NETROPY® NETWORK EMULATOR

USER'S GUIDE

Firmware Version 4.0

APPOSITE
TECHNOLOGIES

Netropy® Network Emulator User's Guide

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1 OVERVIEW

Thank you for purchasing the Apposite Technologies Netropy network emulator. This *User's Guide* describes the installation, configuration, and operation of the Netropy product. A companion *Hardware Guide* describes the Netropy hardware for each specific model. A separate *Quick Start Guide* provides a walk-through for first time configuration.

The Netropy network emulator attaches to an Ethernet network and simulates the bandwidth, delay, loss and other conditions of the wide-area network to test application performance.

1.1 Netropy Configuration

The Netropy network emulator is usually configured through the browser-based Netropy GUI (Graphical User Interface). The GUI is accessible through a dedicated management port from any PC or other device with a standard web browser using HTTP or HTTPS.

In addition to the GUI, the Netropy network emulator includes a RESTful API for configuring automation. For automation it is recommended you use the RESTful API as it supports 100% of the WAN emulation functions.

1.2 Netropy Operation

Configuration and operation of the Netropy network emulator via the browser-based GUI requires only a few simple steps:

1. **Open the GUI**
   Connect to the Netropy through the IP/Hostname assigned to the management port.

2. **Select the Emulation Engine**
   Depending on hardware model, the Netropy unit will include between one and four separate Emulation Engines. Each Emulation Engine acts as an independent network emulation system connecting a pair of Ethernet ports.

3. **Add Paths**
   Create separate WAN paths to carry packets between the two ports.

4. **Configure WAN conditions for each path**
   Configure each path with the bandwidth, delay, loss, and other WAN conditions.

5. **Create Endpoints**
   Assign IP address, IP range, IP subnet, VLAN, or TCP/UDP ports to the paths created in step 3.

6. **Start the Emulation Engine**
   Turn on emulation to begin testing.

7. **Monitor traffic**
   View the graphs and link statistics to monitor application performance.

8. **Change configuration**
   The configuration can be changed on the fly by adding or deleting paths, modifying path conditions, or updating endpoints using either the GUI or RESTful API.

1.3 Netropy Models and Firmware Versions

The seven current Netropy models, N61, N91, 10G1, 10G2, 10G4, 40G, and 100G can all run the firmware described in this *User's Guide*. The various models offer identical functionality and differ only in capacity and number and type of network interfaces. The Netropy N90 model has been superseded by the N91 but can run the firmware described in this manual. Earlier Netropy models, the N60, N80, and 10G, are limited to running firmware versions up to v2.2.

Depending on when the Netropy unit was produced and if the firmware on the unit was updated, the unit may be running an earlier version of the firmware than described in this User's Guide. Please consult the appropriate *User's Guide* for the version of firmware running on your unit.

2 INSTALLATION AND SET-UP

To configure and operate the Netropy network emulator through its browser-based GUI, the dedicated Ethernet management port must first be configured with an appropriate IP address and subnet mask. For convenience, the MGMT interface comes pre-configured with an IP address of 10.0.0.10, and is accessible from a directly-connected host on the 10.0.0.0/255.0.0.0 subnet. The IP address and subnet mask of the MGMT interface can be changed through the Netropy GUI or through the command-line interface.

2.1 Preparation

Management of the Netropy device through the GUI requires a PC running a web browser with Flash version 10 or later installed.

Initial configuration of the management interface requires either:

- a PC running a supported web browser that can be configured and placed on the 10.0.0.0/255.0.0.0 network.
- a PC with an RS-232 serial port running terminal emulation software such as HyperTerminal or PuTTY.

2.2 Hardware Installation

Plug in a standard power cord (a U.S. power cord is supplied with the unit) and turn on the power. Depending on the particular model, the system will be available for use within 1 to 4 minutes.

For additional hardware installation details, please see the *Hardware Guide* for your model.

2.3 IP Address Configuration via the Netropy GUI

To configure the MGMT interface using the Netropy GUI:

1. Configure a PC running a supported web browser with the IP address 10.0.0.2 or other address on the 10.0.0.0/255.0.0.0 subnet.
2. Connect an Ethernet cable between the PC and the MGMT port on the Netropy unit.

3. Open the browser on the PC and enter `http://10.0.0.10`. Review the End User License Agreement.

4. Netropy units are shipped with a temporary license pre-installed for initial operation. Follow the instructions on the screen to download and install a regular license. This step may be skipped, and the license installed later.

5. Click on the Administration link at the top of the page and select the Network Settings tab. Set the IP address, subnet mask, and optional default gateway for the management interface, then click the *Apply Changes* button.

6. After the management interface has been configured, use the Ethernet cable to connect the MGMT port to the management network.

2.4 IP Address Configuration via the Serial Console

To configure the MGMT interface using the serial console:

1. Using the provided serial cable, connect the serial port of a PC running terminal emulation software to the CONSOLE port of the Netropy WAN emulator. Set the serial port parameters to 9600 baud, 8 bits, no parity, 1 stop bit, and disable flow control. See the *Hardware Guide* for your model for more details on connecting to the serial console.

2. Press `[ENTER]` to display a login prompt. At the prompt, log in as "`admin`". There is initially no password.

   ```
   netropy login: admin
   ```

3. Use the following commands to set the IP address, netmask, and default gateway of the MGMT port:

   ```
   mgmt set addr <ip-address> netmask <mask>

   mgmt set gw <default-gateway>
   ```

   IP addresses and subnet masks are entered in dotted-decimal format. For example:

   ```
   [netropy]> mgmt set addr 192.168.1.1 netmask 255.255.255.0
   ```

4. After the management interface has been configured, use an Ethernet cable to connect the MGMT port to the management network. Open a browser and enter the IP address of the MGMT port. Review the Netropy End User License Agreement.

5. Netropy units are shipped with a temporary license pre-installed for initial operation. Follow the instructions on the screen to download and install a regular license. This step may be skipped and the license installed later.

2.5 Network Installation

Each Netropy Emulation Engine is installed between two LAN segments and acts as a bridge or router between those two segments. Packets received on one port of the Emulation Engine are subjected to configured emulation conditions before being forwarded or routed to the opposite port.

If configured as a layer 2 bridge, install each Engine on an Ethernet network in a location where the traffic that is to be sent over the emulated WAN will be forced to flow through the device. If configured as a router, install the Engine between two separate subnets and configure static routes to pass traffic through the Engine. Each Engine is configured separately as a bridge or router.

3 CONFIGURATION

Configuration of the Netropy network emulator is aided by understanding a few basic concepts and terminology.

3.1 Emulation Engine

The Netropy Emulation Engine forwards packets and applies the configured emulation conditions between ports 1 & 2.

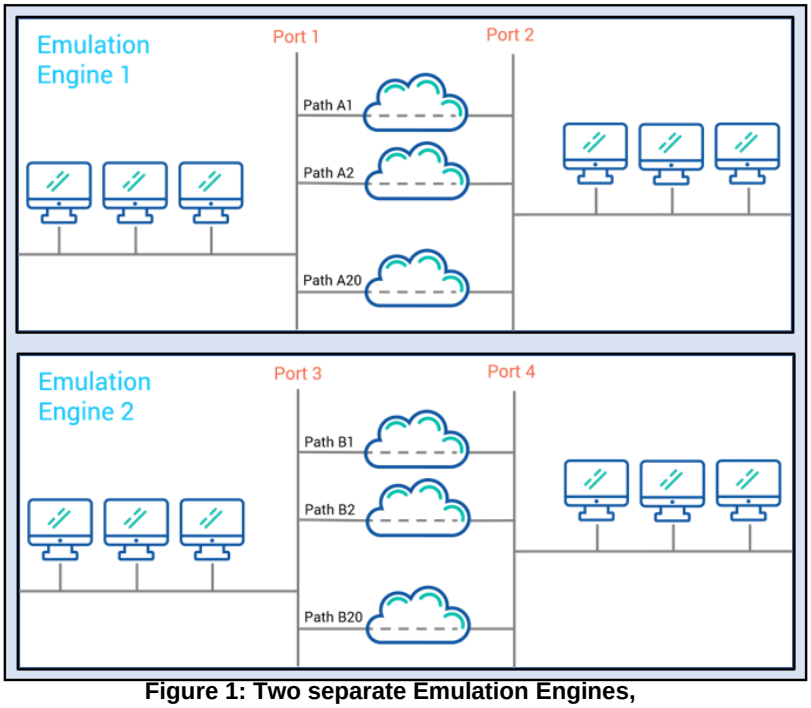


Figure 1: Two separate Emulation Engines, each with 30 paths between each pair of ports.

Depending on hardware model, the Netropy unit contains between one and four separate Emulation Engines. Each Engine operates independently of the others, and can be thought of as a separate emulation device. Each engine has its own Ethernet ports, a network architecture that may include multiple paths and classifiers, and separate traffic statistics and graphs.

See Section 4 for more details on the Emulation Engine.

3.2 Paths

A path is a single configuration of bandwidth, latency, loss, and other network properties. Netropy can have up to 30 separate paths.

Each path represents a single WAN link, and all traffic using the path is aggregated over the path.

Each path consists of three components: a WAN access link connecting the LAN to the WAN on each side and traversal over the WAN in the middle.

Each WAN access link connects a LAN to the WAN. Bandwidth constraints and conditions that affect bandwidth availability are configured in the WAN access link. The traversal over the WAN is characterized primarily by its latency, jitter, and loss conditions.

See Section 5 for more details on configuring paths.

3.3 Endpoints

Endpoints are filters that specify which IP, IP Network, VLAN, or Ports are sent over which paths. Most users will assign Endpoints by IP address or IP range.

See Section 7 for more details on configuring Endpoints.

3.4 GUI & API

Most users will find the browser-based graphical user interface to be the most convenient way to configure and operate the Netropy network emulator. However, a RESTful API is also available for integration with test automation tools.

4 EMULATION ENGINE

4.1 Overview of Emulation Engines

The Netropy Emulation Engine forwards packets and applies the configured emulation conditions between a pair of Ethernet ports.

Depending on hardware model, the Netropy unit contains between one and four separate Emulation Engines. Each engine operates independently of the others, and can be thought of as a completely separate emulation device. Each engine has its own Ethernet ports, a network architecture that may include multiple paths and endpoints, and separate traffic statistics and graphs.

The Emulation Engine can be turned on or off. Emulation is initially turned off after reboot or power cycle. Emulation can be turned on or off from the main page of the GUI or through the API. When emulation is off, all packets are forwarded directly between the Emulation Engine's two ports, bypassing any emulation. Throughput graphs and statistics can be viewed for emulated paths, as well as for the bypass traffic.

The entire configuration of the Emulation Engine can be downloaded to a local file from the Save tab of the Administration window. This configuration file can then be used to reconfigure any Engine. However, 3.0 configuration files are not compatible with 4.0 firmware.

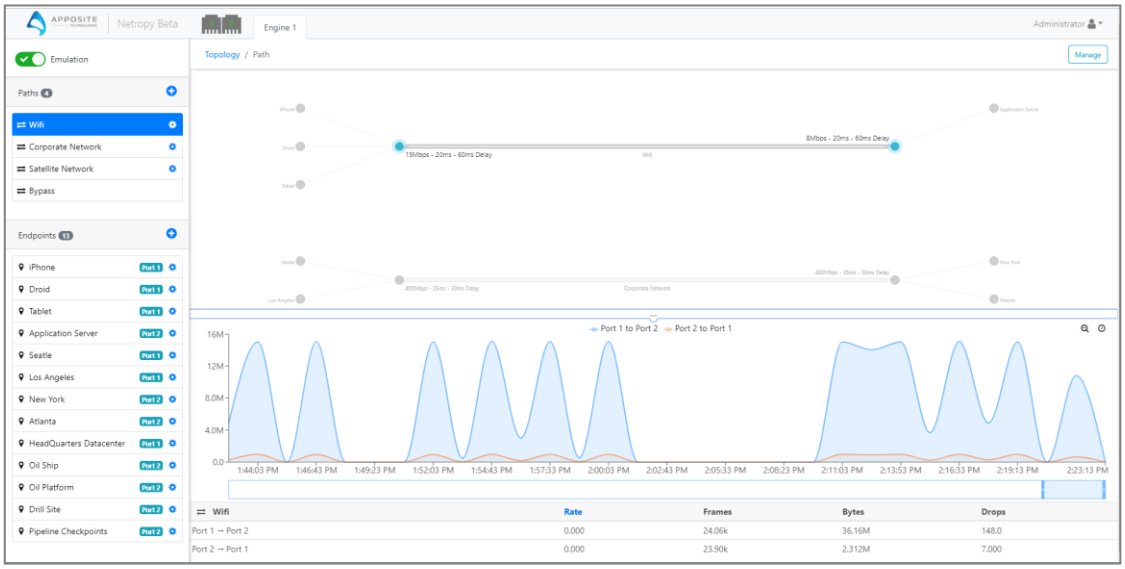


Figure 2: Main Page of the GUI

5 PATHS

5.1 Overview of Paths

A path is a single configuration of bandwidth, latency, loss, and other network properties. The Emulation Engine can have up to 30 separate paths. Each path represents a single WAN link, and all traffic using the path is aggregated over the path.

Each path consists of three sections:

- WAN access link connecting a local network (in single-link mode) or individual devices (in per-client emulation mode) to the WAN line or cloud.
- WAN line or cloud.
- WAN access link connecting the WAN line or cloud to a local network.

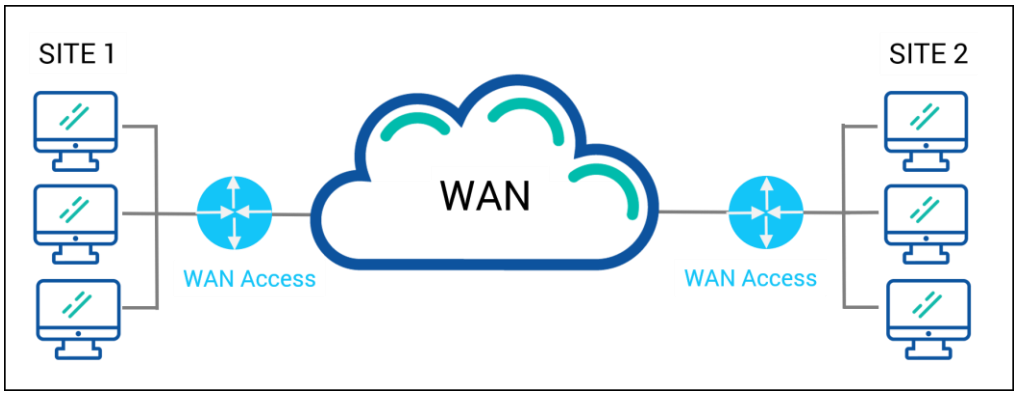


Figure 3: Path Components

The WAN can be any type of wide-area network connection between two sites including terrestrial private lines, shared networks such as the Internet, and specialized satellite or wireless networks. The WAN is characterized primarily by its latency, jitter, and loss conditions.

Each WAN access connects a local network or individual client connected to the WAN. Bandwidth constraints and conditions that affect bandwidth availability are configured for the WAN access.

5.2 Path Types

Most network connections can be characterized as either point-to-point or cloud-based.

Private lines such as T1 or OC-3 lines directly connecting two sites are point-to-point connections. The bandwidth out-bound from one site is the same as the bandwidth in-bound at the other site, and typically the latency is constant. On these links, the bandwidth is throttled in the outbound direction from each site, and there is generally no need to configure the in-bound WAN access parameters.

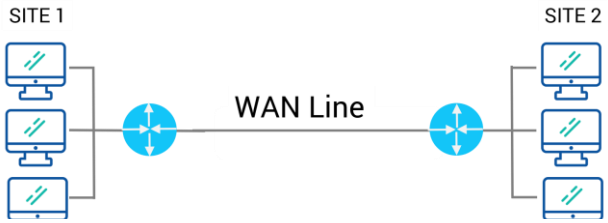


Figure 4: Point-to-Point Line

Network connections that consist of an access link to a shared network such as the Internet, an MPLS network, or a Metro Ethernet ring, can be thought of as a cloud. Cloud networks typically have limited bandwidth access to a high-speed WAN, and frequently different speed access to the WAN at each site. In these situations, traffic can hit a bandwidth bottleneck both out-bound from a site to the WAN and in-bound from the WAN to the other site, making it necessary to configure both out-bound and in-bound WAN access parameters. Similarly, if there is variable delay in the WAN cloud, it may be necessary to configure the in-bound WAN access parameters to rate-limit the resulting flow.

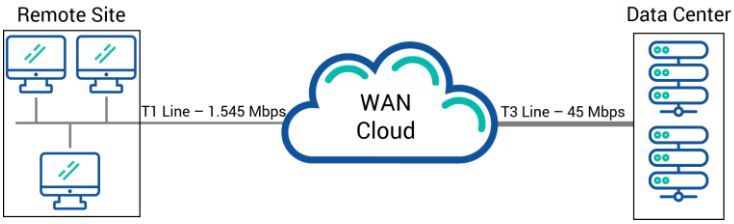


Figure 5: Cloud Network

5.3 Configuring Paths

Each path is displayed on the main page of the Netropy GUI using an arrow labeled with its name. To configure a path, click on the arrow or click on the path in the left margin then choose manage.

The Path Configuration window is used to rename the path as well as configure the WAN and WAN access conditions of the path.

To rename a path, click in the text box at the top of the path configuration to edit it.

When finished with WAN settings, click the *Apply Changes* button. If the Path Configuration window is closed without clicking the *Apply Changes* button, any unapplied changes will be lost.

Changes to the WAN and WAN Access conditions can also be made from the RESTful API.

5.4 Adding and Deleting Paths

To add a new path, click the *"+"* button on the main page in the left margin Path area.

To delete an unneeded path, click the path in the left margin or the arrow in the topology view.

Then choose “manage” and use the delete button at the top to remove. Paths cannot be deleted while they are being used by an Endpoint.

6 PATH PARAMETERS: CONFIGURING EMULATION CONDITIONS

6.1 Configuring Path Parameters

Each path consists of three sections:

- WAN access link connecting a LAN to the WAN
- Traversal of the WAN line or cloud
- WAN access connecting the opposite LAN to the WAN

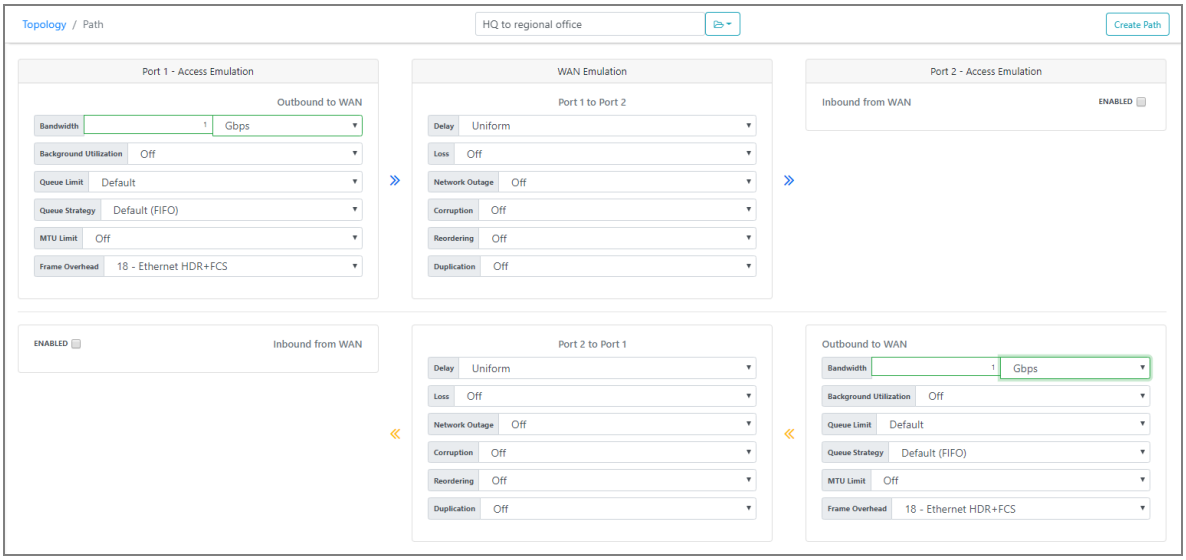


Figure 6: Path Configuration Window

The active configuration is not modified until the *Apply Changes* button is pressed.

Final validation of the configuration is performed when the *Apply Changes* is pressed. If there are no errors in the configuration, the new configuration immediately takes effect. If there are any errors in the configuration, a red box is displayed around the invalid panel.

6.2 WAN Access Parameters

The WAN Access panel configures the parameters that affect bandwidth availability for traffic

outbound from the LAN to the WAN, and optionally for traffic inbound onto the LAN from the WAN. There are separate panels for the WAN Access link on both sides of the WAN.

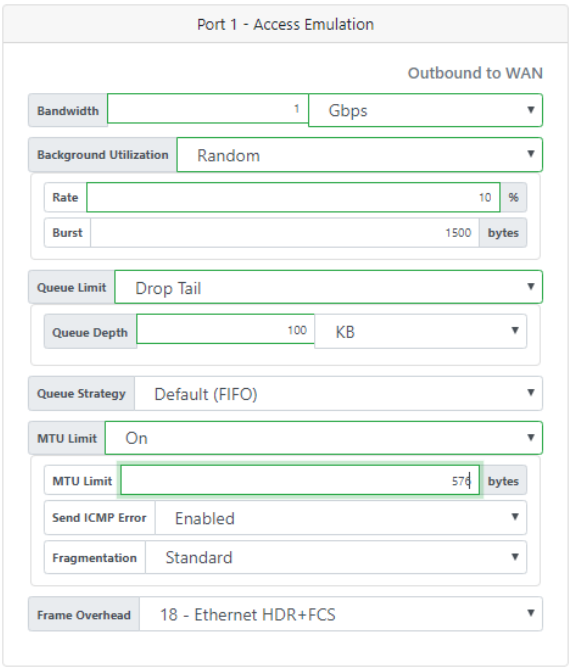


Figure 7: WAN Access Configuration Panel

6.2.1 Bandwidth

The Bandwidth panel is used to configure the rate of the WAN access link.

The bandwidth is set in increments of 1 bit per second, with a minimum rate of 100 bps and a maximum rate determined by the maximum port speed (1 Gbps up to 100 Gbps depending on model).

A series of values for bandwidth changing over time can be added in a Recording file and played using the Playback feature. See Section 8 for details.

If the entered bandwidth is higher than the maximum port speed or higher than the license key, a red error box will be drawn around the panel when the *Apply Changes* button is pressed and the changes will not be applied.

Figure 8: Bandwidth Panel

6.2.2 Background Utilization

The Background Utilization panel is used to create extra traffic that competes for bandwidth with the real application traffic passing through the WAN access link. Background traffic only affects the WAN access link on which it is configured, and is not transmitted through the other components of the path or outside the Netropy. To have background traffic compete for bandwidth on the opposite WAN access link, create an identical background traffic configuration on the WAN access link inbound to the opposite port.

Background traffic can be useful for testing the performance of particular applications over links that are congested with other traffic, and for inducing jitter to test real-time applications. Background traffic can be created with random packets based on an average link utilization rate.

6.2.2.1 Random Background Traffic

The Netropy Emulation Engine can generate random background traffic to compete with the real application traffic for bandwidth across the emulated WAN link. Random background traffic is specified as a link utilization rate and a traffic burst size.

The link utilization rate specifies the average percentage of bandwidth consumed by the background traffic. The link utilization rate can be set to 0 – 100% of the bandwidth in increments of 0.01%.

The burst size sets the size of the background traffic blocks and is specified in bytes from 64 – 2,000,000 bytes. The default value is 1500 bytes. Larger bursts of background traffic induce greater jitter in the actual traffic.

Random background traffic is modeled as a Poisson process in which bursts of data of a fixed size are transmitted at an average rate such that the bandwidth will be occupied at the specified link utilization rate. Because it is a random process, over short periods the actual background utilization rate may vary from the configured value.

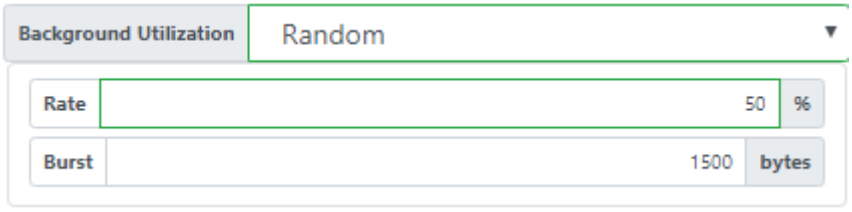


Figure 9: Background Utilization - Random

6.2.3 Queue Limit

The Queue Limit panel is used to select the queue management algorithm and configure the associated queuing parameters. The queue management algorithm controls the buffering and discarding of packets when they arrive faster than the rate of the WAN access link. The queue

management algorithm and parameters can be set to match the configuration of an existing WAN access router.

There are three choices for the Queue management algorithm:

- Drop Tail
  The Drop Tail algorithm (also called tail drop) is a simple FIFO queue of a configured maximum size. When the buffer is full, any additional packets that arrive are discarded. Using Drop Tail, specify the size of the buffer in KB or packets.

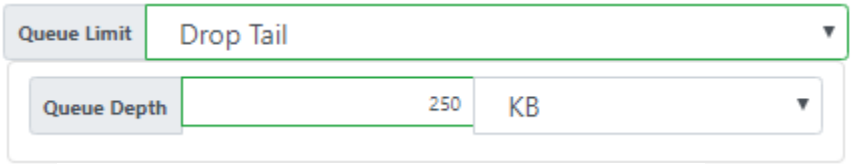


Figure 10: Queue Limit – Drop Tail

- RED
  Random Early Detection (RED) is an active queue management algorithm that monitors the average queue size and begins randomly dropping a small number of packets before the queue is full to create smoother flows and fairer drops. RED begins dropping packets at the configured minimum threshold, with the probability of drop increasing linearly until the configured maximum threshold, after which all packets are dropped. Configure the total buffer size, minimum threshold, and maximum threshold in KB or packets. For more details on RED, see http://www.icir.org/floyd/red.html. The value used for max_p is 0.1 and for w_q is 1/512.

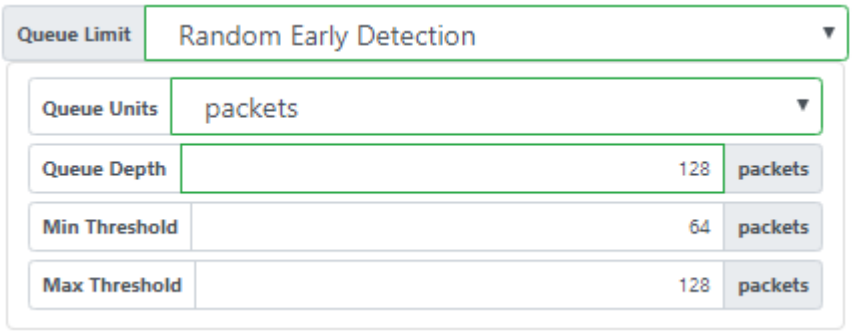


Figure 11: Queue Limit – RED

- Default
  The default option sets the queue management algorithm to Drop Tail and configures the queue depth to the equivalent of 250 ms at the currently configured bandwidth rate. For example, if the bandwidth is set to 100 Mbps, the default queue depth will be 3.125 MB. Changes to the bandwidth will automatically adjust the queue depth.

If priority queuing is selected under Queuing Strategy, the specified queue limits apply separately

to the queue for each priority level.

All entries for queue depth and thresholds are limited to 100,000 packets or 100,000 KB.

6.2.4 Queuing Strategy

The queuing strategy panel determines the manner in which packets are queued and transmitted. The three options are a single FIFO queue, Priority queuing, and Round Robin.

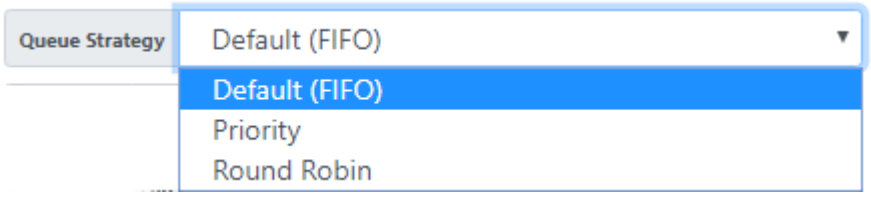


Figure 12: Queuing Strategy

- Default (FIFO)
  The default option uses a single FIFO queue. Packets are transmitted in the order they arrive, with no prioritization of packets.

- Priority
  For class of service prioritization, incoming packets can be directed onto eight separate priority queues based on the priority setting in the packet. Packets are transmitted based on strict priority: if there are any packets on a higher priority queue, they will be transmitted before any packets on a lower priority queue. Queues are numbered from highest (7) to lowest (0).

The queue management algorithm and settings specified in the Queue Limit panel applies separately to each of the eight priority queues. For example, if Drop Tail is selected with a queue depth of 100 KB, each of the eight priority levels will consist of its own 100 KB queue.

There are two options for specifying the field to use for the priority level of the packets:

IP Precedence: the three bits of precedence in the ToS field of IPv4 packets, or the three bits of precedence in the traffic classifier of IPv6 packets.

VLAN PCP: the three bit Priority Code Point field in the VLAN header.

- Round Robin
  Similar to Priority queuing, incoming packets are directed onto eight separate queues based on the IP Precedence or VLAN PCP priority value of each packet. Packets are pulled from each queue and transmitted in round robin order.

As in Priority queuing, the queue management algorithm and settings specified in the Queue Limit panel applies separately to each of the eight queues.

6.2.5 MTU Limit

The MTU limit panel allows the setting of a path MTU (Maximum Transmission Unit), specifies whether ICMP error messages are sent, and specifies whether IPv4 packets larger than the MTU limit are fragmented.

If MTU limits are enabled, any IPv4 packet that exceeds the MTU can either be dropped or fragmented, depending on the IP Fragmentation setting:

Figure 13: MTU Limit

- Standard
  IPv4 packets without the Don't Fragment (DF) bit set are fragmented and all other packets are dropped.

- Never – Drop Only
  Packets larger than the MTU limit are always dropped.

- Always – Ignore DF
  Packets larger than the MTU limit are always fragmented regardless of the setting of the DF bit. This option should only be used when specifically required for testing.

All non-IPv4 packets larger than the MTU limit are dropped. IPv6 packets are never fragmented.

The MTU limit can be set to any value between 68 bytes and 9216 bytes.

The sending of IPv4 ICMP Destination Unreachable Fragmentation Needed or IPv6 PKTTOOBIG error messages to the originator of the packet can be enabled or disabled. When enabled, ICMP error messages are transmitted out the interface on which the original packet was received switching the source and destination Ethernet and IP addresses of the original packet.

ICMP error messages are limited to 15 packets per second (per path per direction), with short term bursts of up to 15 packets.

6.2.6 Frame Overhead

Frame overhead is the number of additional bytes required by a link-layer technology when transmitting a packet of data. Typically, the frame overhead consists of link-layer addressing and error checking information.

To emulate a link-layer technology with a particular frame overhead, select the value from the drop-down list, if available, or choose C*ustom* and enter the specific value.

To emulate the traversal of a frame over the WAN, Netropy calculates the effective size of the frame as the payload of the Ethernet frame (without the Ethernet header or FCS) plus the specified frame overhead.

There are three choices for frame overhead:

- Ethernet (header + FCS)
  This option emulates a WAN link layer with an Ethernet-like frame of 18 bytes of header and frame check sequence (FCS). This is the default option and is a reasonable choice if the properties of the link layer are unknown.

- Ethernet (header, FCS, preamble, pad)
  This option emulates an actual Ethernet link, including the preamble and padding between Ethernet frames. Select this option to emulate an Ethernet-based WAN network.

- Custom
  This option allows the specification of any link layer frame overhead in bytes per packet up to a maximum of 300 bytes. Select this option if the link layer frame overhead is known.

6.3 WAN Parameters

WAN delay, loss, link outage, corruption, reordering, and duplication parameters are configured on the WAN section of the Path Configuration window. The conditions are set separately for the two directions.

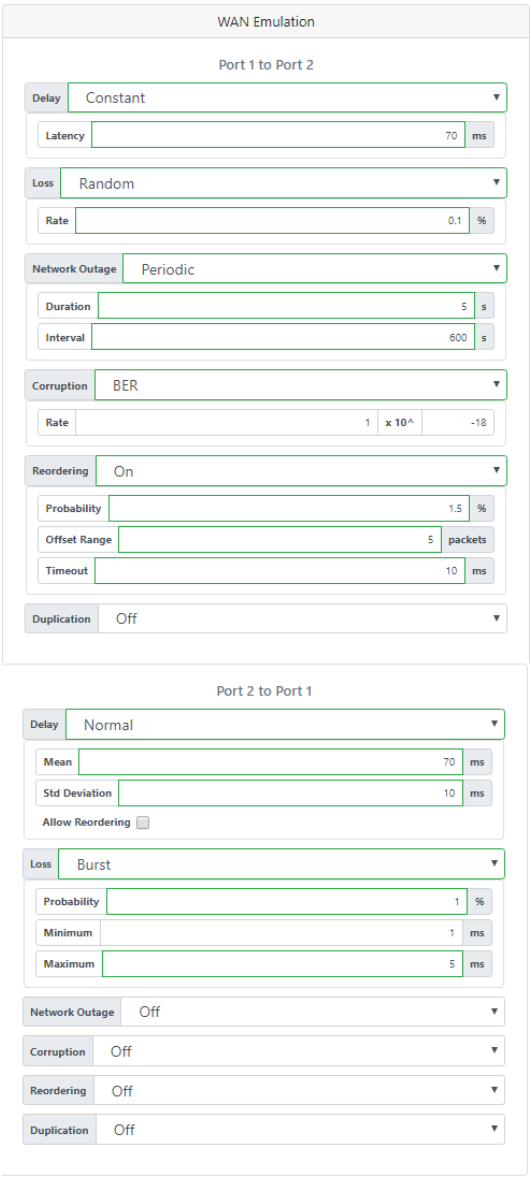


Figure 14: WAN Parameter Configuration Panel

6.3.1 Delay

The Delay panel sets the latency and jitter in each direction. For variable latency distributions, a short delay applied to a later packet may cause it to have a calculated transmission time prior to that of earlier packets with a longer delay. By default, packets are transmitted in the order received, which can skew the actual amount of delay applied. If “Allow Reordering” is selected, the order of the packets can be changed.

- Off: No latency added.
- Constant: A single, fixed value for latency.

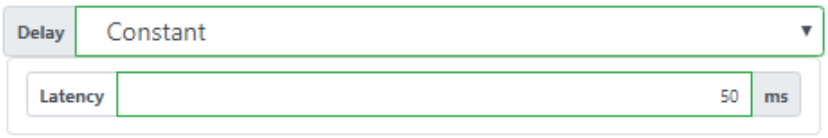


Figure 15:
Delay - Constant

- Uniform: A uniform distribution of latency ranging between the configured minimum and maximum values. The Minimum value must be less than or equal to the Maximum.

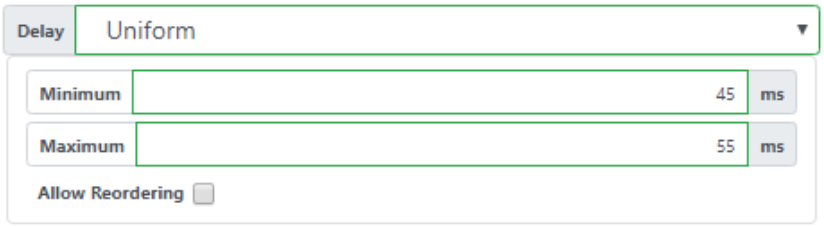


Figure 16:
Delay – Uniform Distribution

- Exponential: An exponential distribution curve, with a specified minimum and mean.

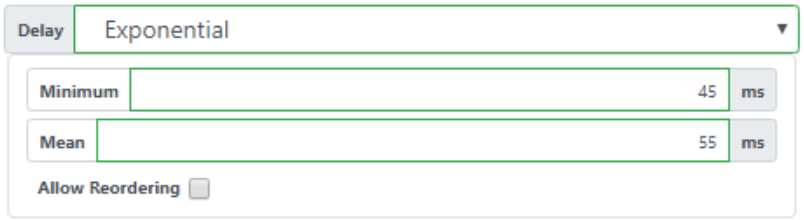


Figure 17:
Delay – Normal Distribution

- Normal: A normal (Gaussian) distribution, with a specified mean and standard deviation (jitter). To avoid negative latencies, the mean must be at least 3 times the Std Deviation.

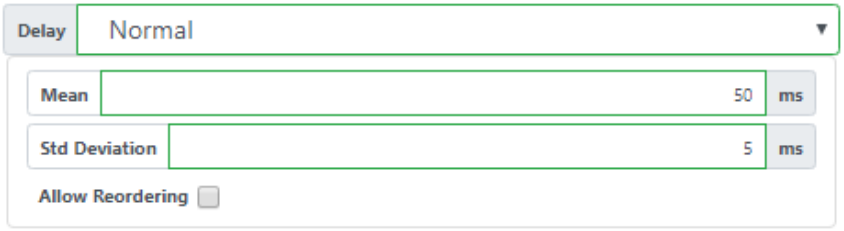


Figure 18:
Delay – Normal Distribution

- Accumulate & Burst: Packets are held until either a packet count or time threshold is reached, then optionally delayed by an additional configured 'extra delay,' then transmitted as a burst. The timer for the time threshold is started when the first packet in the burst is received. The maximum packet count threshold is 1000 packets, and the maximum time threshold is 10000 ms (10 seconds).

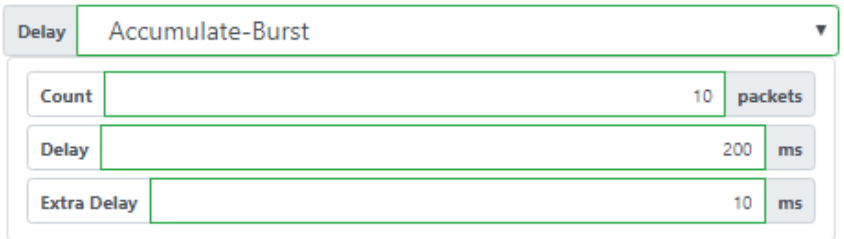


Figure 19:
Delay - Accumulate and Burst

- All delay values are specified in milliseconds in increments of 0.01 ms.

In addition to specifying the latency using this delay panel, a series of values for latency that change over time can be added in a Recording file and played using the Playback feature. See Section 8 for details.

By default, frames are not reordered even if subjected to differing delays using a uniform or normal distribution. To allow packets to be reordered, check the “Allow Reordering” option. For example, if the delay is set as a uniform distribution between 10 and 100 ms and the first frame is subjected to a 90 ms delay and the second frame is subjected to a 20 ms delay, by default, the second frame cannot be transmitted until after the first frame has been transmitted. If “Allow Reordering” is selected, (and assuming no congestion) the second frame will be transmitted 20 ms after arrival and the first frame will be transmitted 90 ms after arrival, causing the order of the packets to be switched.

To specify jitter, use either the normal or uniform distribution. Use the normal distribution to specify jitter as the standard deviation from the mean delay. Use the uniform distribution to specify peak-to-peak jitter between the minimum and maximum values of delay.

The various Netropy hardware models have different limits on the ability to process high packet rates combined with large latencies.

☞	The end-to-end round trip time (RTT) is a combination of four separate delays in each direction: the propagation delay, transmission delay, queuing delay, and reordering delay.

6.3.2 Loss

The Loss panel configures packet loss each direction. The options are:

- Off: No packet loss.
- Random: Random packet loss. Specify a single value for the probability that each packet will be lost. Rates can be set from 0 – 100% in increments of 0.0001%.

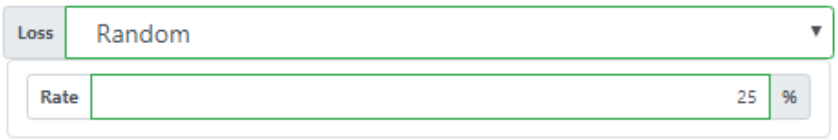


Figure 20: Loss - Random

- Burst: Burst loss. Specify the probability that each packet will begin a burst of lost packets, and a minimum and maximum number of packets that will be lost in sequence. For a fixed burst size, set the minimum and maximum to the same value. Probabilities can be set from 0 – 100% in increments of 0.0001%.

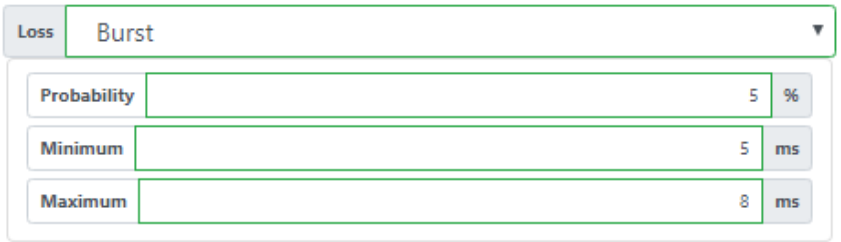


Figure 21: Loss - Burst

- Gilbert-Elliott: Gilbert-Elliott two-state loss. Specify the packet loss rates for the “good” and “bad” states, and specify the per-packet probability of transitioning from each state to the other. All rates are specified as percentages set from 0 – 100% in increments of 0.0001%. When Gilbert-Elliott loss is first configured and each time emulation is subsequently turned on, loss starts in the good state.

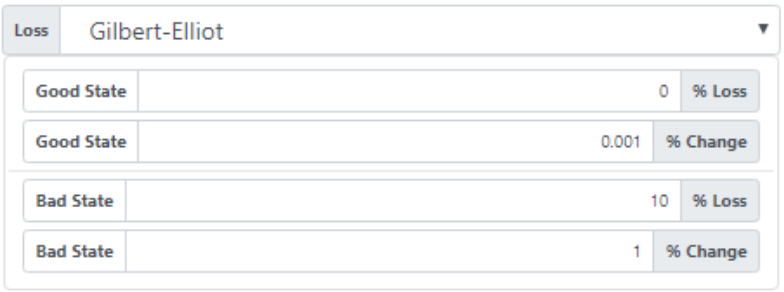


Figure 22:
Loss – Gilbert-Elliott

- Periodic: Periodic packet loss. Specify the loss period and burst size in numbers of packets. For example, a period of 1000 packets with a burst size of 10 packets would result in a fixed pattern of 990 packets forwarded followed by 10 packets dropped.

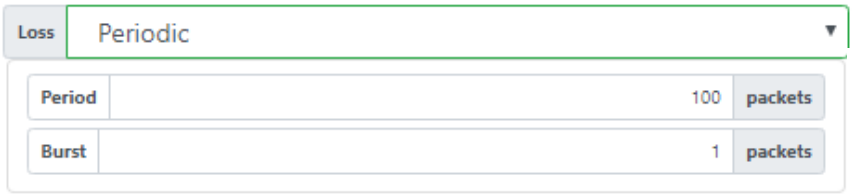


Figure 23:
Loss - Periodic

- BER: Loss due to bit errors. Set the coefficient and exponent. Bit error rates can take values of $1x10^{-18}$ or greater and are entered in scientific notation. The coefficient of the rate must be entered as a value greater than or equal to 1 and less than 10. All packets that contain a bit error are discarded – to transmit corrupted packets, use the Corruption emulation.

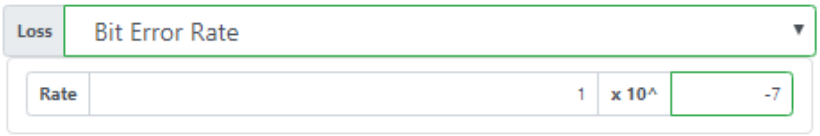


Figure 24:
Loss - BER

In addition to the specifying the loss using this panel, a series of random loss rates that change over time can be added in a Recording file and played using the Playback feature. See Section 8 for details.

6.3.3 Network Outage

The Netropy Outage panel simulates a periodic link outage causing 100% packet loss for a specified duration and interval. The interval is the amount of time between the beginning of successive outages, not the amount of time between the end of one outage and the start of the next outage.

Both the duration and interval can be set as single values or ranges of values separated by a hyphen. Values can be set from 1 ms (0.001 seconds) to 1 week (604,800 seconds) in seconds in increments of 0.001 seconds. If the duration is set to a value that is longer than the interval, the outage will be continuous.

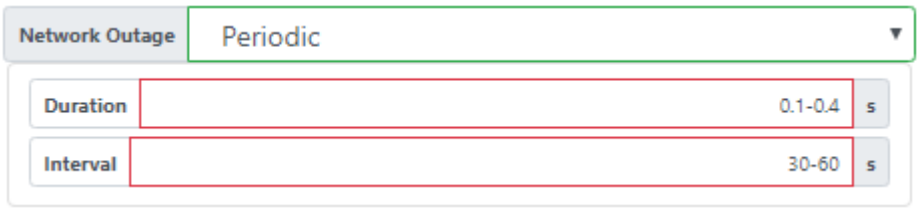


Figure 25: Network Outage

6.3.4 Corruption

The Corruption panel is used to insert bit errors into forwarded packets at the specified bit error rate. Set the BER coefficient and exponent. Bit error rates can take values of $1x10^{-18}$ or greater and are entered in scientific notation. The coefficient of the rate must be entered as a value greater than or equal to 1 and less than 10.

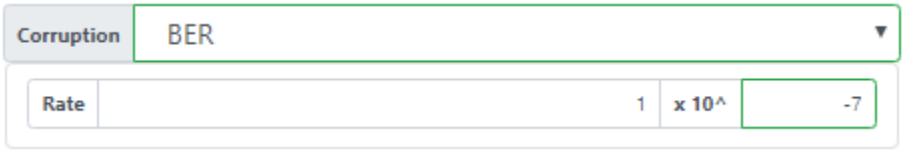


Figure 26: Corruption

Corruption only affects the contents of received Ethernet frames. Neither the Ethernet header (including EtherType and optional VLAN tag) nor the Ethernet FCS will be corrupted.

6.3.5 Reordering

The Reordering panel specifies the probability for each packet that it is reordered, and how far back in the data stream the reordered packet is moved from its original position. If a packet is randomly selected for reordering, it is held until the offset number of packets arrive and reinserted into the data stream at that point. For example, if the offset is 5 packets, any packet that is reordered will be held and reinserted after the fifth subsequent packet.

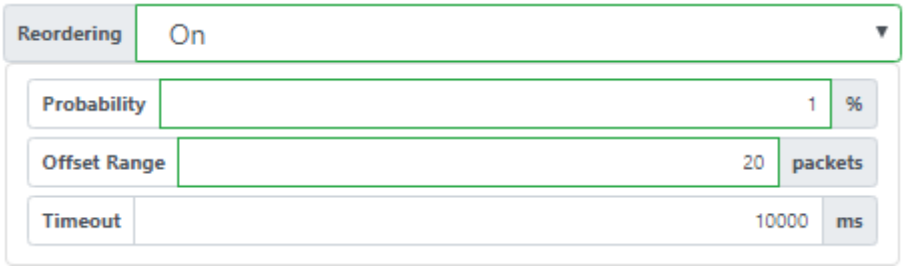


Figure 27: Packet Reordering

To configure packet reordering, set:

- Probability: the likelihood that each frame will be reordered. Probability can be set from 0 – 100% in increments of 0.0001%.
- Offset Range: the number of packets that the reordered packet is moved back in the data stream. Either a single value or a range of values can be configured. To specify a range, input the minimum and maximum reordering offsets separated by a dash, i.e. 5-12.
- Timeout: the maximum amount of time to wait for the number of offset packets to arrive. For example, if the offset is set to 1000 packets and the timeout set to 5 ms, if 1000 packets do not arrive within 5 ms, the packet will be reinserted in the packet stream at that expiration of the 5 ms period. The default value for timeout is 10,000 ms. The timeout value is specified in ms in increments of 0.01 ms.

Only one packet can be held for reordering at any time. While a packet is waiting for reinsertion, the arriving packets are not subject to reordering. For example, if a packet is randomly selected for reordering with an offset of 5 packets, the next five packets that arrive cannot also be reordered.

6.3.6 Duplication

The Duplication panel specifies the probability for each packet that it is duplicated.

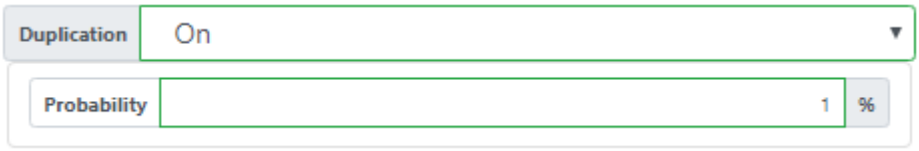


Figure 28: Packet Duplication

Duplicate packets are inserted into the data stream immediately after the original packet. Duplicate packets are then subjected to delay, loss, and reordering independently of the original packet.

The duplication probability can be set from 0 – 100% in increments of 0.0001%.

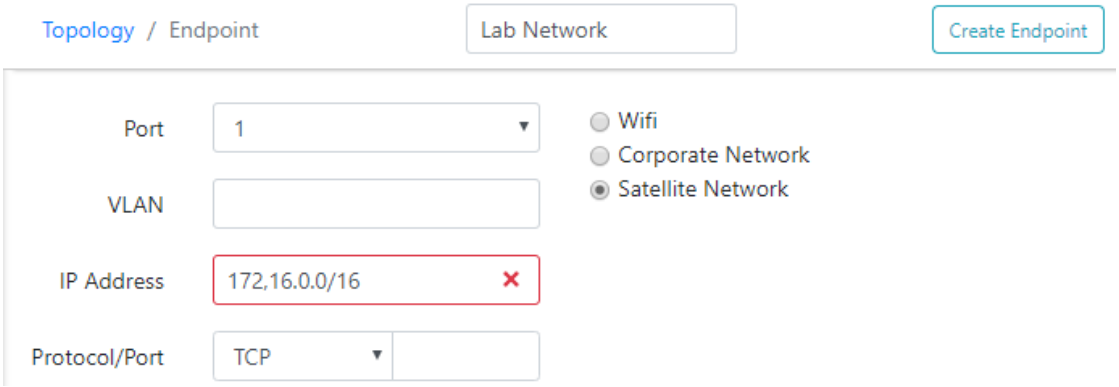
7 ENDPOINTS

7.1 Overview of Endpoints

Endpoints are visual representation of devices, networks, or ports that assign packets to specific paths.

Endpoints can be matched with a path by IP Address, IP Range, IP Subnet, VLAN tag, VLAN Range, or TCP/UDP port. Packets that match the endpoint will then be assigned to the path specified in the Endpoint creation process.

To configure an Endpoint, on the left margin in the endpoints row click the “+” button. This will open the Endpoint configuration menu.



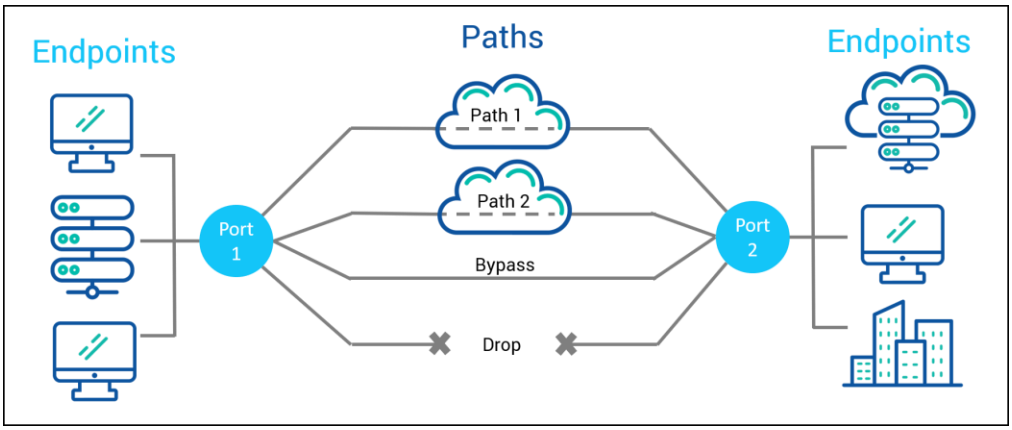
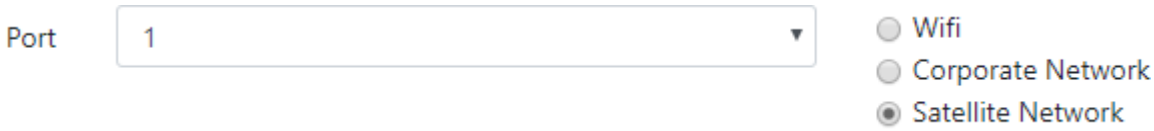


Figure 29: **Endpoints**

7.2 Endpoint Identifiers

Endpoint can be identified by IP address, IP Range, IP Subnet, VLAN tag, VLAN range, or TCP/UDP ports. These settings are used for the Netropy to identify what paths the traffic is assigned to.

7.2.1 Port & Path Selection



The port selection dropdown is used to specify the source port of the Endpoint. This is the physical port the IP, Network, VLAN, or TCP/UDP port is plugged into on the Netropy.

Path selection is how you assign the Endpoint to the correct path.

7.2.2 VLAN Identifier

The VLAN identifier allows you to assign a specic VLAN or a VLAN range to a path. You can specifiy a single VLAN or a range of VLANS by using “-“. For example, “1000-1350” would specify that 350 VLANS starting at VLAN 1000 and ending at 1350 would be assiged to the desired path.

7.2.3 IP Identifier

The IP identifier allows you to assign a spacific IP, IP range, or IP subnet to a specific path. You can specify a single IP address, an IP Subnet in CIDR format, or a range of IPs using “-“. For example, “192.168.100.10-192.168.100.20” would specify 11 IP addresses starting at 192.168.100.10 and ending with 192.168.100.20.

Netropy does support IPv6 addressing.

7.2.4 Protocol/Port Identifier

The Protocol/Port identifier allows you to assign a specific port or a range of ports to a specific path. You can specify a single port or a range of ports using "-". For example, "80-180" would specify 100 ports starting at 80 and ending at 180. These can be set as TCP or UDP ports.

7.3 Endpoint Rules

To pair a single endpoint to multiple endpoints click the icon next to "Manage Endpoint Rules" in the left side margin.

Use the dropdown menu next to "New Rule" to select an endpoint. Choose the endpoint you wish to pair it to from the second drop down menu. Then choose the path using the dropdown next to "Action". Click the "+" button to add the rule. Repeat this process to create multiple rules, then click "Apply Changes".

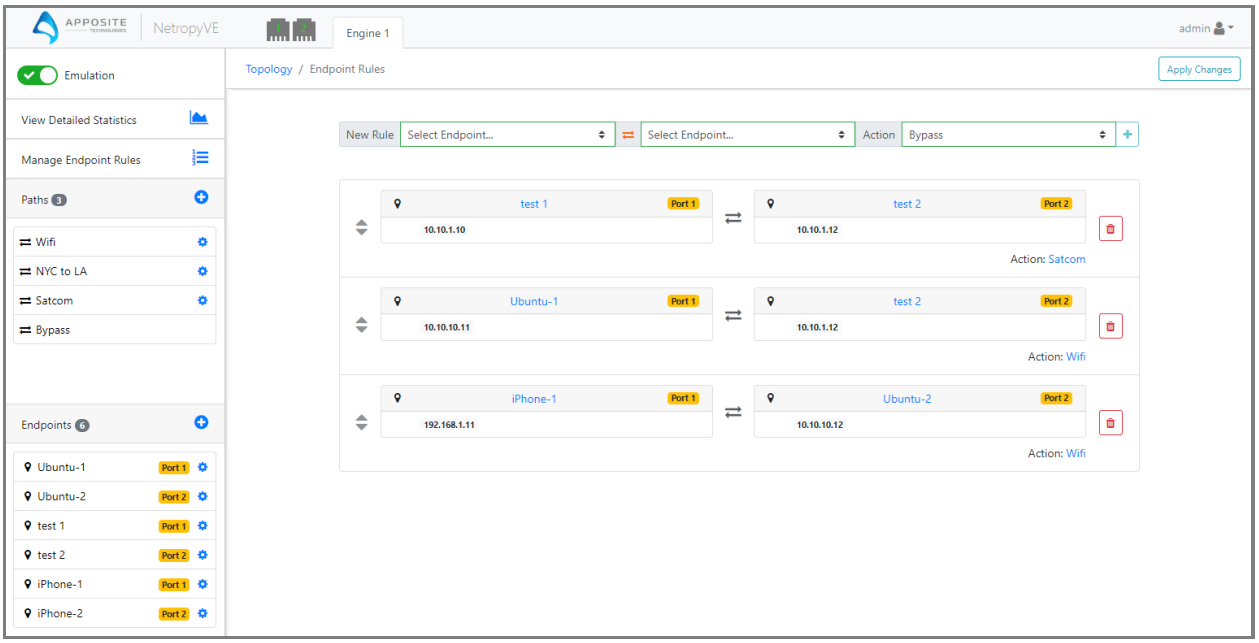


Figure 30: Endpoints

In order to create a rule, Endpoints need to be on opposite ports, i.e. Port 1 and Port 2. If both endpoints are on the same port you will be unable to create the rule.

8 MONITORING & STATISTICS

The Netropy offers 2 types of graphs, single path graphs and detailed statistics graphs. Both types of graphs can be viewed using the GUI and display real-time statistics and throughput.

8.1 Single Path Graphs

To display the single path graph click on the path in the topology view or on the left side margin.

The graph can display the statistics in either direction of a path or overlay both directions (default). To toggle between views, click on the Port 1 to Port 2 or Port 2 to Port 1 links at the top of the graph. The single path graph will only display rate, frames, and bytes. For more detailed statistics, please see section 8.2.

Statistics for background traffic is shown separately from real traffic entering the Engine from external sources.

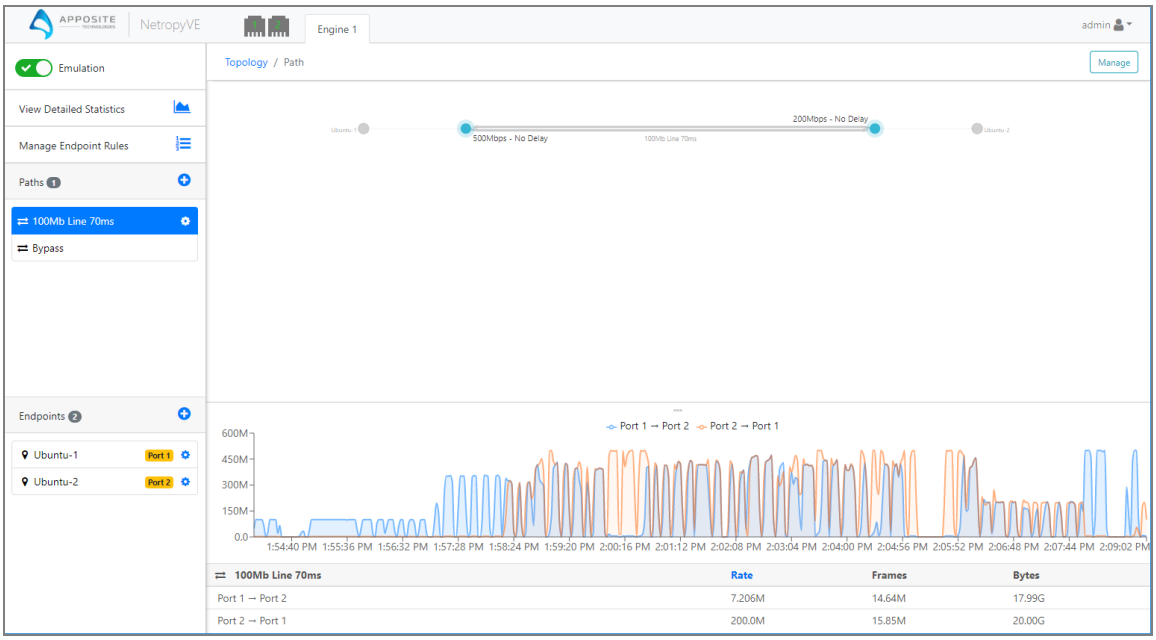


Figure 31: Single Path Graph

8.2 Detailed Statistics Graphs

To display the detailed statistics graph, click on the icon next to “View Detailed Statistics” at the top of the left side margin.

The graph can display the statistics in either direction of a path or overlay both directions (default). To toggle between directional views, click on the arrows next to the path choice dropdowns at the top of the graph. The detailed statistics graph displays rate, frames, bytes, drops, loss drops, reorders, duplicates, corruptions.

Statistics for background traffic is shown separately from real traffic entering the Engine from external sources.

Use the dropdown in the center above the graph to change your view time from 5 mins to 12 hours, or specify a custom time using the “custom” selection.

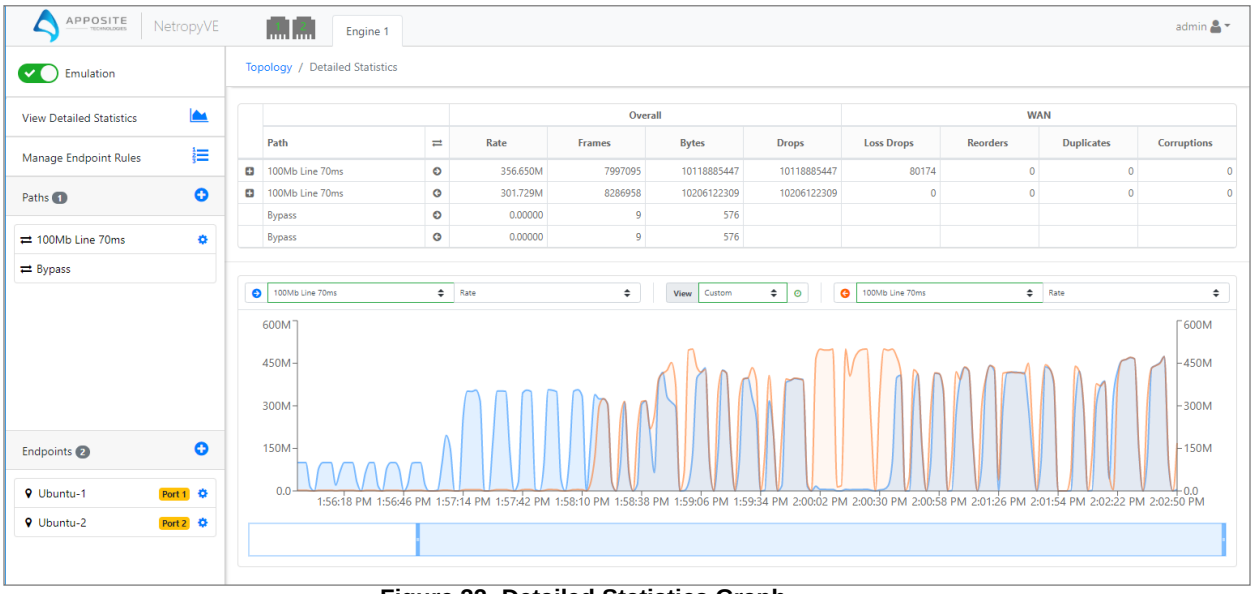


Figure 32: Detailed Statistics Graph

8.3 Statistics

To access the statistics section, click on the icon next to “View Detailed Statistics” at the top of the left side margin.

By default, only overall rate, frames, bytes, drops, loss drops, reorders, duplicates, corruptions are displayed. To view other statistics, click the “+” icon next to the path in the table at the top of the page.

Rates are displayed as averages over the past one second interval. Counters are displayed as cumulative values since the last reset. Rebooting or power cycling the instance resets all values.

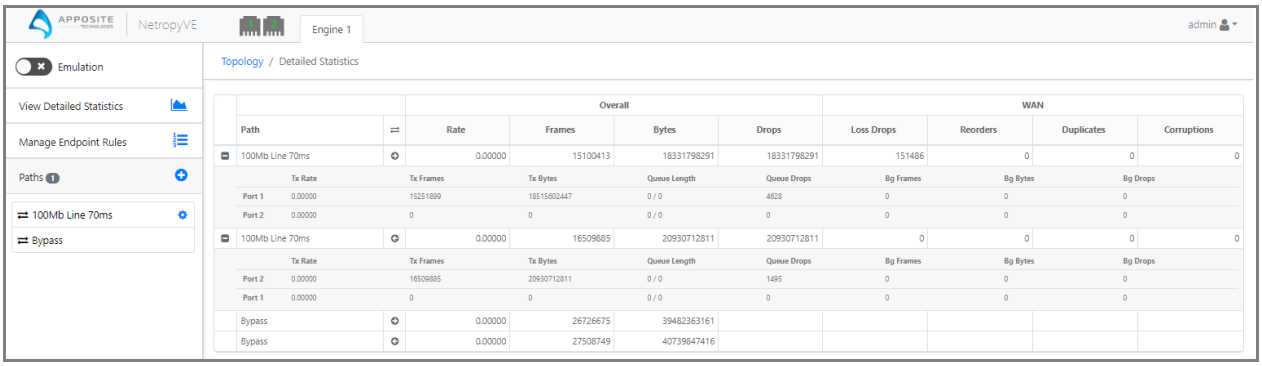


Figure 33: Path Statistics

Statistics cannot be recovered after a reboot or power cycle of the device.

Data available for display for each path in each direction are described in the table below.

Segment	Statistic	Description
Overall	Rate	current transmission rate for traffic delivered across the WAN over the previous 1 sec. interval.
	Bytes/Frames	cumulative number of bytes and packets delivered across the path.
	Drops	cumulative sum of packets dropped as a result of queuing limits on both the outbound and inbound WAN Access links and the frames dropped due to configured WAN loss parameters.
WAN Access	Tx Rate	current transmission rate for traffic delivered across the WAN Access link over the previous 1 sec. interval. Does not include background traffic.
	Tx Bytes/Frames	cumulative number of bytes and packets transmitted over the WAN access link. Does not include background traffic.
	Queue Length – Bytes/Frames	number of bytes and packets currently in the transmit queue, including estimated queue occupancy of background utilization traffic, when configured.
	Queue Drops	cumulative number of packets dropped due to configured queuing limits. Does not include drops of background traffic.
	Background Bytes/Frames	cumulative number of bytes and packets injected as background traffic on the WAN Access link.
	Background	cumulative number of packets of background traffic

	Queue Drops	dropped due to configured queuing limits.
WAN	Loss Drops	cumulative number of packets dropped due to configured loss parameters.
	Frames Reordered	cumulative number of packets reordered.
	Duplicated	cumulative number of packets duplicated.
	Corrupted	cumulative number of packets that contain one or more errors.

8 RECORDINGS

8.1 Overview of Recordings

Path delay, loss, and bandwidth conditions that fluctuate over time can be simulated using a time-series of values from a user-supplied recording file usually generated by the Netropy Recorder for Windows and Linux or the Apposite Recorder for Android™ software. This provides a convenient method of capturing the conditions of a live network link and reproducing those conditions in the lab.

The Netropy Recorder is an application for Windows and Linux available for free download from the Apposite website. The Apposite Recorder for Android provides similar functionality on Android-based phones and tablets and is available for free download on Google Play™. The Netropy or Apposite Recorder sends ICMP Echo Requests from the device on which it is running to a specified destination on the other side of the network, then records the reported delay and loss values to a recording file. For more information on the Recorder software, please consult the *Netropy Recorder User's Guide* or the Help text within the Apposite Recorder for Android.

Users can also create their own recording files to generate any desired time sequence of emulated conditions. Although the Recorder software does not record bandwidth, the recording file can include values for bandwidth as well as latency and loss. To create a recording file, or to edit a recording file created by the Recorder, refer to the Recording File Format description in Section 8.4.

The use of recordings is a 2-step process. First, recording files are loaded into the Netropy network emulator for use by any Path of any engine. Then, available recordings can be selected for playback within the configuration of any Path.

Recordings represent the conditions for a single direction, and consequently, all data represent one-way, not round trip values.

8.2 Managing Recordings

Use the Recordings tab of the Administration window to add and delete recording files.

To add a new recording file, click the *add recording* button and browse to the recording file stored on the management PC or a locally accessible file server. To remove a recording file, select the file and click the *delete recordin*g button.

Selecting a previously loaded recording displays a summary of the delay and loss characteristics of the data, as well as the length of the recording. Clicking the *preview* link displays a graph of the data. Separate graphs will be displayed for each condition included in the file.

Each recording file can be up to 10 MB in size, with the total for all packet capture and recording files limited to 40 MB.

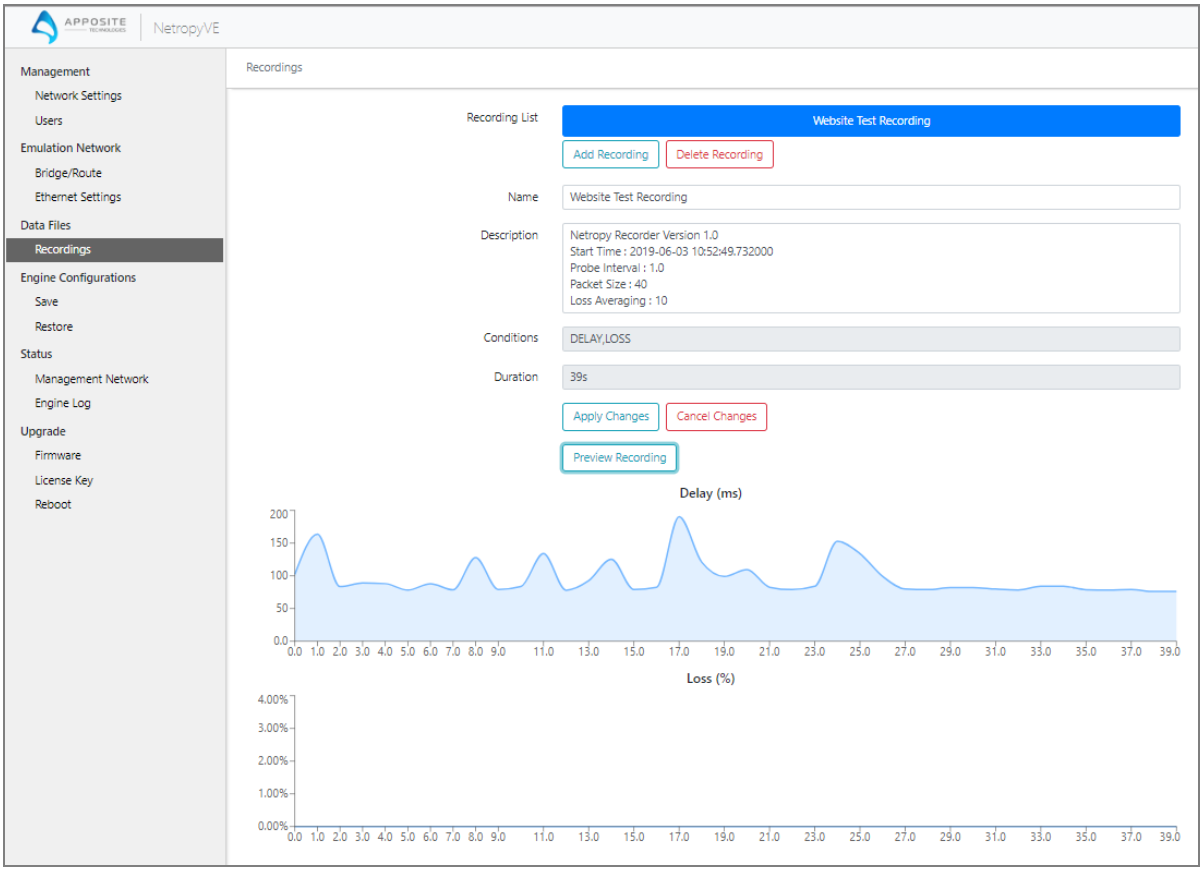


Figure 34: Managing Recordings

8.3 Recording Playback

To playback a recording, first turn off emulation for the engine. Playback can only be configured while emulation is off. Click the “+” on the left side margin next to Path, then click the playback

button at the top of the path management screen.

Select the recording to use for each direction. Playback is configured separately in each direction. The same recording can be used in each direction, different recordings can be used in each direction, or a recording can be used in one direction with non-recorded conditions in the other direction.

Click the check boxes to select whether to use recorded delay, loss, and/or bandwidth. Any parameters not included in the recording are grayed out.

For each path direction, recorded bandwidth can be used to set bandwidth from a port outbound to the WAN, from the WAN inbound to a port, or both. The option to use recorded bandwidth from the WAN inbound to a port will be enabled only if the inbound side of the corresponding WAN Access has been enabled.

Click “Back to Path” on the top right of the screen to return to the Path Configuration window and configure any other emulation parameters if needed.

Playback of the recording begins when emulation is turned on. When playback reaches the end of the recording, it restarts at the beginning and continues looping until emulation is disabled.

To view the progress of the recording playback, return to the Playback Configuration window. While playback is running, a graph of the recording is displayed showing the progress of the playback.

8.4 Recording File Format

Recordings are text files with the format described in the table below. The recording file may contain up to 100,000 lines of data.

Line Type	Syntax and Description

metadata	`# <attribute> : <value>`
	
	A list of attributes of the recording and their values. Must be at the beginning of the file, prior to any recording data, and preceded by a “#” symbol. Defined attributes are:
	`# name (or # title) : <recording name/title>`
	
	The title of the recording displayed above the recording graphs.
	`# description : <recording description>`
	
	A detailed description of the recording. If no description is included in the file, the computed min/avg/max delay and loss values will be displayed as the description of the recording.
	`# contents : <impairment 1, impairment 2, ...,impairment n>`
	
	An ordered, comma-separated list of impairment names that defines the fields of the data section. Valid impairment names are limited to BW, DELAY, and LOSS. For example:
	`# contents : DELAY,LOSS`

	`# contents : DELAY`
	`# contents : BW,DELAY,LOSS`
	If the contents are not specified, "DELAY,LOSS" is assumed.

Data	`<start time> <impairment 1 value> [<impairment 2 value>] [<impairment 3 value>]` Start time is the time in seconds, relative to the beginning of the recording, when the delay and loss values of the line take effect. Start time is a floating point number and must be at least 0.001 seconds greater than the start time of the previous line. There cannot be more than 10 lines in any one second period. On the final line in the recording file, the start time is used only to determine the duration of the previous line with delay and loss values ignored. Delay values are specified as latency in milliseconds with a resolution of 0.01 ms. Loss values are specified as the packet loss rate in percent (without the percent sign) between 0.0000 and 100.0000. Bandwidth values are specified in bits per second.

8.5 Example Recording File

The following is a short example recording file with bandwidth, delay, and loss parameters. Within the first second, the loss values change five times, then remain constant for 19 seconds, then the bandwidth and delay values change over the next 30 seconds.

```
# Name : Example Recording
# Contents : BW,DELAY,LOSS
0, 2000000, 52.5, 0
0.2, 2000000, 52.5, 25.0
0.4, 2000000, 52.5, 50.0
0.6, 2000000, 52.5, 75.0
0.8, 2000000, 52.5, 50.0
1.0, 2000000, 52.5, 25.0
20.0, 2000000, 52.5, 0
25.0, 4000000, 52.5, 0
30.0, 8000000, 60.0, 0
40.0, 8000000, 75.0, 0
50.0, 8000000, 100.0, 0
```

9 ADMINISTRATION

The Netropy network emulator is administered via a separate window accessed by clicking the *Administration* link at the top of the main page.

9.1 Network Settings

The IP address of the management interface of the Netropy and other network settings are configured in the Network Settings tab.

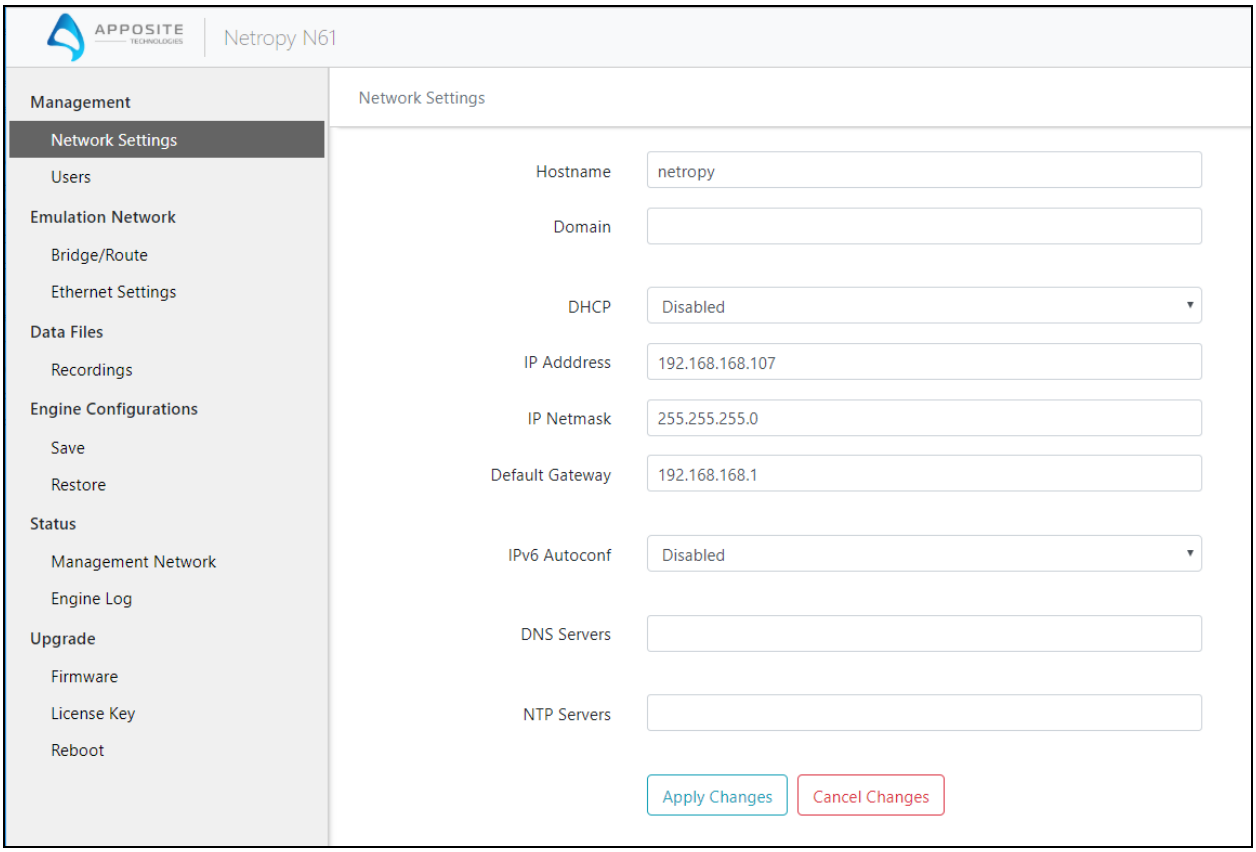


Figure 35: Network Settings Tab

IPv4 address, netmask, and default gateway, as well as DNS and NTP servers may be configured manually or using DHCP. A default gateway is optional.

All IPv4 addresses are entered in dotted-decimal notation. Entries are checked for validity and consistency before changes are applied.

The device can also be managed using IPv6. When IPv6 Autoconf is enabled, a link-local IPv6 is created and the device attempts to obtain a global IPv6 address and default gateway. The assigned IPv6 address is shown on the Management Network status tab.

When the IP address is changed, connectivity to the device will be lost and must be reestablished using the new address.

Up to 3 DNS servers and up to 3 NTP servers may be configured. DNS or NTP servers configured manually will override any servers set automatically through DHCP.

If you cannot regain connectivity to the device after changing the network settings, use the CONSOLE interface to verify or change the network settings.

9.2 Users

Usernames and passwords are administered in the Users tab.

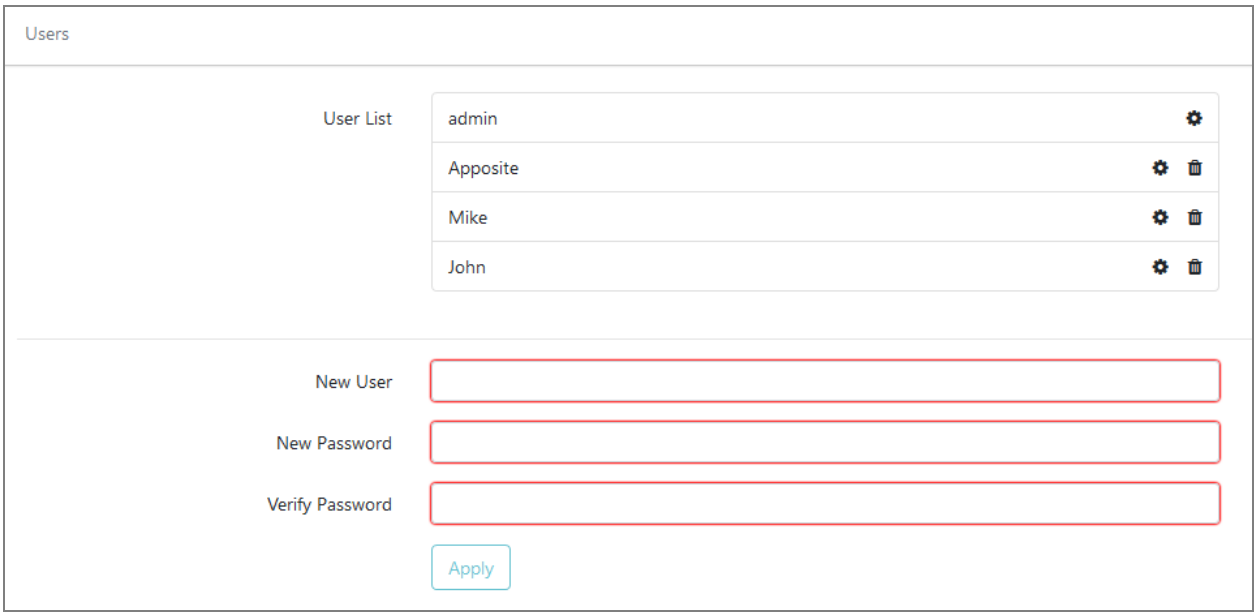


Figure 36: User Administration Tab

Initially, the device has a single user, *admin*, with instance ID as the password. Additional users can be added or deleted by *admin*. Passwords for each user can be set or cleared by the individual user or by *admin*.

Users other than *admin* are unprivileged, and can make configuration changes but cannot make system administrative changes.

10.3 Bridge/Route

The Netropy emulator can be installed as either a bridge or router to forward frames between the two ports of each Emulation Engine. By default, each Engine is configured as a bridge, and this mode is recommended for simplicity unless the two ports need to be on separate subnets.

Use the Forwarding Mode drop-down selector on the Bridge/Route tab to choose between bridging and routing. This selection is made separately for each Emulation Engine.

Bridge/Route settings are saved with the Engine configuration and are updated when a saved Engine configuration is restored.

10.3.1 Bridging

In Bridging Mode, the Netropy Engine functions as a bridge between the Ethernet segments connected to the two Ethernet ports. In this mode, it can forward any Ethernet-based frame regardless of network layer protocol.

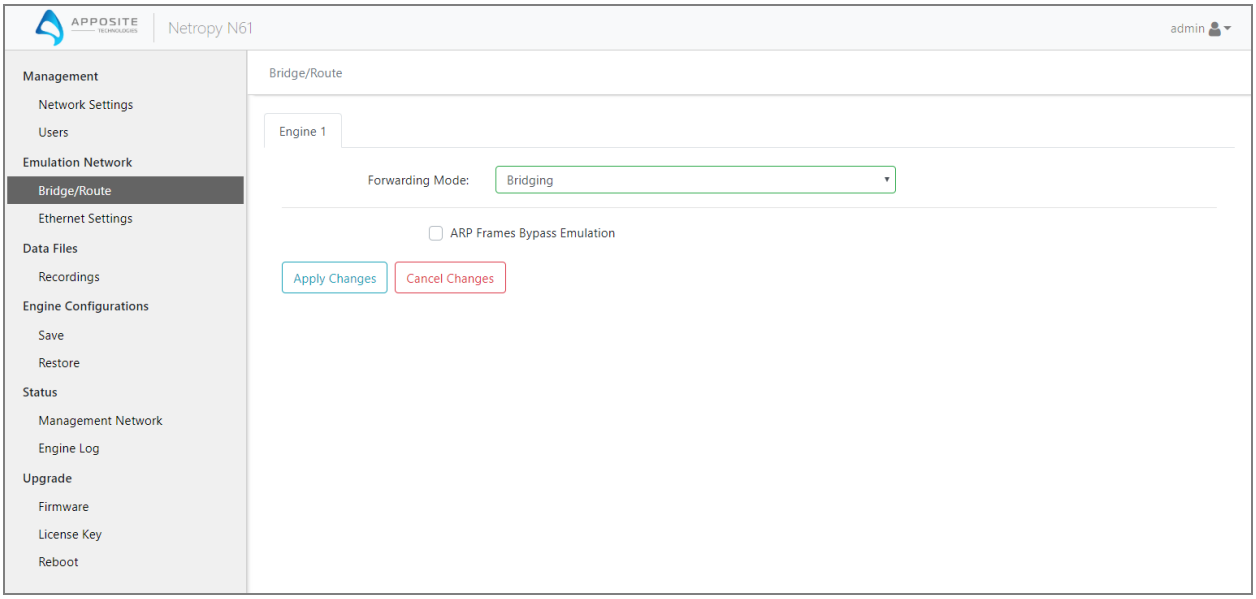


Figure 37: Bridging

By default, all frames are assumed to be part of the WAN traffic and are subjected to the configured emulation conditions. This includes ARP packets, which on a production network may be processed or filtered prior to traversal of the WAN. Check the *ARP Frames Bypass Emulation* box to have those packets forwarded directly between the two ports with no impairment regardless of the configuration of the Emulation Engine.

10.3.2 Routing

In Routing Mode, the Netropy Engine functions as a router between the Ethernet segments connected to the two ports of the Engine. Configure the IP address and netmask of the two interfaces. If necessary, add static routes to off-link destinations. All addresses are entered in dotted-decimal notation.

Routing Mode supports only the forwarding of IPv4 frames and does not support multicast forwarding.

10.4 Ethernet Settings

The speed, duplex, and flow control settings for the Ethernet ports used for emulation are configured in the Ethernet Settings tab.

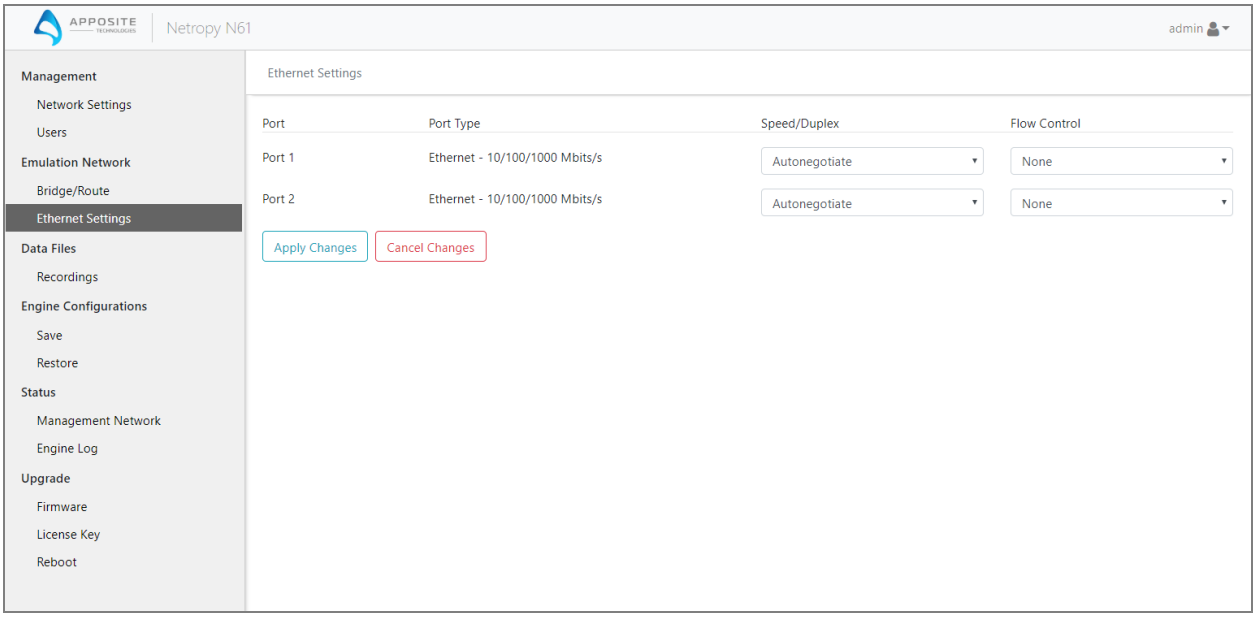


Figure 38: Ethernet Settings Tab

By default, the Ethernet ports are set to auto-negotiate the proper speed and duplex settings, and flow control is turned off. On the 10/100/1000baseT emulation ports, auto-negotiation can be disabled and the ports forced to a particular speed and duplex setting via the drop-down menu. In nearly all cases, the default settings should be used and should only be changed to resolve incompatibilities with directly-connected equipment.

Auto-negotiation cannot be disabled on 1 Gbps SFP ports or any 10 Gbps or higher speed ports, although flow control can be turned on if needed. Auto-negotiation cannot be disabled on the MGMT port.

Jumbo frames of up to 9 KB are supported on all emulation ports.

If the speed and duplex setting of an interface is selected manually, the device the port is connected to must also be forced to the same setting.

10.5 Recordings

Importing and deleting Recording files for automated playback of a time series of latency and loss conditions is managed through the Recordings tab. For more details on the use of recordings, see Section 8: Recordings.

10.6 Save and Restore Engine Configurations

The configuration of a selected Emulation Engine can be saved to a file on the management PC from the Save tab. The stored configuration file can then be loaded into a different Netropy unit regardless of model. The restore operation overwrites the current configuration of the Engine.

Recording and PCAP files are included in the configuration file if they are used in any path in the Engine. This can cause configuration files to be very large.

The bridging or routing settings are saved with the Engine configuration and are updated when a saved Engine configuration is restored.

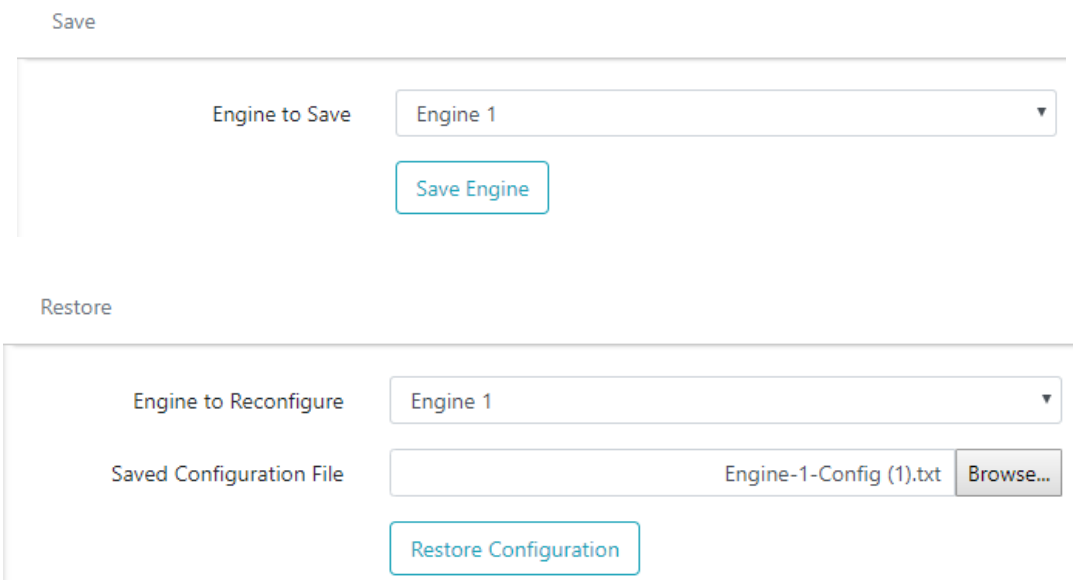


Figure 39: Save and Restore Tabs

10.7 Management Network

The Management Network screen shows the current configuration for the IP address and netmask, default gateway, network domain, and DNS and NTP servers. Press the refresh button to update with the latest status.

10.8 Engine Log

A log file of error messages and warnings is shown on the Engine Log tab. A separate log is maintained for each Engine. Each line includes a sequence number and the time in GMT. Log messages will be generated at most once per second.

If there are any error conditions that could affect the validity of the test results, the LEDs on the Engine tab on the main configuration window remain red until the log message has been marked as read or the log cleared.

Error conditions reported in the log are:

`timing error exceeded <#>us`

The engine has detected that the error in emulation timing has exceeded the indicated number of microseconds.

`<#> frames lost`

The engine has been overload and was unable to process all received frames, with the indicated number of frames dropped.

`out of buffers - <#> events`

The engine ran out of buffer space to receive new frames from the network. The number of failed attempts to allocate buffer space is reported.

`automatic engine shutdown`

Emulation was aborted. The current engine configuration requires more resources than supported by the hardware.

10.9 Firmware

The version of the Netropy firmware currently installed is displayed in the Firmware tab.

To upgrade the firmware, first download the new image to the management PC or a local file server from the Netropy support site. Then use the *browse* button to select the file, and click *upgrade* to install.

The Netropy device will automatically reboot after a successful firmware upgrade.

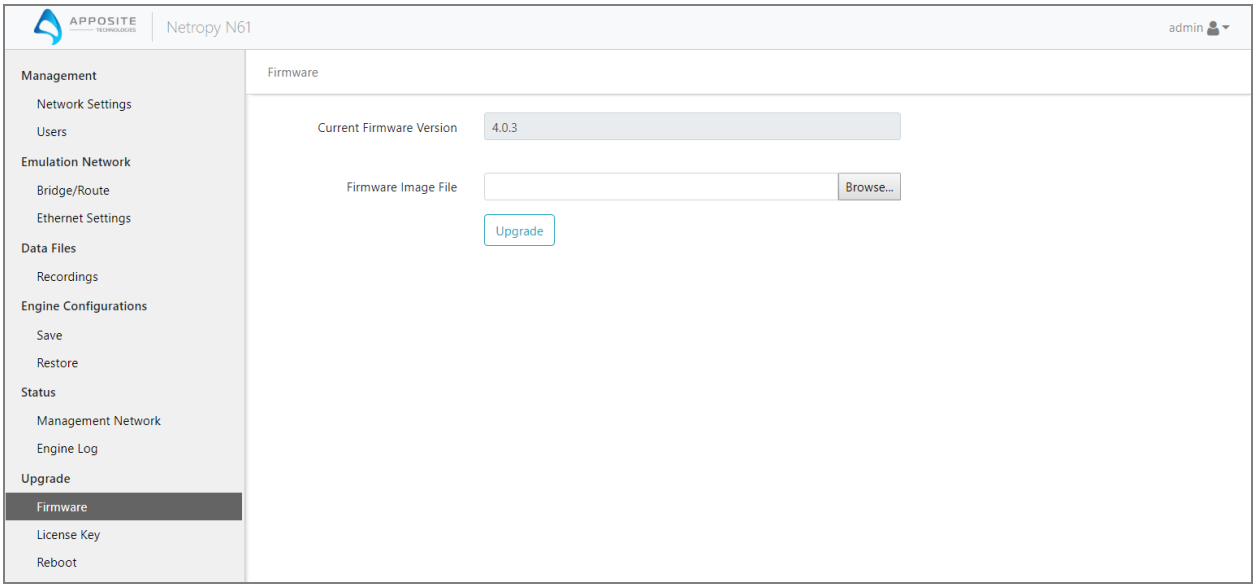


Figure 40: Firmware Tab

☞	The same procedure can be used to restore an older version of firmware if necessary. However, when downgrading to an older release, some settings may not be preserved.

☞	Firmware updates are available on the Netropy support section of the Apposite website. To obtain access the support site, register your unit at apposite-tech.com/register.html. An active product license or maintenance contract is required. Registered users will also receive email notices of firmware updates.

10.10 License Key

The serial number, license expiration date, and bandwidth limit are displayed in the License Key tab. If an expiration date is not shown, the license does not expire. For information on renewing a license, see apposite-tech.com/renewals.html.

The license key controls the maximum bandwidth that can be configured in either direction for each path.

To add a new license key, use the *browse* button to select the license key file and click *apply key* to install.

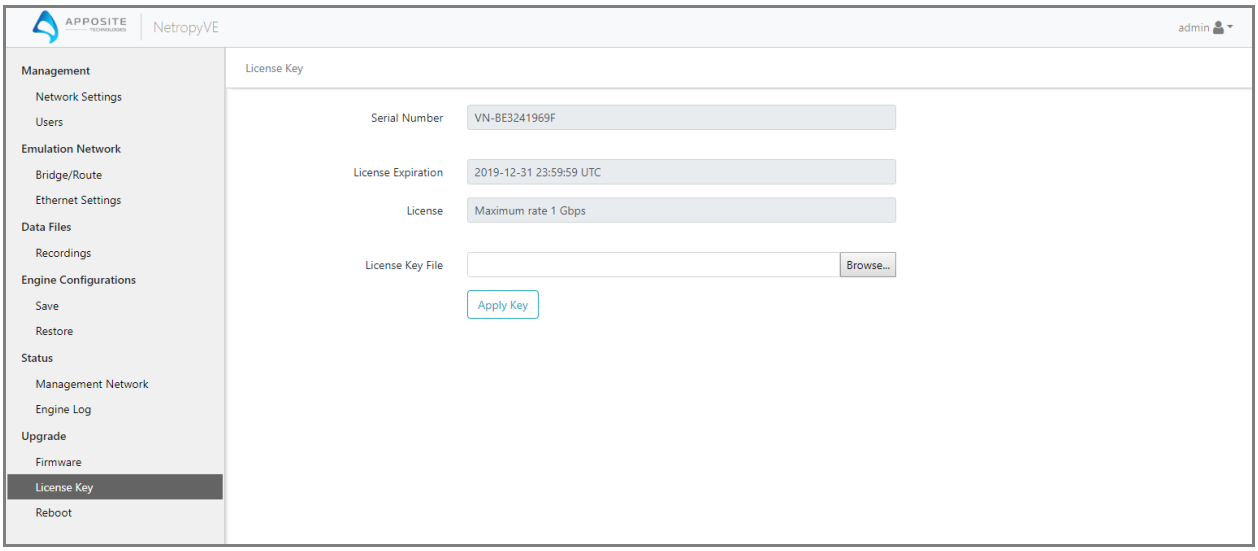


Figure 41: License Key Tab

11 COMMAND LINE INTERFACE

The Netropy command line interface (CLI) can be accessed via the CONSOLE interface or through a Telnet or SSH connection.

The following are the only features available through the CLI:

- ARP and PING commands
- Manually set system clock
- Reinitialize the unit to factory settings
- LDAP authentication
- Packet capture
- Management functions
- HTTP certificates

All engine CLI commands have been disabled in 4.0. To automate engine/network impairments please see the API documentation.

To access the CLI, log into the device at the prompt as "`admin`" or other configured username.

The SSH and Telnet services can be enabled or disabled through the CLI using the `telnet` and `ssh` commands. By default, both are enabled. Multiple simultaneous sessions are allowed.

SSH can be used to execute a single command or to log in for an on-going session similar to Telnet.

11.1 CLI Help

The CLI includes several levels of help. The "`help`" command by itself displays a list of commands. "`help`" with a command name displays the syntax and options for the command.

When entering commands, the <Tab> key can be used to complete a partially entered command name. If there are multiple possible completions, pressing the <Tab> key again will display a list of options.

11.2 CLI Top Level Commands

Command	Syntax and Description
arp	`arp show` Displays a table of IP addresses and associated MAC addresses for the MGMT interface.
capture	`capture port <port> [raw|detail] [arp|ip <address>] [snaplen <len>] [filter <filter string>]` Displays frames received by and sent from the specified port until control-C is pressed. See Section 11.3.2 for a detailed description.

clock	`clock show`
	Displays the current system time and date.
	`clock set <hh>:<mm>:<ss> <YYYY>-<MM>-<DD>`
	Sets the time and date used for log messages. All fields are required. Clock settings are permanent and survive reboots and power cycles of the device.
	If an NTP server is configured, it will override the settings from this `clock` command.

help	`{help | ?} [<command>]` Displays a list of available commands or syntax of a specified command. A question mark after any command also displays the syntax for that command.

http	`http load <ssl-certificate-url>`
	Installs an SSL certificate. FTP, HTTP, and TFTP services are supported for upload. Uploaded certificate replaces the self-signed certificate supplied in the firmware.
	Ex: http load ftp://192.168.0.100/certs/certificate.crt
	`http {on | off}`
	Enables or disables unsecured access to the GUI via HTTP. HTTP service is on by default. Secured access to the GUI via HTTPS is always enabled.

init	`init config` Returns the configuration to factory default settings. Takes effect upon reboot unless the configuration is saved prior to reboot.
logout	`logout` Logout from the command line interface.

mgmt	`mgmt show`
	Displays the IP address and other management information.
	`mgmt show ldap`
	Displays the current LDAP configuration.
	`mgmt show ntp associations`
	Displays the synchronization state with the configured NTP servers.

mgmt	`mgmt set addr {dhcp | addr <addr> netmask <mask>}`
	Sets the IPv4 address and netmask of the MGMT interface either manually or using DHCP. If DHCP is enabled, DHCP sets the default gateway.
	`mgmt set domain <domain>`
	Sets the network domain name of the device.
	`mgmt set gw <addr>`
	Sets a default gateway for the MGMT interface.
	`mgmt set hostname <name>`
	Sets the hostname of the device.
	`mgmt set ipv6 {on|off}`
	Turns on or off IPv6 Autoconfiguration to assign an IPv6 address and default gateway for the MGMT interface.
	`mgmt set ldap ...`
	See Section 11.3.1 for LDAP configuration syntax.
	`mgmt set nameserver <addr> [<addr2> [<addr3>]]`
	Sets up to three DNS servers for the device. This command overrides any nameservers set through DHCP and any DNS servers previously configured.
	`mgmt set ntp server <server> [<server2> [<server3>]]`
	Sets up to three network time protocol servers for the device. This command overrides any NTP servers set through DHCP and any NTP servers previously configured.
	`mgmt clear ldap`
	Turns off LDAP authentication and clears the LDAP configuration.
	`mgmt clear nameserver`
	Clears all manually configured DNS servers. Does not change any DNS servers set through DHCP.
	`mgmt clear ntp server`
	Clears all manually configured NTP servers. Does not change any NTP servers set through DHCP.

packet-captures	`packetcaptures list`
	Displays a list of imported PCAP files, their ID numbers, and size in bytes.
	`packetcaptures add <packet-capture-url>`
	Imports a PCAP packet capture file. FTP, HTTP, and TFTP services are supported.
	Ex: packetcaptures add http://192.168.0.100/captures/voipstream.pcap
	`packetcaptures delete <id>`
	Deletes the specified packet capture file.

password	`password clear [<user-id>]`
	Clears the password for the specified user. If no user is specified, command applies to the user executing this command. Only *admin* can specify a user other than himself.
	`password set [<user-id>]`
	Prompts for a new password for the specified user. If no user is specified, command applies to the user executing this command. Only *admin* can specify a user other than himself.

ping	`ping <ip-address> [<size>]` Pings from the device to the IP `address` with the specified sized packets using the MGMT interface. Use CTRL-C to stop.
reboot	`reboot` Reboots the device. Returns user to the login prompt after reboot.

recordings	`recordings list`
	Displays a list of imported recording files and their ID numbers.
	`recordings add <recording-url>`
	Imports a recording file of delay, loss, and bandwidth conditions. FTP, HTTP, and TFTP services are supported.
	Ex: recordings add http://192.168.0.100/recordings/wireless.txt
	`recordings delete <id>`
	Deletes the specified recording file.

Serial number	`serialnumber` Displays the serial number of the unit.
ssh	`ssh [enable | disable | fingerprint]` Enables or disables SSH service, or displays the fingerprint of the SSH server's public keys. If service is disabled, any sessions in progress are terminated. With no argument, 'ssh' reports current status of the service.
telnet	`telnet [enable | disable]` Enables or disables telnet service. If Telnet is disabled, any sessions in progress are terminated. With no argument, the command reports current status of Telnet service.
upgrade	`upgrade <upgrade-image-url>` Upgrades the Netropy firmware. FTP, HTTP, and TFTP services are supported. Ex: upgrade ftp://server/netropy-image
user	`user [add <user-id> | delete <user-id> | list]` Adds, deletes, or lists usernames.
Version	`version` Displays the operating firmware version.

11.2.1 LDAP Management Commands

CLI commands for LDAP authentication are listed in the table below:

show	`mgmt show ldap` Displays the current LDAP configuration.
set	`mgmt set ldap server <server> [port <#>]` Identifies the LDAP server by IP address or host name. Optionally specifies a non-standard port to connect to. The default port is 389.

	Ex.: mgmt set ldap server ldapserver.example.com
	`mgmt set ldap basedn <search-base-DN>`
	Identifies the Distinguished Name of the search base in the remote LDAP database. If there are embedded spaces in the base DN string, the string must be enclosed in quotation marks.
	Ex.: mgmt set ldap basedn dc=example,dc=com
	`mgmt set ldap filter attribute <string> [<LDAP-search-string>]`
	Specifies the attribute that contains the username and optionally an additional LDAP search string. The LDAP search string must be compatible with the formal definition found in RFC 4515. If there are embedded spaces in the search string, the string must be enclosed in quotation marks.
	Ex.: mgmt set ldap filter attribute uid (&(gidNumber=20)(class=Expert))
	The resulting search string will be `(&(uid=user)(&(gidNumber=20)(class=Expert)))` where "user" is replaced by the login name.
	`mgmt set ldap security {disable | enable}`
	Enable or disable Transport Level Security. TLS is enabled by default.
	`mgmt set ldap bind dn <bind-DN> [password <password>]`
	Specifies a Distinguished Name and password with which to bind to the LDAP server before performing a search operation. If not configured, an anonymous bind will be used.
	Ex. mgmt set ldap bind dn cn=user,dc=example,dc=com
	`mgmt set ldap {on | off}`
	Turns LDAP authentication on or off.

clear	`mgmt clear ldap` Turns off LDAP authentication and clears the LDAP configuration.

11.2.2 Capture Command

The ‘capture’ command displays packets received or transmitted through the emulation ports.

This feature is intended to be used for examining and troubleshooting network connectivity. At high packet rates, the capture command will not capture all packets and may cause packet loss or timing errors for forwarded traffic.

This feature is only available through the CLI.

The capture command is unrelated to the packetcapture feature used to import and replay PCAP files as emulated background traffic.

Capture Command Syntax:

```
capture port <port> [raw|detail] [arp|ip <address>] [snaplen <len>]
[filter <tcpdump filter string>]
```

Displays frames received by and sent from the specified port until control-C is pressed. Only one running capture can be active per port. Options are described below:

- None: a timestamp and summary description are displayed for each frame.
- `detail`: the Ethernet header and additional details about the contents of the frame are displayed.
- `raw`: binary PCAP data is output. Using this 'raw' option, it is possible to save a packet capture file on a PC by running the capture command via ssh. The resulting file can then be read by a packet analyzer such as Wireshark. For example, a Linux command could be:

```
ssh admin@netropy capture port 1 raw > port_1_packets.pcap
```

It is also possible to display packets in real-time in Wireshark with the command (on Linux):

```
ssh admin@netropy capture port 1 raw | wireshark -k -i -
```

- `arp|ip <address>`: adds a high speed pre-filter for lossless capture of a subset of packets matching a specific IP address or all ARP packets from a high packet rate stream.
- `snaplen`: limits frame capture to the first 'len' bytes of the frame.
- `filter`: controls which frames will be captured. Tcpdump-style filter options are accepted. For example, "`filter ip host 10.0.0.1`" captures all frames with IP source or destination address of 10.0.0.1.

12 SECURITY

12.1 Users and Passwords

Initially, the Netropy system has a single configured user, *admin*, password, *admin*. Additional users can be added or deleted by the *admin* user through the Administration window of the GUI. Passwords for each user can be set or cleared by the individual user or by *admin*. LDAP server can also be used for user authentication, but needs to be configured using CLI.

12.2 Recovering from a Lost Admin Password

If the *admin* password has been lost, boot to the recovery firmware to gain access to the device and reset the configuration to factory defaults:

1. Connect to the serial console port.
2. Power cycle the unit. Type "`recovery`" at the boot prompt to load the recovery image.

   ```
   boot: recovery
   ```

3. At the prompt, log in as "admin".

   ```
   netropy login: admin
   ```

4. Reset the configuration.

   ```
   [admin@netropy]> init config
   ```

5. Reboot or power cycle the unit and return to the regular operating firmware with no configuration. The management interface will also be reset to the default of 10.0.0.10.

12.3 SSL

The Netropy GUI is accessible via HTTP or HTTPS. HTTPS allows administration of the GUI using SSL security. Netropy includes a non-unique, self-signed certificate. Use of this self-signed certificate may generate an error in the browser that the signing certificate authority is unknown and not trusted. Either ignore this error or install your own certificate.

To install a new certificate, use the "http" command from the CLI:

```
http load <url>
```

For example:

```
netropy> http load http://192.168.0.100/certs/certificate.crt
```

By default, the Netropy GUI is accessible via unsecured HTTP. However, HTTP service can be disabled using the "http off" command from the CLI. HTTPS service is always enabled.

12.4 SSH

The Netropy CLI is accessible over the network via SSH. To verify the identity of the Netropy SSH server, use the "`ssh fingerprint`" command to display the fingerprints of the SSH server's public keys.

12.5 LDAP

An LDAP server can be used for user authentication. When LDAP authentication is enabled, it is used in addition to local authentication for GUI and CLI access.

LDAP can only be configured through the command line interface. See Section 11.3.1 for LDAP command syntax.

To authenticate a user via LDAP, the following steps are performed:

1. A connection to the LDAP server is initiated. If LDAP security is enabled, a TLS session is negotiated.

2. An initial bind operation is performed on the connection. If a 'bind DN' has been configured, then the configured 'bind DN' and password are used for the bind. Otherwise an anonymous bind is attempted.

3. A search is performed to find the database entry that corresponds to the user's username. The search parameters consist of a configurable 'base DN' and a search filter. The 'base DN' specifies the root of the subtree that will be searched. The default search filter requires an exact match between the username and the 'uid' attribute. An alternate attribute for this comparison can be configured. For a more specific search, a full LDAP search string can be ANDed to this filter.

4. If a matching entry is returned by the server, then a new bind is attempted for authentication. This bind uses the DN found in the returned entry and the password supplied by the user. The "Simple" authentication method is requested.

5. If the bind is successful, then authentication is successful.

Notes:

Only one matching entry will be returned by the LDAP search even if there are multiple database entries that match the search filter.

For locally-defined users, the local authentication is always attempted before LDAP authentication.

Only the user *admin* has administrative privileges.

13 APPOSITE SUPPORT

13.1 Registration

For access to the Netropy support site with firmware upgrades, documentation, and other support materials, register your unit at: http://www.apposite-tech.com/register.html. License key download will automatically register you.

Registered users will receive email notification whenever new firmware versions are released.

13.2 Customer Support

If you experience any problem with the Netropy hardware, consult the *Hardware Guide* for your model. If you have any questions about the firmware not answered in this *User's Guide*, please check the Apposite Technologies website at http://www.apposite-tech.com for updated firmware and documentation. If your question is not answered, please contact Apposite Support.

Netropy units with a product license receive support and maintenance for the term of the license, including hardware warranty, firmware updates, and customer support. The license expiration date for limited term licenses is shown in the Netropy GUI on the Administration window License Key tab.

For units with an unlimited term license (purchased prior to August 2017), one year of maintenance is included with purchase, after which a yearly maintenance renewal is required for ongoing support. License and maintenance renewals are available from Apposite or your Netropy reseller.

If you believe the firmware is not functioning properly, please upgrade to the latest firmware release. If the problem persists, please contact Apposite Support at:

support@apposite-tech.com
1.310.477.9955 ext. 2

When contacting Apposite Support, please include the following information:

- Netropy model
- Serial number
- Your e-mail address and phone number
- Installed firmware version
- A detailed description of the problem

Do not attempt to fix any hardware problem yourself. Netropy Network Emulators contain no user serviceable parts. Opening the chassis voids the warranty.

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Beta 3.1

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PureMVC

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