

## Calibrating TR-398 Issue-2 and Mesh on a 4-Chamber Setup

**Goal**: Setup and run a TR-398 Issue 2 test for an AP using a 6-radio 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 2 test document.

In this test scenario, a LANforge cluster (of a 1 523c and 3 521as) is used to emulate different station and AP scenarios and generate 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 2), 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.



1. Configure Chamber View for TR-398 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, 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. This cookbook will use the Chamber View scenario seen 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							$\odot$ $\otimes$ $\otimes$
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 <u>Q</u> K	<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	Create/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 0	Cor	nnected				Virtual 🗾 Vope	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	
	•		•	•		•			•	-	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)	-
	¥		•	<b>~</b>		•		•		-	Cable (100 ddB)	•	None (0 ddB)	•	None (0 ddB)	-
	•		•	<b></b>		•	<b></b>	-	•	-	Cable (100 ddB)	-	None (0 ddB)	•	None (0 ddB)	-
	•		•			•		-	•	-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	•		•	•	· · · · · ·	•	<b></b>	•		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	•		•	•		•	<b>•</b>	•	•	-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	T		•	<b>•</b>		•	<b>•</b>	•	•	-	Cable (100 ddB)	•	None (0 ddB)	-	None (0 ddB)	-
	T		•	•		•	•	-	•	-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
	Ŧ		•	•	-	•		-	•	-	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)	Ŧ	None (0 ddB)	-	None (0 ddB)	-
	•		•	-		•		-		-	Cable (100 ddB)	Ŧ	None (0 ddB)	-	None (0 ddB)	-
					Sync		Apply OK Can	nce	el							

D. Create a chamber object to hold the LANforge system and add the LANforge to it. 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.

•	Create/Modify Chamber																
Name:		MobileStations		Width:		150		Height:		150							
Chamber Type		Medium (1)	•	Isolation		80		Speed (rpm)		0.0							
Turntable Type		CT850A (0)	•	Turntable				Position (deg)		0.0	<u></u>	Tilt (deg)		0.0			
Managed By:		None	•	Turntable Rpt: Positi	on	0.0 Tilt: 0.0 RPM: 0.0				🗆 V	/irt	ual 📃 Open					
DUT-1			-	DUT-2			-										
DUT-3			•	DUT-4			-										
LANforge-1		1 (mobilestations)	•	LANforge-2		None	-										
LANforge-3		None	•	LANforge-4		None	•										
Int CX A		Int CX B		Int Atten		Ext CX A		Ext CX B		Ext Atten	,	Atten Floor		Zero-Atten RSSI 2.4Ghz		Zero-Atten RSSI 5Ghz	
None	-	None	•		•	Chamber.MobileStations.0	•	Chamber.TR-398.0	•	1.1.85.3	-	OTA (0 ddB)	•	None (0 ddB)	•	None (0 ddB)	-
None	•	None	•		•	Chamber.MobileStations.1	•	Chamber.TR-398.1	•	1.1.85.2	-	OTA (0 ddB)	•	None (0 ddB)	•	None (0 ddB)	-
None	-	None	•		•	Chamber.MobileStations.2	•	Chamber.TR-398.2	-	1.1.85.1	-	OTA (0 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	•	None	•		T	Chamber.MobileStations.3	•	Chamber.TR-398.3	•	1.1.85.0	-	OTA (0 ddB)	•	None (0 ddB)	•	None (0 ddB)	-
None	•	None	•		•	Chamber.MobileStations.4	-	Chamber.TR-398.4	-	1.1.1002.3	-	OTA (0 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	•	None	•		¥	Chamber.MobileStations.5	•	Chamber.TR-398.5	•	1.1.1002.2	-	OTA (0 ddB)	•	None (0 ddB)	•	None (0 ddB)	•
None	-	None	•		•	Chamber.MobileStations.6	-	Chamber.TR-398.6	-	1.1.1002.1	-	OTA (0 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	•	None	•		•	Chamber.MobileStations.7	•	Chamber.TR-398.7	-	1.1.1002.0	-	OTA (0 ddB)	-	None (0 ddB)	•	None (0 ddB)	-
None	-	None	-		•	None	-	None	-		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	•		•	None	-	None	-	· ·	-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	•	None	•		•	None	-	None	-		-	Cable (100 ddB)	-	None (0 ddB)	•	None (0 ddB)	-
None	-	None	•		•	None	-	None	-	· · · · ·	-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	•		•	None	-	None	-		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	-		T	None	-	None	-		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	•		•	None	-	None	-		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
None	-	None	-		•	None	-	None	-		-	Cable (100 ddB)	-	None (0 ddB)	-	None (0 ddB)	-
						Sync Ap	ply	ОК Са	ance	el							

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/Modify Scenario 💿 💿 🛞																
Sc	enario	ľ	Text Outpu	it													
		Sce	nario Name	e TR-398		-	Delete 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			Am	ount		Uses-1		Uses-2		Frequency		Maps To		
×	1.1	-	STA: STA-	AC	-	1 (:	1)	•	wiphy0	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-1	-
×	1.1	-	STA: STA-	AC	-	1 (:	1)	•	wiphyl	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-2	-
×	1.1	•	STA: STA-	AC	•	1 (:	1)	•	wiphy2	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-1	-
×	1.1	•	STA: STA-	AC	•	1 (:	1)	•	wiphy3	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-2	-
×	1.1	•	STA: STA-	AC	•	1 (:	1)	•	wiphy4	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-1	-
×	1.1	•	STA: STA-	AC	-	1 (:	1)	•	wiphy5	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T Radio-2	-
×	1.1	•	Upstream	: upstream	-	1 (:	1)	•	eth1	•	AUTO	•	AUTO (-1 Mhz)	•	DUT: TR398-DU	T LAN	-
•												1					•
B	uild Ne	ew		<u>L</u> oad Scenario			<u>L</u>	Jpd Save	ate and e Scenario	)			<u>A</u> pply Save	an Sce	d nario	<u>C</u> anc	el

- 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. Apply the Scenario, then Build the scenario.



4. Select the **TR-398-Issue-2** test from *Tests* dropdown in the right panel. Then click *Run Test.* 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. In this example, the upstream port is the *eth2* port on the LANforge in *Mobile Stations* chamber.

0	TR-398 Issue 2 Automated Test (cv-inst	-1) 💿 💿 😒
Per-Test Config 1 Per-Test Config 2 Per-Test C	onfig 3 Advanced Configuration Report Configuratio	on TR398-Issue3
Settings Virtual Sta Radio Settings	802.11AX Settings 802.11AX Setting	ngs 2 Mesh Settings Mesh Settings 2
Colored DUT CC:		Hertman Barts 112 oth2
Selected DOT 5G.		opstream port.
Selected DUT 2G:	linksys_velop velSelect 5Ghz DUT to be used in this test.	Turn-Table-Chamber:
Selected DUT 6G:	linksys_velop velop_lanforge d8:ec:5e:7a:21:e9 (2)	Extra Download Path-loss 0 (0)
2.4Ghz 2m RSSI	-26 🔹	5Ghz 2m RSSI -30 💌
Skip 2.4Ghz Tests Skip 5Ghz Te Use Issue-3 Behaviour Allow-1	ests 🗹 Skip 6Ghz Tests 🔽 Skip N/AC Tests 🗌 Skip 1w (MFP/PMF)	p AX Tests
TR-398 Tests to Run:	Estimated Test Duration: 3 m	
Calibrate 802.11AX Radios	Calibrate 802.11AC Radios	Calibrate Group Throughput
Calibrate 802.11AX Attenuators	Calibrate 802.11AC Attenuators	
Calibrate Mesh Root Attenuators	Calibrate Mesh Node-1 Attenuators	Calibrate Mesh Root to Node-1 Attenuators
Calibrate Mesh 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 AX 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
8.1.1 Mesh Backhaul RvR	8.1.2 Mesh Backhaul Node-2 RvR	8.2.1 Mesh Roam Time
	<u>Skip</u>	Another Iteration Pause Cancel

5. Configure the Virtual Sta Radio Settingstab.

A. Select the *Virtual Sta Radio Settings* tab. This tab is for radios that can have virtual stations on them (either AC, N, some AX). Notice that there are 3 groups here, this will be the 3 slots of radios (Slots 2, 3, 4) in the *Mobile Clients* Chamber. Visit the pictures in the next 2 steps to see close ups of the attenuator diagram that has the slots. Slot 2 (Group 0) has W0 ad W1 (wiphy0 and wiphy1). Slot 3(Group 1) has W2 and W3 (wiphy2 and wiphy3). Slot 4 (Group 2) has W4 and W5 (wiphy4 and wiphy5). Leave the '2.4Ghz RSSI 0 Atten' and '5Ghz RSSI 0 Atten' blank, those will be auto calculated when we calibrate the attenuators. Lastly, fill out the attenuator modules column (with the correct serial numbers that relate to each group). All these attenuators will be the TR-398 section of the attenuator stack. In this case, those are attenuators T1, T2 and T3. These attenuators are also all connecting the **Node 3/Root** chamber to the **Mobile Clients** chamber. Match the according attenuator to each group on the attenuator diagram. Fill out all the dropdowns under 'Attenuator Modules' for ports 0-3 on the matching attenuator. Select the 'Use Virtual AX Stations' checkbox.

0			TR-398 Issue 2 Auto	mated Test (cv-in	ist-1)			$\odot$ $\odot$ $\otimes$
Per-Test Config 1	Per-Test Config 2	Per-Test Config 3	Advanced Configuration	Report Configur	ation TR39	98-Issue3		
Settings	Virtual Sta Radio	Settings	802.11AX Settings	802.11AX Se	ettings 2	Mesh Settings	١	Aesh Settings 2
	Group; 0	Radi	0	2.4Ghz RSSI 0 Atter	n 5Ghz RSSI (	) Atten Attenuator Mo	dules	
	ECh-	117	1 winbul)	-23	-44	1 1 3282 0	-	
	5012		• wipilyo	-23		1.1.3202.0		
	2.4Ghz	1.1.5	5 wiphy1	-23	-44	1.1.3282.1	<b>•</b>	
	6Ghz			-23	-44	1.1.3282.2	-	
				-23	-44	1.1.3282.3	-	
	Group: 1							
	5Ghz	1.1.6	6 wiphy2	-23	-43	1.1.3290.0	-	
	2.4Ghz	1.1.5	7 wiphy3 💌	-23	-43	1.1.3290.1	-	
	6Ghz		-	-23	-43	1.1.3290.2	-	
				-23	-43	1.1.3290.3	-	
	Group: 2							
	5Ghz	1.1.8	8 wiphy4 💌	-30	-47	1.1.3284.0	-	
	2.4Ghz	1.1.9	9 wiphy5 🗸 🔻	-30	-47	1.1.3284.1	-	
	6Ghz		-	-30	-47	1.1.3284.2	-	
				-30	-47	1.1.3284.3	-	
	🗹 Use Virtu	al AX Stations 🗌 U	Jse AX Radios for AC tests					
			<u>S</u> tart	Skip	An	nother Iteration	Pause	<u>C</u> ancel

B. Below is the attenuator diagram of the 4-chamber setup in the example. Another name for the *Node-3* Chamber is the *Root* chamber.



C. Below is a closer look at the bottom right box of the attenuator diagram in the step above.



D. Below are the serial numbers of the attenuator stack. They are stacked in the same order as the attenuator diagram.



- 6. Configure the *802.11 AX Settings* (1 & 2) tabs. Please contact *support@candelatech.com* for assistance in filling out these tabs. These settings only apply to AX capable radios that do not support virtual stations.
- 7. 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 picture below is a final version of the calibrated mesh setup. In an uncalibrated version (yours), all the rows in the 'RSSI 0 Atten' columns will be empty. Fill out select the 2.4Ghz and 5Ghz BSSIDs for both Node 1 and Node 2 Chambers in the top section. Fill out the 'Atten Modules' column for each group (using ports 0-3 for each attenuator). To find out the correct attenuator, trace the attenuator diagram to find out which attenuator connects which 2 Chambers. In Group 1 (in this section), use the attenuator and radios used in 'Group 2' of the *Virtual Sta Radio Settings* tab. This attenuator is both TR398 and Access (A3/T1), so it belongs in both *Virtual Sta Radio Settings* and *Mesh Settings* 

0			TR-398 Issue	2 Au	itomated Test (d	:v-inst-1)			$\odot$ $\otimes$ $\otimes$
Per-Test Config 1	Per-Test Config 2 Pe	r-Test Config 3	Advanced Confi	gura	tion Report Conf	figuration TR398	3-Issue3		
Settings	Virtual Sta Radio Sett	ings	802.11AX Settin	gs	802.11/	AX Settings 2	Mesh Settin	ngs	Mesh Settings 2
	Node-1 DUT Node-1 DUT Node-2 DUT Node-2 DUT Use 2-ba Background	5G: 2G: 5G: 2G: 2G: ind pass/fail Scan Module:	linksys_velop velop_ linksys_velop velop_ linksys_velop velop_ linksys_velop velop_ simple	Janfi Janfi Janfi	orge d8:ec:5e:7a:21 orge d8:ec:5e:7a:21 orge d8:ec:5e:7a:21 orge d8:ec:5e:7a:21 RSSI Threshold:	:e9 (2) :e9 (2) :e9 (2) :e9 (2) -65		▼ ▼ ▼	
	Short Interva	al:	30	-	Long Interval:	300		-	
	Group 0: Roo	ot to Node-1	Radio		2.4Ghz RSSI 0 Atter	-63	n Attenuator Modu	ules	
					40		4.4.2272.4		
					-49	-03	1.1.32/3.1		
					-49	-63	1.1.3273.2	-	
					-49	-63	1.1.3273.3	-	
	Group 1: Mol	bile Station to F	Root						
	5Ghz		1.1.9 wiphy5	•	-30	-47	1.1.3284.0	-	
	2.4Ghz		1.1.8 wiphy4	•	-30	-47	1.1.3284.1	•	
					-30	-47	1.1.3284.2	-	
					-30	-47	1.1.3284.3	-	
	Group 2: Mol	bile Station to I	Node-1						
					-45	-38	1.1.3280.0	•	
					-45	-38	1.1.3280.1	-	
					-45	-38	1.1.3280.2	-	
					-45	-38	1.1.3280.3		
					I	J I			
				<u>S</u> t	art Ski	p 🗌 And	ther Iteration	Pause	Cancel

er-Test Config 1       Per-Test Config 3       Advanced Configuration       Report Configuration       TR398-Issue3         Settings       Virtual Sta Radio Settings       802.11AX Settings       802.11AX Settings 2       Mesh Settings 2         Advanced Configuration       Report Configuration       TR398-Issue3       Mesh Settings 2         Advanced Configuration       Report Configuration       TR398-Issue3       Mesh Settings 2         Advanced Configuration       Robit Station to Node-2       33       49       1.13281.1       •         33       49       1.13281.1       •       33       49       1.13281.3       •         Group 4: Node-1 to Node-2				TR-398 Issue 2 Autom	nated Test (cv-inst-1)			$\odot$
Settings         Virtual Sta Radio Settings         802.11AX Settings         802.11AX Settings 2         Mesh Settings         Mesh Settings 2           2.4Gha RSSI 0 Atten 5Gha RSSI 0 Atten Attenuator Modules         Group 3: Mobile Station to Node-2         11.3281.0         •           33         49         11.3281.1         •         33.3         49         11.3281.2         •           33         49         11.3281.2         •         33.3         49         11.328.3         •           Group 4: Node-1 to Node-2         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -<	Per-Test Config 1	Per-Test Config 2	Per-Test Config 3	Advanced Configuration	Report Configuration	TR398-Issue3	7	
2.4Ghz RSSI 0 Atten 5Ghz RSSI 0 Atten Attenuator Modules         Group 3: Mobile Station to Node-2         33       49         33       49         33       49         33       49         33       49         33       49         33       49         33       49         11.3281.1       •         33       49         11.3281.2       •         33       49         11.3281.3       •         Group 4: Node-1 to Node-2       •         38       51       1.1.3283.0         38       51       1.1.3283.0         38       51       1.1.3283.0         38       51       1.1.3283.0         Group 5: Root to Node-2       •         41       46       1.1.3291.0         41       46       1.1.3291.0         41       46       1.1.3291.0	Settings	Virtual Sta Radio	Settings	802.11AX Settings	802.11AX Settings	2 M	esh Settings	Mesh Settings 2
Group 3: Mobile Station to Node-2 $33$ $-49$ $1.1.3281.0$ $\checkmark$ $-33$ $-49$ $1.1.3281.1$ $\checkmark$ $-33$ $-49$ $1.1.3281.2$ $\checkmark$ $-33$ $-49$ $1.1.3281.3$ $\checkmark$ Group 4: Node-1 to Node-2 $-38$ $-51$ $1.1.3283.0$ $\checkmark$ $-41$ $-46$ $1.1.3291.0$ $\checkmark$			2	4Ghz RSSI 0 Atten 5Ghz RS	SI 0 Atten Attenuator Mo	dules		
$33$ $49$ $1.1.3281.0$ $\checkmark$ $33$ $49$ $1.1.3281.1$ $\checkmark$ $-33$ $49$ $1.1.3281.2$ $\checkmark$ $-33$ $-49$ $1.1.3281.3$ $\checkmark$ Group 4: Node-1 to Node-2 $\checkmark$ $\checkmark$ $-38$ $-51$ $1.1.3283.0$ $\checkmark$ $-38$ $-51$ $1.1.3283.1$ $\checkmark$ $-38$ $-51$ $1.1.3283.2$ $\checkmark$ $-38$ $-51$ $1.1.3283.3$ $\checkmark$ $-38$ $-51$ $1.1.3291.3$ $\checkmark$ $-41$ $-46$ $1.1.3291.1$ $\checkmark$ $-41$ $-46$ $1.1.3291.2$ $\checkmark$ $-41$ $-46$ $1.1.3291.3$ $\checkmark$			Gro	up 3: Mobile Station to Node	-2			
$-33$ $-49$ $1.1.3281.1$ $\checkmark$ $-33$ $49$ $1.1.3281.2$ $\checkmark$ $-33$ $-49$ $1.1.3281.3$ $\checkmark$ Group 4: Node-1 to Node-2 $-38$ $-51$ $1.1.3283.0$ $\checkmark$ $-38$ $-51$ $1.1.3283.1$ $\checkmark$ $-38$ $-51$ $1.1.3283.2$ $\checkmark$ $-38$ $-51$ $1.1.3283.3$ $\checkmark$ $-38$ $-51$ $1.1.3283.3$ $\checkmark$ $-38$ $-51$ $1.1.3283.3$ $\checkmark$ $-38$ $-51$ $1.1.3291.0$ $\checkmark$ $-41$ $-46$ $1.1.3291.1$ $\checkmark$ $-41$ $-46$ $1.1.3291.2$ $\checkmark$ $-41$ $-46$ $1.1.3291.3$ $\checkmark$			4	-49	1.1.3281.0	-		
-33 $-49$ $1.1.3281.2$ $-33$ $49$ $1.1.3281.3$ Group 4: Node-1 to Node-2 $-38$ $-51$ $1.1.3283.0$ $-38$ $-51$ $1.1.3283.1$ $-38$ $-51$ $1.1.3283.2$ $-38$ $-51$ $1.1.3283.2$ $-38$ $-51$ $1.1.3283.3$ $-38$ $-51$ $1.1.3283.3$ $-38$ $-51$ $1.1.3281.3$ $-38$ $-51$ $1.1.3291.3$ $-41$ $-46$ $1.1.3291.0$ $-41$ $-46$ $1.1.3291.2$ $-41$ $-46$ $1.1.3291.2$ $-41$ $-46$ $1.1.3291.3$			-4	33 -49	1.1.3281.1	-		
-33 $-49$ $1.1.3281.3$ Group 4: Node-1 to Node-2 $-38$ $-51$ $1.1.3283.0$ $-38$ $-51$ $1.1.3283.1$ $-38$ $-51$ $1.1.3283.2$ $-38$ $-51$ $1.1.3283.3$ $-38$ $-51$ $1.1.3283.3$ $-38$ $-51$ $1.1.3283.3$ $-38$ $-51$ $1.1.3281.3$ $-38$ $-51$ $1.1.3281.3$ $-38$ $-51$ $1.1.3281.3$ $-38$ $-51$ $1.1.3291.0$ $-41$ $-46$ $1.1.3291.0$ $-41$ $-46$ $1.1.3291.2$ $-41$ $-46$ $1.1.3291.3$			-	33 -49	1.1.3281.2	-		
Group 4: Node-1 to Node-2         -38       -51       1.1.3283.0         -38       -51       1.1.3283.1         -38       -51       1.1.3283.2         -38       -51       1.1.3283.3         -38       -51       1.1.3283.3         -38       -51       1.1.3281.3         -38       -51       1.1.3291.0         -41       -46       1.1.3291.1         -41       -46       1.1.3291.2         -41       -46       1.1.3291.3			-	33 -49	1.1.3281.3	-		
-38 $-51$ $1.1.3283.0$ $-38$ $-51$ $1.1.3283.1$ $-38$ $-51$ $1.1.3283.2$ $-38$ $-51$ $1.1.3283.3$ $-38$ $-51$ $1.1.3283.3$ $-38$ $-51$ $1.1.3283.3$ $-38$ $-51$ $1.1.3291.0$ $-41$ $-46$ $1.1.3291.1$ $-41$ $-46$ $1.1.3291.2$ $-41$ $-46$ $1.1.3291.3$			Gro	up 4: Node-1 to Node-2				
-38 $-51$ $1.1.3283.1$ $-38$ $-51$ $1.1.3283.2$ $-38$ $-51$ $1.1.3283.3$ $-38$ $-51$ $1.1.3283.3$ Group 5: Root to Node-2 $-41$ $-46$ $1.1.3291.0$ $-41$ $-46$ $1.1.3291.1$ $-41$ $-46$ $1.1.3291.2$ $-41$ $-46$ $1.1.3291.2$ $-41$ $-46$ $1.1.3291.3$			-	38 -51	1.1.3283.0	-		
-38       -51       1.1.3283.2         -38       -51       1.1.3283.3         -38       -51       1.1.3283.3         Group 5: Root to Node-2         -41       -46       1.1.3291.0         -41       -46       1.1.3291.1         -41       -46       1.1.3291.2         -41       -46       1.1.3291.2         -41       -46       1.1.3291.3			4	38 -51	1.1.3283.1	-		
-38       -51       1.1.3283.3         Group 5: Root to Node-2         -41       -46       1.1.3291.0         -41       -46       1.1.3291.1         -41       -46       1.1.3291.2         -41       -46       1.1.3291.2         -41       -46       1.1.3291.3			4	38 -51	1.1.3283.2	-		
Group 5: Root to Node-2         -41       -46         -41       -46         -41       -46         -41       -46         -41       -46         -41       -46         1.1.3291.2       ▼			4	38 -51	1.1.3283.3	-		
-41       -46       1.1.3291.0         -41       -46       1.1.3291.1         -41       -46       1.1.3291.2         -41       -46       1.1.3291.3			Gro	up 5: Root to Node-2				
41       -46       1.1.3291.1       ▼         -41       -46       1.1.3291.2       ▼         -41       -46       1.1.3291.3       ▼			-4	41 -46	1.1.3291.0	-		
-41     -46     1.1.3291.2       -41     -46     1.1.3291.3			-4	41 -46	1.1.3291.1	-		
-41 -46 <b>1.1.3291.3</b>			-4	41 -46	1.1.3291.2	-		
			-4	41 -46	1.1.3291.3	-		

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

8. Click on the *Advanced Configuration* tab. Set 2.4GHz channel and 5GHz channel to '-1'/ AUTO. AUTO won't work for all cases (like the ap-coex test), but will work for most of them.

			TR-398 Issue 2 Auton	ated Test (cv-inst-1)			$\odot$	×
Per-Test Config 1	Per-Test Config 2	Per-Test Config 3	Advanced Configuration	Report Configuration	TR398-Issue3	7		
Settings	Virtual Sta Radio	Settings	802.11AX Settings	802.11AX Settings	2 M	esh Settings	Mesh Settings 2	
	She	ow Config	Import Config					
		Save	DEFAULT					
		Load	DEFAULT	•				
		Delete	DEFAULT	-				
				_	🖌 Au	ito-Helper		
	IP ToS:		Best Effort (0)	Multi-Conn:	Ten (	(10) 🔻		
	2.4Ghz Chanr	nel	AUTO (-1 Mhz)	5Ghz Channel	AUTO	(-1 Mhz) 🔻		
	Duration-60:		Default (1 min)	Duration-120:	Defau	Ilt (2 min) 🔻		
	Attenuation A	djustment	0	Test Retries:	0	•		
	STA TX Power	-	20 dBm (20)					
	DUT AP Expe	cted TX Power-2.4G:	20 dBm (20)	<ul> <li>DUT AP Expected TX P</li> </ul>	ower-5G: 23	dBm (23) 🔻		
	Opposite-Spe	ed:	None (0 bps)					
			Start	Skip	Another Iter	ation 🔲 P	Pause Cancel	

- 9. Calibrate Zero Attenuation RSSI for all chamber to chamber connections and attenuators. This also verifies attenuators are connected and functioning as expected. We are calculating 0 atten against the LANforge.
  - A. Start by setting the LANforge in the center of all the chambers to be calibrated, with the LANforge wiphy0 antenna pointing straight up, while the other antennas lay flat. Then point all the chamber antennas to the LANforge wiphy0 antenna sticking straight up.
  - B. Calibrate the attenuators first. In this example, we calibrated the 802.11AC attenuators first. Similarly in other testbed setups, if there are AX radios or single-sta radios, calibrate the attenuators for those first (one checkbox at a time). Do 3 trials of each attenuator calibration and take the average as your final value to put as the box values. Make sure to rotate 'AP' and 'station' LANforge (if able to and the LANforge is not cabled into the wall) with the LANforge W0 antennas still pointed in the middle of all the chamber antennas on every trial.

Calibrate 802.11AC Attenuators

C. In the image below, similarly as above, run each of the checkboxes **one** at a time, until all are run. Do 3 trials of path calibration and take the average as your final value. Make sure to rotate 'AP' and 'station' LANforge (if able to and the LANforge is not cabled into the wall) with the LANforge W0 antennas still pointed in the middle of all the chamber antennas on every trial.

0		TR-398 Issue 2 Autom	ated Test (cv-in	st-1)	$\odot$ $\odot$ $\otimes$
Per-Test Config 1	1 Per-Test Config 2 Per-Test C	onfig 3 Advanced Configuration	Report Configura	ation TR398-Issue3	
Settings	Virtual Sta Radio Settings	802.11AX Settings	802.11AX Se	ttings 2 Mesh	Settings Mesh Settings 2
Sele	ected DUT 5G:	linksys_velop velop_lanforge d8:ec	:5e:7a:21:e9 (2)	<ul> <li>Upstream Port:</li> </ul>	1.1.2 eth2
Sele	ected DUT 2G:	linksys_velop velop_lanforge d8:ec	:5e:7a:21:e8 (1)	Turn-Table-Chamber:	
Sele	ected DUT 6G:	linksys_velop velop_lanforge d8:ec	:5e:7a:21:e9 (2)	Extra Download Path-le	oss 0 (0)
2.40	Ghz 2m RSSI	-26		▼ 5Ghz 2m RSSI	-30 💌
	Skip 2.4Ghz Tests Skip 5Ghz Te Use Issue-3 Behaviour Allow-1	ests 🗹 Skip 6Ghz Tests 🗌 Skip 1w (MFP/PMF)	N/AC Tests 🛛 S	ikip AX Tests	
TR-3	398 Tests to Run:	Estimated Test Duration: 30 m			
	Calibrate 802.11AX Radios	Calibrate 802.11AC Radios		Calibrate Group Th	roughput
	Calibrate 802.11AX Attenuators	Calibrate 802.11AC Attenuator	s		
	Calibrate Mesh Root Attenuators	Calibrate Mesh Node-1 Attenua	ators	Calibrate Mesh Ro	ot to Node-1 Attenuators
<b>v</b>	Calibrate Mesh Node-2 Attenuators	Calibrate Mesh Node-1 to Node	e-2 Attenuators	Calibrate Mesh Ro	ot to Node-2 Attenuators
	6.1.1 Receiver Sensitivity	6.2.6 Latency		6.4.2 Multiple Asso	c 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 St	ability
	6.2.4 Dual-Band Throughput	6.3.3 AX Peak Performance		6.5.2 AP Coexisten	ce
	6.2.5 Bi-Directional Throughput	6.4.1 Multiple STAs Performant	ce	6.5.3 Automatic Ch	annel Selection
	8.1.1 Mesh Backhaul RvR	8.1.2 Mesh Backhaul Node-2 R	/R	🔲 8.2.1 Mesh Roam T	ïme
		<u>Start</u>	Skip	Another Iteratio	n Pause <u>C</u> ancel

- 10. At this point, all the 0 Atten values should be filled out (for Virtual Sta Radio Settings and Mesh Settings 1 & 2 tabs in this example). Save these values as a database in both the TR398 window database and the LANforge 'Status' tab database sections. May also be good to take screenshots of all the final values and save it off-LANforge.
- 11. Run a TR-398 Issue 2 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 2 Automa	ated Test (cv-ins	t-1)	$\odot$ $\otimes$ $\otimes$
Per-Test Config 1 Per-Test Config 2 Per-Test 0	Config 3 Advanced Configuration	Report Configurat	ion TR398-Issue3	
Settings Virtual Sta Radio Settings	802.11AX Settings	802.11AX Sett	tings 2 Mesh Se	ttings Mesh Settings 2
Selected DUT 5G:	linksys_velop velop_lanforge d8:ec:	5e:7a:21:e9 (2)	Upstream Port:	1.1.2 eth2
Selected DUT 2G:	Select 5Ghz DUT to be used in this	test. 21:e8 (1)	Turn-Table-Chamber:	<b></b>
Selected DUT 6G:	Linksys_velop velop_lanforge d8:ec:	5e:7a:21:e9 (2)	Extra Download Path-loss	s 0 (0)
2.4Ghz 2m RSSI	-26	•	5Ghz 2m RSSI	-30 💌
Use Issue-3 Behaviour Allow-	11w (MFP/PMF) Estimated Test Duration: 6 m	ж столо <u>—</u> эк		
Calibrate 802.11AX Radios	Calibrate 802.11AC Radios		Calibrate Group Thro	ughput
Calibrate 802.11AX Attenuators	Calibrate 802.11AC Attenuators			
Calibrate Mesh Root Attenuators	Calibrate Mesh Node-1 Attenuat	tors	Calibrate Mesh Root	to Node-1 Attenuators
Calibrate Mesh 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 9	Stability
6.2.1 Maximum Connection	6.2.7 Quality of Service		6.4.3 Downlink MU-M	IMO
<ul> <li>6.2.2 Maximum Throughput</li> </ul>	6.3.1 Range Versus Rate		6.4.4 Multicast	
6.2.3 Airtime Fairness	Consistency 6.3.2 Spatial Consistency		6.5.1 Long Term Stab	ility
6.2.4 Dual-Band Throughput	6.3.3 AX Peak Performance		6.5.2 AP Coexistence	
6.2.5 Bi-Directional Throughput	6.4.1 Multiple STAs Performance	ê	6.5.3 Automatic Chan	nel Selection
8.1.1 Mesh Backhaul RvR	8.1.2 Mesh Backhaul Node-2 Rv	R	🔲 8.2.1 Mesh Roam Tim	e
	<u>S</u> tart	Skip	Another Iteration	Pause <u>C</u> ancel

12. 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, Ferndale, WA 98248, USA www.candelatech.com | sales@candelatech.com | +1.360.380.1618*