

Testing Station Roaming with 802.11r, 802.11k and Protected Management Frames

Goal: Setup and run a Station Roam test against a cluster of APs supporting 802.11k, 802.11r, and Protected Management Frames (PMF/MFP). This test uses a 2-radio LANforge CT522 system, but other similar systems will work as well. This tests AP functionality and stability over many roam attempts. This is a good test of the AP's management plane stability, and may also be a good controller test in case the AP system uses a controller.

In this test scenario, the LANforge CT522 is used to create 2 stations and then have them roam between the APs. The test will count the number of successful roams as well as various different failure cases. This example assumes you have some experience with Chamber View, and that you have a LANforge system and properly configured AP cluster. A programmable attenuator and two isolation chambers would add the ability to test station roams at different RF signal levels, but this test normally runs fine withour chambers or attenuators. This feature is in LANforge version 5.3.9 and higher.



1. Configure Chamber View for Station Roaming and Similar Tests.

A. Open Chamber View by clicking on the 'Chamber View' button in the LANforge-GUI. If you have an appropriate scenario already created, then skip to the next section, otherwise you will need to build a scenario that matches your system. You can right-click in Chamber View to create various objects. If you do not have chambers or attenuators, just create the DUT object and skip the chamber setup. This image shows the completed setup.

•		Cha	mber View				\odot \otimes \otimes
Q Q Q ((() () () () () () () () () () () ()	(m-11-2-010)	Scenario Config -Scenario Config -11-2-0100 -17db -47db -47db -47db -47db -47db	juration	(jw-11r-0001 (jw-11r-0000			Manage Scenarios dut-If-br-ap Apply Scenario <u>Iests:</u> Roam Test <u>Run Test</u> <u>Snap Report</u>
Show External CX Show Internal CX Show Internal CX Show Attenuators Show WiFi Connections	Show LANforge Show DUT Show Inactive DUT Show Device Profiles Show Traffic Profiles	III Show RSSI Show Bps Apply Motion	Info Print	Sync	Apply	<u>B</u> uild Scenari	o <u>C</u> lose

B. Create a Device Under Test (DUT) Profile for each of your APs. The BSSID is important to configured so that LANforge knows when it is connected to the correct AP. The authentication information and BSSID should be the same for all APs in the cluster, so probably you just need to change the name and BSSID for each of your DUTs and click save. To aid the visual representation of the roaming, consider putting the DUTs in a circle around the LANforge system as shown in the image above.

0	Create/M	lodify DUT	\odot \otimes \otimes					
Name	jw-11r-0100							
Image file	NONE		Choose Image 🛛 🗙					
SW Info		HW Info	vap0100, w0					
Model Number		Serial Number						
Serial port		WAN						
LAN		API version	0					
SSID-1	ben-jw-llr	Password-1	lanforge-llr					
SSID-2		Password-2						
SSID-3		Password-3						
Mgt IP	0.0.0.0	Ant-1	0					
Ant-2	0	Ant-3	0					
BSSID-1	04:f0:21:17:22:bd	BSSID-2	00:00:00:00:00:00					
BSSID-3	00:00:00:00:00	Active	AP DUT					
STA DUT	WEP	WPA	WPA2					
WPA3	Provides DHCP on LAN	Provides DHCP on WAN						
Notes								
	Apply OK Cancel							

C. Configure an Upstream profile using eth1 on the LANforge system.

Create/Modify Profile Image: Create/Modify Profile							
Name:	upstream-dhcp	Type:	Upstream (4)		-		
Mode:	Auto (0) 💌	Antennas:	Default (0)		-		
Instances:	1(1)	Frequency:	AUTO (-1 Mhz)		-		
SSID:		Password:					
Pattern:		DHCP Server	WEP				
WPA	WPA2	WPA3	🗌 802.11r				
802.1x EAP-TTLS	Restart DHCP on Connect	Notes:					
	<u>Apply</u>	<u>C</u> ancel					

D. Configure an STA profile supporting 802.11r on the LANforge system. Roaming tests normally should de-select the Restart DHCP on Connect behaviour, as shown.

Create/Modify Profile							
Name:	sta-llr	Type:	STA (1)				
Mode:	Auto (0) 🗸	Antennas:	Default (0) 🗸				
Instances:	1 (1)	Frequency:	AUTO (-1 Mhz) 🗸				
SSID:		Password:					
Pattern:		DHCP Server	WEP				
WPA	WPA2	WPA3	✓ 802.11r				
802.1x EAP-TTLS	Restart DHCP on Connect	Notes:					
<u>Apply</u> <u>OK</u> <u>Cancel</u>							

E. Configure a Chamber View Scenario and add the STA profile (mapped to desired wiphyX radios and DUT). Add an upstream profile mapped to DUT LAN side (or possibly WAN side if that is more appropriate for your DUT). You can map to any of the DUT APs in the cluster and the system will still be able to roam to the others.

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Sc	cei	nari	io	r	Fext Output																	
				9	Scenario Nam	ne dut-lf-br-ap		Ŧ		Dele <u>t</u> e Scenario		Cr <u>e</u> at	e P	rofile		Create Traffic <u>P</u>	rofil	e	Add <u>B</u>	low		
Del	R	lesc	oui	rce	Profile			Мо	bd	Amount		Uses-1		Uses-2		Frequency		Maps	То			
×]	1.1		•	STA: sta-llr	r	-	۲	8	1	-	wiphyl	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: j	w-llr-	2-000	0 Radio-1	•
×]	1.1		•	Upstream: u	upstream	-		8	1 (1)	•	ethl	•	AUTO	•	AUTO (-1 Mhz)	-	DUT: j	w-llr-	0001	LAN	-
×]	1.1		•	STA: sta-llr	r	-	0	8	1	-	wiphy0	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: j	w-llr-	2-000	0 Radio-1	-
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2. Use Chamber View to run a Station Roam test.

A. Open Chamber View by clicking on the 'Chamber View' button in the LANforge-GUI. Load appropriate scenario or create a new scenario as needed. Apply the Scenario, then Build the scenario.

•	Chamber View	$\mathbf{\hat{v}}$ $\mathbf{\hat{x}}$
() () () () () () () () () () () () () (Scenario Configuration	 ▲ Manage Scenarios dut-If-br-ap ▼ Apply Scenario Iests: Roam Test Run Test Snag Report
Show External CX Show LANforge Show Internal CX Show Internal CX Show Attenuators Show WIFI Connections Show Traffic Profil	III I IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	ario <u>C</u> lose

B. Select the **Roam Test** test and click **Run Test**. You should see the Wifi Mobility Test configuration window pop up. You can normally just use the defaults in the Roaming Parameters tab, so that tab is ignored in this example. By default, all of the stations will be selected to use in the roam test. You may adjust the selection at this time.:

•	WiFi Mobility	\sim \sim							
1: Roaming Parameters 2: Ports 3: Manual Te	sting 4: Script Generator 5: Roar	ming Script							
WiFi Stations									
Ports in Use	← Add Port	Free Ports							
1.1.8 sta0000 1.1.9 sta0400	Remove Port →								
	Linear Sor <u>t</u>								
	2 Ports Selected								

C. You can do some manual testing, including some 802.11k/v features on the Manual Testing tab, but in this example, we will not be using those features.

• WiFi Mobility	\odot	×
1: Roaming Parameters 2: Ports 3: Manual Testing 4: Script Generator 5: Roaming Script		
Actions for Station Ports		-
Use CIVIC Use LCI BSS Query Reason Code: Low RSSI (16)	-	
Station: 1.1.sta0000 🔽 Target AP: c4:4b:d1:75:d1:47 DUT-bssid1: jw-11r-2-0001	-	
WNM BSS Query Query Neighbors Roam To		
Actions for VAP Ports		-
Disassoc Timer: 3s (3 s) VRL: http://candelatech.com		
Target Station: 04:f0:21:7b:37:f3 1.1.8 sta0000 🔻 Target AP: c4:4b:d1:75:d1:47 DUT-bssid1: jw-11r-2-000	1 🔽	
Request Beacon IE Hex: 510000000002ffffffffff		
Request Transition Dissassoc Imminent ESS Dissassoc Imminent Request Beacon		
Request LCI SA Query		

D. The Script Generator tab is used to create the roaming script. If your APs support Neighbor Report Requests, then you can click the Query Neighbors button and it should populate the BSSID Entry Field as well as the Scan Frequency List. If your stations have not been brought up yet, then the Query Neighbors button will cause them to associate. It make take a small bit of time until the neighbor report becomes available, please click the Query Neighbors button again after 10 or so seconds. Double-check that all of your APs are found and that the frequency list is the expected value. If your AP does not support Neighbor Query, then manually enter the BSSIDs and frequencies.

•	WiFi Mobility	\odot \times \times
1: Roaming Parameters 2: Ports 3: Manual Te	esting 4: Script Generator 5: Roaming Script	
<pre># Queried via KKM c4:4b:d1:75:d1:47 info=0x19af op_class 04:f0:21:92:c0:cf info=0x19af op_class 04:f0:21:02:82:ff info=0x19af op_class 04:f0:21:a7:f6:2a info=0x19af op_class 04:f0:21:17:22: bit info=0x19af op_class 04:f0:21:17:22:bit info=0x19af op_class</pre>	BSSID Entry Field =128 chan=36 phy_type=9 128 chan=36 phy_type=9 128 chan=36 phy_type=9 128 chan=36 phy_type=9 =128 chan=36 phy_type=9 =128 chan=36 phy_type=9	
c4:4b:d1:11:34:47 info=0x19af op_class= c4:4b:d1:11:34:47 info=0x19af op_class: Sleep Between Roam (ms):	128 chan=36 phy_type=9 =128 chan=36 phy_type=9 ▼	
Sleep After Scan (ms):	2s (2 s)	
Scan Frequency List:	5180	
Use 'FT-DS' roaming		
	Query Neighbors <u>G</u> enerate Script	

E. When the BSSIDs have been discovered to manually entered, click the Generate Script button. The generated script describes the roaming behaviour. You may also edit or paste in your own script, and you may save the generated script text for later use.

• WiFi Mobility	\sim \sim	×
1: Roaming Parameters 2: Ports 3: Manual Testing 4: Script Genera	tor 5: Roaming Script	
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 <ds> © Resource: Station's resource ID number, often '1' © STA: name of the station to roam: 'stal1' © BSSID the BSSID address of the AP: 00:01:02:03:04:05 © DS: Add 'DS' to end of roam command to do FT-DS roaming © 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 stal NA 'trigger freq 5180 5300' sleep 1 roam 1 stal dc:a5:f4:ff:4f:ae sleep 20 do_cli scan 1 stal NA 'trigger freq 5180 5300' sleep 1 roam 1 stal dc:a5:f4:f3:ce:9e sleep 20 do_cli scan 1 stal NA 'trigger freq 5180 5300' sleep 1 roam 1 stal dc:a5:f4:f3:ce:9e sleep 20 do_cli scan 1 stal NA 'trigger freq 5180 5300' dc</ds>	o_cli scan 1 1 sta0000 NA 'trigger freq 5180' o_cli scan 1 1 sta0400 NA 'trigger freq 5180' aep 2.0 am 1 sta0400 c4:4b:d1:11:34:47 aep 10.0 o_cli scan 1 1 sta0400 NA 'trigger freq 5180' o_cli scan 1 1 sta0400 N	

F. To start the test, click the **Start** button (which will change to 'Stop' once start is clicked) to start the test. An interactive report window will be created and will be updated as the test runs. The AP cluster used in this example has some issues and is rejecting a lot of roam attempts with 'code-17', which indicates the AP thinks it has no more capacity. Hopefully your system works better!



G. When the test is complete, click the **Save HTML** button to save an HTML report and generate the PDF. The PDF file will be linked from the HTML page. You can also click 'Save PDF' and the browser will be directed to open the pdf file directly. Please see this example Roam Report

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