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# LANforge-GUI User Guide

## Table of Contents

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## Overview

The LANforge-GUI is a graphical management interface to the LANforge system. The GUI connects to the LANforge manager process, which automatically discovers the LANforge Data Generators (also called 'Resources') on its management network. Because the connection to the server is a standard TCP/IP interface, the GUI can access the server remotely, even over a low bandwidth connection. The GUI has extensive 'tooltip' support, so if you are unsure of what a particular field or option box does, momentarily position the mouse cursor over the field of interest and view the brief description.

Clicking the **HELP** button will pop up a new window using your default browser displaying the section of the LANforge-GUI User Guide relating to the selected tab on the GUI display.

You can resize and re-arrange most tables in the GUI by dragging the columns around. You can use right-click options to select which table columns to display, save the current configuration, and return the table to the default values.

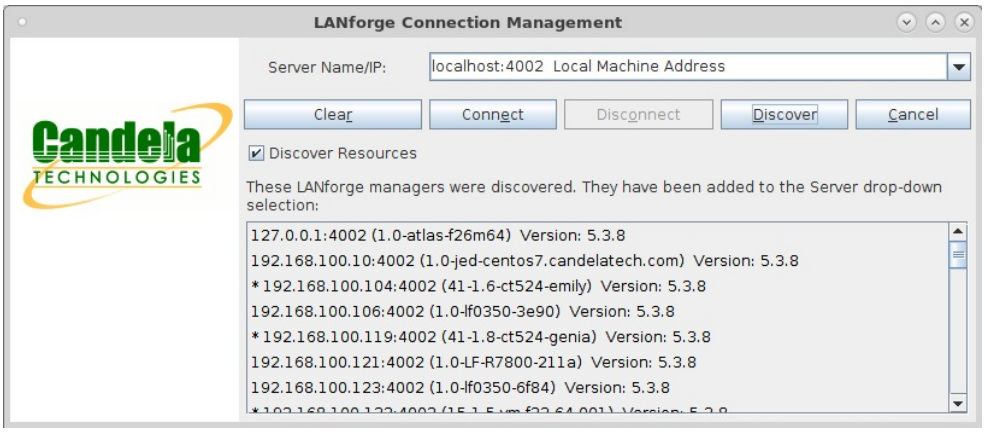
**NOTE** (Windows Vista users): Clicking **HELP** will direct your default browser to the Table of Contents of the LANforge-GUI User Guide and not to the specific section. From the Table of Contents, you can click on the

section desired.

For a some ideas on how to test specific architectures and protocols, see the cookbooks:
LANforge-GUI FIRE Cookbook and
LANforge-GUI ICE Cookbook.

1. ## Getting Started & Logging In

After installing the LANforge-GUI, you are ready to begin. First, start up the LANforge-GUI by double-clicking the anvil icon on the desktop. After clicking **OK** on the End User Licence Agreements, three windows should pop up, one of which is a login window that looks something like this:




**NOTE** (Windows Vista users): LANforge-GUI must be run as administrator from the desktop shortcut or Start menu.

Enter the name or IP address of the LANforge server that you wish to connect to. If you are running the GUI on the same machine as the LANforge server, then you can enter 'localhost' here. Note that the default server port is 4002, but this could be different depending on how the LANforge server was installed. You can also click the **Discover** button to have the GUI discover other LANforge systems on the local subnet. **NOTE**: The discovery process may be inhibited if the machine running the GUI has a firewall enabled.

Newly discovered systems are added to the drop-down menu and can then be selected. After entering the correct information or selecting the server from the drop-down menu, click the **Connect** button, and the GUI will attempt to connect to the server. If the server is re-started, or if the connection from the GUI to the server is lost for any other reason, the GUI will attempt to reconnect to the server every 5 seconds.

The last 20 servers that you logged into will be added to the drop-down menu for ease of use when re-connecting. If you ever want to re-initialize the list, remove the lfcnf.txt file that is in the LANforge-GUI installation directory and re-start the GUI. A new file will be created the next time you connect to the server.

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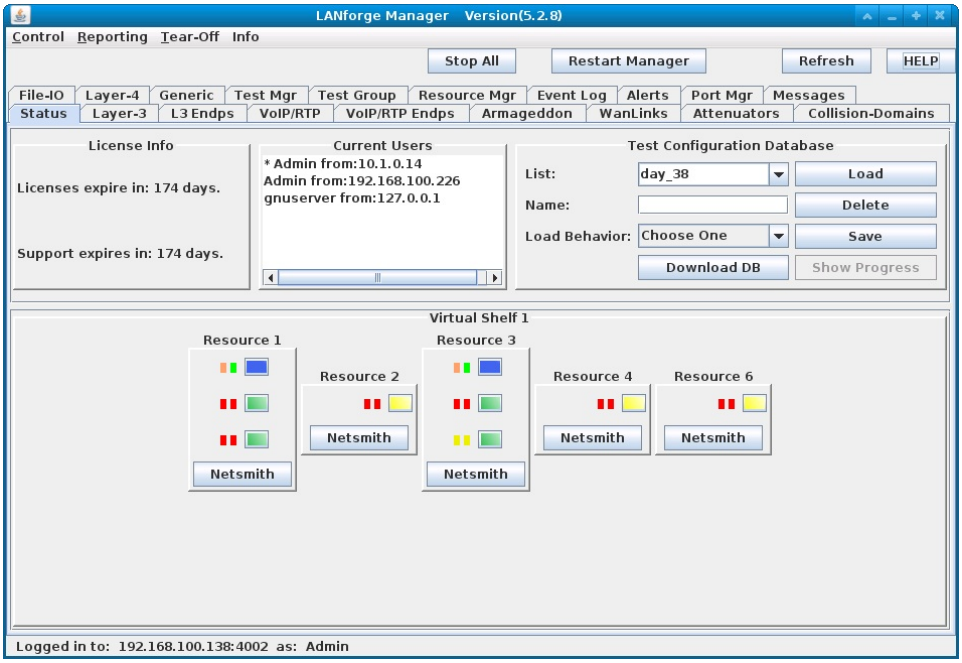
2. ## LANforge Manager

After you have connected to the server, the splash screen will disappear and the LANforge Manager window will appear with the **Status** tab displayed:




The **Status** Tab contains the following management panels:

- The **License Info** panel displays LANforge license information and lists days remaining on the license and software support. The background of each counter will turn yellow when the licenses are within 1 month of expiration, and red when within 1 week of expiration.
- The **Current Users** panel lists users that are logged into the LANforge Server. Because the LANforge system can be accessed by multiple users simultaneously, this panel will help you coordinate and understand the current usage of the LANforge system. Some of the 'users' are other LANforge processes.
- The **Test Configuration Database** panel displays the current list of configuration databases that may be found on the LANforge Server. Use this panel to load, save, download and delete test databases. When loading, you are given the option of overwriting the current configuration with the database you are loading, or you can just append the new database to the existing configuration.

  The database files are stored in plain text, and are human readable. It is possible, though not necessarily advisable, for you to edit the databases by hand, or auto-generate them with a custom script.

  To find the actual database files, look in the `/home/lanforge/DB/` directory on the LANforge machine. The current configuration is saved to the 'DFLT' database every 30 seconds. A backup database will be also saved every 10 minutes with the name 'day_XXX' with XXX corresponding to the ordinal (Julian) date. To save the current database under specific name, enter it in the Name field and click the **Save** button.

  Downloaded databases are saved below the LANforge GUI client current directory. On Linux, the path is `/home/lanforge/saved_dbs`, and Windows `C:\Program Files\LANforge-GUI_5.2.8\saved_dbs`.

  Note on appending: it is possible to append databases that conflict. For example, two configurations could each have a cross-connect named "cx1." The last definition wins, and the results may look a little messy.
- The **Virtual Shelf** panel lists each LANforge data generating unit (Resource) assigned to a virtual shelf. A virtual shelf is simply a method of grouping Resources into logical collections. Each Resource is assigned to a shelf when initially configured.

  Each Resource has a certain number of 'ports' displayed which are color-coded according to their function:

  - **Blue**: Management port for each Resource
  - **Green**: Data-generating ports
  - **Yellow**: Ports configured in the database but non-existent (or not yet discovered) on the real hardware
  - **Red**: Ports configured to be ignored by the client

  The color of the two small squares to the left of each 'port' indicate the current Link Rate and Link Status for that port. Some drivers may not support port-speed reporting in a

manner that LANforge can detect, but LANforge will continue to function normally other than reporting the wrong link speed. The leftmost square (Link Rate) will be:

- **Purple**: 10Gbps
- **Orange**: 1Gbps
- **Green**: 100Mbps
- **Yellow**: 10Mbps
- **Red**: No Link

The middle square (Link Status) will be:

- **Green**: Full-Duplex
- **Yellow**: Half-Duplex
- **Red**: No Link

The port layout is specified in a config file for each Resource and should have been configured correctly during installation. The tool-tip for each port indicates the interface identification, alias, and port status. Clicking on a port displays the **Port Mgr** tab with the specified port selected (highlighted) to provide detailed information.

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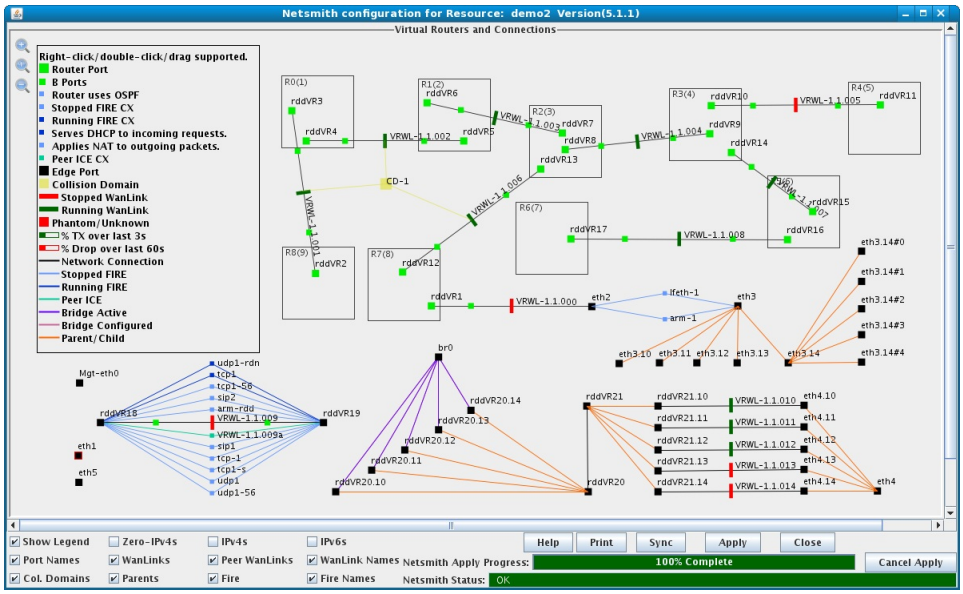
## 3. Netsmith: Virtual Network Configurator

LANforge includes the Netsmith graphical configurator for virtual routers, LANforge-FIRE, and LANforge-ICE testing scenarios. Please be aware that the Virtual Router functionality only works when the LANforge resource servers are running on Linux. The updated iputils program and the Candela kernel (or a kernel with the Candela patch applied) are also required. If you purchase a LANforge system (as opposed to software-only), this will all come pre-installed. If you are installing the software on your own system, please read the install guide(s) carefully.

Open Netsmith by clicking the **Netsmith** button located below the resource of interest on the **Status** tab Virtual Shelf panel. When the Netsmith tool is first opened, it will auto-create as much as possible based on the current system configuration and resources. The positioning of the objects will most likely need to be changed. For most objects, just click-and-drag them to the new location using the mouse. Some objects, such as FIRE cross-connect (CX) representations are not independently draggable, but you can drag the port endpoints to reposition the FIRE CXs.

Click on the magnifying glass icons on the upper left of the Netsmith display to zoom-in, reset to default, and zoom-out, respectively.




Objects can be easily moved within the Netsmith display to suit your personal preference. Individual objects can be moved by left-clicking and draging to the new location. A selection box can also be created to move a group of objects by first left-clicking and draging to outline a box of the desired size. The selection box with its contents can then be dragged to a new location on the Netsmith display. The location of the selection box can be fine-tuned by using the left/right/up/down arrow keys while holding down the Ctrl key. Single objects can be moved in a similar manner by first selecting them with a single mouse click. Once the object is in the desired location, click the **Apply**

button to save the changes.

In general, you can click-and-drag to move, double-click to modify, and right-click on objects to get a menu of available actions for each object or group of objects.

Here is an example of how to create a simple routed network emulation using three physical ports and one virtual router. This will emulate a central location with a 10Mbps network connection, and 2 remote sites with 1.54Mbps T1 connections, all connected through a routed network.
For more examples, please see the LANforge-GUI FIRE Cookbook and LANforge-GUI ICE Cookbook.

| Step | Screenshot |
|---|---|
| **1.** Open the Netsmith tool by clicking the **Netsmith** button located on the bottom panel of the **Status** tab display. |  |
| **2.** Three ethernet interfaces will be used in this example: eth0, eth1, and eth2. Ethernet interfaces can be clicked and dragged from their default location at the bottom-left corner of the display to the center for clarity. Clicking the **Apply** button at the bottom-right of the Netsmith window will save their locations on the display. Double-click eth0 to display the Create/Modify Connection window and modify its connection. |  |
| **3.** Deselect the 'Skip' checkbox to the right of 'WanLink:', 'Port 2-B:' and 'Port 2-A' to "un-skip" these connections in the Create/Modify Connection window. This will automatically create new entities as needed. Click **OK** to save the changes. |  |
| **4.** Double-click eth1 and eth2 and follow the same steps as above. When completed, right-click in a blank area within the window and select 'New Router.' This will display the Create/Modify Virtual Router window. |  |
| **5.** A router name will be automatically assigned (e.g., R0) or a different name can be typed in the 'Name:' field if desired. Click **OK** when complete. |  |
| **6.** Drag the rddVRXX sides of the connections into the newly created virtual router. Click the **Apply** button to create the new ports and WanLinks. |  |
| **7.** You should see the newly created objects go from red squares to green and black boxes. The WanLinks (red rectangles) will turn green when started. |  |
| **8.** Right-click on each rddVRXX interface in the virtual router and select 'Modify Port' to add the appropriate IP Address, IP MASK, and Gateway IP. The default gateway for each port will be the IP address of the corresponding rddVRXX port in the virtual router. Selecting the 'IPv4s' or 'IPv6s' checkboxes on the bottom panel will display IPv4 or IPv6 addresses, respectively, on the Netsmith display. |  |
| **9.** If this is to be part of a larger routed network, then you can double-click the port(s) in the virtual router and set the 'Next-Hop' and up to eight subnets that will be using this next hop. Please note that 0.0.0.0/0 is a valid subnet, and simply means 'ANY.' This is one way to set the default gateway for all unknown traffic. Click **OK** when done modifying the Virtual Router. |  |
| **10.** When all of the ports in the Virtual Router have appropriate IPs, and the connection has the proper next-hops and subnets, click **Apply** to flush the changes to the LANforge server and create the proper routing tables. | |

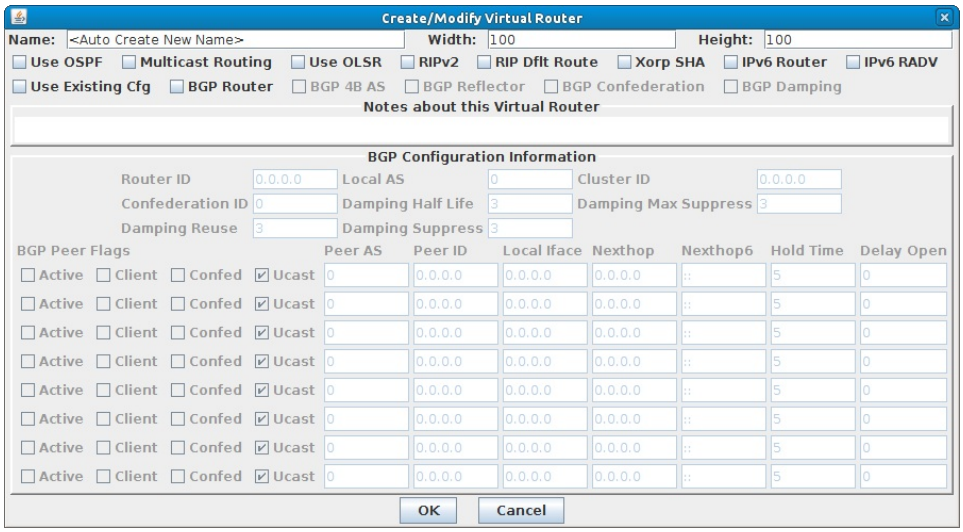
**11.** Modify the WanLinks by right-clicking the green (running) or red (stopped) rectangles and selecting 'Modify WanLink.' Set the transfer rate to 10Mbps on one, and 1.54Mbps on the other two. Set latency and other changes as required and click **OK**

**12.** Start each WanLink by right-clicking its colored rectangle and selecting 'Toggle WanLink.' After completing changes in Netsmith, click the **Apply** button to flush the changes to the LANforge server.

**13.** Connect your network equipment to ports eth0, eth1, and eth2. Your network equipment should now be able to ping through LANforge and you should see the latency that was configured in the WanLinks.

## Virtual Routers

To create a new Virtual Router, right-click in a blank area within the Netsmith window and select 'New Router.' This will bring up the Create/Modify Virtual Router window:




LANforge will generate a name automatically unless one is entered. The name, graphical size, notes field and other router configuration flags can all be modified when created or at a later time. The virtual router will use simple subnet routing rules unless otherwise directed. Xorp must be installed before using the following routing features: OSPF, Multicast, RIP, Xorp SHA, or BGP.

**Use OSPF**

Select this checkbox if the virtual router is to use Open Shortest Path First (OSPF) routing protocol.

**Multicast Routing**

Select this checkbox if the virtual router is to route multicast traffic. **NOTE**: IPv6 multicast routing is not currently supported, but IPv4 works fine.

**Use OLSR**

Select this checkbox if the virtual router is to use Otimized Link State Routing (OLSR) protocol.

**RIPv2**

Select this checkbox if the virtual router is to use RIP for IP Version 2.

**RIP Dflt Route**

Select this checkbox if the virtual router is to accept default-routes from RIP peers.

**Xorp SHA**

This function is specific to a particular OEM.

**IPv6 Router**

Select this checkbox if the virtual router is to route IPv6 traffic.

**IPv6 RADV**

IPv6 RADV protocol will automatically assign IPv6 addresses to other hosts on network interfaces in this virtual router. A patched version of radvd may be required to support this functionaly as

older version do not properly deal with the virtual interface names that LANforge uses. Contact your vendor if you have questions.

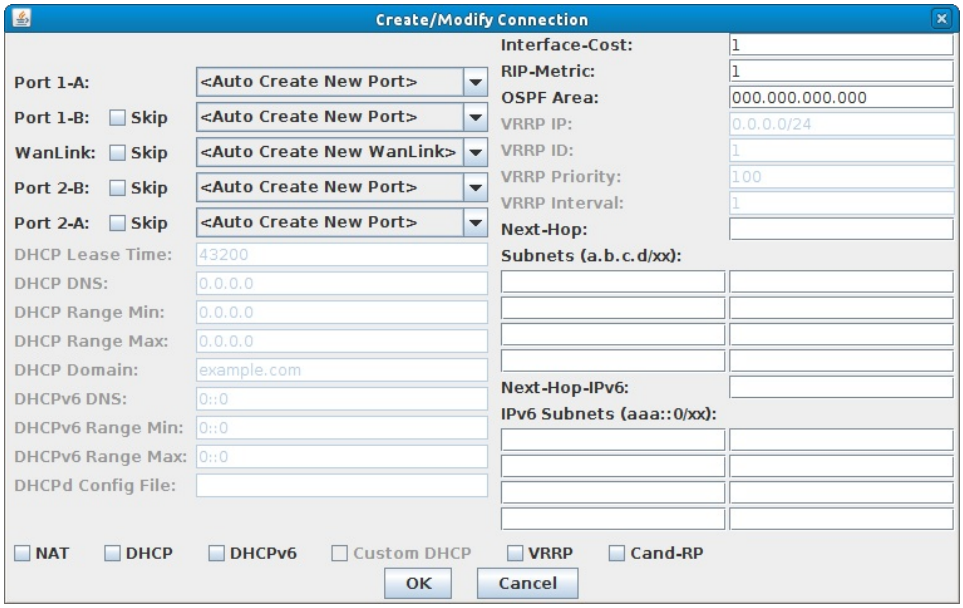
**BGP Router**

Selecting this checkbox enables Border Gateway Protocol (BGP) checkboxes and BGP Configuration Information fields.

After creating a virtual router, existing interfaces can be dragged into it or new virtual devices can be created and associated to it. In order to be accessible to outside objects, however, the Virtual Router must either contain an interface (Port) that connects to the outside world or be connected to another Virtual Router that eventually connects to the outside world.

## Netsmith Connections

Netsmith Connections are used to connect routers to each other and to connect routers to the outside world. To create a new Netsmith Connection, right-click in a blank area within the Netsmith window and select 'New Connection.' This will bring up the Create/Modify Connection window:




You can choose up to 4 ports and one WanLink to be part of this connection. The number and combination of ports/WanLink selected changes the behavior significantly. In the example below, it is assumed that Port-1 will be the 'outside' port, but Router Connections do not have an inherent direction...it all depends on how you configure it.

- **Port 1-A** will be the name of the local port. If you want this connection to connect to the outside world, use a real device such as eth1 or perhaps an 802.1Q VLAN device for this value. If you want to use this connection to connect two virtual routers, then choose the default <Auto Create New Port> option and a redirect-device (rdd) will be created when the changes are applied.
- **Port 1-B** will be the name of the local B port. If you want this connection to connect to the outside world, this should be skipped. If you want to use this connection to connect two virtual routers with a WanLink (Network Impairment) included, then choose the default <Auto Create New Port> option and a redirect-device paired with Port 1-A will be created for you when the changes are applied.
- **WanLink** will be the name of the WanLink (LANforge-ICE) that connects the local ports to the remote ports. If you skip one of the B ports, then the WanLink will connect to the A port. If you skip both B ports, the WanLink will connect the two A ports directly. If both B ports are active, the WanLink will connect the two B ports (assuming the B ports are redirect-devices associated with the A ports) so that the A ports are logically connected to each other through the B ports via a WanLink bridge. If you want to connect two routers without using a WanLink (e.g., to reduce the number of WanLink licenses) both B ports and the WanLink can be skipped. This last case assumes that the A ports are (or will be) a pair of redirect-devices.
- **Port 2-B** will be the name of the remote B port. Skip this port If you want the remote side of the connection to connect to the outside world. Otherwise, choose the default <Auto Create New Port> option and a redirect-device paired with Port 2-A will be created for you when the changes are applied.
- **Port 2-A** will be the name of the remote A port. If you want the remote side of the connection to connect to the outside world, this should be a real interface, such as eth2 or

perhaps an 802.1Q VLAN device. If you want to use this connection to connect two virtual routers, then choose the default <Auto Create New Port> and a redirect-device paired with Port 2-B will be created for you when you apply the changes. If you want to associate a port to a virtual router without any WanLink emulation, you can skip Port 2-A and have a stand-alone port that can be dragged into a router. This is the default case for newly discovered non-redirect device interfaces.

- **NAT** is the option to configure an interface on the Netsmith connection to perform Network Address Translation on the outgoing packets. NAT can be also be performed on an interface not associated with a Netsmith connection such as ethX. Please note that while LANforge NAT works properly, LANforge does NOT support any automatic firewalling at this time. That means that if the routing supports it, network connections can originate outside the NAT and route internally. There are ways to enable custom scripts to set up firewalling if that is required: Contact your vendor for more details.
- **DHCP** is the option to configure an interface on the Netsmith connection to serve Dynamic Host Configuration Protocol using a LANforge generated dhcpd.conf file. DHCP can be enabled on any interface within a virtual router.
- **DHCPv6** is the option to configure an interface on the Netsmith connection to serve Dynamic Host Configuration Protocol for IPv6 using a LANforge generated dhcpd6.conf file. DHCPv6 can be enabled on any interface within a virtual router.
- **Custom DHCP** is the option to configure an interface on the Netsmith connection to serve DHCP using your own dhcpd.conf file.
- **VRRP** is the option to configure an interface on the Netsmith connection to run the VRRP protocol.
- **Cand-RP** is used for multicast routing. Selecting the Cand-RP checkbox will designate this connection as the Candidate Rendezvous Point for its associated router to use in its bootstraping logic. The selected interface should be one that is visible to all other multicast routers in your network. If one is not selected, LANforge will select one for you.
- **Interface-Cost** is the option to configure an interface on the Netsmith connection with an OSPF route cost. OSPF will choose routes with lower costs when possible.
- **RIP-Metric** is the RIP interface metric for the connection. Valid entries are 1-15 (15 = infinite).
- **OSPF Area** is the OSPF area for the interface. If unsure, set to the default of 0.0.0.0
- **Next-Hop** is the next router gateway to be used by packets leaving on a router-connection. This can be used to help LANforge route to external networks when using static routing. For OSPF networks, the OSPF network will take care of all route discovery automatically.
- Up to 8 additional **Subnets** can be specified to lie beyond this connection. This will influence the routing tables for the virtual routers, and should correspond to the subnets in the user's network-under-test. The **Next-Hop** gateway will be used for packets destined for these subnets. Please note that 0.0.0.0/0 is a valid subnet, and efectively means the default gateway for the entire cluster of virtual routers.

## Right-Click Menus

Most objects have right-click menus associated with them to perform various actions. You cannot click on the connecting lines or the 'B' ports at this time.

- **Connection Endpoints** support Display Wanlink, Connect (to a previously selected endpoint), Modify, Toggle WanLink (on/off), Modify WanLink, Modify Port, Create Ports (create VLANs on the selected interface), Sniff Port (with Wireshark protocol analyzer), Reset Port, Delete Port, Delete WanLink, Delete (Router Connection). Please note that if you delete a connection endpoint, any previously auto-created WanLinks or virtual devices associated with that connection will also be deleted when you apply the changes. **Deleting ports and WanLinks take affect immediately, so be careful!**
- **Virtual Routers** support New Connection, Modify, Show Routing Table (as is currently configured in the kernel), and Delete. Deleting a Virtual Router will not delete any Router Connections.
- **Fire CXs** (various traffic-generating LANforge cross-connects) cannot be dragged, but they do support right-click actions: Display, Toggle (on/off), Start, Stop, Modify, and Delete. **WARNING: There is no confirmation for these actions, including 'Delete', and they are applied immediately upon choosing the action.**
- **Peer ICE CXs** are WanLinks associated with a particular connection but not currently running. If you have 3 WanLinks between the same two ports, only one can be running at a time: One will be shown as the central connection, and the other two will be shown as Peer ICE CXs. The Peer ICE CXs support these right-click actions: Switch (to running this WanLink), Modify, and Delete. **WARNING: There is no confirmation for these actions, including 'Delete', and they are applied immediately upon choosing the action.**

- **A Selection Box** can be created by left-clicking on an empty space and dragging and releasing the mouse. One can then drag the selection box and everything it includes to a new location. It also supports some right-click group actions, including: Display, Toggle, Start, Stop, Modify and Delete. Not all objects contained in the box may support every option, and in that case, they will be silently ignored with no ill affect. **WARNING: There is no confirmation for these actions and they are applied immediately upon choosing the action.**

### Visual Display

The Netsmith window provides a real-time view of WanLinks and other LANforge entities. A movable legend is displayed in the upper-left portion of the Netsmith window. Edge ports appear as solid black squares and are accompanied by a red outline if the port has no link. Any objects drawn as a solid red square are not currently found in the LANforge system, even though the Netsmith has been configured such that they (should) exist. This can happen if interfaces or WanLinks were removed after Netsmith had discovered them, or if new WanLinks or connections have been created in Netsmith, but the changes have not been Applied yet. If these should really be deleted, just right-click and delete the offending objects and Apply the changes.

- **For WanLinks**, a perpendicular green bar indicates it is running, and a red bar indicates it is stopped. A parallel traffic-throughput box is also drawn to indicate WanLink activity over the last 3 seconds. The green graph indicates the percentage of network utilization flowing **towards** the interface it faces. The red graph reports the percentage of dropped packets vs. transmitted packets over the last 1 minute.
- **LANforge-FIRE** connections are shown associated with their endpoint interfaces. They are drawn light-blue if stopped, and darker blue if running.
- **Port Relationships** ports will have orange connections to their parent object (for instance, an 802.1Q VLANs parent will be the the ethernet or other lower-level network device.) Bridge devices will be connected to the interfaces contained in the bridge device by dark blue lines. If the bridge is configured to own a device, but it is not currently configured as such by the kernel, then that line will be a purplish color. The purple color indicates not all may be as desired, so you may need to modify or reset the bridge device.

#### Display Options

The checkboxes at the bottom of the Netsmith window can be used to display or hide various details to suit the user's preference. Selecting or deselecting these flags will not affect the actual configuration of LANforge in any way.

#### Netsmith Buttons

There are several buttons at the bottom-right of the Netsmith window.

- **Help** shows this help information in a web browser.
- **Print** will print the entire diagram, resizing it to fit onto a single page. One might choose to print it to a PDF printer and expand the PDF for very high-resolution viewing of a complex network configuration.
- **Sync** will re-read the current LANforge configuration and re-draw the Netsmith window appropriately. This will cause un-saved changes (such as Virtual Router and Router Connection modifications) and positional changes to be lost. The Sync function may be required to display some newly created WanLinks and virtual interfaces in the Netsmith window.
- **Apply** will force all changes to the LANforge server. It will auto-create any virtual devices and WanLinks that have been added to Netsmith since the last Apply. It will also cause the router to re-calculate all of the Virtual Router routing tables and configuration. You must Apply the changes after creating, deleting, changing virtual-router/connection associations, and when you change the port IP addresses for the changes to take full affect. For large numbers of virtual routers, Apply can take several minutes. The progress bar will update as the work completes.
- **Cancel Apply** stops the current 'Apply' process. This can often leave the virtual router configuration in a bad state, so you should make whatever changes you require and then re-apply.
- **Close** closes the Netsmith window without applying any further changes.

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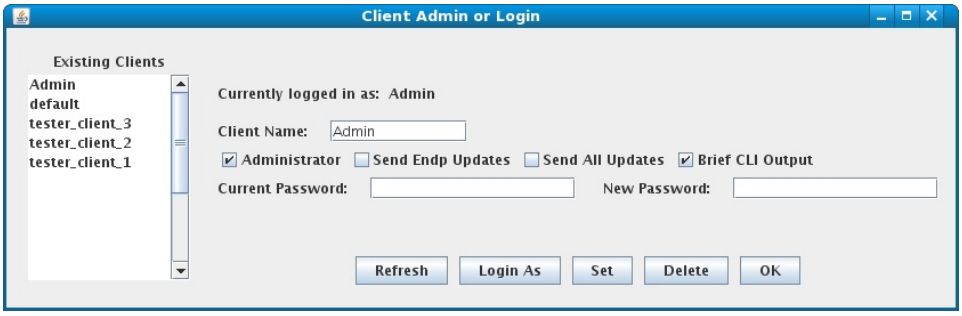
## 4. Client Administration and Client Login

The LANforge security and administration framework has a concept of Clients (users), Test Managers, and Cross-Connects. A Test Manager is a grouping of one or more Clients and zero or more Cross-

Connects. Any Client registered with a Test Manager can manage any of the Cross-Connects assigned to that Test Manager. As a special case, WanPaths can also be assigned to a Test Manager.

When you first log into the LANforge system through the GUI, you will be logged in as the user 'default'. The GUI will then try to log you in as user 'Admin'. If a password has been set for Admin and if the user 'default' does NOT have Administrator privileges, that login will fail and the login window will pop up to allow the user to change users and/or enter the correct password. **If only a few different testers will be using LANforge at a given time, you may never need to create a new user. And if you are not concerned about who uses LANforge, there is no need to set an Admin password.** It may be useful, however, to do so if you have a larger group of users or if communication between the users is not easy.

To log in as a particular user, select **'Client Admin or Login'** from the **Control** pull-down menu. You will get a screen that looks like this:




Existing clients are displayed in the left panel. To view or modify client details, double-click the name in the left panel. Client details including name, Admin status, and some other flags are displayed on the right. Click **Set** to save any changes. To log in as a Client, double-click the client name in the Existing Clients list, enter a password if one is set, and click **Login As**. To create a new Client, enter a new name, set appropriate flags, enter a password if desired, and click **Set**. To delete an existing Client, double-click it, and click **Delete**.

## Flags

**Administrator**

If enabled, the user will not be restricted in what it can do.

**Send Endp Updates**

If enabled, endpoint updates will automatically be sent to this Client. In most cases, this should be disabled since the GUI will request updates as appropriate.

**Send All Updates**

If enabled, endpoint, Port, and other updates will automatically be sent to this Client. In most cases, this should be disabled since the GUI will request updates as appropriate.

**Brief CLI Output**

This has only minor affect on the output of the CLI text interface. It should usually be enabled, but does not make much difference either way.

Creating a Client for use by the CLI interface can be done through the GUI as well. Unless you are using some sort of scripting program to control the CLI, it is advised that you uncheck both Send Updates flags, or the CLI will be so noisy that you will not be able to see what you are doing!

## Securing LANforge

By default, LANforge requires no password and the GUI will log in each Client as a super-user. To make LANforge more secure, deselect the Administrator flag from the default Client, then set a password for the Admin Client. You cannot set a password on the default Client, and a 'default_tm' Test Manager will always exist with the associated 'default' Client. To restrict the default Client's access, create a new Test Manager that does not include the default user, and add Cross-Connects to it.

Passwords may be reset by any Client selected as Administrator. Passwords are stored in a plain text file on the LANforge server at [LANforge-Home]/DB/passwd. If this file is deleted, all Clients will be able to log in without a password. This password protection will help keep Clients from accidentally interfering with configurations that they should not have access to, but **should NOT** be considered a serious means of securing the LANforge machine.

**NOTE:** LANforge is not designed as a highly secure application. You should ensure that the LANforge system cannot be accessed by un-authorized users on IP ports 4001 and 4002 through the use of firewalls or similar restrictions. Please contact LANforge support if you need more detailed information

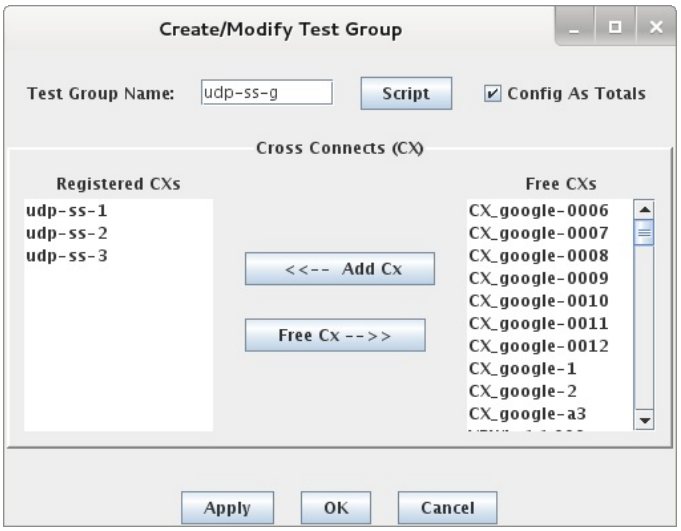
on securing LANforge.



## 5. Connection Groups

A Connection Group is a collections of tests (Layer-3, WanLinks, VOIP, etc) that can be easily managed as a group. This includes starting, stopping and running scripts. Connections can belong to more than one Connection Group, but a Connection Group can only start if none of it's CXs are running in another Connection Group.

To create a new Connection Group, select the **Connection Group** tab and click **Create**. This will bring up the Create/Modify Connection Group window:




**Connection Group Name**

Enter the name of the new Connection Group. The group name should be unique with no more than 47 characters and should not contain spaces.

**Config As Totals**

When configuring a connection group (such as through the use of a GUI Script or LANforge CLI commands), the values can be treated as individual settings for each CX in the group, or the settings can be divided such that when all CXs' settings are added together they match the configured value. For instance, if **Config As Totals** is selected on a connection group with 10 cross-connects in it, and a script sets the 'tx rate' to 100Mbps, then each CX will be set to 10Mbps tx rate.

**Apply**

Click Apply to save the current configuration and leave the window open for additional changes. If you change the name and apply again, you will get a new copy, for instance.

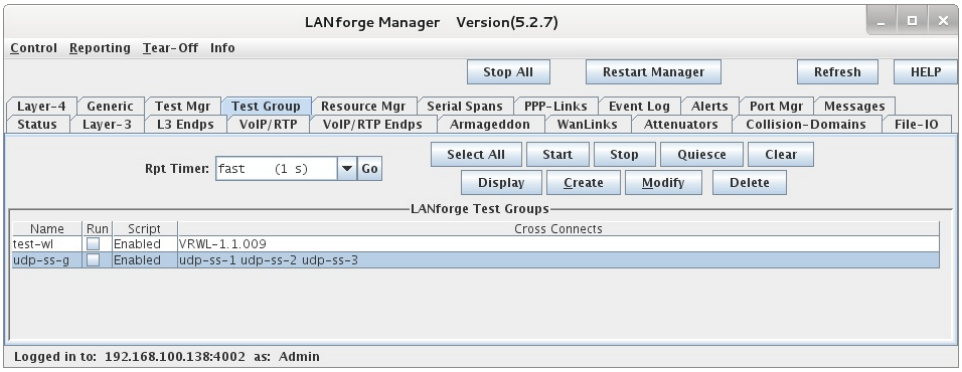
**OK**

Click OK to save and close the window.

**Cancel**

Close the window without saving the current configuration.

After creating the Connection Group, the **Connection Group** tab will display a summary of all existing Connection Groups and allow starting and stopping them. You can right-click for some additional options.

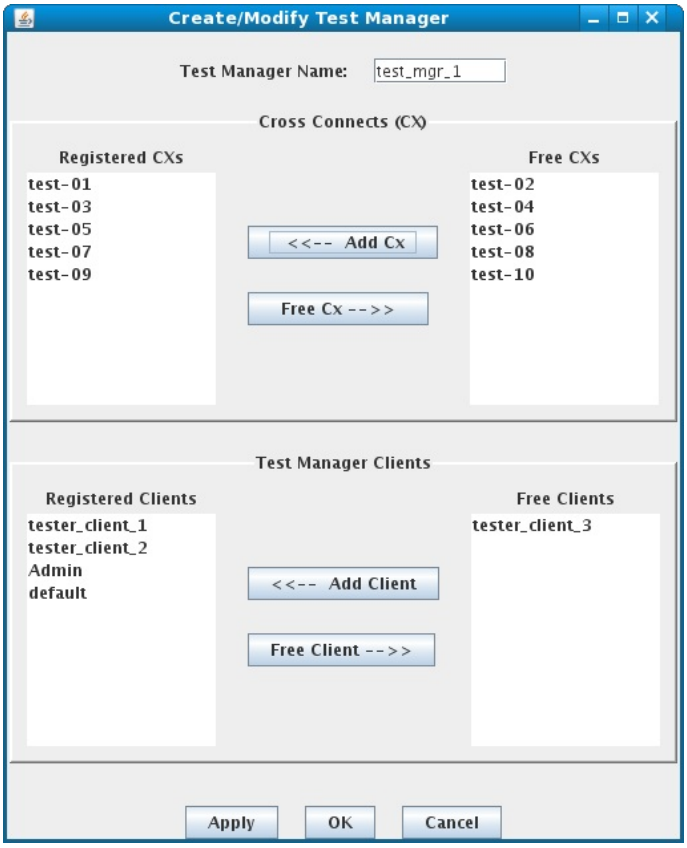





## 6. Test Managers

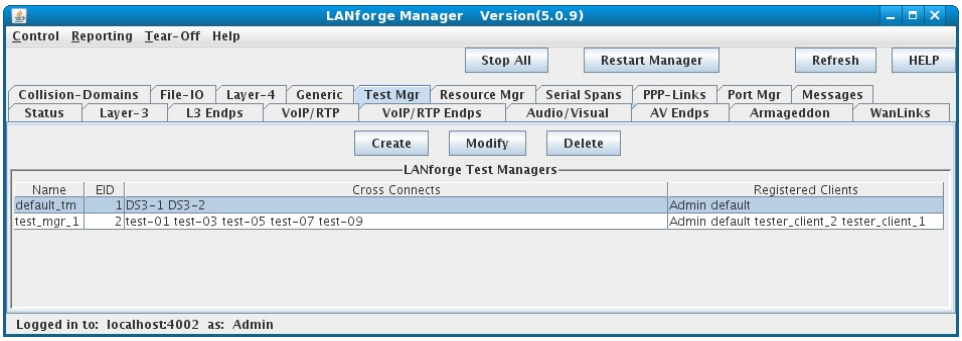
A Test Manager is a construct that represents a particular view into the LANforge system. In most cases, the default Test Manager can satisfy routine uses and the creation of addtional Test Managers is not required. Each Test Manager can have a selection of Cross-Connects and a list of Clients who are authorized to use the Test Manager. This allows one to set up multiple different tests on a LANforge system and quickly change the view to different test sets.

To create a new Test Manager, select the **Test Mgr** tab and click **Create**. This will bring up the Create/Modify Test Manager window:




1. Enter the name of the new Test Manager. Almost all names in the LANforge system are restricted to 47 characters and cannot contain spaces.
2. If you are just starting, there will be no Cross-Connects to register or free, but after the system has been configured, you may adjust the Cross-Connects that belong to a given Test Manager by adjusting the top panel of the Create/Modify Test Manager window.
3. You will need to register at least one Client with the Test Manager if you want to do any useful work. Unless you have created your own Client, you should add the 'default' and 'Admin' Client at this time. Registering a Client with a test manager means that Client has permission to modify and use all resources associated with that Test Manager.
4. Click the **Apply** button to send the changes and keep the window open for other modifications, or click **OK** to send the information and close the window.

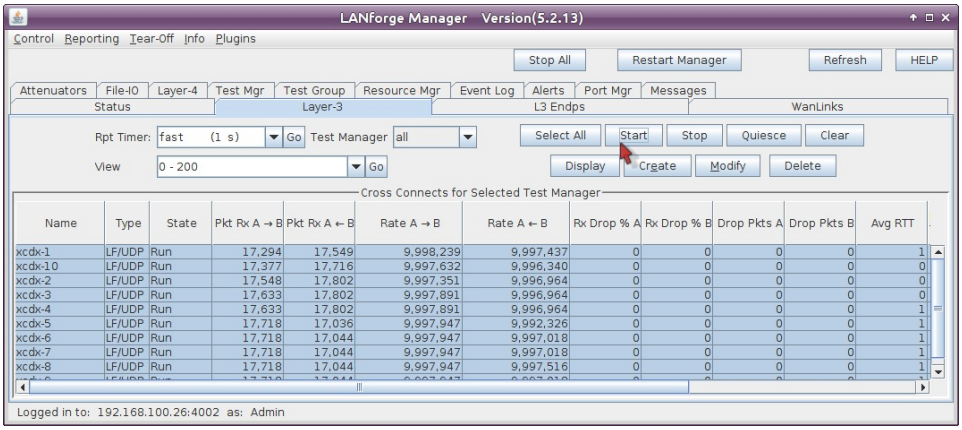
After creating the Test Manager, the **Test Mgr** tab will display a summary of all existing Test Managers, including the one just created. To modify a Test Manager, select it and click the **Modify** button. This will bring up the Create/Modify Test Manager window described above.





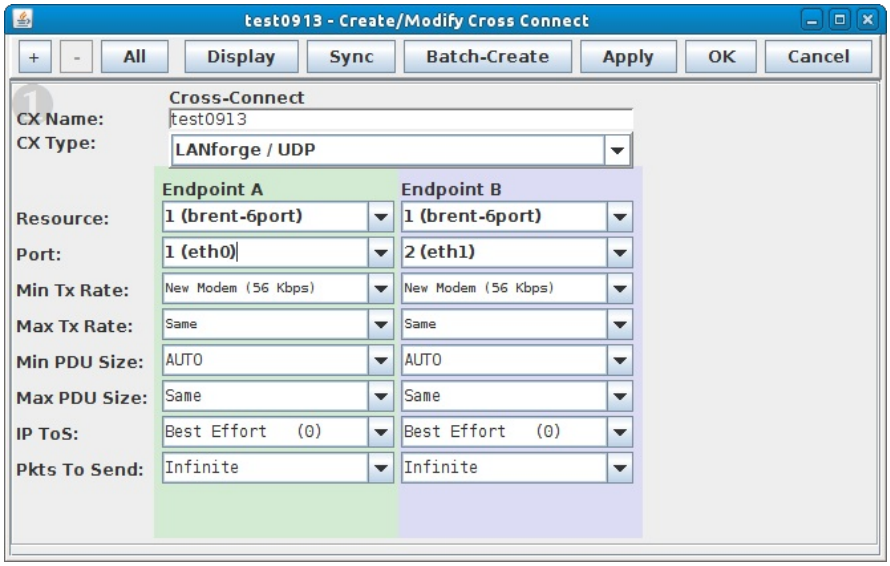

7. ## Layer-3 Cross-Connects (FIRE)

Layer-3 Cross-Connects represent a stream of data flowing through the system under test. A Cross-Connect (CX) is composed of two Endpoints, each of which is associated with a particular Port (physical or virtual interface). The **Layer-3** tab displays connections 0-200 by default. Connection numbering is 0-based where 0 represents the first connection name. To display all connections or a specified range of connections, select 'all' from the View field drop-down menu or enter range values (`[min]-[max]`) in the View field, then click the **Go** button to display the new range of connections.

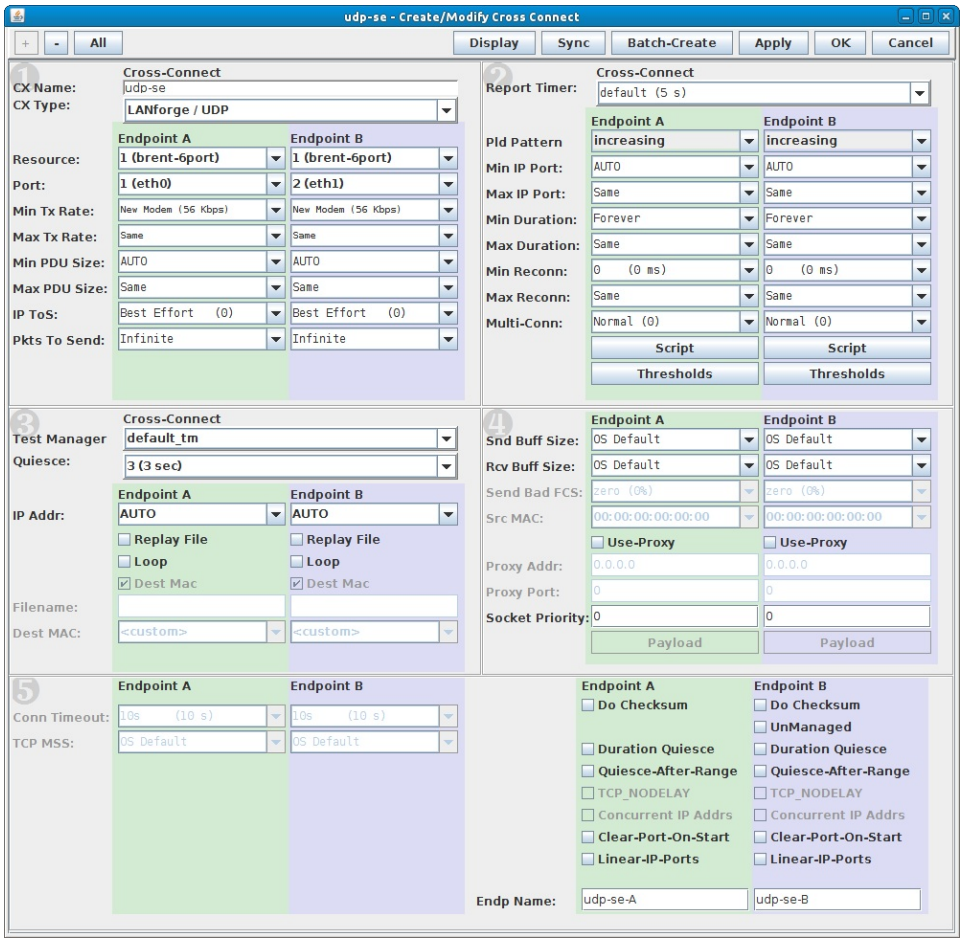



## Creating & Modifying Cross-Connects

When creating a Cross-Connect (CX), the details of each Endpoint including the Shelf, Resource, and Port that the Endpoint resides on need to be specifed. In this way, you determine which data-generating port (which is connected to some port on the system under test) the CX's traffic will flow over. In order to create a CX, click the **Create** button on the **Layer-3** tab which will bring up the Create/Modify Cross Conect window:




The modify screen displays the first configuration section which is sufficient for creating the CX. You may expose further details by pressing the "+" button in the upper right hand corner, or use the keystrokes `control +` and `control -`. There are five sections for this screen. Some fields are only valid for certain protocols and will remain greyed out unless that protocol is selected.




After the desired settings have been entered, click **Apply** or **OK** to create the Cross-Connect.

**NOTE**: A series of tests based off the current configuration can be created by clicking the **Batch-Create** button.

## Cross Connect Information

Sections of the Create/Modify Cross Connect window labeled Cross-Connect contain information relating to the entire CX, including the name, CX Type, Report Timer, and the Test Manager. There are Cross-Connect settings in sections 1, 2, and 3.

**CX Name**

The CX name uniquely identifies the cross-connect in the LANforge configuration. It should have

no spaces or other and be no more than 47 characters in length.

**CX Type**

The CX Type determines the protocol that the CX will use and are selected from a drop-down menu. The current supported types are:

- **Ethernet** passes a custom protocol over raw ethernet. This type of traffic is constrained to a local LAN (it cannot be routed). This is a good way to test pure packet throughput at the Ethernet level, and will show many types of link layer faults, like corrupted packets, dropped packets, and so forth that the higher level protocols might not show.

- **Custom Ethernet** can be used to specify the exact pattern of bytes to transmit onto the Ethernet wire, including the Ethernet header. Additionally, the LANforge replay feature can replay Ethernet packets captured by LANforge-ICE, Wireshark or any other application that supports the 'pcap' packet capture format. When replay is selected, LANforge plays the packets exactly as they were captured, including the same Ethernet headers, transmission rates, etc. You may choose the **Dest Mac** option to re-write the destination MAC address for the packets being replayed. This may help make sure the network under test accepts the packets.

  To replay a capture file, select the appropriate filename for each endpoint. For more information on generating the capture files, please see the **Dump Packets** notes in the LANforge-ICE section. LANforge can also replay standard pcap format packet dumps. It is possible to use the PcapPlusPlus utilities to split pcap streams. Here is an example of splitting a stream using bpf-filter syntax:

  ```
  $ PcapSplitter -f lf-mcon.pcap -m bpf-filter -o . -p "src 1.1.1.3"
  ```

  This will generate a file from the `lf-mcon.pcap` capture that has traffic eminating from endpoint with IP `1.1.1.3`. Use both files when creating the Custom Ethernet connection. (Other pcap editing utilities also exist: `editcap` comes with WireShark, and `tcpreplay-edit` comes with tcpreplay).

  This connection type also activates a GUI feature that allows you to build your own custom TCP/IP packets. Because LANforge has almost no control over what you send, it cannot detect received packets on the other end of the connection. You can use traffic sniffers or look at the port counters to get ideas of how many packets were actually received. See Configuring Payloads.

  Custom Ethernet endpoints will receive, count, and throw away frames accepted by the port the endpoint runs on. This includes any packets sent by other LANforge connections. If the port is put into PROMISC mode, the port may even receive frames destined for other MAC addresses. So, received packets/bytes/bits-per-second stats for Custom Ethernet protocols should be used with care.

- **UDP** traffic is a non-stream oriented IPv4 protocol that is commonly used for streaming video, music, and other real-time (and possibly lossy) protocols. UDP can be routed, so it is not constrained to the local LAN like the Ethernet protocol is.
- **UDP6** is similar to UDP, but uses the IPv6 protocol.
- **Custom UDP** connections let you specify the exact bytes to transmit as the payload of a UDP datagram. This might be useful for simulating RTP, for instance. See Configuring Payloads.
- **TCP** is a stream based protocol that carries the vast bulk of the Internet's traffic. It is routable, and it will re-transmit packets that are dropped, so the only packets LANforge should show as dropped are those that are still in the kernel buffers, or those in transit when the CX is stopped. LANforge can report the number of retransmitted packets on Linux. This provides an estimate of dropped frames, but TCP may also retransmit on an overly delayed packet that was not actually lost.
- **TCP6** is similar to TCP, but uses the IPv6 protocol which provides a much larger address space and is expected to replace IPv4 sometime in the future.
- **Custom TCP** connections let you specify the exact bytes to stream over a TCP/IP connection. LANforge has no way of knowing where one of your 'packets' starts or ends, so it cannot detect dropped or mangled bytes on the receive side. You can use the bytes sent and received counters to get a good idea though. See Configuring Payloads.
- **SCTP** is a protocol with a mix of features somewhat simialar to UDP and TCP. It runs over IPv4, generates PDUs similar to UDP, but has guaranteed delivery and ordering guarantees like TCP. It is only supported on Linux platforms.
- **SCTP6** is the same as SCTP, except it runs over the IPv6 protocol.

**Report Timer**

The Report Timer specifies how often the LANforge data generators send updates to the LANforge server, and how often the LANforge server pushes endpoint information up to the clients (GUIs) that have requested the automatic updates. If you are running the GUI over a slow link, or have a slower machine, it is recommended to increase the report timer to 5000ms (5 seconds) or higher.

**Test Manager**

The Test Manager specifies who 'owns' this CX, and can be used to segregate a large LANforge system for use by many engineers. For most users, however, assigning all CXs to the default_tm Test Manager is fine.

**Quiesce**

When the user clicks 'Quiesce' to stop a test, instead of just 'Stop', LANforge will gracefully stop the transmitting Endpoint and wait the selected number of seconds before stopping the receiving Endpoint so that test data flowing through the device-under-test will be completely received by LANforge. This can give more exact results when doing detailed investigation of packets and bytes sent and received, for instance.

## Layer-3 Cross Connect Endpoints

The left and right form columns of each info panel are used to define endpoints A and B. They are labeled TX Endpoint and RX Endpoint and are respectively colored green and purple. Endpoints are generally symmetric for UDP and Ethernet. For TCP/IP, the TX endpoint acts as a client, and the RX endpoint acts as a server (it waits for connections). Selecting different options may enable/disable certain fields.

**Resource**

The machine on which this endpoint should reside.

**Port**

The physical or virtual interface with which this endpoint should be associated.

**Min Tx Rate**

The minimum transmit rate that LANforge will attempt to send, in bits per second. This value is not applicable for the packet-capture replay function as the packets are replayed at the exact rates they were captured.

**Max Tx Rate**

The maximum transmit rate that LANforge will attempt to send, in bits per second. If this is greater than the min-tx-rate, then LANforge will vary the speed between the min and max creating a random stairstep pattern of data transmission over time that randomly returns to the min-tx-rate. That is, the traffic distribution is a random rate and random duration burst with random intervals between bursts. The bursts are bounded by the Min and Max TX Rate. Traffic will initially be sent at the Tx Min rate. This value is not applicable for the packet-capture replay function as the packets are replayed at the exact rates they were captured.

**Min/Max PDU Size**

The write size, in bytes. The PDU size includes **only** the bytes for the selected protocol. For instance, if you select a 1472 byte packet for a UDP connection, the Ethernet frame will actually be 1514 bytes in length because of the addition of the 14 bytes of Ethernet header, the 20 bytes of IP header, and the 8 bytes of the UDP header. When configuring an Ethernet connection, you would select a length of 1514 to create a packet of 1514 bytes since there is no underlying data protocol.

For UDP and TCP protocols, the packets on the wire will never exceed the port's MTU + Ethernet-Header-Length (1514 on normal Ethenet ports). If the maximum is larger than the minimum, then each packet will be a random size between min and max.

**NOTE:** When using IPv4 or IPv6 multicast, LANforge may have trouble receiving PDUs that span multiple frames. So, a maximum payload size of 1472 is suggested. Please contact support if you want more details on this restriction.

**IP ToS**

For IP based protocols, you can specify the ToS (aka QoS) bits in the IP header. This can be useful for testing QoS settings in the device under test. You can select one of the values from the drop-down menu or enter your own value. The following website might be helpful in decyphering ToS and DSCP values: http://www.speedguide.net/tcpoptimizer.php#advanced, http://www.tucny.com/Home/dscp-tos.

**NOTE:** When running LANforge in Windows, QoS must first be setup by following the instructions in the Microsoft Knowledge Base article 248611: http://support.microsoft.com/default.aspx?

scid=kb;EN-US;q248611

**Pkts to Send**

This specifies the number of packets to send before LANforge will automatically quiesce the test. Set this value to zero (Infinite) to have the test run until stopped by the user.

**Pld Pattern**

The payload pattern for the data generated by LANforge:

- Increasing: A pattern of bytes repeatedly incrementing from 0x00 to 0xFF.
- Decreasing: A pattern of bytes repeatedly decreasing from 0xFF to 0x00.
- Random: A pattern of random bytes from 0x00 to 0xFF. This pattern is generated for every packet sent and hence is CPU intensive.
- Random-Fixed: A pattern of random bytes from 0x00 to 0xFF is created for the first packet and then duplicated for subsequent packets.
- Zeros (0x00): A payload of only zeros.
- Ones (0xFF): A payload of all 0xFF.
- CUSTOM: A user-specified payload pattern.
- PRBS-4-0-3: A payload pattern from a 4-bit linear shift register.
- PRBS-7-0-6: A payload pattern from a 7-bit linear shift register.
- PRBS-11-8-10: A payload pattern from a 11-bit linear shift register.
- PRBS-15-0-14: A payload pattern from a 15-bit linear shift register.

**Min/Max IP Port**

If left 'AUTO', the LANforge system will select the IP ports for both transmit and receive endpoints. The user can also specify a particular IP port, but should be aware of potential port conflicts with other LANforge tests and third-party services running on the Linux machine. Endpoints will send traffic with the source IP port as specified, and peer endpoints will send to that port.
To send traffic to a specific port without expecting a response from the target, the destination port can be specified by making the receive endpoint UnManaged and specifying the destination IP and IP Port.
If configured to make many connections with the TCP Duration option, set the IP Port to 0 (zero) or use a large range on the 'A' endpoint. Using 0 means that the OS can choose any local IP port that it wishes when making the connections. A previously used IP port will not be usable for a short timeout period (30+ seconds typically). These timers are configurable in most operating systems...contact support if you have questions.

**TTL**

This specifies the 'time-to-live' when configuring Multicast endpoints. It does not apply to other prototocols at this time.

**Min/Max Duration**

This specifies how long the connection will run before it is torn down and reestablished. For instance, this option can be used to test how many TCP connections per second a firewall can handle. If you want a single long running connection, just use 'Forever'. Otherwise, select the number of milliseconds the connection should run before it is reestablished. **NOTE:** You should set the IP Port to 0 (zero) or use a large port range on the endpoint A (this is the endpoint that originates the connection) when setting TCP Duration to values other than 'Forever'.

**Min/Max Reconn**

This determines how long to wait before initiating a new connection. This only takes affect when using Min/Max duration.

**Multi-Conn**

LANforge now supports running Endpoints in separate processes to make optmimal use of multi-core CPU systems. In addition, it is now possible to create multiple TCP connections for TCPv4 and TCPv6 Cross-Connect types. The first option of simply running the Endpoint in a separate process involves setting Multi-Conn to 1. This works for UDP and TCP Layer-3 Cross-Connects.
To enable multiple concurrent connections in a single TCP cross-connect, use '1' for the 'B' endpoint (since it acts as the server-side socket) and then set the connection count in the A endpoint. For instance, if you wanted 5000 TCP connections to test your firewall, set Multi-Conn to 5000 on the A endpoint, and 1 on the B endpoint.
The settings for the endpoint (rate, packet size, etc) will be the same for each of the multi-connections. So, if you have Multi-Conn of 5000 and a min/max speed of 100kbps, LANforge will attempt to generate 500Mbps of traffic. The statistic totals for all multi-connections will be reported in the single Cross-Connect.
Running multiple thousands of multi-connections is much more efficient than running thousands of regular Layer-3 connections in LANforge, but it still uses up resources. It is suggested that you

ramp up your load slowly at first to make sure your system has enough RAM and CPU power to handle the load.

**NOTE: Some advanced features, such as using IP address ranges, cause the endpoints to be started and stopped. When this happens to multi-conn endpoints, the counters for the previous run will be cleared each re-start. This limitation may be fixed in future releases if it becomes a problem.**

**IP Addr**

When using secondary IP addresses, you may choose the primary or any of the secondaries for each endpoint. You may also choose to use a random IP address or do a linear walk of all addresses on the configured interface (Port).

When using random or linear IP addresses, the connection logic should be configured to only run for a limited duration (see Min Duration). Internally, this will cause LANforge to stop and restart the connection when the duration is completed, choosing a new IP address and/or IP port as needed.

For un-managed endpoints, it specifies the destination IP address for the peer interface.

**Replay File**

Select this to replay a previously captured packet stream specified in the 'Filename' field for Custom-Ethernet connections. For other connection types, the file contents will be used as payload for the selected protocol.

**Loop**

When this and 'Replay File' is selected, the file will be replayed continuously until the user stops the test. When Loop is NOT selected, the test will stop after the file has been played once.

**Filename**

This field is only available when the **Replay File** checkbox selected. For the Custom-Ethernet protocol, this selects the filename for replaying a previously captured stream of packets. The file capture protocol must be pcap or the proprietary format saved by LANforge-ICE.

For other protocol types, the file data will be used as the protocol payload. This would be somewhat similar to a file-transfer protocol such as FTP or HTTP.

**Dest MAC**

The destination MAC address to be used when replaying a packet capture. This is useful for replaying captured files against a different router than was originally sniffed. The MAC should address should be that of the router's interface connected to LANforge.

**Send & Receive Buffer Size**

Configure socket buffer send and receive buffer sizes. For TCP connections, this correlates to sending and receiving window sizes. Using the OS Default is suggested for most users, but setting it larger can increase throughput in some higher-latency situations.

**Send Bad FCS**

For layer-2 Ethernet protocols one can also specify the number of frames to be generated with purposefully bad Ethernet CRCs. This 'bad CRC' feature is only supported by certain Ethernet adapters and drivers. Please contact Candela if you wish to use this feature.

**Src MAC**

This is used to configure the MAC address of un-managed layer-2 Ethernet endpoints. The peer (managed) interface will then send packets to this MAC.

**Use-Proxy**

Selecting the Use-Proxy option allows you to direct packets to an intermediate system instead of directly to the peer endpoint. May be useful for testing certain firewall configurations.

**Proxy Addr**

This configures the proxy IP address. This may be used to re-direct LANforge traffic through a third-party proxy system. It is expected that the proxy will properly forward the connection to the other LANforge endpoint. For TCP traffic, the proxy only makes sense on the A endpoint. The **Use-Proxy** checkbox must be selected to enable these settings.

**Proxy Port**

This configures the proxy IP port. This should be used in conjunction with the **Proxy Addr** described above.

**Socket Priority**

You can use the 'Socket Priority' field to set a particular priority for the generated packets. When used in conjunction with the priority -> .1q priority mapping supported in the 802.1Q VLAN stack on Linux, you can have packets created with particular 802.1Q priorities. You can also use other Linux tools external to LANforge to modify behavior of the packets based on the priority. Socket Priority may influence ToS if the operating system is configured to do so, but it will not do so by

default.

**Connection Timeout**

This determines how long LANforge will wait for a TCP connection to establish. This is independent of any TCP level settings, which are controlled by the operating system.

**TCP MSS**

By default, the OS will determine the TCP MSS based on the MTU for the network path between the two endpoints. The user may over-ride this value by setting it to a fixed size smaller than the MTU. This ensures that packets on the wire are no larger than the configured MSS plus protocol headers. Modern NICs can offload the TCP Segmentation allowing very rates with small TCP packets. This is a good way to do high packet-per-second testing with TCP protocol packets.

**Checksum**

This option will cause LANforge to perform a 32-bit CRC calculation for the payload. This gives a very high degree of packet corruption detection at each layer, but due to the extra work the CPU has to do, the maximum traffic rates may be smaller. Note that TCP/IP, and the Ethernet protocol itself already has CRC checks, so you may not need to enable LANforge checksumming to perform your testing successfully.
Received bit-errors will be calculated in the LANforge payload portion starting 28 bytes into the UDP or TCP payload. In addition, the bit-errors are only checked when LANforge CRC is enabled and detected to be invalid. If the 28-byte header is corrupted, LANforge will not detect it, and may also give false positives for other packet errors. Bit-Errors are only calculated for certain payload patterns: Increasing, Decreasing, Zeros, Ones, and the PRBS patterns.
Bit-error results will be displayed on the **L3 Endps** tab under the RX BER column for each endpoint.

**UnManaged**

This designates an endpoint as not controlled by LANforge. This can be used to fling UDP packets at some third-party application, for instance. It would be less useful for testing TCP in most cases.

**Duration Quiesce**

This will cause the connection to Quiesce (pause transmit and stop), after the first connection duration has completed. This allows the user to configure the connection to run for a fixed amount of time.

**Quiesce-After-Range**

This option will cause the connection to stop after it has completed a linear IP-Port range and/or a linear IP address range.

**TCP_NODELAY**

Selecting the 'TCP_NODELAY' checkbox will decrease latencies in many cases and aid generation of small TCP frames by disabling the connection's Nagle algorithm. Selecting 'TCP_NODELAY' will normally decrease performance at higher speeds.

**Concurrent IP Addrs**

When using multiple-connections, and when the associated Port has secondary IP addresses enabled, this option causes the multiple-connections to use multiple IP addresses concurrently. With this disabled, only one IP will be used at a time.

**Clear-Port-On-Start**

This option will cause the ports in use by the connection to have their counters cleared upon start of the Endpoint. This is most useful when only a single Endpoint is using a port at a time.

**Linear-IP-Ports**

This option will cause an IP Port range to be used in a linear manner. For instance, if you use min-ip-port of 5000 and max of 5005, the connections will be made from port 5000, 5001, .. 5005. If you do not select this option, and have an IP port range, a random port between min and max will be used for each connection attempt.

**Endp Name**

Endpoint names must be no more than 47 alpha-numeric characters and contain no spaces. LANforge automatically fills this in based on the CX name, so normally there is no need to change this field.

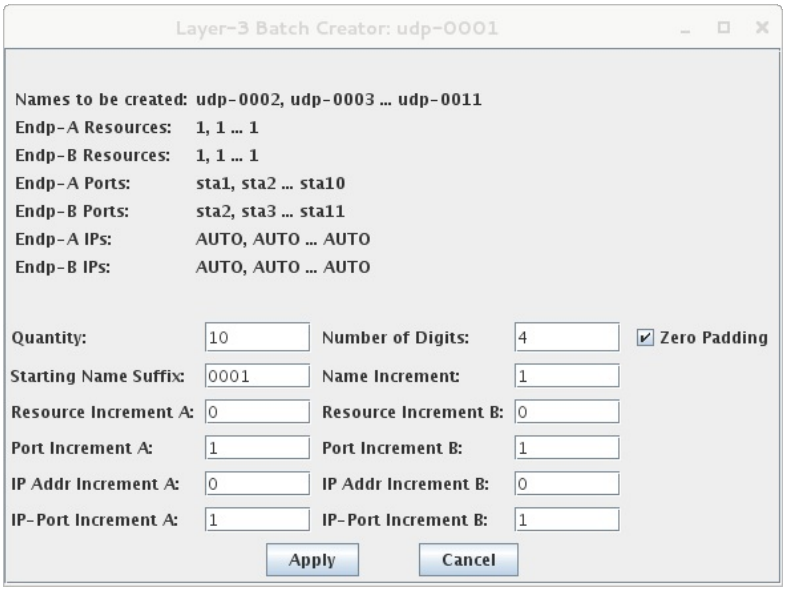
**Rcv Mcast**

This designates the endpoint as a multicast receiver as opposed to a sender.

## 8. Batch-Create Cross-Connects

A series of tests can be created based on the CX Name and other current settings in the

Create/Modify Cross-Connect window by using the Batch-Create function. For best results, create a valid connection for the first in the series to be batch-created, select the connection and click **Modify**. Clicking the **Batch-Create** button at the bottom of the window will pop up the Layer-3 Batch Creator:




After the desired settings have been entered, click **Apply** or **OK** to create the series (batch) of Layer-3 Cross-Connects.

**Quantity**

The number of Layer-3 connections to batch-create, using the selected Cross-Connect for the initial values.

**Number of Digits**

The number of characters (padding) to be used in appending each connection name. Adds leading zeros (zero-pads) to connection names as required (this may help with sorting connections). For best results, this number should match the format of the selected connection (Ex: 3 for an initial connection named LFtcp-001).

**Zero Padding Checkbox**

Uncheck the 'Zero Padding' checkbox if you do not desire leading zeros for the connection names when they are created.

**Starting Name Suffix**

The first number in the series (Ex: 001 for LFtcp-001) from which subsequent connections will be incremented. If the original connection name ends in a number or series of numbers, it will be displayed here.

**Name Increment**

Connection Names in the batch will be incremented by this amount. If set to 2, the next connections following cx-001 would be cx-003, cx-005, etc.

**Port Increment A/B**

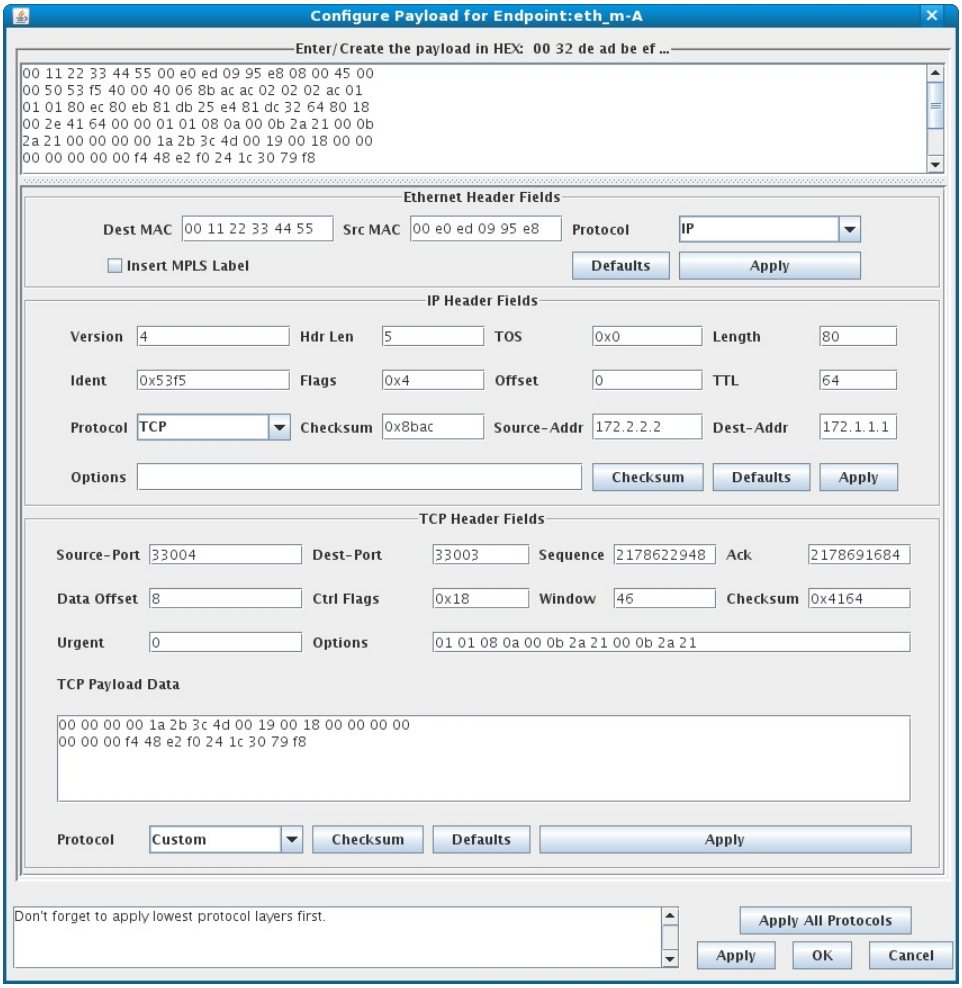
Ports used for each connection will be incremented by this amount. If set to 2, then eth2 would be incremented to eth4, eth6, etc.

**IP-Port Increment**

IP-Ports used for each connection will be incremented by this amount if the IP-Port field is not set to AUTO. If set to 2, then IP-Port 1234 would be incremented to 1236, 1238, etc.

## Custom Payloads

The **Payload** button allows for the configuration of custom payloads if a custom CX Type has been selected. A payload from a previous packet capture can be copied/pasted or one can be created by entering data into the various fields. For a Custom Ethernet Endpoint, clicking the **Defaults** button followed by **Apply** in each panel of the Configure Payload window will create a payload that looks something like this:




As you fill in the lower protocol layers (for instance, the Ethernet header), other protocol builders will be added to the GUI display as selected. For example, if you choose the IP protocol in the Ethernet header, the IP builder will appear. It will parse the top ascii-HEX window if possible and initialize its fields appropriately. From the IP protocol builder, you can choose TCP as the next layer, and the TCP builder will appear. Clicking the **Apply** button in each panel transfers the hex to the appropriate portion of the payload. The **Apply All Protocols** button at the bottom of the window can be used instead of the individual **Apply** buttons if desired. When finished, click **Apply** or **OK** to save the protocol to the selected endpoint.

## Protocol Builders

LANforge supports several protocol builders. If a builder is not available for a protocol you wish to transmit, you can always paste a captured packet, or hand build one in HEX and transfer it to the text editor at the top of the Payload panel.

You can also initialize most protocols to defaults, and the resulting values will correspond to live packets gathered from our network. The ethernet protocol is slightly different, see the notes below. Make sure you initialize from the lower layers up to the higher layers.

**Ethernet Header**

You can specify the Source, Destination and Protocol fields in the Ethernet Header. If you tell this protocol to initialize to defaults, it will grab the MAC addresses from the two ports it is connected to. This may or may not be what you want, so be ready to re-enter the fields accordingly. Selecting the 'Insert MPLS Label' checkbox adds another panel to the window to configure the payload for MPLS (Multiprotocol Label Switching).

**MPLS Header(s)**

You can specify one or more MPLS labels in this panel. Multiple MPLS labels can be added creating a "label stack" by selecting the 'Insert MPLS Label' checkbox in each new panel. For details, look up RFC 3031.

**IP Header**

You can specify the various IP header fields. For details, look up the venerable RFC 791. If you change a field, you will probably want to re-checksum both the IP header and higher protocols too (in that order).

**TCP Header**

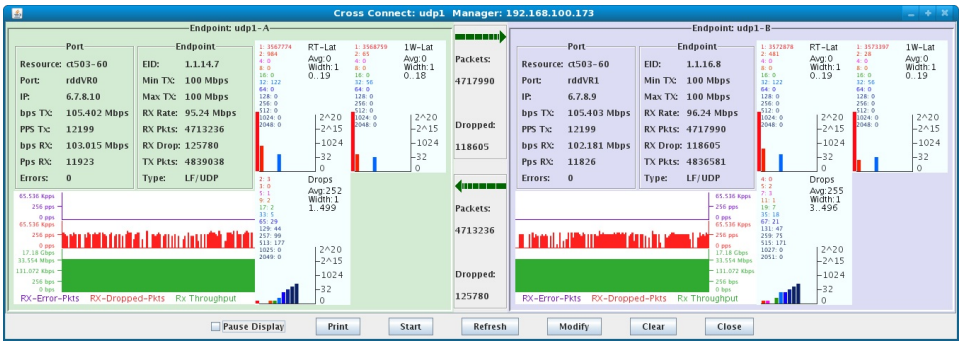
You can specify the various TCP header fields. For details, look up the venerable RFC 793. If you change a field, you will probably want to re-checksum the header with the checksum button.

Protocol builders for **802.1Q VLAN**, **ARP**, **IP-IP**, **IPX**, **LLC/SNAP**, and **MPLS** labels have recently been added. Please let us know if there is a particular builder you would like to see implemented and more can be added in a future release.

### Cross Connect Display

Individual Cross-Connects can be selected for display from the **Layer-3** tab. Select a Cross-Connect and click the **Display** button to bring up a summary window for that cross-connect.

The Cross Connect display is divided into three panels. The left and right panels describe information for endpoints A and B, respectively. The center panel describes the number of confirmed packets flowing and dropped from left-to-right and right-to-left, as indicated by the arrows.




The busy graphs on the right of each panel display the packet latency distributions for each endpoint. LANforge detects latency with a timestamp in each (non-custom) LANforge protocol packet. The precision is to 1 millisecond. If the two endpoints are using NTP protocol to keep themselves in sync, then they are usually within 0-3 milliseconds apart. Because of this, latencies may be negative at times. This just shows the difference in the clocks, and by looking at both sides of the connection, you can deduce the true round-trip latencies. For the best latency measurements, have both the sending and receiving port on the same machine. For even higher precision, consider an Armageddon endpoint, which has microsecond latency reporting.

LANforge only counts the latencies when it receives the packet. This is not exactly the time that the packet was received by the LANforge hardware because the packet must flow through the protocol stacks up to the LANforge server. This is the primary cause of the range of latencies you will see reported even on a simple and fast LAN. The average is usually very close though: It is a running average of the last 100 packets received.

Two latency graphs are displayed for each endpoint. The upper graph reflects latencies counted in the last 30 seconds, and the lower graph for the last 5 minutes. The upper right portion of each display widget lists the average latency (in milliseconds), width, and min/max latency within the respective time period. The color-coded numbers on the upper left of each widget are counters for each latency 'bucket' and are represented by the vertical bar graph below it.

The units for the size of the buckets are milliseconds, and are logarithmic (2^X) in scale. The exponential values (1, 2, 4, 8, etc.) will be multiplied by the bucket 'width' (currently always 1), and added to the minimum latency. For instance, if the minimum latencies for the top and bottom are 30 and 10 milliseconds, respectively, then the range of the first several buckets for each will be:

```
31:
32:
34:
38:
46:
...
```

and

```
11:
12:
14:
18:
26:
...
```

Assuming the minimum is 30, if the bucket "1" has 2000 beside it, then that means that 2000 packets have been received in the last time-period that had less than 31 milliseconds of latency. If the bucket "2" has 30 beside it, then that means 30 packets had latency between 31 and 32 milliseconds.

The minimum latency can change over time, which will cause the buckets to shift their values. Although this may be confusing at first, it allows LANforge to report high-precision data regardless of

the latency of the system under test.

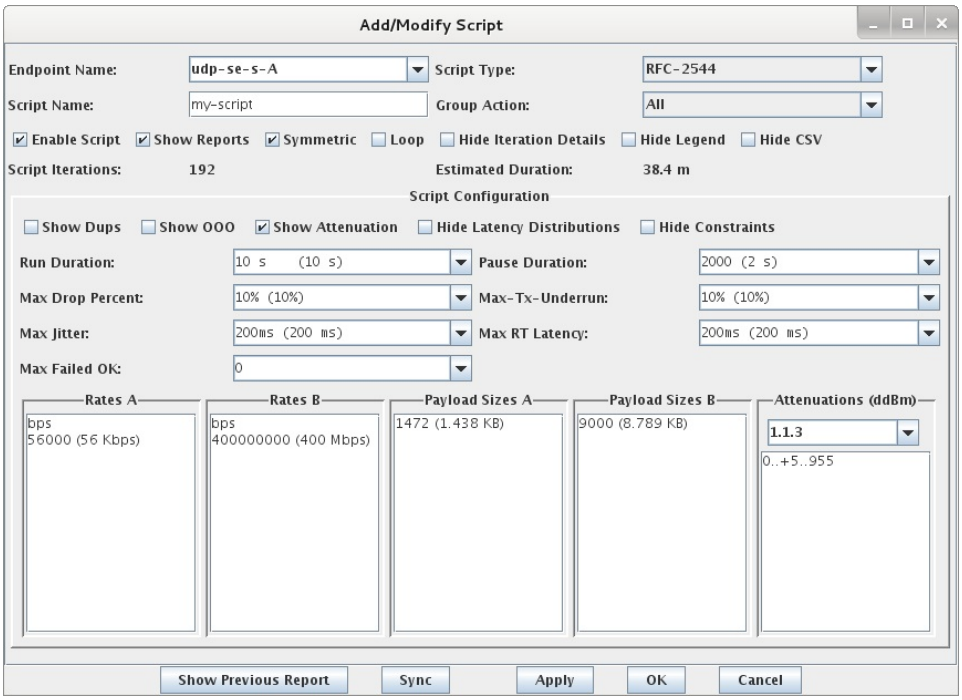
When viewing the Spreadsheet output, the lat_0, lat_1, etc columns show the number of packets received in the last 30 seconds that fall into the buckets.

### Scripted Cross Connect

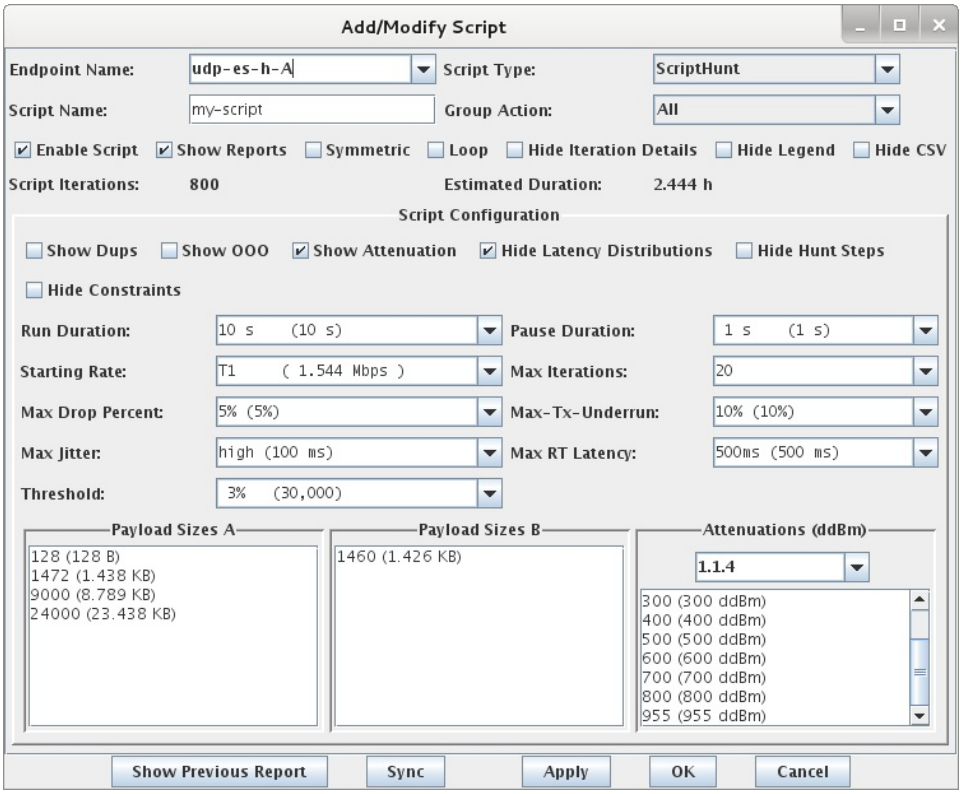
As of release 5.1.2 and later, a Layer-3 Cross Connect can be scripted via the LANforge GUI so that the user can setup a single connection to run at different rates and payload sizes for various durations. Release 5.2.7 includes improvements that allows iterating through Attenuations too (provided the user has a LANforge Attenuator) and running scripts on Connection Groups.

The Add/Modify Script window is divided into two panels. The top panel identifies the endpoint and defines the script type and scripting options. The bottom panel describes the script configuration.

The 2544 script allows implementing part of the RFC 2544 script and is generally used to test throughput performance at various packet sizes, and tx rates. For WiFi testing, Attenuation steps may also be added. The user may specify constraints that mark each iteration as pass/fail based on how it performs against the constraints.




The Hunt script automatically finds the highest speed that meets the constraints specified by the user. It can iterate through various packet sizes.




**Endpoint Name**

The Endpoint that the script will control.

**Script Type**

There are three Script Types. The default values that appear for Script2544, HuntScript and ScriptWL can be modified to suit your testing needs.

- **NONE** - Deletes any existing script on the endpoint.
- **Script2544** - Defines a default set of rates, payload sizes and Attenuations for a Layer-3 or Armageddon endpoint.
  You may use the default rates and payload sizes which are described in RFC-2544, a methodology for benchmark testing, or you can modify the default rates and payload sizes by typing in the values you want to use in the script configuration text boxes.
- **ScriptWL** - Defines a default set of rates, latencies, jitter and drops for a scripted WanLink.

**Script Name**

The name of the script. At this time only one script can be associated with each endpoint and the name is basically ignored.

**Group Action**

LANforge 5.2.7 introduces the use of Connection Groups. This is a collection of cross-connects and other tests that can be controlled by a single Connection Group entity. For scripting, this allows some unique opportunities. If Group action is **All** then the script on a Connection Group will apply to all connection group entities at the same time. If the group action is **Sequential** then only one CX in that Connection Group will be started at a time, and the script will only affect that one CX at a time.

**Generic Script Options**

These checkboxes allow you to control various script options.

- **Enable Script:** Whether or not to enable the use of the script. A script configuration can be defined for an endpoint and then disabled so that the script configuration is preserved for future use when the script is enabled again.
- **Show Reports:** During the running of a script, this option will allow per-iteration and summary results to be generated and displayed in a pop-up text display window.
- **Symmetric:** Symmetric allows the script configuration to apply to both endpoints associated with a connection. This would be used for a bi-directional test. With this option, the script per-iteration and summary results will include both endpoints in a single report. **NOTE: With 5.2.7, the scripts support 'B' side settings as well, so the values configured on each endpoint by the Symmetric script may not be identical.**
- **Loop:** Run the script to completion over and over until stopped by the user. When this

is not selected, the test will stop after one full run of the script.

- **Hide Iteration Details:** Hides only the per-iteration results in the script report. Summary results will still be displayed.
- **Hide Legend:** Hides only the report legend that describes the column headings in the script report.
- **Hide CSV:** Hides only the comma seperated value data in the script report.

**Script Iterations**

Displays a running tally of the number of iterations your current script configuration contains. For Hunt Scripts, this is an upper bound since each hunt iteration may stop early if it detects it has properly met its precision constraints.

**Estimated Duration**

Displays an estimated total script running time that the current script configuration will take to complete. For Hunt Scripts, this is an upper bound since each hunt iteration may stop early if it detects it has properly met its precision constraints.

**Script Configuration**

The details of each iteration of the script. Not all of these settings apply to each script type.

**Hunt and 2544 Script Options**

These checkboxes allow you to control options for the 2544 and Hunt scripts.

- **Show Dups:** Whether or not to report Duplicate packet statistics in the script results.
- **Show OOO:** Whether or not to report Out-of-Order packet statistics in the script results.
- **Show Attenuation:** Whether or not to report RX-Signal and Attenuation statistics in the script results. This is only useful when Attenuation is being used (which requires LANforge Attenuator hardware.)
- **Hide Latency Distributions:** Whether or not Latency Distributions should be included in the script results.
- **Hide Hunt Steps:** Whether or not the individual Hunt-Step results should be included in the script results.
- **Hide Constraints:** Whether or not the constraints messages should be included in the script results.

**Run Duration**

The length of time that each iteration should run. Values can be chosen from the list or typed in with one of the following suffixes:
ms - milliseconds, s - seconds, m - minutes, h - hours, d - days.

**Pause Duration**

The length of time between each iteration. Values can be chosen from the list or typed in with one of the following suffixes:
ms - milliseconds, s - seconds, m - minutes, h - hours, d - days.

**Starting Rate**

For Hunt scripts, the rate at which to start hunting. Choosing a value close to the expected results may slightly speed up the Hunt script, but using the default value should be fine as well.

**Max Iterations**

For Hunt scripts, this is the maximum number of hunt steps for each script iteration. If this is set too small, the script may not have enough steps to zero in on the maximum rate with the desired precision.

**Max Drop Percent**

This determines the maximum allowed drop percentage for the iteration to be considered a success.

**Max-Tx-Underrun**

This determines the maximum allowed difference between requested TX Rate and actual TX Rate for the iteration to be considered a success. For instance, when transmitting on Wireless interfaces, the maximum speed that the system can actually transmit will be limitted by the WiFi connection rate at that time.

**Max Jitter**

This determines the maximum allowed average jitter for the iteration to be considered a success.

**Max RT Latency**

This determines the maximum allowed average round-trip time for the iteration to be

considered a success.

**Max Failed OK**

For 2544 scripts: This determines the maximum number of iterations that can fail before the entire test is considered a failure.

**Rates**

A default set of rates is shown when the script type is selected, but you can also enter your own set of rates that each script iteration should step through. Rates can be entered using **bps** or **pps** units. Values should be seperated by a comma or newline.
With LANforge release 5.2.7, ranges can be entered as well. The syntax is: `start..oper..stop`
For example: `1M..+5M..100M` would start at 1Mbps and increase by 5Mbps for each iteration step until it reached 100Mbps. Valid operators are: +, -, x, *, /

**Payload Sizes**

A default set of payload sizes is shown when the script type is selected, but you can also enter your own set of payload sizes that each script iteration should step through. Payload sizes can be entered with one of the following suffixes:
B - Bytes, KB - Kilobytes, MB - Megabytes. Values should be separated by a comma or newline.
**Note:** For Layer-3 TCP and UDP, payload size is the size in bytes of just the payload. For Layer-3 Ethernet or Armageddon, payload size corresponds to the actual Ethernet frame size.
Ranges can be entered as well. The syntax is: `start..oper..stop` For example: `64..*2..9000` would start at 64 and double each iteration step until it reached 9000. Valid operators are: +, -, x, *, /

**Attenuations**

If you are using a LANforge Attenuator, you may have the 2544 and Hunt scripts iterate through attenuation settings. Attenuations may be entered as ddB (tenths of a dB). Values should be seperated by a comma or newline.
Ranges can be entered as well. The syntax is: `start..oper..stop` For example: `0..+5..955` would start at 0 and increase by 5 for each iteration step until it reached 955. Valid operators are: +, -, x, *, /

**Show Previous Report**

Show the results of the last script run. Using 'ctrl-T' after selecting the CX in the main LANforge-GUI window will also pop up the last results.

**Sync**

Update the script configuration fields with the current script settings already in use.

**Apply**

Attempt to apply changes to the script configuration to the current endpoint, but do not close the window.

**OK**

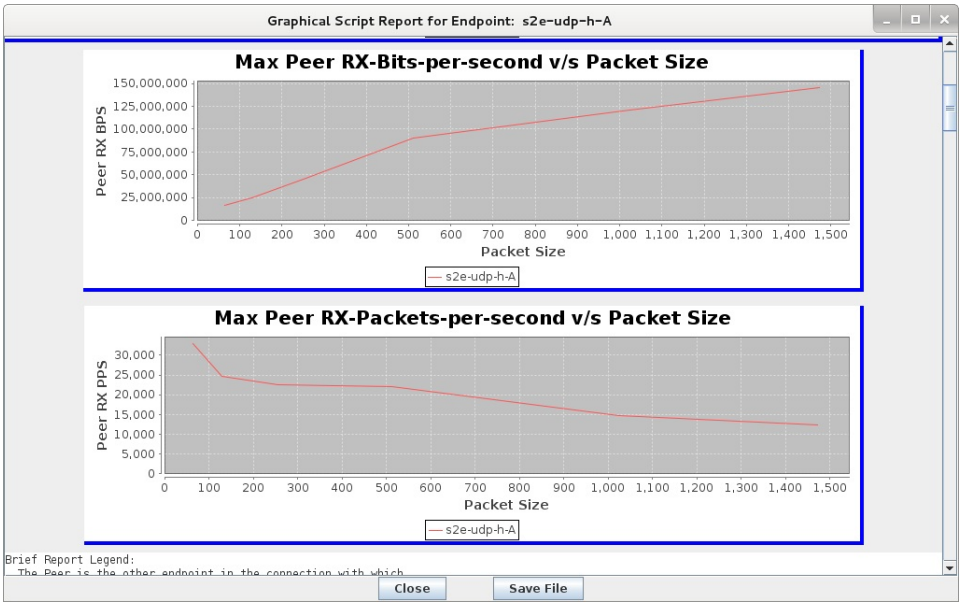
Attempt to apply changes to the script configuration to the current endpoint and close the window. If the apply fails, your changes will be lost.

**Cancel**

Make no changes and close the window.

The scripts create text output when they are running, and when finished, the GUI can create some 2D and 3D graphs for Hunt and 2544 scripts. The script results are plain text, so they can be saved for later viewing. As of LANforge 5.2.7, there is not a clean way to 'load' old results, but you can just delete any existing script results and paste in old ones from a text editor. Click the **Graphical Display** button on the Script Report window to see the graphs. The Grapical Display may be saved to an HTML report (after optional adjustment of the 2D and 3D graphs).

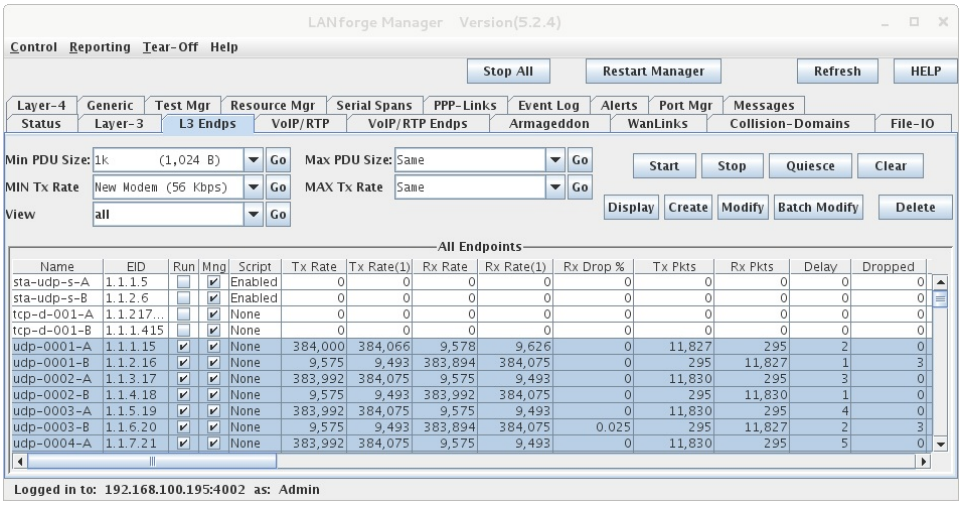
Example Hunt Script Graphical results:



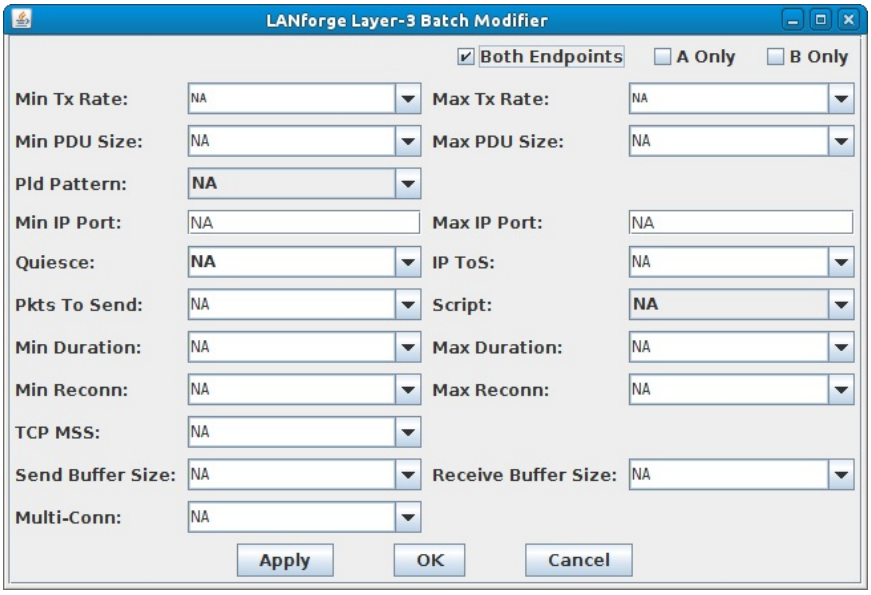



## 9. Layer-3 Endpoints (FIRE)

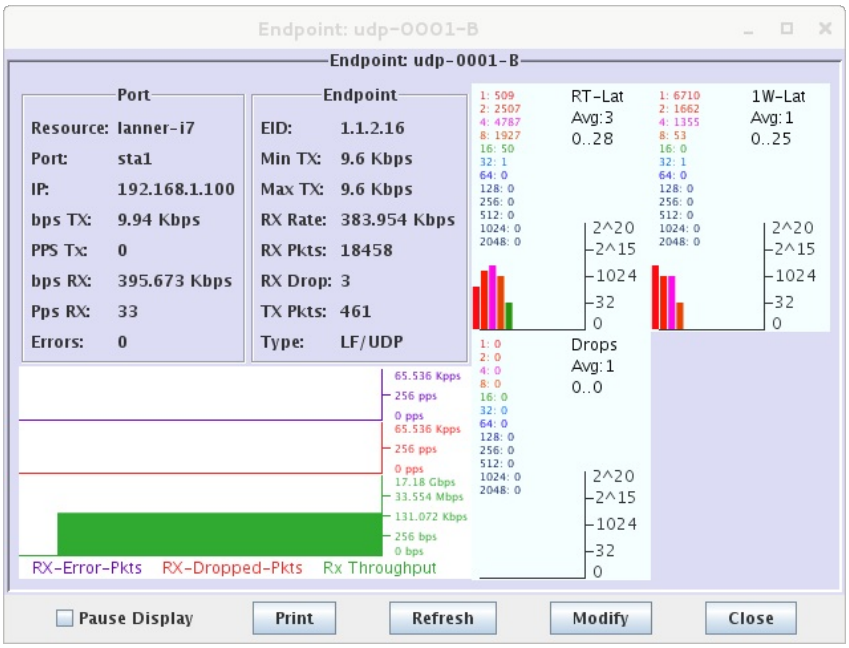
Although the **Layer-3** tab will be used to stop/start/modify your (non-IGMP) CXs, the fine details of each Cross-Connect are displayed on the **L3 Endps** tab. If you select a CX on the **Layer-3** tab by single-clicking on its row, the Endpoints associated with that CX will be selected when switching to the **L3 Endps** tab. The **L3 Endps** tab displays Endpoints 0-400 by default. Endpoint numbering is 0-based where 0 represents the first Endpoint name. To display all Endpoints or a specified range of Endpoints, select 'all' from the View field drop-down menu or enter range values ( `[min]-[max]` ) in the View field, then click the **Go** button to display the new range of Endpoints.




Bulk changes to Endpoint values can be performed easily via the **L3 Endps** tab. For example, if you want several of your Endpoints running at 56000bps then you can select them, and use the 'MIN Tx Rate' combo-box to set the desired value. Additional bulk changes can be made to selected Endpoints by clicking the **Batch Modify** button. Selected values from the drop-down menus will be applied to all selected Endpoints. Endpoint values marked 'NA' will remain unchanged. For more specific modifications, select the Endpoint in question and click the **Modify** button. Endpoints can also be modified through their respective Cross-Connect on the **Layer-3** tab.

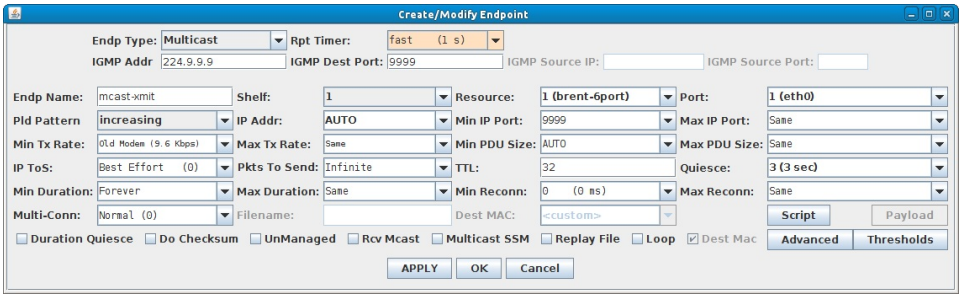



If you wish to see graphs for the received packets for a particular Endpoint, you can select one or more Endpoints and click on the **Display** button. The display of a sample Endpoint is shown here:




## Creating & Modifying Multicast Endpoints

LANforge supports the IGMP UDP Multicast protocol. Because there is a one-to-many relationship, these Endpoints are not handled by the standard cross-connect paradigm. Instead, you can create multiple Endpoints, specifying one generator and zero or more receivers for a particular IGMP address/port pair. To create an IGMP Endpoint, click the **Create** button on the **L3 Endps** tab. This will bring up the Create/Modify Endpoint window. To modify an existing IGMP Endpoint, select it and click the **Modify** button.




**Endp Type**

The Endpoint Type should be 'Multicast.' Custom Multicast is not supported at this time (please enquire if you are interested in this feature.)

**Report Timer**

The Report Timer is how often (in millisecond units) the Endpoint reports to the GUI. 1000-5000 (1-5 seconds) is suggested for most cases.

**IGMP Address**

The IGMP Address is the 'IP' address of the multicast group. Multicast IP addresses must be in the range between 224.0.0.0 and 239.255.255.255, inclusive. The IGMP Address and Port specifies a particular multicast group.

**IGMP Dest Port**

The IGMP Destination Port is the UDP port that this Endpoint will transmit to, assuming it is a transmitter. If it is a receive-only Endpoint, then this field can be left blank ("IP Port" specifies the receiving port.)

**IP Port**

The IP Port is the port that the Endpoint listens to if it is a receiver. If it is a transmitter, then this field can be left at the default setting.

**TTL**

The Time-to-Live field determines how far the IGMP packet may travel. '1' restricts travel to the local subnet only. Larger numbers allow it to travel across routers. Be careful not to flood other networks by accident!

**Rcv Mcast**

If the 'Rcv Mcast' checkbox is selected, this Endpoint will be a receiver. If not, then it will be an IGMP multicast generator. You should have one generator per unique multicast IP address and port, and zero or more receivers.

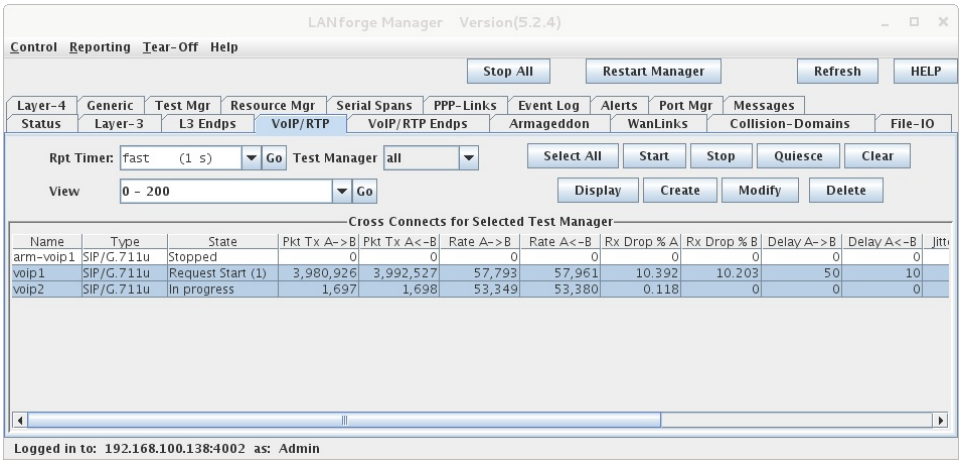
---



## 10. VoIP Call Generator (SIP, RTP, RTCP)

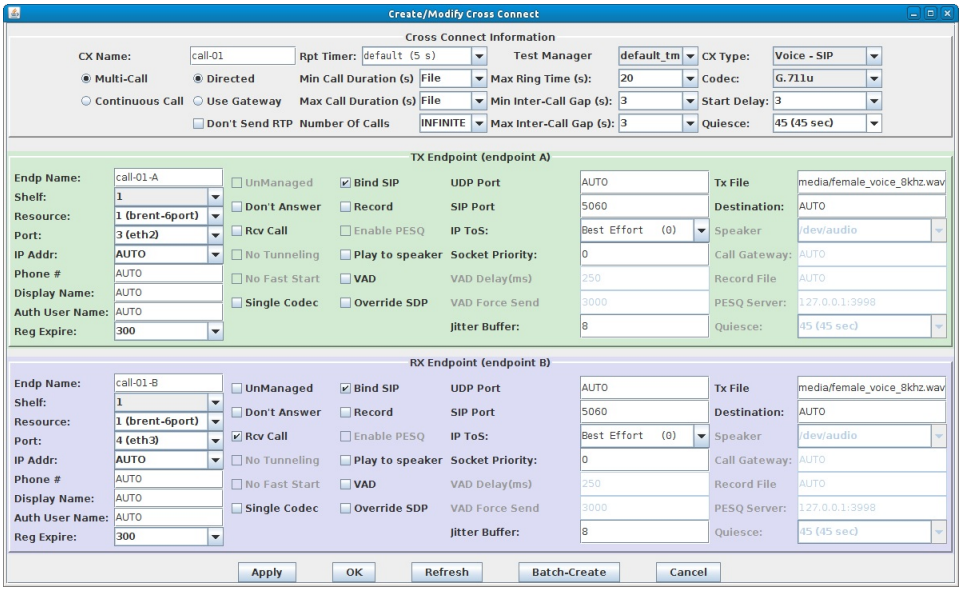
LANforge can create Voice over IP (VoIP) calls between LANforge interfaces. You may also setup third-party phones to call LANforge or be called by LANforge.

VoIP consists of several protocols. LANforge currently supports the SIP (Session Initiated Protocol) emssaging protocol. The voice payload is transmitted with the Real Time Protocol (RTP) which runs over UDP. The Real Time Control Protocol (RTCP) is used for latency and other accounting, and runs over UDP with the same priority as the RTP traffic. The **VoIP/RTP** tab displays connections 0-200 by default. Connection numbering is 0-based where 0 represents the first connection name. To display all connections or a specified range of connections, select 'all' from the View field drop-down menu or enter range values ( `[min]-[max]` ) in the View field, then click the **Go** button to display the new range of connections.




### Creating & Modifying VoIP Cross-Connects

When creating a VoIP Cross-Connect (CX), you specify the details of each Endpoint, including the Shelf, Resource, and Port that the Endpoint resides on. In this way, you determine upon which data-generating port (which is connected to some port on the system under test) the call's traffic will flow. In order to create a CX, click the **Create** button on the **VoIP/RTP** tab. This will bring up the Create/Modify VoIP Cross Connect window:




After the desired settings have been entered, click **Apply** or **OK** to create the Cross-Connect.

**NOTE**: A series of tests based off the current configuration can be created by clicking the **Batch-Create** button.

## Cross Connect Information

The top panel of the Create/Modify Cross Connect window contains information relating to the entire CX, including the name, CX Type, report timer, and the assigned test manager. The CX name must be unique in the LANforge system.

**Report Timer**

The report timer specifies how often the LANforge data generators send updates to the LANforge server, and how often the LANforge server pushes endpoint information up to the clients (GUIs) that have requested the automatic updates. If you are running the GUI over a slow link, or have a slower machine, it is recommended to increase the report timer to 5000ms (5 seconds) or higher.

**Test Manager**

The Test Manager specifies who 'owns' this CX, and can be used to segregate a large LANforge system for use by many engineers. For most users, however, assigning all CXs to the default_tm Test Manager is fine.

**CX Type**

The CX Type determines the protocol that the CX will use. LANforge currently only supports SIP. SIP makes a voice call using the SIP messaging protocol. If you are using 'Directed' mode, then the endpoints can call directly to each other without using a SIP proxy server. With the 'Use Gateway' option, a SIP server will be used to handle the call routing. LANforge has been tested with a wide variety of third-party SIP gateways, including Asterisk.

**Call Modes**

Two call modes are available: 'Continuous Call' makes a single call and plays the wave file in a loop until the call is stopped by the user. 'Multi-Call' mode allows you to select the number of times to loop the wave file, the number of calls to make, and the maximum time of the call. For PESQ, you should use the 'Multi-Call' option.

**Call Gateway Options**

Two Call Gateway options are available: 'Directed' means that the VoIP endpoints directly call themselves, without registering with or using a proxy or gateway. In this configuration most of the endpoint attributes can be 'AUTO' because LANforge can determine the settings automatically. In 'Use Gateway' mode the call endpoints will register with a gateway or proxy and make calls through it. To authenticate and register a VoIP endpoint with a call gateway/proxy use the following format to supply the password: **[<password>@]<Call Gateway/Proxy IP | FQDN>[:<port>]**

**Call Duration**

Min/Max Call Duration determine the length of the call. If 'File' is selected then the call will be as long as it takes to play the chosen wave file. If Min is not equal to Max, a random value between the min and max will be chosen for each call made. For PESQ, select 'File' for the call duration.

**Max Ring Time**

Determines how long the calling endpoint will wait for the called party to pick up before deciding the call was a 'No Answer'.

**Codec**

Determines the codec for the RTP voice payload. Currently G729, G711u, G726-16, G726-24, G726-32, G726-40 and Speex codecs are supported. By default, the phones will advertise all supported Codecs, with a preference on the one selected here. If you want to **only** advertise the single selected codec, then also enable the 'Single Codec' checkbox in the Endpoint configuration sections.

**Start Delay**

Specifies the amount of time (in seconds) to wait before initiating a call after a test has been started.

**Number of Calls**

Specifies the number of calls to make before the endpoint stops itself. Select 'INFINITE' if you want to run until the user stops the call manually.

**Inter-Call Gap**

Min/Max Inter-Call Gap specifies how long to wait between calls. If min is not equal to max, a random value will be chosen between min and max for each call.

**Don't Send RTP**

By default, LANforge will generate the RTP payload for each call. This requires significant processing resources, so if you only care about the SIP messaging, you can select this checkbox to disable sending of RTP.

## 11. VoIP Cross Connect Endpoints

Each Endpoint can be configured independently of the other. The default is to have the 'A' endpoint call the 'B' endpoint. The 'B' endpoint can be un-managed, which means LANforge assumes that it is a third-party endpoint, such as a Cisco or Grandstream SIP phone.

**Name, Shelf, Resource, Port**

The Endpoint name, shelf, resource, and port information determines the Port (interface) this endpoint will use.

**Phone Number**

The Phone Number is the SIP identifier for the endpoint. If you are using a Gateway, then this number must be configured in the Gateway so that the endpoint can register. For directed calls, this can be 'AUTO' and LANforge will choose some random value and make it work. For SIP, if you put in a number, the SIP To/From headers will be number@IP:port. If you want LANforge to use a domain for the To/From headers, then you can enter something like: 1234@domain.com for the phone number. If you are using non-standard SIP ports, then you must specify the SIP port too: 1234@domain.com:50600

**Display Name**

Allows configuration of the SIP Display Name attribute for caller ID. The default is AUTO which will display the phone number.

**Auth User Name**

Specify the user in this field if using an authenticating proxy and/or authenticating calls. The phone number will be used if 'AUTO' is selected.

**Reg Expire**

Allows you to set the registration expire timer.

**Flags & Options**

Several flags (checkboxes) are used to enable or disable certain features which affect the behavior of the selected endpoints.

- **UnManaged** tells LANforge that this particular Endpoint is not a LANforge endpoint. Use this when configuring LANforge to call third-party SIP phones, for example.
- **Don't Answer** will make LANforge decline to 'pick up' the phone when called.
- **Rcv Call** configures this endpoint to wait for calls to be made to it, but will not originate any calls.
- **Single Codec** tells LANforge to only use the codec specified in the top panel of this window. With this function disabled, the specified codec will be preferred, but any supported codec will be advertised and accepted.
- **Bind SIP** should be checked if the gateway is connected to the same (ethernet)

interface as the VoIP endpoint. This is usually required for Directed calls. If you are using the management network for the gateway, then deselect this checkbox.

- **Record** tells LANforge to record the received audio stream to the specified wav file. This must be selected if you want to enable PESQ reporting.
- **Enable PESQ** activates LANforge VoIP PESQ automated voice quality reporting. You must purchase a separate PESQ license for your LANforge system in order to enable this feature. To configure the VoIP endpoint for PESQ, select the 'Enable PESQ' checkbox. You must also configure the PESQ server. The PESQ server is the LANforge machine on which you install the PESQ license. PESQ can run along side other LANforge processes, so everything can be installed on a single machine if desired. For optimal results, select the 'Multi-Call' call mode and 'File' for the call duration. You also have to enable the 'Record' feature so that the received audio is saved to the local file system for processing by PESQ.
- **Play to speaker** tells the LANforge server to play received audio on its speaker, providing a sound system exists and is configured correctly. The default sound device for Linux is /dev/audio.
- **VAD** (Voice Activity Detection) is supported by SIP and will suppress RTP packets if silence is detected more than the specified 'VAD Delay' in milliseconds.
- **Override SDP** replaces the connection IP address in the SDP with the 'real' IP address of the SIP peer. This feature should normally be deselected, but it may help if the peer is running through a 'dumb' NAT.

**UDP Port**

UDP Port specifies the port that RTP traffic will use. RTCP will use one port higher than that, so if you choose to configure these manually, be sure to leave space. You can also use 'AUTO', in which case LANforge will allocate ports accordingly.

**SIP Port**

SIP Port specifies the UDP port for the SIP messaging protocol. The default SIP port is 5060, so if you are trying to configure an un-managed endpoint that corresponds to a third-party SIP phone, using 5060 is a good choice.

**IP ToS**

You can specify the ToS/DSCP (aka QoS) bits in the IP header. This value will be set on RTP and SIP packets. Please refer to the IP ToS section in this user guide.

**Socket Priority**

If you are running VoIP over 802.1Q VLAN interfaces on the LANforge system, setting the socket priority can allow you to map the priority to the 802.1Q priority. Use the external 'vconfig' Linux tool to configure the mappings between a particular socket priority and the .1Q priority.

**VAD Delay**

How much consecutive silence before VAD is enabled.

**VAD Force Send**

Force a send of an RTP packet at least every X milliseconds. Helps keep connections from being timed out with some phones.

**Jitter Buffer**

Jitter buffer is used to smooth out network jitter inherent in RTP traffic. Specify the buffer size (number of 20ms packets).

**Tx File**

The Tx File is the WAV file to play. LANforge comes with two sample wav files: A male and female reading some standard phrases meant to fully exercise the english language sounds. You may also create your own. Wave files must use single-channel 8-bit encoding. The Linux tool, SoX, can be used to convert various formats to the correct encoding. Assuming you have a sound/music file called muzak.ogg, the command syntax is:

```
$ sox muzak.ogg -U -c 1 -b -v 1.1 -r 8000 /tmp/muzak.wav resample -q1
```

```
# muzak.ogg == input file, can be almost any type of sound file.
# -U      == ulaw encoding
# -c 1    == one channel
# -b      == 1-byte encoding (8-bit)
# -v 1.1  == increase volume by 1.1/1.0 percent, optional
# -r 8000 == 8000 samples per second.
# /tmp/muzak.wav  == output file, has to be a .wav extension.
# resample -q1    == makes it sound better, evidently, I can't tell.
```

**Destination**

If the destination number/URL to be called is different from the peer endpoint's phone number, you may specify it in this field.

**Speaker**

If you have a properly configured sound card, you can play the received call to the speaker real-time. Only a single endpoint can play on a particular machine at the same time. Select the 'Play to Speaker' checkbox to enable this feature. This feature is only supported for SIP, and only on Linux. You can also save the received audio to a file and play it through normal audio programs on any operating system.

**Call Gateway**

For 'Use Gateway' calls, you will need to specify the SIP Proxy. The proxy or gateway should usually be located in the system/network under test. This is a potentially complex matter, so please contact Candela Technologies or your supplier if you have any questions. For authenticated SIP registration, append the password to the front of the IP address: [password@]IP[:port]

**Record File**

If you want a copy of the received wav file, or if you are using PESQ, enter the filename to which to save the received audio stream. This should be unique for all endpoints so that you do not corrupt other calls' files.

**PESQ Server**

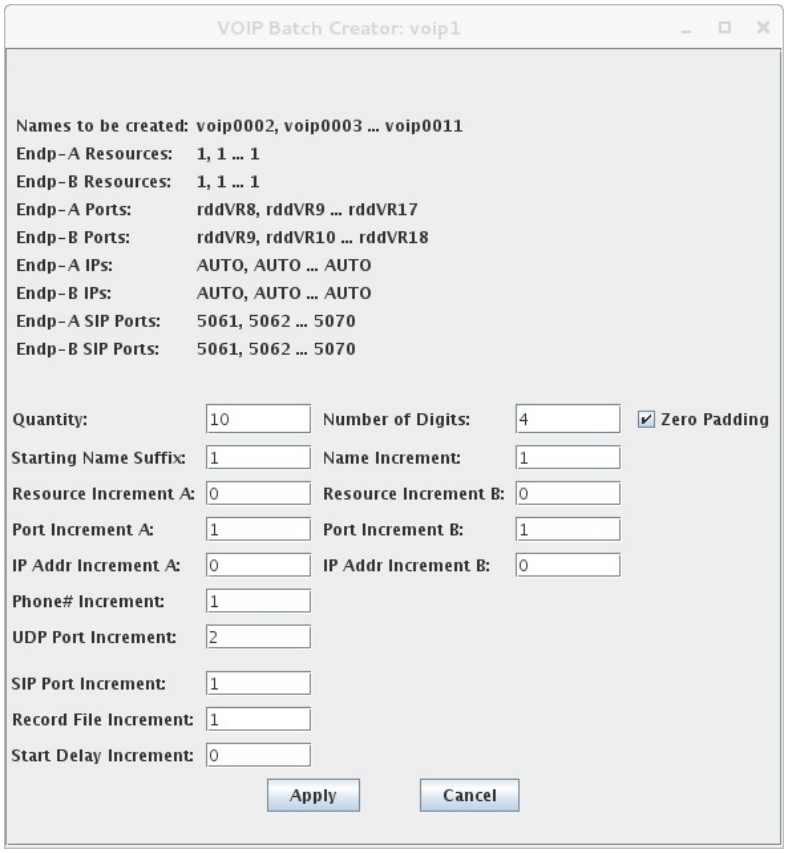
To enable PESQ automated reporting, you must have a PESQ license and/or access to a machine running a licensed PESQ server. Enter the IP address of that machine and the port (default port is 3998) in this field.
For multi-core PESQ machines, there can be up to 5 PESQ processes running (one per core). In this case, you can se the Port to be the number of processes to have LANforge randomize the port. For instance, on a 4-core machine, you could use: 172.0.0.1:4 to randomly use ports 3995-3998. This feature is available in release 5.2.9 and later.

**Quiesce**

Instead of stopping both VoIP Endpoints immediately, LANforge will gracefully stop the transmitting Endpoint and wait the selected number of seconds before stopping the receiving Endpoint so that all transactions may be completed.

## 12. Batch-Create Cross-Connects

A series of tests can be created based on the CX Name and other current settings in the Create/Modify Cross-Connect window by using the Batch-Create function. For best results, create a valid connection for the first in the series to be batch-created, select the connection and click **Modify**. Clicking the **Batch-Create** button at the bottom of the window will pop up the VoIP Batch Creator:




After the desired settings have been entered, click **Apply** or **OK** to create the series (batch) of VoIP Cross-Connects.

**Quantity**

The amount of VoIP connections to batch-create, using the selected Cross-Connect for the initial values.

**Number of Digits**

The number of characters (padding) to be used in appending each connection name. Adds leading zeros (zero-pads) to connection names as required (this may help with sorting connections). For best results, this number should match the format of the selected connection (Ex: 2 for an initial connection named call-01).

**Zero Padding Checkbox**

Uncheck the 'Zero Padding' checkbox if you do not desire leading zeros for the connection names when they are created.

**Starting Name Suffix**

The first number in the series (Ex: 01 for call-01) from which subsequent connections will be incremented. If the original connection name ends in a number or series of numbers, it will be displayed here.

**Name Increment**

Connection Names in the batch will be incremented by this amount. If set to 2, the next connections following cx-01 would be cx-03, cx-05, etc.

**Port Increment A/B**

Ports used for each connection will be incremented by this amount. If set to 2, then eth2 would be incremented to eth4, eth6, etc.

**Phone# Increment**

Phone numbers will be incremented by this amount if the Phone # field is not set to AUTO.

**UDP Port Increment**

UDP Ports will be incremented by this amount if the UDP Port field is not set to AUTO.

**SIP Port Increment**

SIP Ports will be incremented by this amount if the SIP Port field is not set to AUTO.

**Record File Increment**

The Record File will be incremented by this amount if the Record File field is not blank.

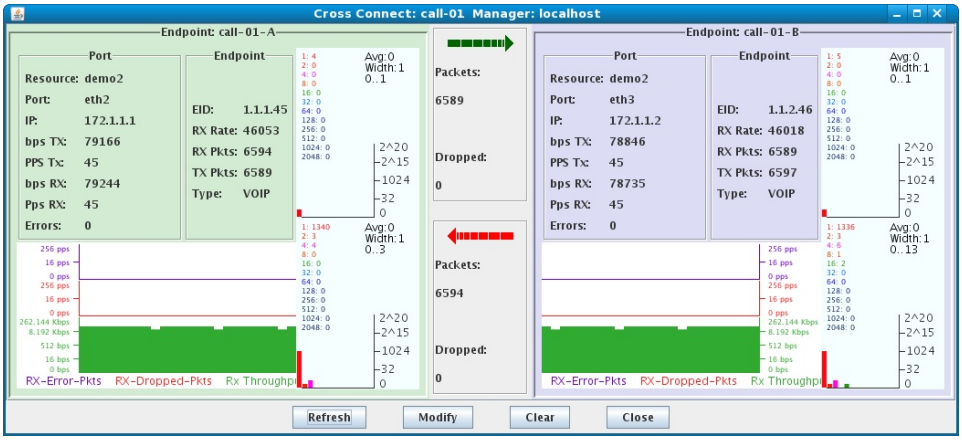
**Start Delay Increment**

Start Delay will be incremented by this amount.

### VoIP Call Display Panel

Individual VoIP cross-connects can be selected for display from the **VoIP/RTP** tab. Select a cross-connect and click the **Display** button to bring up a summary window for that cross-connect.

The VoIP Cross Connect display is divided into three panels. The left and right panels describe information for endpoints A and B, respectively. The center panel describes the number of confirmed packets flowing and dropped from left-to-right and right-to-left, as indicated by the arrows.




The busy graphs on the right of each panel display latency and jitter distributions for each endpoint over the last 30 seconds. LANforge detects latency with the RTCP protocol. Jitter is determined from the timestamp on the received RTP packets. Note that the jitter calculation is made before the packet is processed by the RTP Jitter buffer.

The upper graphs reflect RTCP latency, and the lower graphs reflect jitter derived from the RTP packets. The upper right portion of each display widget lists average values for latency and jitter, respectively. Min/max values are displayed below the average. The color-coded numbers on the upper left of each widget are counters for each latency and jitter 'bucket' and are represented by the vertical bar graph below it.

The units for the size of the buckets are milliseconds and are logarithmic (2^X) in scale. For instance, if the average latency is 101 milliseconds, then the buckets will be:

```
102:
103:
105:
109:
117:
...
```

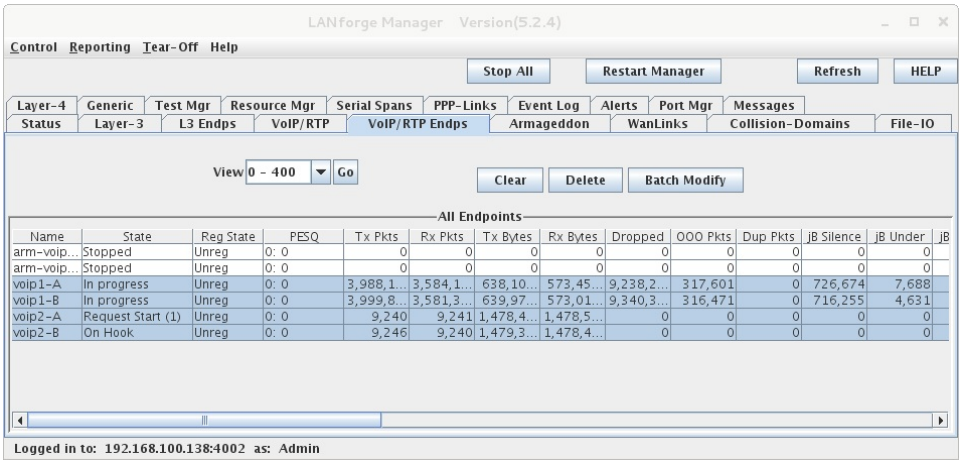
If the bucket "102" has 2000 beside it, then that means that 2000 packets have been received in the last time-period that have less than 102 milliseconds in latency. If the bucket "105" has 30 beside it, then that means 30 packets had latency between 103 and 105 milliseconds.

---

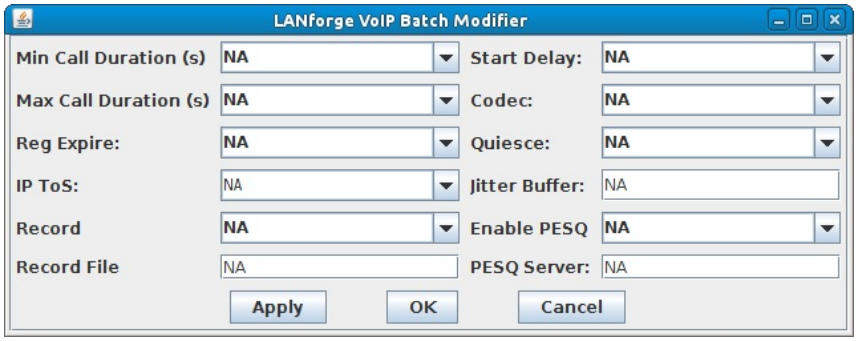


## 13. VoIP Endpoints

Although the **VoIP/RTP** tab will be used to stop/start/modify your VoIP/RTP Call CXs, the fine details of each Cross-Connect are displayed on the **VoIP/RTP Endps** tab. If you select a call on the **VoIP/RTP** tab by single-clicking on its row, the Endpoints associated with that CX will be selected when switching to the **VoIP/RTP Endps** tab. The **VoIP/RTP Endps** tab displays Endpoints 0-400 by default. Endpoint numbering is 0-based where 0 represents the first Endpoint name. To display all Endpoints or a specified range of Endpoints, select 'all' from the View field drop-down menu or enter range values (`[min]-[max]`) in the View field, then click the **Go** button to display the new range of Endpoints.




Bulk changes to VoIP Endpoints can be performed easily via the **VoIP/RTP Endps** tab by selecting one or more endpoints and clicking the **Batch Modify** button. Selected values from the drop-down menus will be applied to all selected endpoints. Endpoint values marked 'NA' will remain unchanged. Endpoints can also be modified through their respective Cross-Connect on the **VoIP/RTP** tab.



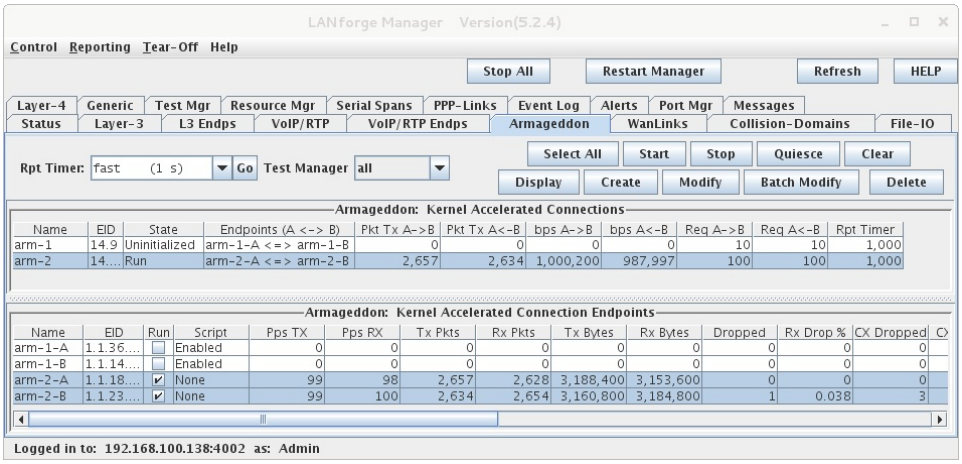



## 14. Armageddon (Accelerated UDP/TCP)

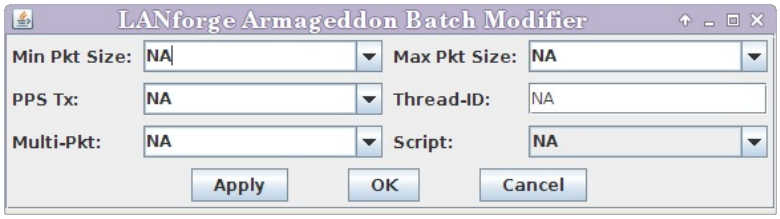
Armageddon Cross-Connects require special Linux kernel features. If you purchased your machine from Candela, then these features will already be included. Otherwise, you should make sure you have installed the kernel patches or a pre-compiled kernel from Candela.

The Armageddon traffic generator can generate UDP packets with various IP and UDP header fields. It also generates TCP packets, however this is NOT stateful TCP, so it acts a lot like UDP in that it will not back-off, and does not use any real TCP protocol features. More importantly, it can generate packets at line speed on 10/100/1000 Mbps and Multi-Gigabit Ethernet networks. Armageddon can also measure latency with 1 microsecond precision, and the sending and receiving ports can be on the same machine.

**NOTE:** If you are running Armageddon on a flat (non-routed) network, then LANforge can figure out all the defaults for you. However, if you are running in a routed network, you will need to manually enter the MAC address of your router in the Destination MAC field of the Armageddon section 2 configuration panel.

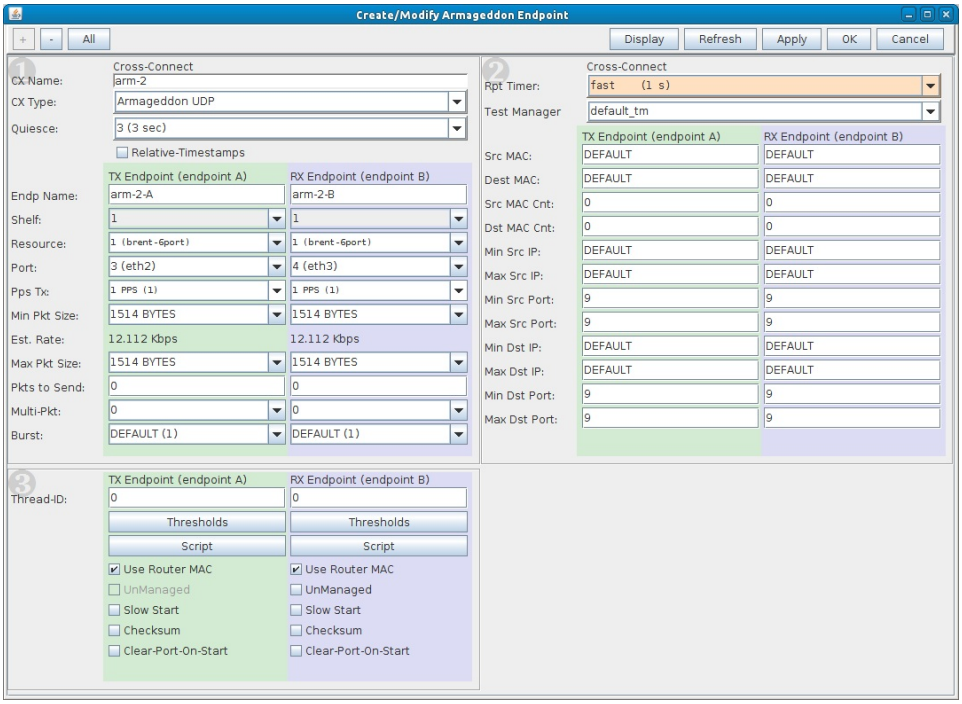



Bulk changes to Armageddon Endpoints can be performed easily by selecting one or more endpoints and clicking the **Batch Modify** button. Selected values from the drop-down menus will be applied to all selected endpoints. Endpoint values marked 'NA' will remain unchanged.




## Creating & Modifying Armageddon Cross-Connects

When creating an Armageddon CX, you specify the details of each Endpoint, including the Shelf, Resource, and Port that the Endpoint resides on. In this way, you determine which data-generating port (which is connected to some port on the system under test) the CX's traffic will flow over. In order to create an Armageddon CX, click the **Create** button on the **Armageddon** tab. This will bring up the Create/Modify Armageddon Endpoint window:




## Cross Connect Information

Sections of the Create/Modify Armageddon Endpoint window labeled Cross-Connect contain information relating to the entire CX, including the name, CX Type, Report Timer, Test Manager, Quiesce, and Relative-Timestamps. There are Cross-Connect settings in sections 1 and 2. The name must be unique in the LANforge system.

**CX Type**

The CX Type determines the protocol that the CX will use. The current supported types are:

- **Armageddon UDP** generates and receives UDP packets. Protocol header fields will default to sane values based on the ports you select, but you can specify or randomize most fields to customize the packets that you send. For generating traffic for a routed network, you may have to override the default destination MAC address with the one from your router. Currently, the payload will just be random bytes from un-initialized memory, except for a small header at the beginning of the UDP payload that LANforge uses to detect dropped and reordered packets.
- **Armageddon TCP** will frame up TCP frames and send them at very high rates. This is NOT stateful TCP, so it acts a lot like UDP in that it will not back-off, and does not use any real TCP protocol features

**Quiesce**

Instead of stopping both Armageddon endpoints immediately, LANforge will gracefully stop the transmitting Endpoint and wait the selected number of seconds before stopping the receiving Endpoint so all transactions may be completed.

**Relative-Timestamps**

Selecting the 'Relative-Timestamps' checkbox directs LANforge to use the CPU's 'TSC' cycle counter for the selected connection. This is more efficient on most platforms, but not all hardware has a stable TSC counter, so if you suspect latency timing issues, disable this option. Relative timestamps will never be used if the peer endpoint is on a different machine.

**Report Timer**

The report timer specifies how often the LANforge data generators send updates to the LANforge server, and how often the LANforge server pushes endpoint information up to the clients (GUIs) that have requested the automatic updates. If you are running the GUI over a slow link, or have a slower machine, it is recommended to increase the report timer to 5000ms (5 seconds) or higher.

**Test Manager**

The Test Manager specifies who 'owns' this CX, and can be used to segregate a large LANforge system for use by many engineers. For most users, however, assigning all CXs to the default_tm Test Manager is fine.

### Armageddon Cross Connect Endpoints

The left and right form columns of each info panel are used to define endpoints A and B. They are labeled TX Endpoint and RX Endpoint and are respectively colored green and purple. Selecting different options may enable/disable certain fields.

**Endp Name**

The unique name for this endpoint. LANforge generates a default value based on the CX Name.

**Shelf**

The virtual 'shelf' for this endpoint. The default of 1 is the only correct answer in most configurations.

**Resource**

The LANforge machine that this endpoint should be associated with. Choose from the drop-down values.

**Port**

The real or virtual network interface this endpoint should be associated with. Choose from the drop-down values.

**Pps Tx**

The desired packets-per-second to transmit. If the hardware/network cannot actually run at this speed, it will run as fast as it is able.

**Min Pkt Size**

The minimum packet size. This includes all ethernet headers, but does NOT include the 4 byte CRC at the end of the ethernet frame. The reported bits-per-second and bytes received WILL take the 4 byte CRC into account.

**Est. Rate**

The estimated transmit rate in bits-per-second based on configured settings.

**Max Pkt Size**

The maximum packet size. This includes all ethernet headers, but does NOT include the 4 byte CRC at the end of the ethernet frame. If this value is larger than the Min Pkt Size, each new packet will have a random size between min and max, in a random distribution.

**Pkts to Send**

This specifies the number of packets to send before LANforge will automatically quiesce the connection. Set this value to zero (Infinite) to have the test run until stopped by the user.

**Multi-Pkt**

This setting determines the number of times the exact same packet will be transmitted before a new one is created. Setting this value to greater than one can increase performance of the LANforge machine, but it will decrease the chance of detecting out-of-order packets. This is not usually a problem. When using Armageddon on virtual interfaces, such as MAC-VLANs and 802.1Q VLANs, this value must be 0 due to internal driver limitations. Other drivers *may* have this limitation as well.

**Burst**

Enables 'xmit_more' bursting at the driver layer. This can provide significant throughput improvement with some modern network adapters.

**Src MAC**

The source MAC address in the generated packets. If DEFAULT is entered in this field, LANforge will use the MAC address of the configured port for this endpoint.

**Dest MAC**

The destination MAC address in the generated packets. If DEFAULT is entered in this field, LANforge will use the MAC address of the peer endpoint's configured port.

**Src MAC Cnt**

If greater than 1, the source MAC address will be incremented through the specified range. This allows the test to create packets from what appears to be many different ethernet NICs and can be good for stress-testing ethernet switches and other types of equipment that attempt to detect and optimize for network flows.

**Dst MAC Cnt**

If greater than 1, the destination MAC address will be incremented through the specified range. This allows the test to create packets to what appears to be many different ethernet NICs and can be good for stress-testing ethernet switches and other types of equipment that attempt to detect and optimize for network flows.

**Min Src IP**

The source IP address for the generated packets. If DEFAULT is entered in this field, LANforge will use the IP address of the configured port for this endpoint.

**Max Src IP**

The source IP address for generated packets. If this value is larger than the Min Src IP, then the generated packets will cycle through the IP address range creating traffic from each IP address. If DEFAULT is entered in this field, LANforge will use the IP address of the configured port for this endpoint.

**Min Src Port**

The source IP port for the generated packets.

**Max Src Port**

The source IP port for generated packets. If this value is larger than the Min Src Port, then the generated packets will cycle through the IP port range creating traffic from all IP ports.

**Min Dst IP**

The destination IP address for the generated packets. If DEFAULT is entered in this field, LANforge will use the IP address of the peer endpoint's configured port.

**Max Dst IP**

The destination IP address for generated packets. If this value is larger than the Min Dst IP, then the generated packets will cycle through the IP address range creating traffic to each IP address. If DEFAULT is entered in this field, LANforge will use the IP address of the peer endpoint's configured port.

**Min Dst Port**

The destination IP port for the generated packets.

**Max Dst Port**

The destination IP port for generated packets. If this value is larger than the Min Src Port, then the generated packets will cycle through the IP port range creating traffic to all IP ports.

**Thread-ID**

The kernel thread on which this endpoint should be running. Both endpoints currently default to

thread '0'. If 'AUTO' is entered, the endpoint will use a native method to spread packet generation load across the available Armageddon threads. When the CPU is not the bottleneck (often on today's hardware), it is usually best to keep all endpoints on the same thread.

**Thresholds**

Set the min/max transfer and receive rates. If the connection throughput goes outside of the set range, an alert and/or event will be sent. This is useful for longer term throughput tests.

**Script**

Please see the Layer-3 script section. Scripts basically work the same for Armageddon as they do for Layer-3 CXs.

**Use Router MAC**

If specified, and if Destination MAC is 'DEFAULT', then LANforge will attempt to find and use the MAC of the default gateway for the interface (Port) associated with this endpoint for the destination MAC. This option should always be selected when using Armageddon to test a routed network.

**UnManaged**

This designates endpoint B as not controlled by LANforge. With this enabled, LANforge will not expect a response from the target. This setting can be used to fling UDP packets at some third-party application, for instance. It would be less useful for testing TCP in most cases.

**Slow Start**

Use slow-start logic. This ramps up the speed a bit slower when starting the endpoint and after a clear of its stats. With this disabled (the default value), the endpoint may over-shoot the desired bandwidth for a fraction of a second causing unexpected stress on the network under test.

**Checksum**

This option will cause LANforge to perform a 16-bit UDP checksum on send and receive. Note that TCP/IP already has CRC checks so the checksum option is unnecessary and disabled for Armageddon TCP connections.

**Clear-Port-On-Start**

This option will cause the ports in use by the connection to have their counters cleared upon start of the endpoint. This is most useful when only a single endpoint is using a port at a time.

---



15. # WanLinks (ICE)

WanLinks support the LANforge WAN/Network emulation feature set called LANforge-ICE. In the default WanLink configuration, two interfaces act like a transparent layer-2 ethernet bridge. The WAN emulation is applied as traffic flows through this bridge. Each WanLink is composed of two WanLink Endpoints that represent one of the sides of the WAN/Network emulation. WanLinks can apply various characteristics to traffic flowing through them including maximum-bandwidth, latency, jitter, jitter-frequency, dropped-packets, duplicated-packets, reordered-packets, bit & byte errors, and more!

## Overview of WanLink Configuration

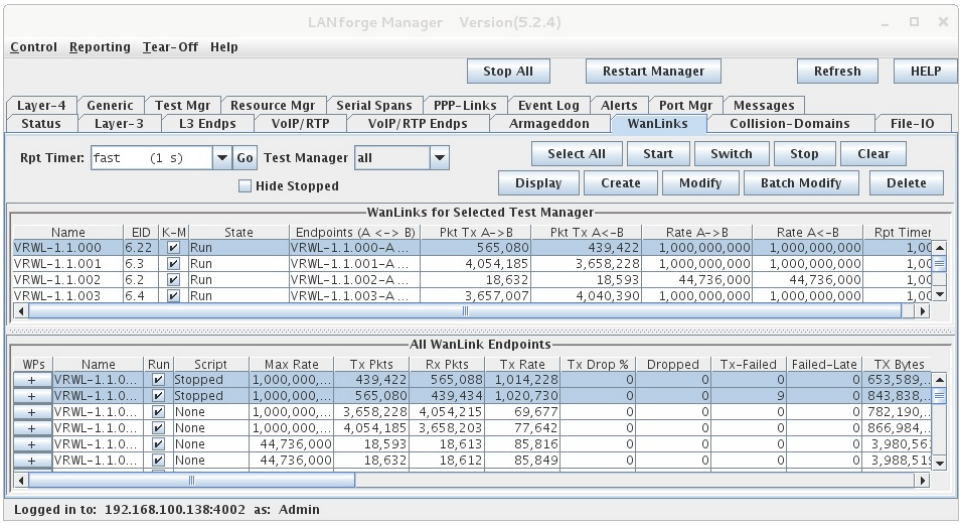
A WanLink emulates a bridged Ethernet network with characteristics determined by the user. Packets are received in one Ethernet (or virtual) interface and are transmitted out the other interface. This means that when you add the LANforge machine to an existing network configuration, no routing changes are needed. When designing your network, you can think of a pair of WanLink ports as an ethernet switch or even just a pass-through cable! WanLinks can bridge 802.1Q VLAN, Ethernet and Redirect interfaces.

LANforge-ICE supports multiple virtual routers per system when LANforge is running on Linux. On Windows, only bridge-mode is supported. Use the Netsmith tool described earlier in this guide to configure LANforge-ICE in the routed mode.

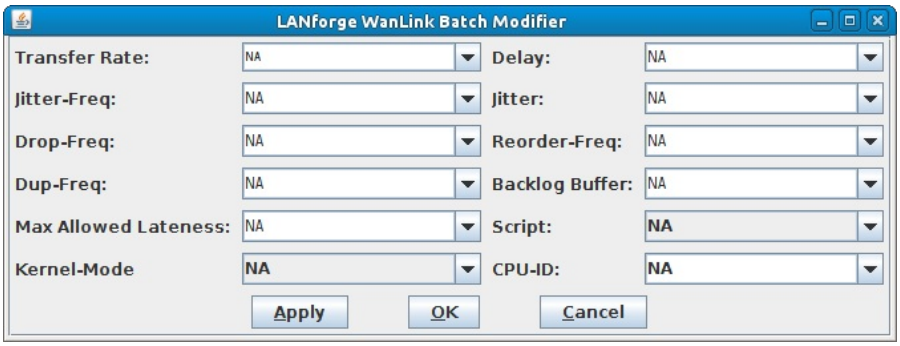
LANforge-ICE works best using a minimum of three ethernet ports: two for each WanLink and the third to access the LANforge machine remotely for management purposes. To ensure that there is no interaction with the LANforge machine's protocol stacks, the IP address for each WanLink port is automatically removed.

It is possible to run WanLinks on a machine with only two ports, but you will not have the option to manage LANforge remotely unless you cleverly configure some virtual interfaces. In this scenario, your machine will need to be configured for a loopback device to manage LANforge. See the LANforge Server Installation Documentation for how to configure a loopback device on your machine. **NOTE**: There are work-arounds for even this restriction if you use a more complex Netsmith setup with bridge

devices. Contact support if you have such a need.

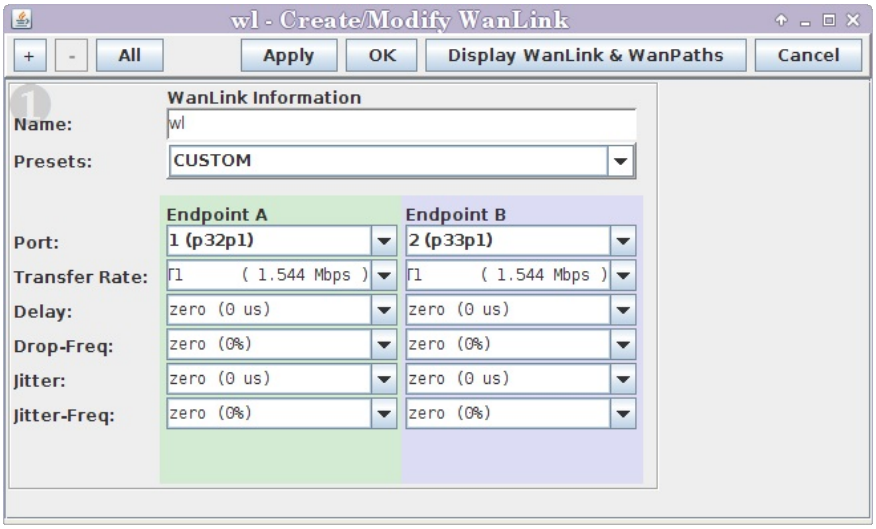



Bulk changes to WanLink Endpoints can be performed easily by selecting one or more endpoints and clicking the **Batch Modify** button. Selected values from the drop-down menus will be applied to all selected endpoints. Endpoint values marked 'NA' will remain unchanged.

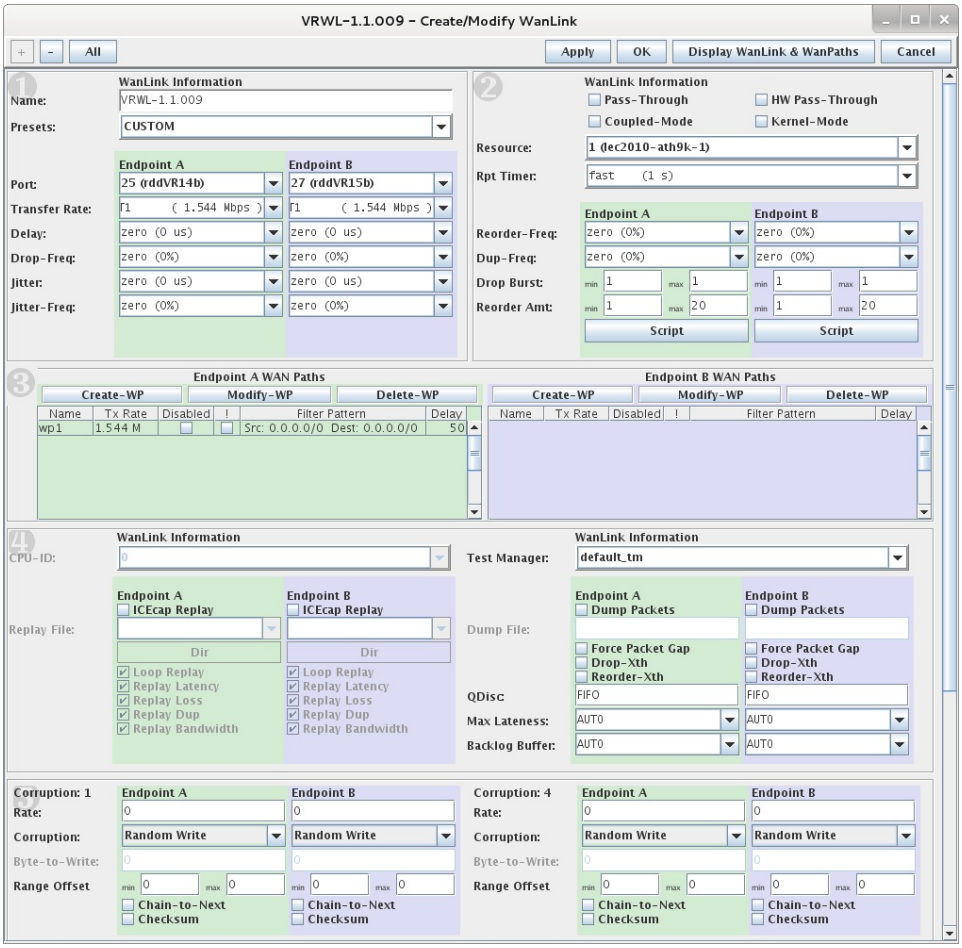



## 16. Creating & Modifying WanLinks

When creating a WanLink, the details of each WanLink Endpoint must be specified, including the Port where the WanLink Endpoint resides. This determines which port the WanLink will use for receiving traffic. The peer endpoint's interface will be used for transmitting packets. In order to create a WanLink, click the **Create** button on the **WanLinks** tab. WanLinks can be attached to Ethernet, Redirect, and 802.1Q VLAN interfaces. WanLinks should NOT be directly attached to MAC-VLAN, 802.11a/b/g, or PPP interfaces at this time.




The WanLink Create/Modify screen expands from configuration section 1 to section 5. Use the **+** button to expose new configuration sections. You may also use keystrokes control + and Control - to expose and hide sections. Generally, more advanced or obscure features are found on the higher sections.




## 17. WanLink Information

The top section of info sections 1, 2, and 4 of the Create/Modify WanLink window contains information relating to the entire WanLink, including the name, resource, report timer, test manager, and presets.

**Name**

Enter a unique name no more than 47 characters in length.

**Presets**

The Presets function may be used to help configure common network transports (e.g., Fast DSL, DS1/T1, DS3/T3, 1G). Selecting a preset from the drop-down menu fills in some of the configuration fields in the lower panels of the window. Configuration settings can then be modified to suit your particular needs (not all DSL networks run at the same speed, for instance). Clicking **Apply** or **OK** saves the WanLink configuration as entered in the panels (via preset selection or modified-by-user).

**Coupled-Mode**

Forces the emulation to be symmetric so you only need to configure Entry Point A. The values will be automatically set in Entry Point B when you click **Apply** or **OK**.

**Pass-Through**

Enables the packets to pass through the emulation with minimal impairment, regardless of the other configuration. The profile must be running for it to pass any traffic, even in Pass-Through mode. Please note that there will be *some* impairment due to the overhead of passing the packets through the software/hardware.

**HW Pass-Through**

Causes the two physical ports to be connected by physical relays when the WanLink is running, effectively making them a single wire. This takes LANforge completely out of the loop and allows full wire-speed throughput with no impairments. This mode is only supported by special NIC hardware and drivers, which may not exist on your system. **NOTE**: Affected ports will revert to their default Bypass settings in the **Port Mgr** tab when the WanLink is no longer running.

**Kernel-Mode**

Allows for much higher emulation speeds and supports all features of the normal WAN emulation mode. Kernel-Mode is available for the WAN emulation if you are using a pre-compiled Linux kernel from the Candela downloads page.

**Resource**

Select the Resource (machine) on which the WanLink will reside. For LANforge-ICE systems with only one machine, you do not need to change these values from their default.

**Rpt Timer**

The report timer specifies how often the LANforge data generators send updates to the LANforge server, and how often the LANforge server pushes endpoint information up to the clients (GUIs) that have requested the automatic updates. If you are running the GUI over a slow link, or have a slower machine, it is recommended to increase the report timer to 5000ms (5 seconds) or higher.

**CPU ID**

With release 5.1.4, LANforge supports one WanLink thread per CPU core. To make optimal use of multi-core systems, you can spread the WanLinks across the different CPUs. For very high-speed emulations (multiple-gigabit), you may also want to experiment with pinning Port interrupts to ensure that the packets handled by the wanlink stay 'close by' in cache.

For example, on our E3 v3 processor system, this configuration can run full 10Gbps line speed:

```
WanLink (on eth4, eth5) using CPU id 3
           eth4 using CPU-mask 0x1
           eth5 using CPU-mask 0x2
```

To set the Ethernet port's CPU-mask, you also have to manually disable the IRQ balance daemon as root user:

```
# systemctl stop irqbalance
```

```
# systemctl disable irqbalance
```

If you wish to use general-purpose features later, it is usually best to re-enable irqbalance.

**Test Manager**

The Test Manager specifies who 'owns' this CX, and can be used to segregate a large LANforge system for use by many engineers. For most users, however, assigning all CXs to the default_tm Test Manager is fine.

### WanLink Entry Points

The settings for each WanLink Entry Point apply to packets **entering** the Port associated with that endpoint.

**Port**

The external ethernet or virtual interface this Entry Point resides on. Ports used in WanLinks should have their IP address, MASK, and Gateway set to **0.0.0.0** at least when the WanLink is running. LANforge will forcefully set the IP to 0.0.0.0 as soon as you start the WanLink.

**Transfer Rate**

This sets how much data, in bits-per-second, will be accepted for this Entry Point.

**Delay**

This sets the amount of latency to be added to each packet as it enters this Entry Point. With LANforge release 5.2.4, Jitter may be entered in micro-second units. This only takes affect when the WanLink is running in kernel-mode, and it is accurate within several hundred micro-seconds when running at moderate speeds. User-space mode and older releases are limitted to mili-second precision.

**Drop Frequency (Drop-Freq)**

How many packets out of every 1 million (1,000,000) will be purposefully dropped. This is used to simulate errors on the WAN. By default, a single packet is dropped per drop event in a random distribution. This can be entered as a percentage, for example: 5%

**Jitter**

This sets the amount of random jitter to be added to each packet as it enters this Entry Point. A flat random amount of jitter between 0 and the value entered here will be applied in addition to any base delay already configured. This feature does not reorder any packets. Keep in mind that any packets directly behind a jittered packet will be delayed until the affected packet is able to be translated. For a stream with 5ms packetization, for example, a 100ms delay will affect the next 20 or so packets until the packet backlog is cleared. For this reason, you should probably not set **Jitter-Freq** above 20% if you are running packets through the LANforge at near its maximum emulation speed. If you are running packets at slower speeds, then you can set the jitter-frequency high because it is less likely there will be a packet immediately following the jittered packet. Please see the **Jitter-Frequency** setting as well.

With LANforge release 5.2.4, Jitter may be entered in micro-second units. This only takes affect when the WanLink is running in kernel-mode, and it is accurate within several hundred micro-seconds when running at moderate speeds. User-space mode and older releases are limitted to mili-second precision.

**Jitter Frequency (Jitter-Freq)**

This sets the number of packets per million to have jitter randomly applied through the WanLink. Entering 10000, as an example, will apply jitter to about 1 out of every 100 packets or 1%. A percentage (0.07%, for example), can also be entered. Please see the **Jitter** section as well.

**Reorder Frequency (Reorder-Freq)**

How many packets out of every 1 million (1,000,000) will be purposefully reordered. You can configure the min and max reorder offset in the 'Advanced' configuration screen. This is used to simulate behavior that you will see in multi-path networks and is good for testing RTP and other streaming media protocols.

**Duplicate Frequency (Dup-Freq)**

How many packets out of every 1 million (1,000,000) will be purposefully duplicated. This will cause the other side of the simulated WAN to receive two identical packets. This is used to simulate errors on the WAN.

**Drop Burst**

Entering a value greater than 1 for **Min** and/or **Max Drop Burst** will create bursts of dropped packets. A random number of packets between Min and Max (inclusive) will be dropped for each drop event (randomly selected based on the **Drop-Freq** settings).

**Reorder Amt**

This gives you the ability to specify how many packets will be allowed to go by before the reordered packet is re-inserted into the stream. If Min is less than Max, then a random value between Min and Max will be chosen for each reorder event.

**Dump Packets**

dump packets must have a unique directory configured or files will be over-written. When dump packets is enabled, any existing capture files in the configured directory will be over-written.

**Force Packet Gap**

Selecting this checkbox will enforce a gap of at least 80% of the theoretical inter-packet gap for the configured speed between each packet. The 80% is used to allow for the LANforge system to make up for internal processing overhead, i.e. 20% of the inter-packet gap time may be needed by the LANforge system to catch up from previous (micro) delays. Enabling this feature can cause significant performance degradation at speeds of greater than about 2Mbps but results in more realistic emulations of constant-rate serial networks such as T1, DS3, etc.

**Drop-Xth and Similar Fields**

Selecting the **Drop-Xth**, **Reorder-Xth**, or **Dup-Xth** checkboxes will cause packets to be dropped, reordered, or duplicated at fixed intervals as opposed to the default random distributions. Values for X are entered in the Drop-Freq, Reorder-Freq, or Dup-Freq fields of the Create/Modify WanLink window by selecting from the drop-down menu or entering a number or percentage in the field.

If selected, then all packets received will be logged to the specified directory. They can later be replayed with a LANforge-FIRE custom-ethernet connection. This allows the capture and replay of packet flows and protocols that exactly fit your environment.

**QDisc**

The **QDisc** field provides for a QDisc (Queue Discipline) priority to be set for the selected endpoint. First In First Out (FIFO) is the default priority. A Wighted Round-Robin (WRR) process schedule can be entered using the following format (no spaces): WRR,weight1-v1-m1...-vX-mX,...,weightX-vX-mX,...
The value-mask pairs (vX-mX) are matched to the associated queue/weightX. Higher weight is higher priority. Minimum weighting should be equal to or greater than your MTU. For example, 3 WRR queues (2000, 50000, and 20000) with match-all-bits mask of 255 for IP-TOS values of 10, 11 and 12 would look like this:
**QDisc:** `WRR,2000-10-255,50000-11-255,20000-12-255`
In this example, 10 is in the lowest priority queue and 11 is in the highest. The value-mask pair behave like the IP address and network mask pair. An incoming packet's 8-bit IP-TOS header field is compared against the value-mask pair. The packet is placed in the queue if the TOS matches the value-mask pair. **NOTE**: The low 2 bits of the IP-TOS header field are restricted from use.
**NOTE: QDisc is only supported in user-space mode at this time.**

**Max Lateness**

This sets the maximum amount of extra delay that a packet can have before being dropped by LANforge on transmit. This is in addition to latency + jitter + serialization delay. In most cases it should coorespond to the Backlog Buffer, since packets queued there will be transmitted late. Using the AUTO value is usually best unless you have specific needs. AUTO max-lateness is calculated as maximum time needed to traverse the emulated network plus backlog-buffer plus 10ms. The actual lateness is shown in the WanLink Endpoints table.

#### Backlog Buffer

Most equipment that you will find in any network will contain a certain amount of buffers to smooth bursty traffic so that packets are not needlessly dropped. The backlog buffer is your way of configuring this value. The units are in multiples of 1024 bytes (1KB). The size of the buffer depends on many things, and should generally be larger for higher-speed simulations. Due to the bursty nature of Ethernet (and ethernet drivers in common systems), we suggest these buffer sizes when trying to simulate a relatively well structured WAN:

| WanLink Speed | Backlog Buffer Size |
|---|---|
| 56Kbps - 256Kbps | 2-8 |
| 257Kbps - 1.54Mbps | 8-32 |
| 1.5Mbps - 45Mbps | 32-256 |
| 45Mbps - 155Mbps | 256-1024 |
| 155Mbps - 1Gbps | 1024-8192 |
| 1Gbps - 10Gbps | 8192-65536 |

Selecting AUTO will set the backlog such that it can hold at least 10 ms of data at the configured speed. It will hold more than 10ms of packets at slower speeds in order to accomodate small bursts of packets. For instance, if the rate is 10Mbps, AUTO mode will cause the backlog to be set to 62KB. The actual backlog size is shown in the WanLink Endpoints table.

#### Packet Corruptions

LANforge-ICE supports bit and byte error corruptions in ethernet frames. The **Rate** field determines how often to apply the corruption (out of 1 million packets). Select the type of corruption you want to apply from the **Corruption** drop-down menu:

- **Random Write:** Will write a random byte to one byte between the min and max offset into the ethernet frame.
- **Write Byte:** Will write the byte specified in the **Byte-to-Write** field to a location between the Min and Max Offset into the ethernet frame.
- **Bit-Flip:** Will flip one bit from 0 to 1 or 1 to zero in a byte between the Min and Max Offset into the ethernet frame.
- **Bit-Transpose:** Will transpose two bits in a byte between the Min and Max Offset into the ethernet frame.
- **TCP RST:** Will send TCP Reset packets to kill the TCP connection. **Note: This feature only works with a user-mode WanLink.**

The **Min** and **Max Offset** fields determine the location of the corruption. If Min is less than Max, the corruption will be at a random byte between Min and Max.

If the **Chain-to-Next** checkbox is selected, any time this corruption is applied, the **next** corruption will be applied as well. This can allow you to reliably generate multiple corruptions in a single packet.

If the **Checksum** checkbox is selected, LANforge will attempt to recalculate the IPv4, UDP, and TCP checksum for the packet after applying the corruption. This will allow the errored packet to be accepted by the stacks on the receiving machine as if the data were actually valid. This feature will only work if the UDP or TCP payload does not span more than one physical ethernet frame. The ethernet checksum (FCS) is not controlled by LANforge at this time, and will always be recalculated by the network adapter on transmit.

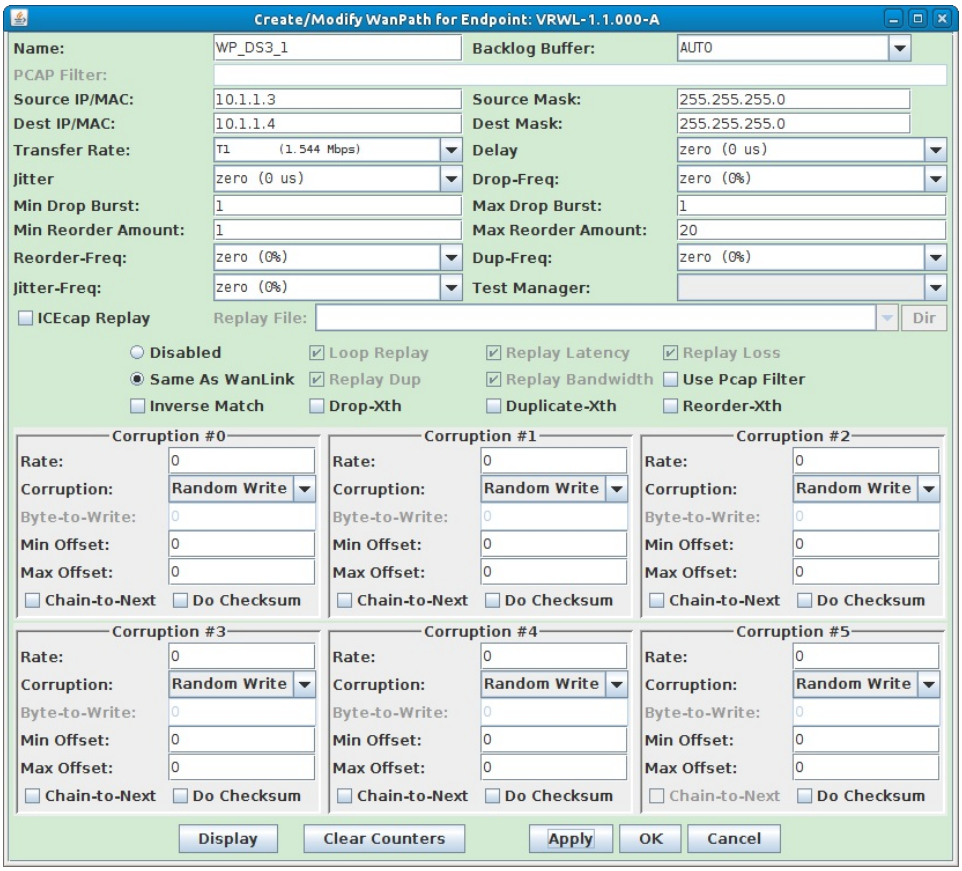
### Creating & Modifying WanPaths

WanPaths represent a virtual WAN between a source and destination IP or MAC Address range. This allows you to set up one WanLink that simulates a physical pipe, and multiple WanPaths that simulate connections between different machines or sets of machines on your network. You can have up to

128 WanPaths on each WanLink endpoint.

The configuration of a WanPath is similar to that of a WanLink, except that the WanPath belongs to a specific WanLink, and you must specify the IP Address ranges (or other match criteria) that are to match this WanLink.

Please note that when you add a WanPath to an endpoint, the patterns match with regard to packets entering the interface that the endpoint uses. If you want to match on a source IP of 192.1.1.2 and the endpoint is configured on eth0, then put that machine on the network connected to eth0.




**Name**

The name of this particular WanPath. Must be unique across the parent WanLink.

**Pcap Filter**

This field is enabled by selecting the 'Use Pcap Filter' checkbox in the center of the window. Enter the Pcap filter for this WanPath using the same syntax as that of 'tcpdump'.

**Source IP/MAC**

The Source IP or MAC address that matches this WanPath. For IP address matching, the number of bits that are matched are controlled by the Source IP Mask. For MAC address matching, any non-zero mask will match exactly, and a zero mask will match all. For pcap pattern matching, this value is ignored entirely.

**Source Mask**

Specifies how many bits of the Source IP are significant. If this is 0.0.0.0 it will match anything. You can also enter an integer number between zero and 32, inclusive. For MAC addresses, 0 means 'ANY' and anything else means match exactly the single MAC. For pcap pattern matching, this value is ignored entirely.

**Dest IP/MAC**

The Destination IP or MAC that matches this WanPath. For IP address matching, the number of bits that are matched are controlled by the Source IP Mask. For MAC address matching, any non-zero mask will match exactly, and a zero mask will match all. For pcap pattern matching, this value is ignored entirely.

**Dest Mask**

Specifies how many bits of the Destination IP are significant. If this is 0.0.0.0 or 0 it will match anything. You can also enter an integer number between zero and 32, inclusive. For MAC address matching, any non-zero mask will match exactly, and a zero mask will match all. For pcap pattern matching, this value is ignored entirely.

**ICEcap Replay**

If checked, then the LANforge-ICE connection will read values from an XML file and change its values accordingly. The XML file consists of periodic samples of network characteristics. The WAN capture file can be created with scripts or third-party applications. Contact Candela for more information on how to generate these scripts. The other 'replay' related flags below pertain to this feature and determine the behavior described by the XML file.

**Running States**

If the 'Stopped' button is selected, the WanPath will not be active and all traffic will be handled as if the WanPath does not exist. Selecting 'Same as WanLink' will activate the WanPath when the WanLink is active.

**Inverse Match**

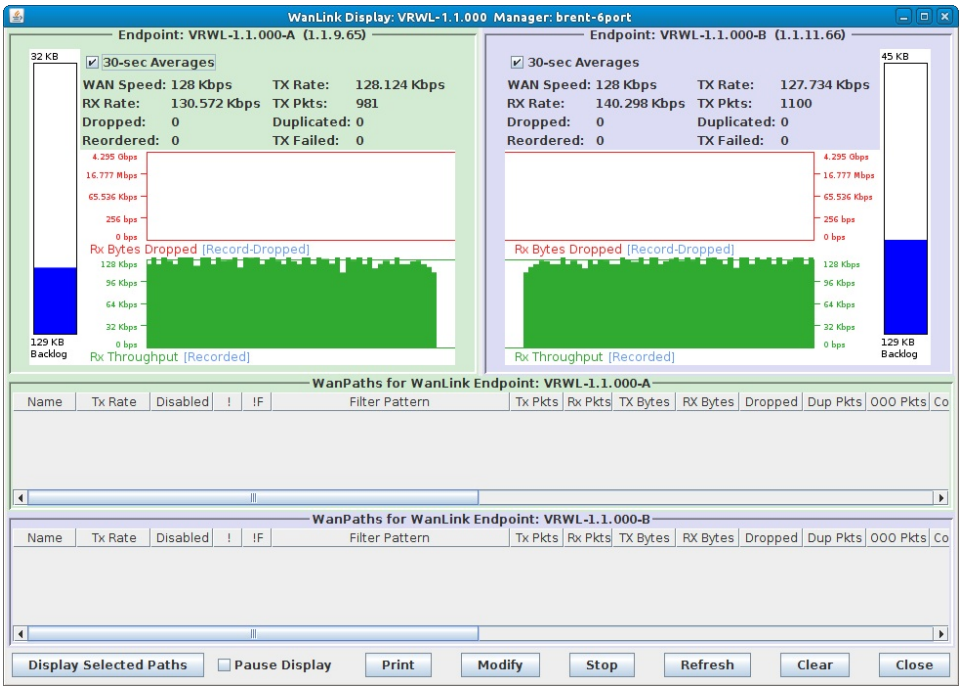
Selecting the 'Inverse Match' checkbox will reverse the match logic of the WanPath so that a 'false' pattern match is actually 'true'.

**Drop-, Reorder-, Dup-Xth**

These functions are analogous to those in the Advanced options for WanLinks. Selecting the **Drop-Xth**, **Reorder-Xth**, or **Dup-Xth** checkboxes will cause packets to be dropped, reordered, or duplicated at fixed intervals as opposed to the default random distributions. Values for X can be selected from the corresponding drop-down menus or entered using a number or percentage in the field.

## Displaying WanLinks and WanPaths

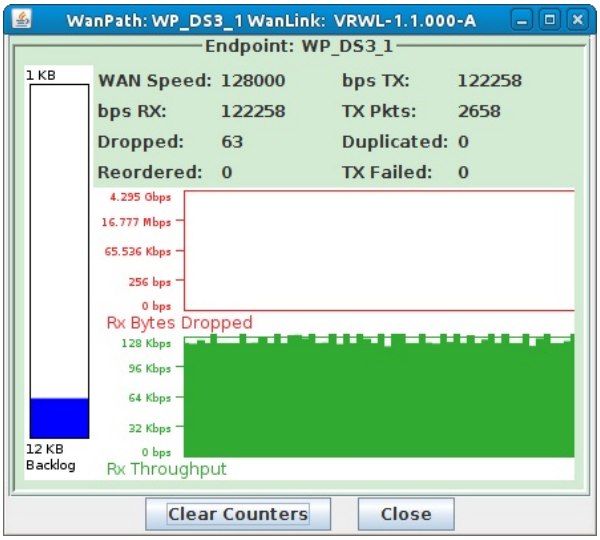
After creating a WanLink, you may display it to watch the flow across your emulated WAN in detail. To display one or more WanLinks, select the row(s) and click the **Display** button.




**Vertical Backlog Buffer Bar Graph**

The number at the bottom of the vertical bar graph indicates the amount of memory that the WanLink has reserved for network buffer emulation. The number at the top of the vertical bar graph indicates the amount of buffer used for packets that are 'in-flight'. See 'Backlog Buffer' under 'WanLink Entry Points' for more information about the Backlog buffer.

Individual WanPaths can also be displayed by selecting one or more WanPaths and clicking the **Display Selected Paths** button at the bottom of the window.




**Vertical Backlog Buffer Bar Graph**

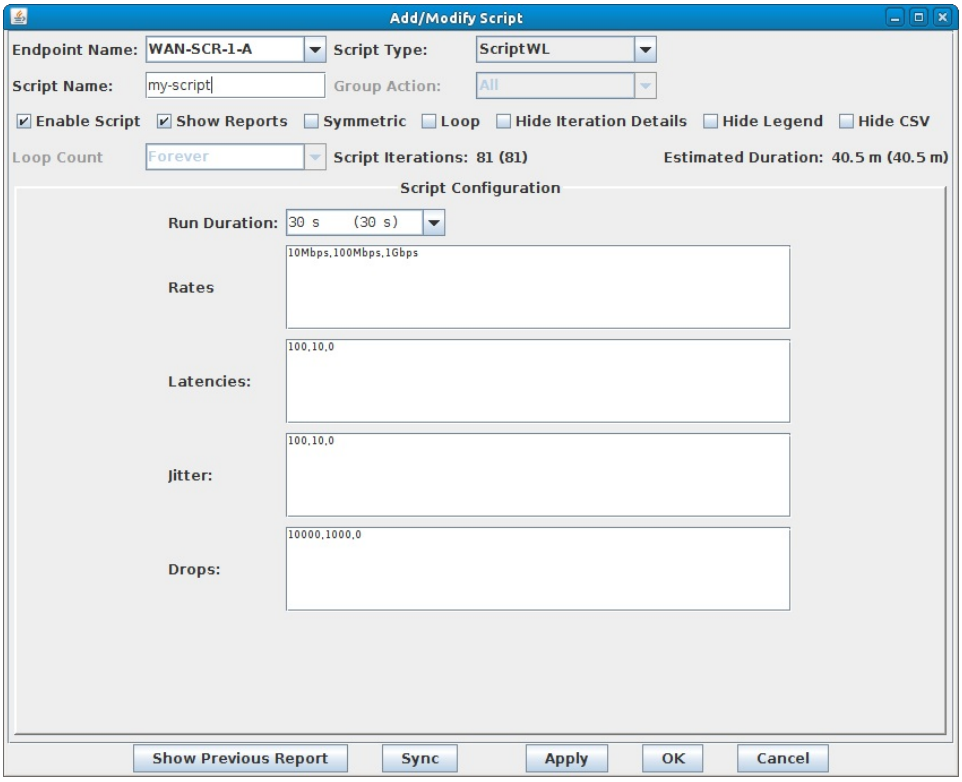
The number at the bottom of the vertical bar graph indicates the amount of memory that the WanLink has reserved for network buffer emulation. The number at the top of the vertical bar graph indicates the amount of buffer used for packets that are 'in-flight'. See 'Backlog Buffer' under 'WanLink Entry Points' for more information about the Backlog buffer.

## Scripted WanLink

As of release 5.1.2 and later, a WanLink can be scripted via the LANforge GUI so that the user can setup a single WanLink to run with different rates, latencies, jitter and drops for various durations.

The Add/Modify Script window is divided into two panels. The top panel identifies the endpoint and defines the script type and scripting options. The bottom panel describes the script configuration.

A full sample report from the WanLink script showing results for each iteration and a summary of transmit and receive packet statistics plus link utilization can be found at: examples/wanlink-scripted/Scripted-WanLink-Text-Report.txt




**Endpoint Name**

The Endpoint that the script will control.

**Script Type**

There are three Script Types. The default values that appear for RFC-2544 and ScriptWL can be modified to suit your testing needs. The Run Duration value can also be modified to suit your

testing needs. Simply select a value from the list or type in the exact value you want to use.

- **NONE** - Deletes any existing script on the endpoint.
- **RFC-2544** - Defines a default set of rates and payload sizes for a scripted Layer-3 or Armageddon endpoint.
  You may use the default rates and payload sizes which are described in RFC-2544, a methodology for benchmark testing, or you can modify the default rates and payload sizes by typing in the values you want to use in the script configuration text boxes.
- **ScriptWL** - Defines a default set of rates, latencies, jitter and drops for a scripted WanLink.

**Script Name**

The name of the script. At this time only one script can be associated with each endpoint.

**Script Options**

These checkboxes allow you to control various script options.

- **Enable Script** Whether or not to enable the use of the script on the endpoint. A script configuration can be defined for an endpoint and then disabled so that the script configuration is preserved for future use when the script is enabled again.
- **Show Reports** During the running of a script, this option will allow per-iteration and summary results to be generated and displayed in a pop-up text display window.
- **Symmetric** Symmetric allows the script configuration to apply to both endpoints associated with a connection. This would be used for a bi-directional test. With this option, the script per-iteration and summary results will include both endpoints in a single report.
- **Hide Iteration Details** Hides only the per-iteration results in the script report. Summary results will still be displayed.
- **Hide Legend** Hides only the report legend that describes the column headings in the script report.
- **Hide CSV** Hides only the comma seperated value data in the script report.

**Script Iterations**

Displays a running tally of the number of iterations your current script configuration contains.

**Estimated Duration**

Displays an estimated total script running time that the current script configuration will take to complete.

**Script Configuration**

The details of each iteration of the script.

- **Run Duration** The length of time that each iteration should run. Values can be chosen from the list or typed in with one of the following suffixes:
  ms - milliseconds, s - seconds, m - minutes, h - hours, d - days.
  **Note:** There is no Pause Duration for scripted WanLinks because it would mean that the WanLink is stopped which would drop all traffic. Instead, the scripted WanLink iterates over the different specified rates, latencies, jitter and drops until the completion of the script at which time the original WanLink settings are used and the WanLink is kept running.
- **Rates** A default set of rates is shown when the ScriptWL type is selected, but you can also enter your own set of rates that each script iteration should step through. Rates can be entered using **bps** or **pps** units. Values should be seperated by a comma or newline.
- **Latencies** A default set of latency values are shown when the ScriptWL type is selected, but you can also enter your own set of latency values that each script iteration should step through. Latency values can be entered in units of milliseconds and should be separated by a comma or newline.
- **Jitter** A default set of jitter values are shown when the ScriptWL type is selected, but you can also enter your own set of jitter values that each script iteration should step through. Jitter values can be entered in units of milliseconds and should be separated by a comma or newline.
  **Note:** The frequency of the scripted jitter values will adhere to the settings on the WanLink Jitter-Freq field.
- **Drops** A default set of dropped packets values are shown when the ScriptWL type is selected, but you can also enter your own set of dropped packets values that each script iteration should step through. Dropped packets values can be entered in units of per-million packets or as a percentage.

**Sync**

Update the script configuration fields with the current script settings already in use.

**Apply**

Attempt to apply changes to the script configuration to the current endpoint, but do not close the window.

**OK**

Attempt to apply changes to the script configuration to the current endpoint and close the window. If the apply fails, your changes will be lost.

**Cancel**

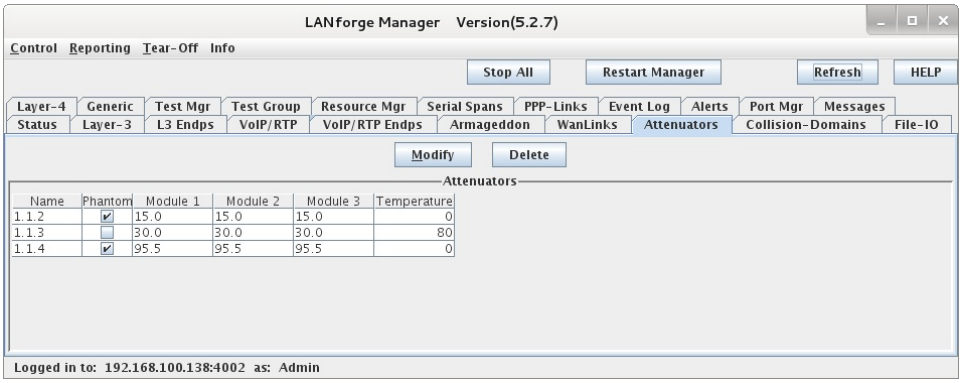
Make no changes and close the window.

---

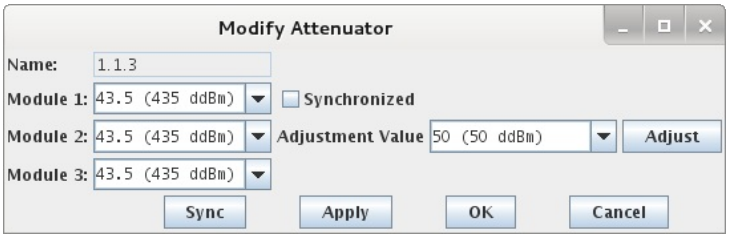


## 18. RF Attenuation

LANforge 5.2.7 introduces support for the LANforge Attenuator system. The attuator is used for testing WiFi systems by decreasing (attenuating) the RF signal as it flows through the attenuator. This allows one to emulate having an AP and WiFi station very far apart while sitting comfortably in the lab. To use the attenuator, plug the attenuator's USB cable into your LANforge machine and then click 'Refresh' on the Attenuators tab in the LANforge GUI. The attenuator information should appear in the Attenuators tab a few seconds later.




To configure an Attenuator, select the **Attenuators** tab and click **Modify**. This will bring up the Modify Attenuator window:




**Name**

This is the identifier for the Attenuator: 1.[resource].[atten-serial-num] It is for information only and cannot be changed.

**Synchronized**

If selected, then any changes will be applied to all attenuation modules in this Attenuator.

**Module**

Each module in the attenuator can be configured independently, or if the **Synchronnized** checkbox is selected, then all will be configured to the same value as Module 1. Select from the drop-down box or enter the desired attenuation in tenths of a dB (ddB). The Attenuator hardware supports increments of 0.5 dB and will round down, so setting the attenuator to 114 is the same as setting it to 110 ddB. You may verify the settings once you apply them by looking at the LANforge Attenuator LCD display.

**Adjustment Value**

This is an increment/decrement field. Set it to the desired value, and then each time you click the **Adjust** button the attenuator modules will all be modified as requested. This makes it easy to step through attenuation ranges with a click of the mouse.

**Synch**

Update the Modify window with the latest report from the LANforge machine. This can be useful if you are also adjusting the Attenuator by hand or by some other script or program.

**Apply**

Click Apply to save the current configuration and leave the window open for additional changes. If you change the name and apply again, you will get a new copy, for instance.

**OK**

Click OK to save and close the window.

**Cancel**

Close the window without saving the current configuration.

---



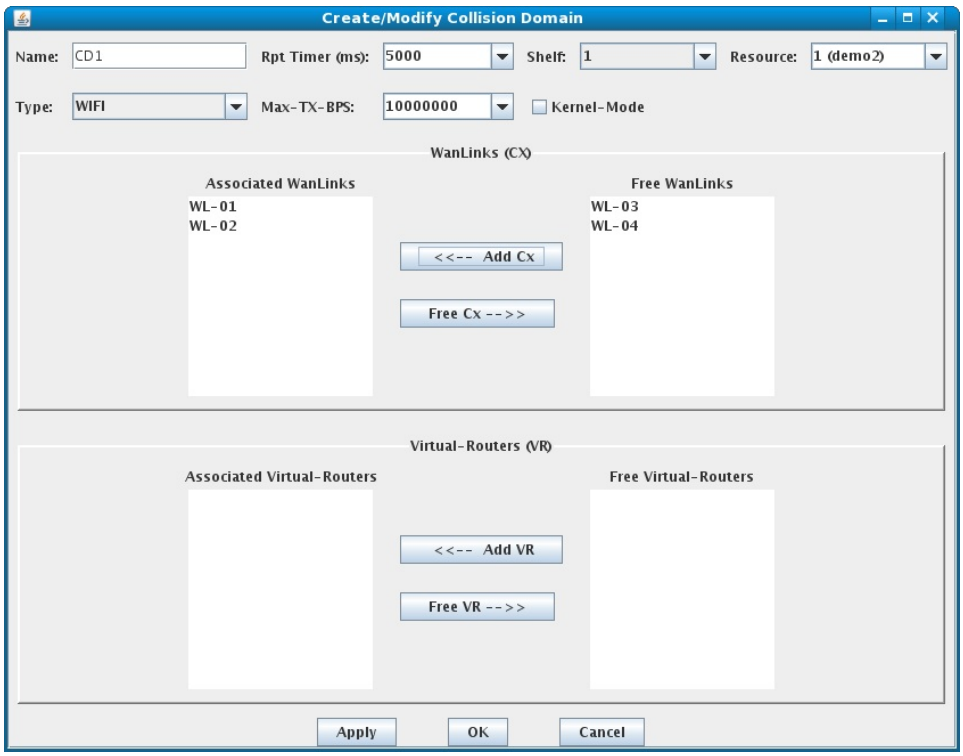
19. # Collision Domains (ICE)

Collision Domains complement the LANforge WAN/Network emulation feature set (LANforge-ICE) by allowing the user to associate multiple WanLinks in a group with an aggregate rate limitation. This feature is useful for emulating wireless networks where several links may allow high speeds individually, but the associated Access Point allows a fixed total throughput. For example, you could configure ten 36Mbps speed WanLinks, each with their own impairment profile, into a Collision Domain that is rate limited to 54Mbps. This would limit the group of WanLinks to no more than 36Mbps individually and 54Mbps combined, emulating the effect of having a WiFi collision domain on the network under test.

## Creating & Modifying Collision Domains

After creating a set of WanLinks, go to the **Collision-Domains** tab and select **Create**. The WanLinks that you created will be displayed in the right-hand (Free WanLinks) column. Move the WanLinks to be associated with the Collision Domain to the left-hand (Associated WanLinks) column by selecting them and clicking the **<<— Add CX** button. After the desired settings have been entered, click **Apply** or **OK** to create the Collision Domain.

**NOTE**: Adding Virtual Routers to a Collision Domain is not supported at this time.




The top panel of the Create/Modify Collision Domain window contains information relating to the Collision Domain, including the name and report timer. You can also select the Shelf and Resource that the Collision Domain will reside on. For LANforge-ICE systems with only one machine, you do not need to change these values from their default of one (1).

**Type**

Type specifies the Collision Domain being emulated. **WIFI** and several modes of **WISER** are the

only types supported at this time. WISER is only supported when used in conjunction with third-party libraries to emulate military radios.

**Max-TX-BPS**

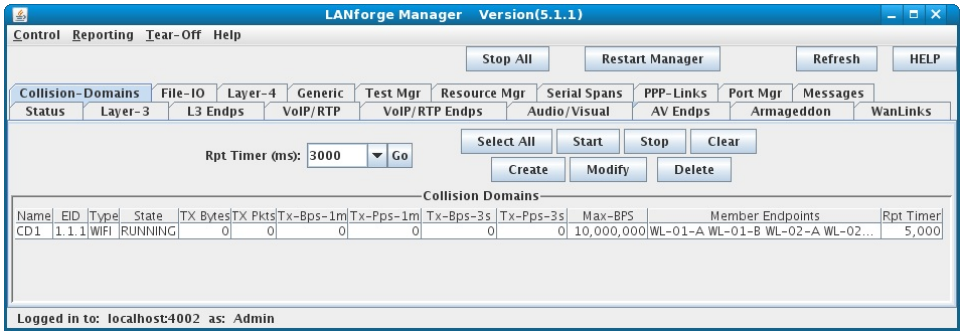
Specifies the aggregate rate that you want applied to all WanLinks associated with this Collision Domain.

**Kernel-Mode**

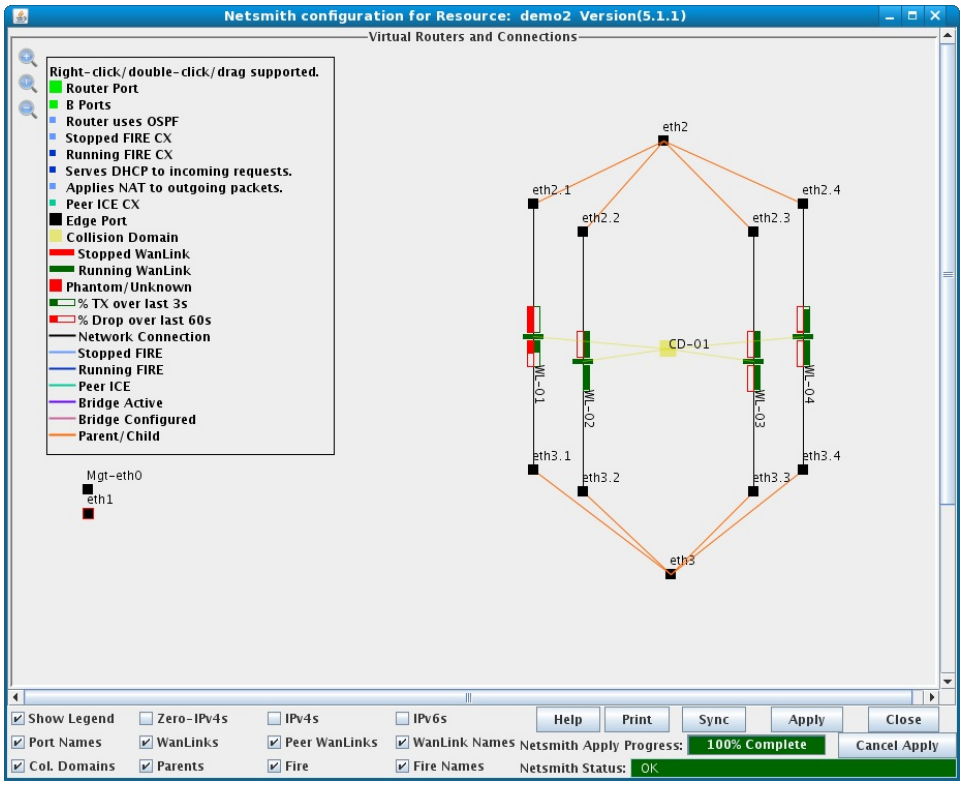
Kernel-mode for Collision Domains is not supported at this time. All WanLinks associated with the Collision Domain also must **NOT** be in kernel-mode.

## Displaying Collision Domains

To view the Collision Domain while it is running, go to the **Collision-Domains** tab.



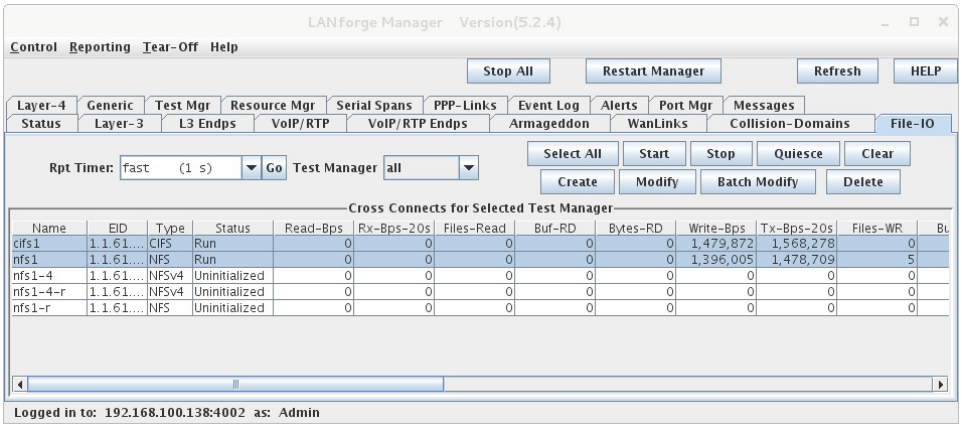

You can also use Netsmith to view the graphical representation of your Collision Domain.



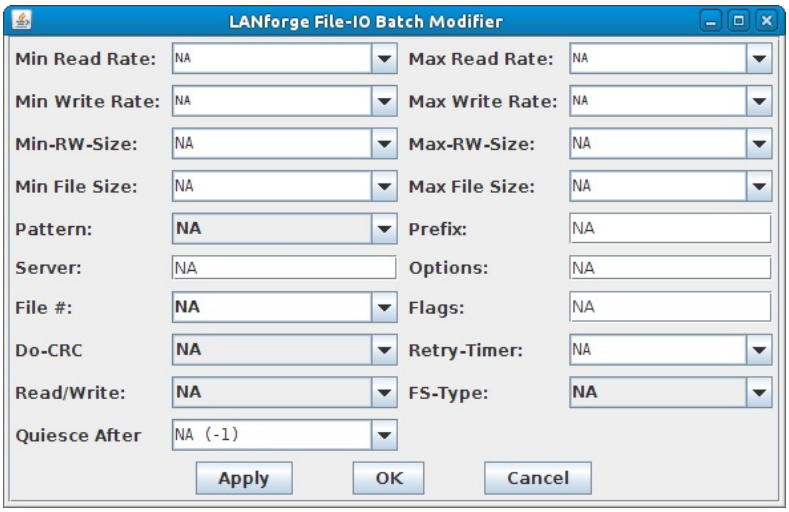



20. # File Endpoints

File Endpoints are used to generate file system traffic. If you happen to configure LANforge to have file systems mounted over NFS, iSCSI, CIFS, or SMB (SAMBA), then the file system tests will indirectly produce network traffic as well. A file endpoint is synonymous with a file cross-connect, because LANforge only controls or manages a single side. The other side may be either the local file system or a remote NFS server: It makes no difference to the LANforge software suite's configuration. LANforge on Linux supports virtualization of NFS and CIFS clients, allowing one system to emulate several thousand clients. This can be useful for testing file-servers and WAN acceleration technologies.

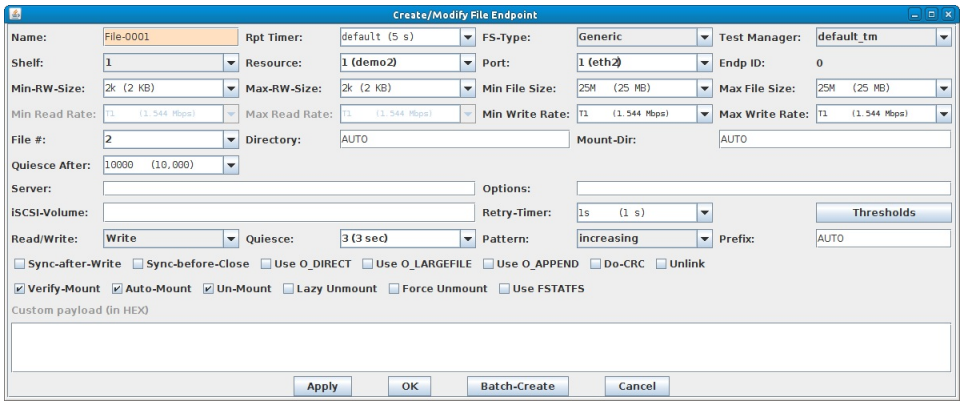



Bulk changes to File Endpoints can be performed easily by selecting one or more endpoints and clicking the **Batch Modify** button. Selected values from the drop-down menus will be applied to all selected endpoints. Endpoint values marked 'NA' will remain unchanged.




## Creating & Modifying File Endpoints

When creating a File Endpoint, you get to specify attributes such as file size, how many files, read vs. write, chunk-size to read/write and some options relating to synchnonizing (flushing) the files to disk. A File Endpoint is a complete test by itself (you do not directly create File Cross-Connects as you do with some other endpoint types). In order to create a File Endpoint, click the **Create** button on the **File-IO** tab. This will bring up the Create/Modify File Endpoint window:




After the desired settings have been entered, click **Apply** or **OK** to create the Endpoint.

**NOTE**: A series of tests based off the current configuration can be created by clicking the **Batch-Create** button.

## File Endpoint Information

**Name**

Enter a unique name for this File Endpoint.

**Rpt Timer**

Select how often (in milliseconds) the endpoint should report to the GUI. 1000-5000 (1-5 seconds) is suggested for most cases.

**FS-Type**

Select the file system type that will be used to create and verify mount points for this endpoint.

**Test Manager**

The Test Manager specifies who 'owns' this Endpoint, and can be used to segregate a large LANforge system for use by many engineers. For most users, however, assigning all Endpoints to the default_tm Test Manager is fine.

**Shelf, Resource, Port, Endpoint ID**

The shelf and resource determine which machine the test will run on. The port does not make any difference at this time, but in the future may help with directing network traffic to a particular interface. LANforge will assign a unique Endpoint-ID for display only when the endpoint is created.

**Min/Max-RW-Size**

The Min-RW-Size and Max-RW-Size specify the minimum and maximum read or write (depending on the mode) size in bytes for each call to the system read and/or write calls. Larger read/write sizes will give more throughput, smaller ones may stress the system harder in certain other ways. If the min and max are different, LANforge will randomly pick values between the min and max values entered.

**Min/Max File Size**

The Min File Size and Max File Size specify the minimum and maximum file size in bytes only when writing. When reading, LANforge will read any size file in the specified directory.

**Min/Max Read Rate**

The Min Read Rate and Max Read Rate specify how fast the Endpoint will attempt to read the file(s). If the values are not the same, LANforge will randomly pick values between the min and max rates entered. The picked value will be used for a short (random) amount of time to simulate burstiness.

**Min/Max Write Rate**

The Min Write Rate and Max Write Rate specify how fast the Endpoint will attempt to write the file(s). If the values are not the same, LANforge will randomly pick values between the min and max rates entered. The picked value will be used for a short (random) amount of time to simulate burstiness.

**File #**

Select the number of files to create when doing the write tests. LANforge will continiously write data as long as the endpoint is running and will re-use (overwrite) files as required. If you selected to use 10 files, for example, and a File Endpoint runs long enough to write 15 files, then 5 of the 10 files in your directory will have been written over once with new data.

**Directory**

Enter the location for files to be written to or read from. AUTO will use /mnt/lf/(endpoint name). When writing, if the specified directory in the field does not exist, LANforge will create it.
**NOTE**: The specified directory and files must exist on the LANforge resource before running a 'Read' endpoint. Since these are created by the 'Write' endpoint, it should be run first.

**Mount-Dir**

Enter the local directory to mount. If blank, 'Directory' will be used. AUTO will use the Directory field's contents.

**Quiesce After**

You can have the endpoint quiesce after a desired number of files are read or written.

**Server**

Enter the server IP and directory to mount.
Some examples:

- **NFS:** 192.168.100.5/exports/vol1
- **NFSv6:** [2002::100:157]:/rpool/ben
- **CIFS:** //192.168.100.19/vg0_drbd.vol1.test01
- **iSCSI:** 192.168.100.19 (and configure volume: iqn.2011-04.com.openfiler:tsn.vol5)
- **iSCSI with LUN:** 192.168.100.19 (volume: iqn.2011-04.com.openfiler:tsn.vol5-lun-2)

**Options**

Enter any desired mount options (Example: rsize=16384,wsize=16384). If left blank, then no mounting options will be applied. For CIFS testing, you can use 'cache=none to disable all file-system caching (similar to selecting O_DIRECT flag for other file-system types.) For example:
`username=lanforge,password=lanforge,cache=none`

On kernels older than 3.7, the option is 'directio' instead of 'cache=none', for example:
`username=lanforge,password=lanforge,directio`

**iSCSI-Volume**

Enter the iSCSI volume to mount (Example: iqn2.2009-2.com.example:for.all)

**Retry-Timer**

Specify how long LANforge will retry on IO errors before stopping.

**Thresholds**

Set the min/max transfer and receive rates. If the connection throughput goes outside of the set range, an alert and/or event will be sent. This is useful for longer term throughput tests.
**NOTE**: Only tx/rx rate and no-rx-since are supported on File-IO endpoints.

**Read/Write**

Select whether the endpoint will write to or read from the specified directory. An endpoint can be changed from Write to Read (and vice versa), but the endpoint must first be stopped. Simultaneous writes and reads requires creating two separate File Endpoints.
**NOTE**: The same endpoint can easily be used to first write then read files as long as the write and read operations are conducted separately. Run the endpoint first as 'Write' until all files are written, stop the endpoint and change to 'Read', then run the endpoint as 'Read'.

**Quiesce**

Instead of stopping the File Endpoint immediately, LANforge will wait the selected number of seconds in order to finish reading or writing the next file. If the quiesce period expires before the read or write is complete, the File Endpoint is stopped.

**Pattern**

Select the data pattern to be used when writing to the disk. If you are using the check-sum feature, then there will also be a small header written to disk before the payload so we can do verification checks when reading. Selecting 'CUSTOM' enables the Custom payload field at the bottom of the window.

**Prefix**

The prefix may be used to distinguish files written for multiple endpoints. The prefix will be prepended to any file created for writing. AUTO will use the endpoint name for a prefix.

**Flags & Options**

The following flags (checkboxes) are used to enable or disable certain features which affect the behavior of the selected endpoint:

- **Sync-after-Write** determines whether or not the fsync method will be called after every write. This really slows down performance, but may be perfect for some types of tests.
- **Sync-before-Close** does the fsync call right before a file is to be closed. This isn't as much of a performance killer as Sync-after-Write, but it can still slow things down. It does simulate some real world tools, such as Mail Transfer Agents (MTAs) like Sendmail.
- **Use O_DIRECT** allows you to open files with O_DIRECT. This tells the OS not to buffer the files, which may improve performance on writes, and will disable client-side caching for reads. This option may require read/write size to be a multiple of 512 bytes.
  **NOTE**: This option is ignored on Windows operating systems and CIFS file system mounts on Linux. For CIFS mounts on Linux, use the 'cache=none' mount option to similar behaviour, for example: `username=lanforge,password=lanforge,cache=none`
- **Use O_LARGEFILE** allows you to open files larger than 4GB in size on a 32-bit system.
- **Use O_APPEND** will use the O_APPEND flag instead of O_TRUNC when reopening files for writing. This will make files grow even larger.
- **Do-CRC** allows you to tell the Endpoint to do a 32-bit CRC (checksum) on the payload and header being written to disk. If you read this with a File Endpoint that is also doing a CRC check, it will detect, with great certainty, any corruption in the file.
- **Unlink** may allow you to work around interoperability issues between client and server when using CIFS. Try enabling this if you get errors when over-writing files.
- **Verify-Mount** directs LANforge to attempt to verify that the file system is properly associated with the selected port.
- **Auto-Mount** directs LANforge to attempt to mount the specified server on the local

directory.

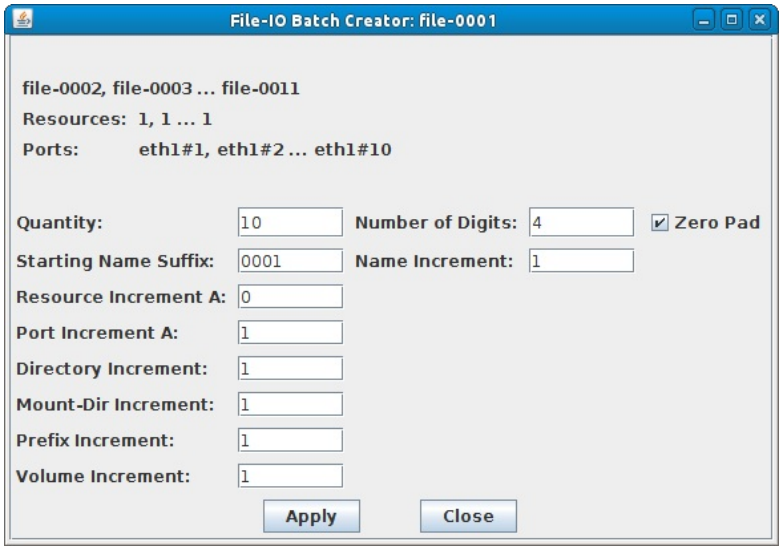
- **Un-Mount** directs LANforge to attempt to unmount the directory when stopping the test.
- **Lazy Unmount** passes the -l flag to umount. This allows unmounts that are normally blocked due to an unresponsive NFS server to (mostly) unmount immediately.
- **Force Unmount** passes the -f flag to umount. This allows unmounts that are normally blocked due to an unresponsive NFS server to unmount immediately.
- **Use FSTATFS** will verify the file-system type when opening files. This can take a bit of time on some file systems, but it can be used to detect unexpected file-system unmounts etc. If a mismatch is detected, the test will be stopped with an error message.

**Custom Payload**

If you are using a custom payload, then you can specify the payload (up to 2048 bytes) in HEX in the edit box provided. This pattern will be written to disk as entered, except that it will be prepended with the FileEndpoint header.

## Batch-Create File Endpoints

A series of tests can be created based on the Name and other current settings in the Create/Modify File Endpoint window by using the Batch-Create function. For best results, create a valid endpoint for the first in the series to be batch-created, select the endpoint and click **Modify**. Clicking the **Batch-Create** button at the bottom of the window will pop up the File-IO Batch Creator:




After the desired settings have been entered, click **Apply** or **OK** to create the series (batch) of File Endpoints.

**Quantity**

The number of File Endpoints to batch-create, using the selected endpoint for the initial values.

**Number of Digits**

The number of characters (padding) to be used in appending each endpoint name. Adds leading zeros (zero-pads) to endpoint names as required (this may help with sorting connections). For best results, this number should match the format of the selected endpoint (Ex: 4 for an initial endpoint named File-0001).

**Zero Padding Checkbox**

Uncheck the 'Zero Padding' checkbox if you do not desire leading zeros for the endpoint names when they are created.

**Starting Name Suffix**

The first number in the series (Ex: 0001 for File-0001) from which subsequent endpoints will be incremented. If the original endpoint name ends in a number or series of numbers, it will be displayed here.

**Name Increment**

Endpoint Names in the batch will be incremented by this amount. If set to 2, the next connections following cx-0001 would be cx-0003, cx-0005, etc.

**Resource Increment A**

Resources used for each endpoint will be incremented by this amount. If set to 2, then resource

1 would be incremented to 3, 5, etc.

**Port Increment A**

Ports used for each endpoint will be incremented by this amount. If set to 2, then eth2 would be incremented to eth4, eth6, etc.

**Directory Increment**

The local directory set in the Directory field will be incremented by this amount if not set to AUTO. If set to 2, then /mnt/lf/foo0001 would be incremented to /mnt/lf/foo0003.

**Mount-Dir Increment**

The mount directory will be incremented by this amount if the Mount-Dir field is not set to AUTO. If set to 2, then /mnt/lf/foo0001 would be incremented to /mnt/lf/foo0003.

**Prefix Increment**

The endpoint prefix will be incremented by this amount if the Prefix field is not set to AUTO. If set to 2, then lf0001 would be incremented to lf0003.

**Volume Increment**

The iSCSI volume will be incremented by this amount if the iSCSI-Volume field is not blank. If set to 2, then iqn.2009-2.com.lanforge:for.all.0 would be incremented to iqn.2009-2.com.lanforge:for.all.2

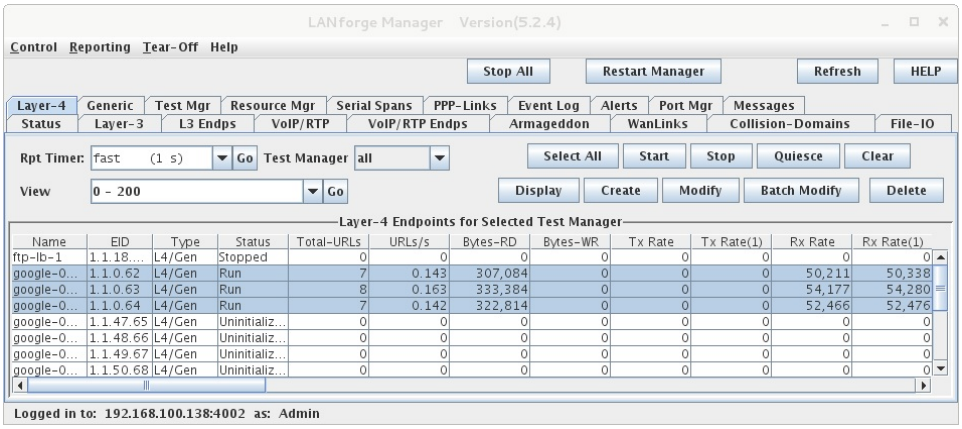
**NOTE**: Volume names are NOT zero-padded by the batch-creator.

---



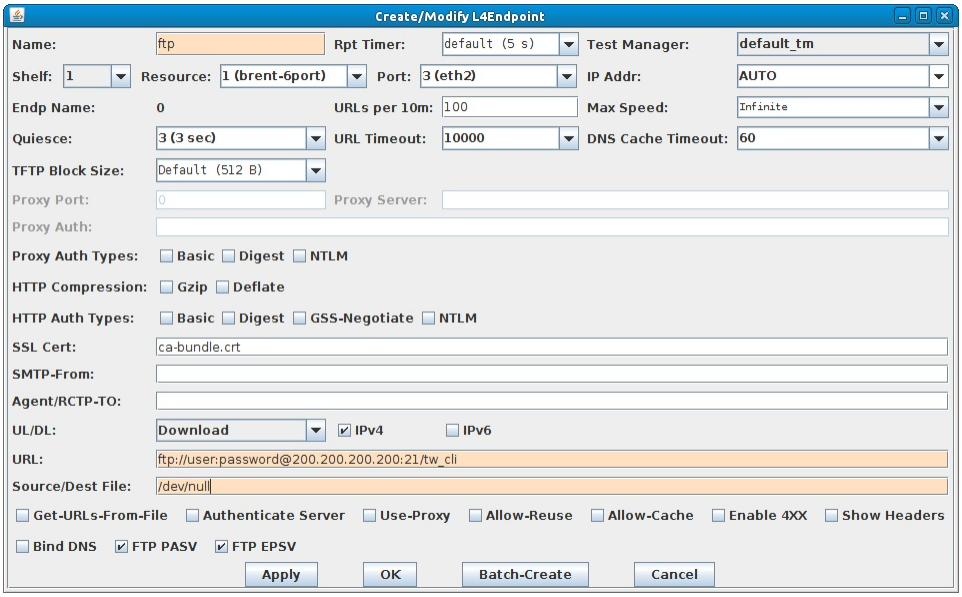
## 21. Layer 4-7 Endpoints (FTP, HTTP, etc.)

You can now create endpoints with these protocols: HTTP, HTTPS, FTP, FTPS, TFTP, SCP and SFTP. These are stateful protocols that will communicate properly with third-party servers. FTP, FTPS, TFTP, SCP and SFTP can upload and download, and the other protocols are only for downloading. The **Layer 4-7** tab is used to manage Layer 4-7 endpoints.




### Creating & Modifying Layer 4-7 Endpoints

To Create a new Layer 4-7 endpoint, click on the **Create** button. This will bring up the Create/Modify L4 Endpoint window. To modify a layer 4-7 endpoint, select the endpoint(s) and click the **Modify** button. You will see a window that looks like this:




After the desired settings have been entered, click **Apply** or **OK** to create the Endpoint. **NOTE**: A series of tests based off the current configuration can be created by clicking the **Batch-Create** button.

If you would like to have LANforge act as an **FTP server**, modify a port and under Services enable FTP. If you are on release 5.2.7 or lower, please see the `/home/lanforge/local/sbin/ct-vsftpd-notes.txt` file on the LANforge machine for directions on setting that up properly.

If you wish to use anonymous FTP upload, make sure the URL points to a directory within `/var/ftp`, for example, `ftp://10.0.0.2/testdir/upload-file.txt` . The directory should be owned by the ftp user (see below commands to create a directory and change ownership).

Create directory:
```
# mkdir /var/ftp/testdir
```

Change directory owner:
```
# chown ftp:ftp /var/ftp/testdir
```

**Note:** If you are using a LANforge release prior to 5.3.5 you will need to enable anonymous uploading by adding the below two lines to the `/home/lanforge/vr_conf/vsftpd_PORT.conf` file after the line `userlist_enable=YES`.
After the change, reset the port that has FTP enabled:

```
anon_upload_enable=YES
anon_other_write_enable=YES
```

### L4 Endpoint Information

**Name**

The Name specifies the name of this Endpoint, and must be unique across the LANforge system.

**Rpt Timer**

The Report Timer specifies how often the Endpoint voluntarily reports data (you can query it at any time).

**Test Manager**

The Test Manager specifies who 'owns' this Endpoint, and can be used to segregate a large LANforge system for use by many engineers. For most users, however, assigning all Endpoints to the default_tm Test Manager is fine.

**Shelf, Resource, Port**

The Shelf and Resource specify which machine this Endpoint will operate on, and the Port specifies which port will be used for outgoing traffic. It will usually dictate the port for incoming traffic too, but LANforge cannot strictly enforce that if you are using a non-LANforge system to serve up the Layer 4-7 data.

**IP Addr**

When using secondary IP addresses, you may choose the primary or any of the secondaries for each endpoint. You may also choose to use a random IP address or do a linear walk of all addresses on the configured interface (Port).
When using random or linear IP addresses, the connection logic should be configured to only run for a limited duration (see Min Duration). Internally, this will cause LANforge to stop and restart the connection when the duration is completed, choosing a new IP address and/or IP port as needed.

For unmanaged endpoints, it specifies the destination IP address for the peer interface.

**Endpoint Name**

The Endpoint Name is just the unique identifier for this endpoint, and may not be modified by the user.

**URLs per 10m**

The "URLs per 10m" field specifies the number of URLs that the endpoint will process in a 10-minute period. This is where you set your rate limiting.

**Max Speed**

Max Speed configures a maximum download or upload rate for the endpoint. You may select a preset value or enter a custom value by typing in the field.

**Quiesce**

Setting the Quiesce value to N seconds tells LANforge to wait to receive packets for N seconds before stopping the test if the Quiesce button is used to stop the test. This is useful if the network under test has high latency.

**URL Timeout**

Specify how long the endpoint should wait to connect, in milliseconds, before timing out.

**DNS Cache Timeout**

This setting is how long to cache a DNS lookup in seconds. If set to zero then there is no caching of DNS entries and a lookup will be performed on every URL request.

**TFTP Block Size**

The block size, in bytes, of a TFTP transfer can be set to support RFC 2348.

**Proxy Port, Proxy Server**

The Proxy Port and Proxy Server relates to HTTP proxies, and will be filled in according to your network setup if you choose to use this feature.

**Proxy Auth, Proxy Auth Types**

If your proxy requires authentication, enter the user password in the 'Proxy Auth' input field. The proxy authentication types are:

- Basic: Sends username and password in plain text over the network.
- Digest: Described in RFC 2617, does not send the plain text password over the network.
- NTLM: NT LAN Manager is a proprietary Microsoft 'challenge/response' protocol.

**HTTP Auth Types**

The available HTTP authentication types are:

- Basic: Sends username and password in plain text over the network.
- Digest: Described in RFC 2617, does not send the plain text password over the network.
- GSS-Negotiate: Described in IETF draft-brezak-spnego-http-04.txt, a Microsoft implementation of SPNEGO and GSSAPI authentication mechanisms.
- NTLM: NT LAN Manager is a proprietary Microsoft 'challenge/response' protocol.

**SSL Cert**

Enter the filename of the SSL (HTTPS) certificate in this field. LANforge ships with an example certs file called 'ca-bundle.crt' which may have all the certs you need.

**SMTP-From**

Enter the FROM email address for use when sending email with SMTP.

**Agent/RCPT-TO**

For non email protocols (ie, HTTP), this is the user-agent string. For SMTP email, this is the 'To' addresses for the email. For multiple addresses, use:
`<a@b.com><b@c.com>..<q@z.com>`

**UL/DL**

UL/DL specifies whether you are uploading to or downloading from the URL, respectively. Select 'Download' for HTTP URLs to avoid undesired results. Select either 'Upload' or 'Download' for FTP URLs, but make sure your FTP server is configured to allow the anonymous login to do what you are requesting. You can set UL/DL to use IPv4 or IPv6:

- IPv4: Use IPv4 for addressing and DNS resolving where possible.
- IPv6: Force URL to be resolved as IPv6 address.

**URL**

The URL specifies the thing you are downloading from, or uploading to. Here is an example URL for an Upload:

- ftp://172.1.1.103/pub/upload/gnuserver.upload

Some URLs include:

- Upload/Download a file with FTP, using anonymous login:
  ftp://172.1.1.103/pub/gnuserver
- Upload/Download a file with FTP using user/password to login:
  ftp://user:password@ftp.my.site:8021/README
- Upload/Download a file with TFTP login:
  tftp://192.168.100.6/bthelper
- Download a file with HTTP:
  http://172.1.1.103/index.html
- Download a file with HTTPS:
  https://172.1.1.103/index.html
- Download all email in INBOX with POP3:
  pop3://user:password@mail.candelatech.com/
- Upload/Download a file with scp:
  scp://user:password@192.168.100.3//home/user/10M.file-dl
- Upload/Download a file with sftp:
  sftp://user:password@192.168.100.3//home/user/10M.file-ul
- Send email with SSL security using SMTP:
  smtps://user:password@mail.candelatech.com
- Send email with SSL security using SMTP, use script to generate random email text:
  Select **Get-URLs-From-File**
  Specify file in URL textbox: `smtp_urls.txt`
  The file should have contents similar to:

```
$ system 'update_email_txt.pl > /tmp/smtp_script_mail.txt'
ul smtps://user:password@mail.candelatech.com /tmp/smtp_script_mail.txt
```

- Send/Receive Telnet protocol, use script with expect logic:
  Select 'Get-URLs-From-File'
  Specify file in URL textbox: telnet_urls.txt
  The file should have contents similar to:

```
log Starting telnet session
dl telnet://192.168.100.6 /tmp/fs2-telnet.txt
expect login: user
expect Password: password
expect ]$ ls
expect ]$ exit
done
log Done with telnet session.
```

Another option is to have a list of URLs in a file on the LANforge data generator machine. In that case, you specify that filename (relative to /home/lanforge) and the Layer 4-7 Endpoint will process every URL in that file, over and over again. A file might look like:

```
# Format is:
# [ul | dl] 'URL' 'filename'

# Get default web page from lf1
dl http://172.1.1.103/index.html /tmp/172.1.1.103_index.html

# Get default web page from lf4
dl http://172.1.1.103/index.html /tmp/172.1.1.103_index.html

# Get a file via FTP
dl ftp://172.1.1.103/pub/gnuserver /tmp/172.1.1.103_gnuserver

# Put a file via FTP
ul ftp://172.1.1.103/pub/upload/gnuserver.upload /tmp/172.1.1.103_gnuserver

# Log a message to LANforge logs
log This is the message that will show up in the logs.

# Sleep for one second (1000 ms)
sleep 1000
```

```
# expect [input] [output]  Only works with Telnet currently.
expect login:  user

# Done with telnet connection.
done

# Call a system command (Used to generate a new email text in this case)
# The environment variable LFL4_SYSCNT will be set to the number of times
# the system call as been executed while processing this script.
system 'update_email_txt.pl > /tmp/smtp_script_mail.txt'

# Set some values in the Layer 4-7 Endpoint
set smtp_from support@candelatech.com
set rctp_to <customer1@foo.com><customer2@foo.com>
```

#### Source/Dest File

The Source/Dest File specifies where you will save the downloaded URL, or what you will upload to the URL if you are uploading. **Be careful not to overwrite any useful files! LANforge runs as root, and will happily overwrite any file you specify! We suggest you always use files in the /tmp directory for safety.**

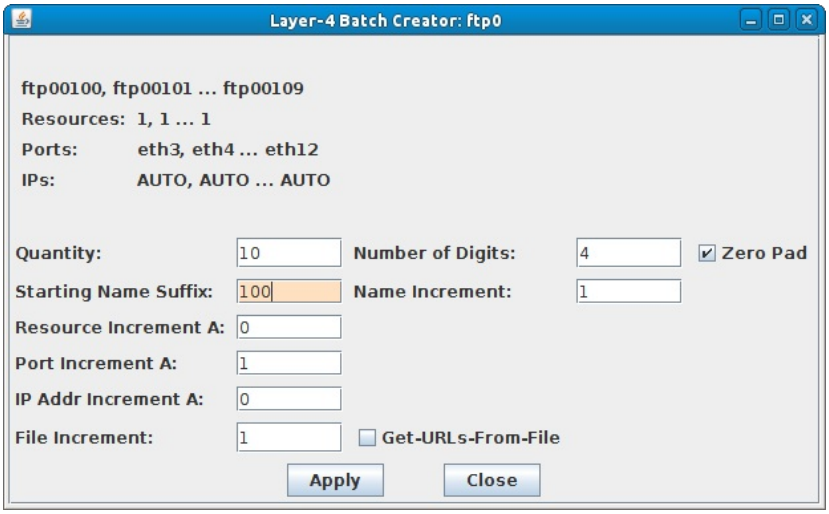
#### Flags & Options

The following flags (checkboxes) are used to enable or disable certain features which affect the behavior of the selected endpoint.

- **Get-URLs-From-File** tells the endpoint to treat the URL as a file on the local machine. Note that you do not (at this time) put any URL protocol on the filename. In other words, use `/tmp/foo.txt`, and not `file://tmp/foo.txt`.
- **Authenticate Server** should be checked if you are using SSL (HTTPS) and want to verify the server. Do not select this checkbox if your server is not authenticated.
- **Use-Proxy** enables the use of HTTP proxy settings.
- **Allow-Reuse** allows LANforge to reuse existing connections when possible. When not selected, LANforge will create a new connection for each requested URL.
- **Allow-Cache** allows LANforge to use cached objects from servers.
- **Enable 4XX** enables 4XX error reporting, counting all HTTP error codes 400 and above. When enabled, any HTML data associated with this response code will be ignored. When disabled, no error will be reported for error codes 400 and above and HTML content will be downloaded as normal.
- **Show Headers** downloads/shows headers as appropriate. For example, this allows email headers to be downloaded when using IMAP.
- **Bind DNS** ensures DNS queries originate from the endpoint's port. Without this enabled, it will usually originate from the management port.
- **FTP PASV** will often work better than the PORT option when running through firewalls and NAT.
- **FTP EPSV** (extended version of FTP PASV) will often work better than the EPRT option when running through firewalls and NAT.

### Batch-Create Layer 4-7 Endpoints

A series of tests can be created based on the Name and other current settings in the Create/Modify L4Endpoint window by using the Batch-Create function. For best results, create a valid endpoint for the first in the series to be batch-created, select the endpoint and click **Modify**. Clicking the **Batch-Create** button at the bottom of the window will pop up the Layer 4-7 Batch Creator:




After the desired settings have been entered, click **Apply** or **OK** to create the series (batch) of Layer 4-7 Endpoints.

**Quantity**

The number of Layer 4-7 Endpoints to batch-create, using the selected endpoint for the initial values.

**Number of Digits**

The number of characters (padding) to be used in appending each endpoint name. Adds leading zeros (zero-pads) to endpoint names as required (this may help with sorting connections). For best results, this number should match the format of the selected endpoint (Ex: 3 for an initial endpoint named L4test100).

**Zero Padding Checkbox**

Uncheck the 'Zero Padding' checkbox if you do not desire leading zeros for the endpoint names when they are created.

**Starting Name Suffix**

The first number in the series (Ex: 100 for L4test100) from which subsequent endpoints will be incremented. If the original endpoint name ends in a number or series of numbers, it will be displayed here.

**Name Increment**

Endpoint Names in the batch will be incremented by this amount. If set to 2, the next connections following cx-101 would be cx-103, cx-105, etc.

**Resource Increment A**

Resources used for each endpoint will be incremented by this amount. If set to 2, then resource 1 would be incremented to 3, 5, etc.

**Port Increment A**

Ports used for each endpoint will be incremented by this amount. If set to 2, then eth2 would be incremented to eth4, eth6, etc.

**IP Addr Increment A**

The amount by which IPs for Endpoint A will be incremented. If the port has IPs 1.1.1.1 and 1.1.1.5, and the increment value is set to 1, then the endpoints will alternate between those two.

**File Increment**

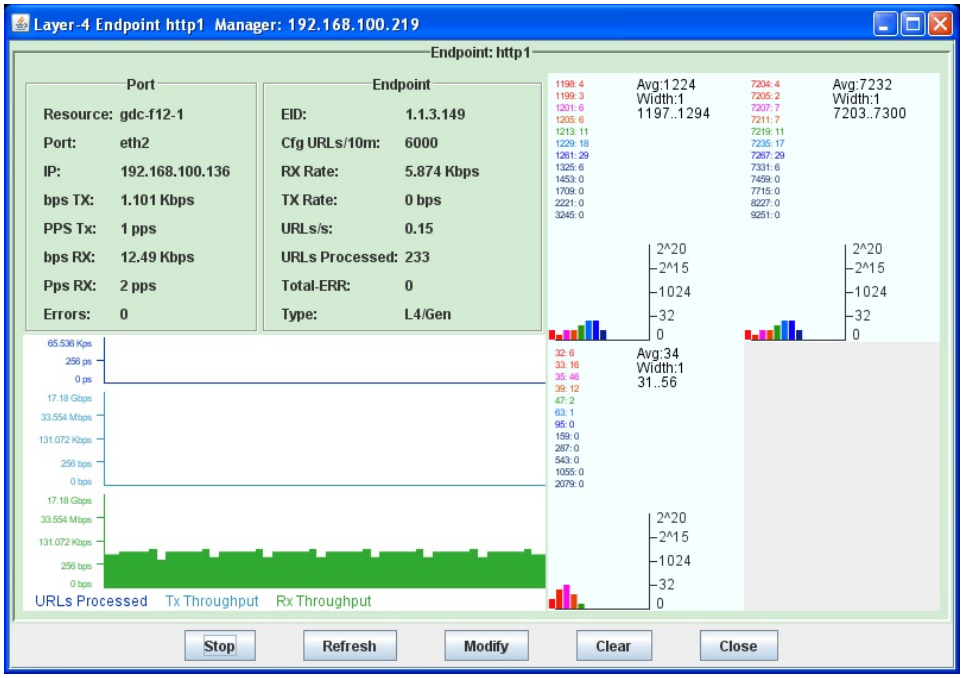
Files (for saving) will be incremented by this amount.

**Get-URLs-From-File**

Tell the endpoint to treat the URL as a file on the local machine.

## Layer 4-7 Endpoint Display

Individual Layer 4-7 connections can be selected for display from the **Layer 4-7** tab. Select a connection and click the **Display** button to bring up a summary window for that connection.




The graphs on the right side of the Layer 4-7 Endpoint display window show the latency distributions for various measured parameters in milliseconds. The top left graph shows the latency distribution of the time it took to receive the first byte of data from the server. The top right graph displays the distribution of the time it took to complete the URL request from beginning to end. And the bottom left graph indicates the latency distribution for DNS lookups.

LANforge only counts the latencies when it receives the packet. This is not exactly the time that the packet was received by the LANforge hardware because the packet must flow through the protocol stacks up to the LANforge server. This is the primary cause of the range of latencies you will see reported even on a simple and fast LAN. The average is usually very close though: It is a running average of the last 100 URLs received.

The upper right portion of each display widget lists the average latency (in milliseconds), width, and min/max latency within the respective time period. The color-coded numbers on the upper left of each widget are counters for each latency 'bucket' and are represented by the vertical bar graph below it.

The units for the size of the buckets are milliseconds, and are logarithmic (2^X) in scale. The exponential values (1, 2, 4, 8, etc.) will be multiplied by the bucket 'width' (currently always 1), and added to the minimum latency. For instance, if the minimum latency is 30 milliseconds, then the range of the first several buckets for each will be:

```
31:
32:
34:
38:
46:
...
```

Assuming the minimum is 30, if the bucket "1" has 2000 beside it, then that means that 2000 URLs have been received in the last time-period that had less than 31 milliseconds latency. If the bucket "2" has 30 beside it, then that means 30 packets had latency between 31 and 32 milliseconds.

The minimum latency can change over time, which will cause the buckets to shift their values. Although this may be confusing at first, it allows LANforge to report high-precision data regardless of the latency of the system under test.

When viewing the Spreadsheet output, the lat_0, lat_1, etc columns show the number of packets received in the last time period that fall into the buckets.

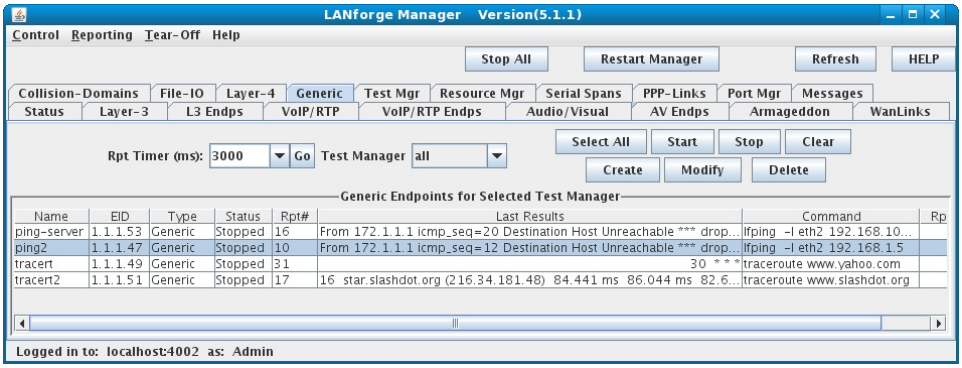
---



## 22. Generic (User) Endpoints (ping, traceroute, etc.)

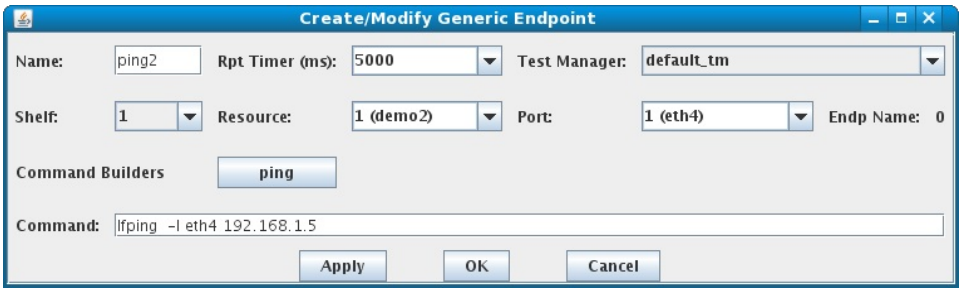
LANforge has the ability to control command line tools and collect their results. For example, the 'ping -I eth4 172.1.1.2 -s 1024' command will ping to host 172.1.1.2, using the local interface eth4. The command must not redirect standard-out, or LANforge may not be able to properly stop the test. It is up to the user to specify the correct command line, but Candela Technologies will be happy to offer

suggestions and help with any tools you would like to use in this manner.




## Creating & Modifying Generic Endpoints

To Create a new Generic endpoint, click on the **Create** button on the **Generic** tab. To modify, select the Endpoint(s) and click the **Modify** button. You will see a window that looks like this:




**Name**

The Name specifies the name of this Endpoint, and must be unique across the LANforge system.

**Report Timer**

The Report timer specifies how often the Endpoint voluntarily reports data (you can query it at any time).

**Test Manager**

The Test Manager specifies who 'owns' this Endpoint, and can be used to segregate a large LANforge system for use by many engineers. For most users, however, assigning all Endpoints to the default_tm Test Manager is fine.

**Shelf, Resource, Port**

The Shelf and Resource specify which LANforge data generator the command will be run on. The Port specifies which interface the traffic should go on, but at this time, LANforge does not enforce that the command-line is correct. The user must specify the correct command line arguments to whatever command is being used.

**Endpoint Name**

The Endpoint Name is the unique identifier for this endpoint, and may not be modified by the user.

**Command Builders**

The Command is the command that will be run on the specified machine. It should be identical to what you would have to type if you were to telnet into that machine and run the command.

## Other commands/tools you might find useful:

**PING (ICMP)**

You can use the standard ping program, but you may also want to consider the lfping script included with LANforge. It wraps the ping program and offers better reporting.

```
lfping -I eth1 -s 1024 192.168.1.100
```

**Traceroute (ICMP)**

Traceroute is a tool that is used to show each packet hop (router) for a path through a network. It utilizes ICMP response codes to determine the path.

```
traceroute www.slashdot.org
```

**DNS**

DNS is the protocol that programs use to resolve domain names into IP addresses and vice versa. We provide a modified version of the standard unix 'dig' tool for generating DNS traffic:

```
./dig -b <local-ip> -B <local-iface> [@<nameserver.com>] <domain>
```

**SMTP**

SMTP is the Simple Mail Transfer Protocol, which handles the vast bulk of email on the internet. We provide the smtp-client.pl program which is a simple client script that can talk to a third-party mail server, such as sendmail. You can get some additional help on the tool by running the command: ./smtp-client.pl --help from the Linux prompt on the lanforge machine. The text file to be sent as email can have headers, for instance:

> Subject: Test Email
>
> This is a test email.

```
$ ./smtp-client.pl --enable-auth --verbose \
--user <user-name> \
--host $lt;mail-server-name-or-ip> \
--local-host $lt;local-ip> \
--local-iface $lt;local-iface> \
--to $lt;target@email.com> \
--from $lt;me@domain.com> \
--pass $lt;mail-server-password> \
--data $lt;text-file-to-email>
```

**TELNET**

Telnet requires user-interaction, so we utilize an expect script. Please examine the telnet_expect_wrapper.pl and telnet.expect scripts. You will also need to use the modified 'telnet' executable that comes with LANforge.

**Netcat, Nmap**

Scripts to generate random netcat and Nmap traffic have been donated by Daniel Berry. You will need to edit the script slightly to match your network configuration. Please see the rand_nc.pl and rand_nmap.pl scripts for details.

**Curl, Wget**

If Layer 4-7 endpoints do not provide the traffic behavior you require, it is possible to create custom scripts using curl or wget. To direct traffic across specific interfaces, you need to bind the invocation of those utilities to the specific interfaces. Often, you want to make such scripts loop over a list of URLs to fetch.

### Example of downloading YouTube videos involving LANforge Curl

⚠ This example is known to work with Fedora releases 19-21 that use the **0.4.x** versions of `clive`. Newer releases of Fedora use the **0.9.x** version of `clive` which does not appear to work well with the `quvi` package.

To effectively download YouTube videos, you need to install the **clive** program (as found in Fedora 17 or later, the version using the quvi utility).

```
# sudo yum install clive # Fedora 17
```

```
# sudo apt-get install clive # Ubuntu 12.04
```

There are scripting files to accompilish this in /home/lanforge/generic:

**`clive_battery.txt`**

a list of youtube urls to download

**`clive_config_templ.txt`**

a skeleton configuration file

**`create_clive_conf.bash`**

creates one clive configuration script. It needs the name of the specific interface and the dns server that interface would use. E.G.:
`create_clive_conf.bash sta1001 10.99.99.2`

**`create_n_clives.bash`**

creates a series of configuration scripts, It needs the prefix of the interfaces to use, the starting

interface number, the ending interface number, and the DNS ip that those interfaces would use. E.G.:
`create_n_clives.bash sta 1001 1100 10.99.99.2`

**`clive_loop.bash`**

loops the clive command over the contents of clive_battery.txt for the specified interface. This is the command that gets put into the generic endpoint. E.G.:`clive_loop.sh sta1001`

Start by creating 10 wifi station endpoints, `sta1001 – sta1010` and getting them to associate with their wifi access point. Next, setup a directory for a series of clive configs. You will then create a clive config file for each port. (Example now uses `/var/tmp` because `/tmp` is often memory-backed and a large test could make your system start swapping.)

```
$ mkdir /var/tmp/clive
$ ln -s /var/tmp/clive /tmp
$ ln -s /home/lanforge/generics/clive_loop.bash /tmp/clive/loop.bash
$ ln -s /home/lanforge/generics/clive_battery.txt /tmp/clive
$ cd /home/lanforge/generics; ./create_n_clives.bash sta 1001 1010 10.99.99.2
```

Following this, test one of your clive config files on the command line:

```
$ export LD_LIBRARY_PATH=/home/lanforge/local/lib
$ CLIVE_CONFIG=/tmp/clive/clive_sta1001.config /usr/bin/clive -O /tmp/clive/video.out 'http://www.youtube.com/watch?v=B
$ ls -lh /tmp/clive/video.out   # check the file size
$ file /tmp/clive/video.out     # check that it is not a html file
```

If you do not get a video downloaded, please try these steps:

1. Edit a clive config file (EG `clive_sta1001.config`) and add `-qv` to the `curl` command. Example:

```
--get-with "nice -n 19 /home/lanforge/local/bin/curl -qv -m 30
 --max-redirs 1
 --connect-timeout 10
 -sLki -4 -c '/tmp/clive/curl-eth1.cookie'
 -b '/tmp/clive/curl-sta1000.cookie'
 --interface 'sta1000'
 --localaddr '192.168.100.28' --dns-servers '8.8.8.8'
 --dns-interface 'sta1000'
 --dns-ipv4-addr '192.168.100.28'
 -C - -o %f %u --user-agent 'Mozilla/5.0' "
```

   Proceed to run the test command (beginning with CLIVE_CONFIG= ...)

2. Validate that your station can resolve the hostname 'www.youtube.com' by using the `dig` command:

```
$ dig -t 192.168.100.28 @8.8.8.8 www.youtube.com
```

3. Validate that your station can ping the youtube:

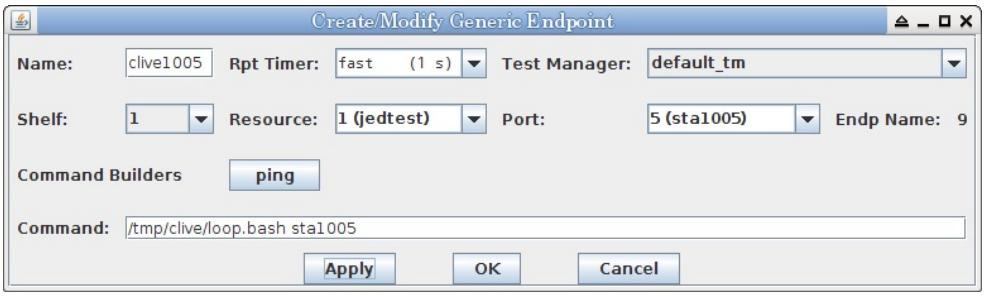
```
$ host www.youtube.com
www.youtube.com is an alias for youtube-ui.l.google.com.
youtube-ui.l.google.com has address 172.217.11.174
youtube-ui.l.google.com has IPv6 address 2607:f8b0:4007:80d::200e

$ ping -I 192.168.100.28 172.217.11.174
```

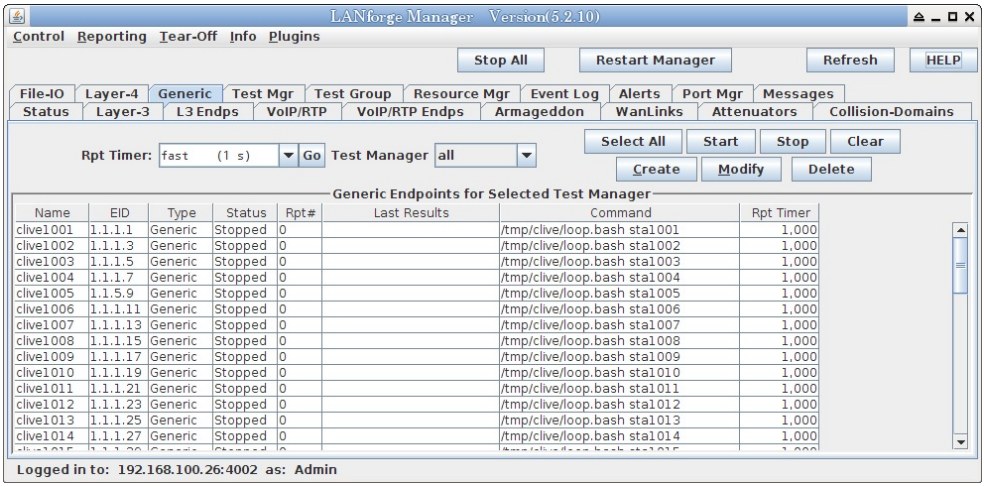
### When your stations can download

For each station, you will enter the shortened version of the command that calls the loop:

| | |
|---|---|
| Name: | clive1001 |
| Port: | (sta1001) |
| Command: | /tmp/clive/loop.bash sta1001 |




Continuing, you can then create your 10 generic endpoints using the endpoint config.




When you are confident that your clive endpoints are downloading, in the **Generic** tab you can highlight all endpoints and click **Start** to start all scripts downloading.

---



## 23. Resources (Data Generator Machines)

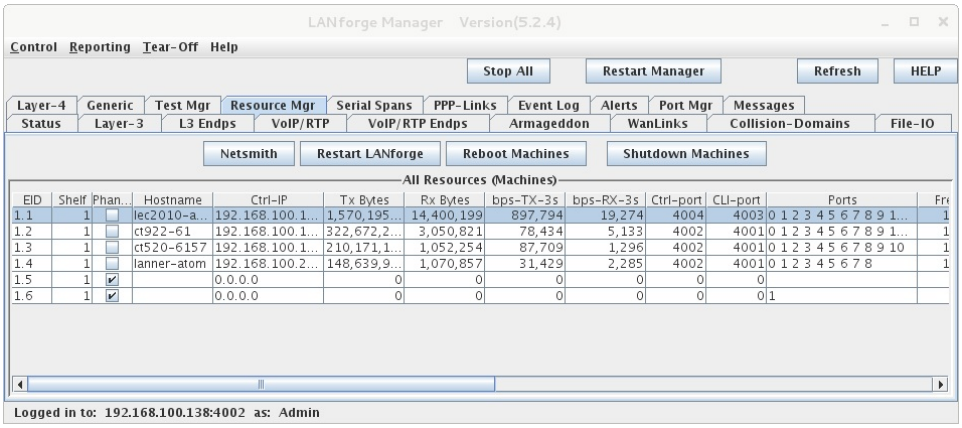
The LANforge system uses the term 'Resource' to apply to a data-processing machine. The **Resource Mgr** tab displays information on all Resources discovered by the LANforge server and provides the ability to perform system functions on selected machines (one or more). Clicking the **Netsmith** button will open a Netsmith display window for the selected Resource(s). Clicking the **Restart LANforge** button will restart the LANforge server on the selected Resource(s). Clicking the **Reboot Machines** button will reboot the operating system on selected Resource(s). Clicking the **Shutdown Machines** button will shutdown the operating system on the selected Resource(s).

If a resource indicates 'Phantom', then the LANforge server is not running on it, or the LANforge manager is unable to communicate with it for some reason. You will not be able to manage a Resource in this state. If the Resource is not Phantom, then you can also reboot the Resource OS, or shutdown the OS for good (i.e., until a power-cycle of the individual Resource.)

If you have LANforge systems in a geographically disperse deployment, you may wish to connect them to a GPS device to automatically obtain their location. LANforge supports this feature, and all you need to do is configure the right serial port settings using the lfconfig tool. You may also manually enter the coordinates using the CLI.

**POWERING DOWN NOTE:** If you DO wish to power down a Resource completely (i.e. remove power), then you should ALWAYS choose to shutdown the Resource first, and give it about 1 minute to take itself down gracefully.

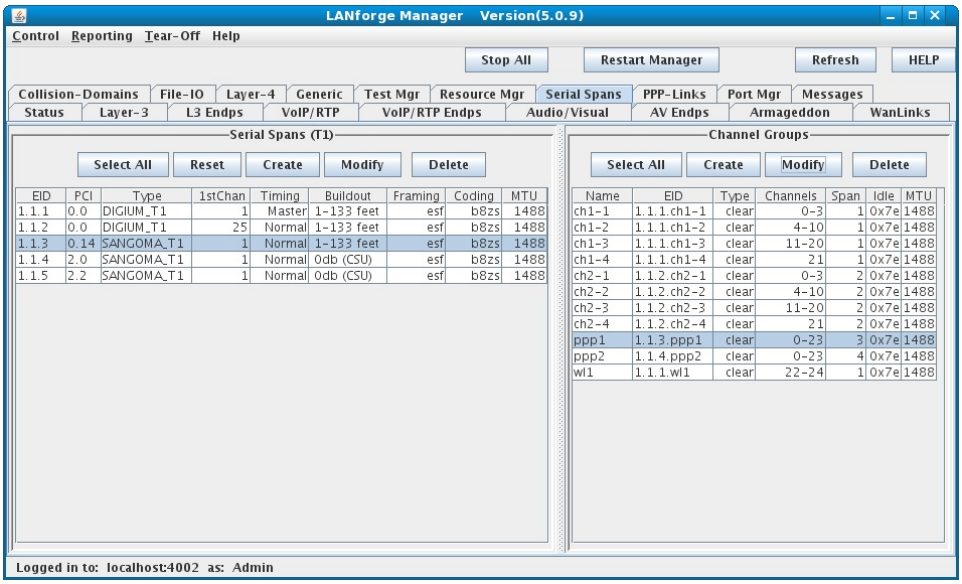
**NOTE**: Shutting down a machine will destroy any test that is using that machine. The operating system may not come back up until a power-cycle is performed.





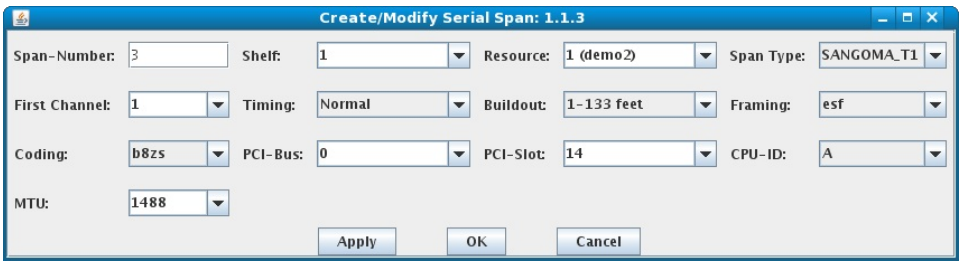

24. # Serial Spans

The **Serial Spans** tab is used to manage T1 and E1 spans and channel groups. T3 and other higher speed interfaces may be supported in the future. Currently, Digium T1 cards and Sangoma T1 and E1 cards are supported.




## Creating & Modifying Serial Spans

LANforge cannot currently detect the T1/E1 spans automatically, so you must add them through the GUI if your system is not pre-configured. Click the **Create** button in the Serial Spans (T1) panel of the **Serial Spans** tab. This will bring up the Create/Modify Serial Span window:




**Span-Number**

This number must be unique on each Resource. This number is used to configure Digium cards, so if you have a system with both Digium and Sangoma T1 adapters, you should configure the Digium interfaces with IDs starting with 1.

**Shelf**

The virtual shelf for the LANforge machine that will hold the T1 interface.

**Resource**

The LANforge machine that will hold the T1 interface.

**Span Type**

The type of hardware for this span. Sangoma-T1 and Sangoma-E1 are the only valid choices at this time.

**First Channel**

This is used to configure the Digium adapters. For T1 interfaces, the first channel can be calculated with this formula: span-number * 24 + 1

**Timing**

This influences how the T1 interface derives its timing. The correct setting depends on the settings of the device terminating the span. If the peer is MASTER, then set LANforge to Normal, and vice versa.

**Buildout**

Choose the setting closest to the actual length of the T1 span this interface will be attached to.

**Framing**

The framing for this T1 interface. ESF is a good choice if you are uncertain and are using T1 NICs. D4 is also supported by Sangoma NICs.

**Coding**

The encoding protocol for this T1 interface. b8zs is a good T1 choice if you are uncertain. AMI is also supported by Sangoma.

**PCI-Bus**

This is needed for Sangoma T1 cards only. You can find the PCI bus by looking at the output of `wanrouter hwprobe`

**PCI-Slot**

This is needed for Sangoma T1 cards only. You can find the PCI slot by looking at the output of `wanrouter hwprobe`

**CPU-ID**

This is needed for Sangoma T1 cards only. For a 2-port NIC, one interface will be 'A' and the other will be 'B'.

**MTU**

This specifies the MTU for the in-band management. This can be left at the default of 1488 and does not affect LANforge behavior.

## Creating & Modifying Channel Groups

After creating a Serial Span, you can now configure one or more channel groups on the span. Digium T1 cards support up to 24 channel groups per span, but the Sangoma cards we have tested only support 1 channel group at this time. Click the **Create** button on the Channel Groups panel of the **Serial Spans** tab. This will bring up the Create/Modify Channel Group window:


**Name**

The name for the channel group should be unique to the specified resource and no more than 47 characters in length.

**Shelf**

The virtual shelf for the LANforge machine that will hold the channel group.

**Resource**

The LANforge machine that will hold the channel group.

**Span**

The Span number that this channel group will reside upon.

**Channel Group Type**

Specifies the encoding for this channel group. Select 'clear' for PPP channel groups.

**Channels**

Specifies the particular channels to use for this channel group. Examples of possible entries include: "ALL", "0-23", "0-4,7,9,20-23", and "1,2,3,4,5,6".

**MTU**

This specifies the MTU for this channel group. If your machine is being over-worked and/or dropping packets, try increasing the MTU. For PPP links, the MTU is not critical, and should be set to a larger value, like 1488 or 1500.

**Idle Flag**

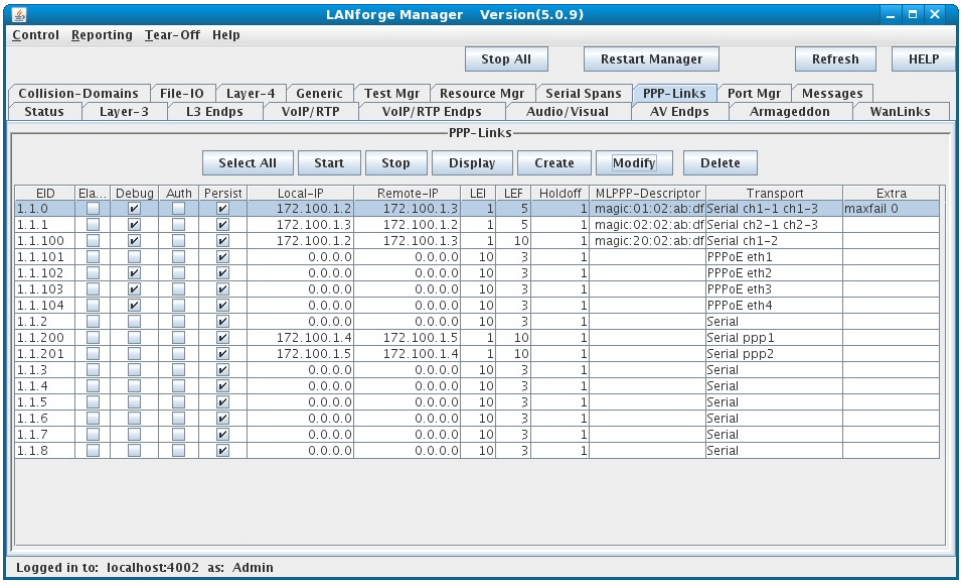
This specifies the idle flag for this channel group. This byte pattern will be sent automatically by the T1 hardware whenever there is nothing else to send. This value should probably match the idle flag used by the peer equipment to which LANforge is attached.

---



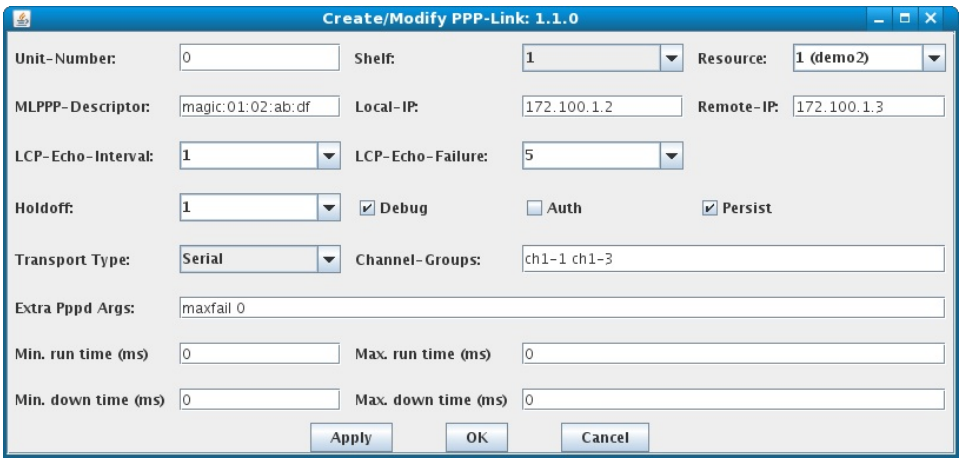
## 25. Creating & Modifying PPP Interfaces

The PPP connections will run over one or more T1 channel groups, and PPPoE interfaces can be created over regular ethernet (assuming you have a PPPoE server available). If you choose more than one channel group, then the multi-link PPP protocol will be used.




The basic building block of the ppp daemon is the pppd server. If you only use Sangoma T1 hardware or PPPoE, the default pppd on modern distributions will work. LANforge creates a start script in the pppScripts directory. When the PPP link is started, LANforge will fork and exec this script.

To create a PPP connection, click **Create** from the **PPP-Links** tab. This will bring up the Create/Modify PPP-Link window:




**Unit-Number**

Should be unique for a particular resource. This will be the XXX in the device name pppXXX. For instance, if the interface should be called ppp2, then set the Unit-Number to 2.

**Shelf**

The virtual shelf for the LANforge machine that will hold the PPP Link

**Resource**

The LANforge machine that will hold the PPP Link

**MLPPP-Desriptor**

If using Multi-Link PPP, then set the descriptor here. It should start with magic: and then be followed by asci-hex. For example: magic:01:02:ab:df The identifier should be unique for each PPP-Link on a particular machine.

**Local-IP**

Specify the Local-IP for this PPP Interface. Not needed for PPPoE.

**Remote-IP**

Specify the Remote-IP for this PPP Interface. When connecting two PPP links to each other, the Local & Remote IP addresses should be swapped. Not needed for PPPoE.

**LCP-Echo-Interval**

Specifies, how often (in seconds) a Link Control Protocol echo should be sent.

**LCP-Echo-Failure**

Specifies how many echo failures we can have before we consider the link to be down.

**Holdoff**

How long (in seconds) to wait before trying to reestablish a PPP link that has gone down for some reason.

**Flags & Options**

The following flags (checkboxes) are used to enable or disable certain features which affect the behavior of the selected endpoint.

- **Debug** will run the ppp daemon in debugging mode. The log files will be placed in the pppLogs directory.
- **Auth** should be selected if you want to authenticate this PPP connection. Auth is not supported at this point, so leave this un-selected.
- **Persist** will cause LANforge to attempt to reestablish the PPP link if the link goes down for some reason. In most cases, this option should be selected.

**Transport Type**

Specifies the transport type over which the PPP is sent (e.g., Serial, PPPoE, TTY). The drop-down menu selection here configures the the following data field to enter Channel-Groups, PPPoE-Port, or TTY-Device, respectively.

**Channel-Groups (for Serial transport type)**

Specifies the channel group(s) to use for this PPP Link. If multiple groups are specified, multi-link PPP will be used and the MLPPP-Descriptor must also be specified.

**PPPoE-Port (for PPPoE transport type)**

Specifies the ethernet port to use as the network interface for PPPoE transport.

**TTY-Device (for TTY transport type)**

Specifies the TTY device to use for PPP transport.

**Extra Pppd Args**

If you want to pass your own arguments to the pppd process, add them in this field. If you add the wrong options you can cause all sorts of problems, so use this with care.

**Run Timers**

If you want the PPP link to come up and down at some interval, you can set the min/max run and down timers. The LANforge traffic generation cross-connects will automatically re-start when the PPP links come back up.

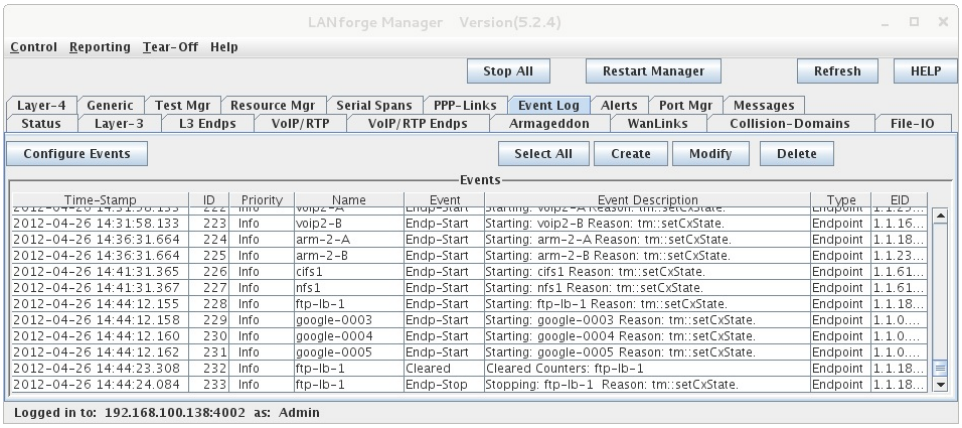


26.

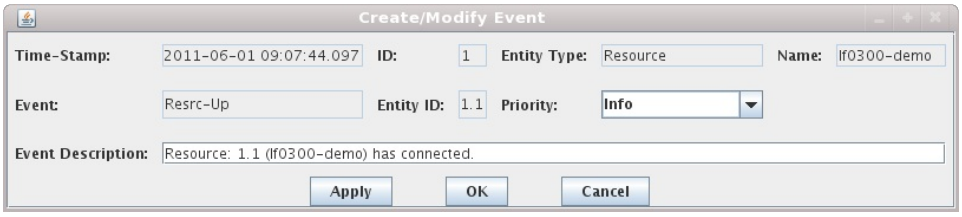
## Event Log

The **Event Log** tab is used to record interesting events. The user may also create custom events. This

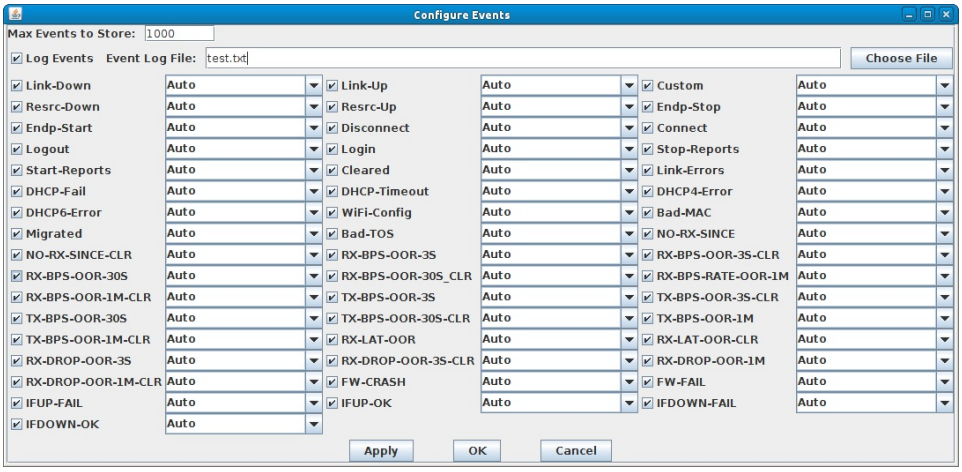
may help users correlate test results with certain events, such as link up/down, starting and stopping of tests, etc. Suggestions are welcome for more events of interest.




The text message in the events can be modified by the user. Double-click the event, or use the right-click popup-menu to bring up the Create/Modify widget.



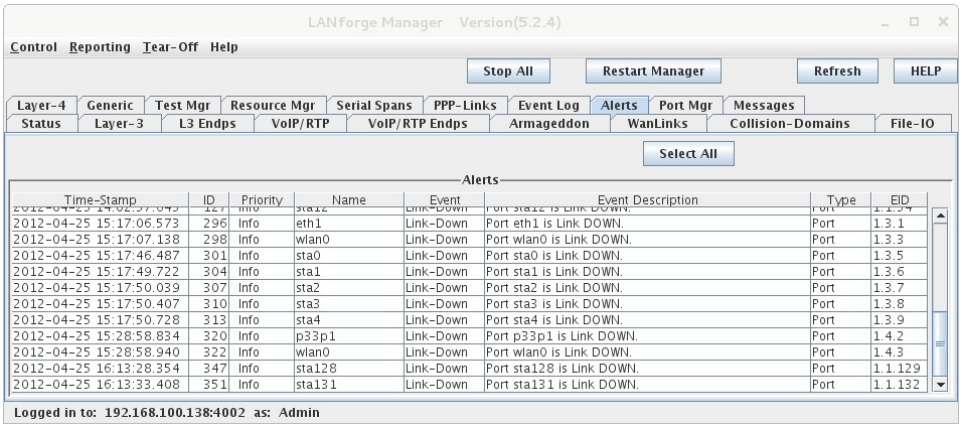

They can also be logged to a file and the default priorities can be overridden. Each event type can also be filtered out if the user is not interested in it. To modify these settings, click the **Configure Events** button, and modify the values in the resulting window:






27. ## Alerts

The **Alerts** tab is used to display current alerts in the system. This includes interfaces that are not connected and similar problems. As of release 5.2.4, only a few Alerts are supported, but more will be added in future releases. Suggestions are welcome.

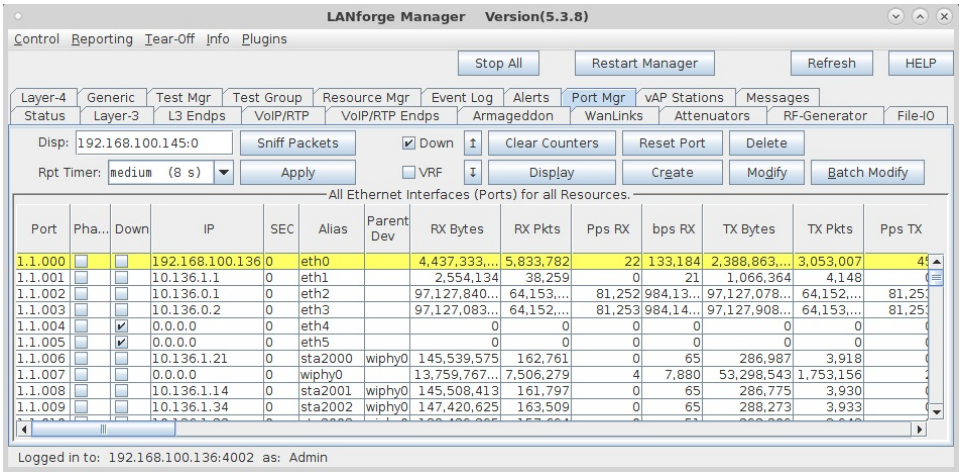





## 28. Ports (Interfaces)

The **Port Mgr** tab represents the individual Ethernet Ports and other virtual interfaces on the LANforge Data Generators (Resources). It has a large number of counters whose values are acquired from the kernel drivers. Each port can be configured with an IP address (and must be configured if you are running anything other than raw Ethernet protocols or LANforge-ICE) and a default gateway. The Default Gateway will be used when the system-under-test acts as a router. LANforge is designed to make each port look as if it's a separate computer, so you are able to specify a different default gateway on each port, or the same one if you desire. You are not restricted to the use of Port IP addresses, except that you must not have duplicate IP addresses on the same Resource, and of course they must make sense in whatever testing network you have configured. TCP/IP networking can be complex, so if you have questions not addressed here, email support@candelatech.com and they will explain how LANforge can address your specific needs.

LANforge can also give you easy access to some ethernet driver configuration options, including various link speeds and auto-negotiation settings. This, of course, will only work if you have the cards and ethernet drivers which support these features.




The buttons on the top panel of the **Port Mgr** tab are used to view and manage individual ports.

**Down** (checkbox)

Select this to see admin down ports. Unselect this to hide admin down ports.

**VRF** (checkbox)

Select this to see VRF interfaces. Unselect this to hide VRF interfaces.

↥ (up arrow)

Click this to bring selected ports admin-up.

↧ (down arrow)

Click this to bring selected ports admin-down.

**Clear Counters**

Clears the counters for the selected ports.

**Reset Port**

Clicking **Reset Port** tells the driver to drop the ethernet link of the selected port. It will then read the TCP/IP configuration information from a file that was generated when you configured (Modified) the Port, and rebuild all of the TCP/IP information, including the default gateway, IP address, and subnet-mask.

#### View Details

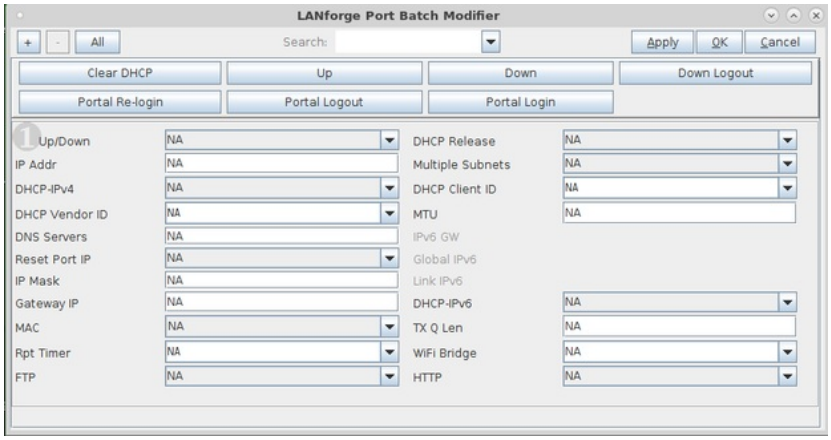
Clicking **View Details** opens the Current Settings window which displays a read-only view of the selected port. This will be automatically updated as information is received from the server. It is useful to have one of these windows open while configuring a port as it allows you to see exactly what the server is reporting at any given time.

#### Batch Modify

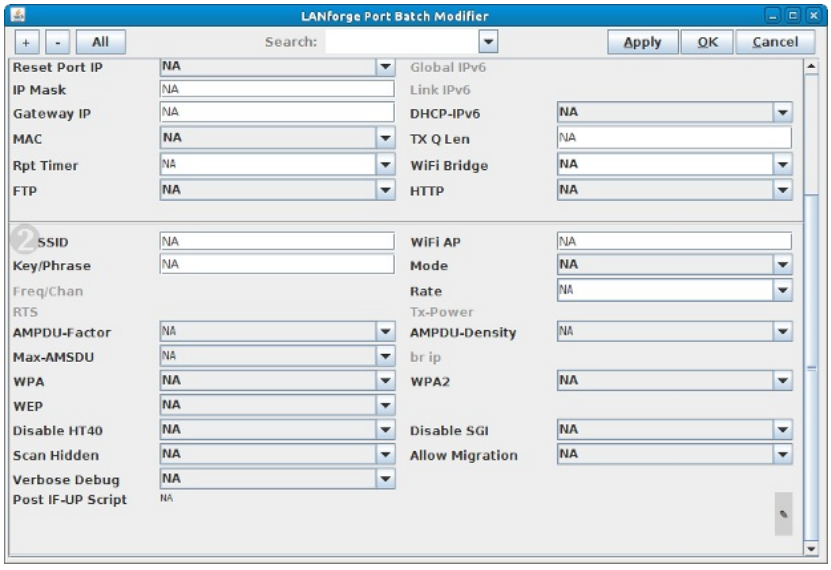
Bulk changes to ports can be performed easily by selecting one or more ports and clicking the **Batch Modify** button. Selected values from the drop-down menus will be applied to all selected ports. Port values marked 'NA' will remain unchanged.

As of LANforge version 5.3.2, the Batch Modify Ports screen expands from one to five panels:

Basic port settings



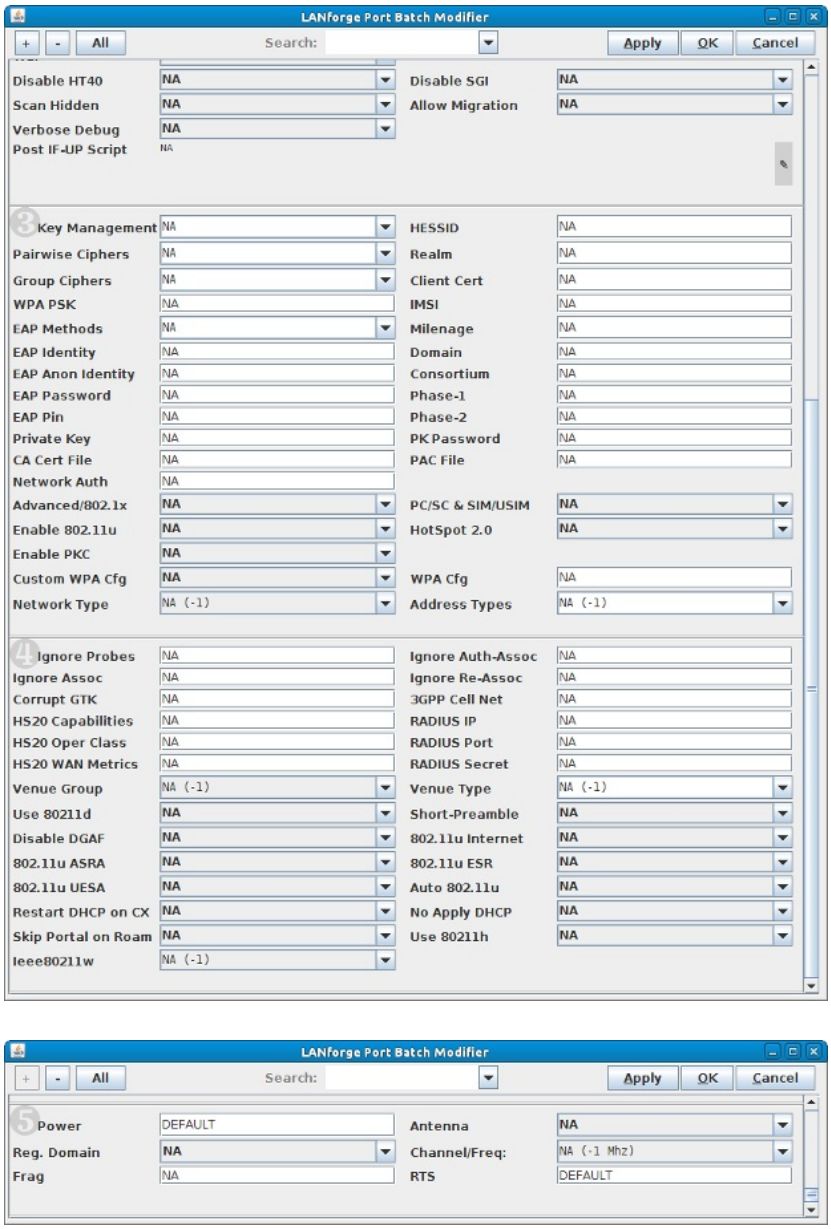

Basic WiFi settings



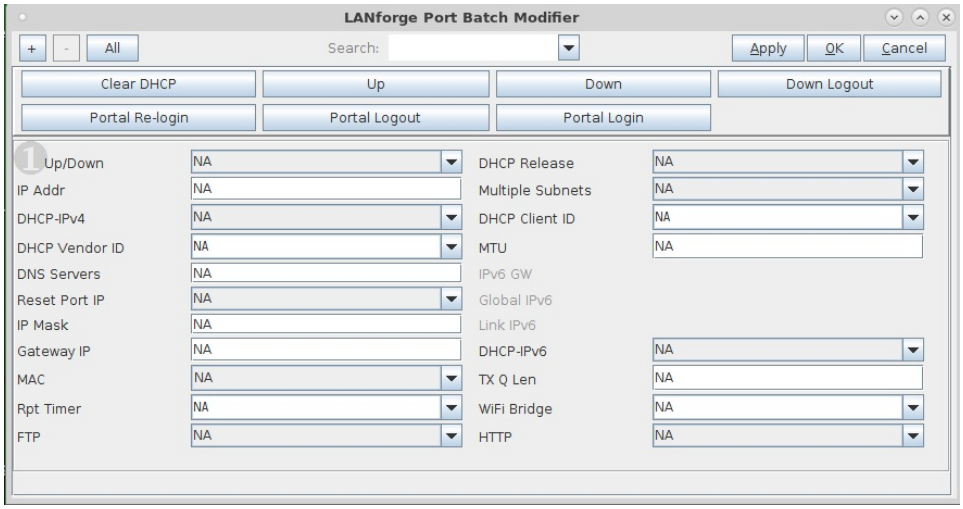
Advanced WiFi station options

Advanced WiFi AP options

Additional WiFi settings




When you modify fields in the batch modify screen, they are highlighted so that you can quickly survey your changes before you apply them.

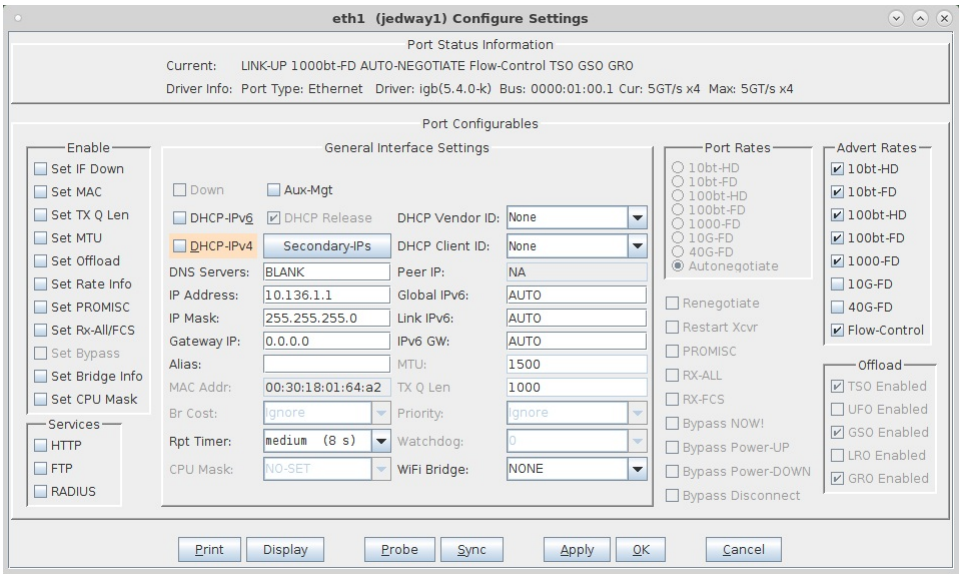



29. **Viewing & Modifying Ports**

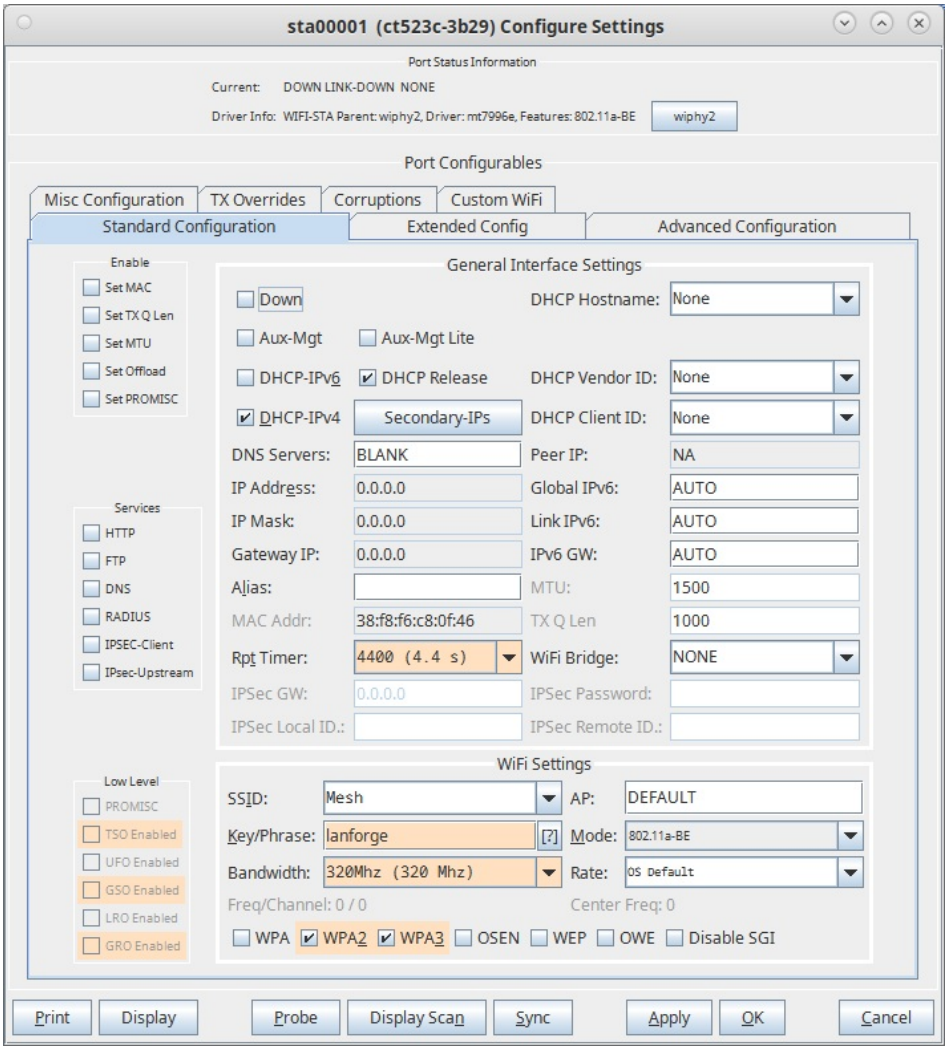
To modify a port configuration, select the port and click the **Modify** button. This will bring up the Configure Settings window for the selected port. The available options depend on the type of

interface being configured:

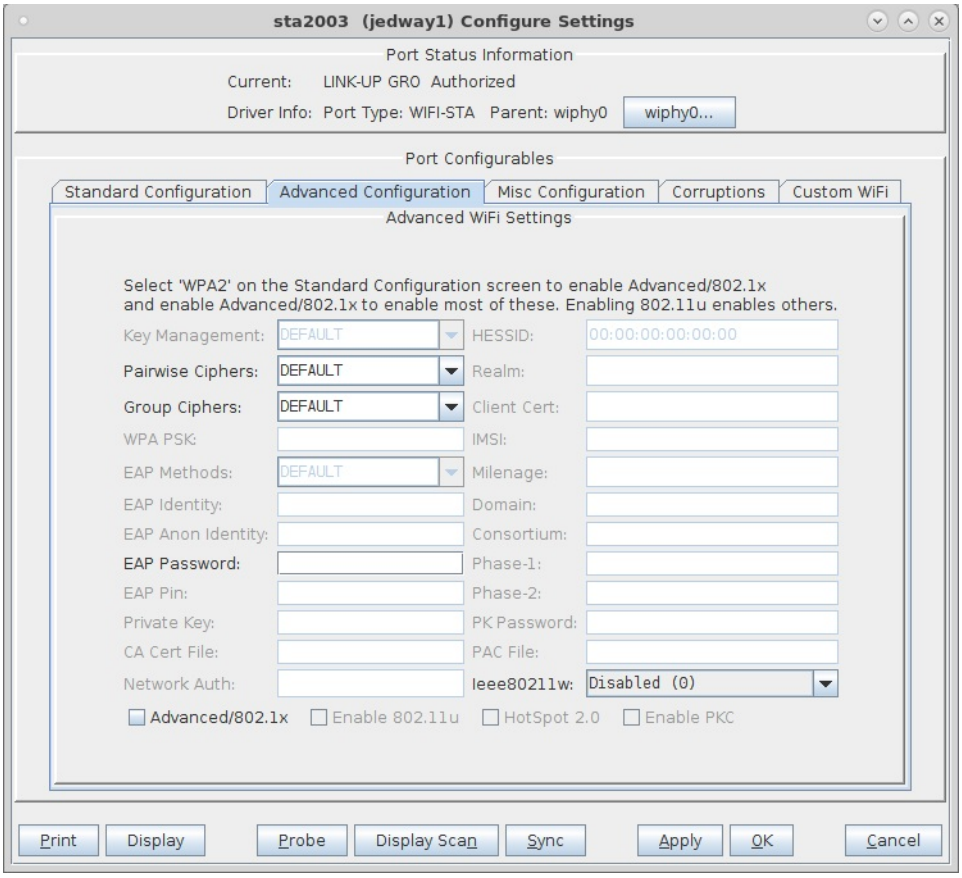
**Ethernet and Similar Interfaces**



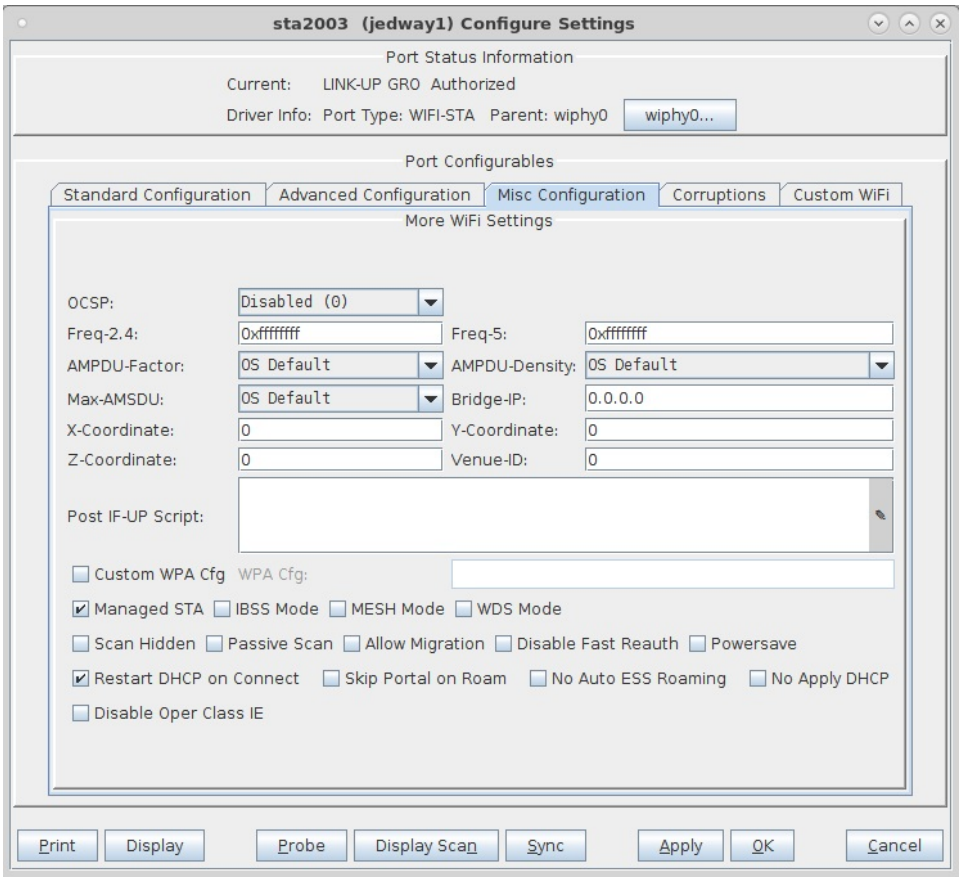

**WiFi Station Interfaces**




**WiFi Station Interfaces (Advanced Configuration)**

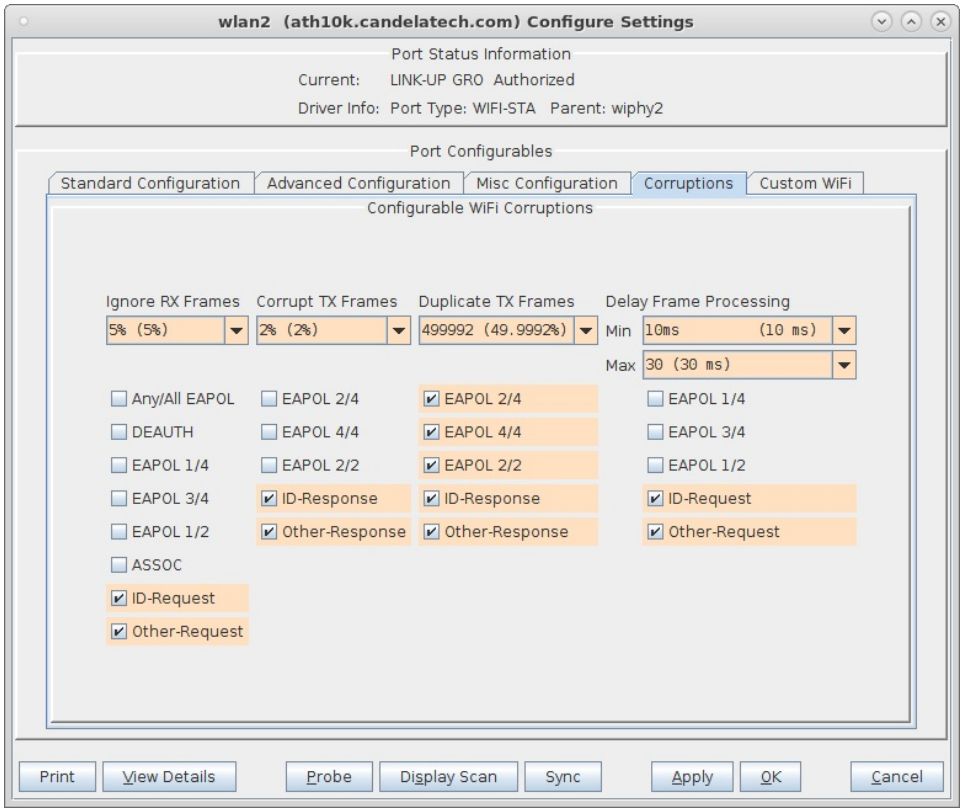



WiFi Station Interfaces (Misc Configuration)




### Corruptions

With release 5.3.6, LANforge supports dropping, delaying and corrupting various types of WiFi management packets. This can be used to test how APs handle bad networks and/or mis-configured or buggy station devices.




**Some details and hints about specific configurations follows.**

**Ignore RX Frames**

This configures the supplicant to ignore (drop) a percentage of certain types of WiFi management frames it receives, including basic authentication, WPA2, and EAP (RADIUS) related messages.

**Corrupt TX Frames**

This configures the supplicant to set a random byte in certain management frames to a random value before transmitting. This can be used to test that the AP can properly handle invalid frames.

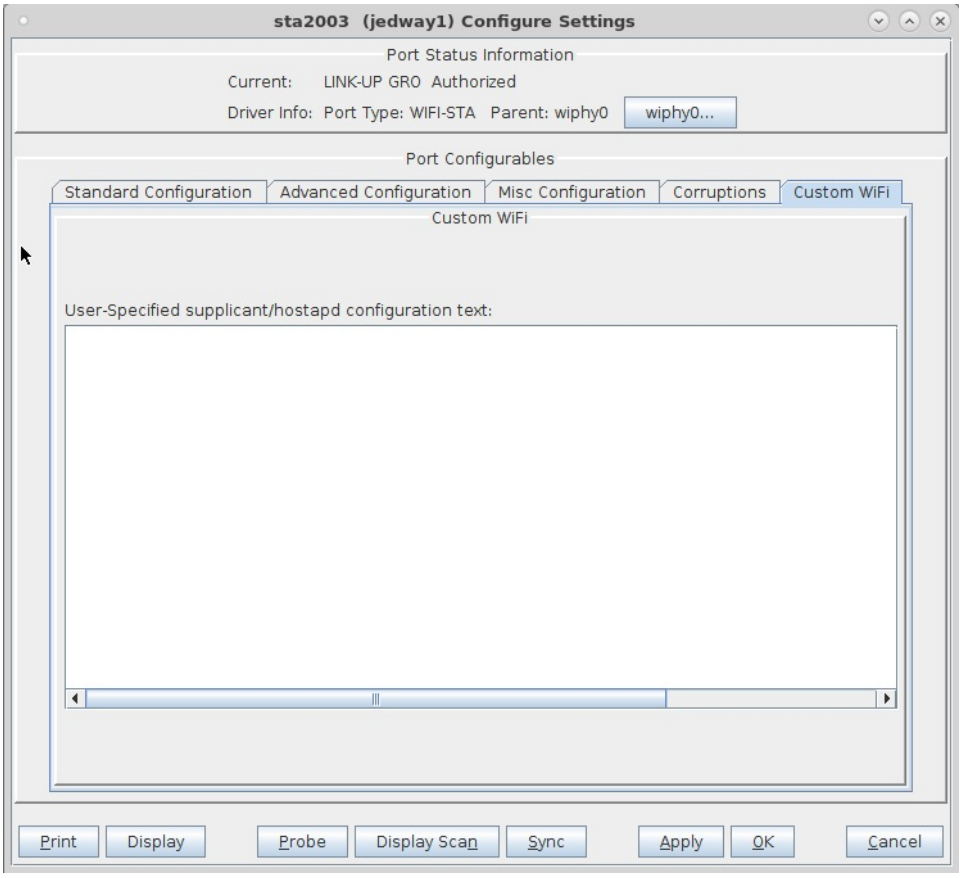
**Duplicate TX Frames**

This configures the supplicant randomly send duplicates of certain management frames. This can be used to test that the AP can properly handle invalid frames.

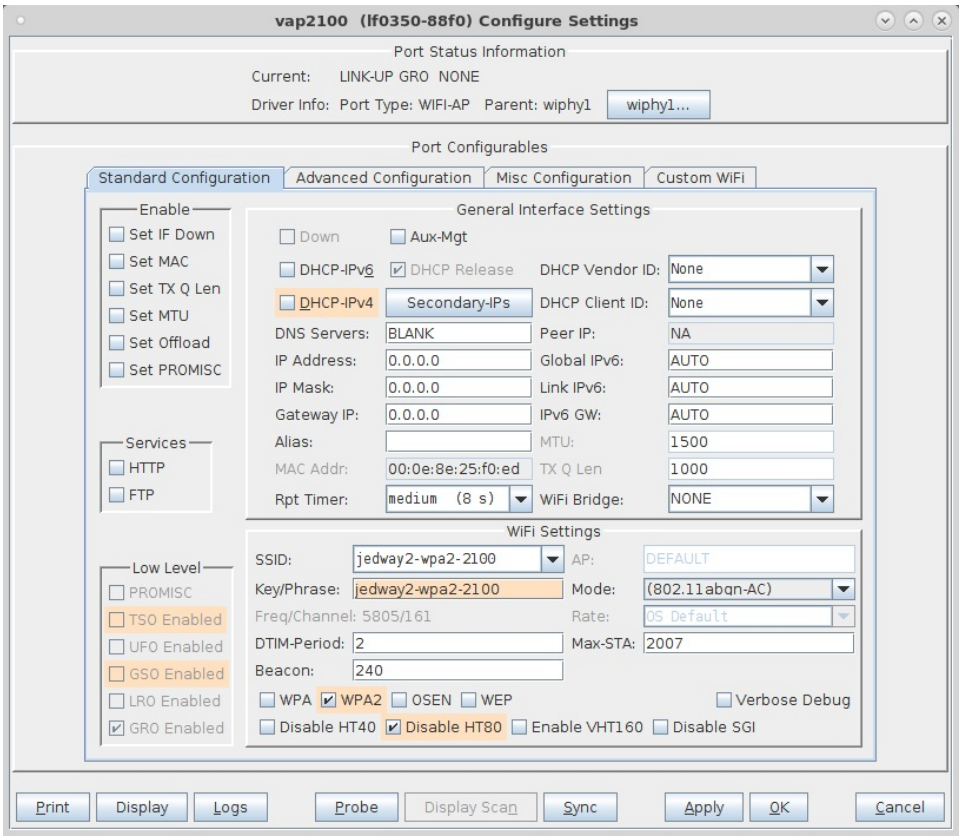
**Delay Frame Processing**

This configures the supplicant to delay processing a percentage of certain types of WiFi management frames, including basic authentication, WPA2, and EAP (RADIUS) related messages. This effectively delays the response back to the AP.

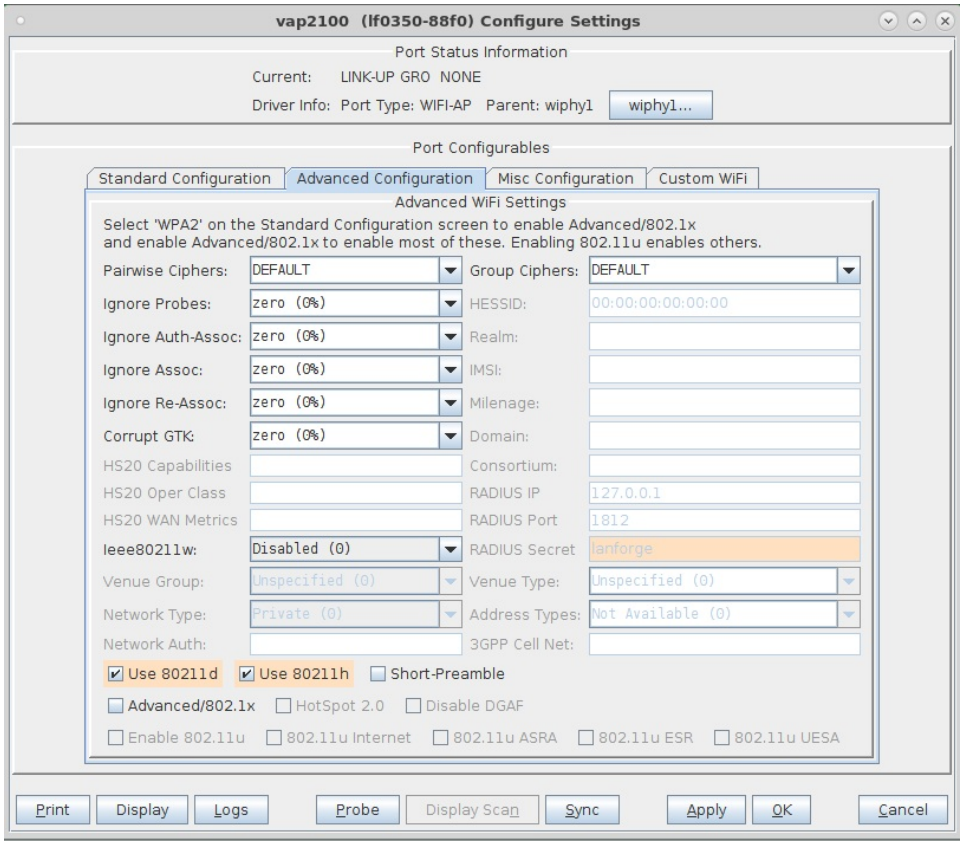
**WiFi Station Interfaces (Custom WiFi)**



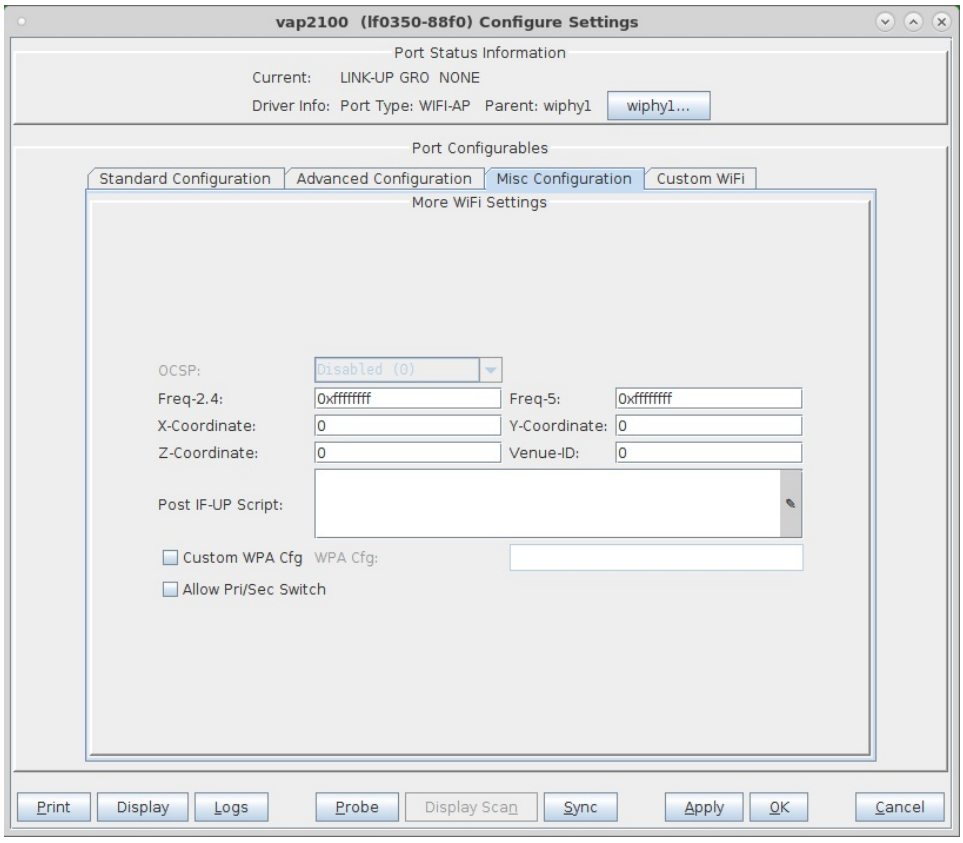

WiFi Virtual Access Points



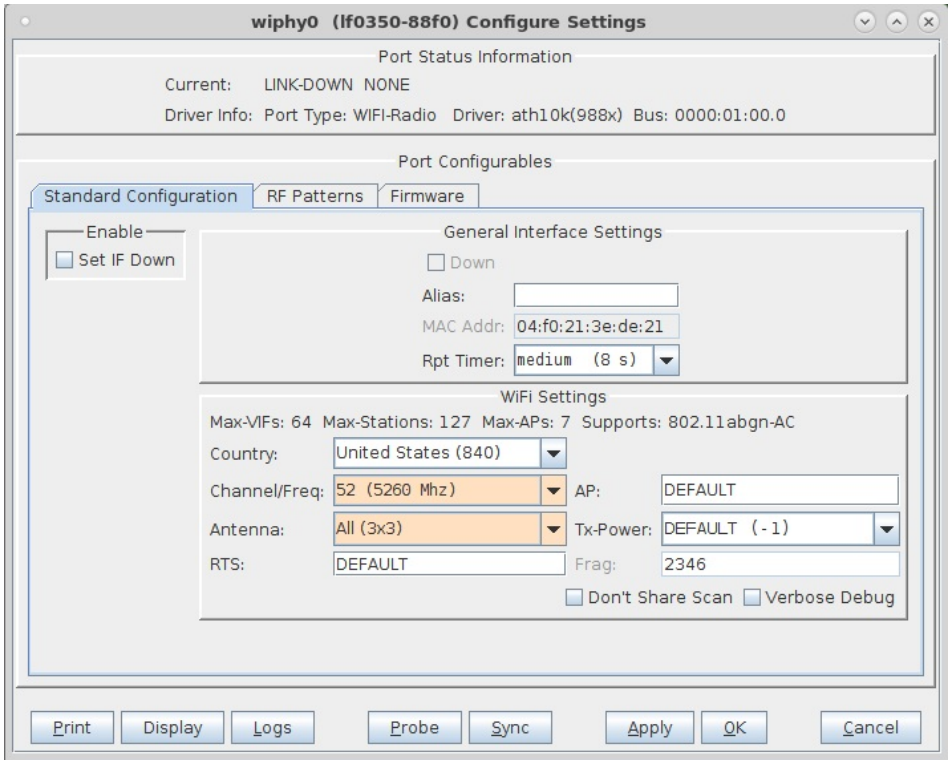

WiFi Virtual Access Points (Advanced Configuration)



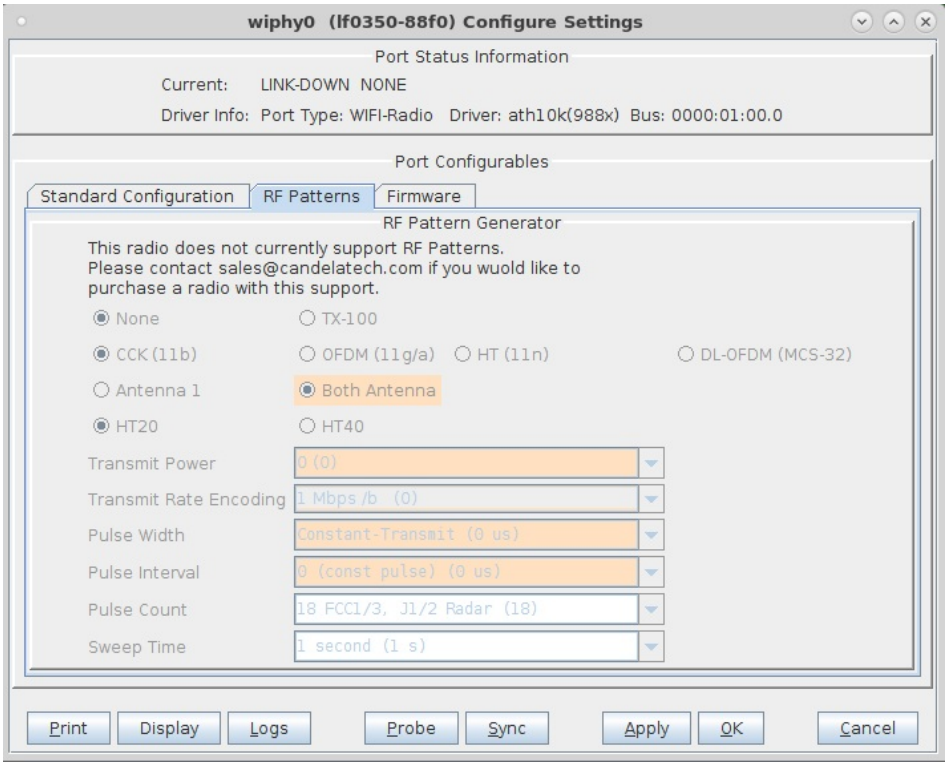

**WiFi Virtual Access Points (Misc Configuration)**



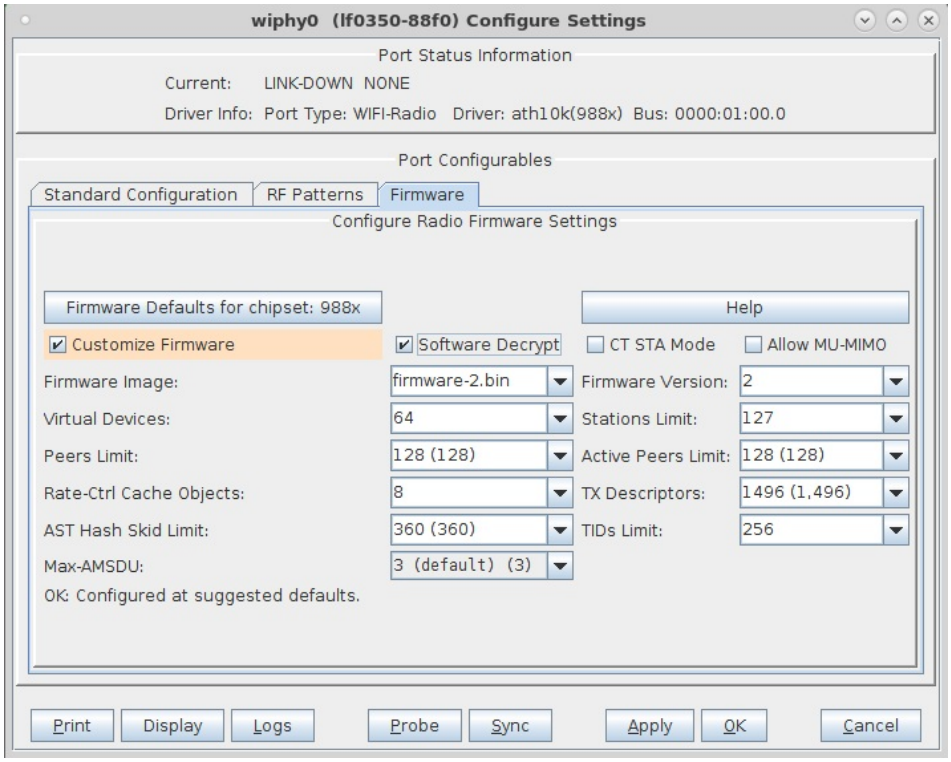

**WiFi Radio (Wiphy) Interfaces**




**WiFi Radio (Wiphy) Interfaces, RF Patterns**




**WiFi Radio (Wiphy) Interfaces, Firmware**




The upper panel displays Port Status Information as currently reported by the drivers. Port status will be updated automatically, but can also be updated by clicking the **Refresh** button on the LANforge Manager window.
**NOTE:** With Bypass hardware installed, the 'Current:' line will include one of the following states: BYPASS-ENABLED, BYPASS-ENABLED BYPASS-SLAVE, BYPASS-DISABLED, or BYPASS-DISABLED BYPASS-SLAVE.

The lower panel displays Port Configurables.
**NOTE:** The 'Set Bypass' checkbox, which allows for setting the Watchdog timer and other Bypass functions, will only be enabled if hardware support for the bypass feature set is detected.

The 'Enable' section of checkboxes on the left enables/disables configurable fields. Some options can cause port resets and other fairly intrusive behavior, so many options are disabled by default. LANforge can usually detect when no actual changes have been made, so do not worry too much about selecting more 'Enables' than required.

**Set IF Down**

Enables the **Down** field.

**Set MAC**

Enables the **MAC Addr** field.

**Set TX Q Len**

Enables the **TX Q Len** field.

**Set MTU**

Enables the **MTU** field.

**Set Offload**

Enables modifying the Offload options. For instance, turning on the TSO (TCP Segmentation Offload) feature can significantly improve TCP throughput on the NICs that support this feature.

**Set Rate Info**

Enables the buttons in the **Port Rates** panel, checkboxes in the **Advert Rates** panel, as well as the **Renegotiate** and **Restart Xcvr** checkboxes. Normally it is best to leave these settings at Autonegotiate.

**Set PROMISC**

Enables the **PROMISC** checkbox.

**Set RX-All/FCS**

Enables the **RX-ALL** and **RX-FCS** checkbox.

**Set Bypass**

Enables the Bypass-related checkboxes and the **Watchdog** drop-down menu (Bypass hardware

required). See below for more details on Bypass hardware features.

**Set Bridge Info**

Enables the **Br Cost** and **Priority** drop-down menus.

**Set CPU Mask**

Enables the **CPU Mask** selection box.

**Services**

With release 5.2.8, services may be enabled on an interface. Usually, the default service of the same type must be disabled, or at least re-configured to not use the ports that LANforge is using. These services usually act as the server side for Layer 4-7 connections, and provide full send-to-self functionality. This means that one LANforge interface can be running a HTTP connection that accesses the HTTP server on another port. The traffic will be directed over the network-under-test and not just route internally as some non-LANforge servers might.

**HTTP**

The HTTP service is provided by a modified version of the 'nginx' web server. It uses `/usr/local/lanforge/nginx/html` as its base file location. To create a custom nginx config file, edit `/home/lanforge/vr_conf/nginx_[netdevice-name].conf` and disable/enable the service. Note the comments at the top of the auto-generated conf files about how to keep LANforge from overwriting the config file on start of the service.

By default, LANforge will attempt to run the HTTP server on the standard port 80. This will conflict with the Apache web server running by default on the LANforge machine. To work around this, either:

- edit the nginx conf file and use some other port,
- stop the http service on the host OS, or
- reconfigure Apache on the host OS to use a non-standard port.

To edit nginx, see comments at top of the auto-generated config file, and remove the first line if needed. Then, change the 'listen' line so that it looks something like this:

```
listen       4.3.1.2:8080 bind_dev=eth1;
```

Restart nginx by these actions:

1. Disable the service in the Port-Mgr tab,
2. apply,
3. Enable service,
4. apply.

You may want to copy a large file into the `/usr/local/lanforge/nginx/html/` directory so that you have something to download:

```
sudo ln -s /usr/share/dict/linux.words /usr/local/lanforge/nginx/html/
```

**FTP**

The FTP service is provided by a modified version of the 'vsftpd' FTP server. It uses the home director of whatever 'user' is used to log into the ftp server.

**RADIUS**

Enable RADIUS service, using hostapd as radius server. The config file must be supplied by the user and must be named `/home/lanforge/wifi/hostapd_[port-name].conf`

**Down**

Configures the interface admin up or down. Selecting this will make the port admin-down, which effectively makes it unused by the system until brought back up. Deselect and apply to bring the interface back up.

**Aux-Mgt**

Enable/disable Auxiliary Management status on this interface. There can be one Aux-Mgt interface per LANforge machine. They are configured through LANforge, and can include WiFi VAP and Station interfaces. If the port is a VAP, it will automatically configure and start a DHCP server and NAT services using information from the main management port.
When configuring an Aux-Mgt network, be sure to use a subnet that is different than the normal management network and the data-generation ports.
The expected use of Aux-Mgt ports is to allow management of LANforge systems over a secondary WiFi management network when Wired Ethernet is not easily available. The TP-LINK TL-WN722N USB WiFi NIC has proved to be a good candidate for this option. Please contact your sales representative for more details.

**DHCP-IPv6**

Enable/disable IPv6 DHCP.

**DHCP Release**

Enable/disable explicit DHCP-Release when stopping DHCP on an interface.

**DHCP Vendor ID**

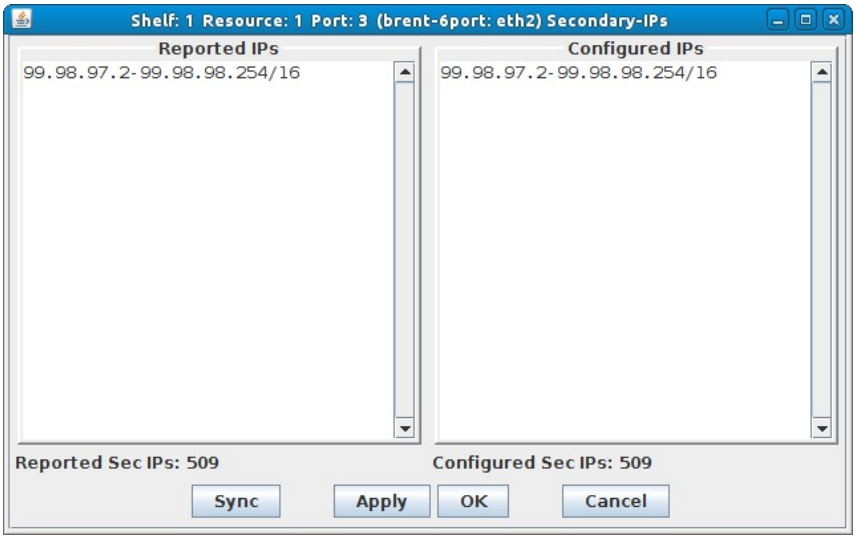
Optional DHCP Vendor identifier (DHCP Option 60). It is only used when DHCP is enabled. You can enter up to 63 characters. Use a custom dhcp client config file if more flexibility is needed (and ask support to make it bigger in next release).

**DHCP-IPv4**

Selecting this checkbox sets the interface to be a DHCP-IPv4 client and disables the other IPv4 fields. The interface will attempt to acquire an address after the change is applied. To setup an interface as a DHCP server, see the Netsmith section of this guide.

**Secondary-IPs**

Click this button to create/delete/modify the Secondary IPv4 Addresses for this interface.




The left text box displays the current secondary IPs that currently exist, and the right is the current configuration. To change the secondary IPs, modify the right-hand side appropriately and press Apply.
The syntax is: `IP[-MaxIP]/prefix IP2[-MaxIP2]/prefix ...`
Example: `1.1.1.1-1.1.2.254/16 2.3.4.5/24 4.5.6.7/16`

**DHCP Client ID**

Allows you to specify the DHCP client ID for DHCP requests. This is only used if DHCP is enabled. Leave on None to not use this feature.

**DNS Servers**

Allows configuration of the DNS Servers. This will not affect the normal OS DNS behavior, but the LANforge Layer 4-7 (HTTP, FTP, etc) protocols will use the configured DNS when making requests. The ifup-post script that can do WiFi portal logins also uses this configuration. When using DHCP on the interface, there is usually no need to configure this field.

**Peer IP**

Used to configure GRE tunnel remote endpoints.

**IP Address**

Allows you to change the IP address on the interface.

**IP Mask**

Allows you to change the IP Mask for the interface.

**Gateway IP**

Allows you to change the default gateway for packets leaving from this interface.

**Global IPv6**

Set the Global scope IPv6 address. AUTO will work if the network-under-test is running a Router Advertisement Daemon.

**Link IPv6**

Set the Link-Local scope IPv6 address. Normally this should remain set to AUTO.

**IPv6 GW**

Set the IPv6 default gateway. Must be AUTO if the Global IPv6 address is set to AUTO.

**Alias**

Allows the user to enter a cutomized name for this interface. Must contain no spaces or other funny characters.

**MTU**

Allows you to change the Maximum Transmission Unit (MTU) for this interface. You should understand the implications before changing this. Default is 1500 for most devices. Many Gigabit Ethernet systems can handle 8k or larger MTU settings, yielding increased throughput in some scenarios.

**MAC Addr**

Allows you to change the MAC address of the interface.

**TX Q Len**

Allows you to change the Transmit Queue Length (in packets) for this interface's driver. A good range is between 100 and 2000, and you should be towards the higher end for ports expected to run at higher speed.

**Br Cost**

Allows you to change the bridge port cost (lower cost is 'better'). This is only used when an interface is part of a bridge.

**Priority**

Allows you to change the bridge port priority (lower value means higher priority). This is only used when an interface is part of a bridge.

**Rpt Timer**

Allows you to specify how often this interface should report back to the LF Manager/GUI. Value is in milliseconds. Make this larger to decrease load on the system when using lots of interfaces.

**Watchdog**

This drop-down entry field allows you to set the Watchdog Timer (WDT) for the selected port. If the WDT for this port is not reset in the selected time interval, the port will be set to Bypass Mode. This feature requires special hardware support.

**CPU Mask**

This drop-down entry field allows you to pin the interrupts for this interface to a particular subset of CPUs. For general purpose LANforge use, this will probably **decrease** performance, but for certain scenarios it can significantly increase performance. One positive scenario is high-speed (multi gigabit) LANforge-ICE on a multi-core system. You can pin the interface IRQs and configure the WanLinks for a particular CPU to make optimal use of CPU resources, bus, memory and cache access. If you are unsure of what value to set here, leave it at the default of 'NO-SET' or 'ALL' to ensure the default values will not be modified, or contact support for more information. When configuring a port to bind to a specific set of CPUs, the value entered here is a bitfield. Bit 0 corresponds to CPU 0, etc.
Please note that most Linux distributions come with 'irqbalance' enabled by default. It may conflict with LANforge IRQ pinning unless specially configured to stay out of the way, so you may want to disable irqbalance with a command similar to:

```
/etc/init.d/irqbalance stop; chkconfig irqbalance off
```

**WiFi Bridge**

This drop-down entry field allows you to configure WiFi Bridges. A WiFi bridge is used to transparently tie an external MAC address to a specific WiFi Station interface in LANforge. Starting in release 5.2.2, an IP address can be configured on the WiFi Station interface to bridge by IP instead of MAC address. See 'Bridge-IP' below. This can be used to make a LANforge WiFi emulator support third-party traffic generators.

To create a WiFi Bridge, set exactly one non-STA interface to a wifi bridge ID and set at least one STA interface to that same bridge ID.

The algorithm will look at packets arriving on the non-STA interface and attempt to match the source MAC to the MAC of an STA. If it finds the STA, the packet will be bridged onto that STA and transmitted out the wireless interface. Packets arriving on the STA interfaces will be bridged onto the non-STA interface. If the destination MAC is broadcast, it will be re-written to be the MAC of the STA.

The MAC of the STA must therefor exactly match the MAC of the external device being bridged. To bridge more than one external device, additional WiFi station interfaces should be

created, using the MACs of the external devices.

Interfaces in a WiFi bridge should not have any IP addresses configured, and should not be running any other LANforge traffic such as WanLinks, Armageddon, Layer-3, etc.

**Port Rates**

Allows you to change the rates on the ethernet driver. **NOTE**: The 'Autonegotiate' mode is most flexible and should be used for normal operations, including when using copper 1000Mbps NICs. The selectable buttons can be used to set a fixed speed. This may work around bugs in your driver or in the device under test, but make sure the same speed is set on both ends of the connection!

**Renegotiate**

Selecting this checkbox allows you to force the interface to renegotiate the link speed. This may fix a hung driver, but don't count on it!

**Restart Xcvr**

Selecting this checkbox allows you to restart the ethernet transceiver. This may fix a hung driver, but don't count on it!

**PROMISC**

Selecting this checkbox allows you to put the adapter into promiscuous (accept all frames) mode.

**RX-ALL**

Certain drivers (Intel 10/100, 10/100/1000 and some Realtek NICs) have been modified by Candela to allow them to receive packets with bad Ethernet Frame Checksums (FCS) and other errors. This allows you to use a packet sniffer like Wireshark to diagnose packets with errors.

**RX-FCS**

This option instructs the NIC to include the 4-byte FCS at the end of the Ethernet frame in packets received from the network. This will aid debugging of bad FCS values, but it will break certain applications (such as LANforge-ICE) on these Ports while RX-FCS is enabled.

The buttons located at the bottom of the window provide functionality in addition to the standard **Apply**, **OK**, and **Cancel**.

**View Details**

This function is exactly the same as selecting **View Details** on the **Port Mgr** tab.

**Probe**

Probes the low level information for this port.

**Sync**

Synchronizes self with the current database as reported by the server.

LANforge supports virtual WiFi stations (Virtual STA) interfaces when LANforge is used with supported WiFi NICs. Currently, only certain Atheros 802.11a/b/g and 802.11a/b/g/n NICs are supported.

**SSID**

The correct SSID allows a Virtual STA to associate with an AP with the same SSID. If set to **[BLANK]**, the station will try to associate with any available AP. If the SSID is not configured (empty string), LANforge will not attempt to use the interface and an Alert will be created indicating the problem. Releases prior to 5.2.5 used an empty string to mean [BLANK].

**AP (Virtual STA devices only)**

Specify the station ID of the AP with which you wish this Virtual STA to associate. The station ID looks like an ethernet MAC address. To associate with any available AP, set this to DEFAULT.

**Key/Phrase**

Enter the WiFi password here.
For WPA/WPA2, enter the pass-phrase in this field.
NOTE: Using ASCII strings for WEP keys is not well supported, so please use HEX instead.
For HEX keys, enter the key in ASCII HEX, for instance: 7767555d2b276a21655a6c4c49

**Mode**

Specify the Radio mode (A/B/G/N or a combination). Each station can use any mode, but the radio can only be on a single frequency. So, you can have a combination of A, G, and N devices on a 5Ghz channel, or B, G, and N on a 2.4Ghz channel.

**Country (Wiphy devices only)**

Specify the country code for the radio. This cannot override the country code in the NIC itself. If that needs to be overridden, contact support for directions on adding the proper kernel module option.

**Channel/Frequency (Configurable on Wiphy Devices Only)**

This drop-down maps WiFi channel to frequency and lets the user pick the desired frequency. When using VAPs, the channel should be specified (or it will default to channel 1). When using virtual-stations, leaving the channel on AUTO is normally the best option, but LANforge does support forcing the radio to only use a single channel. All VAP, Station and Monitor interfaces on a radio will use the same channel. For concurrent multiple-channel testing, multiple radios and/or LANforge WiFi systems are required.

**Antenna (Wiphy devices only)**

The Atheros a/b/g (ath5k) and /a/b/g/n (ath9k) supports configuring antenna diversity. If using a subset of available radios (perhaps because cables instead of over-the-air testing is being done), then configure LANforge to use just those antenna connectors that are in use. This will usually increase performance.

**NOTE:** Testing shows that at least some WiFi NICs will lock up if B and not A is selected, so if using a subset of channels, use A or A+B instead of B or B+C. Contact support if you have any questions on this.

**Tx-Power (Wiphy devices only)**

Specify the transmit power in dBm for the radio. This applies to all virtual interfaces on the selected radio.

**RTS (Wiphy devices only)**

Specify the RTS threshold. See manual page for 'iwconfig' or contact Candela for more details. This feature does not work on modern NICs and will be removed soon.

**Frag (Wiphy devices only)**

WiFi Fragmentation Threshold limits the size of on-air packets. A smaller fragment size may help in very noisy environments. To enable RTS/CTS, the Fragmentation Threshold must be larger than the RTS Threshold Valid Range: 256..2346 (2346 means disabled). WiFi Fragmentation Threshold is a per-radio setting.

**Rate**

Specify the maximum rate at which the Station should function. Use one of the options in the pull-down menu. Leave at 'OS Default' for best possible rate.

**WPA**

Specify whether the virtual station will use WPA. The pass-phrase must be entered in the Key/Phrase field.

**WPA2**

Specify whether the virtual station will use WPA2. The pass-phrase must be entered in the Key/Phrase field.

**OSEN**

Specify whether the virtual station will use OSEN. The pass-phrase must be entered in the Key/Phrase field.

**WEP**

Specify whether the virtual station will use WEP. The WEP Key must be entered in the Key/Phrase field.

**Disable HT40**

If selected, HT40 (40Mhz channel width in 802.11n) will be disabled even if the AP and station otherwise support it.

**Disable SGI**

If selected, Short Guard Interval (SGI) will be disabled even if the AP and station otherwise support it.

**AMPDU-Factor (Virtual STA devices only - Misc Configuration)**

Specify the AMPDU-Factor. This value can only be decreased from what the hardware supports. For 802.11a/b/g/n ath9k NICs, all values are supported.

**AMPDU-Density (Virtual STA devices only - Misc Configuration)**

Specify the AMPDU-Density. This value can only be increased from what the hardware supports. For 802.11a/b/g/n ath9k NICs, only 8 and 16us is supported currently.

**Max-AMSDU (Virtual STA devices only - Misc Configuration)**

Specify the Max-AMSDU. This value can only be decreased from what the hardware supports, and unfortunately, the 802.11a/b/g/n ath9k NIC only supports the minimum value of 3839 bytes currently.

**Bridge-IP (Virtual STA devices only - Misc Configuration)**

When using Virtual Stations in a WiFi bridge, the bridging can be based on the MAC of the station or you can specify an IP address in this field. When using IP address bridging, only ARP and IP protocols are supported. Contact support if you need additional protocol support.
There are a few special features that help LANforge integrate with certain third-party tools. One is the **No Apply DHCP** option. This lets the station do DHCP, but instead of assigning the IP to LANforge, it prints out the lease information on the LANforge-CLI connection. Third-party scripts can watch for this information and use the IP information to configure their own traffic generators.
Another hidden feature is the ability to make LANforge stations answer ARP requests (without having the IP address information actually configured in the operating system). To enable this feature, create an empty file called: **/home/lanforge/LF_STA_BR_ANSWER_ARP** and restart the LANforge manager process.

**Custom WPA Cfg (Virtual STA / AP - Misc Configuration)**

Specify the location of the custom WPA supplicant config file. For instance, if you want to use MSCHAPv2 (aka WPA Enterprise), you could use a custom config file similar to:

```
ctrl_interface=/var/run/wpa_supplicant
fast_reauth=1

network=(
    ssid="foo"
    key_mgmt=WPA-EAP
    eap=PEAP
    identity="user"
    password="user-password"
    phase1="auth=MSCHAPV2"
    priority=10
)
```

**Scan Hidden (Virtual STA devices only - Misc Configuration)**

If selected, LANforge will scan for hidden SSIDs. This requires more resources than a passive scan, so only enable this feature if hidden SSID APs are being used.

**Passive Scan (Virtual STA devices only - Misc Configuration)**

If selected, LANforge will passively scan for APs (it will not send Probe Requests).

**Allow Migration (Virtual STA devices only - Misc Configuration)**

If selected, and if there is more than one radio in the LANforge system(s) in the LANforge Realm (cluster), then LANforge will attempt to migrate stations to other radios if they cannot associate within a certain time (about 1 minute). This can help test load sharing. Please note that other radios may be on different channels so the stations can even migrate across frequencies with this feature.

**IBSS Mode (Virtual STA devices only - Misc Configuration)**

If selected, the LANforge station device will act as an IBSS interface instead of a managed station device.

**Restart DHCP on Connect (Virtual STA devices only - Misc Configuration)**

If selected, DHCP will always restart when a WiFi station re-connects. If not selected, then a station will not restart DHCP client if it already has an IP address. Un-selecting this is normally suggested for roaming testing.

**Skip Portal on Roam (Virtual STA devices only - Misc Configuration)**

Skip Portal login/logout when we are roaming (when IPv4 address does not change). This should normally be enabled when using portal login and roaming testing.

**No Auto ESS Roaming (Virtual STA devices only - Misc Configuration)**

WPA Supplicant will automatically roam to the best AP in the ESS group when it receives scan results. When doing roaming in LANforge, normally the user wishes to force the station to roam to a particular AP (BSSID). In that case, the **No Auto ESS Roaming** flag should be enabled.

**No Apply DHCP (Virtual STA devices only - Misc Configuration)**

When using certain external traffic generators, the user may wish to have LANforge do DHCP but not actually apply the received lease. When **No Apply DHCP** is enabled, LANforge will do just this, and it will also print the lease information on the LANforge CLI so that third-party scripts can use the information as needed.
In addition, if the station is configured to bridge by IP address, then it will also automatically update the bridge-IP address to match the lease information. It will only apply the new bridge-IP if some other bridge-IP is already configured, so the third-party tool should create the Station with at least some IP address if it wishes this feature to be applied.

**Use-80211D (Virtual AP only - Advanced Configuration)**

Enable broadcast of 802.11D country codes.

**Short-Preamble (Virtual AP only - Advanced Configuration)**

Enable short-preamble.

**Verbose Debug**

Enable verbose logging for WiFi related services on this interface. For radio devices, this modifies logging for the wpa_supplicant process. For VAPs, this modifies logging for the hostapd process. Click the **Logs** button to view the logs realtime. You can also look in the /home/lanforge/wifi/ directory for the complete logs and config files.

**Advanced Configuration**

These relate to the wpa_supplicant tool and may be used to configure various 802.1x and other advanced authentication schemes. The wpa_supplicant manual page has more details. Please see the tool-tips in the LANforge-GUI for a discription of each field, or contact support for more help.
Some details and hints about specific configurations follows:

**HS20 and EAP-AKA**:
On 5.2.11, the '3GPP Cell Net' field was mislabeled '802.11u ANQP'. Its tooltip is correct, however. The AP's MCC and MNC must match the EAP Identity for the stations in order for the ANQP query to match the AP. The MCC and MNC is the first part of the EAP Identity. HS20 Realm and Domain should also be configured on the station.

## Hardware Bypass Modules

Certain hardware supports port pairs physically looped together in a 'master-slave' configuration to be set in Bypass Mode, creating a single logical wire. With bypass hardware installed, the state of each module will be listed on the 'Current:' line of the Port Status Information pane for that port:

- **BYPASS-ENABLED**

  This status will be set on the 'master' port of a Bypass Pair when the 'Bypass' checkbox is selected. This port and its 'slave' peer are in bypass mode.
  **NOTE**: When a Bypass Pair is in Bypass-Enabled state, only the master port LED on the NIC will indicate link status and LANforge will not show link status on the Status tab. When a port pair is in bypass mode, it acts as a single physical cable.

- **BYPASS-ENABLED BYPASS-SLAVE**

  This status will be set on the 'slave' port of a Bypass Pair when the Master port is in the bypass mode.

- **BYPASS-DISABLED**

  This status will be set on the 'master' port of a Bypass Pair when the 'Bypass' checkbox is not selected. This port and its 'slave' peer are in normal mode.

- **BYPASS-DISABLED BYPASS-SLAVE**

  This status will be set on the 'slave' port of a Bypass Pair when the Master port is in the normal mode.

Bypass hardware can be configured via the **Port Mgr** tab or manually enabled via a running WanLink connecting the peer ports. Modifying a selected port via the **Port Mgr** tab and selecting the 'Set Bypass' checkbox enables the Bypass configuration functions on the right side of the pane. The port pair can then be configured to operate in bypass mode immediately, on power-up or power-down/loss of power. A Bypass Disconnect mode can also be selected.
**NOTE**: Although a running WanLink can be configured to override this behavior, affected ports will revert to their default Bypass settings in the **Port Mgr** tab when the WanLink is no longer running. The hardware can be set for WanLinks to 'fail open,' for example.

- **Bypass NOW!** Selecting this checkbox on the 'master' port of a Bypass Pair immediately enables Bypass Mode on this port and its 'slave' peer. A port pair in bypass mode acts like a single physical cable.
- **Bypass Power-UP** Selecting this checkbox on the 'master' port of a Bypass Pair enables Bypass Mode on power up.
- **Bypass Power-DOWN** Selecting this checkbox on the 'master' port of a Bypass Pair enables Bypass Mode on power down or loss of power.
- **Bypass Disconnect** Selecting this checkbox on the 'master' port of a Bypass Pair physically disconnects the cables using special electronics, effectively unplugging the cable as far as the peer machine is concerned.

Several buttons at the bottom of the window allow saving configuration changes and other features.

**Print**

Print the window. Can print to PDF if a PDF printer is installed.

**View Details**

Open a similar window that shows currently reported values. Some values cannot be probed and may be blank.

**Logs**

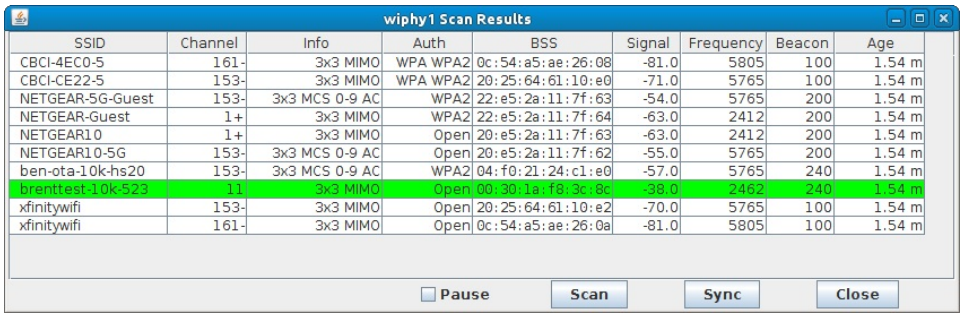
WiFi Radio and VAP interfaces have wpa_supplicant and hostapd processes related to their operation. To view these logs for these processes realtime, click the Logs button.

**Probe**

Request LANforge probe the driver/hardware for the latest settings. Use 'Sync' after probe to update the window with the latest settings.

**Display Scan**

Display current Scan Results and allow additional scan-related activities. Valid for Station interfaces only.




**Sync**

Update fields with latest values reported by LANforge. This will discard any changes that have not been applied.

**Apply**

Apply current configuration and leave the window open for further use.

**OK**

Apply current configuration and close the window.

**Cancel**

Close window without applying any additional changes.

## Creating & Deleting Virtual Interfaces (VLAN, WiFi, Redirect, and Bridge)

LANforge has the ability to create and delete virtual interfaces on the fly. Six types of virtual interfaces are currently supported. You must have a (virtual) port-license for each VLAN that you create: Please contact sales@candelatech.com if you need more licenses. LANforge has no hard upper limit on the number of interfaces that can be created. Candela has tested up to 2000 MAC-VLANs on a high-end machine, with each virtual interface running Layer 4-7 HTTP requests. Support for these virtual interfaces requires the LANforge resource to be running on Linux, with the Candela kernel and updated iputils package. See the Installation Guides for more details if you are installing LANforge on your own machines.

- **MAC-VLAN**

  MAC-VLAN virtual interfaces create the illusion of multiple real interfaces on a single interface. From the outside world, it appears as if the physical LANforge interface is an ethernet switch with multiple machines connected to it. In other words, the MAC-VLANs are completely transparent to the other machines on the network. MAC-VLAN interfaces can be created on physical ethernet interfaces, redirect, and 802.1Q VLAN interfaces.

- **802.1Q-VLAN**

  LANforge also supports creation and deletion of 802.1Q VLANs. Unlike MAC-VLANs, 802.1Q VLANs speak a slightly different protocol on the ethernet network. This means that the systems that the LANforge machine is talking to must also be configured for 802.1Q VLANs. 802.1Q VLAN interfaces can only be created on physical ethernet and redirect interfaces.

- **Redirect-Devices**

  Redirect-devices are a pair of virtual interfaces that are logically connected with a

loopback cable on the far side. Redirect-devices are not directly associated with any physical interface. If rdd0 and rdd1 are a pair, then when you transmit a packet on rdd1, the packet will be automatically received on rdd0. This feature is used for configuring LANforge-ICE in router mode, and can also be used for demonstration purposes where physical interfaces are in short supply.

- **Bridge-Devices**

  Bridge devices are Linux network devices that allow one to aggregate other network interfaces into a single broadcast domain. After creating a bridge device, it can be modified to include the network devices that are to be associated with the bridge. Logically, bridges are very similar to an ethernet switch. Bridge-devices can be configured for Spanning Tree Protocol to better emulate and interact with real world networks.

- **WiFi Virtual Station**

  WiFi Virtual Station (Virtual STA) interfaces create the illusion of multiple distinct WiFi stations (think: laptops with WiFi NICs) using a single physical WiFi radio. To the Access Point(s) (APs) it appears as if each Virtual STA is an individual station. Each Virtual STA has its own MAC, IP address and routing table. All LANforge-FIRE related traffic generation features work with Virtual STAs. Virtual STAs may only be created on Radio (Wiphy) Devices.
  **NOTE**: The only supported Radio hardware is certain Atheros/Qualcom chipset NICs using special drivers provided by pre-built Candela kernels and appliances.

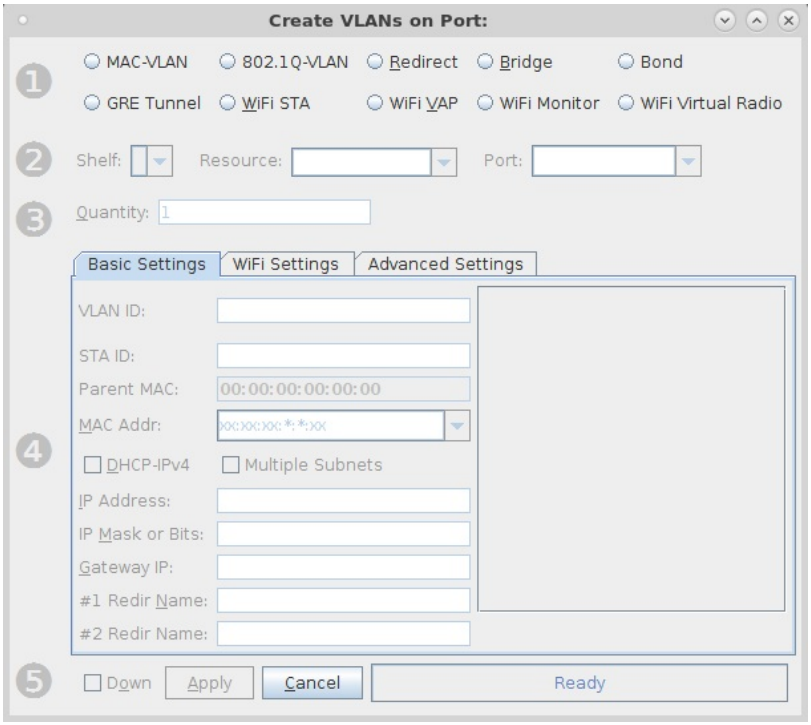
- **Virtual WiFi Access Point**

  WiFi VAP interfaces may only be created on Radio (Wiphy) Devices.
  **NOTE**: Some Radio devices may have improper (or overly conservative) regulatory domain settings. LANforge supports overriding the regulatory domain, but if done improperly, this can put the system out of regulatory (FCC, in the USA) compliance. Please contact support if you want information on how to change the regulatory domain.

- **WiFi Monitor**

  WiFi Monitor interfaces may only be created on Radio (Wiphy) Devices.
  Monitor interfaces are primarily used for sniffing WiFi traffic. Only one monitor interface should be created per radio. Just creating a WiFi Monitor interface can decrease performance on the system, especially when using lots of other virtual WiFi interfaces. Performance will go back to normal when the monitor interface is deleted.

To create one or more virtual interface, select a port on the **Port Mgr** tab and click the **Create** button. This will bring up the Create VLANs window with the selected port as the parent device:




Select a VLAN type at the top of the window. When creating a MAC-VLAN, you must specify a MAC Address to uniquely identify this VLAN. When creating 802.1Q VLANs you must specify the VLAN-ID. For redirect-devices, just specify the two redirect names. We suggest rdd0, rdd1, etc, but you can also name them as regular ethernet devices if you wish (eth2, eth3, etc).

Multiple VLAN interfaces can be created at once by entering a **Quantity** greater than 1. Enter the beginning IP and/or MAC address and the create function will automatically increment the MAC and/or IP addresses. Selecting the **DHCP-IPv4** checkbox will set all interfaces as DHCP-IPv4 clients to receive their IP address via DHCP. The remainder of the interface attributes can be modified following creation via the **Modify** button on the **Ports** tab. Newly created VLAN interfaces will be visible on the Netsmith display after clicking the **Sync** button.

Select the **Use WPA** checkbox to enable WPA and related wpa_supplicant authentication methods.

To delete a virtual interface, select it on the **Port Mgr** tab and click the **Delete** button.

30. ### Sniffing Ports

If you have Wireshark installed and configured correctly on your LANforge machines, and if your machine upon which you are running the GUI supports the X-windows protocol, you may sniff a particular port. To sniff a port, select it and click the **Sniff Packets** button. You may have to change the DISPLAY option box under the **Sniff Packets** button if you have a non-standard setup. For example, if your LF GUI is running on one PC and your LF Server is on another, you would type in the IP address of the LF GUI machine with :0.0 at the end so that the LF Server would be allowed to display the Wireshark program on the LF GUI PC. For Windows PCs running the LF GUI, the cygwin program must be installed per the GUI installation instructions. When Wireshark pops up, you can start sniffing packets by clicking on the 'Capture' menu item.

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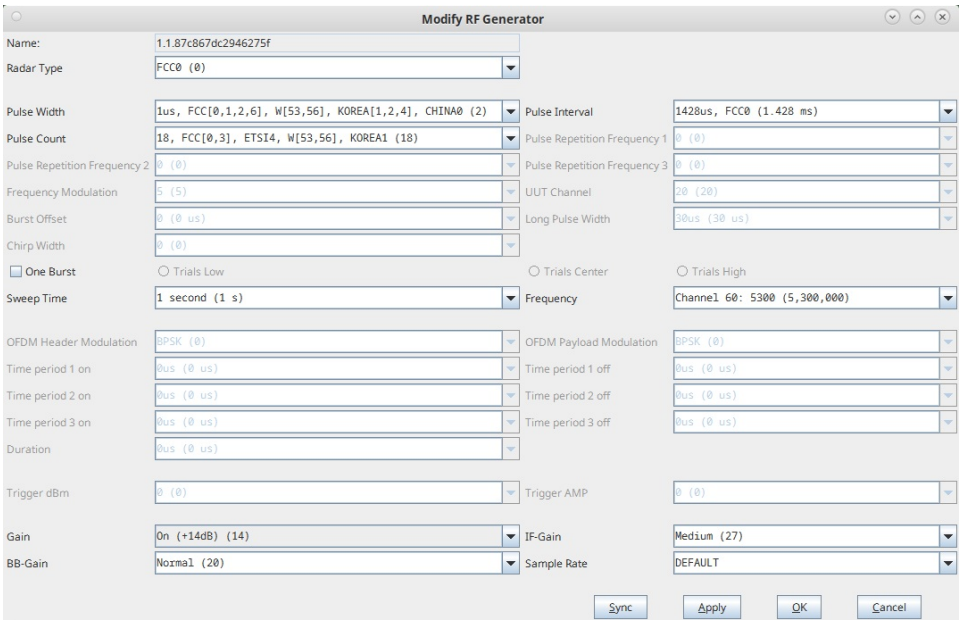
31. ## RF Noise Generator

LANforge currently supports two different RF Noise Generator platforms. The CT711 is based on an a/b/g/n USB NIC with customized firmware. The noise it generates is modulated (CCK, OFDM, HT). Because the signal is modulated, and it does not have better than about 20us precision, it is not good for RADAR emulation, but it can be used as a constant noise source for testing CCA. The CT711 is configured in the Port-Mgr tab, in the wiphyX radio configuration screen.

The CT712 RF Generator from Candela Technologies is a software-defined radio and can be used for RADAR emulation. It supports 1us precision pulse configuration. It generates non-modulated noise, so it can be used for that part of CCA testing as well. The CT712 is configured in the RF-Generator tab of the LANforge GUI. For some more details on RADAR, please see this page on DFS and RADAR patterns.




### CT712 RADAR emulator.

- **FCC and ETSI Buttons**

  The FCC and ETSI buttons configure the pulse width, interval, count and other fields with values that match the respective buttons. For RADAR types that have a range of values, each time you click the button a new set of random values in the correct range will be configured in the config files. Click Apply to make them take effect.

See tooltips on the buttons with '*' after their label for notes on limitations for emulating certain RADAR types.

- **Pulse Width** This specifies the duration (in micro-seconds) for the transmitter to be enabled. The user may type in a specific value, and the LANforge-GUI has pre-set values in pull-down menus for common FCC and ETSI radar patterns.

  A pulse width of `0` means constant transmit. This is useful for CCA testing, especially when used with a programmable attenuator and RF analyzer.

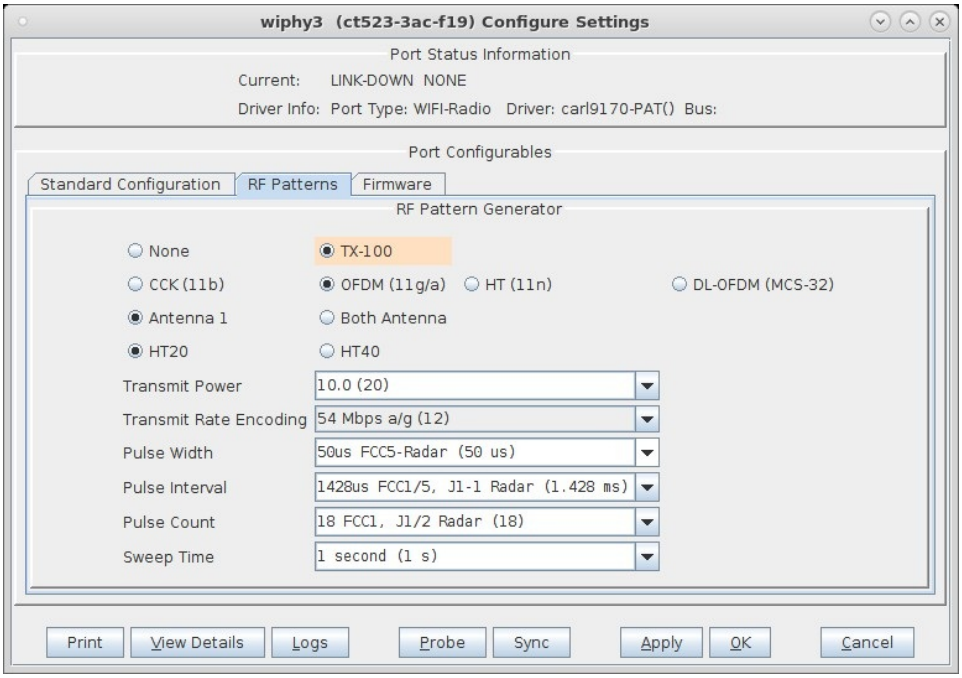
- **Pulse Interval**
  This specifies the time (in micro-seconds) between starting to generate a pulse. This is also known as "Pulse Repetition Interval (PRI)". The user may type in a specific value, and the LANforge-GUI has pre-set values in pull-down menus for common FCC and ETSI RADAR patterns.

- **Pulse Count**
  This specifies how many pulses to generate before pausing for "sweep time". If you want to pulse continuously, set Sweep Time to zero. This is also known as "Pulses per Burst (PPB)".

- **One Burst (5.3.9 and higher)**
  This will cause the RF Generator to generate a single burst of pulses and then stop.

- **Sweep Time**
  This specifies how long to pause (in micro-seconds) between pulse bursts. This emulates RADAR sweep time. Set this value to zero for continuous pulsing.

- **Frequency**
  Specificy the frequency on which to generate the RF noise.




## CT711 Modulated RF Noise Generator.

- **None / TX-100**
  When TX-100 mode is selected, the rest of the fields can be modified, and when submitted, the transmitter on the NIC will be enabled accordingly.

- **CCK / OFDM / HT / DL-OFDM**
  Specifies the signal encoding. CCK has wider lobes and bleeds further into other channels. OFDM is a more square signal pattern and better stays on its channel. HT enables 40Mhz signal generation. DL-OFDM is a method of using 40Mhz channel width to send OFDM encodings.

- **Antenna 1 / Both Antenna**
  Specifies the antennas to use for signal generation.

- **HT20 / HT40**
  HT40 will use 40Mhz signal generation, HT20 will use 20Mhz signal generation.

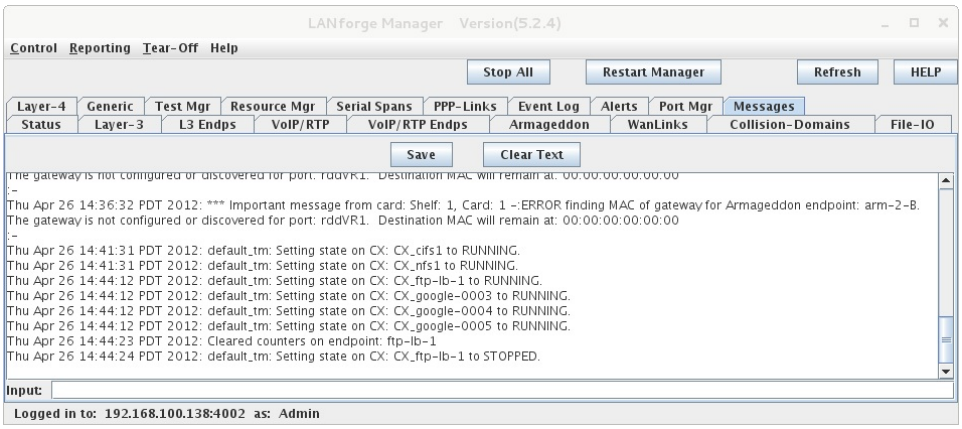
- **Transmit Power**
  This is in units of 1/2 dbM. Using the higher values will cause NIC to bleed badly into adjacent frequencies and will generally show a corrupted signal. This may be useful for some testing scenarios, but for controlled signal generation you will probably want to keep

the value below 20 dbM of power. For precise control of signal level, we suggest using a variable attenuator, like the CT 703.

- **Transmit Rate Encoding**
  This specifies the on-air encoding rate.

32. ## Command Output

The **Messages** tab is used to convey miscellaneous information from the LANforge server to the user. It can also be used to input CLI commands to the LANforge server. You can see an example of its output here:




The **Save** and **Clear Text** buttons only affect the LANforge Manager machine performing the actions and do not affect other machines which may be logged in to the LANforge server. Clicking the **Save** button will pop up a Save window so the contents of the text panel can be saved to the Manager machine. Clicking the **Clear Text** button will clear the message contents and replace them with a Day/Date/Time log entry.

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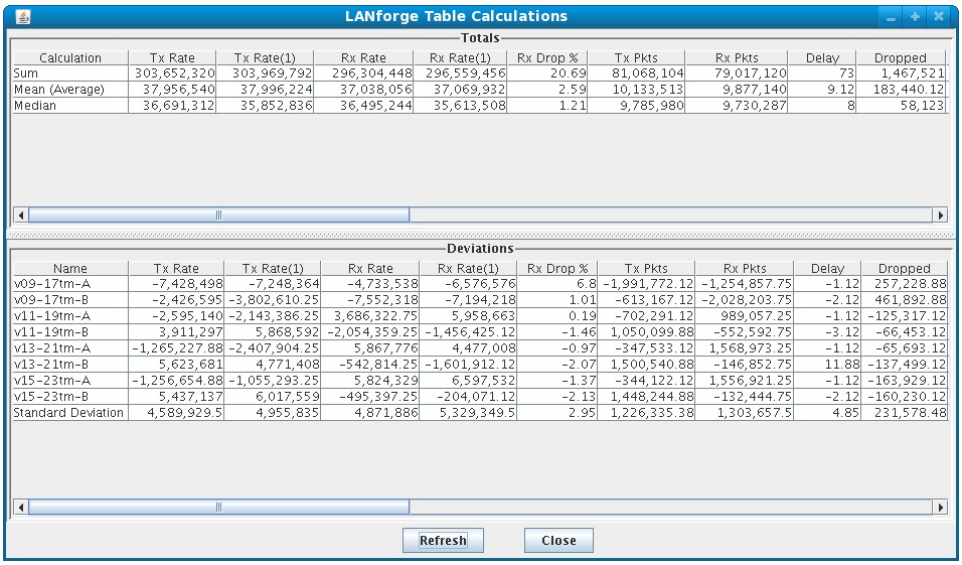
33. ## Automatic Table Calculations

With the release of 5.1.5, most tables in the LANforge-GUI now support automatic calculations of their numeric columns and user-selected rows. Select the rows you are interested in and use the right-click->Calculations menu item to bring up the calculations window.




The top section has three rows: Sum, Mean (Average), and Median. The Mean is the sum of all selected rows divided by the number of rows. The Median is the value in the middle of a sorted list of the column data.

The bottom section lists the deviations from the average for each selected row and the standard deviation for the entire column of data.

The deviation table rows may be sorted by clicking on a column header, and the data can be refreshed for the previously selected rows by clicking **Refresh**. It will not be automatically updated

after the initial creation.

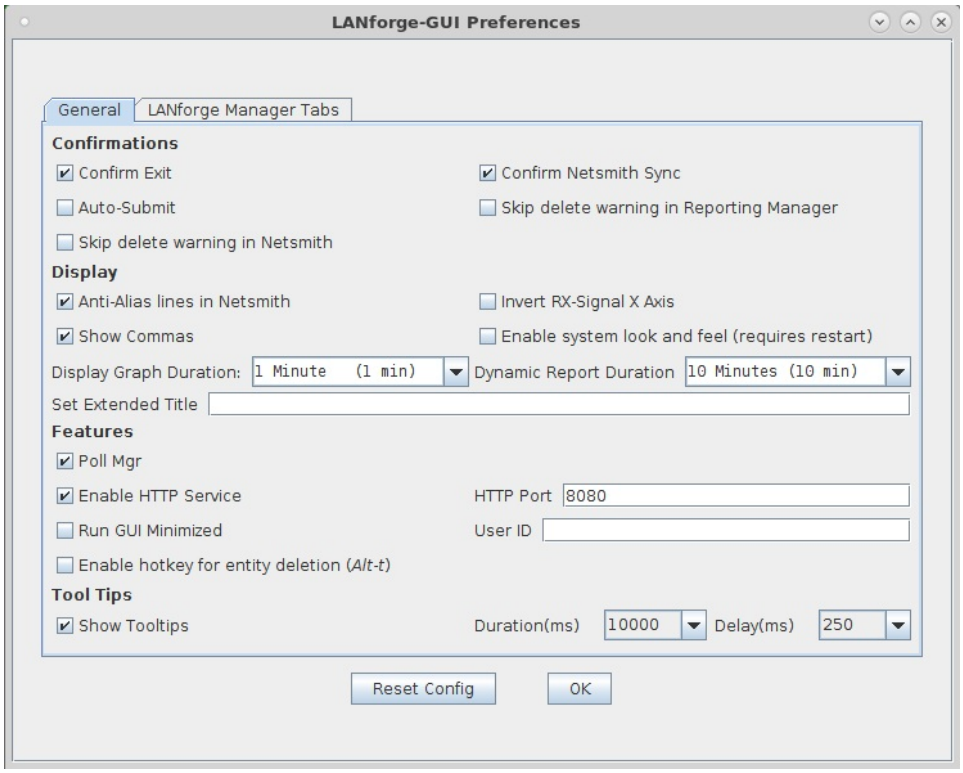


34. ## Pull-Down Options

The four pull-down menus located at the upper left of the LANforge Manager window provide additional features and configuration options.

### Control

- **Connect**: Brings up the LANforge Connection Management window to Connect, Disconnect and Discover LANforge systems. Also brings up the LANforge-GUI Preferences window (see description below).
- **Disconnect**: Brings up the Logout window to disconnect from the LANforge server. Also brings up the LANforge-GUI Preferences window (see description below).
- **Client Admin or Login**: Allows you to log in as a particular user. See Client Login for more information.
- **Debug**: If you are having difficulty with the software, Candela Support personnel may ask you to turn on the logging, and you can do that through this menu item. For normal use, Debug may not be very useful.
- **Preferences**: The LANforge-GUI Preferences window will pop up the first time the GUI is launched and each time the Connect or Disconnect pull-down options are selected. If no changes in preferences are desired, click **OK** to close the window. LANforge-GUI Preferences are divided into two tabs and provide for selecting or deselecting certain functionality and the tabs to be displayed in the LANforge Manager window. Except for the 'Simple ICE' selection, changes to preferences in **LANforge Manager Tabs** will not take effect until the GUI is restarted. Clicking **OK** after changing preferences saves the selections and closes the window. Clicking **Reset Config** restores LANforge-GUI preferences to their default configuration. This will cause the GUI to exit and when restarted, it will be in the default configuration.




#### Confirmation Options

- **Auto-Submit**: Allows for changes in fields which have a 'GO' button to be submitted automatically. If not selected, the 'Go' button must be clicked to submit the change.
- **Confirm Netsmith Sync**: Select this to require user confirmation prior to synchronizing Netsmith (changes not applied will be lost).
- **Skip delete warning in Reporting Manager**: Select this to delete reports in the

Reporting Manager without a confirmation.

- **Skip delete warning in Netsmith**: Select this to delete objects in Netsmith without a confirmation.

### Display Options

- **Anti-Alias lines in Netsmith**: Select this to allow anti-aliasing (sub-pixel smoothing) when rendering Netsmith display objects.
- **Invert RX-Signal X Axis**: Invert values for the RX-Signal X Axis.
- **Show Commas**: Select this to display most numbers with commas.
- **Enable system look and feel (requires restart)**: Enabling the system look and feel forces the Java platform theme to load instead of the Metal theme on application start. Restart the GUI to see the theme change.
- **Set Extended Title**: Text added here will be appended to the given title on the LANforge Manager widget.
- **Display Graph Duration**: Enter the time scale for graphs (default is 1.0 minute).

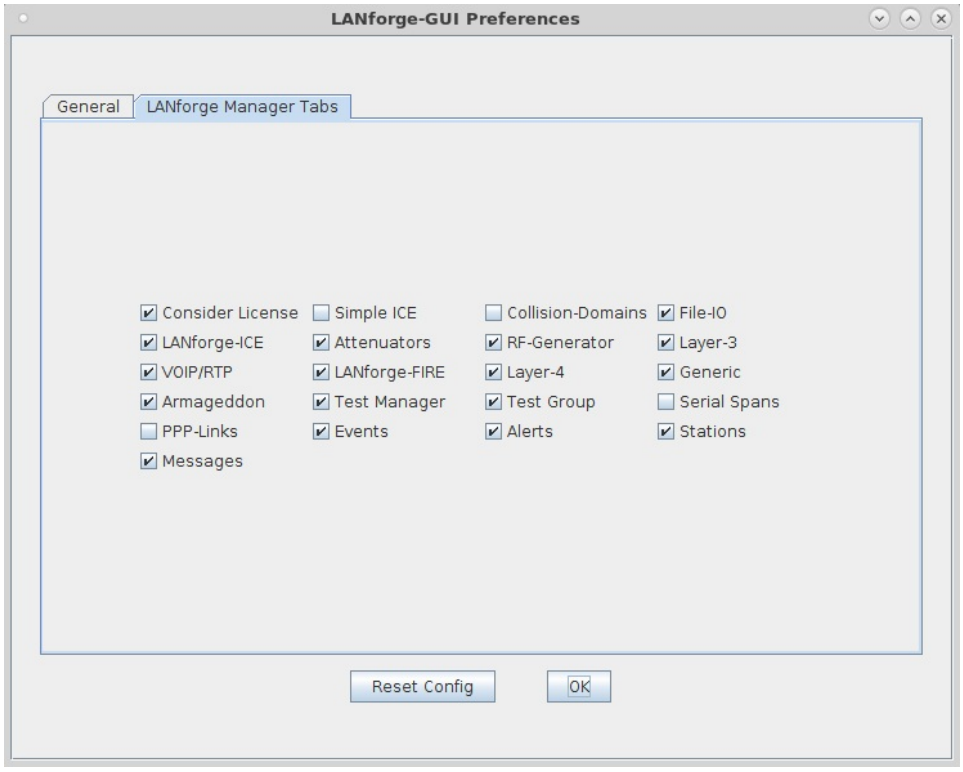
### Feature Options

- **Poll Mgr**: Select this mode for larger configurations with 400+ cross-connects.
- **Confirm Exit**: Select this to require user confirmation prior to exiting the GUI.
- **User ID**: Specify user-id for custom configuration for certain customers.
- **Enable HTTP Service**: Select this to enable querying the GUI for JSON data.
- **HTTP Port**: Specify the port the HTTP service should listen on.
- **Run GUI Minimized**: Select this start the GUI with all windows minimized, including alerts.
- **Enable hotkey for entity deletion**: when selected, the hotkey ALT-T can delete highlighted rows.

### Tool-Tip Options

- **Show Tooltips**: Select this to display tooltip information with the specified duration and delay (milliseconds).

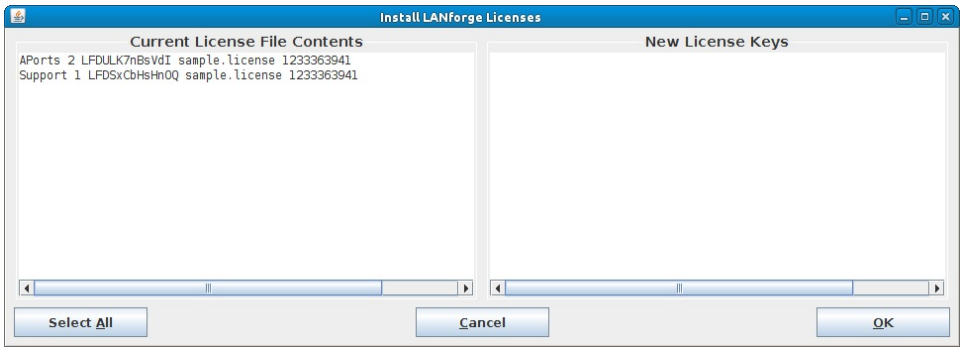
### Tab Display Preferences




- **Simple ICE**: Select this to limit the LANforge display to a simplified LANforge-ICE WAN emulation feature set.
- **Collision-Domains**: Select this to display the ICE (WanLink) Collision Domains tab.
- **File-IO**: Select this to display File related screens.

- **LANforge-ICE**: Select this to display LANforge-ICE related tabs.
- **Attenuators**: Select this to display Attenuator related screens.
- **Layer-3**: Select this to display Layer-3 related screens.
- **VOIP/RTP**: Select this to display VOIP/RTP related screens.
- **LANforge-FIRE**: Select this to display LANforge-FIRE related tabs.
- **Layer 4-7**: Select this to display Layer 4-7 related screens.
- **Generic**: Select this to display Generic Endpoint related screens.
- **Armageddon**: Select this to display Armageddon related screens.
- **Test Manager**: Select this to display the Test Manager tab.
- **Connection Group**: Select this to display Connection Group related screens.
- **Serial Spans**: Select this to display Serial Span related screens.
- **PPP-Links**: Select this to display PPP related screens.
- **Events**: Select this to display Event related screens.
- **Alerts**: Select this to display Alert related screens.
- **Messages**: Select this to display the Messages tab.

- **Install License**: Allows new license keys to be installed on the LANforge server. Current license file contents are listed on the left panel of the Install LANforge Licenses window. Copy the new license information into the right panel labeled 'New License Keys' and click **OK**. The new license file will be in use once the LANforge Manager is restarted.
  **NOTE**: Even if multiple resources are configured in your system, the license information only needs to be installed on the master resource.



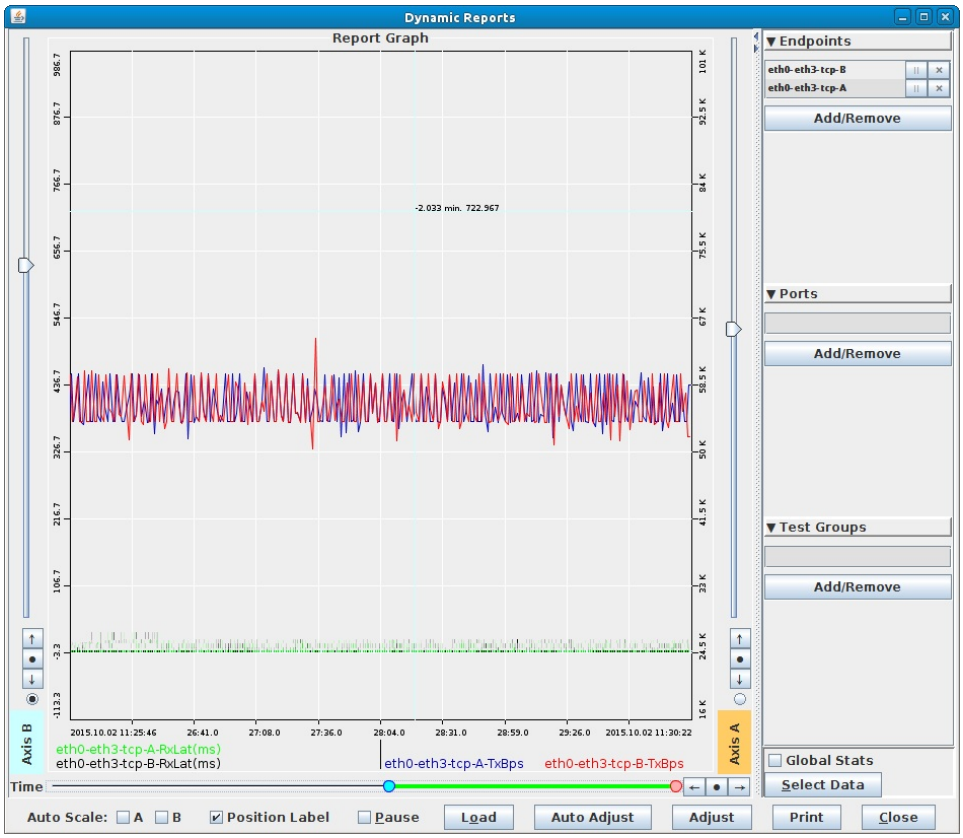

- **Shutdown Machine**: This command will shutdown the Resource 1 machine, which is usually the Manager machine. If your system is not clustered, then this is the one and only LANforge machine.
  **NOTE:** Shutting down a machine will destroy any test that is using that machine and reboot the operating system. The operating system may not come back up until you power-cycle the machine. You should shutdown the machine at least one minute before shutting off the power!
- **Exit**: An alternate way to shut down the LANforge-GUI. A confirmation window will pop up when you select either 'Exit' from the Control pull-down menu or attempt to close the LANforge Manager window. Click the **Exit LANforge GUI** button to confirm the shutdown. Note that exiting the LANforge-GUI does not affect LANforge server processes. Deselecting the 'Confirm when exit is requested?' checkbox will allow the LANforge Manager to shutdown immediately without displaying the confirmation window.


## 35. Reporting

- **Print (Fit to Page)**: Allows you to print the data on a selected tab as viewed in the GUI to a printer or PDF document which will be automatically sized to fit on one page. LANforge does not support printing information displayed on the **Status** or **Messages** tabs.
- **Print (Multi Page)**: Allows you to print the data as viewed in the GUI to a printer or PDF

document, splitting the columns up across several pages.

- **Dynamic Reports**: Allows real-time graphing of multiple data sets from multiple Endpoints and Ports, as well as global stats. Multiple graph windows may be used concurrently. Dynamic Reports can be launched by selecting Endpoint, Cross-Connect and Port rows and then using the **Right-Click → Dynamic Reports**> option.




The main graph has two independent axes, with Axis B controls on the left and Axis A on the right. By default, data-sets other than Latencies are assigned to Axis A and Latencies are assigned to Axis B. The user can drag data sets from one axis to another by dragging the label at the bottom of the graph to the desired side.

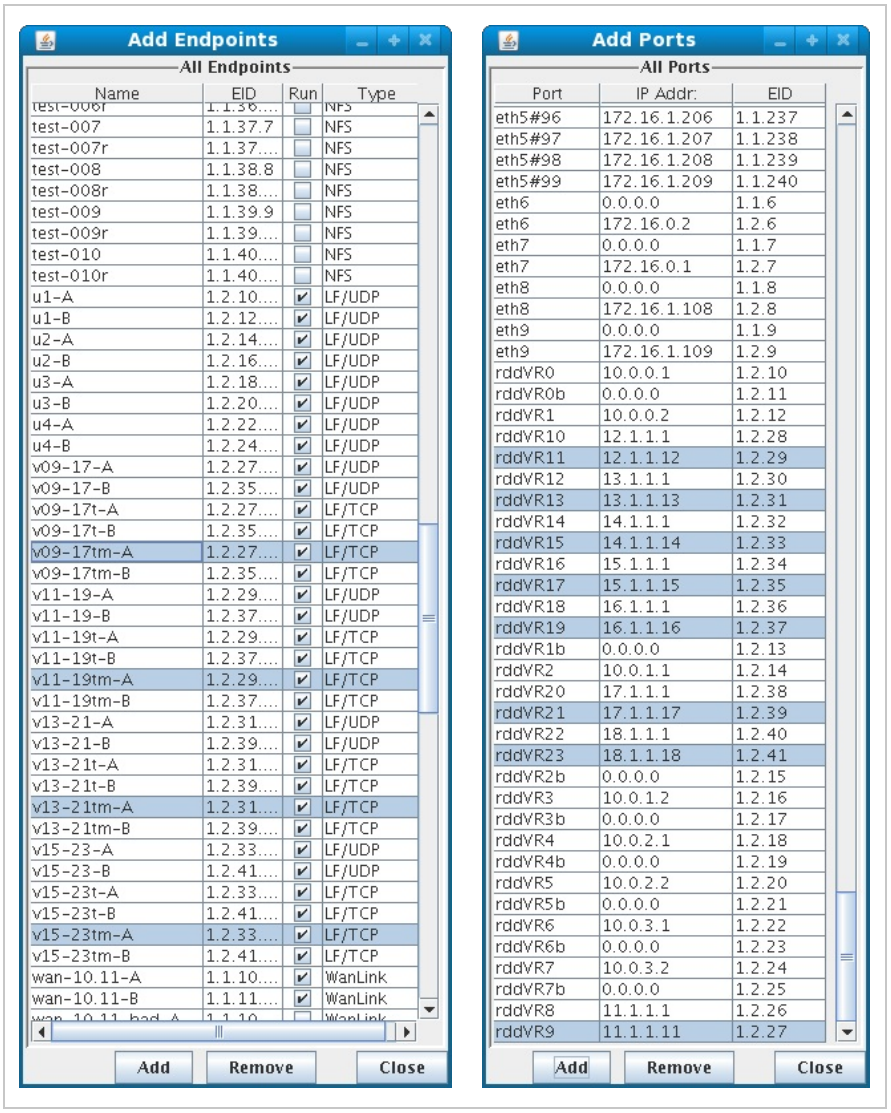
A small button above each of the Axis labels selects that axis for actions that can work on either axis (mouse controlled zooming and clicking).

The vertical drag bars scroll the data associated with that axis up or down. If the mouse is released within the outer 10% of the drag bar, it is automatically re-centered to allow more adjustment.

- Vertical Zooming is handled via several methods:
  - The ↑ **(up arrow)** button zooms in.
  - The ↓ **(down arrow)** button zooms out.
  - The ● **(black circle)** button returns to defaults.
  - The user can drag a box around an area that will become the new vertical bounds for the graph (the horizontal zoom will not be changed by this action).
  - A wheel mouse can also be used to zoom in and out.
  - Double-clicking on a point centers on that point and zooms in.
  - The **Auto Adjust** button will attempt to center the current data sets.
- The horizontal time axis can be controlled by the range-slider at the bottom of the widget.
  - The → **(right arrow)** button zooms in.
  - The ← **(left arrow)** button zooms out.
  - The ● **(black circle)** button returns to defaults.
  - The blue and orange ends of the time axis selection bar can be dragged to select a subset of the total time range.
  - The green connecting bar can be dragged left or right to pan through the total time range.

- **Auto Scale**: The 'A' and 'B' checkboxes here represent the vertical axes. Dynamic report will automatically adjust the selected axes over time so that they are nicely displayed.
- **Postion Label**: Enables/disables the cross-hairs and numeric coordinates printout that follows the mouse cursor.
- **Pause**: When selected, the data sets will be not be updated, allowing detailed analysis, printing, etc.
- **Load**: The Load button will attempt to load previously saved reporting data to fill in the visible time range for the selected Endpoints and Ports. The data is pulled from the CSV files that are generated by the Reporting Manager (see below). Please note that for very large data sets, it can take several minutes to complete the Load operation.
- **Auto Adjust**: This will automatically adjust the vertical axes so that data is nicely displayed.
- **Adjust**: Manually enter the min/max for each of the two vertical axes and the time axis.
- **Print**: Print the entire graph with standard printing tools.

To add data-sets, click on the **Add/Remove** button for Endpoints, Ports, or Connection Groups. After selecting the appropriate entities, use the **Select Data** button to choose your data-type options. You may also select the Global Stats checkbox to graph global data.

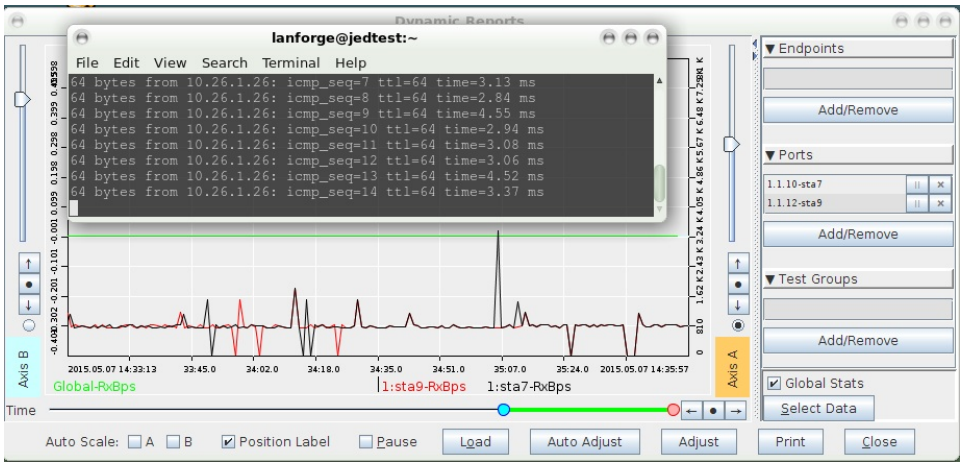



dynamic_reports

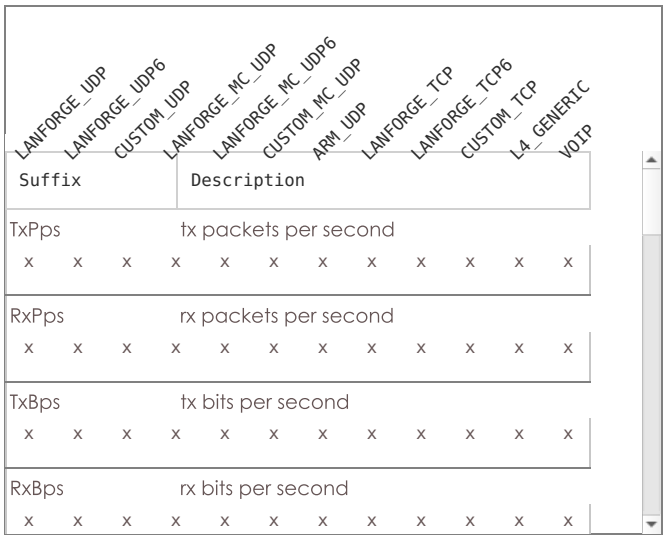
### Global Stats

The **Global Stats** checkbox includes a running total of all running cross-connects. Assume two Layer-3 connections C1 and C2, where C1-A and C1-B are both transmitting at 10Mbits, and C2-A is transmitting at 10Mbps but C2-B is not transmitting. The Global Tx-Bps value for this scenario would be 30Mbps. Activity through the management port, or any port object is

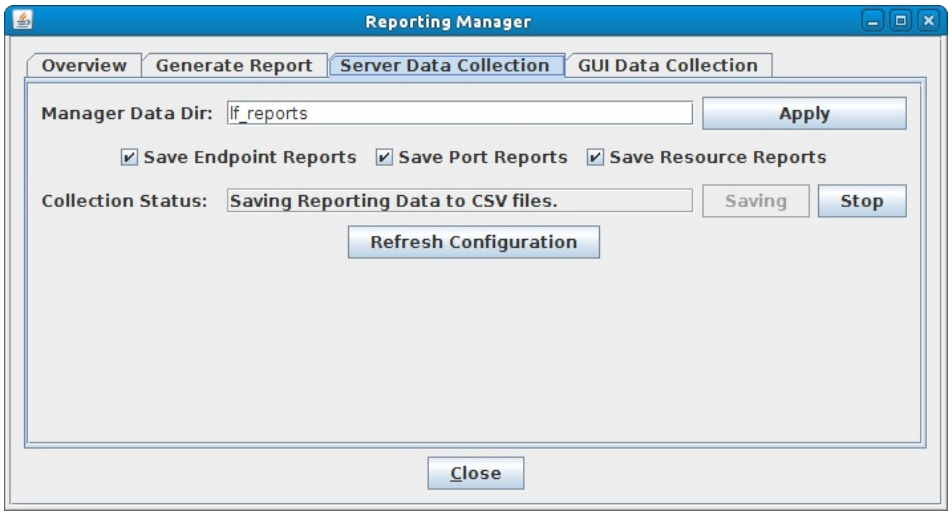
not collected in the Global Stats feature. This means that services outside of LANforge that are running on LANforge managed ports (like apache, nginx, or bind) that are transmitting will only be captured in individual port objects. To demonstrate, you can watch activity of two ports transmitting a ping command, and see that the Global Stats-RxBps value does not change.




Below is a list of values that the Global Stats feature can display. These values are selected from the **Select Values** feature next to it.

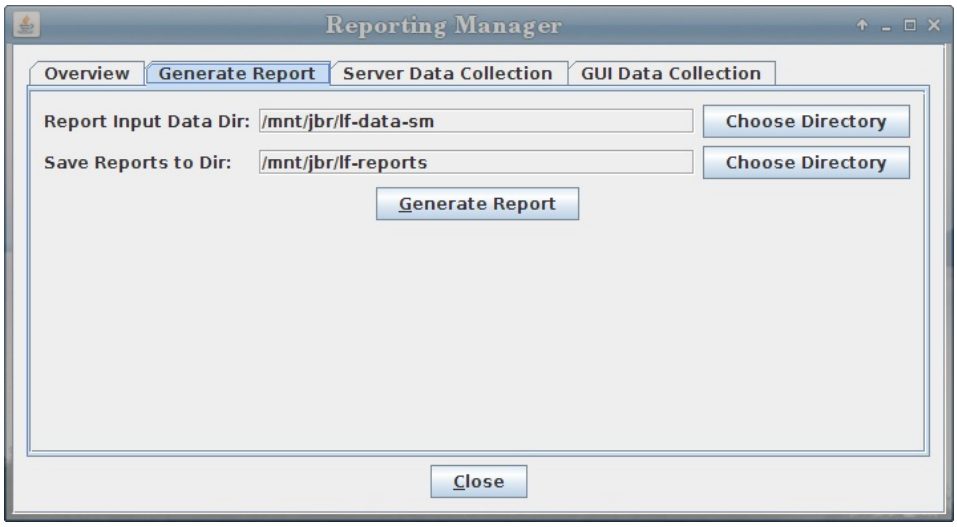



- **Reporting Manager**: Allows you to save data on reporting elements such as Endpoints, Interfaces (Ports) and Resources to .CSV formatted files that can be later turned into graphical HTML reports. The Reporting Manager allows you to control where and when Endpoint CSV data is stored. All report data can be saved on the GUI host PC. Endpoint, Port and Resource reports can also be saved on the LANforge Manager Server machine by selecting one or more checkboxes in the Server Data Collection panel. Data will be saved in the directory listed in the **Server Data Collection→Manager Data Dir** field. This directory is created in the same location where LANforge is installed (typically /home/lanforge/) unless another path is specified. Clicking the **Server Data Collection→Refresh Configuration** button updates the current report settings of the LANforge Manager Server.




The **Save** and **Stop** buttons control the saving of reporting data. Clicking the **Save** button begins saving reporting data to .CSV files in the selected directory. Reporting data will continue to accumulate until the **Stop** button is clicked. Every Collect and Ignore cycle creates a new set of CSV files in addition to any existing CSV files.

Graphical HTML reports of selected Endpoints can be created by clicking the **Generate Report→Generate Report** button any time.




**NOTE**: Manager Server and GUI Reporting are supported if using the LANforge LiveCD but all files must be saved to external storage media.

- **GUI Data Collection→GUI Data Collection Dir**

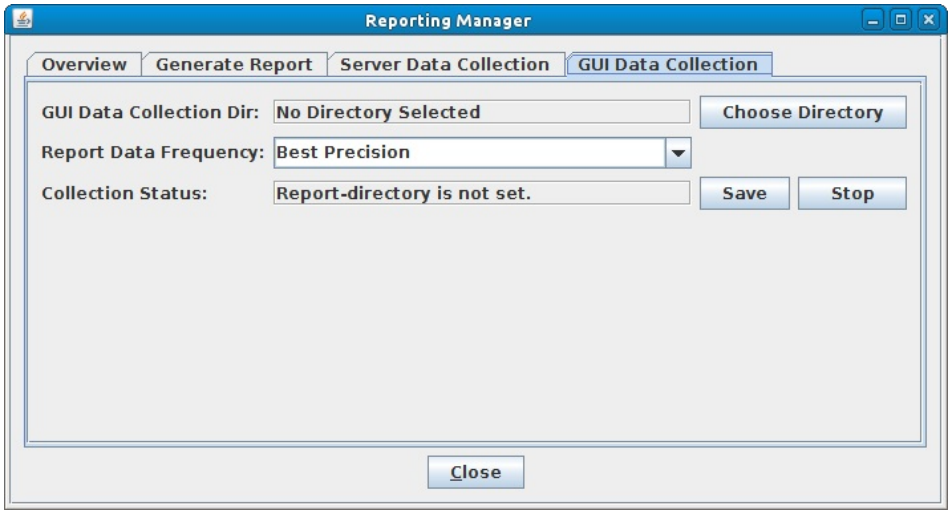
  Displays the file path to the currently selected directory. Click the **Choose Directory** button to select or create a different directory for saving .csv data reports.

  **GUI Data Collection→Report Data Frequency**

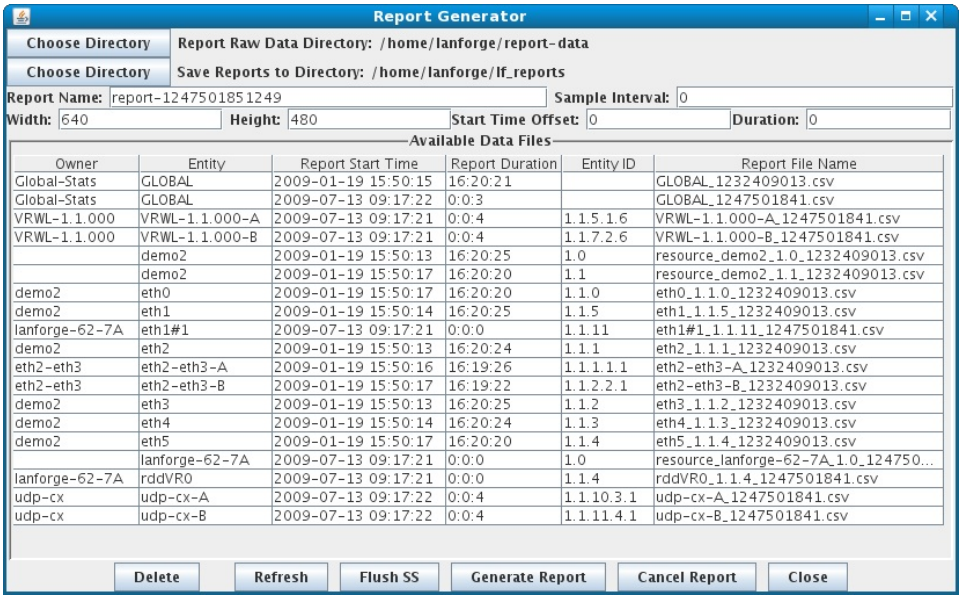
  Select the rate at which Endpoint data will be saved. The value (in seconds) is how often a snapshot of Endpoint data should be taken. Selecting a higher value will reduce disk space usage and lower the stress on the GUI host PC. 'Best Precision' saves data at the rate of each individual reporting element's report timer. It uses the most disk space and the highest processing power of the GUI host PC.

  **GUI Data Collection→Collection Status**

  Displays the current reporting status (whether reporting data is currently being saved or not).




**Generating Reports:** Click the **Generate Report→Generate Report** button to pop up the Report Generator window which enables you to create a customized graphical HTML report. First, choose the directory where the .csv report data was saved. This should be the same location as in the previous step. Next, choose a main directory where the GUI will save the HTML reports. This directory will be the top-level directory under which all Report Name directories will be stored. Alternatively, the individual .csv files can be viewed directly by navigating to the Report Data Directory mentioned above and opening the files with a spreadsheet application.




**Report Name**

Type the directory name for the current HTML report to be stored or accept the default name which includes a UNIX time stamp.

**Sample Interval**

The interval over which cumulative samples will be gathered. For instance, to average 30 seconds worth of reports into a single graph data point, use 30. If the graph is too narrow to hold this many data points, the sample interval will be automatically set to the closest valid value. The actual interval used will be shown in the detailed view of the graph in the generated report.

**Width**

Specify the width (in pixels) of the graphs to be generated.

**Height**

Specify the height (in pixels) of the graphs to be generated.

**Start Time Offset**

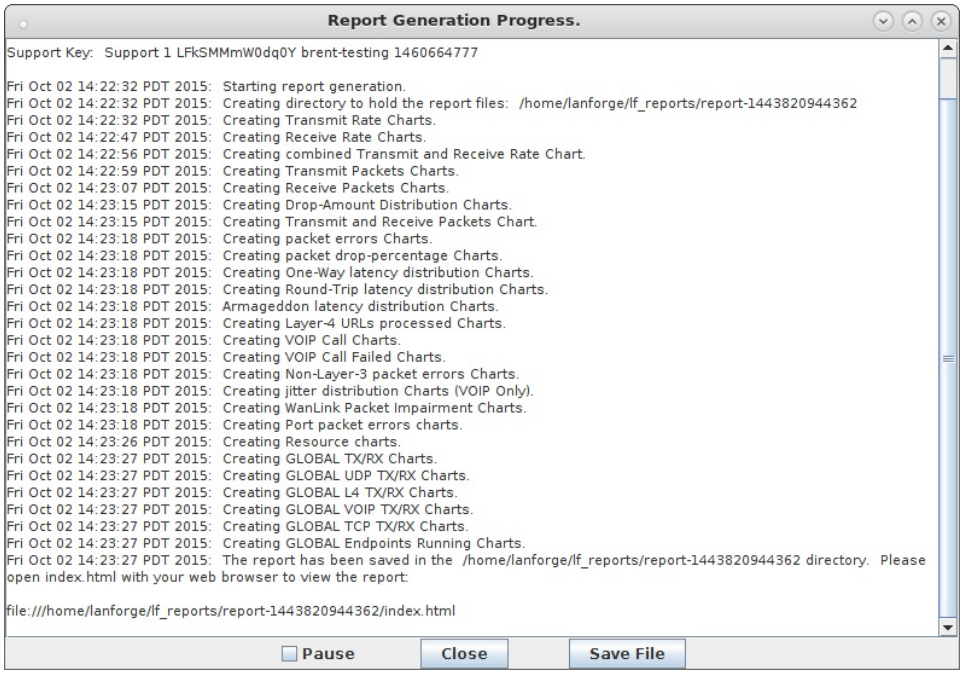
Specify the number of seconds of data to skip before starting the report.

**Duration**

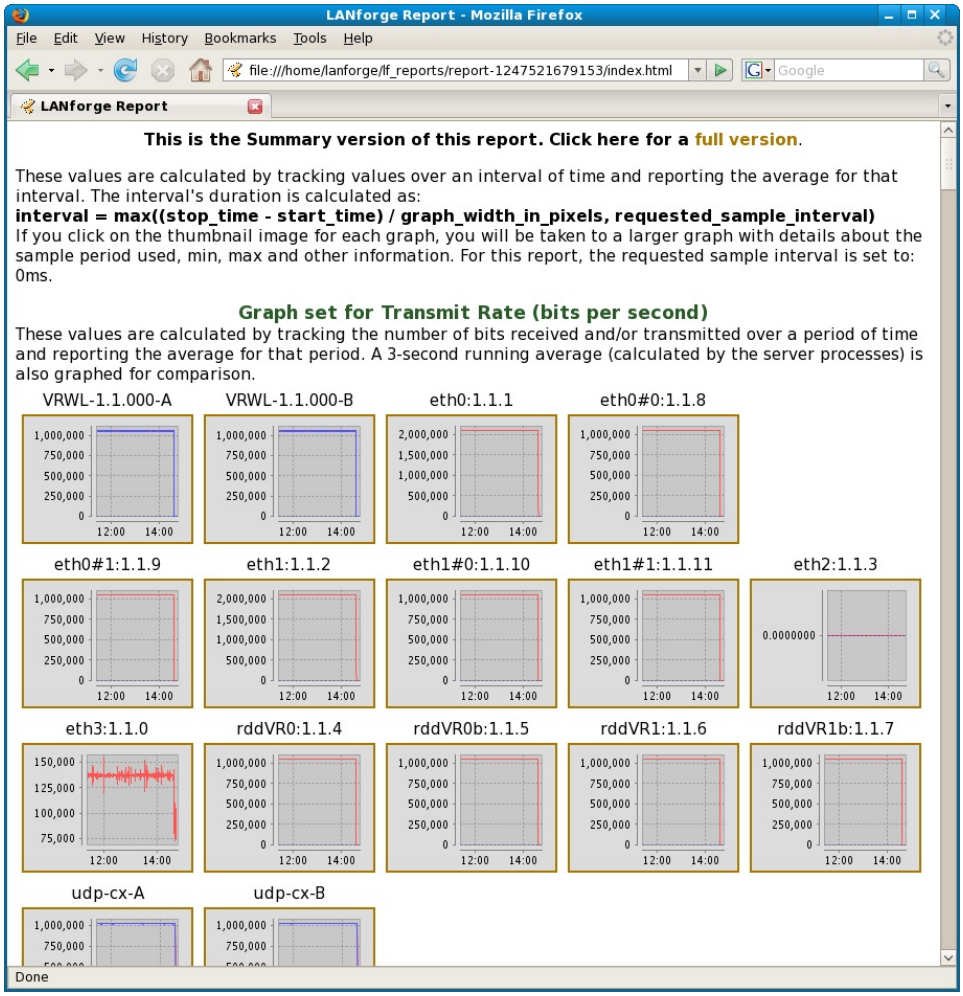
Specify the number of seconds of data to report. Zero means graph all.

After choosing your HTML report options select the Endpoints, Interfaces, and Resources that should be included in the HTML report. When you have the data files you want selected, click the **Generate Report** button.

The Report Generation Progress pop-up will present the entire status of report generation for each Endpoint, Interface, or Resource selected. The duration of report generation will depend on the size and number of .csv data files selected. At the conclusion of the report generation, the progress pop-up will confirm the name and directory of the completed HTML report. Your web browser will then be launched automatically to the index of the newly generated HTML report.

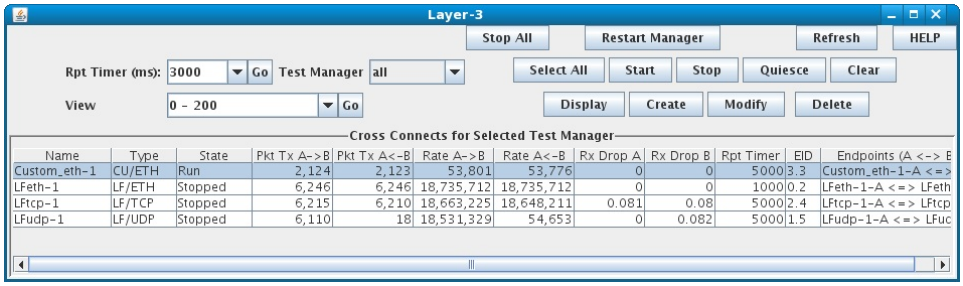



To view the completed HTML report, navigate to the directory printed in the progress pop-up and open the index.html file in your web browser application.




## Tear-Off

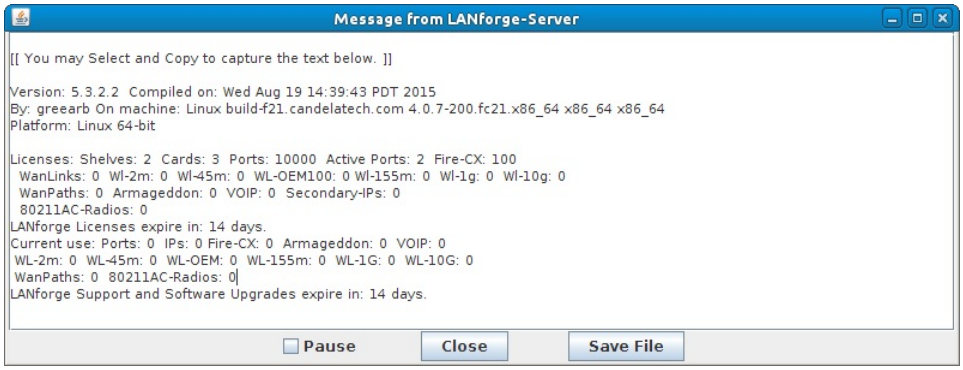
Up to this point, each tab has been shown as it appears among the collection of other tabs embedded in the main window. Selecting a tab from the 'Tear-Off' pulldown menu will display the selected tab in a new window. This will allow you to monitor several tabs at once! Click the 'Close Window' [X] button in the upper right corner of the window to return the tab to the main window. Below is an example of the **Layer-3** tab tear-off:




## Info

The Info Menu provides information about Candela Technologies, Inc., as well as other useful information.

- **About Candela Technologies**: Provides a brief statement about Candela Technologies, Inc.
- **About Current Tab**: Links to the LANforge-GUI Users Guide online.
- **GUI Overview**: Links to the LANforge Network Tester Overview guide online.
- **GUI Version**: Displays build information for the version of LANforge that is currently running.
- **License Info**: Displays the current LANforge license allowances and lists the LANforge licenses currently in use.




## Plugins

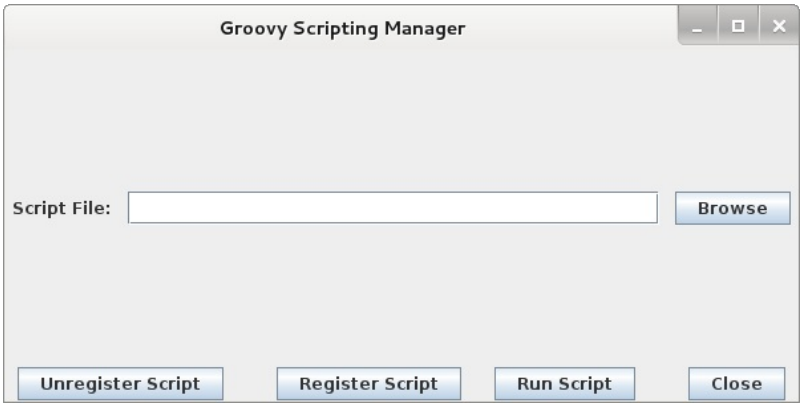
With the release of LANforge version 5.2.9, the LANforge GUI now supports plugin scripts written in the Groovy scripting language. This allows users to utilize the full power of the LANforge GUI to automate tasks, and generate customized reports.

Some scripts are included to provide useful features and to act as starting points for users who wish to write their own scripts. To view the current plugins, use the **Plugins** drop-down menu in the main LANforge GUI window. Some of the plugins are also right-click options on related tables in the LANforge-GUI.

Built-in scripts are automatically loaded (from the `lflclient.jar`) when the GUI starts (though later scripts could unload and/or replace them if desired). Next, all files in the **user_groovy** directory are loaded. If a user wishes to customize an existing script, they should copy it from **example_scripts** to the **user_groovy** directory and make changes. The modified script will first unload the default script before loading itself, it can also just load itself with a different name.

#### Groovy Scripting

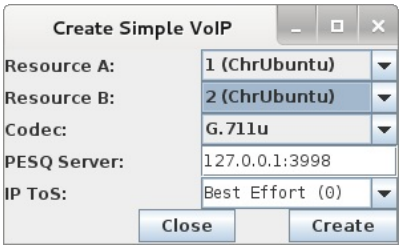
The Groovy Scripting plugin allows users to load, unload, and run custom scripts.




- **Script File**: Path to script file.
- **Browse**: Open up a browse interface to find a script.
- **Unregister Script**: Removes the groovy script from the plugin menu (for the current session).
- **Register Script**: Adds a groovy script to the plugin menu without having to restart the LANforge GUI.
- **Run Script**: Run the groovy script referenced in the Script File field (script does not need to be registered).
- **Close**: Close the Groovy Scripting Manager window.

#### Create Simple VoIP

This script was written for a user that wanted a very simple way to create a VOIP call between two LANforge machines.




- **Resource A**: The resource (machine) endpoint A should reside on.
- **Resource B**: The resource (machine) endpoint B should reside on.
- **Codec**: Choose the codec to be used for voice/video calls.
- **PESQ Server**: Enter in the PESQ address in the format **user@server:port**.
  Example: **bofh@127.0.0.1:3998**.
  For PESQ servers with more than one process, set the port to be the number of processes to spread the load across the PESQ servers. For instance, if using a 4-core PESQ machine, set the value to **127.0.0.0:4**.
- **IP ToS**: The IP Type of Service byte, see RFC-1349, 2474, 2481. Choose a value from the drop-down menu, or type in a value directly. Enter a decimal value or prefix with 0x for hex. Do not use the two low bits, as they conflict with ECN.
- **Close**: Close the Create Simple VoIP window.
- **Create**: Create the VoIP connection.

#### VoIP Reporting

This creates a graphical report for PESQ, Jitter, Packet-Drops, TX-Bps and Round-Trip Latency. To use it, select one or more VoIP Endpoints, and right-click to run this script. This plugin reads GUI Reporting CSV files to generate the graphs, so make sure that reporting is configured to save CSV reports on the GUI Machine. This plugin may take quite a bit of time if there is lots of CSV data for the selected connections and/or if there are lots of connections selected. This plugin does NOT update real-time, it only reads from the CSV files.
Here is a sample report generated by the VoIP Reporting script.

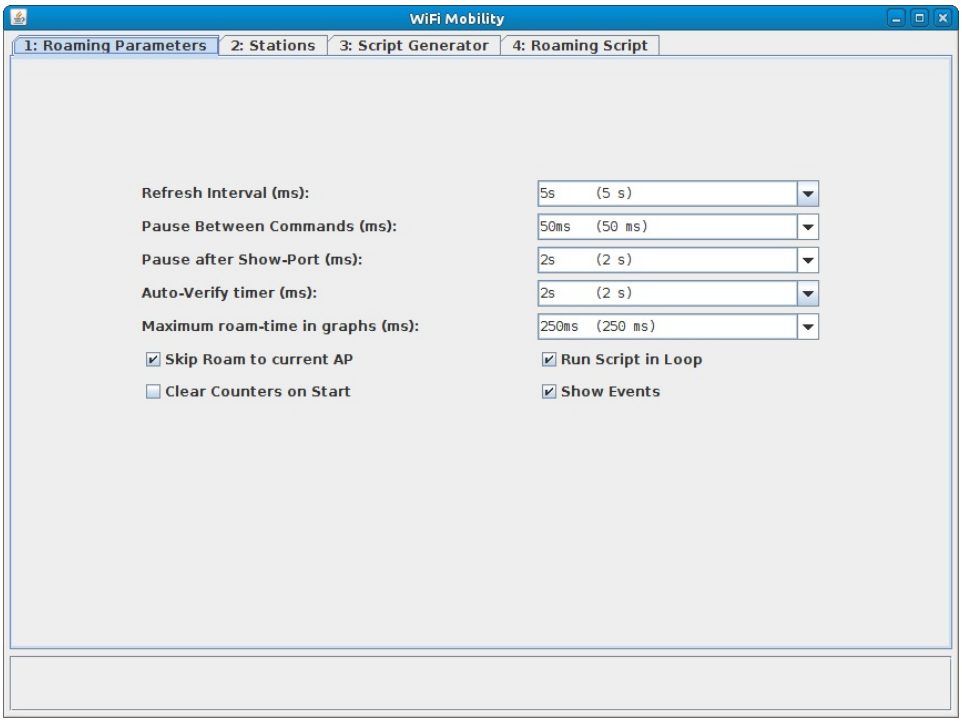
#### WiFi Mobility

The WiFi Mobility test emulates a scenario where mobile WiFi clients (stations) are travelling among a constellation of Access Points. The WiFi stations will make roam attempts based on time, so there is no need or ability to roam based on the AP signal strength. This plugin is good for testing 802.11r, authentication servers, and other components that deal with stations moving from one AP to another. This scenario can emulate about three-hundred stations each attempting to migrate. It can generate association requests as frequently as every 30 milliseconds.

If using more than one station per radio/NIC (wiphy), then the stations can only roam to other APs on the same channel. If you want to roam across different channels, then delete all stations except for the wlanX and use those for the mobility test. To use this plugin, select the stations you wish to migrate on the Port-Mgr tab, right-click and choose **WiFi Mobility**.

For a detailed document on how to configure this, see: WiFi 802.11r Roaming HOWTO.

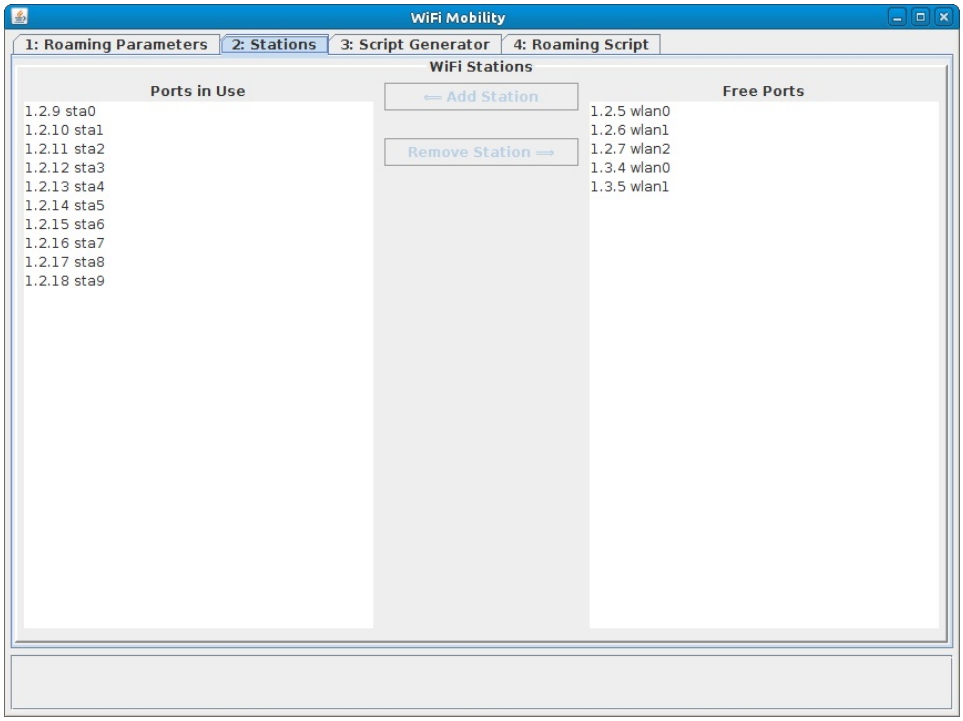
#### Roaming Parameters<




- **Refresh Interval**: This determines how often the plugin requests updates from the stations to verify whether they have successfully roamed or not.
- **Pause Between Commands**: This determines how long the plugin will wait before doing the next script command. This can be used to space out roam attempts a bit so that they do not all happen at the same time.
- **Pause after Show-Port**: This determines how long the plugin will wait after requesting a port update before it will look at the local port information. If the GUI is running over a slow network connection to the LANforge, or if there is a large number of stations used in the plugin you may wish to increase this to several seconds.
- **Auto-Verify timer**: This determines how long the plugin will wait after doing a roam attempt before it begins to check if the roam was successful. Typically this should not be less than 1 second.
- **Maximum roam-time in graphs**: This is the upper-bound for roam-time values reported in the graphs. This keeps the graph at a useful resolution even if a few roam times are very large. The log messages at the bottom of the report record the exact times.
- **Skip Roam to current AP**: If selected, the plugin will check the current AP the station is connected to and will ignore roam attempts to that same AP. Disable this if you are purposefully 'roaming' to the same AP. This can still be useful for testing association, 4-way, ANQP and other times even if you have only a single AP for testing.
- **Run Script in Loop**: If selected, the plugin will run the script to the bottom, and then start again at the top until the user clicks 'stop'.
- **Clear Counters on Start**: If selected, the plugin will clear the station counters on startup.
- **Show Events**: If selected, LF events will show up in the text log window.

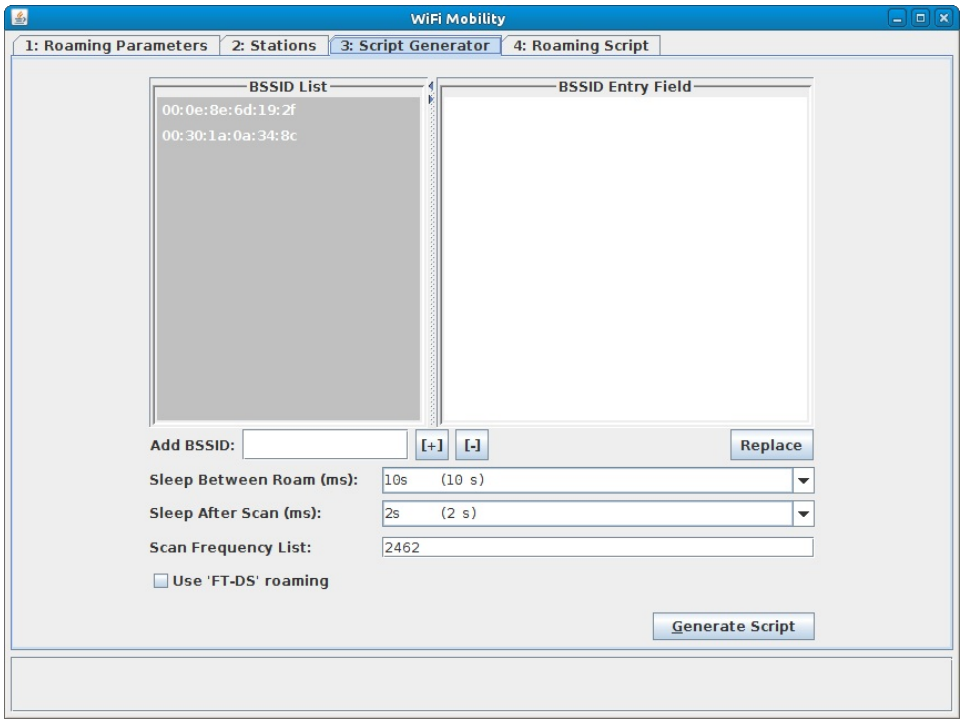
- **Stations**

  Select the stations that will be monitored. This does not restrict your script, but in general, you should select all stations that you are roaming in the script.




- **Script Generator**

  The Script Generator will take a list of BSSIDs placed in the text field on the right and generate a script for you to use in the Roaming Script tab. A warning message will be given at the bottom if an error is encountered. Use the below fields to customize how your script will generate.




  - **BSSID List**: This shows the BSSIDs (typically MAC addresses of the APs) used in migration.
  - **BSSID Entry Field**: Enter or copy/paste a list of BSSIDs into this field. These will replace all entries in the BSSID List on the left.
  - **Add BSSID**: Use this to verify a BSSID. The **[+]** and **[-]** buttons to the right will add/remove the BSSID from the list respectively.
  - **Replace**: This button will completely replace the BSSID List (on left) with the text entered into the BSSID Entry Field (on right).
  - **Sleep Between Roam**: Choose or enter a custom amount of time you want the stations to sleep between roams.
  - **Sleep After Scan**: Choose or enter a custom amount of time you want the stations

to sleep after a scan.

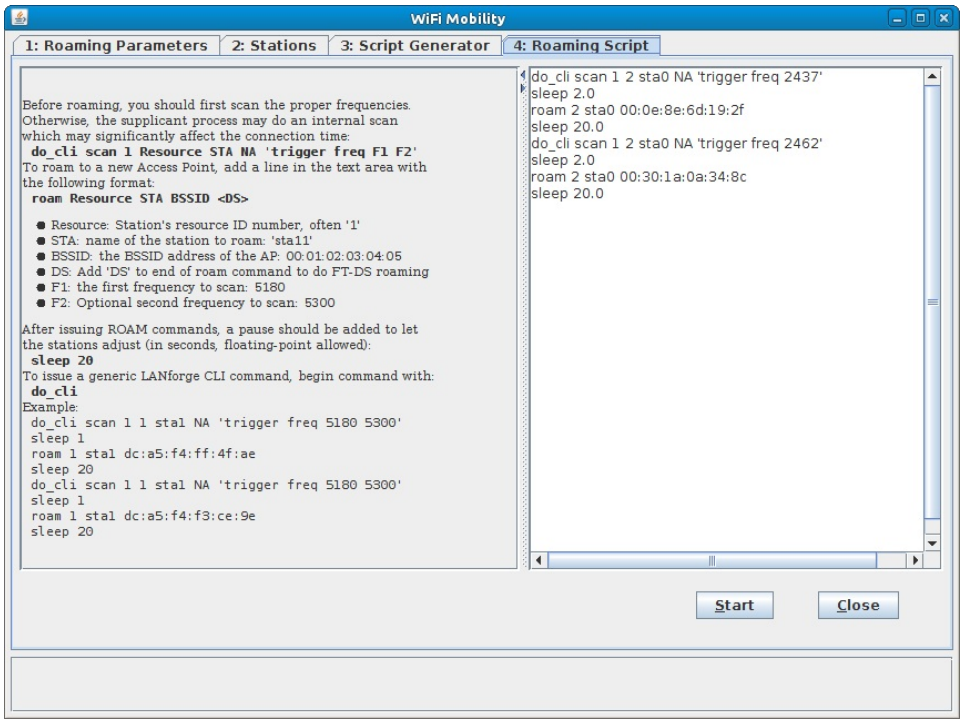
- **Scan Frequency List**: Enter a list of frequencies to scan. For example: 2412 2437 2462
- **Use 'FT-DS' roaming**: Choose whether to use FT-DS roaming or not.
- **Generate Script**: When clicked you will be taken to the Roaming Script tab with the generated script already in place.

- **Roaming Script**

The text field on the right holds the script. This is a set of text commands that will scan, sleep, and roam the stations. The text field on the left has some instructions on the syntax. In particular, you should scan on the target AP's channel 1-2 seconds before attempting a roam. Otherwise, the station may do an automatic scan which will significantly increase the amount of time it takes to complete the roam attempt.

Make sure that any station you wish to roam uses 'DEFAULT' for it's AP field in the Port-Modify screen. Otherwise, it will not be able to roam to an AP other than what it has configured.

Once everything is configured, click **Start** to begin the mobility test.




## Interpreting results

**Station Roam Time**

Total time between starting the roam attempt and completing authentication. It would include 4-way and ANQP times. It does NOT include DHCP negotiation time. Basically, this is how long a station would be disconnected from the network during the roam.

A good AP setup should roam within 50ms when using 802.11r.

**ANQP Time**

Total time to complete the ANQP query/response. This is only in use when configured for HotSpot 2.0.

**4-way AUTH**

Total time to complete the 4-way Handshake. When using 802.11r, the 4-way AUTH should only be done once when the station first connects. Subsequent roam attempts should skip this step. For more details on 4-way auth, see this wikipedia page on The Four-Way Handshake. The plugin will report the last 4-way auth, so if your test shows a single unchanging value, then it was only computed once at the beginning. If it changes, then you know it is doing the 4-way auth on each roam attempt.

**Per AP Graphs**

The Per AP graphs correlate the times with the APs to which the station is roaming. The idea is that if you see one noticeably different than the others then that AP may be having trouble and should be investigated.

**DHCP Time**

DHCP time is duration from starting dhclient until IP lease is acquired. DHCP has some pause timers where it tries to discover DHCP servers, so if it takes several seconds, it probably does not indicate any problem with your system. In most cases, you want to disable DHCP renegotiation when roaming anyway, so that DHCP time will not change once the initial lease is acquired. To disable DHCP negotiation when roaming, deselect the **Restart DHCP on Connect** checkbox in the Misc section of the Port-Modify window for the station(s).

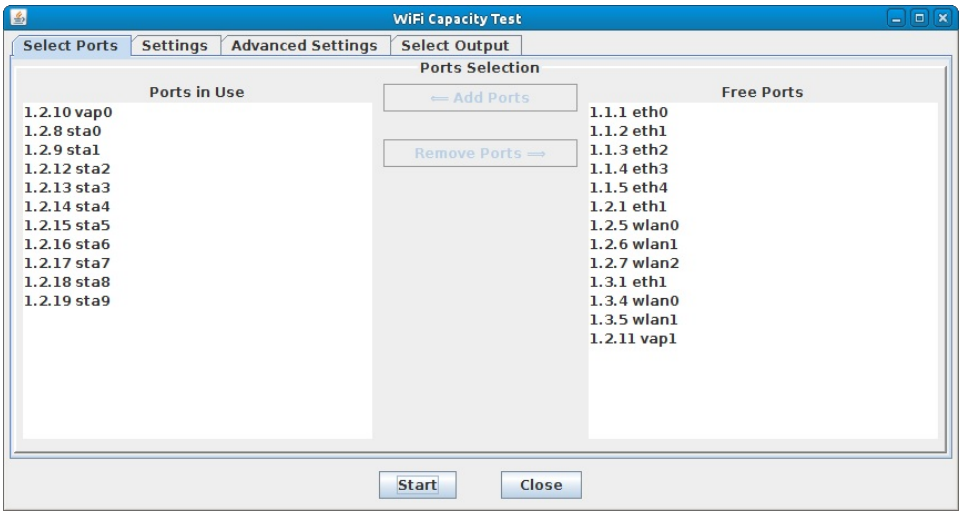
### WiFi Capacity Test

Use the WiFi Capacity Test when you want to test throughput of an Access Point or set of Access Points for an increasing number of WiFi clients. You can also discover the practical limit of clients that an AP can handle, including the number that can associate and the number that successfully were able to acquire DHCP and generate network traffic. This plugin can be used for upload/download testing, or for station-to-station testing.

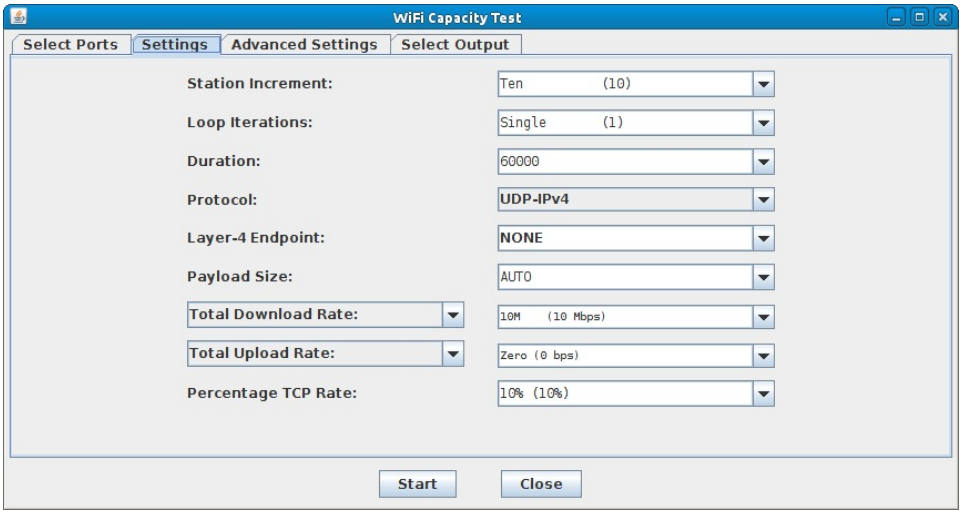
To use it, first create and configure Virtual Station interfaces so that they can connect to the AP(s). For upload or download testing, you must also have at least one non-station interface (typically a wired Ethernet interface) to act as the upstream side of the network. For station-to-station testing, just select an even number of stations and a connection will be made between each pair. Select the interfaces you wish to use on the Port-Mgr tab of the LANforge-GUI and choose launch the WiFi Capacity Test through the Right-Click menu or the Plugins pulldown menu. The script configuration screen should then pop up:

The configurable options are:

- **Select Ports**:




- **Add Ports**: Select and add the interfaces to be used in the test.
- **Remove Ports**: Select and remove the interfaces not required for the test.
- **Settings**

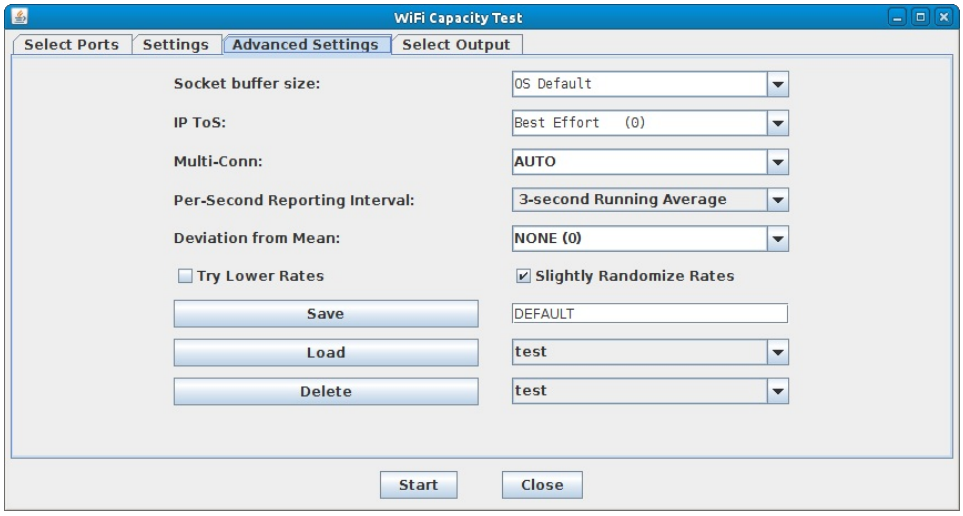



- **Station Increment**: This determines how many additional station interfaces will be brought up for each iteration in the test. The total number of iterations for the test is the total number of stations divided by the station increment. If your test includes 100 stations, with an station increment of 5, you will have 20 increments.
- **Loop Iterations**: Specify how many times the plugin will run through the Station

Increments.

- **Duration**: Time (in milliseconds) each iteration should run traffic before gathering statistics and moving on to the next iteration. Multiply the number of increments (as discussed above) by the station increment plus setup time to estimate the duration of the entire test. With 100 stations, 20 iterations in increments of 5, 10 seconds of setup time with a 60 second iteration duration, your entire test duration would be approximately `20 * (10 + 60) = 1400` seconds, or 24 minutes and 20 seconds.
- **Protocol**: This determines the traffic type for the throughput tests.
- **Layer 4-7 Endpoint**: Choose a Layer 4-7 connection to clone if using Layer 4-7 protocol.
- **Payload Size**: This determines the size of each 'write' for the network traffic. For UDP, this is the UDP PDU size and can directly affect the size of the packets being generated. For TCP, this is just the number of bytes that LANforge tries to write each time it sends network traffic.
- **Total Download Rate**: Aggregate download rate that LANforge will attempt to send. This does not count any protocol overhead.
- **Total Upload Rate**: Aggregate upload rate that LANforge will attempt to send. This does not count any protocol overhead.
- **Percentage TCP Rate**: When using both UDP and TCP traffic at the same time, this field determines the percentage of the total throughput that is requested for the TCP connections. Note that TCP will back off, so it may not actually get the requested percentage.

Advanced Settings

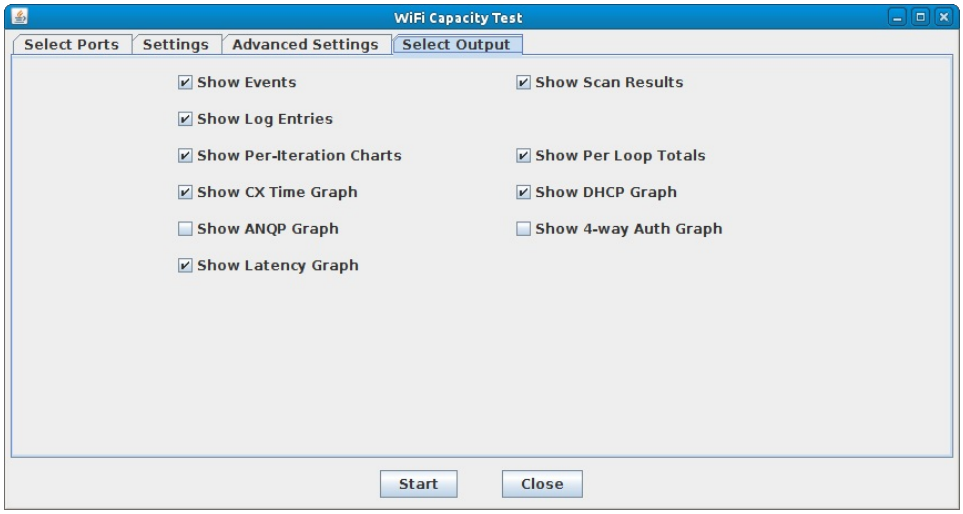



- **Socket Buffer Size**: This sets the UDP or TCP Socket buffer send and receive sizes. Setting this to higher values (1MB - 4MB) can help throughput when using smaller numbers of connections at high speeds, but using the **OS Default** will work better when the bandwidth of each station is relatively slow. If unsure, leave at **OS Default**.
- **IP ToS**: The IP Type of Service byte, see RFC-1349, 2474, 2481. Choose a value from the drop-down menu, or type in a value directly. Enter a decimal value or prefix with 0x for hex. Do not use the two low bits, as they conflict with ECN.
- **Multi-Conn**: If the value is greater than zero, a helper application will be spawned to handle this endpoint. If the value is greater than one, multiple streams will be created for each connection. Each 'multi-connection' will summarize the data for all connections and report to this one endpoint. Multi-conn can improve TCP throughput on higher latency and lossy networks and can help take advantage of multi-core processor systems by using additional traffic generation processes.
- **Per-Second Reporting Interval**: Some graphs report packets and bytes per second. Use this field to select a 3-second or 60-second running average.
- **Deviation from Mean**: Shows the percentage deviance from the mean tx-bps of connections. A 30% deviance would be a range from -15% to +15% away from 0 on the Y-axis. A 100% deviance shows a +/- 50% region.
- **Try Lower Rates**: For UDP testing especially, the aggregate requested throughput that works at smaller numbers of stations may not work for larger numbers of stations. When the **Try Lower Rates** option is selected, LANforge will slow down traffic automatically if it detects that not all connections are able to receive any data at all.
- **Slightly Randomize Rates**: If enabled, the plugin will set the calculated minimum rate

to 1% lower than the requested rate, and the maximum rate to 1% higher than requested. This will tend to make LANforge be more fair when configured to send more traffic than the DUT can handle.

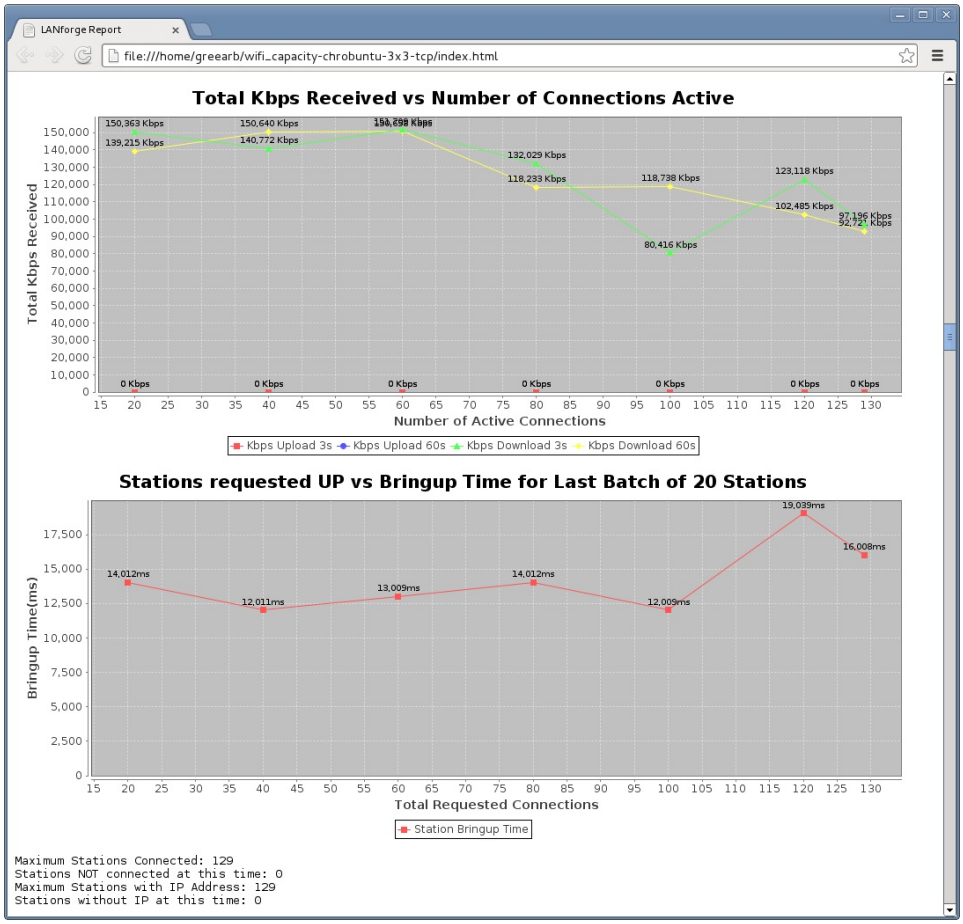
- **Save**: Save the current WiFi Capacity config. Use the text box to the right to name the config file.
- **Load**: Load a previously saved WiFi Capacity config file chosen from the drop-down to the right.
- **Delete**: Delete a WiFi Capacity config file chosen from the drop-down to the right.

**Select Output**




- **Show Events**: Choose whether to show events in the text log window or not.
- **Show Scan Results**: Displays scan information at the bottom of the report.
- **Show Log Entries**: Shows log messages in report below the graphs.
- **Show Per-Iteration Charts**: The iteration of each loop will generate a bar-chart with one column per station to show the stacked tx/rx throughput.
- **Show Per Loop Totals**: Each loop iteration will generate 'totals' graphs for that loop. You may wish to disable this if using more than one loop iteration.
- **Show CX Time Graph**: Displays a graph that shows how long stations take to connect.
- **Show DHCP Graph**: Displays a graph with each station's DHCP time.
- **Show ANQP Graph**: Displays a graph with ANQP times for each port.
- **Show 4-way Auth Graph**: Displays a graph with the 4-way Auth Time for each port.
- **Show Latency Graph**: Displays a Latency vs Time graph for UDP DL, UDP Round-Trip, UDP UL, and Active Stations.

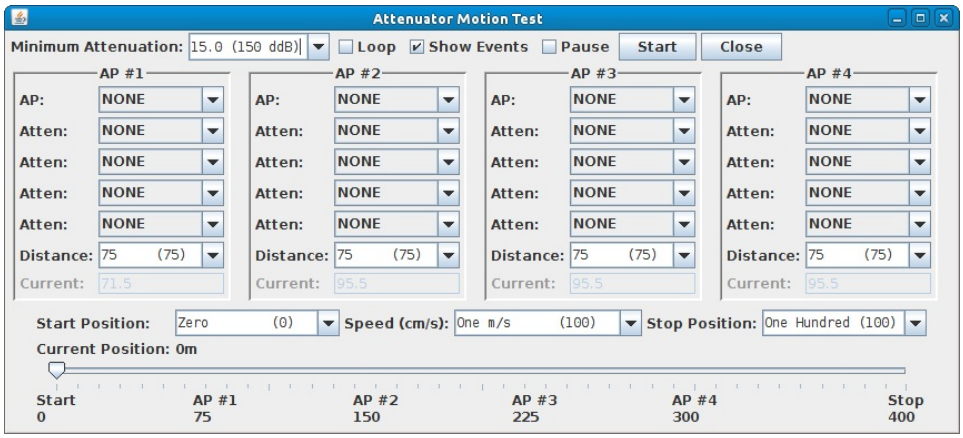
Click **Start** to start running the capacity test. As the script runs, a window of graphs and text is populated. The text may be edited by hand before saving (for instance, to add notes for this particular test). Graphs may be resized or otherwise adjusted. When satisfied with the layout, click **Save File** to generate an HTML report with the text and graph images.




Here is a sample report generated by the WiFi Capcity Test.

### Attenuator Motion Test

The Attenuator Motion Test was designed to emulate a mobile WiFi user walking from the vicinity of one AP towards another AP in order to test how well the mobile device handles roaming from one AP to another. To use this plugin, connect the LANforge attenuator between the device under test (DUT) and the APs. The DUT is typically a wifi handset, laptop, or other mobile wifi device. The APs can be off-the-shelf APs or LANforge APs. If LANforge APs are used, then more statistics are available. Then, configure the virtual distance between the APs and other information needed to determine the virtual path that the DUT takes through the collection of APs. You may space them widely to emulate a dead zone, or close together to emulate a well-covered area. You can use different attenuator channels on a single CT703 for doing 1x1 testing, or you can use multiple CT703/4 Attenuators for MIMO testing.




The configurable options are:

**Minimum Attenuation: Attenuation will not be set lower than the value entered here.**

**Loop**: If selected, the motion test will repeat until you click the **Stop** button or the **Pause** checkbox.

**Show Events: If selected, LANforge events will be shown in the text log window.**

**Pause:**

If selected, the motion test will not proceed until **Pause** is deselected. You can manually

adjust the Current Position while the test is paused.

**Start:**

Starts the attenuator motion test. Once started the button will change to **Stop** which stops the test when clicked.

**Close:**

Stops the motion test and closes the Attenuator Motion Test window. The graphical report will remain open.

**AP #1 - 4:**

The APs numbered one through four represent the APs the test device will run through. These are the configurable settings for each AP:

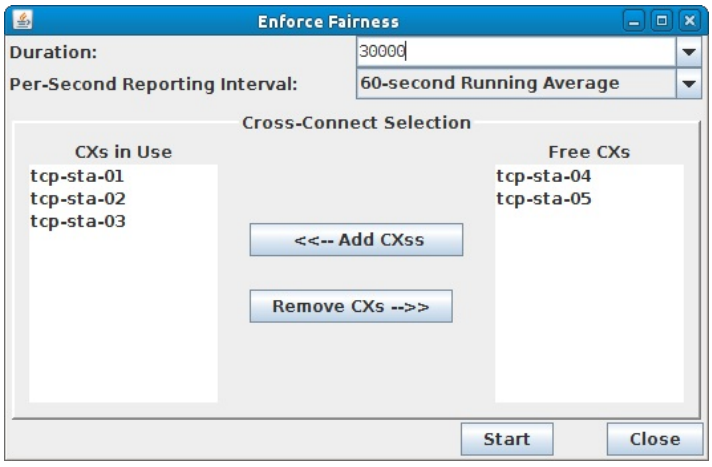
- **AP**: Select a LANforge AP.
- **Atten**: Choose an attenuator module (up to four) that will be grouped with the AP.
- **Distance**: This field represents the distance in meters from the previous AP. If it is the first AP, the distance is from the origin.
- **Current**: This displays the configured attenuation as the Current Position moves.
- **Start Position**: The starting position for the mobile device (in meters) can be changed here.
- **Speed (cm/s)**: The value here will effect how quickly the test device will move from AP to AP. Custom values entered here are in cm/s.
- **Stop Position**: This is the stopping position for the test device. The value represents the distance past the last AP (in meters) that the test device will stop at.
- **Current Position**: Displays the current position of the test device as it travels from AP to AP. The pointer on the bar below will move as the device 'travels' through the APs. The pointer can be moved manually if desired.

**Enforce Fairness**

The Enforce Fairness plugin is used to reduce the the requested transmit rate on a series of WiFi connections until each connection is getting a roughly equal amount of throughput.

This takes a collection of Layer-3 connections and slows them down until the maximum round-trip time is no more than 1 second over the average, and the total requested rate is less than 120% of the actual receive rate. This plugin is useful for throttling down WiFi connections that otherwise might run unfairly due to a few stations hogging all of the bandwidth.

For UDP connections, this may be the only way to see fairness on the network, but for TCP connections, any device-under-test with proper feature set and configuration could also enforce fairness without needing this plugin.




The configurable options are:

**Duration:**

Time (in milliseconds) each iteration should run traffic before gathering statistics and moving on to the next iteration.

**Per-Second Reporting Interval:**

Some graphs report packets and bytes per second. Use this field to select a 3-second or 60-second running average.

**Cross-Connects Selection:**

Select the Layer-3 Cross-Connects to be used in the test.

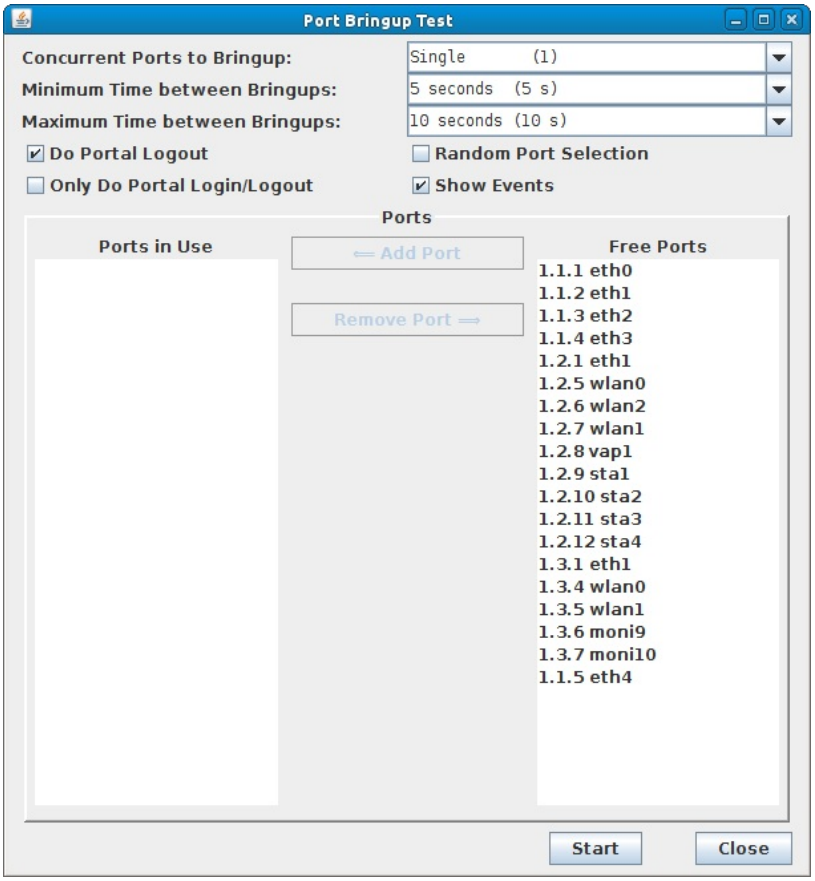
**Start:**

Start running the Enforce-Fairness test. As the script runs, a window of graphs and text is populated. The text may be edited by hand before saving (for instance, to add notes for this particular test). Graphs may be resized or otherwise adjusted. When satisfied with the layout, click **Save File** to generate an HTML report with the text and graph images.

Here is a sample report generated by the Enforce Fairness plugin.

**Port Bringup Test**

This test is good for stressing the AP's station association and authentication logic. This test brings up a series of stations in batches forcing them to do probe requests, authentication, DHCP, and even captive-portal login/logout. It can repeat this test for an arbitrary amount of time.



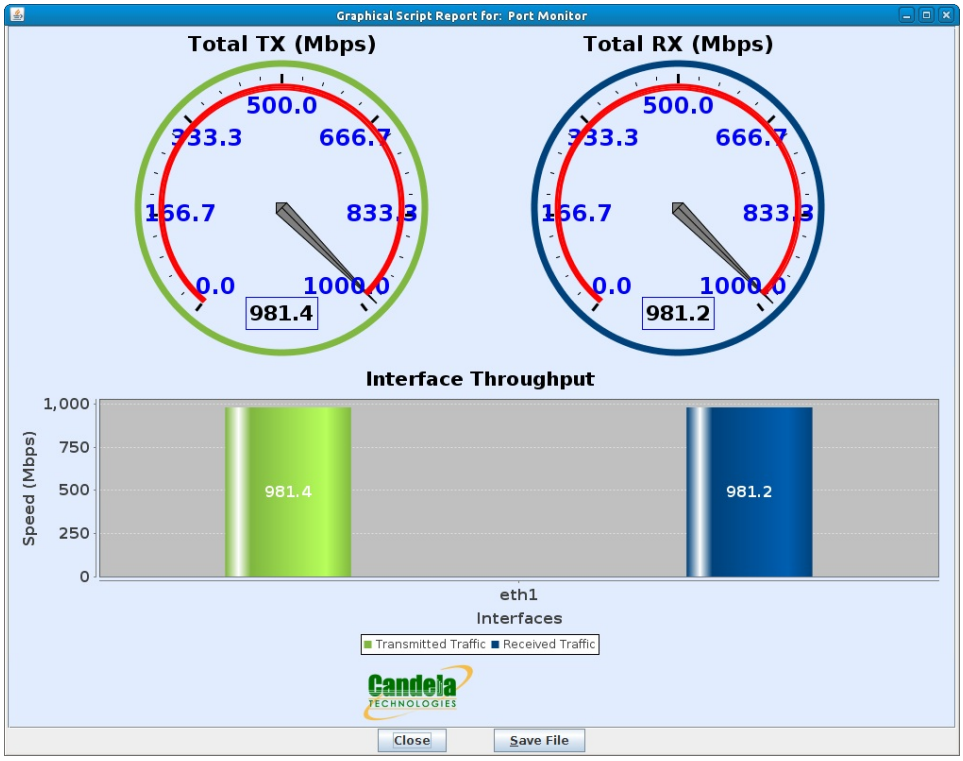

The configurable options are:

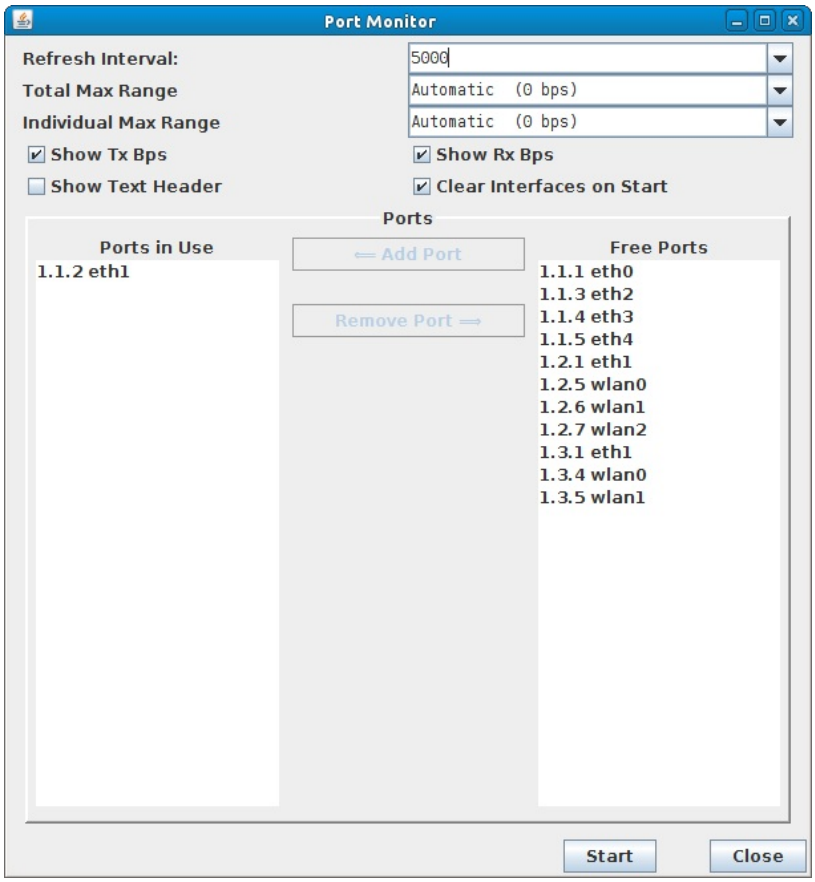
- **Concurrent Ports to Bringup**: Choose how many ports to bringup at a time.
- **Minimum Time between Bringups**: The minimum sleep time between bringing up the ports.
- **Maximum Time between Bringups**: The maximum sleep time between bringing up the ports.
- **Do Portal Logout**: Attempt to do a portal logout when going admin down. This is ignored if port is not configured for portal script.
- **Random Port selection**: Sets ports to admin-up randomly instead of sequentially.
- **Only Do Portal Login/Logout**: The Port Bringup plugin will only do portal login/logouts. The plugin will not attempt to reset the port's driver, DHCP, or wifi supplicant. This option will do nothing if the port is not configured for a portal script.
- **Show Events**: If selected, LANforge events will be shown in the text log window.
- **Add Ports**: Add ports to be used by Port Bringup from the Free Ports list on the right.
- **Remove Ports**: Remove ports from the Ports in Use list on the left so Port Bringup does not use them.
- **Start**: Start running the Port Bringup test.
- **Close**: Stops and closes Port Bringup.

**Port Monitor**

Here is an engaging way to show port speed at a glance. Useful for displaying upload TX bps

and download RX bps.



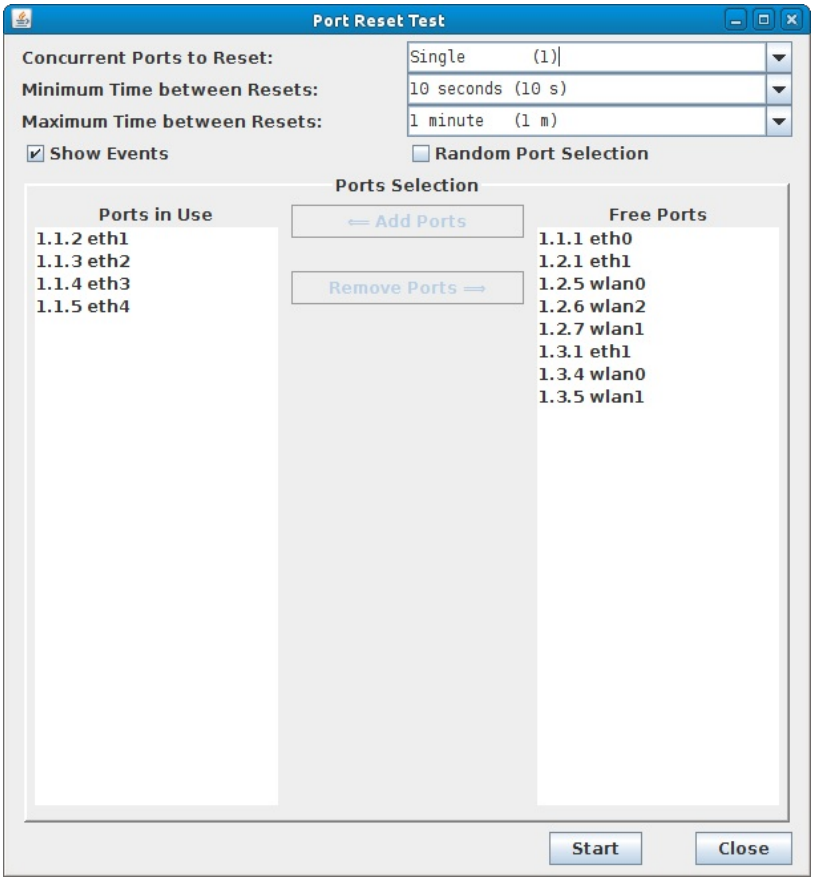

The configurable options are:

- **Refresh Interval**: Choose how often you want the data to update.
- **Total Max Range**: Set the maximum range for the Total TX and Total RX speedometer graphs.
- **Individual Max Range**: Set the maximum range for the Interface Throughput graphs (bar charts).
- **Show Tx Bps**: Enable or disable the Total TX Bps speedometer graph.
- **Show Rx Bps**: Enable or disable the Total RX Bps speedometer graph.

- **Show Text Header**: Displays additional information at the top of the report.
- **Clear Interfaces on Start**: Performs a clear counter on ports monitored once started.
- **Add Ports**: Add ports to be used by Port Monitor from the Free Ports list on the right.
- **Remove Ports**: Remove ports from the Ports in Use list on the left so Port Monitor does not use them.
- **Start**: Starts the Port Monitor test.
- **Close**: Stops and exits the Port Monitor plugin.

#### Port Reset Test

Doing station resets sends out a wide range of requests that can exercise the entire wireless and network stack. For WiFi stations, this can be a good way to test station authentication and related logic. This plugin is similar to the **Port Bringup Test**, but this reset test typically leaves most stations associated while resetting a small number. The **Port Bringup Test** is more often used to bring an entire range of stations down and up in a sequential manner.




The configurable options are:

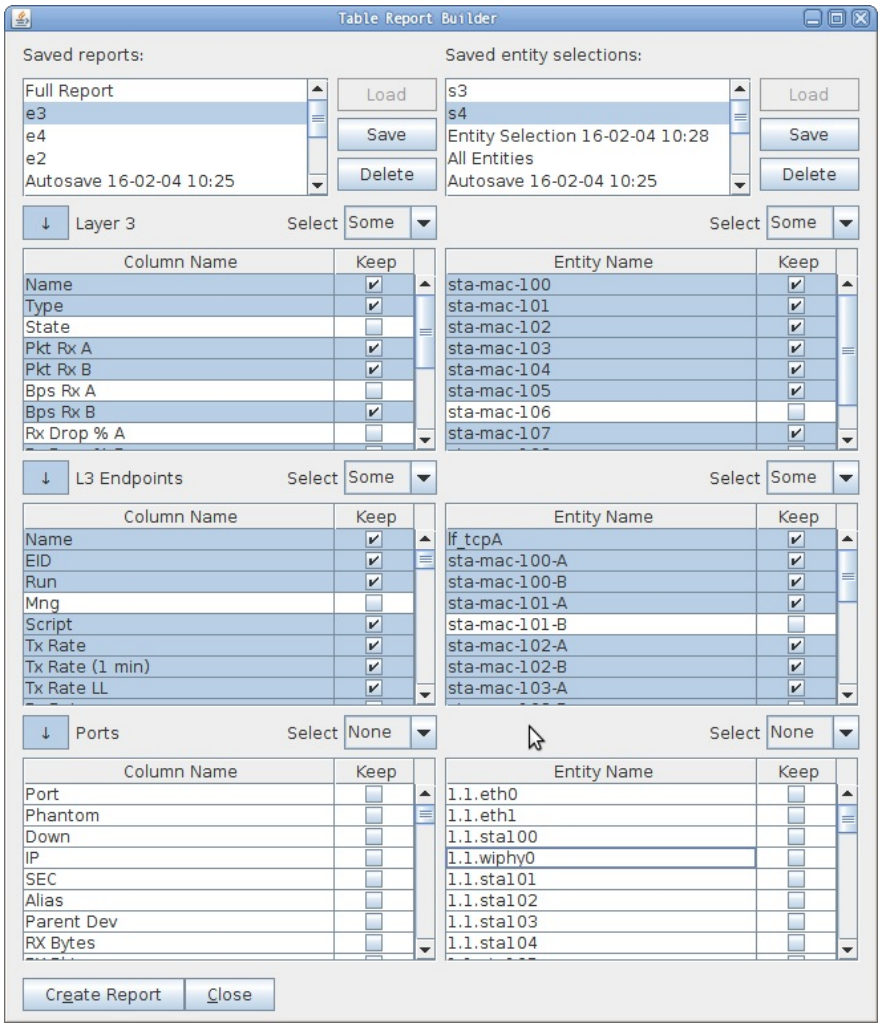
- **Concurrent Ports to Reset**: Determines how many ports to reset at a time.
- **Minimum Time between Resets**: The minimum sleep time between resetting the ports.
- **Maximum Time between Resets**: The maximum sleep time between resetting the ports.
- **Show Events**: If selected, LANforge events will be shown in the text log window.
- **Random Port Selection**: Sets ports to reset randomly instead of sequentially.
- **Add Ports**: Add ports to be used by Port Reset from the Free Ports list on the right.
- **Remove Ports**: Remove ports from the Ports in Use list on the left so Port Reset does not use them.
- **Start**: Start running the Port Reset test.
- **Close**: Stops and closes Port Reset.

#### Table Report Builder

This is a report generator that allows you to select Layer-3 connections, Endpoints and Ports, and place them in a HTML report. The values are what appear in the corresponding LANforge GUI tabs. The significant difference with this report is how any combination of ports, endpoints, connections and their columns can be selected.

- **Report Profiles** define the columns from each tab present in the report. These can be saved for future reports.

- **Entity Profiles** define the ports, endpoints and/or connections reported on. These selections can likewise be saved, but will only be succesfully loaded if you are in the test scenario you first created them in.




If you need transfer or remove these report profiles, they are in the LANforgeGUI directory, under the folders `trb_entities` and `trb_profiles`.

#### Installing new Groovy Plugins

It is possible to install new Groovy Plugins by copying them to your LANforgeGUI/user directory. The steps described below illustrate fixing an actual problem with a plugin. In 5.3.1, the `port_reset.groovy` plugin is broken. There is a fixed copy of `port_reset.groovy` available on our website. For later releases, the fix is included automatically.

#### To install on Linux:

The LANforgeGUI is typically installed in `/home/lanforge/LANforgeGUI_5.3.1` and user provided groovy plugins under `user_groovy`.

Open a terminal, and use these commands:

```
cd /home/lanforge/LANforgeGUI_5.3.1
mkdir user_groovy
cd user_groovy
wget http://guest:guest@www.candelatech.com/private/downloads/r5.3.1/port_reset.groovy
```

#### To install on Windows:

Open the below link in your browser and save the file `port_reset.groovy`. (The file might get saved into My Documents\Downloads).

Follow these steps:

1. Find the LANforge-GUI icon on your desktop:
    1. Right-click the icon and choose Properties
    2. Click the **Find Target** or **Open File Location** button. This opens the LANforge application folder.
2. Now, in the `LANforge_GUI-5.3.1` folder:
    1. Right click, select New→Folder

2. Name the folder `user_groovy`

3. Copy the `port_reset.groovy` from your downloads folder to the `LANforge-GUI_5.3.1/user_groovy` folder.

4. Close and restart the LANforgeGUI

**Usage**

This new script will be activated automatically when your LANforge GUI starts. If you need to add a groovy script after the GUI starts, you can add it to the user_groovy directory and then follow these steps:

1. Choose the Plugins→Groovy Scripting menu item.
2. In the Groovy Scripting Manager window, type in `port_reset.groovy` (or other plugin name).
3. Click the **Register Plugin** button.
4. Now click on the Plugins menu and you will see a new Port Reset Test entry in the plugins list. Use that new plugin.

**Windows Note:** On older versions of windows, the LANforge GUI installs in

```
%USERPROFILE%\Local Settings\Application Data\LANforge-GUI_5.3.2
```

Example:

```
C:\Documents and Settings\jreynolds\Local Settings\Application Data\LANforge-GUI_5.3.2
```

On Windows 7 and newer, the LANforge installs in

```
%LOCALAPPDATA%\LANforge-GUI_5.3.2
```

Example:

```
C:\Users\jreynolds\AppData\Local\LANforge-GUI_5.3.2
```

## 36. Troubleshooting Techniques

If you have having trouble with the LANforge GUI, here are a few techniques you can try to get information about your problem:

**The LANforge GUI will not start.**

It is possible to install a copy of LANforge that lacks a Java runtime. Make sure you have Java installed. You can test this from the command line by running:

```
C:\> java -version
```

It is possible that you have downloaded a version of the LANforge GUI that has been compiled for another processor architecture. If you are running a 32-bit operating system, a 64-bit LANforge GUI will not run. If you use the command-line to start the GUI, it will tell you that the application will not run on your system:

```
C:\Users\bob> cd AppData\Local\LANforgeGUI-5.3.5
C:\Users\bob\AppData\Local\LANforgeGUI-5.3.5> .\lfclient.bat

Java: cannot execute lfclient.jar
```

**The LANforge GUI freezes up**

Somemtimes the LANforge GUI becomes unresponsive. There are a number of possible causes for this, including:

- A network link becoming available. Did the ethernet cable fall out of your laptop, or the WiFi link disconnect?
- Your system has an unreliable connection to the LANforge Manager system. This is certainly possible when your laptop is on a WiFi connection in a testing environment where on-air bandwidth is very conjested. Packet retransmission could arrest the LANforge GUI. We suggest using an ethernet connection to your LANforge manager.
- Memory shortage on your laptop. When running many WiFi Capacity tests, they use a surprising amount of memory. You will usually see an alert window saying that the system is attempting to reclaim memory. Your laptop could start swapping to disk and slow down significantly at that point.

**The LANforge GUI gives you a Out of Memory error(s)**

The JRE running the LANforge GUI is configured to not use all the RAM on your LANforge by default. This is to allow other processes (the server processes and your desktop) to avoid experiencing memory pressure. This can leave RAM for reports.

⚠ Assigning more RAM than is physically present on your LANforge system will make the GUI unable to start. If this happens, remove `/home/lanforge/settings.sh` and attempt restarting your GUI.

**On Linux since 5.3.9:** Please use `htop` on your system before using the GUI -> Control -> JVM+Memory settings window.

On a Candela Technologies LANforge system, your GUI is located in /home/lanforge/LANforgeGUI-5.3.8 and the startup script can be used like:

```
$ cd /home/lanforge/LANforgeGUI-5.3.9
```

```
$ ./lfclient.bash
```

**On Windows since 5.3.9:** the memory settings file is at %LOCALAPPDATA%\lanforge\settings.bat (E.G. `C:\Users\bob\AppData\local\lanforge\settings.bat`). You can safely remove this file. Please use Task Manager to display how much free ram your desktop has when not running the LANforge GUI. If there are problems running the GUI on Windows, you can attempt to use %LOCALAPPDATA%\LANforgeGUI\lfclient2.bat to start with basic JRE 8 settings. E.G.:

1. Open a PowerShell window
2. 
```
PS> cd C:\User\bob\AppData\Local\LANforgeGUI-5.4.9\
```
3. 
```
PS> .\lfclient2.bat
```

**On Windows LANforge 5.3.8 and earlier:** You can edit the `C:\Users\bob\AppData\Local\LANforgeGUI-5.3.8\lfclient.bat` file. and change the `-Xmx` switch to give the application more memory. If you are using a 32-bit version of Windows or a 32-bit version of Java on a 64-bit version of Windows, you will be unable to allocate more than 3GiB of memory. Please consider using a 64-bit version of Windows and the 64-bit version of the LANforge GUI.

### Diagnosing a Lockup

If you do have a GUI lockup, we want to know. Please run the LANforge GUI using the command line (as referenced above: `AppData\Local\LANforgeGUI-a.b.c\lfclient.bat`).

When the GUI locks up again, press the **Thread Dump** key combination: `Ctrl`+`Break`. This will not display a new window, but it will print a stack trace in the command window. Please email that output to us at **`support@candelatech.com`** and it will help us diagnose the problem.

If you are on the desktop of a Candela Technologies LANforge system, you can trigger a stack trace using the `Ctrl`+`\` key combination. You can also use the commands `kill -3 `pgrep java`` to trigger a stack trace from another terminal.