

SDN Adaptive Load Balancing

Feature Description

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1 Introduction

The Kemp LoadMaster contains adaptive load balancing technology which can be used with a Software Defined Networking (SDN) Controller. In traditional networks, there is no end-to-end visibility of network paths and applications are not always routed optimally. The LoadMaster, integrated with an SDN Controller solution, solves this problem by making the critical flow pattern data available.

The LoadMaster pulls the Layer 2/Layer 3 information from the switches in the network via the SDN Controller. The LoadMaster combines the Layer 2/3 information with the Layer 4/7 information to make more optimized traffic distribution decisions. The LoadMaster can be used to provide end-to-end visibility of network paths for optimal routing of applications across the server and switching infrastructure.

The Kemp SDN solution provides greater efficiency by enabling:

- Application visibility to the network
- Network data to be pulled by the Application Delivery Controller (ADC)
- Adaptive load balancing

A Virtual Service which is using an adaptive scheduling method can be viewed as a control system. The intent is to dynamically distribute load over the Real Servers.

1.1 Document Purpose

The purpose of this document is to describe how to connect the LoadMaster to an SDN Controller and how to configure the Virtual Services to use SDN adaptive load balancing.

1.2 Intended Audience

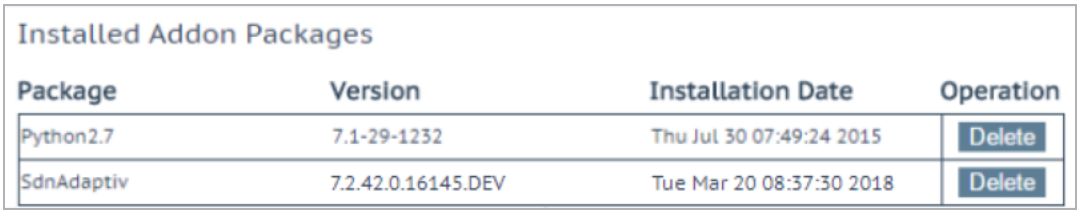
This document is intended to be read by anyone who is interested in finding out how to configure the SDN adaptive settings in the Kemp LoadMaster.

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2 SDN Adaptive Load Balancing

2.1 Prerequisites

Before using the SDN adaptive feature in the LoadMaster, the SDNAdaptiv and Python add-ons must be installed. To check if these add-ons are already installed, in the main menu of the LoadMaster Web User Interface (WUI) - go to **System Configuration > System Administration > Update Software**.



Any installed add-ons will be listed in the **Installed Addon Packages** section.

> If an installed add-on package cannot be started, the text will display in red and the hover text says the package could not be started. If this is the case, try rebooting the LoadMaster (**System Configuration > System Administration > System Reboot > Reboot**).

The latest versions of these add-ons are available on the Kemp website: http://kemptechnologies.com. To install the add-ons - download them from the website, go to the **Update Software** screen in the LoadMaster WUI, then upload and install the packages. Then, reboot the LoadMaster to activate the add-ons (**System Configuration > System Administration > System Reboot > Reboot**).

2.2 Configure the LoadMaster

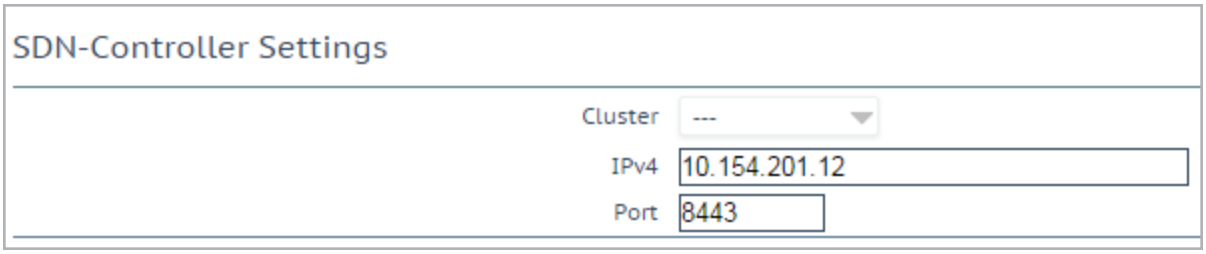
First, connect the LoadMaster to the SDN Controller. Then, configure the Virtual Service(s) to use resource-based (SDN adaptive) scheduling. Refer to the sections below for step-by-step instructions on how to do this.

2.2.1 Connect the LoadMaster to the SDN Controller

To configure the SDN settings in the LoadMaster, follow the steps below:

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1. In the main menu of the WUI, go to **System Configuration > Miscellaneous Options > SDN Configuration**.
2. Click **Add New**.



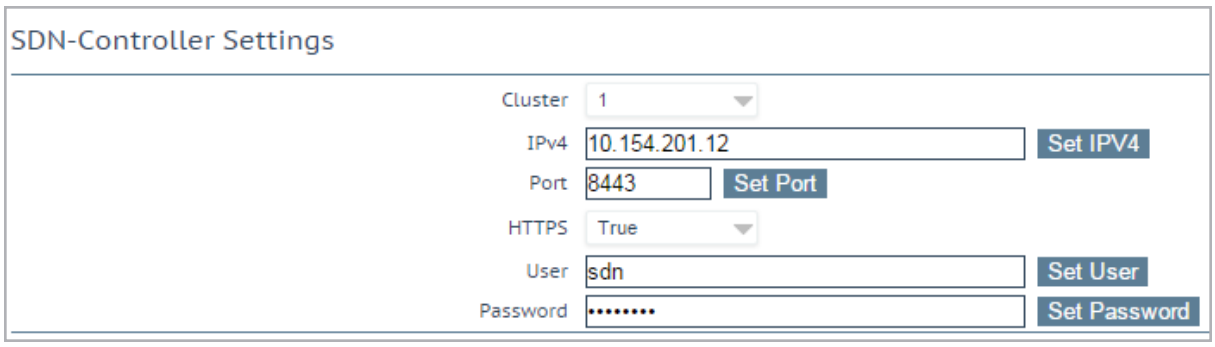
> Keep the **Cluster** field set to the default value.

3. Enter the IPv4 address of the SDN Controller in the **IPv4** text box.
4. Enter the **Port** of the SDN Controller Web Interface in the **Port** text box and click **Add.**

> The default **Port** for the HP VAN Controller is **8443**.

> The default **Port** for the OpenDaylight SDN Controller is either **8181** or **8080**.

5. Click **Mod**.



6. Select the relevant value in the **HTTPS** drop-down list.

> This should be set to **True** for the HP VAN Controller.

> This should be set to **False** for the OpenDaylight SDN Controller.

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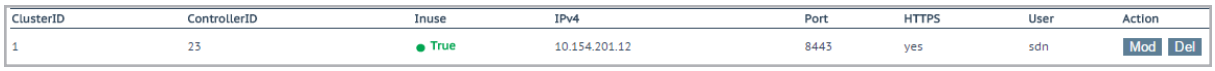
7. Enter the username to be used to access the SDN Controller in the **User** text box.

8. Click **Set User.**

9. Enter the password of the user to be used to access the SDN Controller in the **Password** text box.

10. Click **Password**.

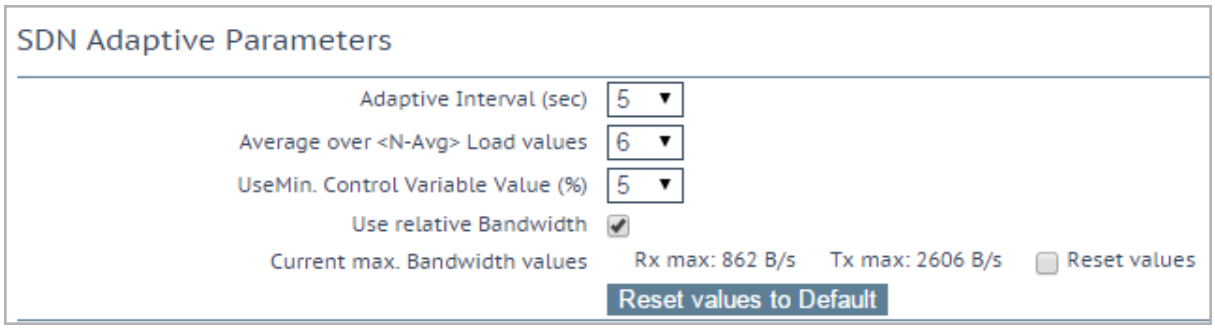
11. Click **Back**.



The **Name**, **Version** and **Credentials** will be displayed if the LoadMaster has successfully connected to the SDN Controller. If the connection is not working, refer to the **Debug Options** section to find out about debug options that can be used to help troubleshoot the problem.

2.2.2 Configure the SDN Adaptive Parameters

The SDN adaptive parameters can be configured by going to **Rules & Checking > Check Parameters** in the LoadMaster WUI.



The **SDN Adaptive Parameters** section contains the following fields:

- Adaptive Interval (sec): When using SDN-adaptive scheduling, the SDN Controller is polled to retrieve the port statistics values for each Real Server. This field value specifies how often this occurs.
- Average over <N-Avg> Load values: Use this value to dampen fluctuations in the system. This ensures that the adaptive value and weight of the Real Servers do not change too frequently which provides a more stable and consistent traffic flow. The default and recommended value for this field is 6.

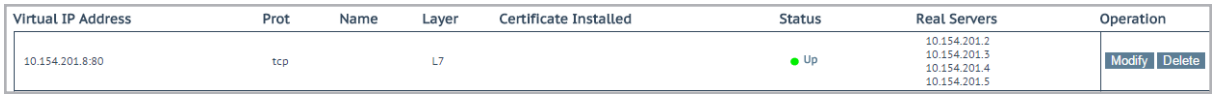
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- UseMin. Control Variable Value (%): Anything below the value set here is considered idle traffic and it does not affect the adaptive value (which is displayed on the Real Servers Statistics screen), for example - in the screenshot above anything below 5% is considered idle.
- Use relative Bandwidth: Use the maximum load observed on the link as the link bandwidth. Kemp recommends enabling this option. If this option is not selected then we use the real bandwidth.
- Reset values: The Reset values check box will appear if the Use relative Bandwidth check box is enabled. Ticking Reset values will reset the maximum load values which have been observed.
- Reset values to Default: Clicking this button will reset the SDN adaptive parameters to their default values.

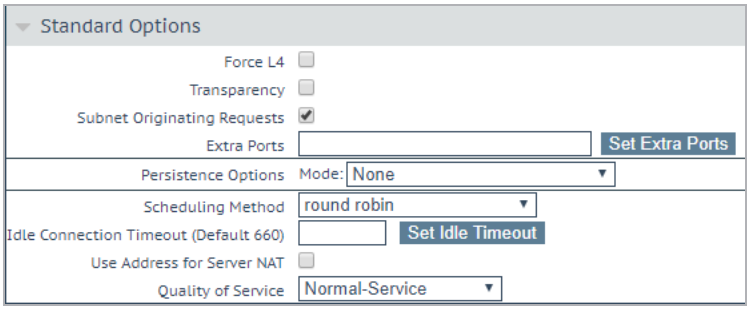
2.2.3 Configure the Virtual Service(s)

To configure the Virtual Service(s) to use resource-based (SDN adaptive) scheduling, follow the steps below:

1. In the main menu of the LoadMaster WUI, select **Virtual Services > View/Modify Services**.



2. Click **Modify** on the relevant Virtual Service.
3. Expand the **Standard Options** section.



4. Select resource based (SDN adaptive) as the Scheduling Method.

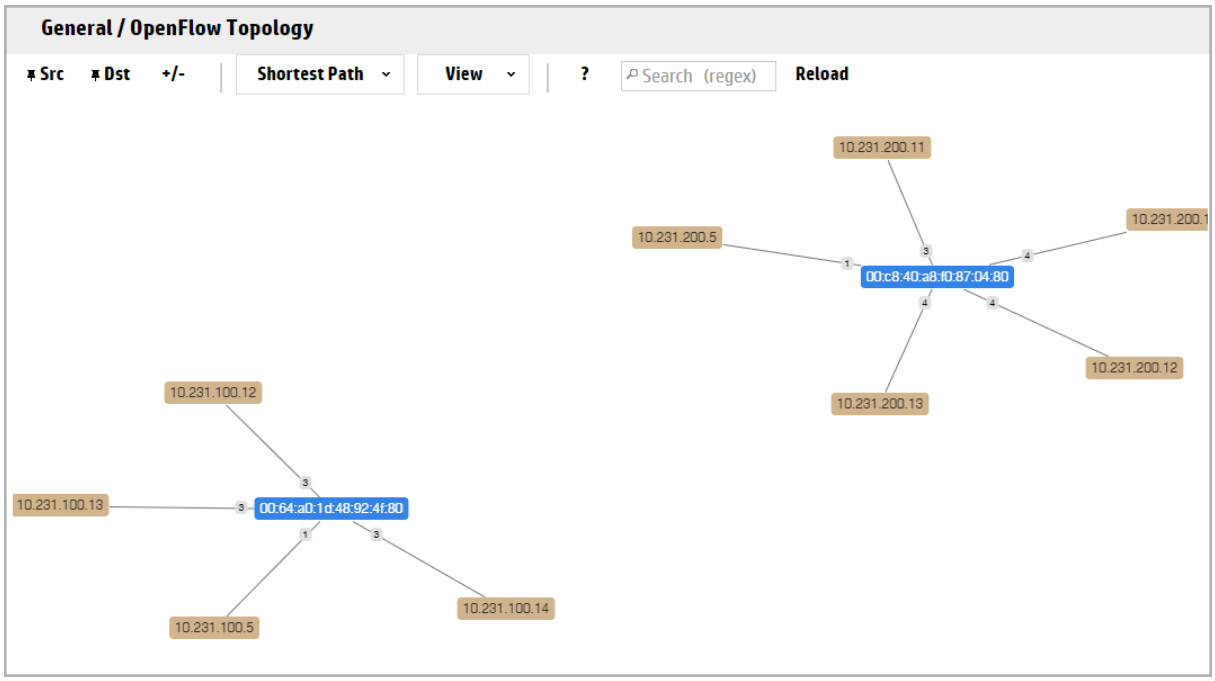
The Virtual Service is now configured to use SDN adaptive scheduling.

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2.2.4 View the OpenFlow Topology

The figure below illustrates a typical HP Van screen. This shows which switches are OpenFlow enabled and what Real Servers are connected to these switches.

This is important as it shows if the Real Servers on the LoadMaster are connected to OpenFlow switches.

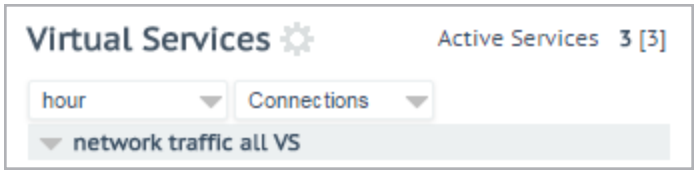


To view the OpenFlow Topology, in the HP VAN SDN Controller WUI, go to **General > OpenFlow Topology**. The switch and Real Server details will be displayed there.

2.3 SDN Statistics

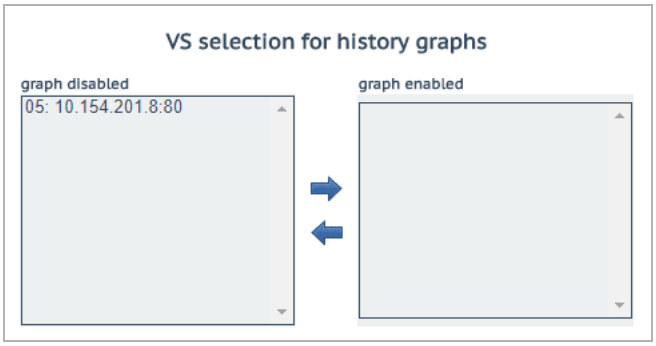
In order for all SDN statistics graphs to be displayed, the relevant Virtual Service(s) and Real Server (s) need to be added to the **Historical Graphs** view. To do this, follow the steps below in the LoadMaster WUI:

1. Go to **Statistics > Historical Graphs**.



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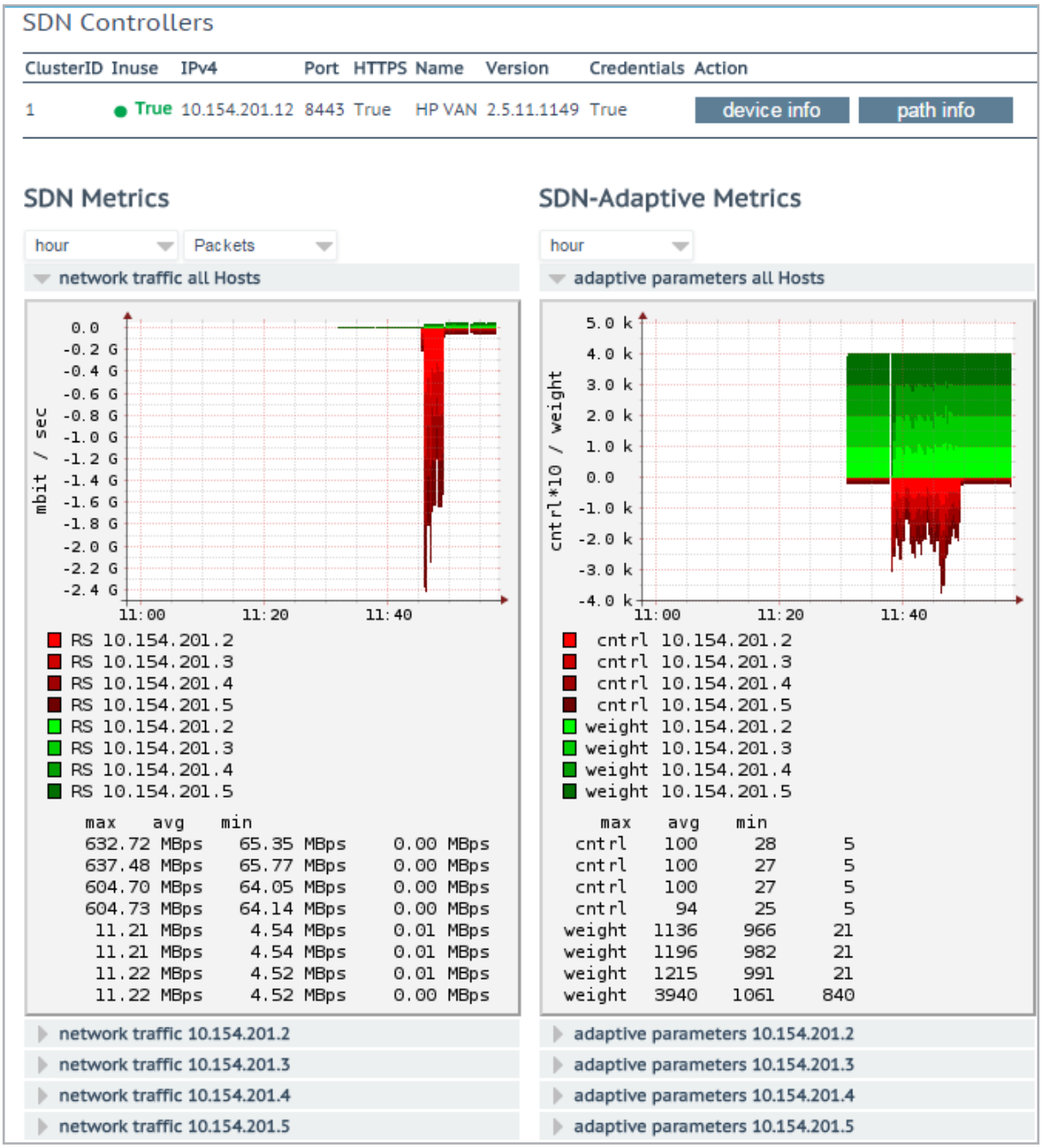
2. Click the cog icon next to Virtual Services.



3. Select the relevant Virtual Services to enable the statistics graphs for.
4. Click the right arrow to enable them.
5. Click the close button.
6. Repeat the steps in the **Real Servers** section to add Real Servers, as needed.

After the Virtual Services and Real Servers have been added, go to **SDN Statistics** in the main menu of the LoadMaster WUI to view the SDN statistics.

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Statistics will not be displayed unless the SDN Controller has been added and is communicating with the LoadMaster. If the **Name**, **Version** and **Credentials** are not displaying it means that the LoadMaster is not connected to the SDN Controller. This

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could mean that the configuration is not correct, or the SDN Controller is down.

Two types of statistics are displayed on this screen - network traffic and adaptive parameters:

- Network traffic - this displays the number of bits and bytes transferred per second for each of the Real Servers. The maximum, average and minimum number of bits/bytes per second are shown.
- Adaptive parameters - this displays details about the adaptive value (cntrl) and the weight.

2.3.1 Device Information

UID	Name	Type	Vendor	Product	Firmware	Serial	IP	IF count	Status
00:00:54:9f:35:1c:c5:30	ovsbr0	Default OpenFlow Switch	Nicira, Inc.	Open vSwitch	2.3.1-git4750c96	None	10.154.201.10	7	Online
00:00:66:52:10:5f:fb:45	ovsbr1	Default OpenFlow Switch	Nicira, Inc.	Open vSwitch	2.3.1-git4750c96	None	10.154.201.10	4	Online

Information about OpenFlow enabled switches on an SDN Controller can be viewed by clicking the **device info** button.

Further information can be seen by clicking the plus (**+**) button to expand each of the devices.

UID	Name	Type	Vendor	Product	Firmware	Serial	IP	IF count	Status
00:00:54:9f:35:1c:c5:30	ovsbr0	Default OpenFlow Switch	Nicira, Inc.	Open vSwitch	2.3.1-git4750c96	None	10.154.201.10	7	Online

Interface Info

ID	Name	State	Mac	Cur.Speed	Max.Speed
id=0x1	Name:eno1	State:[UP]	Mac:54:9f:35:1c:c5:30	1000000	
id=0x4	Name:vnet2	State:[UP]	Mac:fe:54:00:bc:1b:c3	10000	
id=0x7	Name:vnet1	State:[UP]	Mac:fe:54:00:8d:73:9b	10000	
id=0x8	Name:vnet7	State:[UP]	Mac:fe:54:00:b1:4b:3b	10000	
id=0xa	Name:patch-ovsbr0	State:[UP]	Mac:7e:6d:ac:6b:9f:11		
id=0xb	Name:patch-ovsbr3	State:[UP]	Mac:2a:32:8c:e7:4c:5b		
id=0xfffffffe	Name:ovsbr0	State:[UP]	Mac:54:9f:35:1c:c5:30		

Node Info

ID	VID	Port	Mac
10.154.120.62	0	1	00:50:56:b8:13:45
10.154.190.197	0	1	00:50:56:b8:4d:7d
10.154.30.80	0	1	00:0c:29:64:83:1b
10.154.190.104	0	1	00:50:56:b8:e7:31
10.154.190.172	0	1	00:0c:29:91:e6:9d
10.154.190.137	0	1	00:0c:29:d7:aa:5e
10.154.25.30	0	1	00:50:56:b8:b4:5d
10.154.11.40	0	1	00:50:56:b8:1d:fc
10.154.190.145	0	1	00:50:56:b8:54:d5
10.154.120.115	0	1	00:50:56:b8:19:67
10.154.190.111	0	1	00:50:56:b8:e8:08
10.154.190.120	0	1	00:50:56:b8:ee:39
10.154.190.157	0	1	00:50:56:b8:97:f6
10.154.190.126	0	1	80:3f:5d:08:92:d6
10.154.190.122	0	1	00:50:56:b8:e1:0e
10.154.0.3	0	1	20:0c:c8:49:f6:4c
10.154.190.152	0	1	00:0c:29:54:e8:2b
10.154.190.174	0	1	00:50:56:b8:b7:2e
10.154.190.115	0	1	00:50:56:b8:7e:6b
10.154.50.61	0	1	00:50:56:b8:a5:00
10.154.190.151	0	1	00:50:56:b8:1b:67
10.154.190.118	0	1	00:50:56:b8:b7:5c
10.154.190.128	0	1	00:50:56:b8:d4:84
10.154.25.102	0	1	00:50:56:b8:70:8c
10.154.190.190	0	1	00:10:f3:38:4a:e4
10.89.0.44	0	1	00:0c:29:56:ad:2f

The details provided on this screen are described in the table below.

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Section	Name	Additional Information
Device Information	uid	The Unique Identifier (UID) for the device.
	name	The name of the device.
	type	The type of device.
	vendor	The device vendor.
	product	The type of product.
	firmware	The firmware version of the device.
	serial	The serial number of the device.
	ip	The IP address of the device.
	ifcount	The number of interfaces on the device.
	status	The status of the device.
Port Information	id	The ID number of the port.
	mac	The MAC address of the port.

2.3.2 Path Information

Path information can be viewed by clicking the **path info** button.

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Path Info

Dir	Source	Dest	Switch		
			Idx	Name	Dpid
=>	10.231.100.5	10.231.100.12	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
			2	Switch1	00:64:a0:1d:48:92:4f:80
<=	10.231.100.12	10.231.100.5	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
			2	Switch1	00:64:a0:1d:48:92:4f:80
=>	10.231.100.5	10.231.100.13	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
			2	Switch1	00:64:a0:1d:48:92:4f:80
<=	10.231.100.13	10.231.100.5	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
			2	Switch1	00:64:a0:1d:48:92:4f:80
=>	10.231.100.5	10.231.100.14	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
			2	Switch1	00:64:a0:1d:48:92:4f:80
<=	10.231.100.14	10.231.100.5	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
			2	Switch1	00:64:a0:1d:48:92:4f:80
=>	10.231.100.5	10.231.100.15	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
<=	10.231.100.15	10.231.100.5	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
=>	10.231.100.5	10.231.100.16	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
<=	10.231.100.16	10.231.100.5	0	Path2	00:64:34:64:a9:b7:04:80
			1	Switch2	00:64:40:a8:f0:87:04:80
=>	10.231.100.5	10.231.100.17	0	Path2	00:64:34:64:a9:b7:04:80
<=	10.231.100.17	10.231.100.5	0	Path2	00:64:34:64:a9:b7:04:80

The output is described in the table below.

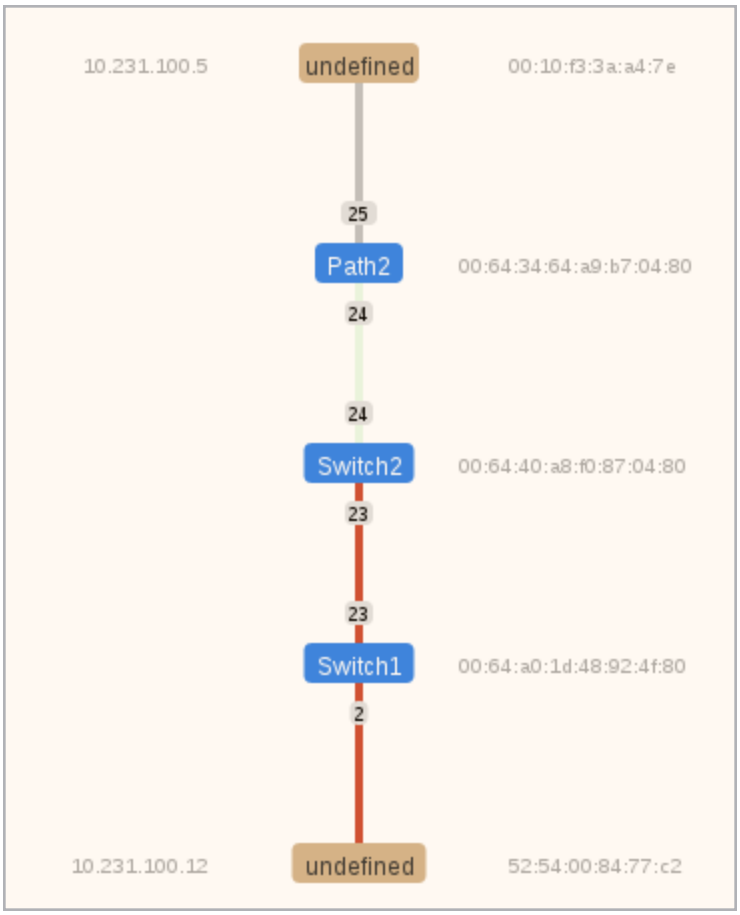
Section	Name	Additional Information
path	dir	The direction of the path.
	source	The source IP address.
	dest	The destination IP address.

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Section	Name	Additional Information
switch	idx	The index number of the switch along the path.
	name	The name of the switch.
	dpid	The Data Path ID (DPID) of the switch.
inport	idx	The switch port number of the inbound traffic.
	name	The name of the inbound port.
	byte	The number of bytes transferred on the port.
outport	idx	The switch port number of the outbound traffic.
	name	The name of the outbound port.
	byte	The number of bytes transferred on the port.

To view a graphical representation of the path, click the **=>** or **<=** icon in the **Dir** column for the relevant path.

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This screen will display the LoadMaster, Real Server and any switches in between. The LoadMaster and Real Server are represented in brown. The LoadMaster is at the top and the Real Server is at the bottom.

The switches are represented in blue. The switch name will appear in the blue boxes if the SDN Controller picks it up.

The Data Path Identifier (DPID) of each switch on the network will be displayed on the right of the switches. The DPID is how the controller identifies the different switches.

The Media Access Control (MAC) address of the LoadMaster and Real Server will be displayed to the right of those devices. The IP address of the LoadMaster and Real Server will also be displayed on the left.

The colour of the paths are explained below:

- Light green: Traffic is idle and the link is healthy.
- Red: The path is congested with traffic.

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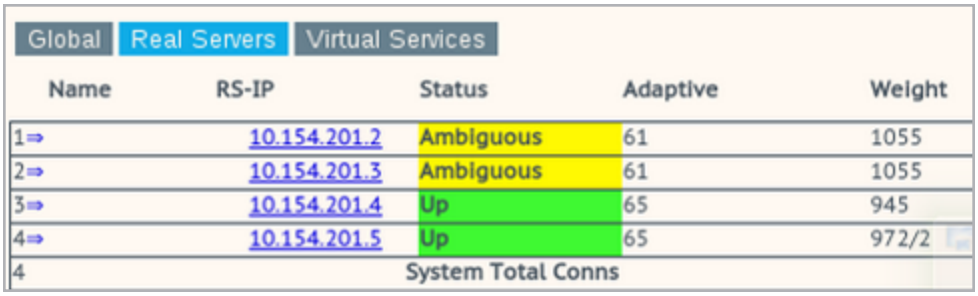
- Grey: The path between the LoadMaster and initial switch will always be shown as grey. All traffic leaves the LoadMaster so it will always be the most congested link.

So, in the example screenshot above - the path between the **Path2** and **Switch2** switches is healthy but the paths between **Switch2** and **Switch1** and the Real Server are congested.

The colour of the path may change as the path gets more or less congested. There is an array of red colours that can be displayed - the darker the red colour is, the more congestion is on the path.

2.3.3 Adaptive Values and Real Server Weights

To view the current adaptive values and Real Server weights, go to **Statistics > Real Time Statistics > Real Servers** in the main menu.



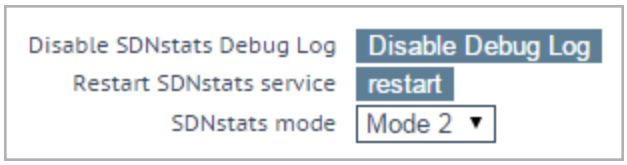
Name	RS-IP	Status	Adaptive	Weight
1⇒	10.154.201.2	Ambiguous	61	1055
2⇒	10.154.201.3	Ambiguous	61	1055
3⇒	10.154.201.4	Up	65	945
4⇒	10.154.201.5	Up	65	972/2
4		System Total Conns		

The information which is gathered from the controller determines what the adaptive value is set to. As the adaptive value goes up, the weight of the Real Server goes down. If all adaptive values are the same, all weights will be the same. When the adaptive values are different the weights will change. The weight of the Real Servers determines where traffic is sent. The adaptive value ranges from the value set in the **UseMin.Control Variable Value** up to 100.

If a Real Server is configured in multiple Virtual Services, two numbers will be displayed for the weight - the first shows the average of the current weights over all Virtual Services that the Real Server is configured in. The second shows the number of Virtual Services that the Real Server is configured in. For example, a **Weight** of **972/2** means that the average weight of a Real Server which is configured in two Virtual Services is 972.

2.3.4 SDN Statistics mode

There are two modes that can be used to gather the SDN statistics.



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The mode can be set by going to **System Configuration > Logging Options > SDN Log Files > Debug Options** and setting the **SDNstats mode**.

The modes are described below:

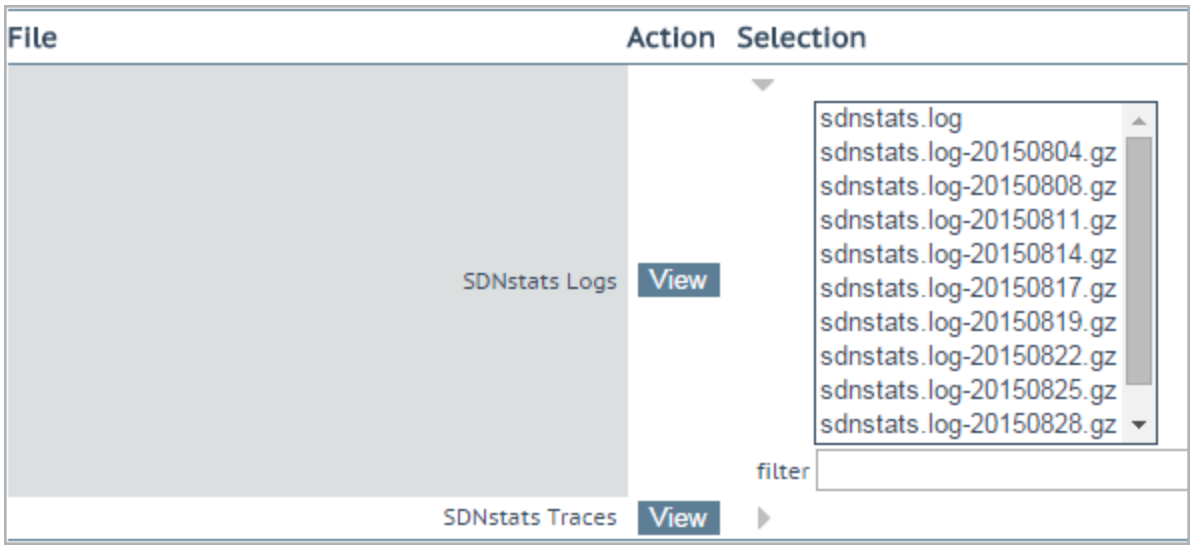
- Mode 1: When set to mode 1, the statistics are taken from the switch port that is connected to the server and the statistics are relayed back to the LoadMaster.
- Mode 2: When set to mode 2, the information is taken from all of the switch ports along the path.

2.4 SDN Log Files and Debug Options

2.4.1 View SDN Logs

To view the SDN logs, follow the steps below in the LoadMaster WUI:

1. In the main menu, go to **System Configuration > Logging Options > SDN Log Files**.



2. Click the **expand/collapse selection** (plus icon) button in the **SDNstats Logs** section.
3. Select the relevant log file to view.

   The **sdnstats.log** file is the main, rolling log file. The .gz files are backups of logs for a particular day.

4. Click **View**.

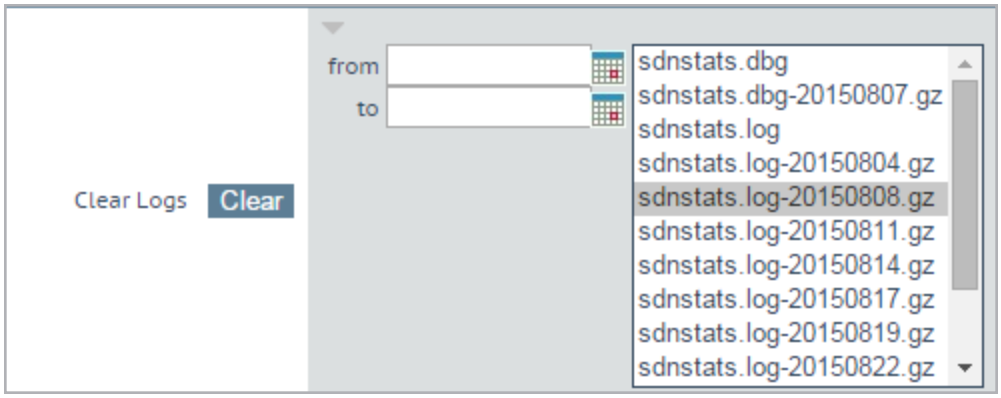
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> A filter can be run on the log files by entering a word(s) or regular expression in the **filter** field and clicking the **View** button.

2.4.2 Clear Logs

To clear the SDN logs, follow the steps below in the LoadMaster WUI:

1. In the main menu, go to **System Configuration > Logging Options > SDN Log Files**.



2. Click the **expand/collapse selection** (plus icon) button in the **Clear Logs** section.
3. Select the relevant log(s) to be cleared.
4. Click **Clear** to clear the logs.

A specific range of log files can be filtered by specifying a date range using the **from** and **to** fields. Specifying a date range will simply select the relevant log files that apply in the right-hand box. Individual log files can still be selected/deselected as needed on the right.

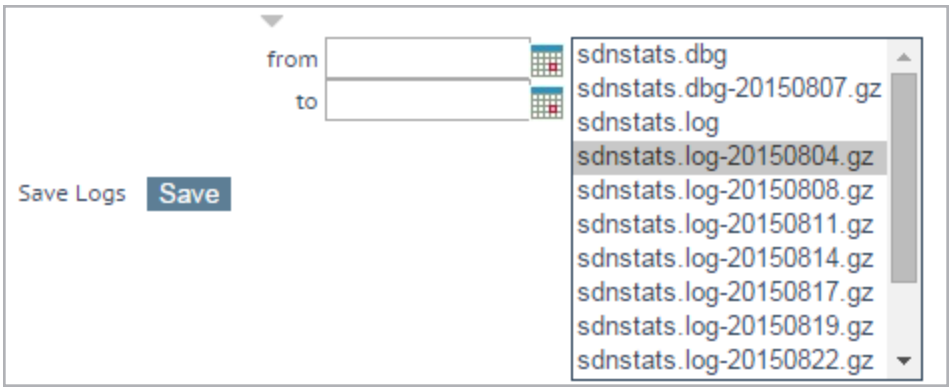
> **Important:** If the **sdnstats.log** file is selected, all logs in that file will be cleared, regardless of what dates are selected in the date range fields.

2.4.3 Save Logs

To save the SDN logs, follow the steps below in the LoadMaster WUI:

1. In the main menu, go to **System Configuration > Logging Options > SDN Log Files**.

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2. Click the **expand/collapse selection** (plus icon) button in the **Save Logs** section.
3. Select the relevant log(s) to be saved.
4. Click **Save** to save all logs.

> A specific range of log files can be saved by selecting a date range using the **from** and **to** fields.

2.4.4 Debug Options

There are a few SDN adaptive-related debug options that can help with troubleshooting SDN issues. Details of each option are provided in the sections below.

2.4.4.1 Enable Debug Logging

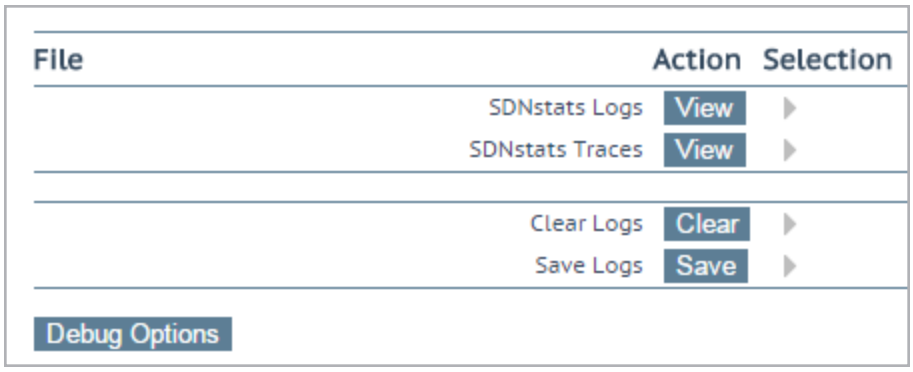
If SDN adaptive-related problems are experienced, SDN Controller debug logging can be enabled. This can help to troubleshoot problems because, in addition to other data, the debug logs show the communication between the SDN Controller and the LoadMaster and if it has been successful or not. For more information, refer to the sections below.

> Debug logging should only be enabled when troubleshooting because it will impact performance of the LoadMaster.

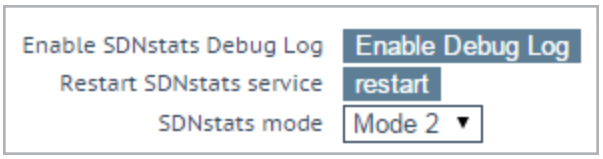
To enable debug logging, follow the steps below:

1. In the main menu, go to **System Configuration > Logging Options > SDN Log Files**.

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2. Click **Debug Options**.

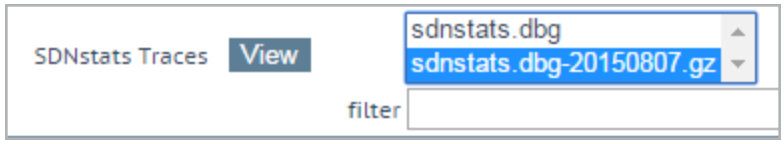


3. Click **Enable Debug Log**.

2.4.4.2 View the SDN Statistic Trace Logging

To view the SDN Controller debug logging, follow the steps below:

1. In the main menu, go to **System Configuration > Logging Options > SDN Log Files**.



2. Click the **expand/collapse selection** (plus icon) button in the **SDNstats Traces** section.

3. Select the relevant log file.

4. Click **View**.

5. A filter can be run on the log files by entering a word(s) or regular expression in the **filter** field and clicking the **View** button.

> A filter can be run on the log files by entering a word(s) or regular expression in the **filter** field and clicking the **View** button.

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```
Apr 19 16:26:32 gstatsv2.py:iter:491 One minute timer
Apr 19 16:26:37 gstatsv2.py:run:506 Calling iter
Probing(10.35.7.10,8443,https=True):
        [HP VAN] SUCCESS [Version] 2.5.20.1227
```

The traces show probing results – this indicates if the LoadMaster can successfully communicate with the SDN controller.

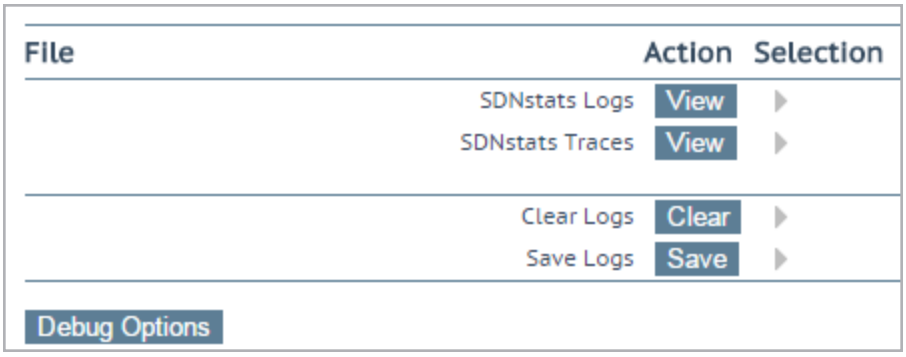
2.4.4.3 Restart the SDN Service

When troubleshooting issues with SDN, the entire SDN service can be restarted. Restarting the connection will not affect any traffic connections - it restarts the daemon, resets the SDN adaptive values to the default of 5 and it re-establishes the connection between the LoadMaster and the SDN Controller.

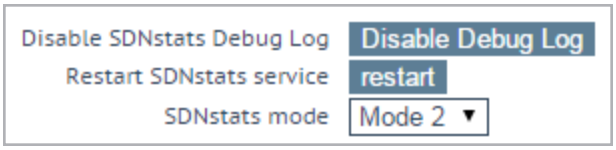
> This will restart the connection to all attached SDN Controllers.

To do this, follow the steps below in the LoadMaster WUI:

1. In the main menu, go to **System Configuration > Logging Options > SDN Log Files**.



2. Click **Debug Options**.



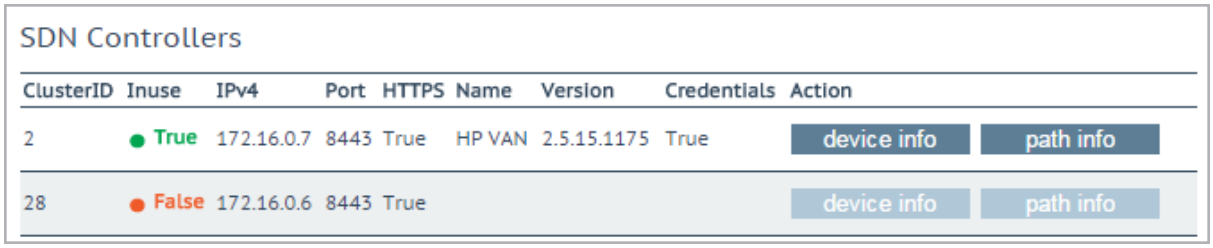
3. Click **restart**.

4. If successful, the **Process ID** will change to a new id.

5. The Process ID can be found by clicking the Debug button in **System Configuration > Logging Options > System LogFiles** and clicking the **ps** button.

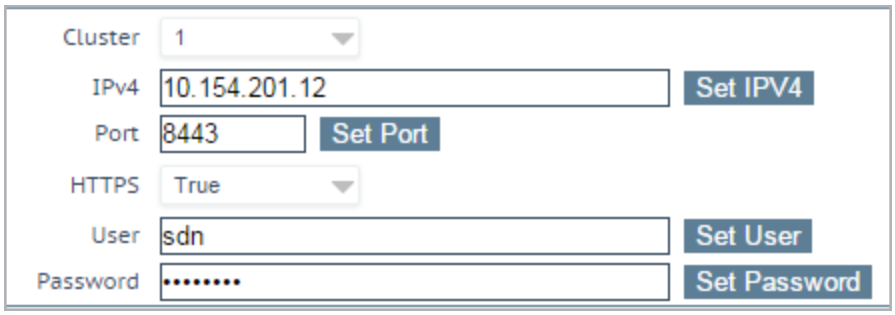
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2.5 Troubleshooting



In the above screenshot of the **SDN Statistics** screen, the **Name**, **Version** and **Credentials** are blank for the row with **Cluster ID**. If this is the case, it means that the LoadMaster is not communicating correctly with the SDN Controller. To try to resolve this, follow the steps below:

1. Ping the SDN Controller from the LoadMaster (**System Configuration > Logging Options > System Log Files > Debug Options > Ping Host**).



2. Recheck the IP address, port and credentials in the SDN Controller settings (**System Configuration > Miscellaneous Options > SDN Configuration**).

3. Restart the SDN daemon (**System Configuration > Logging Options > SDN Log Files > Debug Options > Restart SDNstats service**).

4. Enable SDN statistic debug logging (**System Configuration > Logging Options > SDN Log Files > Debug Options > Enable SDNstats Debug Log**). Then, view the SDN debug logs (**System Configuration > Logging Options > SDN Log Files > SDNstats Traces**). The logs will show what the LoadMaster passed to the SDN Controller.

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References

Unless otherwise specified, the following documents can be found at http://kemptechnologies.com/documentation.

Web User Interface (WUI), Configuration Guide

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