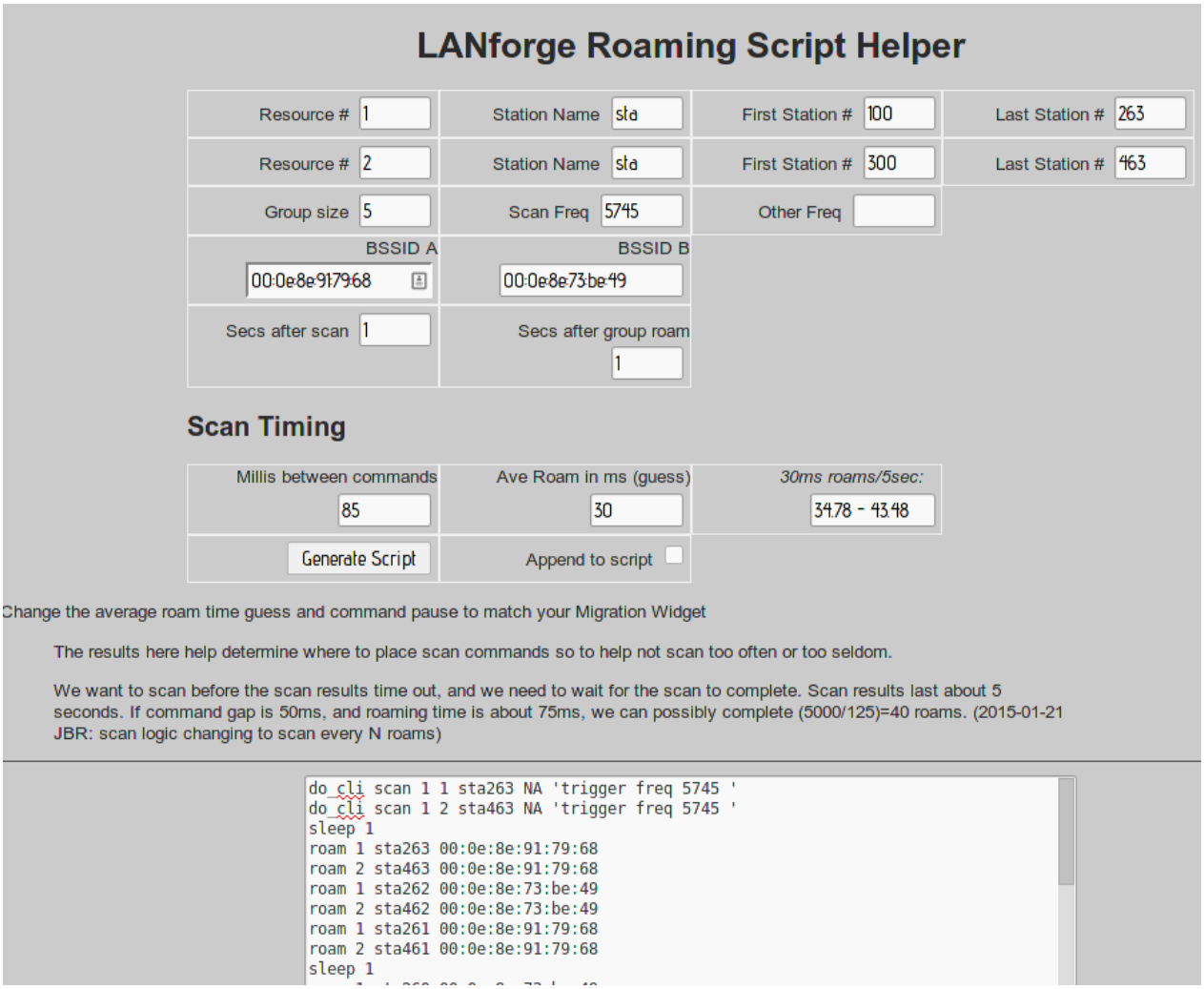
8) Create a Roaming script. Here is a roaming script created using a January 28 version of the scan-script.html utility. It will roam 10 stations a second, alternating between station radios and shuffling stations from their AP to the opposite AP.

```
do_cli scan 1 1 sta263 NA 'trigger freq 5745 '
do_cli scan 1 2 sta463 NA 'trigger freq 5745 '
sleep 1
roam 1 sta263 00:0e:8e:91:79:68
roam 2 sta463 00:0e:8e:91:79:68
roam 1 sta262 00:0e:8e:73:be:49
roam 2 sta462 00:0e:8e:73:be:49
roam 1 sta261 00:0e:8e:91:79:68
roam 2 sta461 00:0e:8e:91:79:68
roam 1 sta260 00:0e:8e:73:be:49
roam 2 sta460 00:0e:8e:73:be:49
roam 1 sta259 00:0e:8e:91:79:68
roam 2 sta459 00:0e:8e:91:79:68
sleep 1
roam 1 sta258 00:0e:8e:91:79:68
roam 2 sta458 00:0e:8e:91:79:68
roam 1 sta257 00:0e:8e:73:be:49
roam 2 sta457 00:0e:8e:73:be:49
roam 1 sta256 00:0e:8e:73:be:49
roam 2 sta456 00:0e:8e:73:be:49
roam 1 sta255 00:0e:8e:91:79:68
roam 2 sta455 00:0e:8e:91:79:68
roam 1 sta254 00:0e:8e:73:be:49
roam 2 sta454 00:0e:8e:73:be:49
sleep 1
roam 1 sta253 00:0e:8e:73:be:49
roam 2 sta453 00:0e:8e:73:be:49
roam 1 sta252 00:0e:8e:91:79:68
roam 2 sta452 00:0e:8e:91:79:68
roam 1 sta251 00:0e:8e:91:79:68
roam 2 sta451 00:0e:8e:91:79:68
roam 1 sta250 00:0e:8e:73:be:49
roam 2 sta450 00:0e:8e:73:be:49
roam 1 sta249 00:0e:8e:91:79:68
roam 2 sta449 00:0e:8e:91:79:68
sleep 1
roam 1 sta248 00:0e:8e:73:be:49
roam 2 sta448 00:0e:8e:73:be:49
do_cli scan 1 1 sta247 NA 'trigger freq 5745 '
do_cli scan 1 2 sta447 NA 'trigger freq 5745 '
sleep 1
roam 1 sta247 00:0e:8e:91:79:68
roam 2 sta447 00:0e:8e:91:79:68
roam 1 sta246 00:0e:8e:91:79:68
roam 2 sta446 00:0e:8e:91:79:68
roam 1 sta245 00:0e:8e:73:be:49
roam 2 sta445 00:0e:8e:73:be:49
roam 1 sta244 00:0e:8e:73:be:49
roam 2 sta444 00:0e:8e:73:be:49
roam 1 sta243 00:0e:8e:91:79:68
roam 2 sta443 00:0e:8e:91:79:68
sleep 1
```

The WiFi Mobility plugin was using this script with the following parameters:

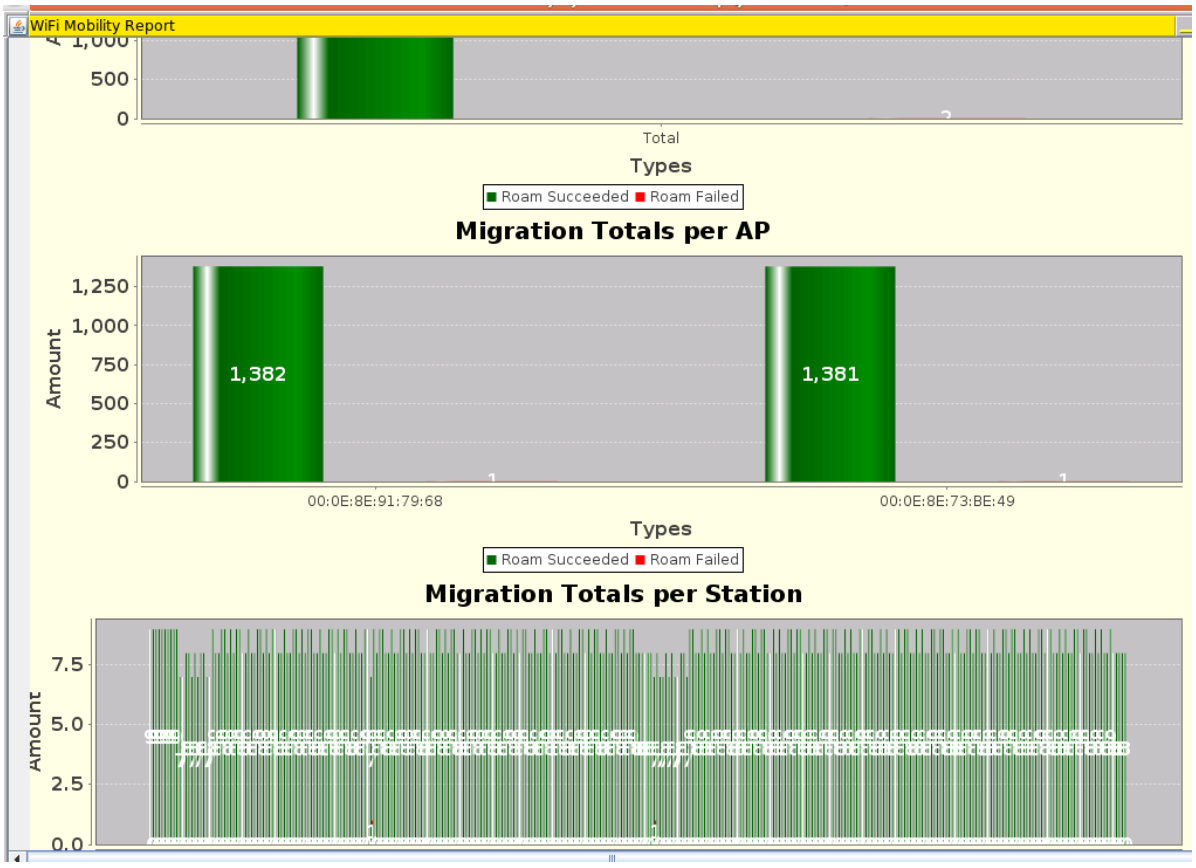
Refresh Interval: **2500ms**,
Pause Between Commands: **85ms**,
Pause after Show Port: **2125ms**,
Auto-Verify Timer: **2750ms**,
Maximum Roam Time in graphs: **1250ms**.

Here is a screen shot of the settings in scan-script helper:



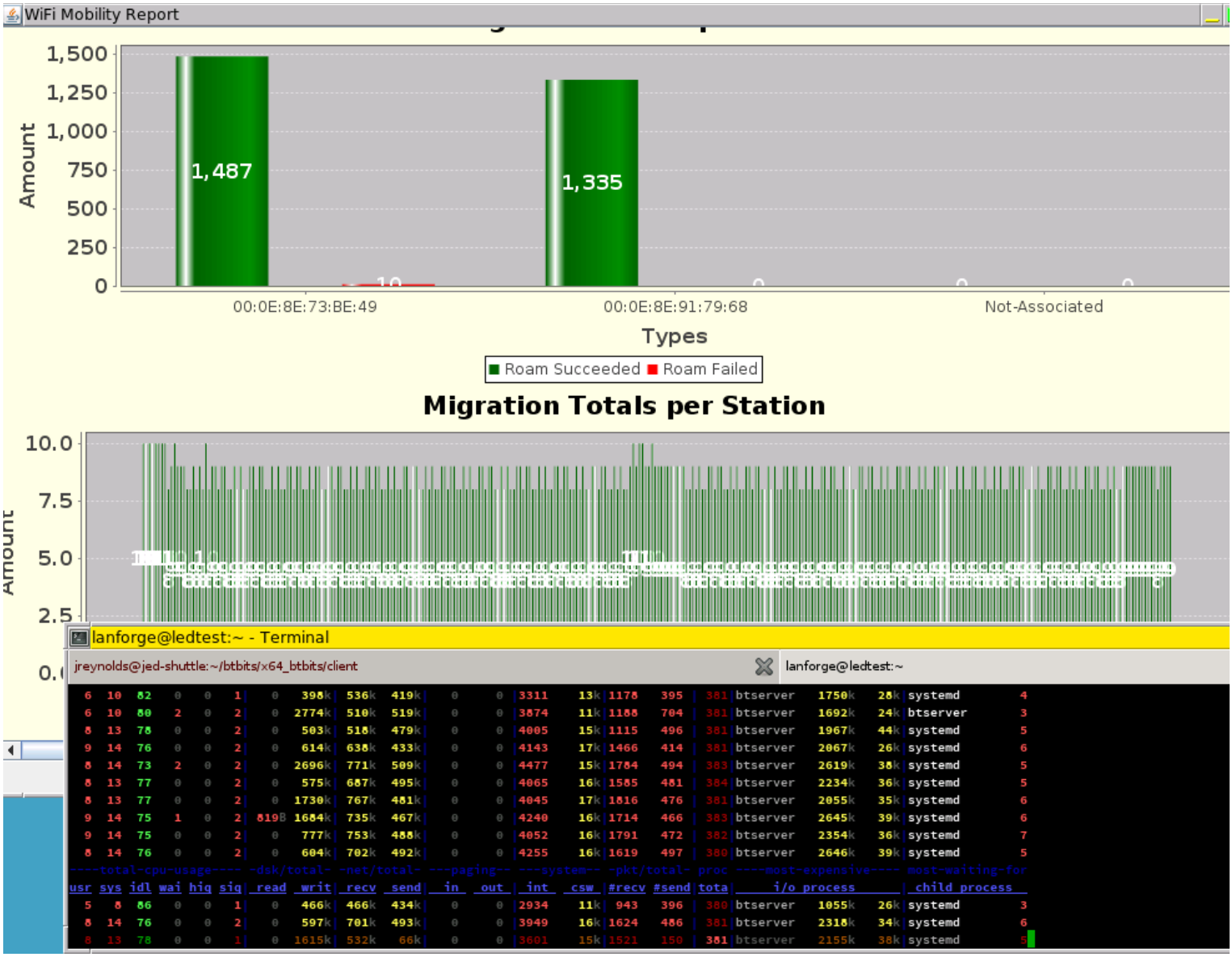
Scenario: Roaming migration, 10 stations per second, WPA.

This is a section of the report created from the 10/sec roaming report:



Scenario: Roaming migration, 20 stations per second, WPA.

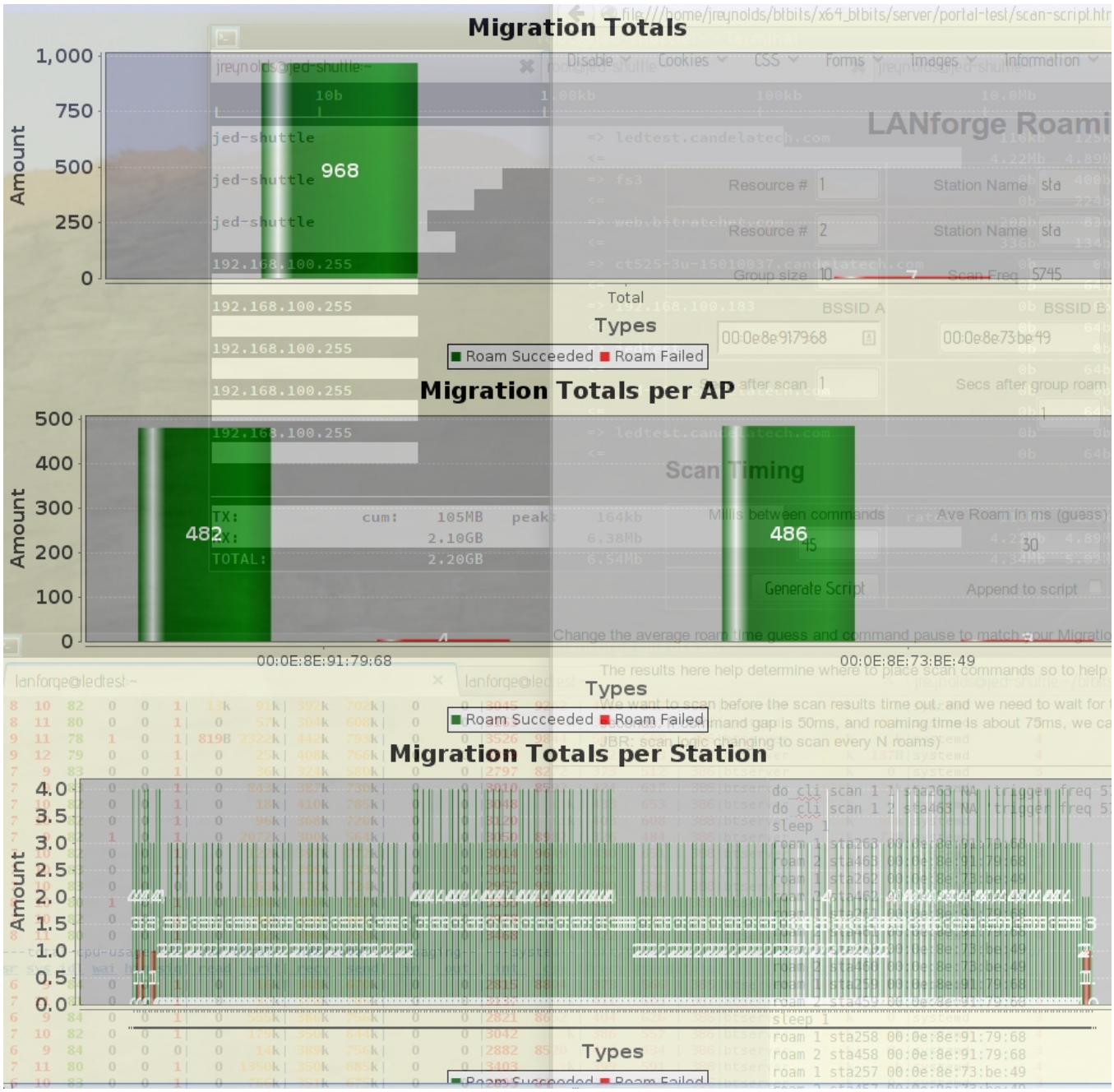
This is a section of the report for roaming 20 stations per second:



We see low system load on the lanforge.

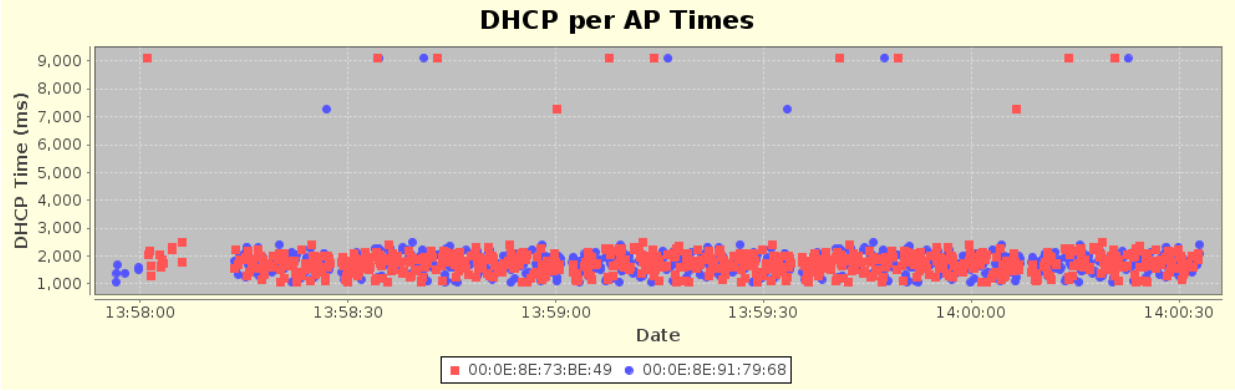
Scenario: Roaming migration, 10 stations per second, RADIUS.

We see similar useful results with RADIUS authentication. (Radius configuration is similar to previous radius configurations in this document.) Pause between commands was 45ms. The errors in this and the next seem related, and I presume there is a problem in the roaming script. However this and the next graph definitely show roaming the desired performance.

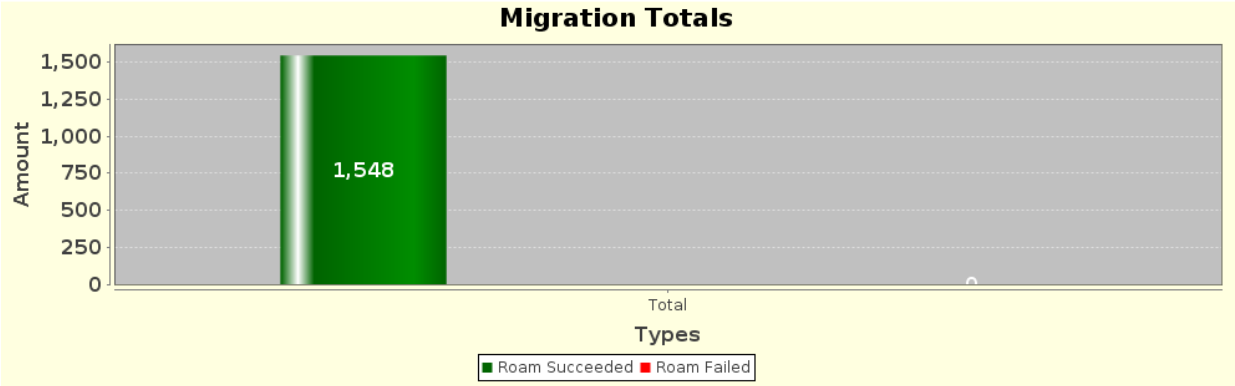


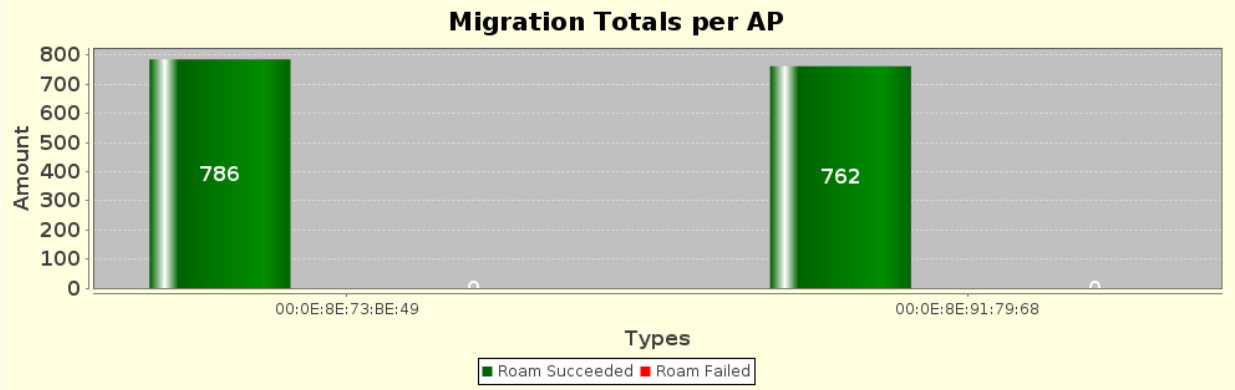
Scenario: Roaming migration, 20 stations per second, RADIUS.

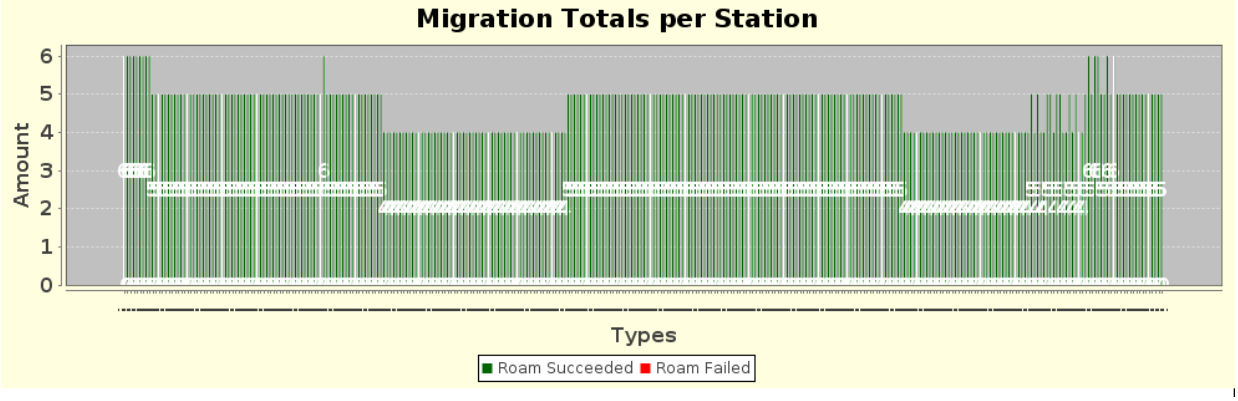
Pause between commands was 45ms.



he 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.

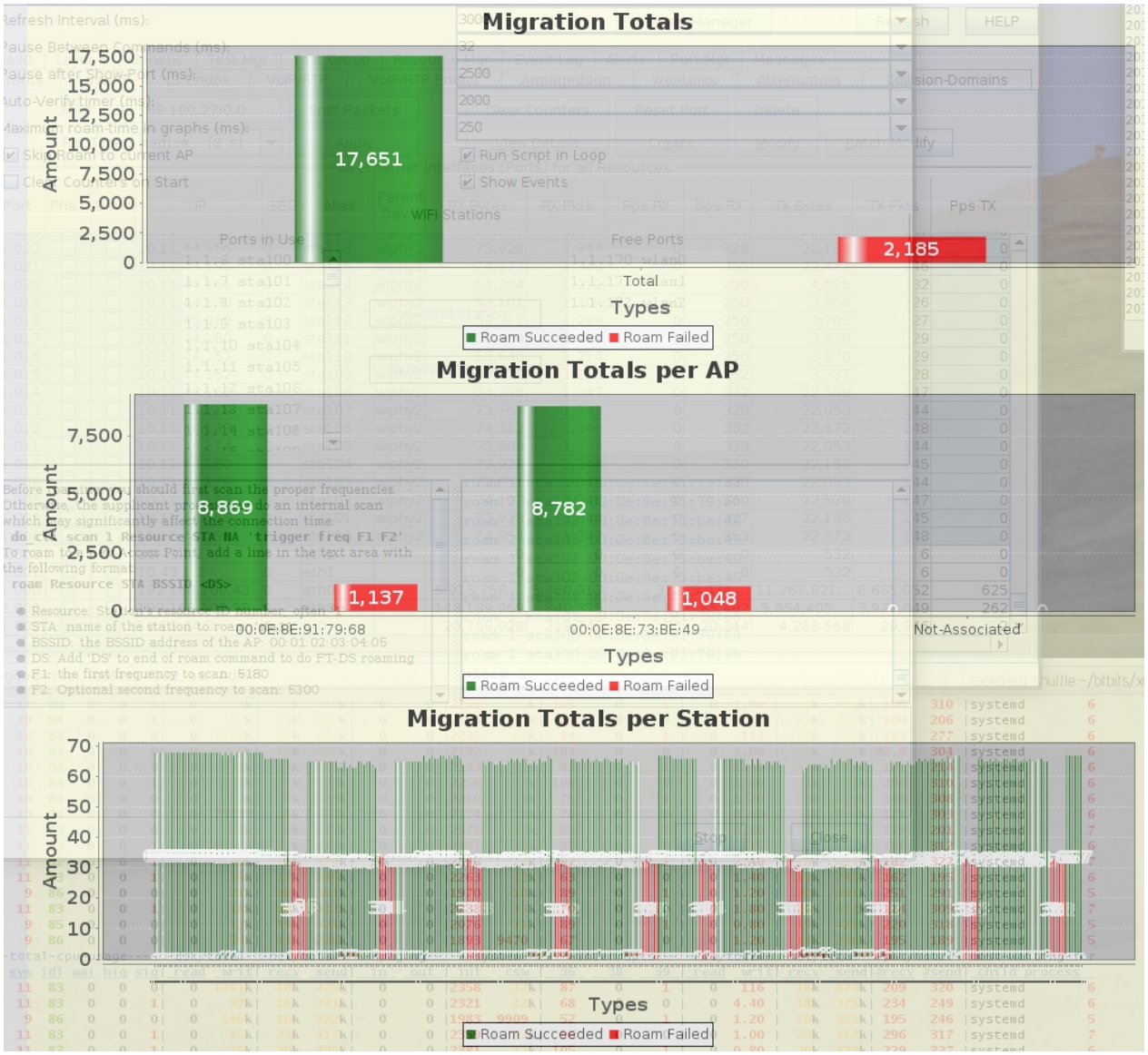






Scenario: Roaming migration, 30 stations/sec, RADIUS

It is possible to reach 30 station migrations per second if you set the pause between commands to 32 ms.



The regular red areas are where the radio scan results begin to expire or where stations fail to finish association because a scan has started too close to their roaming attempt. We saw improved results with migration scripts tuned to assume scan buffers might expire as soon as 2500 milliseconds and the last roam statement before a scan request should be followed by 130ms nap time.

Conclusions

Over the air DHCP performance for bring up is relatively unaffected by types of authentication scheme. The number of back-offs and retries involved in DHCP bring-up seems to be a slow process.

The performance of roaming over WPA2 is excellent. The performance of WPA2+RADIUS shows similar performance. The actual setup for fast roaming performance requires migrations to interleave and avoid radio scan periods. Roaming performance in lab might takes time to tune.

Web Portal login and logout is relatively fast. Possible bottle-necks include SSL and what might be certificate validation latency. There might be ways to speed this interaction up, possibly with methods of certificate caching or local certificate installation.