

**RUGGEDCOM**<sup>®</sup>  
**INDUSTRIAL STRENGTH NETWORKS**<sup>™</sup>

# RuggedPing<sup>™</sup>

## User Guide



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# RuggedPing™ User Guide

## Network recovery measurement tool

Revision 1.1 - March 17, 2010

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## Preface

### Foreword

This guide documents RuggedCom's RuggedPing™ software utility for the characterization and measurement of self-healing mechanisms of modern networks, with particular emphasis on Layer 2 Ethernets running RSTP.

### Who Should Read This User Guide

This guide is intended to be used by technical support personnel who are familiar with the operation of networks. Others who might find this guide useful are network and system planners and system programmers.

### Document Conventions

This publication uses the following conventions:

---

#### **Note**

*Means, "Reader take note". Notes contain helpful suggestions or references to materials not contained in this guide.*

---

#### **Caution**

*A cautionary statement regarding an issue that may have an impact on performance of the tool or of the environment in which it operates.*

---

This document uses UTF-8 (Unicode) character encoding. If the contents of the square brackets: [™] do not appear as a trademark(TM) symbol, please change your web browser's encoding method to "UTF-8".

### More Information / Feedback

If you have questions or concerns about the contents of this guide or the operation of RuggedPing, please contact RuggedCom at [support@ruggedcom.com](mailto:support@ruggedcom.com).

Other documents of interest regarding RuggedCom equipment relevant to RuggedPing are available at <http://www.ruggedcom.com> including:

- Rugged Operating System™ User Guide
- RuggedSwitch® Installation Guide

RuggedNMS™ is a fully-featured enterprise grade network management software platform designed specifically for the rugged communications industry. RuggedNMS provides a comprehensive platform for monitoring, configuring, and maintaining mission-critical IP-based communications networks, such as those found in substation automation and “Smart Grids” for electric utilities, intelligent transportation systems, and advanced control and automation for industrial processes.

For more information on RuggedNMS™ please visit <http://www.ruggednms.com>.

# 1. Introduction to RuggedPing™

## 1.1. Purpose

RuggedPing™ monitors a list of devices in order to measure in detail the performance and behavior of the self-healing mechanisms of fault-tolerant networks.

Fault-tolerant networks are typically designed with some inactive, or standby, redundant connections. When an active connection is interrupted, the network works to converge on a solution that results in it regaining full connectivity. RuggedPing is designed to measure the time it takes from the moment the network is damaged to the time it regains full connectivity.

## 1.2. Features

- Flexible, configurable network autodiscovery mechanism with the option to save discovered nodes for later retrieval and use
- Requires no support on test device nodes other than the ubiquitous ICMP protocol. ICMP, the Internet Control Message Protocol (Internet RFC 792), is implemented by the vast majority of IP devices. ICMP is better known as "ping", after the network utility written to test the response time of IP device nodes.
- Graphical configuration interface with fine-grained control of IP address ranges, timers, network usage, and logging
- Millisecond resolution of events both initiated and detected by the system
- Real-time display of test progress
- Generation of test reports in HTML format
- Logging of application status and test results
- Testing, monitoring and measurement of up to 256 IP devices concurrently

## 1.3. Requirements

RuggedPing is a 32-bit Microsoft Windows application with a graphical user interface. It has been tested against and verified to operate correctly under Microsoft Windows XP Service Pack 3.

RuggedPing must be run on a computer with a network card installed. An IP interface with a valid IPv4 address must be configured on the network card.

---

### **Note**

*RuggedPing can be configured in such a way as to place stress on the CPU and network driver / network card resources of lesser computer systems. Generally speaking, the faster the performance of the CPU and network subsystem running RuggedPing, the better able RuggedPing will be to generate and measure the frequent test data required.*

---

## 1.4. Installation

The RuggedPing installation program unpacks the RuggedPing.exe program binary into a user-selectable directory. This same directory also contains a `logs` subdirectory in which the program maintains log files, a `reports` subdirectory in which generated HTML reports are

stored, and a `User Guide` subdirectory which contains the HTML version of the RuggedPing User Guide.

### 1.5. Caution

---

**Caution**

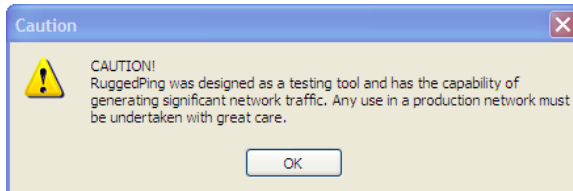
*RuggedPing can be configured to generate a very large volume of IP data traffic, and must therefore be used with great care.*

---

## 2. User Interface

### 2.1. Start-up

When RuggedPing™ is first executed, a splash screen will be displayed, followed by the following caution against using it in production networks, which must be acknowledged before continuing:



**Figure 2.1. Opening Caution**

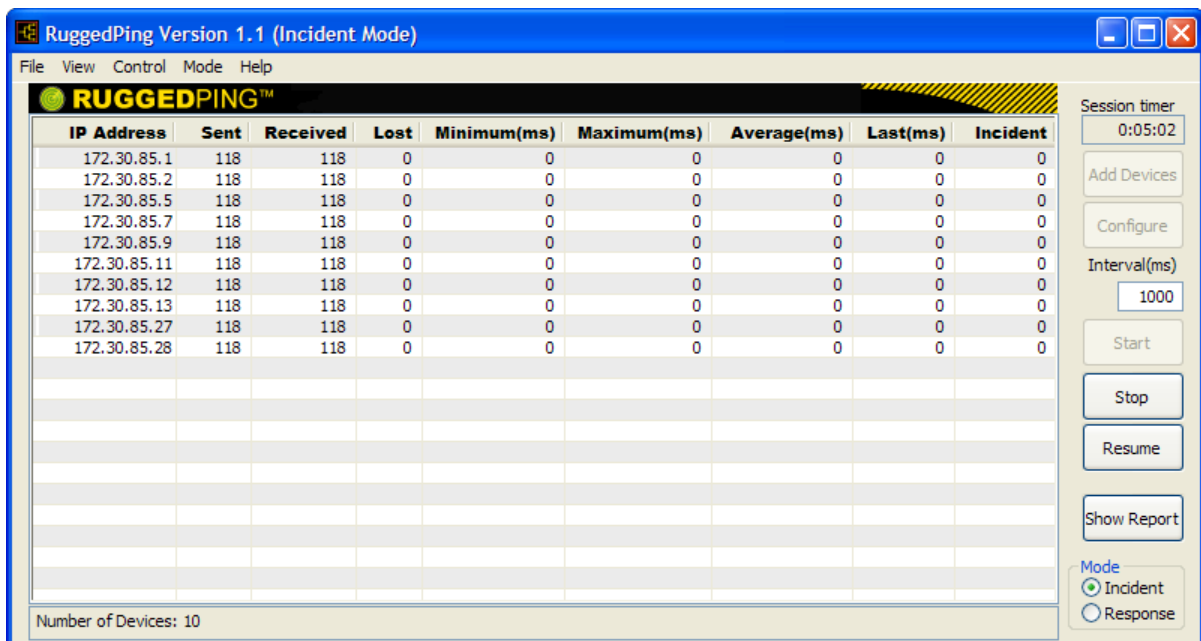
The [Main Window](#) is displayed once the caution message has been acknowledged.

### 2.2. Main Window

The RuggedPing main dialog window is displayed immediately following the opening caution message. RuggedPing configuration, control, test execution and reporting are all accessed via buttons and sub-menus located in the main window. RuggedPing test progress detail is displayed in real time in the table that occupies most of the main window.

The main window can display one of two test modes:

- **Incident mode** (default): displays data for each network device under test that are relevant to the incidence of momentary loss of connectivity associated with failover response of the network.
- **Response mode**: displays raw (ping) response times of network devices under test.



**Figure 2.2. Main Window (Incident Mode)**

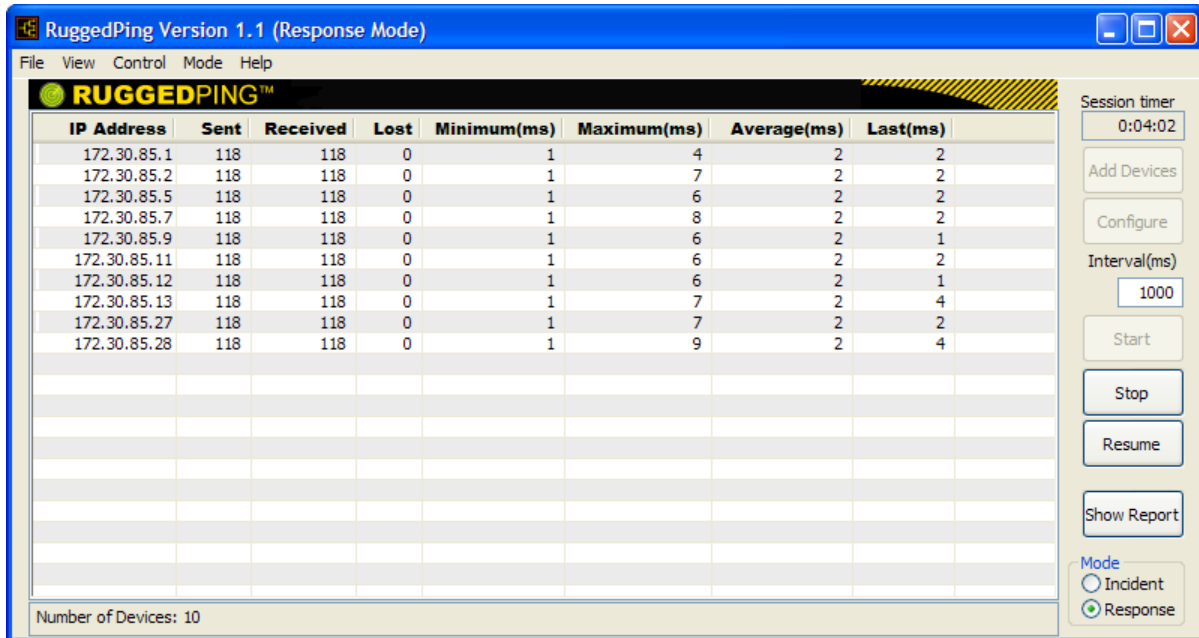


Figure 2.3. Main Window (Response Mode)

It is possible to switch between incident and response modes from the main window using the [Mode Control](#) radio buttons.

### 2.2.1. Main Window Buttons and Indicators

Several buttons and indicators are located in a column on the right hand side of the main dialog window. These allow access to most of the functionality of RuggedPing, so that the menus along the top should rarely need to be accessed.

Note that the **Start**, **Stop**, **Pause**, and **Show Report** buttons are selectively enabled or disabled depending on the current state of RuggedPing, as described below.

- Session timer**      The session timer displays the cumulative test duration in minutes and seconds, from the point at which the **Start** button is clicked. The timer is paused along with the test when **Pause** is clicked, and resumed when **Resume** is clicked. **Stop** stops the timer along with the test in progress.
- Add Devices**      Open the [Add Devices](#) dialog to add network devices to the test. Once devices have been added, the **Start** button is enabled.
- Configure**          Open the [Configuration](#) dialog to edit IP address ranges, timers, network usage, and logging parameters.
- Interval(ms)**      The Interval indicator displays the currently configured [Ping Interval](#). The field may be edited, and the specified interval time will be used for the current test only. Changes to this field will not be saved to the RuggedPing configuration file.
- Start**                Start the test. Once the test is running, the **Start** button is disabled and the **Stop** and **Pause** buttons are enabled. The **Session timer** begins counting minutes and seconds elapsed since the start of the test.

<b>Stop</b>	Stop a currently running test. Once a test is stopped, the <b>Start</b> button is enabled and the <b>Stop</b> and <b>Pause</b> buttons are disabled. The <b>Session timer</b> stops running. Each column of the test results table can be sorted after the test is stopped.
<b>Pause / Resume</b>	Pause a currently running test. All test data will be retained, the session timer will stop running, and the <b>Pause</b> button will change to <b>Resume</b> . When <b>Resume</b> is clicked, the test will resume and the session timer will continue.
<b>Show Report</b>	Once a test session has run and data has been collected, RuggedPing will be able to generate a report. The <b>Show Report</b> button will then be displayed. When clicked, it will display a window prompting for a title and a user name to include in the report. These fields can be left blank if desired. RuggedPing will generate the report in HTML format and display it in a web browser.
<b>Mode</b>	The two mode control radio buttons select RuggedPing's mode:  <b>Incident</b> is the default mode, used to characterize network self-healing mechanisms such as RSTP.  <b>Response</b> mode displays real-time ping statistics for all network devices under test.
<b>Status line</b>	The bottom of the main window shows the <b>Number of Devices</b> configured for testing, and the <b>Number of Events</b> recorded so far for the current test.

### 2.2.2. Main Window Menu Bar

#### File Menu

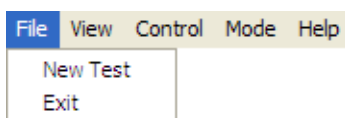


Figure 2.4. File Menu

<b>New test</b>	Clear the list of test devices along with all test result data collected for them. RuggedPing thus reverts to its initial state.
<b>Exit</b>	Exit RuggedPing. If a test is in progress, a message will pop up for user confirmation.

#### View Menu

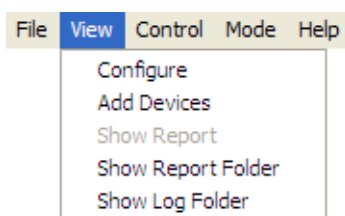
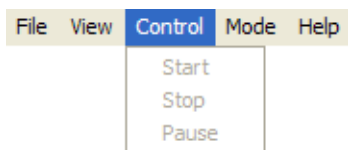


Figure 2.5. View Menu

<b>Configure</b>	Open the <a href="#">Configuration</a> dialog to edit IP address ranges, timers, network usage, and logging parameters.
<b>Add Devices</b>	Open the <a href="#">Add Devices</a> dialog to add network devices to the test. Once devices have been added, the <b>Start</b> button is enabled.
<b>Show Report</b>	Display an HTML-format summary report of the test session. Refer to <a href="#">Show Report</a> for details.
<b>Show Report Folder</b>	If reports have been generated previously, this opens the folder containing any existing HTML reports generated by RuggedPing.
<b>Show Log Folder</b>	Open the folder containing log files generated by RuggedPing.

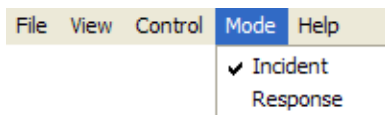
### Control Menu



**Figure 2.6. Control Menu**

- Start** Start the test. Refer to [Start](#) for details.
- Stop** Stop a currently running test. Refer to [Stop](#) for details.
- Pause** Pause a currently running test. Refer to [Pause](#) for details.

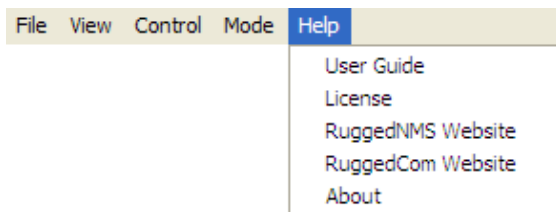
### Mode Menu



**Figure 2.7. Mode Menu**

- Incident** Select Incident mode display. Refer to [Mode Control](#) for more detail.
- Response** Select Response mode display. Refer to [Mode Control](#) for more detail.

### Help Menu



**Figure 2.8. Help Menu**

<b>User Guide</b>	Display the HTML format of this User Guide.
<b>License</b>	Display License for RuggedPing.
<b>RuggedNMS Website</b>	Display the RuggedNMS web site, <a href="http://www.ruggednms.com">http://www.ruggednms.com</a> in a web browser.
<b>RuggedCom Website</b>	Display the RuggedCom web site, <a href="http://www.ruggedcom.com">http://www.ruggedcom.com</a> in a web browser.
<b>About</b>	Display brief information about RuggedPing.

### 2.2.3. Main Window Columns

The central portion of the main RuggedPing window consists of a table of data that is updated in real time while a test is in progress. In **Incident Mode**, each row in the table displays statistics related to the loss and recovery of a device under test in the face of network interruption incidents. In **Response Mode**, the table displays ping response time statistics for devices under test.

While a test is in progress, RuggedPing updates the table at a configurable rate (see [GUI Update Rate](#)). During a **Pause** or after a test **Stop**, the values in the table will reflect the state of the test at the time it was stopped. On a **Resume** command, RuggedPing continues to add to the displayed statistics. On a **Start** command, RuggedPing clears the table and restarts accumulating statistics.

---

#### Note

*In order to save the statistics accumulated during a RuggedPing test, generate a test report using [Show Report](#). Reports are not otherwise generated and saved.*

---

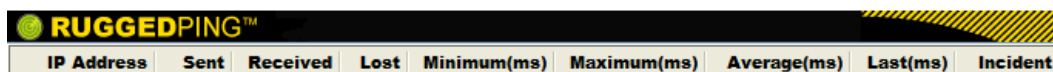


Figure 2.9. Main Window Columns

### Column Definitions

The following columns are defined identically in both **Incident** and **Response** modes:

<b>IP Address</b>	the IP address of a particular device under test.
<b>Sent</b>	the total number of ping request messages sent to the device during the current test.
<b>Received</b>	the total number of ping reply messages received from the device during the current test.
<b>Lost</b>	the total number of ping requests sent to the device for which a corresponding reply was not received (Sent minus Received).

The following column definitions apply to **Incident** mode only:

<b>Minimum(ms)</b>	the shortest recovery time recorded for the device during the current test (across all events).
--------------------	---

<b>Maximum(ms)</b>	the longest recovery time recorded for the device during the current test (across all events).
<b>Average(ms)</b>	the average recovery time recorded for the device for all incidents during the current test (across all events).
<b>Last(ms)</b>	the most recent recovery time recorded for the device during the current test.
<b>Incident</b>	the total number of incidents recorded for the device during the current test.

For a detailed discussion of "recovery time", "incidents", and "events", please refer to [Section 3.4, "Theory Of Operation"](#).

The following column definitions apply to **Response** mode only:

<b>Minimum(ms)</b>	the shortest ping response time recorded for the device during the current test.
<b>Maximum(ms)</b>	the longest ping response time recorded for the device during the current test.
<b>Average(ms)</b>	the average ping response time recorded for the device during the current test.
<b>Last(ms)</b>	the most recent ping response time recorded for the device during the current test.

### **Helpful Hint**

*On completion of a test run ([Stop](#)), the label field for each column may be clicked on in order to sort the table based on the contents of the corresponding column. Clicking the field successive times toggles the sort order.*

*Pausing the mouse over any of these fields causes RuggedPing to pop up the expanded name of the corresponding column.*

## 2.3. Add Devices

The **Add Devices** dialog simplifies the task of adding network devices to RuggedPing for inclusion in the test. There are three ways to add devices to RuggedPing:

- manually adding individual devices
- loading a list of previously saved IP addresses
- using the [Autodiscovery](#) facility

For more detail regarding test devices to configure in RuggedPing, please refer to the paragraph on test devices in the section on [Setting up a Test Environment for RuggedPing](#).

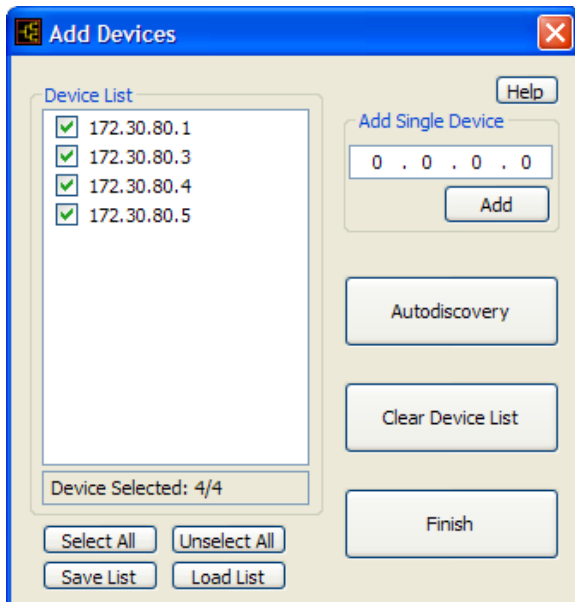


Figure 2.10. Add Devices dialog

<b>Device List</b>	The device list displays the IP addresses of devices added to RuggedPing, with a check box beside each one to allow selective removal of individual devices from the test.
<b>Select All</b>	Select all the entries in the <b>Device List</b> .
<b>Unselect All</b>	Unselect all the entries in the <b>Device List</b> .
<b>Save List</b>	Save all the entries in the <b>Device List</b> to a text file.
<b>Load List</b>	Load device entries from a text file (i.e. one previously saved using <b>Save List</b> ) into the <b>Device List</b> .
<b>Add Single Device</b>	An IP address entry field allows the specification of a numerical IP address in dotted quad notation to add to the device list. Enter the IP address and click <b>Add</b> .
<b>Autodiscovery</b>	Open the <a href="#">Autodiscovery</a> dialog for a ping-based automatic search of IP devices.
<b>Clear Device List</b>	Remove all entries from the <b>Device List</b> .
<b>Finish</b>	Return to the main window in order to proceed with the RuggedPing test.

### 2.3.1. Autodiscovery / Ping Sweep

RuggedPing's autodiscovery facility performs a "sweep" of the configured IP address range, transmitting ping request messages to each address in the range, and adding the address of each responding device to the **Device List** in the [Add Devices](#) dialog, above.

The IP addresses configured in the **Ping Sweep** dialog are saved to the configuration file, and are retrieved the next time the dialog is accessed.

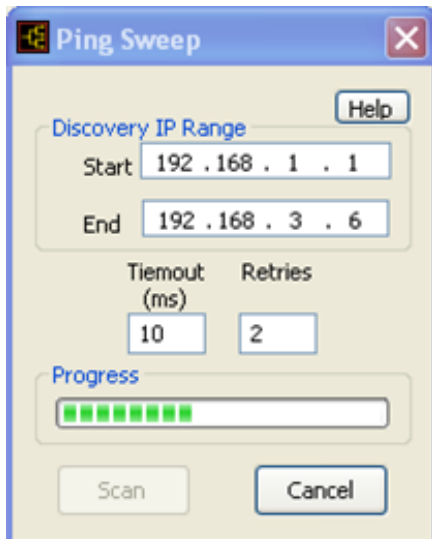


Figure 2.11. Ping Sweep (Autodiscovery) dialog

<b>Discovery IP Range</b>	The <b>Start</b> and <b>End</b> IP addresses denote the range of IP addresses to "sweep" for potential devices to include in the RuggedPing test. These addresses default to the values specified in the <a href="#">Configuration</a> menu.
<b>Timeout (ms)</b>	The time in milliseconds within which a prospective device must answer the ping request in order to be added to the <b>Device List</b> .
<b>Retries</b>	The number of times to ping an individual IP address with no response before deciding that there is no device at that address.
<b>Progress</b>	A graphical indication of the overall progress of the autodiscovery sequence.
<b>Scan</b>	Begin the configured Ping Sweep autodiscovery sequence.
<b>Cancel</b>	Abort an autodiscovery sequence, whether already in progress, or not yet initiated. Any discovered devices will be discarded from the list.

## 2.4. Configuration Window

The Configuration dialog allows control of all the parameters that control the operation of RuggedPing. Configurable parameters fall into four categories:

- Logging
- Test Reporting
- Autodiscovery
- Test Parameters

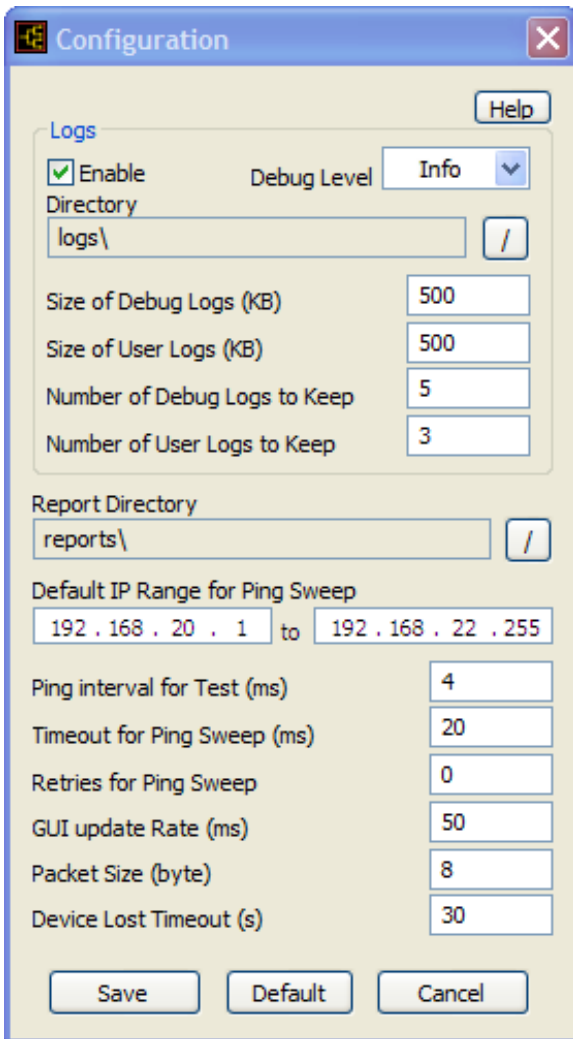


Figure 2.12. Configuration Dialog

## Logs, Report

**Enable**

Enable the logging facility.

**Debug Level**

Control the amount of logging performed by RuggedPing. In decreasing order of log activity: **Info**, **Warning**, **Error**.

**Directory**

The subdirectory of the RuggedPing directory in which to store log files. The / button presents a directory dialog with which to choose a logging directory.

**Size Of Debug Logs (KB)**

If, when RuggedPing starts up, the debug log file exceeds this size (in K bytes), it will create a new one.

**Size Of User Logs (KB)**

If, when RuggedPing starts up, the user log file exceeds this size (in K bytes), it will create a new one.

**Number of Debug Logs to Keep**

The maximum number of debug log files to keep. A new debug log file will replace the oldest one.

<b>Number of User Logs to Keep</b>	The maximum number of user log files to keep. A new user log file will replace the oldest one.
<b>Report Directory</b>	The subdirectory of the RuggedPing directory in which to store generated report files. The / button presents a directory dialog with which to choose a reporting directory.

When RuggedPing starts up with logging enabled, it first checks the sizes of the most recent debug and user log files. If the size of a given log file exceeds the maximum size configured for it, RuggedPing opens a new log file. If the number of saved log files already exceeds the configured number to keep, RuggedPing overwrites the oldest one.

### Network Parameters

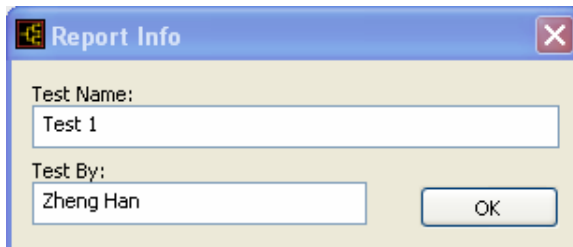
<b>Default IP Range for Ping Sweep</b>	The IP addresses that will be used by default in the <a href="#">Autodiscovery</a> process.
<b>Ping Interval for Test (ms)</b>	The interval, in milliseconds, between successive ping requests transmitted to each device in the list during the RuggedPing test. The minimum is 1ms.
<b>Timeout for Ping Sweep (ms)</b>	The time in milliseconds within which a prospective device must answer the ping request in order to be added to the <b>Device List</b> during the autodiscovery process.
<b>Retries for Ping Sweep</b>	The number of times to ping an individual IP address with no response before deciding there is no device at that address (autodiscovery).
<b>GUI Update Rate (ms)</b>	The interval in milliseconds between updates of the main window while a RuggedPing test is in progress.
<b>Packet Size (bytes)</b>	The size of the payload of each ping request transmitted by RuggedPing.
<b>Device Lost Timeout (s)</b>	The time in seconds that RuggedPing will wait for a device that becomes non-responsive during a test. If this timeout elapses for a particular device with no response, the incident will not be included in the logging of the event in which it began. Note that RuggedPing will continue probing the device throughout the test, so that, if it does resume responding, incidents involving it will be included in subsequent events.

### Other Controls

<b>Save</b>	Save parameters to configuration file.
<b>Default</b>	Revert all configuration parameters to their compiled-in default values.
<b>Cancel</b>	Abandon edits to configuration parameters and return to the main window.


## 2.5. Report Generation

Upon completion of a test, RuggedPing will enable the [Show Report](#) button and menu item. Clicking either one will first prompt for information to be associated with the test: name for the test and a string identifying the tester.



**Figure 2.13. Report Info prompt**

Clicking **OK** causes RuggedPing to generate a test report in HTML format. The first section of the report contains title and summary information, including summaries of the test environment, statistics on data transmitted and recovery timing; and a breakdown of statistics per device.

						
<h1>RuggedPing Test Report</h1>						
<h2><u>1.1</u></h2>						
<b>Tested By:</b>						
<b>Date:</b> 3/5/2010						
<b>Time:</b> 13:41:44						
<b>Test Summary:</b>						
Duration	Number of Devices			Number of Events		
0:00:57	1			10		
<b>Total Packets:</b>						
Sent	Received			Lost		
14350	14312			38		
<b>System Recovery time (ms):</b>						
Minimum	Maximum			Average		
7	12			10		
<b>Device Summary:</b>						
Response Summary:						
Device IP	Ping Packets			Response Time (ms)		
	Sent	Received	Lost	Minimum	Maximum	Average
172.30.85.201	14350	14312	38	<1	9	<1
<b>Incident Summary:</b>						
Device IP	Ping Packets			Recovery Time (ms)		
	Sent	Received	Lost	Minimum	Maximum	Average
172.30.85.201	14350	14312	38	7	12	10

**Figure 2.14. Example RuggedPing Report: Title and Summaries**

The following sections of the report provide a graphical illustration per event, detected by RuggedPing, of recovery times for each device from the longest to the shortest:

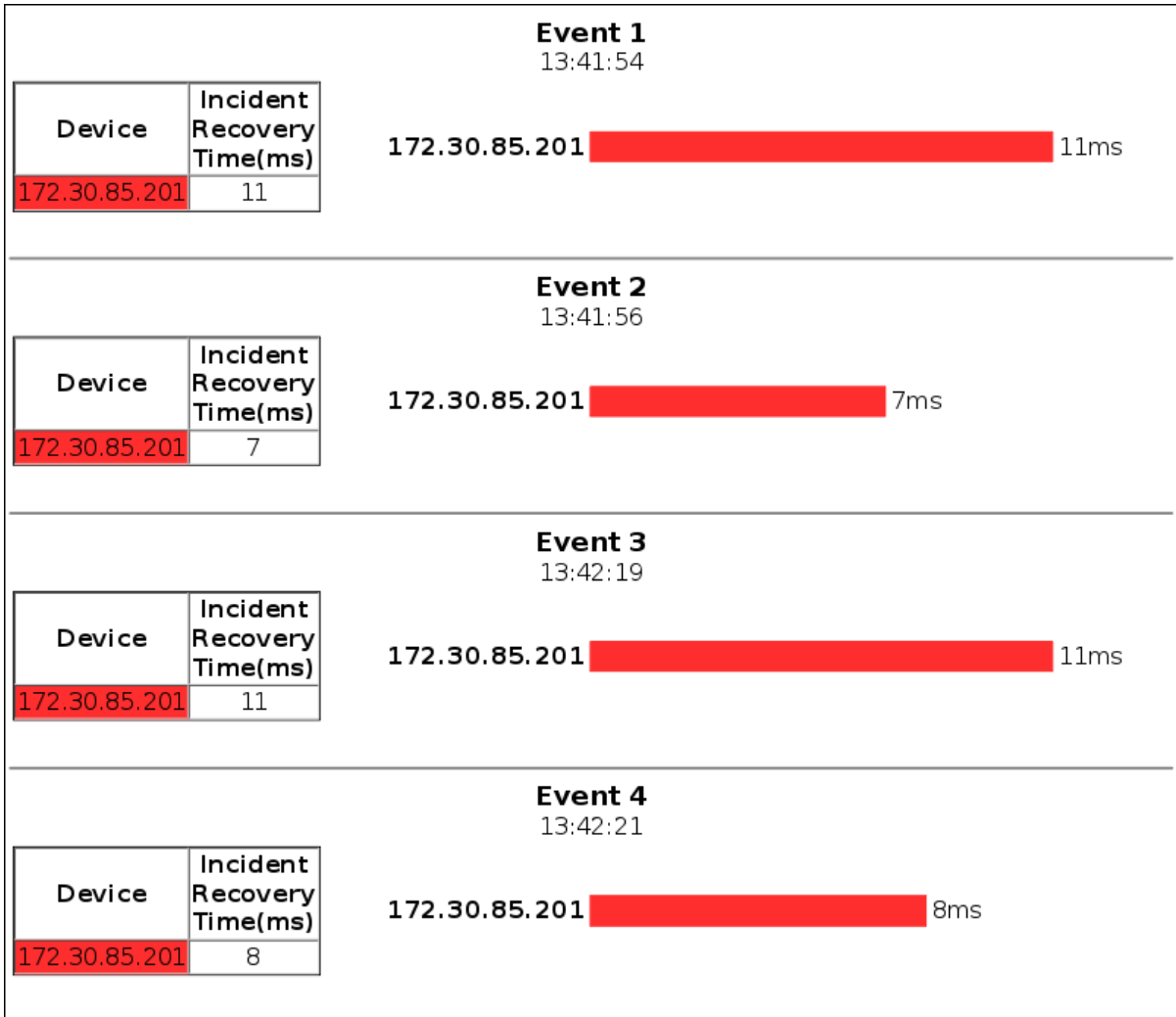


Figure 2.15. Example RuggedPing Report: Events

## 3. Using RuggedPing™

This chapter discusses the process of testing and characterizing the failure recovery behavior of a network using RuggedPing™. It also details the techniques used to gather, organize, and present its results.

### 3.1. Setting up a Test Environment for RuggedPing

Since RuggedPing uses ICMP (ping) for its probe and measurement data, it is capable of collecting and reporting meaningful information on any network's ability to recover from a fault, as long as that network is capable of transporting IP traffic. The typical use case, however, is built on a network of Ethernet bridges in an interconnected topology, whether ring or mesh, running RSTP (the Rapid Spanning Tree Protocol).

In the example below, [RuggedPing Test Setup](#), the PC running RuggedPing is shown connected to a layer 2 network constructed using Ethernet bridges all running RSTP. Active connections are shown as solid lines and inactive, redundant links are shown as dotted lines. Several IP devices are shown connected to the Ethernet bridges in the test network. These are IP hosts that should be capable of responding rapidly (within 1ms) to ping requests.

In order to test the ability of the network to heal around failures, RuggedPing must be configured to probe IP devices shown connected to the network. In the course of probing these test devices, RuggedPing collects statistics on the speed with which the network heals around any faults.

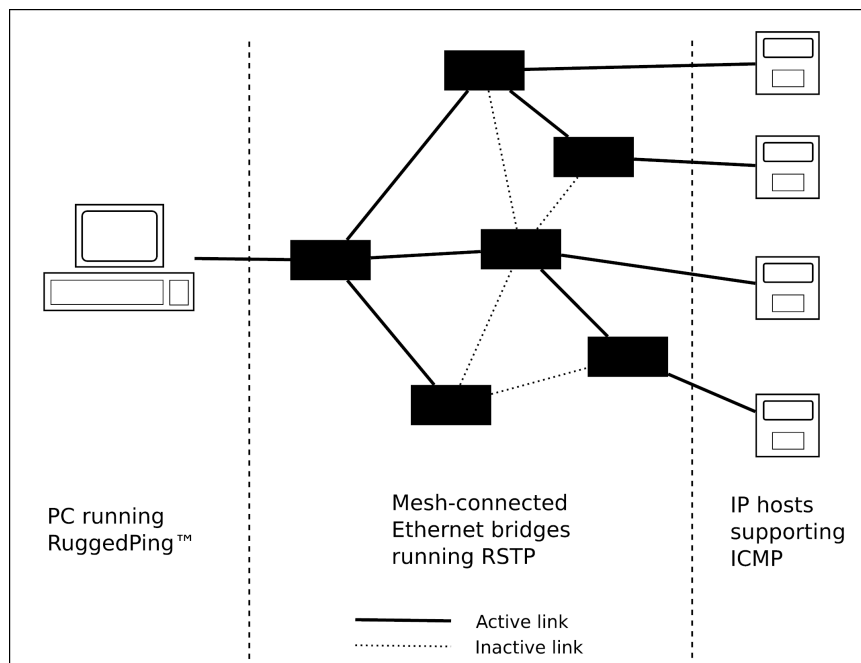


Figure 3.1. RuggedPing Test Setup

### 3.2. Autodiscovery / Ping Sweep

The autodiscovery process takes the form of a "ping sweep", whereby RuggedPing transmits a ping request to each IP address in the configured range in sequence. If a device at a given

IP address responds with a ping reply, RuggedPing adds its address to the **Device List** in the [Autodiscovery](#) dialog.

If RuggedPing receives no response from a given IP address within the configurable ping sweep timeout interval, (20ms by default) it will retry a configurable number of times (none by default).

In the worst case in which no devices in the configured range respond to ping requests, RuggedPing will spend  $T_{\text{discovery}}$ , defined as:

#### Equation 3.1. Total Autodiscovery Time

$$T_{\text{discovery}} = T_{\text{timeout}} \times R \times N$$

where:

$T_{\text{discovery}}$	is the worst-case total time taken to run the autodiscovery sequence
$T_{\text{timeout}}$	is the "ping sweep" timeout
$R$	is the number of retries
$N$	is the total number of IP addresses in the configured discovery range

As an illustration, consider an autodiscovery configuration in the IP range 10.0.0.1 to 10.0.255.255, with a timeout of 50ms and three retries. If no devices respond, this sequence will take roughly 2 hours and 45 minutes.

## 3.3. Test Operation

Once the RuggedPing test settings have been configured in the [Configuration](#) menu and a list of test devices has been populated using the [Add Devices](#) menu, RuggedPing is fully configured and ready to begin the test.

### 3.3.1. Scaling Considerations

When configuring either incident or response tests, it may be possible to overload the resources of the computer system running RuggedPing in such a way as to interfere with test results.

Consider, for example, a situation in which RuggedPing is configured to probe a relatively large number of devices at the minimum time interval and the maximum packet size, on a computer system with insufficient CPU resources (i.e. either a system that is too busy or that has a slow CPU). It is possible that under these circumstances, the computer system running RuggedPing will not be able to keep up with returning packets, and RuggedPing will erroneously report lost packets.

Since it is difficult to determine ahead of time whether a particular RuggedPing test configuration will run without error, it is recommended to perform preliminary testing as described in [Section 3.3.2, "Tuning RuggedPing"](#).

The following variables affect the load that RuggedPing places on a computer system, and should be considered when configuring a test:

- Number of devices in the test
- [Ping Interval](#) setting
- CPU speed
- Network interface speed and performance

#### **Note**

*Network Interface Cards are not all created equal. Differences in implementation of the interface hardware and driver software may translate to large differences in performance, irrespective of the line speed.*

---

The following parameters also affect the load of the RuggedPing test, but to a lesser extent:

- [GUI Update Rate](#)
- [Packet Size](#)

### 3.3.2. Tuning RuggedPing

The first step in running a RuggedPing network test consists of tuning the [Ping Interval](#) by making one or more preliminary test runs. A shorter interval between successive ping requests to each device under test will result in finer resolution test result data. The default is 4 milliseconds, a conservative value for a modern switched Ethernet network consisting of 100Mbps links. The purpose of this tuning process is to configure the shortest ping interval that does not result in any lost packets when the network under test is in steady state (i.e. no disruptive stimulus has been applied to the network).

It is recommended to first run the test (press [Start](#)) with the default ping interval in order to verify that the network is operating correctly and that all configured test devices are reachable and responsive. The running statistics display in the main window should show packets **Sent** and **Received** increasing steadily and no **Lost** packets.

If any packets are lost during this preliminary test, repeat the test using progressively longer ping interval settings. If no packets are lost during the preliminary test, repeat the test using progressively shorter ping interval settings. The optimum ping interval setting is the shortest interval at which no packets are lost during the course of test runs. The minimum allowable interval is 1 millisecond.

It is not necessary to perform temporary changes to the ping interval via the **Configuration** menu. The **Interval** field on the main menu window may be used to set the ping interval temporarily. When a final setting has been decided on, however, it should be saved via the **Configuration** menu.

Note that it is common to see no ping losses in the network even at a ping interval of 1ms. This provides the maximum timing resolution for all RuggedPing measurements and reported data.

### 3.3.3. Introducing Network Disruptions

In order to test the ability of the network to heal itself, planned failures must be introduced into the network under test. RuggedPing is designed with the assumption that the test network can make use of redundant connections by selectively making them active when active links become unavailable. The network in the [RuggedPing Test Setup](#) diagram illustrates such a network.

The simplest way to introduce a failure that will force the network to heal itself is to disconnect one of the active links. While the network is in the process of reconfiguring itself to restore full connectivity, some of the RuggedPing probes to test devices will go unanswered. RuggedPing records these interruptions in network connectivity caused by the artificial introduction of failures and organizes them into [Incidents](#) and [Events](#).

#### **Note**

*Take care not to disconnect any of the links that connect the test devices themselves to the network (the rightmost links in the [RuggedPing Test Setup](#) diagram).*

---

### 3.3.4. Running a Test

Once the tuning step has been performed and the network has been verified to operate correctly in steady state, it is time to perform a test run.

- Press **Start** and verify that the system reaches steady state with no ping losses.
- Disconnect an active link and monitor ping losses via the main window. Once the network has healed around the fault, the ping losses will cease. RuggedPing considers this interval of detected ping losses an Event (see [Events](#), below).
- Reconnect the link that was disconnected in the step above and wait once more for the network to stabilize. Note that the switches in an RSTP network also block briefly when a new link is added to the network, in order to ensure that no loops exist. This process will also be logged as an Event.
- Repeat the process of disconnecting and reconnecting links, as described above, in order to obtain data for several Events.
- To terminate the test, click [Stop](#) and be sure to click [Show Report](#) in order to capture and summarize the data that RuggedPing has collected in the course of the test.

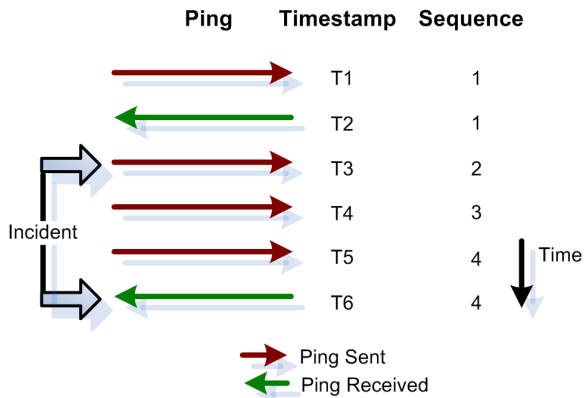
## 3.4. Theory Of Operation

RuggedPing's analysis techniques provide a better characterization of the test data than a straightforward presentation of the statistics could offer. Since the purpose of the test is to characterize and measure the ability of a network to heal around failures, RuggedPing organizes the data into network failure [Events](#), which it compiles from a group of individual [Incidents](#), each involving a particular device under test.

### 3.4.1. Incidents

RuggedPing records an **incident** for a device when the device fails to respond to one or more pings. Ping replies are accounted for by sequence number - the loss of one or more ping replies is detected by a break in the sequence numbers of the replies received from the device under test. An incident is logged beginning with the transmission of the first ping that does not receive a reply, and ends with the reception of the first subsequent correct ping reply.

The [Incident Graph](#) below provides an illustration of an incident as detected by RuggedPing, seen as a sequence of pings transmitted by RuggedPing and responded to by a single device under test.



**Figure 3.2. Incident Graph**

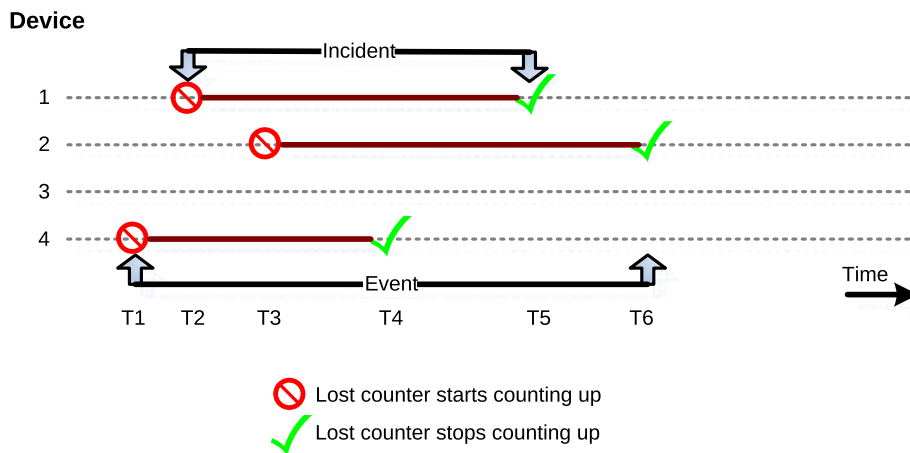
In the illustration, RuggedPing transmits Ping 1 (sequence number 1) to the device, and receives a response from it. It transmits three more pings in sequence but the next response it receives is to Ping 4. Since this reply is out of sequence (the next expected reply was 2), RuggedPing logs incident as having occurred. The duration of the incident is from time T3, the time at which the first unanswered ping (2) is transmitted, until T6, the time at which the sequence of replies from the device resumes.

The duration of an incident is referred to as the **Recovery Time**. It represents the time that an individual device is out of contact with the RuggedPing server due to a network fault. Otherwise stated, the recovery time is the time it takes for the network to recover from a fault, from the point of view of a single device.

### 3.4.2. Events

Whereas an **incident** applies to one device, an **event** applies to the whole set of devices under test. RuggedPing logs an event beginning at the start of the first incident in a group of overlapping incidents, and ending at the close of the last incident in the group.

The [Event Graph](#) below provides an illustration of an event as detected by RuggedPing, seen as a set of individually tracked, overlapping incidents occurring for several devices under test.



**Figure 3.3. Event Graph**

### 3. Using RuggedPing™

---

In the illustration, RuggedPing detects an incident involving Device 4 beginning at T1. Incidents involving Device 1 and Device 2, beginning at T2 and T3 respectively, begin while the incident for Device 4 is still in progress. The last incident to clear is the one for Device 2, at T6. RuggedPing logs an event involving devices 1, 2, and 4, spanning T1 to T6, or from the beginning of the incident involving Device 4, to the end of the incident involving Device 2.

Note that, in this example, there is no incident involving Device 3.

In the unexpected case in which RuggedPing sees that a given device never recovers, an upper limit is set by the [Device Lost Timeout](#). If this timer expires for a given device, RuggedPing will pause, present a pop-up dialog recommending to check the network for unexpected faults and then offer the option to manually resume the test. In the report of the event, it will be noted that during the test, communications were lost with the device.

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