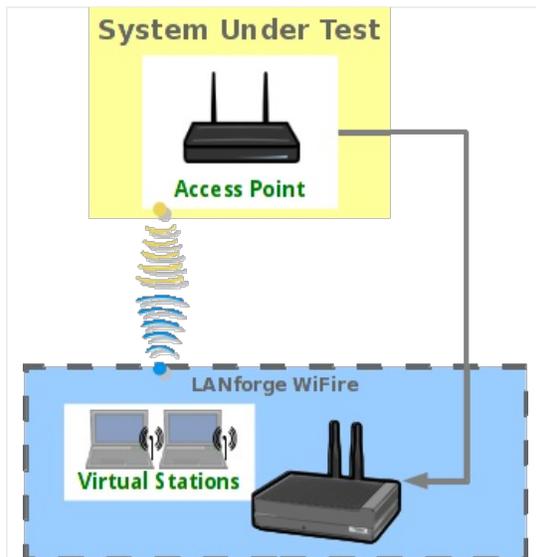
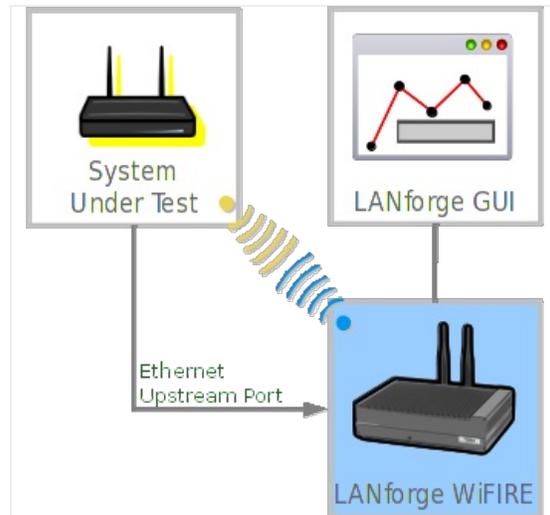


Test WiFi MU-MIMO Download.

Goal: Test WiFi MU-MIMO station Download, one 2x2 station, one 1x1.

Test WiFi MU-MIMO station Download using two MU-MIMO capable radios. One radio will emulate a 2x2 station, and a second will emulate a 1x1 station. When testing MU-MIMO, only a single station can be used per radio. For additional non-MU-MIMO station emulation, additional radios can be configured for multiple station virtual devices. This example uses a system similar to the LANforge CT525 system. It is configured with 4 radios: Two of the 4x4 MU-MIMO radios are used for MU-MIMO testing. The other two are not used in this test scenario. This procedure should work on any system that can support at least 2 of the 4x4 wave-2 radios. The AP in this test is a Netgear R7800 configured in bridging mode. **This feature requires 2 wave-2 WiFi network cards and LANforge release 5.3.5 or higher.**

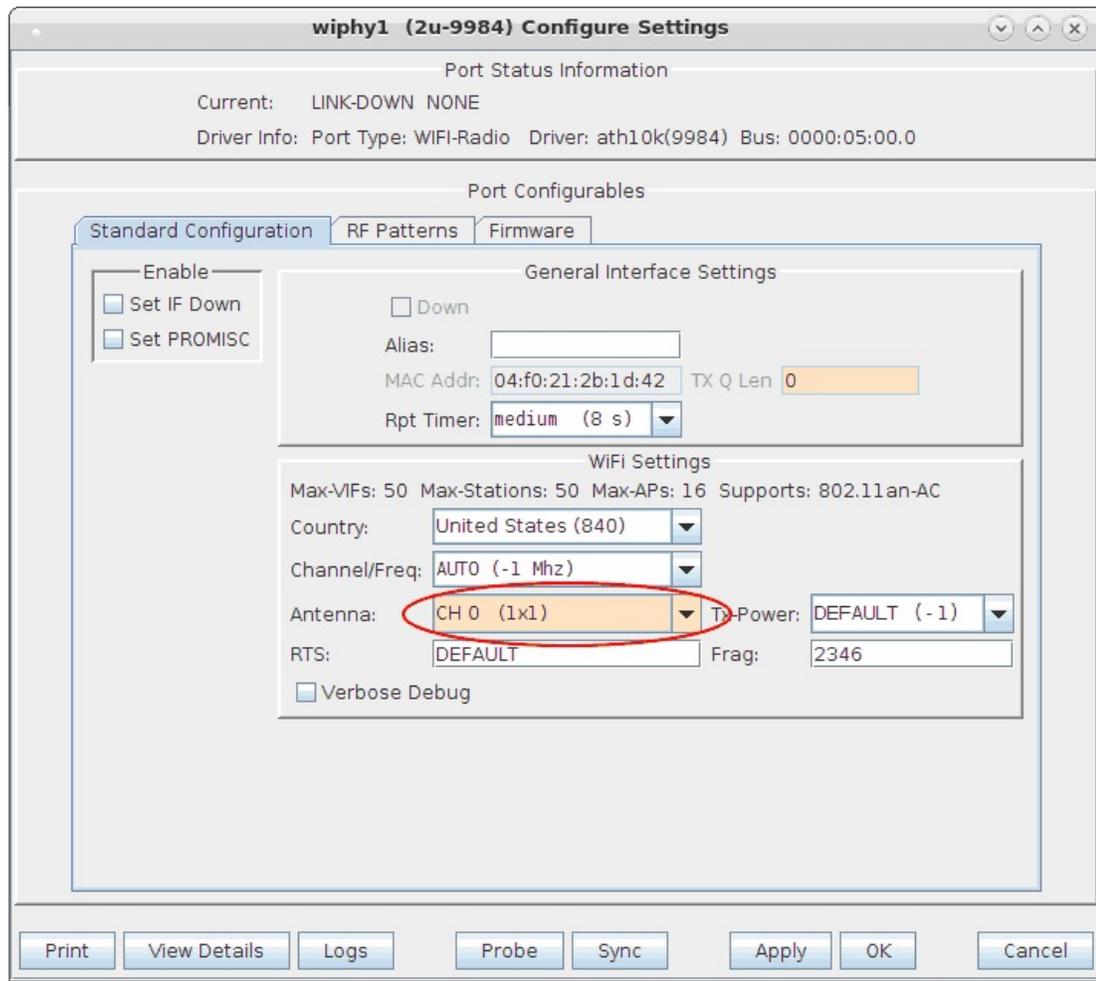


1. Configure Radios and Station devices for MU-MIMO capabilities.

- A. Go to the Port Manager, select the **wiphy0** interface, and click **Modify**. Configure the radio for 2x2 MIMO and click Apply.

The screenshot shows the 'wiphy0 (2u-9984) Configure Settings' window. It is divided into two main sections: 'Port Status Information' and 'Port Configurables'.
Port Status Information:
Current: LINK-DOWN NONE
Driver Info: Port Type: WIFI-Radio Driver: ath10k(9984) Bus: 0000:06:00.0
Port Configurables:
The 'Standard Configuration' tab is active. On the left, there are two checkboxes: 'Set IF Down' and 'Set PROMISC', both of which are unchecked. The 'General Interface Settings' section includes a 'Down' checkbox (unchecked), an 'Alias' text field, a 'MAC Addr' field with the value '04:f0:21:2b:1d:44', a 'TX Q Len' field with the value '0', and a 'Rpt Timer' dropdown menu set to 'medium (8 s)'. The 'WiFi Settings' section shows 'Max-VIFs: 50', 'Max-Stations: 50', 'Max-APs: 16', and 'Supports: 802.11an-AC'. It includes a 'Country' dropdown set to 'United States (840)', a 'Channel/Freq' dropdown set to 'AUTO (-1 Mhz)', an 'Antenna' dropdown menu highlighted with a red circle and set to 'CH 0-1 (2x2)', and a 'Tx Power' dropdown set to 'DEFAULT (-1)'. Other fields include 'RTS' set to 'DEFAULT' and 'Frag' set to '2346'. A 'Verbose Debug' checkbox is also present and unchecked. At the bottom of the window, there are buttons for 'Print', 'View Details', 'Logs', 'Probe', 'Sync', 'Apply', 'OK', and 'Cancel'.

- B. Select the **wiphy1** interface, and click **Modify**. Configure the radio for 1x1 MIMO and click Apply.



- C. For both wiphy0 and wiphy1 ensure that the firmware is configured properly for MU-MIMO. The Port Status Information section at the top should mention the 9984 chipset, as other hardware may not support MU-MIMO. Normally the best option is to go into the **Firmware** tab, click the **Customize Firmware** box, click the top **Firmware Defaults for chipset: 9984** button, and then select **Allow MU-MIMO**. Please note that selecting MU-MIMO disables a feature that allows multiple virtual stations to work properly on a single radio. So, when you are done with MU-MIMO testing, you should probably change this selection back to **Software Decrypt** settings.

- D. Select the **wlan0** interface, and click **Modify**. Configure the station for proper SSID, password, etc., and click Apply. Do the same configuration for **wlan1**.

- E. In this scenario, we are using eth1 as the upstream port. Ensure it is configured properly. In this example, it is actually configured to serve DHCP using a virtual router and the Netsmith feature in LANforge, but for simplicity, it is normally best if you use the AP as DHCP server or just use fixed IP addresses for eth1 and the wlan interfaces instead of using DHCP.

2. Create Layer-3 UDP Download traffic flows.

- A. Go to Layer-3 tab and click **Create** to build a UDP connection. Select the Protocol, ports, rates, and use Multi-Conn 1 so that separate processes are created for optimal throughput performance. Create a second one for the wlan1 interface, with download speed of about 450Mbps since it is only 1x1 MU-MIMO. You may need to adjust the + - buttons at top left to show the section containing Multi-Conn settings.

udp-wlan0-dl - Create/Modify Cross Connect

CX Name: **udp-wlan0-dl**
 CX Type: LANforge / UDP

Endpoint A: 1 (2u-9984)
 Port: **10 (wlan0)**
 Min Tx Rate: **Zero (0 bps)**
 Max Tx Rate: Same
 Min PDU Size: AUTO
 Max PDU Size: Same
 IP ToS: Best Effort (0)
 Pkts To Send: Infinite

Endpoint B: 1 (2u-9984)
 Port: **1 (eth1)**
 Min Tx Rate: **650000000 (650 Mbps)**
 Max Tx Rate: Same
 Min PDU Size: AUTO
 Max PDU Size: Same
 IP ToS: Best Effort (0)
 Pkts To Send: Infinite

Cross-Connect
 Report Timer: fast (1 s)
 Pld Pattern: increasing
 Min IP Port: AUTO
 Max IP Port: Same
 Min Duration: Forever
 Max Duration: Same
 Min Reconn: 0 (0 ms)
 Max Reconn: Same
 Multi-Conn: **One (1)**

- B. Start the test by selecting the connections click **Start**. We see about 500Mbps on wlan0 (2x2) and 200Mbps on wlan1 (1x1). For best results, you may need to tune orientation of the first two antenna on the wiphy0 radio and the first antenna on wiphy1. In addition, it can take a short amount of time for the rates to reach maximum throughput, so you may wish to clear the counters after around 15 seconds of running to make sure the averages do not include the initial ramp-up time.

LANforge Manager Version(5.3.5)

Control Reporting Tear-Off Info Plugins

Stop All Restart Manager Refresh HELP

Layer-4 Generic Test Mgr Test Group Resource Mgr Event Log Alerts Port Mgr vAP Stations Messages
 Status Layer-3 L3 Endps VoIP/RTP VoIP/RTP Endps Armageddon WanLinks Attenuators Collision-Domains File-IO

Rpt Timer: default (5 s) Go Test Manager all Select All **Start** Stop Quiesce **Clear**
 View 0 - 500 Display Create Modify Delete

Cross Connects for Selected Test Manager

Name	Type	State	Pkt Rx A	Pkt Rx B	Bps Rx A	Bps Rx B	Rx Drop % A	Rx Drop % B	Drop Pkts A	Drop Pkts B
udp-wlan0-dl	LF/UDP	Run	1,619,908	0	506,438,968	0	0.644	0	10,842	0
udp-wlan1-dl	LF/UDP	Run	663,837	0	204,113,541	0	53.759	0	771,776	0
udp-wlan2-dl	LF/UDP	Stopped	294,414	0	928,003,014	0	2.207	0	6,644	0
udp-wlan3-dl	LF/UDP	Stopped	170,632	0	365,073,116	0	61.655	0	274,356	0

Logged in to: 192.168.100.141:4002 as: Admin

- C. It can be a bit difficult to know if MU-MIMO is working properly. In general, if you disable MU-MIMO in the AP, then aggregate throughput should decrease significantly. In addition, the current firmware and/or driver is unable to properly report RX encoding rates for MU-MIMO frames, so it always reports low rates. If you see total throughput that is greater than the reported RX Rate, then likely the system is receiving MU-MIMO frames from the AP.

LANforge Manager Version(5.3.5)

Control Reporting Tear-Off Info Plugins

Stop All Restart Manager Refresh HELP

Layer-4 Generic Test Mgr Test Group Resource Mgr Event Log Alerts Port Mgr vAP Stations Messages

Status Layer-3 L3 Endps VoIP/RTP VoIP/RTP Endps Armageddon WanLinks Attenuators Collision-Domains File-IO

Disp: 10.1.1.14:0:0 Sniff Packets Clear Counters Reset Port Delete

Rpt Timer: medium (8 s) Apply View Details Create Modify Batch Modify

All Ethernet Interfaces (Ports) for all Resources.

Vind	bps TX LL	Bytes TX LL	bps RX LL	Bytes RX...	Reset	TX-Rate	RX-Rate	Status	AP	Activity	Signal	Noise	C
0	211,201	367,447...	24,873	571,441...	Complete	1 Gbps	1 Gbps			0			
0	999,989...	41,176...	40	1,512	Complete	1 Gbps	1 Gbps			0			
0	12	462,449	532,141,214	35,835...	Complete	0 bps	0 bps			79.499			
0	12	527,583	226,048,620	15,832...	Complete	0 bps	0 bps			87.421			
0	0	219,524	32,275	6,543,4...	Complete	0 bps	0 bps			91.59			
0	2	314,484	26,334	936,498...	Complete	0 bps	0 bps			0			
0	0	265,614	212	649,699...	Complete	6 Mbps	975 Mbps	Authorized	DC:EF:0...	100	-14 dBm	-95 dBm	
0	0	219,772	211	6,245,9...	Complete	6.5 Mbps	9 bps	Authorized	DC:EF:0...	91.623	-18 dBm	-104 dBm	
0	14	558	210,892,014	8,619,7...	Complete	6.5 Mbps	29.3 Mbps	Authorized	DC:EF:0...	81.765	-25 dBm	-103 dBm	
0	11	558	521,559,168	21,011...	Complete	175.6 Mbps	32.6 Mbps	Authorized	DC:EF:0...	80.286	-26 dBm	-103 dBm	

Logged in to: 192.168.100.141:4002 as: Admin