



## Configuring a Multioperations Scheduler

This chapter describes how to schedule multiple operations using the IP Service Level Agreements (IP SLAs) Multioperations Scheduler.

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## Information About the IP SLAs Multioperations Scheduler

Normal scheduling of IP SLAs operations allows you to schedule one operation at a time. If you have large networks with thousands of IP SLAs operations to monitor network performance, normal scheduling (scheduling each operation individually) is inefficient and time-consuming.

Multiple operations scheduling allows you to schedule multiple IP SLAs operations using a single command through the command-line interface (CLI) or the CISCO-RTTMON-MIB. This feature allows you to control the amount of IP SLAs monitoring traffic by scheduling the operations to run at evenly distributed times. You must specify the operation ID numbers to be scheduled and the time range over which all the IP SLAs operations should start. This feature automatically distributes the IP SLAs operations at equal intervals over a specified time frame. The spacing between the operations (start interval) is calculated and the operations are started. This distribution of IP SLAs operations helps to minimize the CPU utilization and enhances the scalability of the network.

The IP SLAs multiple operations scheduling functionality allows you to schedule multiple IP SLAs operations as a group, using the following configuration parameters:

- Group operation number—Group configuration or group schedule number of the IP SLAs operation to be scheduled.
- Operation ID numbers—A list of IP SLAs operation ID numbers in the scheduled operation group.
- Schedule period—Amount of time for which the IP SLAs operation group is scheduled.
- Ageout—Amount of time to keep the operation in memory when it is not actively collecting information. By default, the operation remains in memory indefinitely.
- Frequency—Amount of time after which each IP SLAs operation is restarted. When the frequency option is specified, it overwrites the operation frequency of all operations that belong to the group. When the frequency option is not specified, the frequency for each operation is set to the value of the schedule period.
- Life—Amount of time in which the operation actively collects information. You can configure the operation to run indefinitely. By default, the lifetime of an operation is one hour.
- Start time—Time when the operation starts collecting information. You can specify an operation to start immediately or at an absolute start time using hours, minutes, seconds, day, and month.

The IP SLAs multiple operations scheduling functionality schedules the maximum number of operations possible without terminating. However, this functionality skips those IP SLAs operations that are already running or those operations that are not configured and therefore do not exist. The total number of operations are calculated based on the number of operations that are specified in the command, irrespective of the number of operations that are missing or already running. The IP SLAs multiple operations scheduling functionality displays a message that shows the number of active and missing operations. However, these messages are displayed only if you schedule operations that are not configured or are already running.

A main benefit for scheduling multiple IP SLAs operations is that the load on the network is reduced by distributing the operations equally over a scheduled period. This distribution helps you to achieve more consistent monitoring coverage. Consider configuring 60 operations to start during the same 1-second interval over a 60-second schedule period. If a network failure occurs 30 seconds after all 60 operations have started and the network is restored before the operations are due to start again (in another 30 seconds), this failure would never be detected by any of the 60 operations. However, if the 60 operations are distributed equally at 1-second intervals over a 60-second schedule period, then some of the operations will detect the network failure. Conversely, if a network failure occurs when all 60 operations are active, all 60 operations will fail, indicating that the failure is possibly more severe than it really is.

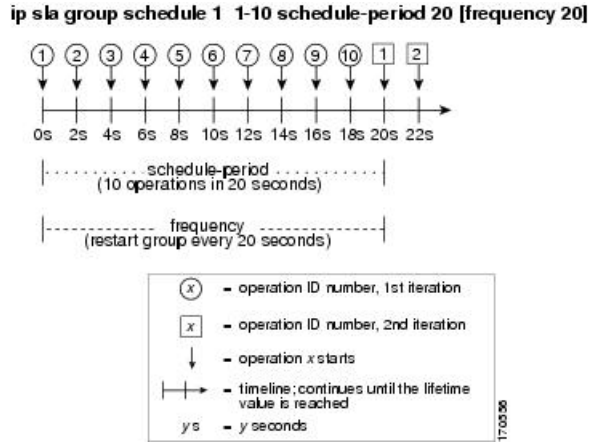
Operations of the same type and same frequency should be used for IP SLAs multiple operations scheduling. If you do not specify a frequency, the default frequency is the same as that of the schedule period. The schedule period is the period of time in which all the specified operations should run.

## Default Behavior of IP SLAs Multiple Operations Scheduling

The IP SLAs Multiple Operations Scheduling feature allows you to schedule multiple IP SLAs operations as a group.

The following figure shows the scheduling of operation group 1 that includes operation 1 to operation 10. Operation group 1 has a schedule period of 20 seconds, which means that all operations in the group are started at equal intervals within a 20-second period. By default, the frequency is set to the same value as the configured schedule period. As shown in the figure, configuring the frequency is optional because 20 is the default.

Figure 1: Schedule Period Equals Frequency--Default Behavior



In this example, the first operation (operation 1) in operation group 1 starts at 0 seconds. All 10 operations in operation group 1 (operation 1 to operation 10) must be started in the schedule period of 20 seconds. The start time of each IP SLAs operation is evenly distributed over the schedule period by dividing the schedule period by the number of operations (20 seconds divided by 10 operations). Therefore, each operation starts 2 seconds after the previous operation.

The frequency is the period of time that passes before the operation group is started again (repeated). If the frequency is not specified, the frequency is set to the value of the schedule period. In the example that is shown in the figure, operation group 1 starts again every 20 seconds. This configuration provides optimal division (spacing) of operations over the specified schedule period.

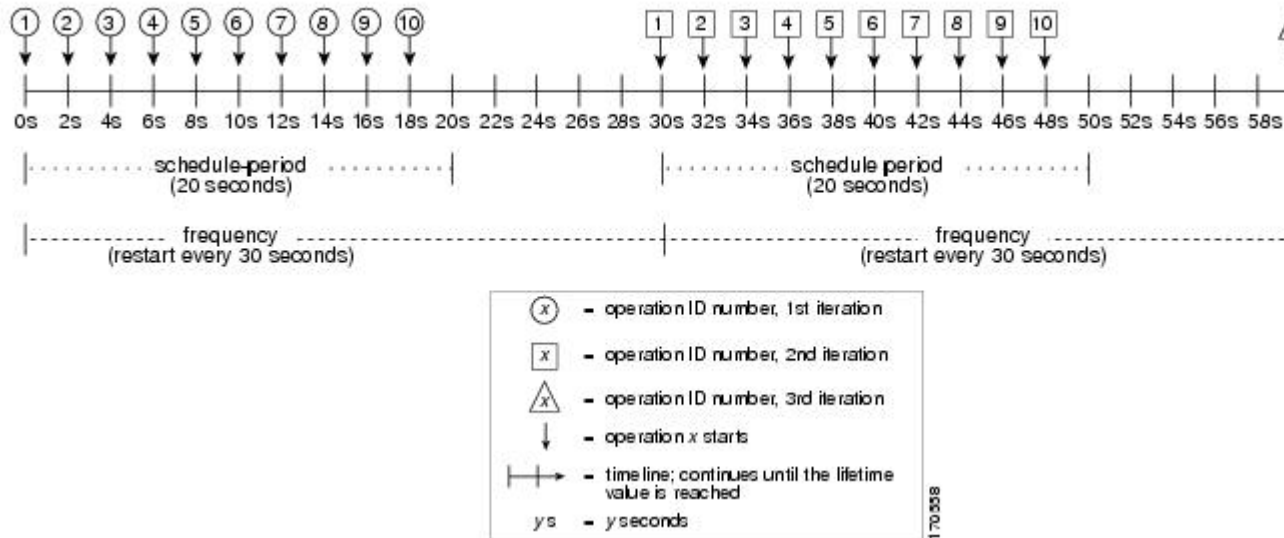
## Multiple Operations Scheduling with Scheduling Period Less Than Frequency

The frequency value is the amount of time that passes before the schedule group is restarted. If the schedule period is less than the frequency, there is a period of time in which no operations are started.

The following figure shows the scheduling of operation 1 to operation 10 within operation group 2. Operation group 2 has a schedule period of 20 seconds and a frequency of 30 seconds.

Figure 2: Schedule Period is Less Than Frequency

ip sla group schedule 2 1-10 schedule-period 20 frequency 30



In this example, the first operation (operation 1) in operation group 2 starts at 0 seconds. All 10 operations in operation group 2 (operation 1 to operation 10) must be started in the schedule period of 20 seconds. The start time of each IP SLAs operation is evenly distributed over the schedule period by dividing the schedule period by the number of operations (20 seconds divided by 10 operations). Therefore, each operation starts 2 seconds after the previous operation.

In the first iteration of operation group 2, operation 1 starts at 0 seconds, and the last operation (operation 10) starts at 18 seconds. However, because the group frequency has been configured to 30 seconds, each operation in the operation group is restarted every 30 seconds. So, after 18 seconds, there is a gap of 10 seconds as no operations are started in the time from 19 to 29 seconds. At 30 seconds, the second iteration of operation group 2 starts. As all ten operations in the operation group 2 must start at an evenly distributed interval in the configured schedule period of 20 seconds, the last operation (operation 10) in the operation group 2 always starts 18 seconds after the first operation (operation 1).

As shown in the figure, the following events occur:

- At 0 seconds, the first operation (operation 1) in operation group 2 is started.
- At 18 seconds, the last operation (operation 10) in operation group 2 is started, which means that the first iteration (schedule period) of operation group 1 ends here.
- From 19 to 29 seconds, no operations are started.
- At 30 seconds, the first operation (operation 1) in operation group 2 is started again. The second iteration of operation group 2 starts here.
- At 48 seconds (18 seconds after the second iteration started), the last operation (operation 10) in operation group 2 is started, and the second iteration of operation group 2 ends.
- At 60 seconds, the third iteration of operation group 2 starts.

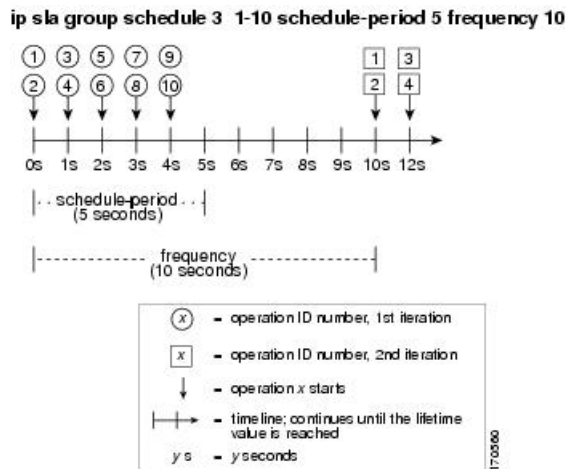
This process continues until the lifetime of operation group 2 ends. The lifetime value is configurable. The default lifetime for an operation group is forever.

# Multiple Operations Scheduling When the Number of IP SLAs Operations are Greater than the Schedule Period

The minimum time interval between the start of IP SLAs operations in a group operation is 1 second. Therefore, if the number of operations to be scheduled is greater than the schedule period, the IP SLAs multiple operations scheduling functionality schedules more than one operation to start within the same 1-second interval. If the number of operations getting scheduled does not equally divide into 1-second intervals, the operations are equally divided at the start of the schedule period with the remaining operations to start at the last 1-second interval.

The following figure shows the scheduling of operation 1 to operation 10 within operation group 3. Operation group 3 has a schedule period of 5 seconds and a frequency of 10 seconds.

**Figure 3: Number of IP SLAs Operations Is Greater Than the Schedule Period—Even Distribution**



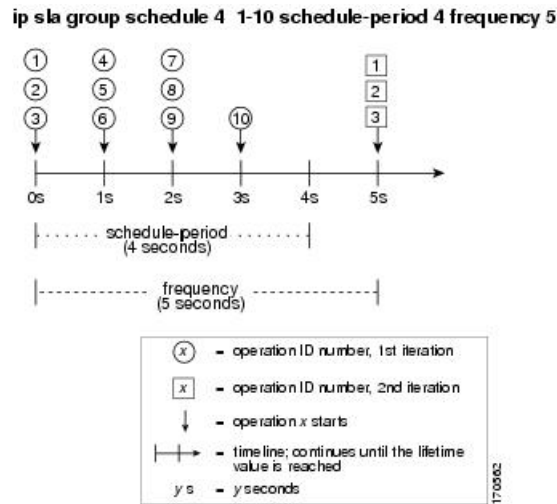
In this example, when dividing the schedule period by the number of operations (5 seconds divided by 10 operations, which equals one operation every 0.5 seconds), the start time of each IP SLAs operation is less than 1 second. Because the minimum time interval between the start of IP SLAs operations in a group operation is 1 second, the IP SLAs multiple operations scheduling functionality instead calculates how many operations it should start in each 1-second interval by dividing the number of operations by the schedule period (10 operations divided by 5 seconds). Therefore, as shown in the previous figure, two operations are started every 1 second.

As the frequency is set to 10 in this example, each iteration of operation group 3 will start 10 seconds after the start of the previous iteration. However, this distribution is not optimal as there is a gap of 5 seconds (frequency minus schedule period) between the cycles.

If the number of operations getting scheduled does not equally divide into 1-second intervals, then the operations are equally divided at the start of the schedule period with the remaining operations to start at the last 1-second interval.

The following figure shows the scheduling of operation 1 to operation 10 within operation group 4. Operation group 4 has a schedule period of 4 seconds and a frequency of 5 seconds.

Figure 4: Number of IP SLAs Operations Is Greater Than the Schedule Period—Uneven Distribution



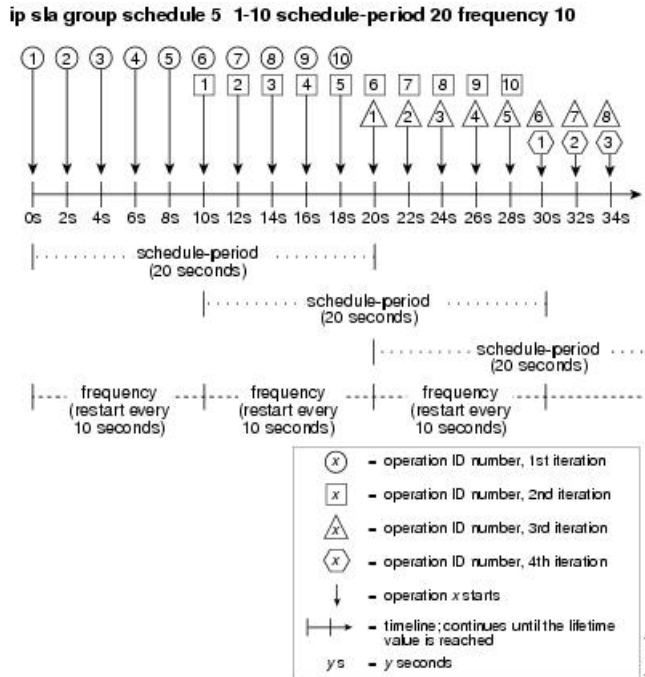
In this example, the IP SLAs multiple operations scheduling functionality calculates how many operations it should start in each 1-second interval by dividing the number of operations by the schedule period (10 operations divided by 4 seconds, which equals 2.5 operations every 1 second). Because the number of operations does not equally divide into 1-second intervals, this number is rounded off to the next whole number (see the figure) with the remaining operations to start at the last 1-second interval.

## Multiple Operations Scheduling with Scheduling Period Greater Than Frequency

The value of the frequency is the amount of time that passes before the schedule group is restarted. If the schedule period is greater than the frequency, there is a period of time in which the operations in one iteration of an operation group overlaps with the operations of the following iteration.

The following figure shows the scheduling of operation 1 to operation 10 within operation group 5. Operation group 5 has a schedule period of 20 seconds and a frequency of 10 seconds.

Figure 5: IP SLAs Group Scheduling with Schedule Period Greater Than Frequency



In this example, the first operation (operation 1) in operation group 5 starts at 0 seconds. All 10 operations in operation group 5 (operation 1 to operation 10) must be started in the schedule period of 20 seconds. The start time of each IP SLAs operation is evenly distributed over the schedule period by dividing the schedule period by the number of operations (20 seconds divided by 10 operations). Therefore, each operation starts 2 seconds after the previous operation.

In the first iteration of operation group 5, operation 1 starts at 0 seconds, and operation 10, the last operation in the operation group, starts at 18 seconds. Because the operation group is configured to restart every 10 seconds (**frequency 10**), the second iteration of operation group 5 starts again at 10 seconds, before the first iteration is completed. Therefore, an overlap of operations 6 to 10 of the first iteration occurs with operations 1 to 5 of the second iteration during the time period of 10 to 18 seconds (see the previous figure). Similarly, there is an overlap of operations 6 to 10 of the second iteration with operations 1 to 5 of the third iteration during the time period of 20 to 28 seconds.

In this example, the start time of operation 1 and operation 6 does not need to be at exactly the same time, but will be within the same 2-second interval.

The configuration that is described in this section is not recommended because you can configure multiple operations to start within the same 1-second interval by configuring the number of operations greater than the schedule period.

## IP SLAs Random Scheduler

The IP SLAs Multioperation Scheduler feature provides the capability to schedule multiple IP SLAs operations to begin at intervals that are equally distributed over a specified duration of time and to restart at a specified frequency. With the IP SLAs Random Scheduler feature, you can now schedule multiple IP SLAs operations to begin at random intervals that are uniformly distributed over a specified duration of time and to restart at

uniformly distributed random frequencies within a specified frequency range. Random scheduling improves the statistical metrics for assessing network performance.



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**Note** The IP SLAs Random Scheduler feature is not in compliance with RFC 2330 because it does not account for interpacket randomness.

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The random scheduler option is disabled by default. To enable the random scheduler option, you must set a frequency range when configuring a group schedule in global configuration mode. The group of operations restarts at uniformly distributed random frequencies within the specified frequency range. The following guidelines apply for setting the frequency range:

- The starting value of the frequency range should be greater than the timeout values of all the operations in the group operation.
- The starting value of the frequency range should be greater than the schedule period (amount of time for which the group operation is scheduled). This guideline ensures that the same operation does not get scheduled more than once within the schedule period.

The following guidelines apply if the random scheduler option is enabled:

- The individual operations in a group operation will be uniformly distributed to begin at random intervals over the schedule period.
- The group of operations restarts at uniformly distributed random frequencies within the specified frequency range.
- The minimum time interval between the start of each operation in a group operation is 100 milliseconds (0.1 seconds). If the random scheduler option is disabled, the minimum time interval is 1 second.
- Only one operation can be scheduled to begin at any given time. If the random scheduler option is disabled, multiple operations can begin at the same time.
- The first operation will always begins at 0 milliseconds of the schedule period.
- The order in which each operation in a group operation begins is random.

## Prerequisites for an IP SLAs Multioperation Scheduler

- Configure the IP SLAs operations to be included in a group before scheduling the group.
- Determine the IP SLAs operations you want to schedule as a single group.
- Identify the network traffic type and the location of your network management station.
- Identify the topology and the types of devices in your network.
- Decide on the frequency of testing for each operation.



# Scheduling Multiple IP SLAs Operations

This section describes how to schedule multiple IP SLAs operations.

## Before you begin



### Note

- The frequency of all operations scheduled in a multioperation group should be the same.
- The operation ID numbers are limited to a maximum of 125 characters. Do not give large integer values as operation ID numbers.

## SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time** {*hh:mm[:ss]* [*monthday* | *daymonth*]} | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b> <b>Example:</b> <pre>switch&gt; enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b> <b>Example:</b> <pre>switch# configure terminal</pre>	Enters global configuration mode.
Step 3	<b>ip sla group schedule</b> <i>group-operation-number operation-id-numbers</i> <b>schedule-period</b> <i>schedule-period-range</i> [ <b>ageout</b> <i>seconds</i> ] [ <b>frequency</b> <i>group-operation-frequency</i> ] [ <b>life</b> { <b>forever</b>   <i>seconds</i> }] [ <b>start-time</b> { <i>hh:mm[:ss]</i> [ <i>monthday</i>   <i>daymonth</i> ]}   <b>pending</b>   <b>now</b>   <b>after</b> <i>hh:mm:ss</i> }] <b>Example:</b> <pre>switch(config)# ip sla group schedule 1 3,4,6-9</pre>	Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.

	Command or Action	Purpose
<b>Step 4</b>	<b>exit</b> <b>Example:</b>  switch(config)# exit	Returns to the privileged EXEC mode.
<b>Step 5</b>	<b>show ip sla group schedule</b> <b>Example:</b>  switch# show ip sla group schedule	(Optional) Displays the IP SLAs group schedule details.
<b>Step 6</b>	<b>show ip sla configuration</b> <b>Example:</b>  switch# show ip sla configuration	(Optional) Displays the IP SLAs configuration details.

## Enabling the IP SLAs Random Scheduler

This section describes how to enable the IP SLAs Random Scheduler.

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *seconds* [**ageout** *seconds*] [**frequency** [*seconds*] **range** *random-frequency-range*] [**life**{**forever** | *seconds*}] [**start-time** {*hh:mm[:ss]* [*monthday* | *daymonth*]} | **pending** | **now** | **after***hh:mm:ss*}]
4. **exit**

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b> <b>Example:</b>  switch> enable	Enables privileged EXEC mode.  Enter your password if prompted.
<b>Step 2</b>	<b>configure terminal</b> <b>Example:</b>  switch# configure terminal	Enters global configuration mode.
<b>Step 3</b>	<b>ip sla group schedule</b> <i>group-operation-number operation-id-numbers</i> <b>schedule-period</b> <i>seconds</i> [ <b>ageout</b> <i>seconds</i> ] [ <b>frequency</b> [ <i>seconds</i> ] <b>range</b>	Specifies the scheduling parameters of a group of IP SLAs operations.

	Command or Action	Purpose
	<p><i>random-frequency-range</i>] [<b>life</b>{<b>forever</b>   <i>seconds</i>}]  [<b>start-time</b>{<i>hh:mm[:ss]</i> [<i>monthday</i>   <i>daymonth</i>]   <b>pending</b>    <b>now</b>   <b>after</b><i>hh:mm:ss</i>}]</p> <p><b>Example:</b></p> <pre>switch(config)# ip sla group schedule 2 1-3 schedule-period 50 frequency range 80-100</pre>	To enable the random scheduler option, you must configure the <b>frequency range</b> <i>random-frequency-range</i> keywords and argument.
<b>Step 4</b>	<p><b>exit</b></p> <p><b>Example:</b></p> <pre>switch(config)# exit</pre>	Exits global configuration mode and returns to privileged EXEC mode.

## Verifying IP SLAs Multiple Operations Scheduling

This section describes how to verify IP SLAs multiple operations scheduling.

### SUMMARY STEPS

1. **show ip sla statistics**
2. **show ip sla group schedule**
3. **show ip sla configuration**

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	<p><b>show ip sla statistics</b></p> <p><b>Example:</b></p> <pre>switch# show ip sla statistics</pre>	(Optional) Displays the IP SLAs operation details.
<b>Step 2</b>	<p><b>show ip sla group schedule</b></p> <p><b>Example:</b></p> <pre>switch# show ip sla group schedule</pre>	(Optional) Displays the IP SLAs group schedule details.
<b>Step 3</b>	<p><b>show ip sla configuration</b></p> <p><b>Example:</b></p> <pre>switch# show ip sla configuration</pre>	(Optional) Displays the IP SLAs configuration details.

## Examples

After you schedule the multiple IP SLAs operations, you can verify the latest operation details using the appropriate **show** commands.

This example shows how to schedule IP SLAs operations 1 through 20 in the operation group 1 with a schedule period of 60 seconds and a life value of 1200 seconds. By default, the frequency is equivalent to the schedule period. In this example, the start interval is 3 seconds (schedule period divided by number of operations).

```
switch (config)# ip sla group schedule 1 1-20 schedule-period 60 life 1200
```

This example shows how to display the details of the scheduled multiple IP SLAs operation:

```
switch# show ip sla group schedule
Group Entry Number: 1
Probes to be scheduled: 1-20
Total number of probes: 20
Schedule period: 60
Group operation frequency: Equals schedule period
Status of entry (SNMP RowStatus): Active
Next Scheduled Start Time: Start Time already passed
Life (seconds): 1200
Entry Ageout (seconds): never
```

This example shows how to display the details of the scheduled multiple IP SLAs operation. The example shows that the IP SLAs operations are multiple scheduled (TRUE).

```
switch# show ip sla config 1
IP SLAs Infrastructure Engine-III
Entry number: 1
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: udp-jitter
Target address/Source address: 101.101.101.1/0.0.0.0
Target port/Source port: 5000/0
Type Of Service parameter: 0x0
Request size (ARR data portion): 32
Packet Interval (milliseconds)/Number of packets: 20/10
Verify data: No
Vrf Name: default
Control Packets: enabled
Schedule:
  Operation frequency (seconds): 60 (not considered if randomly scheduled)
  Next Scheduled Start Time: Start Time already passed
  Group Scheduled : TRUE
  Randomly Scheduled : FALSE
  Life (seconds): 3600
  Entry Ageout (seconds): never
  Recurring (Starting Everyday): FALSE
  Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 5000
Distribution Statistics:
  Number of statistic hours kept: 2
  Number of statistic distribution buckets kept: 1
  Statistic distribution interval (milliseconds): 20
```

This example shows how to display the latest operation start time of the scheduled multiple IP SLAs operation, when the operations are scheduled at equal intervals:

```
switch# show ip sla statistics | include Latest operation start time
Latest operation start time: *03:06:21.760 UTC Tue Oct 21 2003
Latest operation start time: *03:06:24.754 UTC Tue Oct 21 2003
Latest operation start time: *03:06:27.751 UTC Tue Oct 21 2003
Latest operation start time: *03:06:30.752 UTC Tue Oct 21 2003
Latest operation start time: *03:06:33.754 UTC Tue Oct 21 2003
Latest operation start time: *03:06:36.755 UTC Tue Oct 21 2003
Latest operation start time: *03:06:39.752 UTC Tue Oct 21 2003
Latest operation start time: *03:06:42.753 UTC Tue Oct 21 2003
Latest operation start time: *03:06:45.755 UTC Tue Oct 21 2003
Latest operation start time: *03:06:48.752 UTC Tue Oct 21 2003
Latest operation start time: *03:06:51.753 UTC Tue Oct 21 2003
Latest operation start time: *03:06:54.755 UTC Tue Oct 21 2003
Latest operation start time: *03:06:57.752 UTC Tue Oct 21 2003
Latest operation start time: *03:07:00.753 UTC Tue Oct 21 2003
Latest operation start time: *03:07:03.754 UTC Tue Oct 21 2003
Latest operation start time: *03:07:06.752 UTC Tue Oct 21 2003
Latest operation start time: *03:07:09.752 UTC Tue Oct 21 2003
Latest operation start time: *03:07:12.753 UTC Tue Oct 21 2003
Latest operation start time: *03:07:15.755 UTC Tue Oct 21 2003
Latest operation start time: *03:07:18.752 UTC Tue Oct 21 2003
```

## Configuration Example for Scheduling Multiple IP SLAs Operations

This example shows how to schedule IP SLAs operations 1 to 10 in the operation group 1 with a schedule period of 20 seconds. By default, the frequency is equivalent to the schedule period.

```
switch# ip sla group schedule 1 1-10 schedule-period 20
```

This example shows how to display the scheduled multiple IP SLAs operation. The last line in the example indicates that the IP SLAs operations are multischeduled (TRUE).

```
switch# show ip sla group schedule
Multi-Scheduling Configuration:
Group Entry Number: 1
Probes to be scheduled: 1-10
Schedule period :20
Group operation frequency: 20
Multi-scheduled: TRUE
```

## Configuration Example for Enabling the IP SLAs Random Scheduler

This example shows how to schedule IP SLAs operations 1 to 3 as a group (identified as group 2). In this example, the operations are scheduled to begin at uniformly distributed random intervals over a schedule period of 50 seconds. The first operation is scheduled to start immediately. The interval is chosen from the

specified range upon every invocation of the probe. The random scheduler option is enabled and the uniformly distributed random frequencies at which the group of operations will restart is chosen within the range of 80-100 seconds.

```
ip sla group schedule 2 1-3 schedule-period 50 frequency range 80-100 start-time now
```