IP SLAs QFP Time Stamping

This module describes how to configure the IP SLA QFP Time Stamping feature for IP Service Level Agreements (SLAs) UDP jitter operations. This new probe and responder structure enables more accurate network performance measurements.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for IP SLAs QFP Time Stamping

- The devices on which the responder and probe are to configured must both be running Cisco software images that support QFP time stamping in order for the IP SLAs QFP Time Stamping feature to work.
- Time synchronization, such as that provided by NTP, is required between the source and the target device in order to provide accurate one-way delay (latency) measurements. To configure NTP on the source and target devices, perform the tasks in the “Performing Basic System Management” chapter of the *Network Management Configuration Guide*.
- Before configuring any IP SLAs application, you can use the **show ip sla application** command to verify that the operation type is supported on your software image.

Restrictions for IP SLA QFP Time Stamping

- After rebooting the sender or responder devices, the Forward Processor (FP) and Route Processor (RP) times can be inaccurate until SNTP synchronizes the FP clock to the RP clock. To avoid running an operation before the device FP and RP times are stable, wait several minutes after a reboot before starting the UDP jitter operation.
- The one way delay value reported by an IP SLAs UDP jitter operation are dependent on the NTP synchronization level. Even if the device is synchronized, if the NTP offset values on the device are large, then one way values can be inaccurate. In cases where offset value becomes too large, the one way value may not be reported. Also, the NTP offset value on the device can fluctuate and these changes will be reflected in one way values reported.
- If you configure the optimized time stamp location on the source device and the device on which the targeted IP SLAs Responder is configured does not support the optimized time stamp location, the IP SLAs operation will fail.
- IP SLAs QFP Time Stamping is not supported on the Cisco CSR 1000v or Cisco ISRv.

Information About IP SLAs QFP Time Stamping

IP SLAs UDP Jitter Operation

The IP Service Level Agreements (SLAs) UDP jitter operation diagnoses network suitability for real-time traffic applications such as VoIP, video over IP, or real-time conferencing.

Jitter means inter-packet delay variance. When multiple packets are sent consecutively from a source to a destination, for example, 10 ms apart, and if the network is behaving ideally, the destination should receive the packets 10 ms apart. But if there are delays in the network (like queuing, arriving through alternate routes, and so on) the arrival delay between packets might be greater than or less than 10 ms. Using this example, a positive jitter value indicates that packets arrived greater than 10 ms apart. If packets arrive 12 ms apart, then positive jitter is 2 ms; if packets arrive 8 ms apart, negative jitter is 2 ms. For delay-sensitive networks like VoIP, positive jitter values are undesirable, and a jitter value of 0 is ideal.

However, the IP SLAs UDP jitter operation does more than just monitor jitter. As the UDP jitter operation includes data returned by the IP SLAs UDP operation, the UDP jitter operation can be used as a multipurpose data gathering operation. The packets that IP SLAs generate carry packet-sending and receiving sequence information, and sending and receiving time stamps from the source and the operational target. Based on this information, UDP jitter operations are capable of measuring the following:

- Per-direction jitter (source to destination and destination to source)
- Per-direction packet loss
- Per-direction delay (one-way delay)
- Round-trip delay (average round-trip time)

As paths for sending and receiving data may be different (asymmetric), the per-direction data allows you to more readily identify where congestion or other problems are occurring in the network.

The UDP jitter operation functions by generating synthetic (simulated) UDP traffic. Asymmetric probes support custom-defined packet sizes per direction with which different packet sizes can be sent in request packets (from the source device to the destination device) and in response packets (from the destination device to the source device).

The UDP jitter operation sends N number of UDP packets, each of size S, T milliseconds apart, from a source device to a destination device, at a given frequency of F. In response, UDP packets of size P is sent from the destination device to the source device. By default, ten packet frames (N), each with a payload size of 10 bytes (S), are generated every 10 ms (T), and the operation is repeated every 60 seconds (F). Each of these parameters is user-configurable, so as to best simulate the IP service that you provide, as shown in the table below.

Table 1: UDP Jitter Operation Parameters

UDP Jitter Operation Parameter	Default	Configuration Commands
Number of packets (N)	10 packets	**udp-jitter num-packets**
Payload size per request packet (S)	10 bytes	**request-data-size**
Payload size per response packet (P)	The default response data size varies depending on the type of IP SLAs operation configured. **Note** If the **response-data-size** command is not configured, then the response data size value is the same as the request data size value.	**response-data-size**
Time between packets, in milliseconds (T)	10 ms	**udp-jitter interval**
Elapsed time before the operation repeats, in seconds (F)	60 seconds	**frequency (IP SLA)**

The IP SLAs operations function by generating synthetic (simulated) network traffic. A single IP SLAs operation (for example, IP SLAs operation 10) repeats at a given frequency for the lifetime of the operation.

QFP Time Stamping

IP SLAs UDP jitter is the most widely-used IP SLAs operation for measuring metrics such as round-trip time, one-way delay, jitter, and packet loss. The accuracy of measurements depends on the location where the time stamps are taken while the packet moves from the sender to responder, and back.

Typically, time stamps for IP SLAs operations are taken in the IP SLAs process at the Route Processor (RP). This time-stamp location results in inaccurate and inconsistent measurements because the time stamps are subject to scheduling delays experienced at the RP. QFP time stamping moves the location of the time stamping from the RP to the Cisco Packet Processor (CPP).

However, to measure the one-way delay, the clocks on the source and target devices must be synchronized. Because device CPP clocks cannot be synchronized directly to an external clock source, the RP clocks are synchronized with an external clock source and SNTP is used to synchronize RP and Forwarding Processor (FP) clocks. The accuracy of the RP-FP synchronization is poor. To address this issue, the enhanced UDP

jitter probe in the QFP Time Stamping feature stores both the RP and CPP time stamps. RTT and jitter calculations utilize the CPP time stamps, and one-way calculations continue to be based on RP time stamping. Therefore, time synchronization, such as that provided by NTP, is required between the source and the target device in order to provide accurate one-way delay (latency) measurements. One-way latency values are computed using RP time stamps are corrected by applying estimated-correction algorithms based on CPP time stamps.

QFP time stamping includes an enhanced UDP probe and enhanced responder. The devices on which the UDP probe and IP SLAs responder are configured must both be running Cisco software images that support QFP time stamping and the optimized time stamp location (for more accurate RTT measurements). If the UDP jitter operation is targeted to an responder on a device that does not support the optimized time stamp location, the IP SLAs probe will fail.

How to Configure IP SLAs QFP Time Stamping

Configuring the IP SLAs Responder on the Destination Device

Note A responder should not configure a permanent port for the same sender. If the responder configures a permanent port for the same sender, even if the packets are successfully sent (no timeout or packet-loss issues), the jitter values will be zero.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **ip sla responder**
   - **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose

Step 3	Do one of the following:
	• **ip sla responder**
	• **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
	Example:
	`Device(config)# ip sla responder`
	Example:
	`Device(config)# ip sla responder udp-echo ipaddress 172.29.139.132 port 5000`
		(Optional) Temporarily enables IP SLAs Responder functionality on a Cisco device in response to control messages from the source.
		(Optional) Required only if protocol control is disabled on the source. Enables IP SLAs responder functionality on the specified IP address and port.
		• Protocol control is enabled by default.

Step 4	**exit** **Example:** `Device(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Configuring and Scheduling a UDP Jitter Operation on a Source Device

Perform only one of the following tasks:

- Configuring a Basic UDP Jitter Operation on the Source Device
- Configuring a UDP Jitter Operation with Additional Characteristics

Configuring a Basic UDP Jitter Operation with QFP Time Stamping

Perform this task to configure a UDP jitter probe with QFP time stamping on the source device.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*]
5. **frequency** *seconds*
6. **precision microseconds**
7. **optimize timestamp**
8. **end**
9. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*] **Example:** `Device(config-ip-sla)# udp-jitter 172.29.139.134 5000`	Configures the IP SLAs operation as a UDP jitter operation and enters UDP jitter configuration submode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and destination devices.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-jitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**precision microseconds** **Example:** `Device(config-ip-sla-jitter)# precision microseconds`	Enables QFP time stamping.
Step 7	**optimize timestamp** **Example:** `Device(config-ip-sla-jitter)# optimize timestamp`	(Optional) For Cisco ASR 1000 Series routers only. Enables CPP ticks which is more accurate than cpp UNIX time. **Note** If the Responder does not support cpp ticks, the IP SLAs operation will fail.
Step 8	**end** **Example:** `Device(config-ip-sla-jitter)# end`	Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 9	**show ip sla configuration** [*operation-number*] **Example:** `Device# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

Configuring a UPD Jitter Operation with QFP Time Stamping and Additional Characteristics

Note

- The IP SLAs UDP jitter operation does not support the IP SLAs History feature (statistics history buckets) because of the large data volume involved with UDP jitter operations. This means that the following commands are not supported for UDP jitter operations: **history buckets-kept**, **history filter**, **history lives-kept**, **samples-of-history-kept**, and **show ip sla history**.
- The MIB used by IP SLAs (CISCO-RTTMON-MIB) limits the hours-of-statistics kept for the UDP jitter operation to two hours. Configuring a larger value using the **history hours-of-statistics** *hours* global configuration change will not increase the value beyond two hours. However, the Data Collection MIB can be used to collect historical data for the operation. For information, see the CISCO-DATA-COLLECTION-MIB at http://www.cisco.com/go/mibs.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*]
5. **precision microseconds**
6. **optimize timestamp**
7. **history distributions-of-statistics-kept** *size*
8. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **owner** *owner-id*
12. **request-data-size** *bytes*
13. **history statistics-distribution-interval** *milliseconds*
14. **tag** *text*
15. **threshold** *milliseconds*
16. **timeout** *milliseconds*
17. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
18. **flow-label** *number*
19. **verify-data**

20. **vrf** *vrf-name*
21. **end**
22. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*] **Example:** `Device(config-ip-sla)# udp-jitter 172.29.139.134 5000`	Configures the IP SLAs operation as a UDP jitter operation and enters UDP jitter configuration submode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target devices.
Step 5	**precision microseconds** **Example:** `Device(config-ip-sla-jitter)# precision microseconds`	Enables QFP time stamping.
Step 6	**optimize timestamp** **Example:** `Device(config-ip-sla-jitter)# optimize timestamp`	(Optional) For Cisco ASR 1000 Series routers only, optimizes the time stamp location for IP SLAs. **Note** If the device on which the targeted IP SLAs Responder is configured does not also support the optimized time stamp location, the IP SLAs operation will fail.
Step 7	**history distributions-of-statistics-kept** *size* **Example:**	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.

	Command or Action	Purpose
	`Device(config-ip-sla-jitter)# history distributions-of-statistics-kept 5`	
Step 8	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Device(config-ip-sla-jitter)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 9	**frequency** *seconds* **Example:** `Device(config-ip-sla-jitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-jitter)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**owner** *owner-id* **Example:** `Device(config-ip-sla-jitter)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 12	**request-data-size** *bytes* **Example:** `Device(config-ip-sla-jitter)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
Step 13	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-jitter)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 14	**tag** *text* **Example:** `Device(config-ip-sla-jitter)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 15	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-jitter)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
Step 16	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-jitter)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 17	Do one of the following:
	• **tos** *number*
	• **traffic-class** *number*
	Example:
	`Device(config-ip-sla-jitter)# tos 160`
	Example:
	`Device(config-ip-sla-jitter)# traffic-class 160`
		(Optional) In an IPv4 network only, defines the ToS byte in the IPv4 header of an IP SLAs operation.
		or
		(Optional) In an IPv6 network only, defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

Step 18	**flow-label** *number* **Example:** `Device(config-ip-sla-jitter)# flow-label 112233`	(Optional) In an IPv6 network only, defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 19	**verify-data** **Example:** `Device(config-ip-sla-jitter)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 20	**vrf** *vrf-name* **Example:** `Device(config-ip-sla-jitter)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.
Step 21	**end** **Example:** `Device(config-ip-sla-jitter)# end`	Returns to privileged EXEC mode.
Step 22	**show ip sla configuration** [*operation-number*] **Example:** `Device# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

Scheduling IP SLAs Operations

Before you begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.

- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] **frequency** *group-operation-frequency* [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla schedule** *operation-number* [**life** {**forever**	*seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**] • **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range*	**schedule-together**} [**ageout** *seconds*] **frequency** *group-operation-frequency* [**life** {**forever**	*seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm* [:*ss*]}] **Example:** `Device(config)# ip sla schedule 10 life forever start-time now`	• Configures the scheduling parameters for an individual IP SLAs operation. • Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

	Command or Action	Purpose

	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP SLAs operation is not running and not generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP SLAs operation, see the “Configuring Proactive Threshold Monitoring” section.

operation)

To display and interpret the results of an IP SLAs operation, use the **show ip sla statistics** command. Check the output for fields that correspond to criteria in your service level agreement to determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs QFP Time Stamping

Example: Configuring a UDP Operation with QFP Time Stamping

In the following example, two operations are configured as enhanced UDP jitter operations with QFP time stamping and the optimized time stamp location. Operation 2 starts five seconds after the first operation.

Note The device on which ther esponder is configured must (also) support the optimized time stamp location or the probe will fail.

On the source (sender) device:

```
ip sla 1
 udp-jitter 192.0.2.134 5000 num-packets 20
 request-data-size 160
 tos 128
 frequency 30
 precision microseconds     !enables QFP time stamping
 optimize timestamp         !configures optimized time stamp location
ip sla schedule 1 start-time after 00:05:00
ip sla 2
 udp-jitter 192.0.2.134 65052 num-packets 20 interval 10
 request-data-size 20
 tos 64
 frequency 30
 precision microseconds
 optimize timestamp
ip sla schedule 2 start-time after 00:05:05
```

On the destination (responder) device:

```
ip sla responder
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference

MIBs

MIBs	MIBs Link
• CISCO-RTTMON-MIB • IPV6-FLOW-LABEL-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs QFP Time Stamping

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 2: Feature Information for IP SLAs QFP Time Stamping

Feature Name	Releases	Feature Information
IP SLAs QFP Time Stamping	Cisco IOS XE Release 3.7S	This feature enables IP SLAs Cisco Packet Processor (CPP) time stamping to improve the accuracy of IP SLAs UDP jitter operations. For Cisco ASR 1000 Series routers only, this feature also supports optimizing the time stamp location for more accurate RTT measurements. The following commands were introduced or modified: **optimize timestamp**, **precision microseconds**, **show ip sla configuration**.