



Quota Management Scenarios

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Introduction

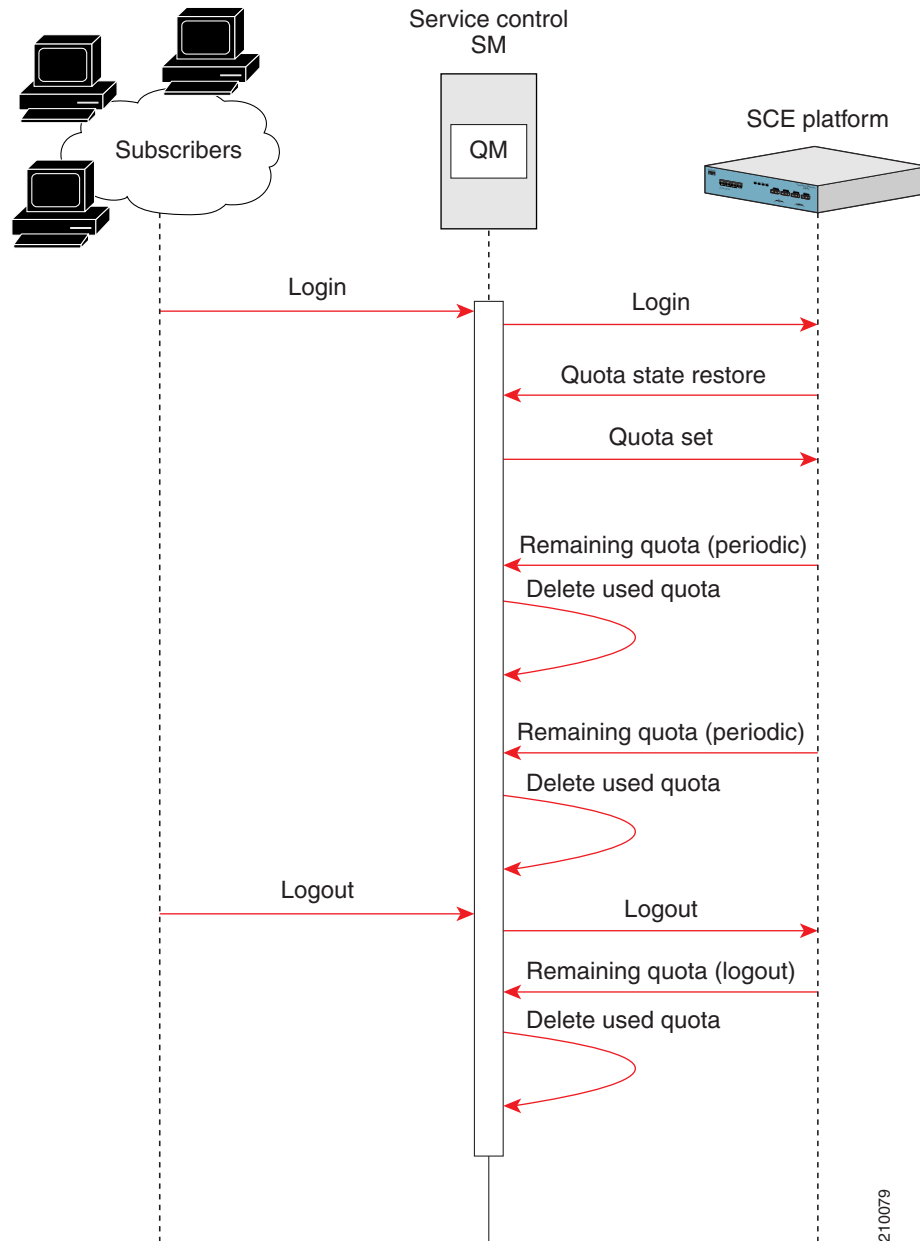
This chapter describes a number of scenarios to help you better understand how the Cisco Service Control Quota Manager works and to understand the messages between the Cisco Service Control Subscriber Manager and the Cisco SCE. It consists of the following sections:

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Quota Preservation Across Subscriber Sessions

This section describes how the subscriber quota is preserved across sessions. [Figure 2-1](#) depicts this scenario.

Figure 2-1 Quota Preservation Across Subscriber Sessions



The following steps describe what happens in this scenario:

1. The subscriber logs in to the Cisco Service Control Subscriber Manager.
2. The SM performs a logon operation to the Cisco SCE, which responds with a Quota State Restore indication. This indication is a request by the Cisco SCE to the SM to find out how much quota the subscriber has left.

3. The SM queries the database, and then responds to the Cisco SCE with a quota set operation. This sets the amount of quota that is allocated to the subscriber based on the subscriber package and the associated quota profile.
4. During the subscriber session and while the subscriber is consuming quota, the Cisco SCE sends remaining quota indications. These are periodic, and the frequency at which they are sent is defined when configuring the PQB file with Cisco SCA BB console.
5. When the Cisco Service Control Subscriber Manager receives each remaining quota indication, the quota manager removes the required amount of quota from the subscriber buckets.

**Note**

A high rate of remaining quota indications results in a higher accuracy for the subscriber quota value. However, it also increases the number of management messages on the network.

6. When the subscriber session is finished, the Cisco Service Control Subscriber Manager performs a logout operation on the Cisco SCE, which responds with a remaining quota indication. The SM uses the value contained in the indication to delete the quota consumed by the subscriber.
7. The quota value is written to the database to be stored until the next subscriber log in.

**Note**

The quota is subtracted from the subscriber quota account only after the quota is consumed, not when it is provisioned. This ensures that in cases of Cisco SCE fail-over, the quota inaccuracy is calculated in favor of the subscriber.

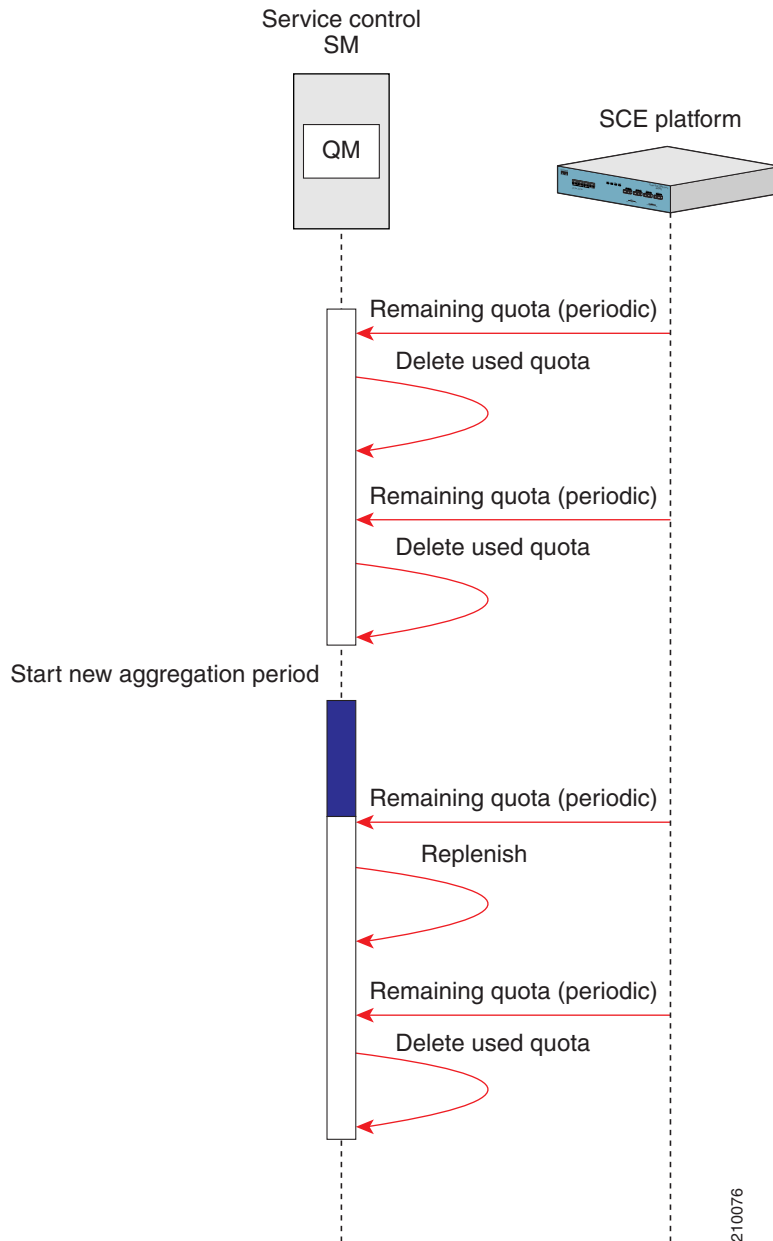
**Note**

In certain scenarios, such as the subscriber being inactive for a certain period, cable modem changed, or removal of the subscriber using a Cisco Service Control Subscriber Manager command, the subscriber is removed from the Cisco Service Control Subscriber Manager and as a result, subscriber quota information is deleted from the Cisco Service Control Subscriber Manager database. When the subscriber logs in the next time, the subscriber gets the full quota again. For example, if a subscriber with a monthly aggregation of 100 GB is removed from Cisco Service Control Subscriber Manager after consuming 50 GB, when the subscriber logs in again, the subscriber gets a fresh monthly aggregation of 100 GB.

Aggregation Period Changeover

Figure 2-2 shows the actions taken for each subscriber when a new aggregation period begins.

Figure 2-2 Aggregation Period Changeover



In Figure 2-2, the subscriber is logged in and consumes quota.

1. The top half of the figure shows the Cisco SCE generating the remaining quota indications and the SM removing the used quota from the subscriber buckets.
2. According to the package and the associated quota profile, a new aggregation period starts.
3. After the start of the new aggregation period, the Cisco SCE sends a remaining quota indication.

4. When the Cisco Service Control Subscriber Manager receives a remaining quota indication, it replenishes the subscriber buckets with the quota amounts defined by the quota profile.

**Note**

Owing to the configuration of the Cisco SCE, the first remaining quota indication may not occur immediately when the new aggregation period begins. This period of time is highlighted in blue in [Figure 2-2](#). The quota consumed in this time period is consumed from the quota allocated to the previous aggregation period. The inaccuracy of the quota value is less than or equal to the quota dosage and is dependent on the rate of the remaining quota indications. This is a limitation of the application.

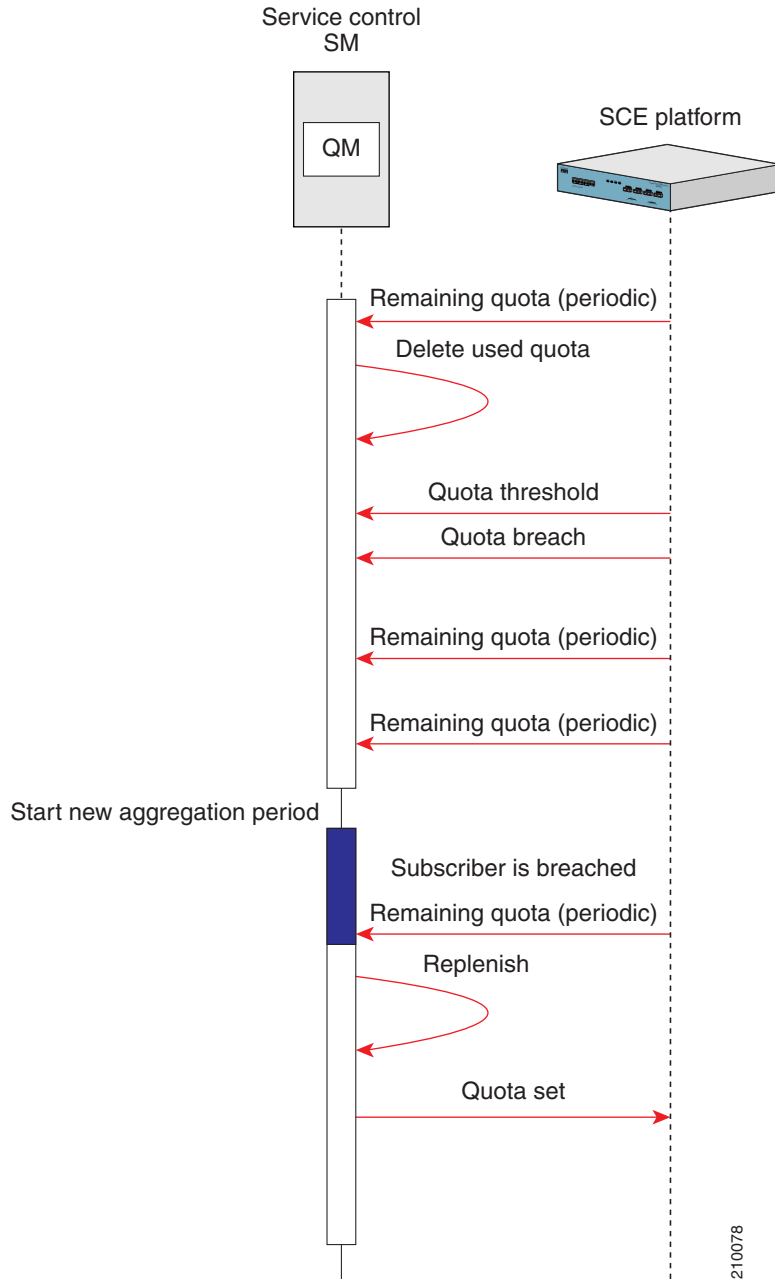
**Note**

If the rate at which remaining quota indications are sent is high, the subscriber quota is replenished at a time in close proximity to the new aggregation period start time. However, this increases the number of management messages on the network.

Quota Breach

Figure 2-3 shows the actions taken in the event that a subscriber completely depletes the quota.

Figure 2-3 Quota Breach



In Figure 2-3, the subscriber consumes data from the quota buckets and the Cisco SCE generates the quota indications.

1. When the quota reaches a configurable threshold value, the Cisco SCE sends a quota threshold indication.

2. In cases in which the subscriber can be granted more quota, a quota set operation is performed. In [Figure 2-3](#), no more quota is available for the subscriber.
3. The subscriber continues to consume quota until the quota buckets are empty. The Cisco SCE sends a quota breach indication when the quota buckets are empty. At the same time, the post-breach action, which was configured in the Cisco SCA BB console, is applied to the subscriber.
4. After a new aggregation period starts, the subscriber is eligible for more quota. However, quota is replenished only after the quota manager receives the remaining quota indication.
5. After the quota is replenished, a quota set operation is performed if the extra consumption reported by the Cisco SCE in remaining quota indication is greater than MAX_DOSAGE (1 GB). If the extra consumption reported by the Cisco SCE in remaining quota indication is lesser than MAX_DOSAGE (1 GB), a quota add operation is performed and the subscriber can continue consuming quota.

**Note**

Owing to the configuration of the Cisco SCE, the first remaining quota indication may not occur immediately after the new aggregation period begins. This period of time is highlighted in blue in [Figure 2-3](#). Because the subscriber is breached and the first remaining quota indication has not arrived, the subscriber is not able to consume quota. This is the only case in which quota inaccuracy is not in favor of the subscriber.

Maximizing Quota Accuracy

One of the most important aspects of the Cisco Service Control Quota Manager is accuracy of the quota levels for any subscriber. When you provision quota by using an external server, a trade-off exists between quota accuracy and the number of network messages.

To maximize accuracy, configure the rate of the periodic remaining quota indication to a high value, and configure the size of the quota dosage to a small value. A configuration causes performance degradation because of the high number of messages being generated in the network.

Quota inaccuracies may occur during the changeover from one aggregation period to the next, or because an Cisco SCE failover. The level of inaccuracy depends on the configuration of the following parameters:

- Rate of the periodic remaining quota indications
- Quota dosage value

During an aggregation period changeover, the following occurs until the first quota indication is received in the new aggregation period:

- The quota consumed by the subscriber is subtracted from the previous aggregation period.
- The quota dosage value limits the size of any quota error.
- The interval between the remaining quota indications limits the length of time during which the consumed quota is subtracted from the previous aggregation period.

In cases of Cisco SCE failover, the following occurs between the last quota indication in the failed Cisco SCE and the first quota indication in the new, active Cisco SCE:

- Any quota consumed by the subscriber is not removed from the subscriber buckets.
- The quota dosage value limits the size of any quota error.
- The length of time during which quota is consumed is limited by the interval between the remaining quota indications.

In all cases of inaccuracy, the quota remaining is calculated in favor of the subscriber. The only exception is if the aggregation period changeover occurs when the subscriber quota is already breached.

Cisco Service Control Subscriber Manager Startup Sequence

The Cisco Service Control Subscriber Manager startup sequence is as follows:

1. The network model notifies the Cisco Service Control Quota Manager with a list of new Cisco SCEs added to the configuration.
2. The Cisco Service Control Quota Manager creates a PPRC_SCESubscriberApi instance for each new Cisco SCE added to the configuration.
3. The Cisco Service Control Quota Manager creates a QuotaListenerImpl instance and registers it on the API instance for each new Cisco SCE added to the configuration.
4. The active Cisco Service Control Subscriber Manager connects to all the Cisco SCEs using the API instance. The standby Cisco Service Control Subscriber Manager does not connect.
5. The Cisco Service Control Subscriber Manager identifies if the Cisco Service Control Quota Manager configuration file was changed and performs a replenish quota operation for all subscribers based on the Cisco Service Control Quota Manager configuration file changes.

EM Agent Startup Sequence

The EM agent startup sequence is as follows:

1. The SCAS_BB MBean registers:
 - The QuotaRdrListener on the RDR server MBean to manage the quota RDRs received from the SML.
 - The QuotaOperationHandler on the SCESubscriberApiMBean to handle quota updates received from the Cisco SCE Subscriber API.
2. After the QuotaRdrListener and the QuotaOperationHandler are registered, SCESubscriberApiMBean waits for incoming PPRC connections from the Cisco Service Control Quota Manager.

Subscriber Login

When a subscriber tries to login:

1. The Cisco Service Control Subscriber Manager logs in the subscriber to the Cisco SCE.
2. The SML detects the login and generates a quota-state-restore RDR for the subscriber.
3. The QuotaRdrListener receives the RDR and generates a PPRC quota-state-restore notification by using the SCESubscriberApiMBean.
4. The Cisco Service Control Quota Manager receives the notification and checks the existing quota for the subscriber on all buckets.
5. If quota is available for the subscriber, the Cisco Service Control Quota Manager invokes the quotaUpdate operation.
6. The SCESubscriberApiMBean manages the invocation and asks the QuotaOperationHandler to add the quota.
7. The QuotaOperationHandler updates the quota for the subscriber on the Cisco SCE (by using the quota-add operation).

Subscriber Logout

When a subscriber tries to log out:

1. The Cisco Service Control Subscriber Manager logs out the subscriber from the Cisco SCE.
2. As a result of the logout, the SML generates a remaining-quota RDR (with reason 1).
3. The QuotaRdrListener receives the RDR and generates a quota-status PRPC notification using the SCESubscriberApiMBean.
4. The Cisco Service Control Quota Manager receives the notification, compares the current quota with the last reported quota of the Cisco SCE, and decrements the difference between the current quota and the last reported quota.

Quota-Status Notification

The SML periodically generates a remaining-quota RDR (reason 0):

1. The QuotaRdrListener receives the RDR and generates a quota-status PRPC notification by using the SCESubscriberApiMBean.
2. The Cisco Service Control Quota Manager receives the notification, compares the current quota with the last reported quota of the Cisco SCE, and decrements the difference between the current quota and the last reported quota.
3. If the current quota is negative, the Cisco Service Control Quota Manager checks whether more quota is available, and invokes quotaUpdate (PRPC invocation) if more quota is available.
4. The SCESubscriberApiMBean manages the invocation and asks the QuotaOperationHandler to add the quota.
5. The QuotaOperationHandler updates the quota for the subscriber (by using the quota-add operation).

Quota Below Threshold Notification

When the SML generates a quota-below-threshold RDR:

1. The QuotaRdrListener receives the RDR and generates a PRPC notification by using the SCESubscriberApiMBean.
2. The Cisco Service Control Quota Manager receives the notification, compares the current quota with the last reported quota of the Cisco SCE and decrements the difference between the current quota and the last reported quota.
3. The Cisco Service Control Quota Manager then checks whether more quota is available, and invokes quotaUpdate (PRPC invocation) if additional quota is available.
4. The SCESubscriberApiMBean manages the invocation and asks the QuotaOperationHandler to add the quota.
5. The QuotaOperationHandler (of SCAS_BB MBean) updates the quota for the subscriber (by using the quota-add operation).

Quota Depleted Notification

When the SML generates quota-breach (quota-depleted) RDR:

1. The QuotaRdrListener receives the RDR and generates a PRPC notification by using the SCESubscriberApiMBean.
2. The Cisco Service Control Quota Manager receives the notification, compares the current quota with the last reported quota of the Cisco SCE, and decrements the difference between the current quota and the last reported quota.
3. The Cisco Service Control Quota Manager then checks whether more quota is available, and invokes quotaUpdate (PRPC invocation) if additional quota is available.
4. The SCESubscriberApiMBean manages the invocation and asks the QuotaOperationHandler to add the quota.
5. The QuotaOperationHandler updates the quota for the subscriber (by using the quota-add operation).

Quota Replenishment

Quota replenishment occurs in the following scenarios:

- A new aggregation period occurs when the number of the slice is equal to 1 (old quota model support).
- The first quota notification occurs in the life of a subscriber.
- When the Cisco Service Control Quota Manager is started. Because the last configuration is not saved, it is not known if the configuration was changed. The Cisco Service Control Quota Manager assumes that the configuration changed and invokes a quota replenishment.
- If the customer configures the global flag `reset_quota_on_profile_change` and one of the following has occurred:
 - The quota profile (packageID) of the subscriber is changed (through SM CLU or because of the move to or out of the penalty package).
 - The static configuration of the quota policies is modified, and a new configuration is loaded on the Cisco Service Control Quota Manager.

Penalty Flows

The subscriber enters the penalty mode when the subscriber uses the entire quota before the window (aggregation period) ends and enters the configured penalty profile for their subscriber package. When such a situation is identified:

- The subscriber is moved to the configured “penalty” package for the configured period of time.
- If configured, subscriber quota usage history before the penalty is kept in the Cisco Service Control Subscriber Manager Database.

When the penalty period passes, the Cisco Service Control Quota Manager checks subscriber usage during the penalty period and moves the subscriber to the post-penalty package according to the configuration. If the subscriber quota usage did not fit any post-penalty threshold, the subscriber stays in penalty for another penalty period.

Penalty Profile

If configured, a penalty profile is applied only if the subscriber breaches the quota in all the active Cisco SCEs. If a subscriber breaches the quota in one Cisco SCE, the subscriber will be in the breached state until the subscriber breaches the quota in all the other active Cisco SCEs.

A Cisco SCE is treated being active for a subscriber if Quota State Restore is generated from that Cisco SCE.

Even when a subscriber is in penalty state, the subscriber may consume a quota that is greater than or less than the bucket size, based on the configuration.

Postpenalty Profile

If configured, a postpenalty profile defines the quota profile to which a subscriber should be moved if the usage during the last aggregation period was lower than the configured threshold.

To define the aggregation period for postpenalty profile, configure the value of the `handle_out_penalty_on_aggregation_period_end` property as true.

The base profile in a quota profile is called a START profile, profiles listed after START profile that contains both penalty profile and postpenalty profiles are called MIDDLE profiles. The profile in which the postpenalty profile is NONE is called the LAST profile.

To configure a valid penalty chain, you must define:

- A penalty profile in the START profile.
- Both the penalty and postpenalty profiles in the MIDDLE profiles.
- A postpenalty profile for the LAST profile.
- The penalty profile as none for the LAST profile.

Removing Cisco SCE from a Configuration

When a Cisco SCE is removed from the configuration:

1. The network model notifies the Cisco Service Control Quota Manager that a Cisco SCE was removed from the configuration.
2. The Cisco Service Control Quota Manager unregisters the quota listener from the removed Cisco SCE and the Cisco Service Control Quota Manager disconnects from the removed Cisco SCE.

Subscriber Manager Failover

When a Cisco Service Control Subscriber Manager fails:

1. The failed Cisco Service Control Subscriber Manager disconnects from each Cisco SCE without unregistering the quota listener.
2. The quota notifications accumulate on the each Cisco SCE internal buffer.
3. The standby Cisco Service Control Subscriber Manager connects to each Cisco SCE and the quota notifications are sent to the new active Cisco Service Control Subscriber Manager.

Cisco SCE Failover

The Cisco Service Control Quota Manager stores the Cisco SCE that sent the last quota notification. When the Cisco Service Control Quota Manager receives a notification from a different Cisco SCE, it does not calculate the quota usage (it ignores the last Cisco SCE bucket sizes, which are not relevant), and updates the last Cisco SCE bucket sizes according to the notification. The quota that was consumed on the failed Cisco SCE since the last notification is not accounted for.

Consumption Quota Allocation Mode with Multiple Cisco SCEs

In this mode, the dosage allocation to the Cisco SCEs is based on the actual quota consumption. `subs1` is the subscriber here.

```
[QuotaProfile.QP11]
packages=11
bucket_sizes=1000
dosage_sizes=500
aggregation_period=30 minutes
penalty_period=none
penalty_profile=none.
```

-
- Step 1** The Cisco Service Control Quota Manager receives a quota-state-restore notification from SCE1 for the subscriber `subs1` with the package11. Because the first QSR quota is not calculated, quota is allocated based on the dosage size mentioned in the `p3qm.cfg` file.

Cisco Service Control Quota Manager remaining Quota = 1000

Last quota reported by SCE = 500

- Step 2** The Cisco Service Control Quota Manager receives a quota-status notification from SCE1, 100 for bucket 1. Because the SCE has a remaining quota of 100, there is no need to provide quota to the SCE.

Cisco Service Control Quota Manager remaining Quota = 600

Last quota reported by SCE = 100

- Step 3** The Cisco Service Control Quota Manager receives a quota-state-restore notification from SCE2 for the subscriber `subs1` with the package11. If the quota available in the Cisco Service Control Quota Manager is greater than 0, Cisco Service Control Quota Manager provides the quota to SCE2.

Cisco Service Control Quota Manager remaining Quota = 600

Last quota reported by SCE = 500

- Step 4** The Cisco Service Control Quota Manager receives NOTIFICATION_TYPE_QUOTA_BELOW_THRESHOLD notification from SCE2, 50 for bucket 1.
- After receiving this notification, the Quota Manager has to decide whether to allocate more quota to the specific SCE or not, for which the QM calculates the remaining quota.
- Remaining quota = 150
 - Minimum of remaining quota and dosage size is allocated to the requested SCE
 - In this case, a quota of 150 is allocated to SCE2
 - SCE1 has a quota of 100 as remaining from the provisioned quota
- QM remaining Quota = 150
Last quota reported by SCE = 50
- Subscriber subs1 on SCE1 can consume its remaining quota of 100 before moving to the breached state, and subs1 on SCE2 can consume the allocated dosage of 150 before moving to the breached state. In this scenario, a subscriber can consume more than the actual bucket size. If SCE1 and SCE2 consume the quota, the total consumed quota will be 1100, which is 100 more than the actual bucket size. This additional consumption needs to be considered as a potential loss for the service provider, if opted for this mode.
- Step 5** If the subscriber consumes the 150 dosage, the subscriber is in breached state on SCE2.
- Because the remaining Cisco Service Control Quota Manager quota is lesser than or equal to 0, the subscriber is in breached state.
- Quota bucket 1 is depleted for the subscriber subs1 until Mon Aug 02 17:12:00 IST 2010.
-

Provisioned Quota Allocation Mode with Multiple Cisco SCEs

In this mode, the dosage allocation is based on the dosages provisioned to the Cisco SCEs when a Quota Request RDR is sent. In this example, the subscriber is subs1 and the configuration is *QuotaProfile.QP11*.

```
[QuotaProfile.QP11]
packages=11
bucket_sizes=1000
dosage_sizes=500
aggregation_period=30 minutes
penalty_period=none
penalty_profile=none.
```

- Step 1** The Cisco Service Control Quota Manager receives a quota-state-restore notification from SCE1 for the subscriber subs1 with the package11.
- Because this is the first QSR, the quota is not calculated. The quota is allocated based on the dosage size mentioned in the p3qm.cfg file.
- Quota Manager remaining Quota = 1000
Last quota reported by SCE = 500
- Step 2** The Cisco Service Control Quota Manager receives a quota-status notification from SCE1, 100 for bucket 1. Because the SCE has a remaining quota of 100, no need to provide quota to the SCE.

Quota Manager remaining Quota = 600

Last quota reported by SCE = 100

Step 3 The Cisco Service Control Quota Manager receives a quota-state-restore notification from SCE2 for the subscriber subs1 with the package11.

The quota is calculated as per the following formula and is provisioned to sce2:

Available quota in Quota Manager - Remaining quota from all SCEs = Available quota.

In this case, $600 - 100 = 500$

Quota Manager remaining Quota = 600

Last quota reported by SCE = 500

Step 4 The Cisco Service Control Quota Manager receives NOTIFICATION_TYPE_QUOTA_BELOW_THRESHOLD from SCE2, 50 for bucket 1.

The quota is calculated as per the following formula:

Available quota in Quota Manager - Remaining quota from all SCEs = Available quota.

The quota is provisioned to sce2.

In this case, remaining quota = $600 - 450 = 150$; $150 - (100 + 50) = 0$

Remaining quota from SCE1 is 100

Remaining Quota from SCE2 is 50

QM remaining Quota = 150

Last quota reported by SCE = 50

Because there is no free quota available in the Cisco Service Control Quota Manager, no quota is allocated to SCE2. If sub1 consumes the remaining quota (50), sub1 is moved to breached state in SCE2 and a subscriber will be in normal mode in SCE1, until the remaining quota is consumed.

Step 5 If the subscribers logs out of SCE1 without consuming the quota, the remaining chunk of the provided dosage should be considered as a potential loss to the subscriber, after moving the subscriber into breached state in SCE2.

Quota bucket 1 is depleted for subscriber subs1 until Mon Aug 02 17:12:00 IST 2010.
