

Calibrating TR-398 Issue-4 and Mesh on a 4-Chamber Setup

Goal: Setup and run a TR-398 Issue 4 test for an AP using a version of the ANforge CT523c or similar system in order to test how well the AP can handle the various test cases specified in the TR-398 Issue 3 test document. TR-398 Issue 4 is Issue 3 with WiFi 7 support.

In this test scenario, a LANforge cluster (of 4+ LANforges) is used to emulate different station and AP scenarios and aenerate and receive traffic with an AP. This example assumes user has some experience with Chamber View, and has an appropriate LANforge system (fit for TR-398 Issue 3/4), programmable attenuators like the CT714 and some isolation chambers like the CT820a and CT840a. Please contact support@candelatech.com for assistance in setting up the TR-398 testbed or configuring your current testbed to match TR-398 needs as close as possible.



1. Configure Chamber View for TR-398 and Similar Tests. Below is a rough step by step of how to make a scenario. For more help on scenario setup, please visit the following link: Chamber View: Basic AP Testing (this cookbook will need a working scenario)

A. Open Chamber View by clicking on the 'Chamber View' button in the LANforge-GUI window. If you have an appropriate scenario already created, please skip to the next section, otherwise you will need to build a scenario that matches your system. Right-click in Chamber View to create various objects. Below is an example of a Chamber View TR-398 scenario. The testbed to be calibrated will not necessarily match the one below.



B. Create a Device Under Test (DUT) Profile that matches your AP. The BSSID is important to configure so that LANforge knows when it is connected to the correct AP. In a mesh scenario, 3 DUT objects may be created, one for each of the mesh AP chambers.

•				Create/Modif	fy DUT							\sim \times
Name	linksys_velop	Image file	NONE	Choose Image	×							
SW Info		HW Info		Model Number								
Serial Number		Serial port		API version	0							
WAN		LAN										
SSID-1	velop_lanforge	Password-1	lanforge	BSSID-1	d8:ec:5e:7a:21:e8	WEP	WPA	WPA2	WPA3	🔲 802.11r	EAP-TTLS	EAP-PEAP
SSID-2	velop_lanforge	Password-2	lanforge	BSSID-2	d8:ec:5e:7a:21:e9	WEP	WPA	WPA2	WPA3	🔲 802.11r	EAP-TTLS	EAP-PEAP
SSID-3		Password-3		BSSID-3	00:00:00:00:00:00	WEP	WPA	WPA2	WPA3	🔲 802.11r	EAP-TTLS	EAP-PEAP
SSID-4		Password-4		BSSID-4	00:00:00:00:00:00	WEP	WPA	WPA2	WPA3	🗌 802.11r	EAP-TTLS	EAP-PEAP
SSID-5		Password-5		BSSID-5	00:00:00:00:00:00	WEP	WPA	WPA2	WPA3	🔲 802.11r	EAP-TTLS	EAP-PEAP
SSID-6		Password-6		BSSID-6	00:00:00:00:00:00	WEP	WPA	WPA2	WPA3	🗌 802.11r	EAP-TTLS	EAP-PEAP
SSID-7		Password-7		BSSID-7	00:00:00:00:00:00	WEP	WPA	WPA2	WPA3	🗌 802.11r	EAP-TTLS	EAP-PEAP
SSID-8		Password-8		BSSID-8	00:00:00:00:00:00	WEP	WPA	WPA2	WPA3	🗌 802.11r	EAP-TTLS	EAP-PEAP
EAP-ID		Mgt IP	0.0.0.0									
Num Ant Radio 1	0	Num Ant Radio 2	0	Num Ant Radio 3	0							
Active	Provides DHCP on LAN	DHCP Client	Provides DHCP on WAN	AP DUT								
Notes												
				Apply QK	<u>C</u> ancel							

C. Create a chamber object to hold the DUT and add the DUT to that chamber. If you have no chambers, create a fake chamber, but the test will not be isolated and may not function as desired. The turntable configuration is different for different models of chambers, this example (bare IP address) is for the CT840a chamber.

0					(Cr	eate/Modify Chamber									×
Name:		TR-398		Width:	150		Height:	[150							
Chamber Type		2D Large (3)	•	Isolation	80		Speed (rpm)	[3.0							
Turntable Type		CT840A (2)	•	Turntable	192.168.100.10		Position (deg)	[0.0		filt (deg)		0.0			
Managed By:		1 (mobilestations)	•	Turntable Rpt: Position	: 0.0 Tilt: 0.0 RPM: 3.0	Cor	nnected				Virtual 🛛 🗹 Ope	n				
DUT-1		TR398-DUT	•	DUT-2		-										
DUT-3			•	DUT-4		•										
LANforge-1		None	•	LANforge-2	None	•										
LANforge-3		None	•	LANforge-4	None	•										
Int CX A		Int CX B		Int Atten	Ext CX A		Ext CX B	1	Ext Atten		Atten Floor		Zero-Atten RSSI 2.4Ghz		Zero-Atten RSSI 5Ghz	
i	•		•			•				-	Cable (100 ddB)	•	None (0 ddB)	•	None (0 ddB)	-
-	T		•	•	-	•				•	Cable (100 ddB)	•	None (0 ddB)	•	None (0 ddB)	-
	•		•			•		-		•	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
-	•		•			•		-		•	Cable (100 ddB)	-	None (0 ddB)	•	None (0 ddB)	-
	¥		•	•		•		•		•	Cable (100 ddB)	•	None (0 ddB)	•	None (0 ddB)	-
	•		•	•		•	-			-	Cable (100 ddB)	•	None (0 ddB)	•	None (0 ddB)	-
	•		•			•	-	-		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	•		•	•	· · · · · · · · · · · · · · · · · · ·	-		-	•	-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	•		•	•		•	-	•		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	•		•	•		•	· · · · · · · · · · · · · · · · · · ·	-		-	Cable (100 ddB)	-	None (0 ddB)	•	None (0 ddB)	-
	•		•			•	-	-		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	•		•	•	· · · · · · · · · · · · · · · · · · ·	•		-		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	•		•	•	r	•		-		-	Cable (100 ddB)	-	None (0 ddB)	•	None (0 ddB)	-
	•		•	•		•	-	•		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	•		•			•	-	-		•	Cable (100 ddB)	•	None (0 ddB)	-	None (0 ddB)	-
	•		•			•	-	-		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
					Sync		Apply OK Car	nce	el							

D. Add the LANforge to the chamber object made above. Add connections from this chamber to the DUT chamber, specifying the proper Attenuator modules. Please note we use the 'OTA' attenuation floor since we have OTA connection between DUT and antennas inside the DUT chamber. Please view our other cookbook on setting up attenuator connections in LANforge.

0						Create/	M	odify Chamber									×
Name:		MobileStations		Width:	1	150		Height:		150							
Chamber Type		Medium (1)	-	Isolation	8	30		Speed (rpm)		0.0							
Turntable Type		CT850A (0)	•	Turntable				Position (deg)		0.0	Т	ilt (deg)		0.0			
Managed By:		None	•	Turntable Rpt: Position	n: (0.0 Tilt: 0.0 RPM: 0.0				Vi	irtu	al 📃 Open					
DUT-1			-	DUT-2			•										
DUT-3			•	DUT-4			•										
LANforge-1		1 (mobilestations)	•	LANforge-2	1	None	•										
LANforge-3		None	•	LANforge-4	8	None	•										
Int CX A		Int CX B		Int Atten	E	xt CX A		Ext CX B		Ext Atten	A	tten Floor		Zero-Atten RSSI 2.4Ghz		Zero-Atten RSSI 5Ghz	
None	•	None	•	-	0	Chamber.MobileStations.0	•	Chamber.TR-398.0	•	1.1.85.3 💌	C	OTA (0 ddB)	•	None (0 ddB)	•	None (0 ddB)	•
None	-	None	•	-	0	Chamber.MobileStations.1	•	Chamber.TR-398.1	•	1.1.85.2 💌	·	TA (0 ddB)	•	None (0 ddB)	•	None (0 ddB)	-
None	-	None	•	•	0	Chamber.MobileStations.2	•	Chamber.TR-398.2	-	1.1.85.1 💌	·)TA (0 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	•	•	0	Chamber.MobileStations.3	•	Chamber.TR-398.3	•	1.1.85.0 💌	C	TA (0 ddB)	•	None (0 ddB)	•	None (0 ddB)	•
None	-	None	•		0	Chamber.MobileStations.4	•	Chamber.TR-398.4	-	1.1.1002.3 🗸	·)TA (0 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	•	None	•	•	0	Chamber.MobileStations.5	•	Chamber.TR-398.5	•	1.1.1002.2 💌	C	0TA (0 ddB)	•	None (0 ddB)	•	None (0 ddB)	•
None	-	None	-	•		Chamber.MobileStations.6	Ŧ	Chamber.TR-398.6	-	1.1.1002.1 💌	·	TA (0 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	•	•		Chamber.MobileStations.7	•	Chamber.TR-398.7	-	1.1.1002.0 💌	·	TA (0 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	-	•		None	•	None	-			able (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	-	-		None	•	None	-		·	able (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	Ŧ	-		None	•	None	-	-	·	able (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	•
None	-	None	-	-		None	•	None	-	-	·	able (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	-	•		None	•	None	-			able (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	•
None	-	None	-	-		None	•	None	-		·	able (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	•	-		None	•	None	-	-		able (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	•	-		None	•	None	-			able (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
				·		Sync App	oly	ОК Са	nce	1							_

E. Configure a Chamber View Scenario and add the STA profile (mapped to desired wiphyX radio and DUT). Add an upstream profile mapped to DUT LAN side (or possibly WAN side if that is more appropriate for your DUT).

0							Create	e/M	odify S	cer	nario					\odot	
Sc	enario	r	Text Outpu	t													
	:	Sce	nario Name	TR-398		-	Dele <u>t</u> e Scena	ario	Cr	<u>e</u> ate	e Profile	•	Create Traffic	P <u>r</u> of	ile Add <u>R</u> o	w	
Del	Resou	irce	Profile			Amo	ount		Uses-1		Uses-2		Frequency		Maps To		
×	1.1	-	STA: STA-A	AC	-	1 (1	.)	•	wiphy0	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-1	-
×	1.1	-	STA: STA-A	٩C	•	1 (1	1)	•	wiphyl	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-2	-
×	1.1	•	STA: STA-A	٩C	•	1 (1	.)	•	wiphy2	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-1	-
×	1.1	•	STA: STA-A	٨C	•	1 (1	L)	•	wiphy3	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-2	-
×	1.1	•	STA: STA-A	AC	•	1 (1	L)	•	wiphy4	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-1	-
×	1.1	•	STA: STA-A	AC	•	1 (1	L)	•	wiphy5	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-2	-
×	1.1	-	Upstream:	upstream	•	1 (1	L)	•	eth1	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T LAN	-
4																	•
B	uild Ne	ew		<u>L</u> oad Scenario				Jpd Save	ate and e Scenario)			<u>A</u> pply Save	an Sce	d nario	<u>C</u> anc	cel

- 2. For TR398 tests, the DUT AP's front should face the antennas for the Group-1 stations. Or, optionally, one can use the Advanced configuration tab to specify the default turntable angle for non rotational tests.
- 3. Open Chamber View by clicking on the 'Chamber View' button in the LANforge-GUI. Load appropriate scenario by clicking on the drop-down above *Manage Scenarios* and selecting the scenario to be used. Click *Apply Scenario*, then *Build Scenario*. Below is an example of a loaded scenario.



4. Select the TR-398 Issue 4 test from Tests dropdown in the right panel. Then click Run Test.



5. The following window below should pop up. In the Settings tab, set slots Selected DUT 5G, Selected DUT 2G, and Selected DUT 6G the according BSSIDs found in the 'Root' Chamber. Also set the upstream port and multicast port if used. In this example, the upstream port is the eth2 port on the Resource 1 (Manager) LANforge. Select Skip 6Ghz Test and Skip MLO Tests, those will not be run during calibration.

0					TR-398 Issue	4 Automate	d Test (cv-inst-	0)					\odot \sim \times
General Confi	guration	RF Configuration	DUT Config	Report	t Configuration	TR398-Issue	e4 Rej	ort 1	×	Report-2 ↑ 🗙	Re	port-3 ↑ 🗙		
Settings	Virtua	al Sta Radios	Single-Sta Radio	5	Single-Sta F	Radios 2	Mesh	Settings		Mesh Setting	IS 2	Individu	al Test Co	nfiguration
	Select	ted DUT 5G:		tr	398-root lanforg	e 00:00:00:00	:00:02 (2)	-	Upstr	ream Port:	•	1.1.2 eth2	-	
	Select	ted DUT 2G:		tr	398-root lanforg	e 00:00:00:00	:00:01 (1)	-	Multi	icast Upstream	Port:		-	
	Select	ted DUT 6G:		tr	398-root lanforg	e 00:00:00:00	:00:03 (3)	•	Turn-	-Table-Chambe	r:		-	
	Select	ted DUT MLO:						-		Refre	sh Port	ts + DUTs		
	TR-39	cip 2.4Ghz Tests 8 Tests to Run:	🗌 Skip 5Ghz Tests	Es	Skip 6Ghz Tests timated Test Du	Skip ML	O Tests	Skip	N/AC 1	Tests 🗌 Skip) AX Te	ests 🗌 Skip B	E Tests	
	Ve	erify Single-Sta Rad	ios		Verify Virt-Sta	Radios				erify Group Th	oughp	ut		
		alibrate Single-Sta	Attenuators		Calibrate Virt-S	Sta Attenuator	s			cing droop in	ougrip			
	 Calibrate Single-Sta Attenuators Calibrate Mesh Sta to Root Attenuators 				Calibrate Mesi	n Sta to Node-	1 Attenua	tors		alibrate Mesh I	Root to	Node-1 Attenua	ators	
	Ca	alibrate Mesh Sta to	o Node-2 Attenuato	rs 🗌	Calibrate Mesl	h Node-1 to No	ode-2 Atte	nuators		alibrate Mesh I	Root to	Node-2 Attenua	ators	
	6.	1.1 Receiver Sensit	ivity		6.2.6 Latency				6	.4.2 Multiple As	soc Sta	ability		
	6.	2.1 Maximum Conr	nection		6.2.7 Quality of	fService			6	4.3 Downlink N	IU-MIN	NO		
	6.	2.2 Maximum Thro	ughput		6.3.1 Range Ve	rsus Rate			6	.4.4 Multicast				
	6.	2.3 Airtime Fairnes	s		6.3.2 Spatial C	onsistency			6	5.1 Long Term	Stabili	ty		
	6.	2.4 Dual-Band Thro	oughput		6.3.3 Peak Per	formance			6	5.2 AP Coexist	ence			
	6.	2.5 Bi-Directional T	hroughput		6.4.1 Multiple 9	STAs Performa	ance		6	.5.3 Automatic	Channe	el Selection		
	6.	2.8 Multi-Band Thre	oughput		7.1.1 RSSI Acc	uracy			7.	.1.2 Channel Ut	ilizatio	n		
	6.	2.9 OFDMA Throug	hput		6.5.5 Puncturir	Ig			6	5.6 MLO				
	6.	4.5 Uplink MU-MIM	10											
	6.	6.1 Mesh Backhaul	RvR		6.6.2 Mesh Ba	ckhaul Node-2	RvR		6	.6.3 Mesh Roan	n Time			
Test is comple	ete.					<u>S</u> tart		Skip		Another 1	Iteratio	on 🗌 Pa	ause	<u>C</u> ancel

- 6. Configure the Virtual Sta Radios tab.
 - A. Select the Virtual Sta Radios tab. This tab is for radios that can support more than 1 virtual station on them (either AC, N, some AX). There are 3 possible groups since TR398 uses 3 groups in total. These groups will be labelled on the diagram that Candela provides to you as **TR-398 Group X (Virtual Clients)**, where X can be 1, 2, or 3. If the groups are not on your diagram, you do not have virtual stations.



				TR-398 Issue	4 Automat	ed Test (cv-inst-0)			\odot \bigcirc
Seneral Conf	figuration	RF Configuration	DUT Config	Report Configuration	TR398-Issu	e4 Report 1 🗙	Report-2 ↑ 🗙	Report-3 ↑ 🗙	
Settings	Virtua	l Sta Radios	Single-Sta Rad	lios Single-Sta	Radios 2	Mesh Settings	Mesh Settings	2 Individ	ual Test Configuration
				Radio	2.4GHz I	85I 0 Atten 5GHz RS	SI 0 Atten Attenuato	r Modules	
		Group: 0							
		5GHz		1.2.13 wiphy17	-25	-30	1.1.8019.4	4 💌	
		2.4GHz		1.2.12 wiphy16	-25	-30	1.1.8019.5	5 💌	
		6GHz		1.2.14 wiphy18	-25	-30	1.1.8019.6	5 🗸	
					-25	-30	1.1.8019.3	7 💌	
		Group: 1							
	5GHz			-25	-30		-		
		2.4GHz			-25	-30		-	
		6GHz			-25	-30		-	
					-25	-30		-	
		Group: 2							
		5GHz			-25	-30		-	
		2.4GHz			-25	-30		•	
		6GHz			-25	-30		-	
					-25	-30		-	
		Prefe	r Virtual STA Radi	ios					
est is comp	lete.				<u>S</u> tart	Skip	Another Ite	eration 🗌 🖡	ause <u>C</u> ance

B. Below is an example of a testbed only having 1 group of virtual stations, which have been filled out in the *Radio* column within the settings.

C. Lastly, fill out the *Attenuator Modules* column, in the right-most section. On the testbed diagram, the **Group X** should be pointing to some specific attenuator modules. Typically, LANforge attenuators have modules, 2 physical ports on the attenuator per module. Usually, P10 and P11 are module 0, P20 and P21 are module 1, P30 and P31 are module 2, and P40 and P41 are module 3. In the picture above, right-most column, attenuator modules are in the format **1.LANforge-Resource-No.Attenuator-Serial-No.Module-No**. The serial number of an attenuator can be found physically on the side of the attenuator. The diagrams group should point to a port and that corresponds to the module being used. The picture above shows an example of the completed attenuator module. Below is what the diagram showed to get those results above.

W16 / W18 (2.4GHz / 6GHz) CH0 W17 (5GHz) CH3	->	A4-P10	
W16 / W18 (2.4GHz / 6GHz) CH1 W17 (5GHz) CH2	->	A4-P20	
W16 / W18 (2.4GHz / 6GHz) CH2 W17 (5GHz) CH1	->	A4-P30	
W16 / W18 (2.4GHz / 6GHz) CH3 W17 (5GHz) CH0	->	A4-P40	

7. Configure the *Single-Sta Radios*. This tab is for stations that only support 1 station at a time. On the testbed diagram, this may be labelled as *Real Clients* stations and these real clients can be split upto 3 groups.

A. Below is an example of what the real clients may look like on the testbed diagram provided.



B. Below is an example of what the radios above would look like filled out in the first page of the *Single-Sta Radios* tab of the TR-398 Issue 4 window.

					TR-39	8 Issue	4 Automat	ed Te	st (cv-ins	t-0)						\sim \times \times
General Confi	iguration	RF Configuration	DUT Cont	g Repor	t Config	uration	TR398-Issu	Je4	Report ↑	×	Report-2 1	×	Report-3	1 ×		
Settings	Virtua	l Sta Radios	Single-Sta	Radios	Sir	ngle-Sta R	adios 2	N	lesh Setting	s	Mesh Sett	ings 2	2	Individ	ual Test Co	onfiguration
			The settin Radi Group: 0	<mark>gs below ap</mark> wiphy0	oply to S	ingle Stat 2.4GHz I -21	ion radios th RSSI 0 Atten	at do r 5GHz -30	n <mark>ot support</mark> i RSSI 0 Atter	virtual n Atte	stations. nuator Modul 8019.0	25				
			1.1.3	wiphy1	•	-21		-30		1.1.	8019.1	-				
			1.1.7	6 wiphy2	-	-21		-30		NA		-				
			1.1.7	7 wiphy3	•	-21		-30		NA		•				
			Group: 1	Quinhut		20		27			8010.2					
			1.1.	8 wipny4	-	-20		-37		1.1.	8019.2	-				
			1.1.	9 wiphy5	-	-20		-37		1.1.	8019.3	-				
			1.1.	0 wiphy6	-	-20		-37		NA		-				
			1.1.3	1 wiphy7	-	-20		-37		NA		-				
			Group: 2	2 usinhu9		20		47			2575.0					
			1.1.	2 wipriyo		-39		-47			3575.0					
			1.1.	3 wiphy9	-	-39		-47		1.1.	35/5.1	-				
			1.1.4	wiphy10	-	-39		-47		NA		-				
			1.1.	wiphy11	-	-39		-47		NA		-				
Test is compl	ete.						<u>S</u> tart		Skip		Anoth	er Iter	ration	P	ause	<u>C</u> ancel

C. Below is the 2nd (and final page) of the above example. Using the same technique as used in the *Virtual Sta* radios, trace the radios to their according attenuator module on the testbed diagram to fill out the correct *Attenuator Module* on the *Single-Sta Radios* page.

					TR-398 Issue	4 A	utomated T	est (c	v-inst-0)				\odot \otimes \times
General Confi	iguration	RF Configuration	n DUT Config	R	eport Configuration	TF	R398-Issue4	Rep	ort 1 🗙	Report-2 ↑ 🗙	Rep	ort-3 ↑ 🗙	
Settings	Virtua	l Sta Radios	Single-Sta Rad	dios	Single-Sta F	Radio	os 2	Mesh S	ettings	Mesh Setting	5 2	Individ	ual Test Configuration
		The sett Ra	ings below apply ' dio	to Si	<mark>ngle Station radios t</mark> h Radio	nat d	lo not support 2.4GHz RSSI (virtual) Atten	stations. 5GHz RSSI	0 Atten Attenuate	or Modu	le	
		1.	1.wiphy12	-	1.1.wiphy14	-	-40		-46	1.1.3575	.0	-	
		1.7	1.wiphy13	-	1.1.wiphy15	Ţ	-40	_	-46	1.1.3575	.1	-	
		Group: 4	1										
		1.3	2.wiphy0	-	1.2.wiphy2	•	-38		-46	1.1.3575	0	-	
		1.3	2.wiphy1	•	1.2.wiphy3	•	-38		-46	1.1.3575	.1	-	
		Group: 5	5										
		1.3	2.wiphy4	•	1.2.wiphy6	•	-40		-47	1.1.3575	.0	-	
		1.3	2.wiphy5	•	1.2.wiphy7	•	-40		-47	1.1.3575	.1	-	
		Group: 6	5	_									
		1.3	2.wiphy8	•	1.2.wiphy10	•	-38		-46	1.1.3575	.0	-	
		1.3	2.wiphy9	•	1.2.wiphy11	•	-38		-46	1.1.3575	.1	-	
		Group: 7	7	_									
		1.3	2.wiphy12	•	1.2.wiphy14	•	-40		-46	1.1.3575	.0	-	
		1.3	2.wiphy13	•	1.2.wiphy15	•	-40		-46	1.1.3575	.1	•	
Test is compl	ete.						<u>S</u> tart		Skip	Another I	teration	P	ause <u>C</u> ancel

8. Configure the *Mesh Settings* and *Mesh Settings 2* tabs. If the test bed being setup has no need for Mesh, please skip this step.

A. Select the Mesh Settings tab. The 2.4G and 5G columns should have default values of -25 and -30 respectively. Typically, under the 'Radio' section in this page, if 'Backhaul' is defaulted to '-1' it is best to leave that as is. Fill out the 'Atten Modules' column for each group (using ports 0-3 for each attenuator). To find out the correct attenuator, trace the testbed diagram to find out which attenuator connects which radios. Sometimes radios for Mesh and TR-398 will be shared (they are NOT shared in this case). One way they may be shared, for example, would be if 'Group 1' (in this Mesh section), may use the attenuator and radios used in 'Group 2' of the Virtual Sta Radio Settings tab. The attenuator may also be split to be both TR398 and Access (A3/T1) too, belonging in both Virtual Sta Radio Settings and Mesh Settings. However, there are multiple ways that attenuators and radios can be shared.

0				TR-398 Iss	ue	4 Automated	Test ((cv-inst-0)						\odot \otimes \otimes
General Conf	iguration	RF Configuration	DUT Config	Report Configurati	on	TR398-Issue4	Re	port î 🗙	Report	t-2 1 ×	Repo	ort-3 î 🗙]	
Settings	Virtua	l Sta Radios	Single-Sta Rad	dios Single-S	ita R	adios 2	Mesh	Settings	Mes	sh Settings	2	Individ	ual Test Con	figuration
		Node-1	DUT 6G:									-		
		Node-1	DUT 5G:									-		
		Node-1	DUT 2G:									-		
		Node-2	DUT 6G:									-		
		Node-2	DUT 5G:									-		
		Node-2	DUT 2G:									-		
		Refr	esh DUTs											
			R	adio		2.4GHz RSSI 0	Atten	5GHz RSSI 0	Atten At	tenuator M	odules	5		
		Group (): Root to Node-	1		25	_	20	-	1 2572 0				
		Backna	ul Root to N1:	Default (-1)	•	-25		-30		1.3572.0				
						-25		-30	1.	1.3572.1		-		
						-25		-30	1.	1.3572.2		-		
						-25		-30	1.	1.3572.3		-		
		Group 1	: Mobile Station	to Root		25		20	1	1 2574 0				
		2 4 CU-		1. wiphy to		-2.5		-50		1 2574.0				
		2.4GHZ	Ľ	. i.wipny io		-23		-50	<u> </u> -	1.5374.1				
						-25		-30						
						-25		-30				•		
Test is compl	ete.					<u>S</u> tart		Skip		Another Ite	ration	F	ause	<u>C</u> ancel

B. Fill out the Mesh Settings 2 tab similarly to Mesh Settings 1

				TF	R-398 Issue	4 Automated 1	est (cv-inst-0)				\odot $($
General Config	uration	RF Configuration	DUT Config	Report Co	onfiguration	TR398-Issue4	Report 🕈 🗙	Report-2 ↑ 🗙	Report-3	1 ×	
Settings	Virtua	l Sta Radios	Single-Sta Ra	adios	Single-Sta R	adios 2	Mesh Settings	Mesh Settings	2	Individu	al Test Configuration
		Group	2: Mobile Statio	n to Node-1		2.4GHz RSSI 0 A	tten 5GHz RSSI 0	Atten Attenuator Me	odules		
						-25	-30	1.1.3575.2	-		
						-25	-30	1.1.3575.3	-		
						-25	-30		-		
						-25	-30		-		
		Group	3: Mobile Statio	n to Node-2							
						-25	-30	1.1.3574.2	•		
						-25	-30	1.1.3574.3	•		
						-25	-30		•		
						-25	-30		-		
		Group	4: Node-1 to No	de-2							
		Backha	aul N1 to N2:	Default (-1)	•	-25	-30	1.1.3573.0			
						-25	-30	1.1.3573.1	•		
						-25	-30	1.1.3573.2	•		
						-25	-30	1.1.3573.3	•		
		Group	5: Root to Node-	-2							
		Backha	aul Root to N2:	Default (-1)	-	-25	-30	1.1.3571.0	•		
						-25	-30	1.1.3571.1	•		
						-25	-30	1.1.3571.2	-		
						-25	-30	1.1.3571.3	-		
ert is complet	te					Start	Skin	Another Ite	ration	Pa	

C. Below is an example of how mesh radios may show up on the testbed diagram provided.

Т

MESH
W16,17,18,19 CH0

I

D. Below is an example of how those mesh radios from above may are represented on the testbed diagram to connect to attenuators.



- 9. Position the LANforge to get ready for calibration. There are 2 ends of calibration, the AP and the Station. Both sides will be LANforges. Typically the LANforge that is the station can be any LANforge type, while the AP may be a smaller LANforge, such as a 521b, 521a, or AT7. But usually testbed setups will have designated LANforges within each chamber and those are what will be used for the stations LANforge. Each calibration test needs 3 trials done. After each trial, the stations LANforge and the AP LANforge will be rotated to get the best RSSI average. As long as the LANforge is not cabled into the wall in any way, it can be rotated.
 - A. Positioning of 521b, upclose, with Wiphy 0 Channel 0 (labelled as W0A0) sticking up



B. Positioning for 521b/521a (521b shown below). The 521b must have the Wiphy 0, channel 0 (W0A0) sticking up. The chamber antennas that are cabled up the testbed (the ones that aren't cabled to anything can be left as is), must be pointing directly at W0A0. The calibration may also do better if the LANforge is higher up, this gives a better chance for the chamber antennas to access single W0A0 antenna. The LANforge can be propped up with foam or cardboard. When the LANforges are rotated for each trial, the chamber antennas should be repositioned to point to W0A0.



C. Below is an upclose of the top hat of the AT7 and it's labels. On the right side is 6Ghz W0-W4, the left side has 2.4/5G W0-W3. On the 2.4/5G side, W0 labelled there only applies to 2.4, while 5G W0 is on the opposite end (labelled W3). Similarly, the W3 labelled on the 2.4/5G AT7 is the 2.4G's actual W3, but 5G's actual W3 is labelled W0. This is important so the user knows which antennas should be pointed up for calibration.



D. Below is an example of an AT7 positioned for calibration. The best way to calibrate with the AT7 is to lay it flat, with the W0 and W3 label sticking up on the 2.4/5 side, which corresponds to both 2.4G and 5G W0 antennas sticking up. The rest of the antennas can be facing as down as possible and away from the two pointing up.



E. Below is an example of the same AT7, rotated once. After rotation, the AT7 should still maintain a position where the W0 for both 2.4G and 5G stick up, with the other antennas pointed down and away from the two sticking up.



10. Establish all the tests that need to be done. From above, we filled out Virtual-Sta radios, Single-Sta radios, and Mesh radios. That means that all the attenuators and pathways that correspond to those need to be calibrated. Below are all the calibration tests that need to be run in the *Settings* tab. Run each of the checkboxes **one at a time** to make sure each test passes. Make sure to check *Skip 6Ghz Tests* and *Skip MLO test* since those tests are not needed for calibration.

	🗌 Skip 2.4Ghz Tests 🗌 Skip 5Ghz Tests 📔	Skip 6Ghz Tests 🕑 Skip MLO Tests 🗌 Skip N/A	AC Tests 🗌 Skip AX Tests 🗌 Skip BE Tests	
	TR-398 Tests to Run:	Estimated Test Duration: 4 h		
	Uverify Single-Sta Radios	Uverify Virt-Sta Radios	Verify Group Throughput	
	Calibrate Single-Sta Attenuators	Calibrate Virt-Sta Attenuators		
	🖌 Calibrate Mesh Sta to Root Attenuators	🖌 Calibrate Mesh Sta to Node-1 Attenuators	Calibrate Mesh Root to Node-1 Attenuators	
	Calibrate Mesh Sta to Node-2 Attenuators	Calibrate Mesh Node-1 to Node-2 Attenuators	Calibrate Mesh Root to Node-2 Attenuators	
	6.1.1 Receiver Sensitivity	6.2.6 Latency	6.4.2 Multiple Assoc Stability	
	6.2.1 Maximum Connection	6.2.7 Quality of Service	6.4.3 Downlink MU-MIMO	
	6.2.2 Maximum Throughput	6.3.1 Range Versus Rate	6.4.4 Multicast	
	6.2.3 Airtime Fairness	6.3.2 Spatial Consistency	6.5.1 Long Term Stability	
	6.2.4 Dual-Band Throughput	6.3.3 Peak Performance	6.5.2 AP Coexistence	
	6.2.5 Bi-Directional Throughput	6.4.1 Multiple STAs Performance	6.5.3 Automatic Channel Selection	
	6.2.8 Multi-Band Throughput	7.1.1 RSSI Accuracy	7.1.2 Channel Utilization	
	6.2.9 OFDMA Throughput	6.5.5 Puncturing	6.5.6 MLO	
	6.4.5 Uplink MU-MIMO			
	6.6.1 Mesh Backhaul RvR	6.6.2 Mesh Backhaul Node-2 RvR	6.6.3 Mesh Roam Time	
Test is complete.			Skip Another Iteration	Pause <u>C</u> ancel

- 11. Run each of the tests checked, that applies to your testbed setup. In the example image given above, all the tests under *TR-398 Tests to Run*, would be run one checkbox at a time.
 - A. For each test, as described earlier in the cookbook, position both the LANforges (if the LANforge is not hardcabled into the chamber) in their according position to their model LANforge. Each of the checkboxes requires 3 trials of the test between 2 chambers, where 1 chamber is the LANforge station and 1 is the LANforge AP. Between each trial, both the station LANforge and the AP LANforge should be rotated, if possible.
 - B. In this cookbook example, the first test we have is *Calibrate Single Sta Attenuators*. This means that the test is run between the Single-Sta radios in the stations chamber (LF1 Group 1, Group 2, Group 3) and the LANforge in the Root Chamber. This test is then run, the data from the 3 group's *2.4GHz RSSI 0 Atten* and *5GHz RSSI 0 Atten* and *5GHz RSSI 0 Atten* is recorded, the station LANforge and AP LANforge is rotated (if possible, if not just rotate 1), and the test is re-run with the same process done 2 more times (with a total of 3 trials). The averages are then taken for Group 0, Group 1 and Group 2 (2.4G and 5G) among the 3 trials and then typed in for the 6 values under the *Single-Sta Radios* tab, as shown in the picture.

С Т	R-398 Is	sue 4 Automated T	est (cv-inst-0)		\odot \sim \times
Individual Test Configuration General Configuration R	F Configur	ration DUT Config	Report Configuration	TR398-Issue4	
Settings Virtual Sta Radios Singl	e-Sta Rad	ios Single	-Sta Radios 2	Mesh Settings	Mesh Settings 2
The settings below	apply to S	ingle Station radios the	at do not support virtu	al stations.	
Radio	2.	4GHz RSSI 0 Atten 5GH	z RSSI 0 Atten Attenua	ator Modules	
1.2.wiphy0	-2	26	1.1.31	00.3	
1.2 winbyl		26	1 1 210	00.2	
1.2.wiphy1	- 2	-59	1.1.51	-	
1.2.wiphyz		-39			
1.2.wiphy3	-2	26 -39	NA		
Group: 1		20	1 1 21	001	
1.2.wiphy4		-44	1.1.31		
1.2.wiphys		-44	1.1.31	••••	
1.2.wiphy6	-2	29 -44	NA		
1.2.wiphy7	-2	-44	NA	-	
Group: 2					
1.3.wiphy20		-64	1.1.30	99.3 🔻	
1.3.wiphy21		32 -64	1.1.30	99.2 🔻	
1.3.wiphy22	-3	-64	NA	-	
1.3.wiphy23	-3	-64	NA	-	
		Start	Skip Ar	nother Iteration	Pause <u>C</u> ancel

C. This same process happens for all the other checkbox tests.

12. Another example of calibration would be for the checkbox *Mesh Sta to Node-1 Attenuators*. In this case, the LANforge station would be in the Stations chamber and the LANforge AP would be placed in the Node-1 chamber. Since the testbed will most likely have the stations in the Stations Chamber, and the AP is unlikely to be to the Stations Chamber, this makes the most sense for calibration. After the AP is placed in the Node-1 chamber, the chamber antennas are pointed to the W0A0 antenna(s), and 3 trials are run with rotations of the AP after each trial. After each trial the 2.4G and 5G values populated in the 2.4G RSSI 0 Atten and 5G RSSI 0 Atten are recorded. At the end of 3 trials, the average is taken and manually entered into the 0 Atten RSSI spot for both 2.4 and 5. Below in the red circle area is where the RSSI values will be populated after each trial and where the final average should be filled out (removing the last auto-filled RSSI value and inputting the 3-trial average instead).

○ TR-398 Issue 4 Automated Test (cv-inst-0) ⊙ (\odot \otimes \otimes			
General Conf	figuration	RF Configuration	DUT Config	Repor	t Configuration	TR398-Issue4	Report 🕈 🗙	Report-2 ↑ 🗙	Report-3 ↑ 🗙		
Settings	Virtua	l Sta Radios	Single-Sta Rad	dios	Single-Sta F	Radios 2	Mesh Settings	Mesh Settings	2 Indiv	idual Test Configuration	
	2.4GHz RSSI 0 Atten 5GHz RSSI 0 Atten Attenuator Modules Group 2: Mobile Station to Node-1										
					/	-25	-30	1.1.3575.2	-		
					(-25	-30	11.3575.3	-		
						-25	-30		-		
						-25	-30		-		
		Group	3: Mobile Station	to Node	-2						
						-25	-30	1.1.3574.2	-		
						-25	-30	1.1.3574.3	-		
						-25	-30		-		
						-25	-30		-		
		Group	4: Node-1 to Nod	le-2							
		Backha	ul N1 to N2:	efault (-1)	-25	-30	1.1.3573.0			
						-25	-30	1.1.3573.1	-		
						-25	-30	1.1.3573.2	-		
						-25	-30	1.1.3573.3	-		
		Group	5: Root to Node-2	2							
		Backha	ul Root to N2: D	efault (-1	1)	-25	-30	1.1.3571.0			
						-25	-30	1.1.3571.1	-		
						-25	-30	1.1.3571.2	-		
						-25	-30	1.1.3571.3	-		
Test is compl	lete.					<u>S</u> tart	Skip	Another Ite	eration	Pause <u>C</u> ancel	

13. At this point, all the 0 Atten values should be filled out. Save these values as a database in both the TR398 window database and the LANforge 'Status' tab database sections. It may also be good to take screenshots of all the final values and save it off-LANforge.

A. Below is a picture of how to save as a database in the TR-398 window.

0			TR-398 Issue	4 Aut	om	ated Test (cv-inst-0))			\odot
Individual Test	Configuration	General Configuration	RF Configuration	n DU	T Co	onfig Report Configurat	ion TR398-Issue4			
Settings	Virtual	Sta Radios Sin	gle-Sta Radios	[Single-Sta Radios 2	Mesh Settings	6	Mesh S	ettings 2
		Show Config	Save			final_calibration				
		Import Config	Load			DEFAULT				
			Delete	e		DEFAULT				
		Use-IPv6	UDP-Burst		-	UDP-GRO	🖌 Auto-Helper			
		IP ToS:	Best Effort	(0)	-	Multi-Conn:	Ten (10)	-		
		Background TOS:	BK (WiFi)	(32)	•	Best-Effort TOS:	BE (WiFi) (100)	-		
		Video TOS:	VI (WiFi)	(128)	•	Voice TOS:	VO (WiFi) (192)	-		
		UDP Send Buffer Size:	OS Default		•	UDP Receive Buffer Size:	OS Default	-		
		TCP Send Buffer Size:	OS Default		•	TCP Receive Buffer Size:	OS Default	-		
		Pld Pattern	random_fixed (3	3)	▼	Multiple Endpoints:	Three (3)	•		
		SAE-PWE	Both (2)		•	Allow-11w (MFP/PMF)	Disable-MLO			
		Duration-60:	30		•	Duration-120:	30	•		
		Test Retries:	0		•					
		Opposite-Speed:	20kbps (20 Kbp	os)	•	1Gbps Throughput Limit:	925Mbps (925 Mbps)	-		
		2.5Gbps Throughput Limit:	2.3Gbps (2.3 G	bps)	•	5Gbps Throughput Limit:	4.6Gbps (4.6 Gbps)	-		
				St	art	Skip	Another Iteration		Pause	Cancel
				<u> </u>		exip				22.1001

B. Below is a picture of how to save as a database in the *Status* tab of LANforge.

🚱 Applications Places System 🚊 🔟 😜 🛛 🧾 💝		· · · · ·				EN	Mon Feb	3, 10:59:40
📷 🛃 LANforge Manager Ve 🛃 Chamber View (5.4	.9)							
LANforge Manager Version(5.4.9) 📀 🔗 🗵								× × ×
Control Reporting Windows Info Iests								
			Chamber	⊻iew <u>S</u> top	All Restar	t Manager	Refresh	HELP
VolP/RTP Endps Attenuators RF-Generator File-IO	Generic Test Mgr Resource M d Port Mgr MIO	Agr DUT Profiles Traffic-Pro Links Laver-3	ofiles Alerts Warnings	Wifi-Messages +	Armageddoa	WanLinks	VolP	/RTP
License Info		Current Users	10 11 19 0	20,0		Saved Test Configurations		
Licenses expire in: 331 days. * Admin from:127.0.0.	1				Configuration:	DFLT	-	Load
TR-398 gnuserver from:127.0.0	0.1				Download DB	Show Progress		Delete
Support expires in: 331 days.					Save DB Name:	final tr 398 calibration		Save
Status Vie <u>w</u> : Ports by Resource 🗨					Overwrite D	UT Chamber I Profile		
Realm 32							_	
		Resource 2 Resource 3	Resource 4 Resource 5	Resource 6				
	Manager/Resource 1		🔳 ** 🔳 ** 🔳 **					
	•• 🔳		🗰 es 📰 es 🗰 es 🗉					
	Netsmith			•• 🔳				
		Netsmith Netsmith	Netsmith Netsmith	Netsmith				
Logged in to: localhost:4002 as: Admin						2	6 stations:	31 231 00

C. Below is a picture of what an outline might look like for documentation of the 3 trials. This outline is just for the Mesh calibration tests.

		MESH STATIONS		
		Mesh Root - Node 2	1	
2G 5G	1st Position	2nd Position	3rd Position	Average #DIV/0! #DIV/0!
		Mesh Station - Node	2	
2G 5G	1st Position	2nd Position	3rd Position	Average #DIV/0! #DIV/0!
		Mesh Node 1 - Node	2	
2G 5G	1st Position	2nd Position	3rd Position	Average #DIV/0! #DIV/0!
		Mesh Root - Node 2	2	
2G 5G	1st Position	2nd Position	3rd Position	Average #DIV/0! #DIV/0!
		Mesh Station - Node	1	
2G 5G	1st Position	2nd Position	3rd Position	Average #DIV/0! #DIV/0!

14. Run a TR-398 Issue 4 throughput test. Select the *6.2.2 Maximum Throughput* checkbox to run the test. After verifying the throughput test is working as expected, select and run other tests as desired.

0	TR-398 Issue 4 Automated Test (cv-inst-	0) 📀 🔊 😣			
Individual Test Configuration General Configuration	RF Configuration DUT Config Report Configur	ation TR398-Issue4			
Settings Virtual Sta Radios Si	ngle-Sta Radios Single-Sta Radios 2	Mesh Settings Mesh Settings 2			
Selected DUT 5G:	Root Mesh 70:58:a4:ff:75:61 (2)	Upstream Port: 1.3.eth2			
Selected DUT 2G:	Root Mesh 70:58:a4:ff:75:59 (1)	Multicast Upstream Port: 1.3.eth2			
Selected DUT 6G:	Root Mesh 70:58:a4:ff:75:69 (3)	Turn-Table-Chamber: TR-398			
Selected DUT MLO:	Root Mesh 70:58:a4:ff:75:69 (3)	Refresh Ports + DUTs			
Skip 2.4Ghz Tests Skip SGhz Tests		AC TESTS IN SKIP AX TESTS			
TR-398 Tests to Run:	Estimated Test Duration: 12 m				
Verify Single-Sta Radios	Verify Virt-Sta Radios	Verify Group Throughput			
Calibrate Single-Sta Attenuators	Calibrate Virt-Sta Attenuators				
Calibrate Mesh Sta to Root Attenuators	Calibrate Mesh Sta to Node-1 Attenuators	Calibrate Mesh Root to Node-1 Attenuators			
Calibrate Mesh Sta to Node-2 Attenuators	Calibrate Mesh Node-1 to Node-2 Attenuators	Calibrate Mesh Root to Node-2 Attenuators			
611 Beceiver Sensitivity	626Latency	6 4 2 Multiple Assoc Stability			
	6.2.7 Quality of Service	6.4.3 Downlink MU-MIMO			
6.2.2 Maximum Throughput	6.3.1 Bange Versus Bate	6.4.4 Multicast			
6.2.3 Airtime Fairness	6.3.2 Spatial Consistency	6.5.1 Long Term Stability			
6.2.4 Dual-Band Throughput	6.3.3 Peak Performance	✓ 6.5.2 AP Coexistence			
6.2.5 Bi-Directional Throughput	6.4.1 Multiple STAs Performance	6.5.3 Automatic Channel Selection			
6.2.8 Multi-Band Throughput	7.1.1 RSSI Accuracy	7.1.2 Channel Utilization			
6.2.9 OFDMA Throughput	6.5.5 Puncturing	6.5.6 MLO			
6.4.5 Uplink MU-MIMO					
6.6.1 Mesh Backhaul RvR	6.6.2 Mesh Backhaul Node-2 RvR	6.6.3 Mesh Roam Time			
<u> </u>					
	<u>S</u> tart Skip	Another Iteration Pause <u>Cancel</u>			

15. 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. Another option is to click 'Save PDF' and the browser will be directed to open the pdf file directly. Please see this passing example TR-398 Issue 2 Maximum Throughput Test Report . *Candela Technologies, Inc., 2417 Main Street, Suite 201, Femdale, WA 98248, USA*

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