


Cambium Networks™




QUICK START GUIDE

QoE Appliance

Release 4.20

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Contents

Chapter 1: About This Guide

This Quick Start Guide assists operators in acquiring a high-level understanding of the following QoE platform:

- Hardware
- Installation method
- Initial login procedures
- Configuration.

Chapter 2: Product Description

The QoE product provides a centralized traffic management solution that allows the Wireless Internet Service Provider (WISP) operator to manage network traffic. The following operations can be configured by QoE:

- **Application-level shaping**: to limit the rate of certain applications.
- **Subscriber rate limiting**: to limit the subscriber rate.
- **TCP optimization**: to optimize TCP flows by working as TCP a proxy that manages the TCP sessions by:
  - Acknowledging TCP packets on behalf of the receiver
  - Retransmitting TCP segments on behalf of the sender
  - Controlling the TCP flow to increase or decrease the session rate based on the session health.
- **Denial of Service (DoS) attack detection**: QoE can be configured to detect DoS and generate a report for the potential attacks. It does not act on the attack. It does not mitigate and block the attack.
- **Application Insight**: QoE provides an insight into the traffic consumed by applications.

The Advantech FWA-1112VC hardware, when running on QoE, can manage and accelerate traffic up to 1 Gbps.

Chapter 3: Hardware Configuration

This chapter describes the hardware configuration of the QoE appliance.

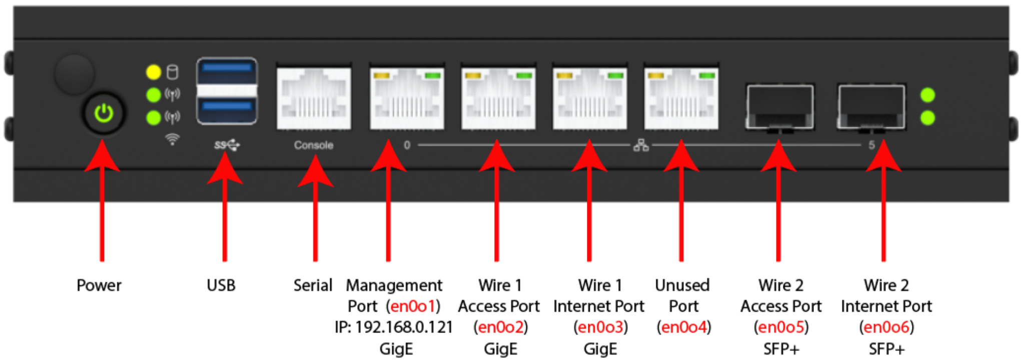


Figure 1: *QoE hardware -Front view*

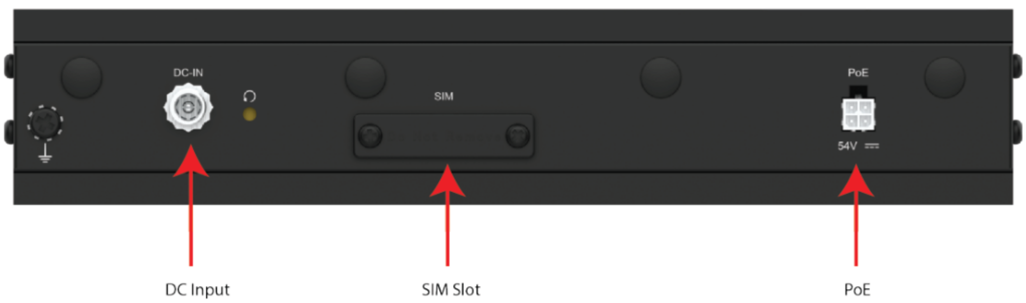


Figure 2: *QoE Hardware -Rear view*

The default QoE appliance configuration of the system are explained in Table 1.

Table 1: QoE appliance configuration

Port number	Description
0	Management port: 192.168.0.121/24, gateway: 192.168.0.1, no VLAN.
3	Port en0o4 is not configured and should not be used.
1 and 2, 4 and 5	The remaining port pairs are bridged to form a wire, as follows: • Ports (en0o2 and en0o3) for Wire 1 which is GigE (1 G) • Ports (en0o5 and en0o6) from Wire 2, which is SFP+ (10 G)

The default QoE configuration is explained in Table 2.

Table 2: QoE configuration

Port number	Description
1	Port (en0o2): AP interface of Wire 1. APs are connected to this port.

Port number	Description
2	Port (en0o3): Internet interface of Wire 1. The Internet interface is connected to this port.
4	Port (en0o5): AP interface of Wire 2. APs shall be connected to this port.
5	Port (en0o6): Internet interface of Wire 2. The Internet interface shall be connected to this port.

Attention

Ensure that the APs and the Internet links are connected to the correct port. This is very important for proper TCP acceleration operation. If they are swapped, the TCP optimizer shows a warning message and impacts the optimization performance.

Chapter 4: Network Deployment

The QoE functionality is required to view the subscribers' individual IP addresses (to limit each subscriber's maximum rate). It is important to deploy the QoE platform in a network where there is no NAT between the QoE and the subscribers.

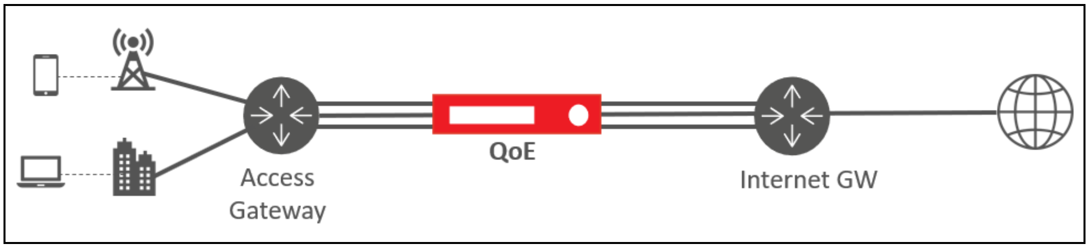


Figure 3: *Network deployment*

It is recommended that a bypass path is established between the neighboring nodes of the QoE (Access and Internet Gateways in the diagram above). If there is a failure in the active link or the QoE, the traffic is automatically steered through the bypass path. Such bypass link can be set up at layer-2 (Example: Mikrotik's *active-backup* link bonding or an active-backup LACP setup) or layer-3 (Example: OSPF or BGP dynamic routing).

> **Note**
>
> Since the links are established directly between the two neighboring nodes, transparently with the QoE in the middle, the link monitoring mechanism should not be electrical (Example: MII), but based on messages (Example: ARP or fast LACP).

External bypass device

A bypass device is connected to the external links and the QoE. The device triggers an internal bypass if it detects the QoE is down (monitoring takes place through a USB connection between the QoE server and the Niagara). A bypass device is enabled by selecting Normal in **Configuration** > **Interfaces** > **Bypass**. It is also possible to force the bypass from the QoE with the option Forced Bypass in the same screen.

Figure 4 shows the bypass device connection that is connected to the external links and the QoE.

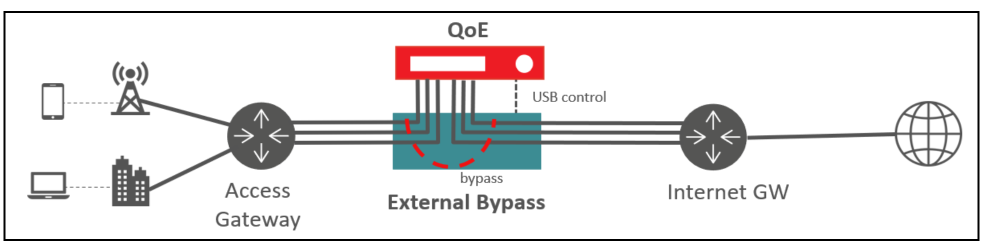


Figure 4: *External bypass device*

> **Note**
>
> Only Niagara devices are supported in this release.

Defining a bypass link

A bypass link can be set up at layer-2 (for example, Mikrotik's active-backup link bonding, or an active-backup LACP setup) or layer-3 (for example, OSPF or BGP dynamic routing). Since the links are established directly between the two neighboring nodes, transparently with the QoE in the middle, the link monitoring mechanism should not be electrical (for example, MII), but based on messages (for example, ARP or fast LACP).

Figure 5 shows how to define a bypass link.

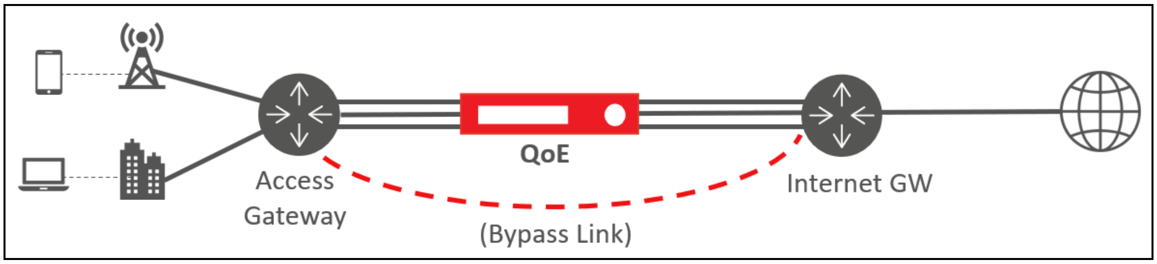


Figure 5: *Defining a bypass link*

Chapter 5: Accessing User Interface (UI)

The QoE has a web-based UI used to perform the common management tasks. Web browsers such as Chrome, Firefox, Safari, and Microsoft Edge are supported. Click the Help icon ( ) on the top-right of the UI to access the corresponding contextual help page.

> **Note**
>
> The MS Explorer browser is not supported.

To access the management UI, navigate to https://192.168.0.121 and type the below username and password.

- **Username**: admin
- **Password**: cambium

The home page has a lateral menu, a dashboard, and a small summary of system information.

The dashboard displays all the icons in **Green**. The network interfaces icon will not be in green until all the configured wires are connected (if there are interfaces that are not used in any of the configured wires, it remains in orange) and the icon traffic will not be in green until traffic flows through the QoE. In some icons, clicking on them navigates to a window with more information about the QoE status.

If Cambium Networks logo is not displayed at the top-left corner of the UI, then refer to **QoE Appliance Installation Guide** and execute the **Step 5** of *Automatic setup* procedure.

An overview of the user interface is given in Figure 6.

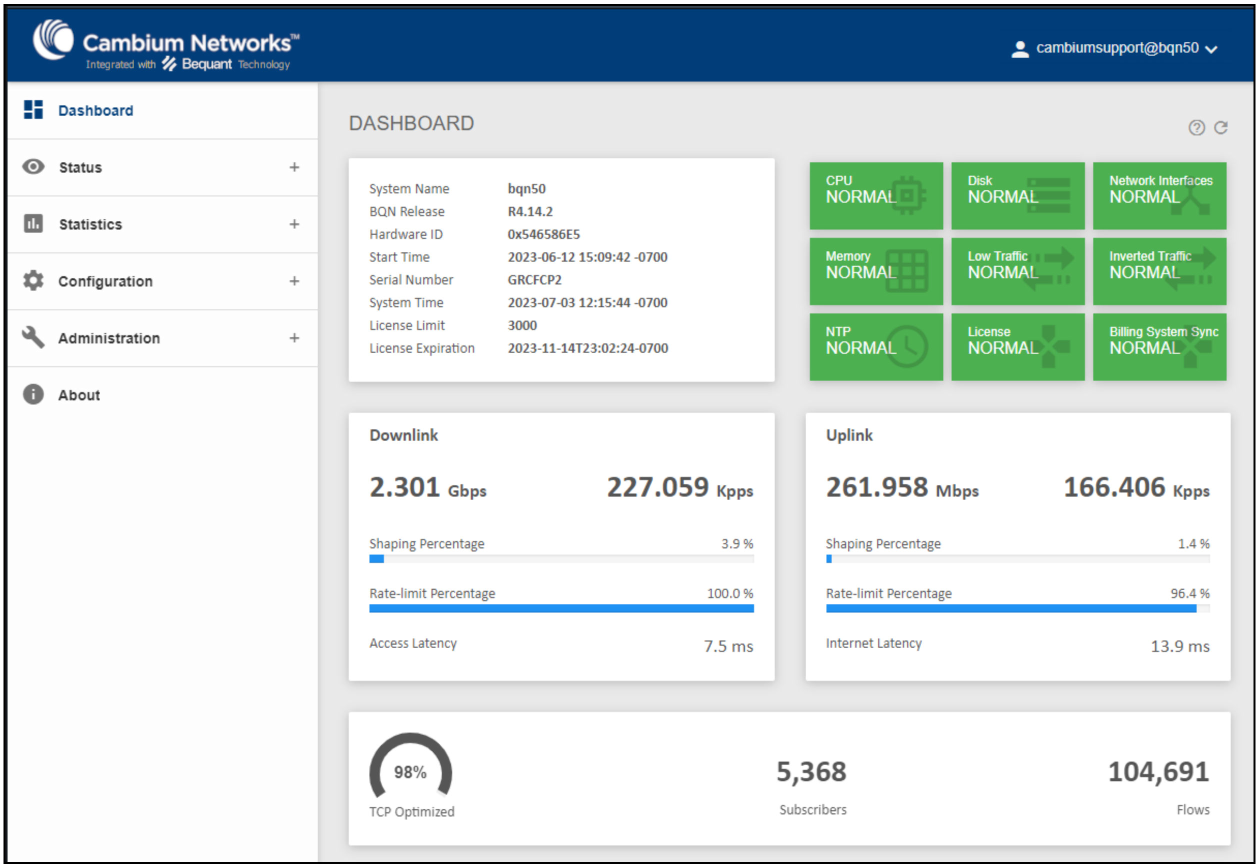


Figure 6: *User interface*

Chapter 6: Configuring QoE

This chapter describes the configuration of the QoE appliance. It includes the following topics:

- Configuring management interface
- Setting timezone
- Setting TCP acceleration
- Wire configuration

Configuring management interface

To change the settings of the management interface, perform the following procedure:

1. Navigate to **Configuration > Interfaces > Management**.

   IP settings include the IP address and mask, the default gateway, and the VLAN identifier (if any).

   > **Note**
   >
   > Configure management network interface to **en0o1**.

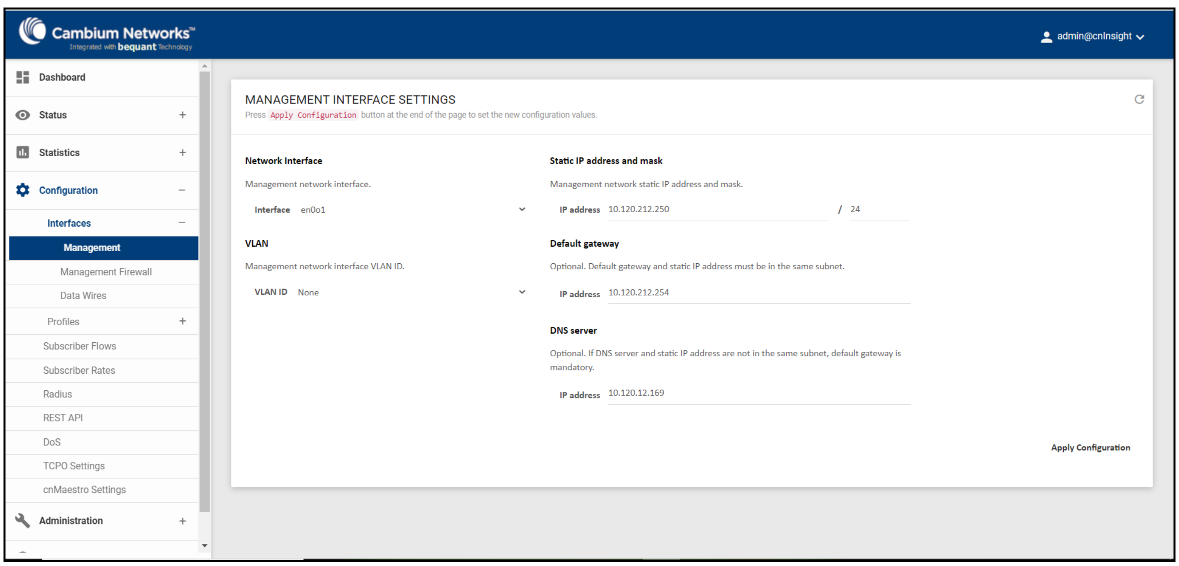
   

   Figure 7: *Configuring management interface*

2. Configure an optional DNS server IP address.

   > **Note**
   >
   > Do not change the network interface used for management, unless indicated by the Cambium Networks support personnel.

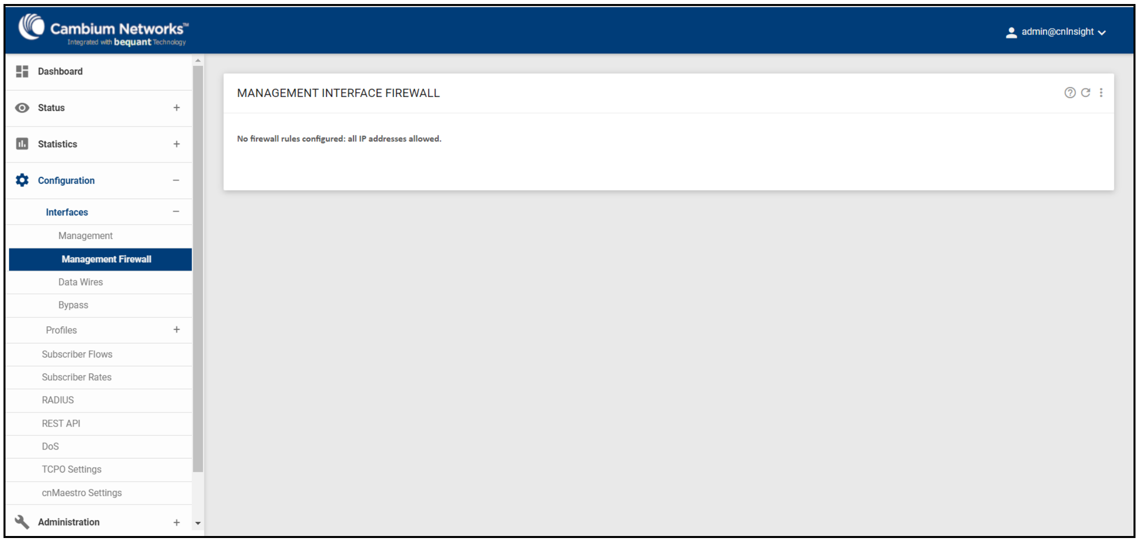
3. After completing the new settings, click **Apply Configuration** to apply the changes.

   Connecting back to the node requires access from the new subnet and logging back into the UI.

Management interface firewall

To set up the management interface firewall, which applies only to the management interface (not to the interfaces configured in wires), perform the following steps:

1. Navigate to **Configuration** > **Interfaces** > **Management Firewall**.



   The IP address ranges allowed to access the management interface is displayed. By default, no IP address ranges are configured, and all are allowed.

2. To add an allowed IP address range, click icon and **Add IP Address Range...**.

   When one IP address range is allowed, the firewall is enabled and all IP addresses not covered by the configured IP address ranges are blocked.

> **Note**
>
> It is important to include an IP address range that includes the IP address from which the user is accessing the UI and the subnet of the management IP address.

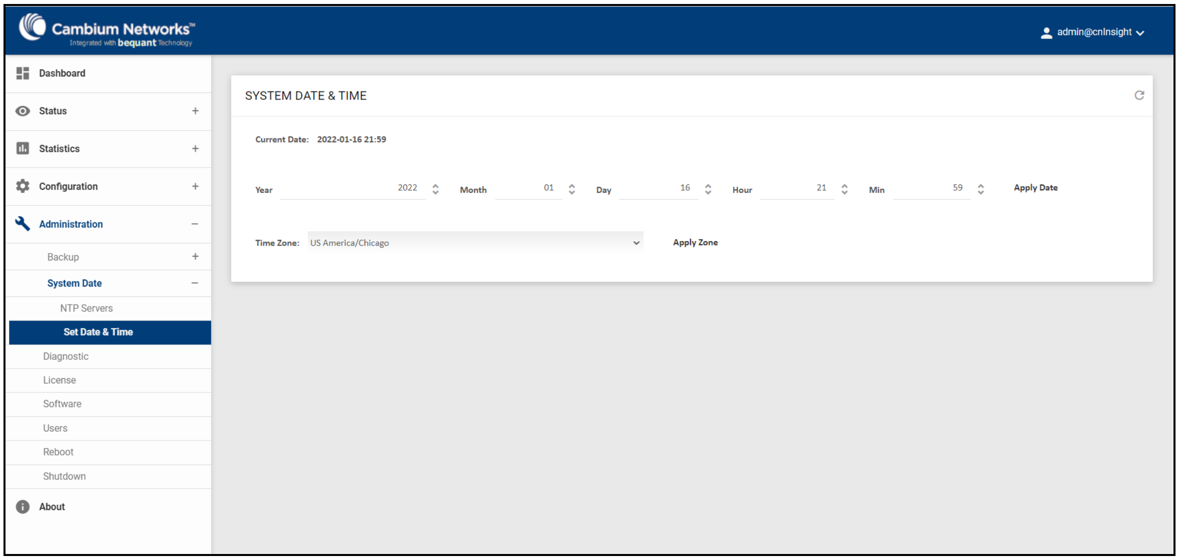
Setting time zone

To change local date and time, click **Apply Date** and **Apply Zone**. Enter initials of the country of interest (for example, ES for Spain) in **System Date & Time** window through the list of time zones. By default, the system is set to **Central Standard Time Zone (Chicago, IL, USA)**.

To change the system time zone, perform the following steps:

1. Navigate to **Administration** > **System Date** > **Set Date & Time** from the home page.

   The **System Date & Time** page appears, as shown below:



2. Set the date and time and, click **Apply Date**.

3. Select the time zone from the drop-down and click **Apply Zone**.

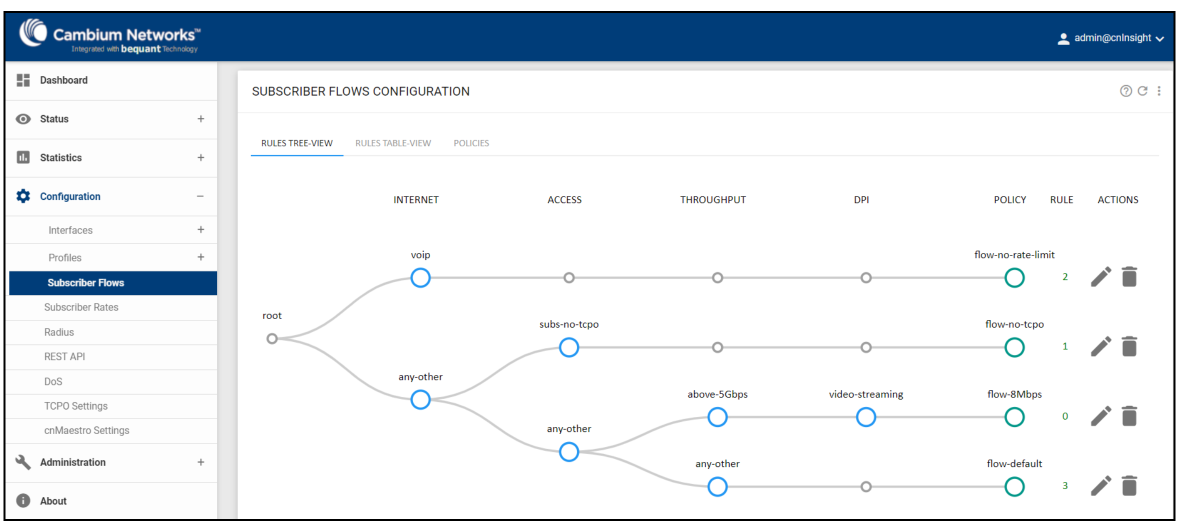
Setting TCP acceleration

By default, TCP Optimization is enabled for all TCP flows. Some TCP flows can be excluded from TCP optimization by turning off the **TCP Optimization** option in the appropriate subscriber flow policy.

To change the TCP Optimization setting, perform the following steps:

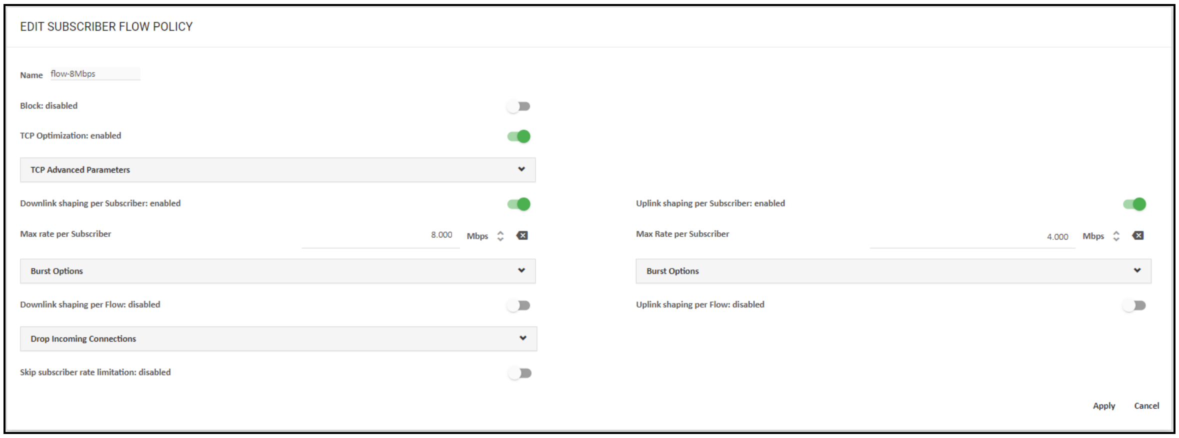
1. Navigate to **Configuration** > **Subscriber Flows** from the home page.

   The **Subscriber Flows Configuration** page appears as shown below:



2. Click the appropriate flow policy (for example, flow-default).

   The **EDIT SUBSCRIBER FLOW POLICY** page appears, as shown below:



3. Enable or disable **TCP Optimization**.

4. Click **Apply** to save the configuration.

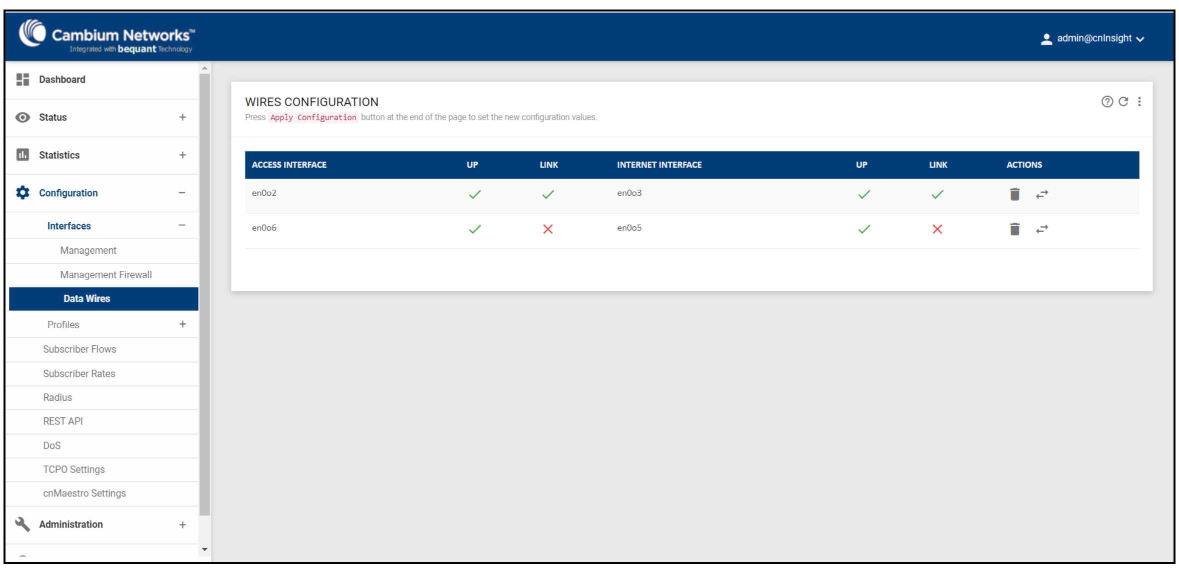
Wire configuration

A wire is a network interface pair processing subscriber traffic.

To configure wires, perform the follwing steps:

1. Navigate to **Configuration** > **Interfaces** > **Data Wires**.

   The **Wires Configuration** page appears as shown below:



Wires are directional, with the first network interface connected to the access towards the subscribers and the second interface on the Internet side.

Warning

If any mistake happens while connecting the ports, then click icon to swap.

2. To add a wire, click ⋮ icon and select **Add Wire...**.

   A form allows selecting the access and Internet interfaces (the form lists the available interfaces).

3. To remove a wire, click delete icon.

> **Note**
>
> Do not delete the wires unless indicated by the Cambium Networks support personnel, as misconfiguration may lead to service loss.

4. Click **Apply Configuration** to apply the changes.

Chapter 7: QoE Functionalities

QoE supports the following functionalities on the traffic processed:

- TCP Optimization (TCPO)
- Limit application speeds on a per-application basis (shaping)
- Limit the maximum total speed of a subscriber (rate plan management)
- DoS attacks detection
- Usage monitoring per subscriber and per application

Basic concepts for QoE configuration

All IP data packets that flows through QoE belong to a subscriber and a flow. The QoE acts on traffic grouped per subscriber and per flow.

- **A subscriber** refers to an IPv4 address on the access side, or any IPv6 address from the same or 64 subnet on the access side. Refer to Subscriber Identification section for more details.
- **A flow** is a TCP connection, a UDP flow, or a flow with another protocol (for example, ICMP ping). A subscriber can have many flows at the same time.

To decide the corresponding functionality to the flows or subscribers, QoE uses the following three concepts:

- **Policies** define the actions to perform on the traffic, along with action parameters (for example, a speed limit).
- **Profiles** classify the traffic according to certain criteria (for example, an access profile identifies all the traffic from subscribers whose IP address is within the set of IP address ranges in that access profile).
- **Rules** relate to policies and profiles (for example, a rule may specify that some specific access profiles are limited by a rate policy. That is, subscribers whose IP addresses are in same subnet which contain a specific rate limit).

Profiles

Profiles classify the traffic and help to determine the rules and policies that are applied to the each subscriber and flow. There are different profile types, according to the properties being used for classification. To configure the profile, navigate to **Configuration** > **Profiles** from the home page.

The current version supports the following profile types:

- **Interface Profile** identifies the flows or subscribers whose first data packet comes in through a network interface within the list of network interfaces specified by the interface profile.
- **VLAN Profile** identifies the flows or subscribers whose first data packet uses a VLAN tag within the set of VLAN tags (or the absence of any tag) specified by the VLAN profile.

- **Policy-Rate Profile** is used to select the Flow Policies based on the Rate Policy of the subscriber. It is a list of Subscriber Rate Policy names, or patterns with wildcards. These profiles match the name of the subscriber rate policy assigned to the subscriber session.

- **Internet Profile** identifies the flows coming from or going to an IP address on the Internet side, contained in the set of IP address ranges specified by the Internet profile. Optionally, Internet side ports can also be specified (for example, port 80).

- **Access Profile** identifies the flows or subscribers coming from or going to an IP address on the access side, contained in the list of IP address ranges specified by the access profile. Optionally, access side ports can also be specified.

- **Time Time-based profile** activates the rule during a period of time. A time profile is a list of time ranges, and it is true if any of the ranges is true. The ranges within the same profile cannot overlap. A range can apply to all days of the week or just to a period of days.

- **Throughput Profile** identifies all the flows, which are created when the total downlink traffic going through the QoE is above the threshold specified by the throughput profile.

- **DPI (Deep Packet Inspection) Profile** identifies the flows that use an HTTP/HTTPS/QUIC. This domain is included in the list of HTTP/HTTPS/QUIC domains specified by the DPI profile. There are a set of pre-defined DPI signatures, which include the domains for popular applications (like the most important video streaming apps or the most common software updates).

Subscriber flow policies

When a new flow is created, a subscriber flow policy is assigned to it, which specifies how to treat all the flows within that subscriber, which share that same policy. The following are the actions that can be defined in a subscriber flow policy:

- **TCP Optimization**: It improves TCP traffic performance. It specifies whether to apply optimization to TCP traffic. It is recommended to set I to ON (the default value).

- **Shaping per subscriber**: It limits the speed to a given value. It is possible to limit the downlink and/or uplink direction. The limit applies to all flows matching the policy belonging to the same subscriber. For example, if a limit of 6 Mbps is specified for video streaming, and the subscriber has three video streaming flows from different servers, the three flows will share the 6 Mbps limit (getting around 2 Mbps for each subscriber). It is possible to define bursts that allow flows to exceed temporally the limit.

- **Shaping per flow**: It limits the speed of one flow to a given value. It is possible to limit in the downlink and/or uplink direction. The limit applies to any flow matching the policy. For example, if video streaming flows are assigned to a per flow 2 Mbps limit, a video flow cannot exceed those 2 Mbps. Shaping per flow can be combined with shaping per subscriber. For example, if there is a per subscriber 6 Mbps limit, and a 2 Mbps per flow, a subscriber with four flows has them limited to the 6 Mbps maximum (around 1.5 Mbps for each subscriber). Per flow shaping has no burst option. Because per-flow shaping is not applied per subscriber, it can be used even when there is a NAT between the QoE and the end subscribers.

- **Block**: It blocks all flows falling in the blocking policy, in both the directions, and does not allow to proceed. It should be used with care, to avoid affecting traffic different to the one intended.

- **Skip subscriber rate limitation**: The traffic from flows getting this policy does not affected by the rate limitation specified in the rate policy for this subscriber. They only gets the rate limitation specified by this flow policy (if any).

To configure the policies, navigate to **Configuration** > **Subscriber Flows**, and select the **POLICIES** tab.

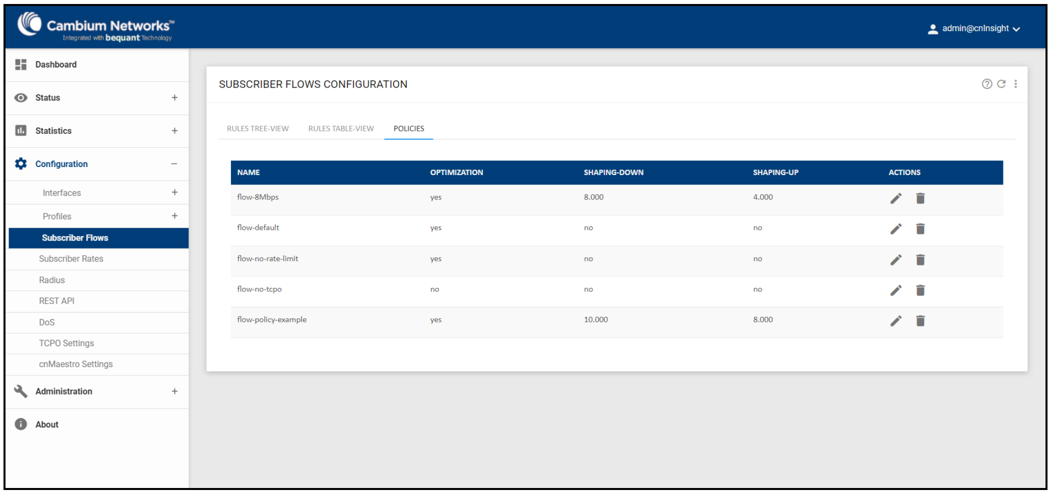


Figure 8: *Subscriber flow policies*

Shaping per subscriber

Figure 9 defines a downlink speed limit of 10 Mbps, an uplink limit of 8 Mbps and bursts of 3 seconds of double the normal speed.

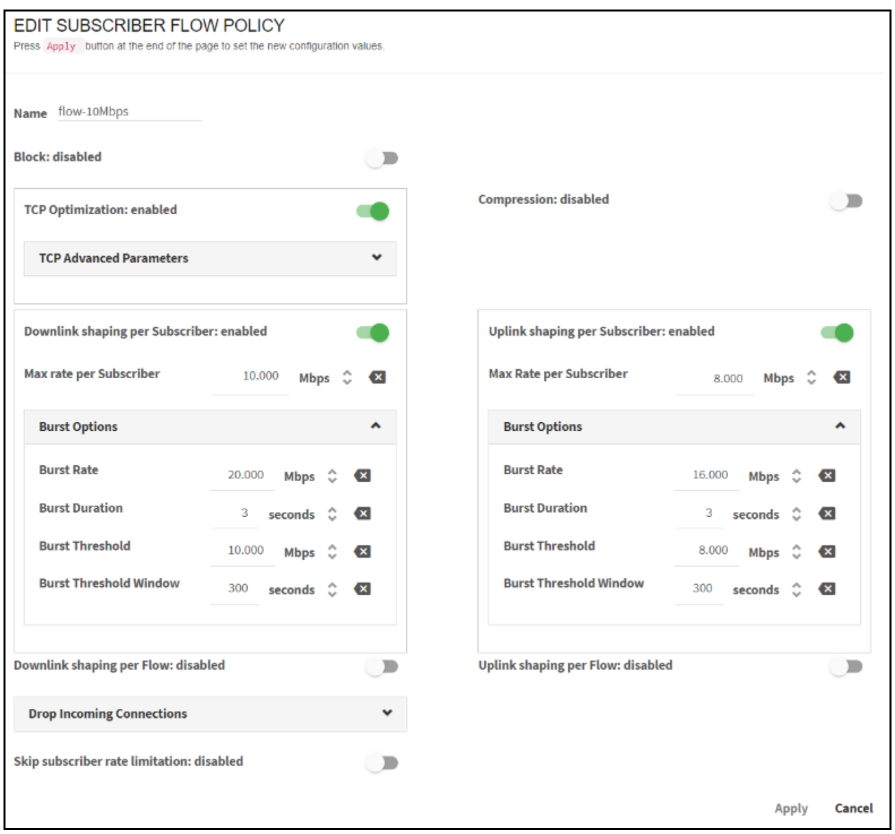


Figure 9: *Shaping per subscriber*

Burst options

Bursts are configured under **Advanced** parameters of the appropriate direction (for example downlink shaping). Figure 10 displays the burst threshold, shaping rate and burst rate.

Burst policy is defined by four parameters:

- **Burst Rate**: Maximum rate during the burst, typically bigger than the normal shaping max rate (Example: allow a burst of 20 Mbps for flows normally limited to 10 Mbps).
- **Burst Duration**: Duration of the burst, for how long the burst rate can be sustained.
- **Burst Threshold**: An average speed that, if exceeded, prevents a new burst from happening. It is the way to control when a new burst can be granted. For example, for a 10 Mbps limit with 20 Mbps bursts, a 5 Mbps burst threshold will require the subscriber flows to drop the speed to half its normal limit before allowing a new burst.
- **Burst Threshold Window**: The period in seconds used to compute the average speed that is checked versus the threshold. The longer the window, the bigger the weight of past subscriber activity on the decision of grating a new burst.

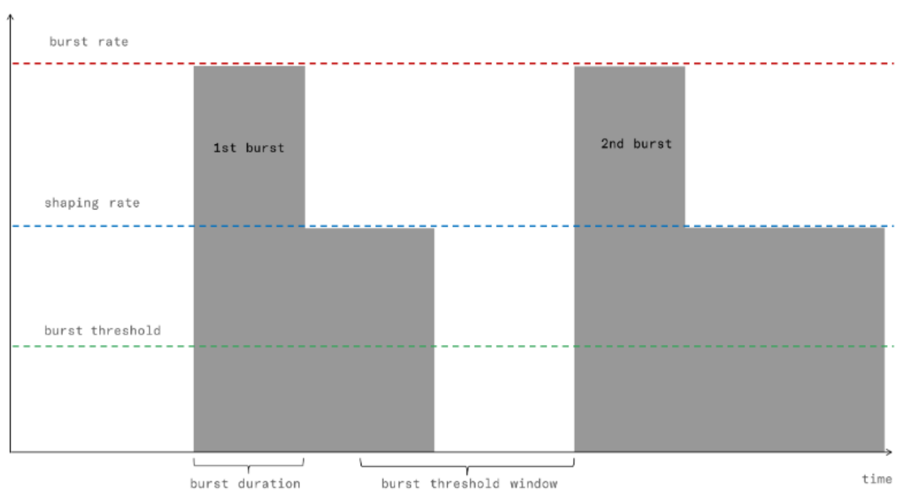


Figure 10: *Burst options*

Shaping per flow

It is possible to add a shaping per subscriber. Per flow and per subscriber shaping limits act at the same time. Per flow shaping limits the speed of individual flows and subscriber shaping limits the combined flow speed per subscriber.

Figure 11 is a policy with a limit per flow of 4 Mbps in either direction.

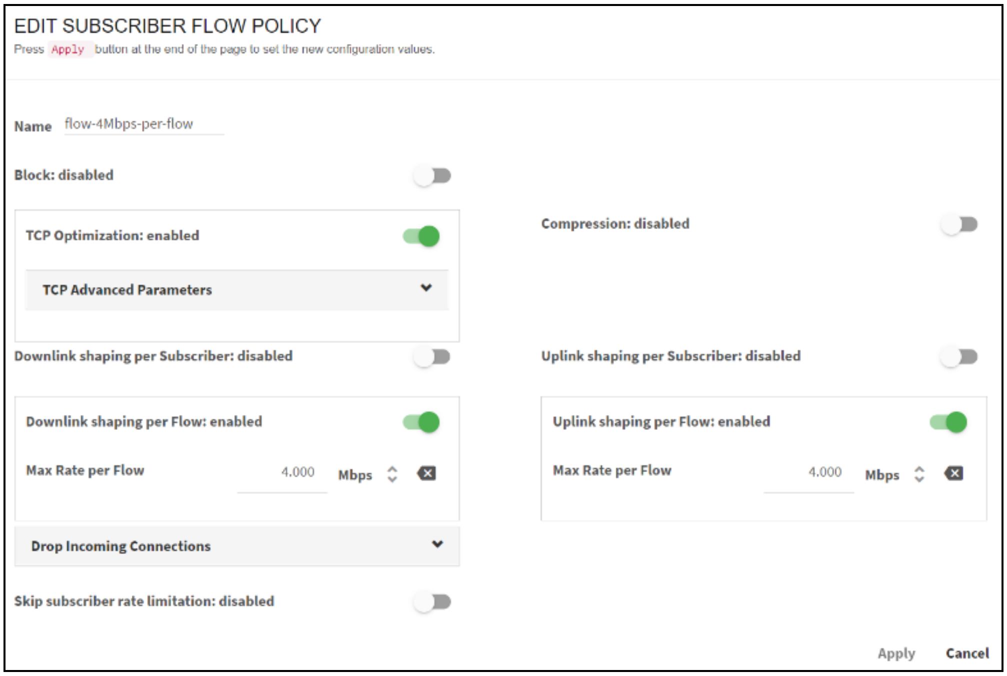


Figure 11: *Shaping per flow*

Blocking incoming traffic

It is possible to block incoming traffic, initiated from the Internet (TCP connections, UDP flows or other IP traffic like ICMP pings). To perform this, there are **Drop Incoming Connections** section as part of a Subscriber Flow policy. Figure 12 displays the blocking incoming traffic options.

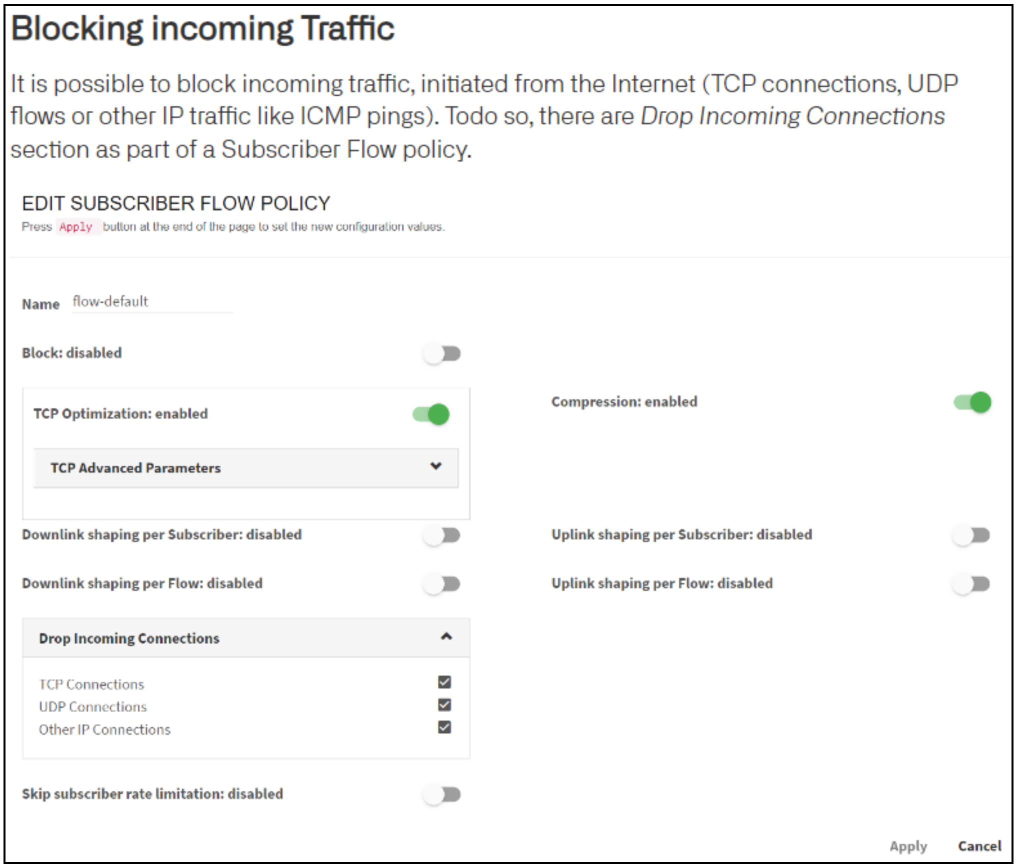


Figure 12: *Blocking incoming traffic*

Subscriber rate policies

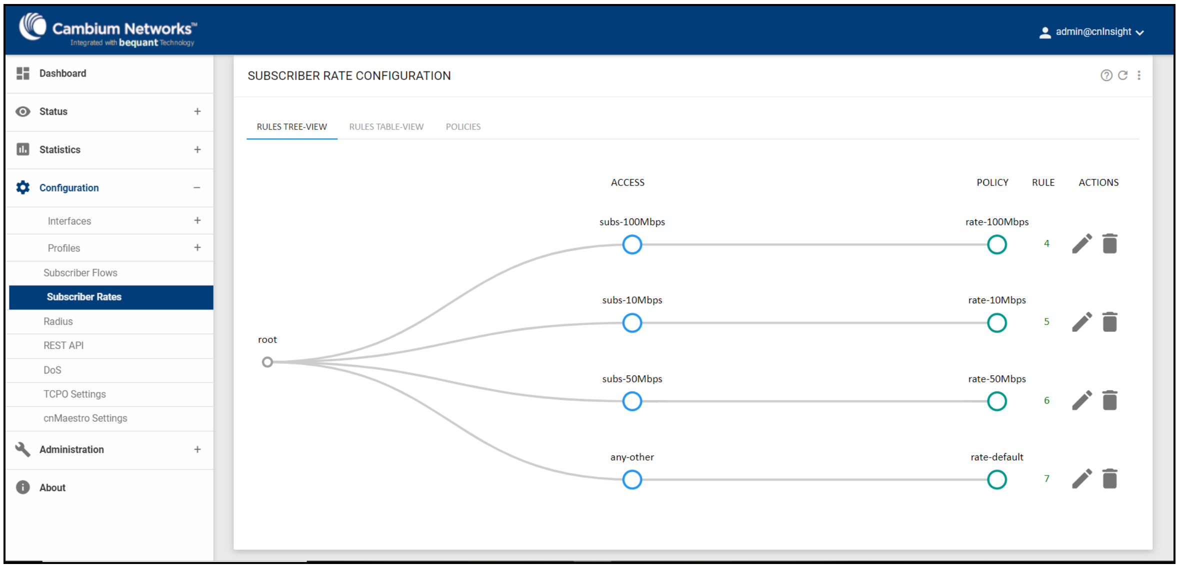
Subscriber rate policies are applied per subscriber. The following are the possible actions:

- **Maximum downlink speed**: The maximum speed in the downlink direction for all traffic going towards the subscriber's IP address.
- **Maximum uplink speed**: The maximum speed in the uplink direction for all traffic coming from the subscriber's IP address.
- Under **Advanced Parameters**, you can find the same burst options as for **Subscriber Flow Policies**.
- There is an **Automatic Congestion Management (ACM)** option, that detects congestion and select a rate limit automatically (off by default).

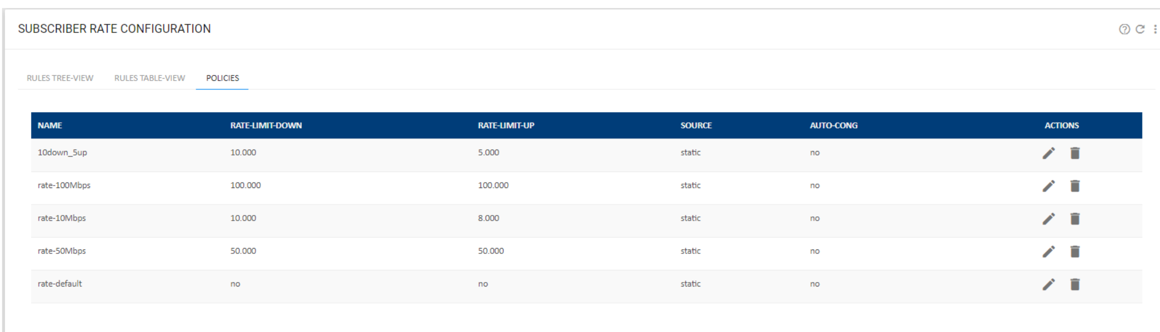
To configure policies, perform the following steps:

1. Navigate to **Configuration** > **Subscriber Rates** from the home page.

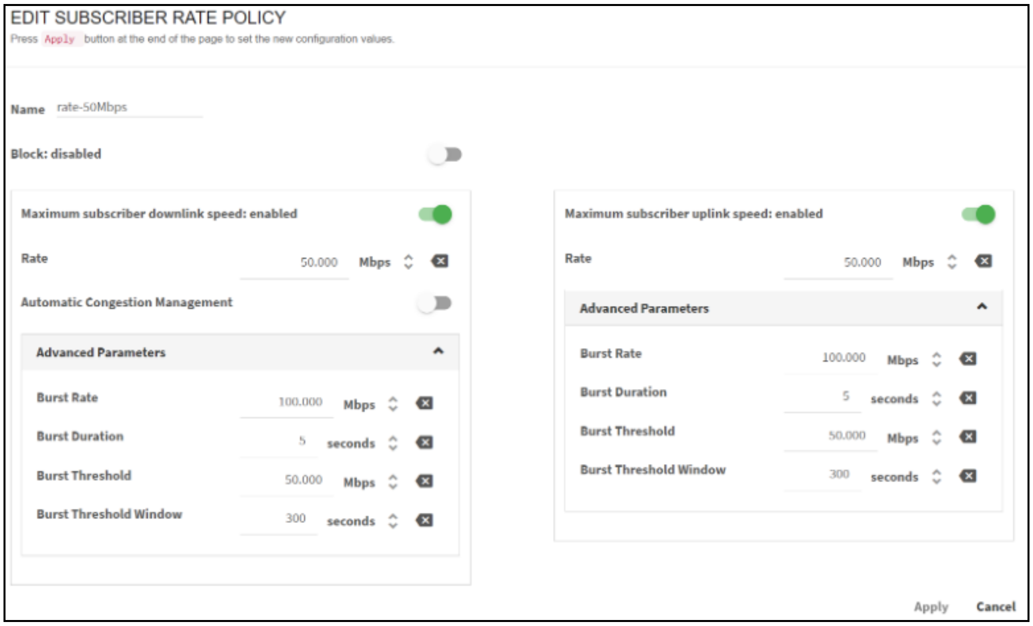
   The **Subscriber Rate Configuration** page appears as shown below:



2. Select the **POLICIES** tab.



3. Click **Edit** icon to configure the policies.



Refer to Subscriber Identification section to know how all the traffic from the same subscriber are identified.

Note

Policy changes takes minimum one minute to make the changes for the existing subscriber sessions.

Automatic Congestion Management (ACM)

When the subscriber rate limits are unknown, then the QoE can automatically detects them using machine learning. So the QoE becomes the bandwidth management element, and the network can be benefited from QoE reduced latencies. The ACM also detects the congestions below the subscriber rate limit when rate limits are known.

To enable the ACM from QoE configured Rate Policies, enable the **Automatic Congestion Management** of a Subscriber Rate Policy (typically the rate-default one). Figure 13 shows enabling ACM from QoE configured Rate Policies tab.

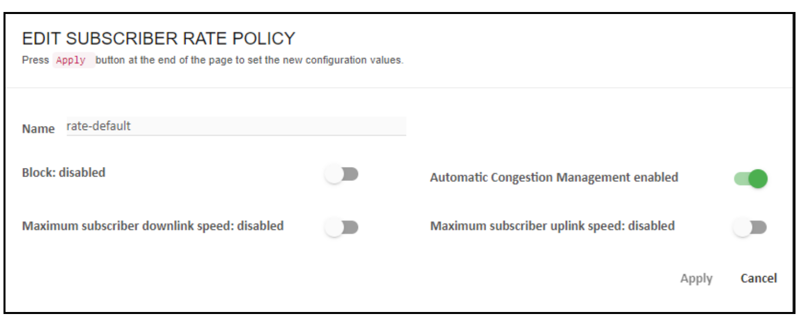


Figure 13: *Enabling ACM from QoE configured Rate Policies tab*

To enable this feature in Dynamic Rate Policies from RADIUS, navigate to **Configuration** > **External Subscriber Data** > **RADIUS** and enable **Automatic Congestion Management**. Figure 14 shows enabling ACM from RADIUS tab.

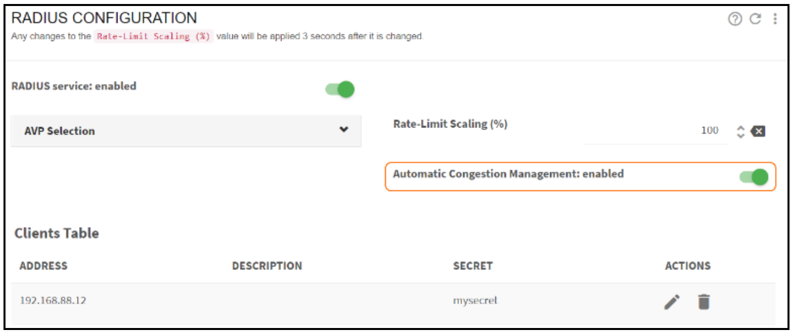


Figure 14: *Enabling ACM from RADIUS tab*

Rules

Rules specify which policies are assigned to each subscriber and flow, as a function of how they match the profiles in the rule.

There are independent sets of rules for each policy type: subscriber flow rules select the appropriate subscriber flow policy for each flow, subscriber rate rules select the appropriate subscriber rate policy for each subscriber.

A rule can use one profile of each type (or use the **any** option, if the profile type is indifferent), and it defines only one policy to apply.

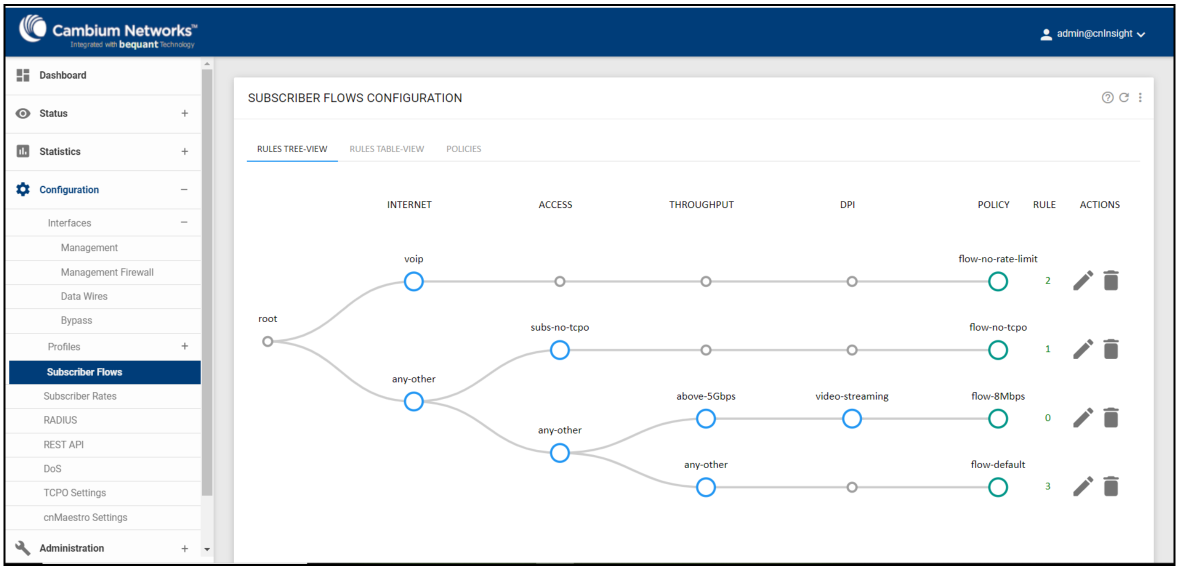
Every set of rules may have many rules, but only the one with the best match will be selected for each flow or subscriber. To evaluate the rules in a way that maximizes performance, profiles are checked in order. This pre-defined order determines which rule is finally selected. A tree-view of the rules helps in identifying which rule is selected in each case. See the *Decision Tree* sections for more information on the trees and the profile evaluation order.

Manually configured rule priorities are not used because of the performance penalties they entail and the burden on the operator to keep priorities consistent.

To configure subscriber flow rules, perform the following steps:

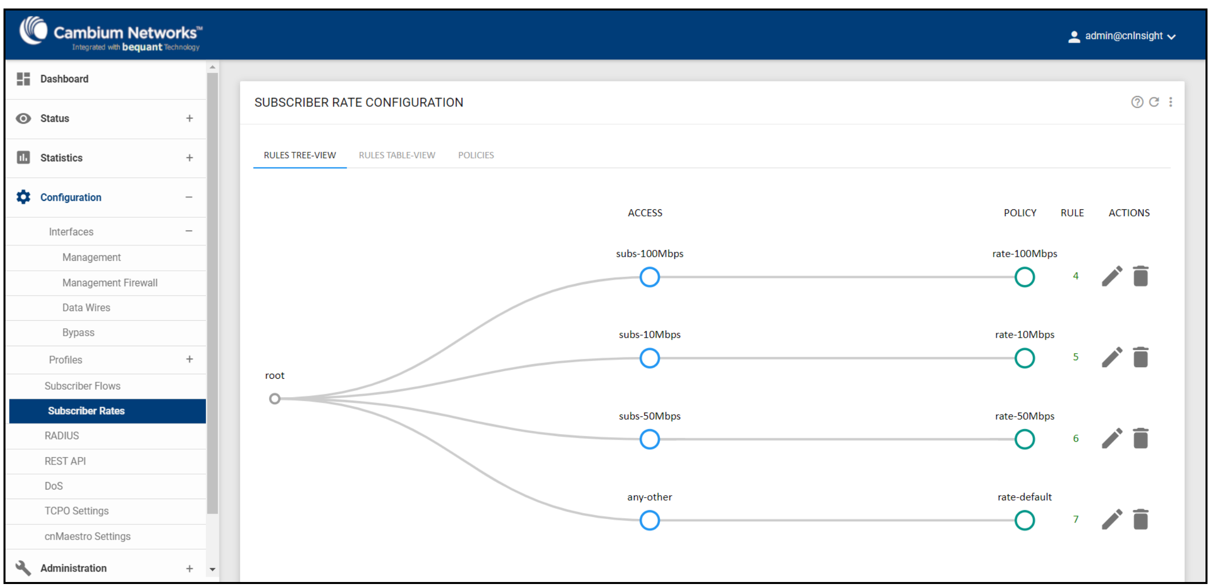
1. Navigate to **Configuration** > **Subscriber Flows** from the home page.

   The **Subscriber Flows Configuration** page appears as shown below:



2. Select **RULES TREE-VIEW** or **RULES TABLE_VIEW** tab.

To configure the subscriber rate rules, navigate to **Configuration** > **Subscriber Rates**.



APIs

The QoE has two APIs to select subscriber rate policies, instead of using the QoE local rules, that act as a default. There are two APIs:

- RADIUS API
- REST API

RADIUS API

When QoE receives a RADIUS accounting indicating that a subscriber with an IP address has a rate policy, that policy is selected independently according to the configured rules. Rules apply only for subscribers without radius information.

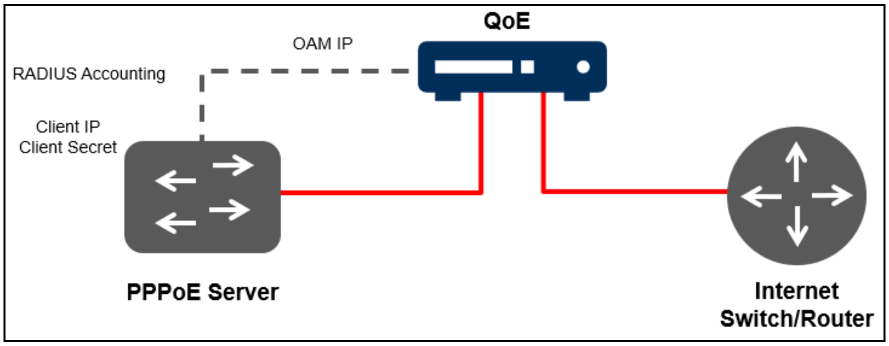


Figure 15: *Radius API*

The QoE receives RADIUS *accounting*, configuring the RADIUS source (for example, a PPPoE server or a RADIUS server) to send accounting information to the QoE management IP address.

In the QoE UI, navigate to **Configuration** > **Radius** and set RADIUS as **ON**. On the top-right corner click ⋮ and select **Add Client...** from the upper-right menu to configure the IP address of the radius accounting source and the secret used.

> **Note**
>
> More than one source can be configured.

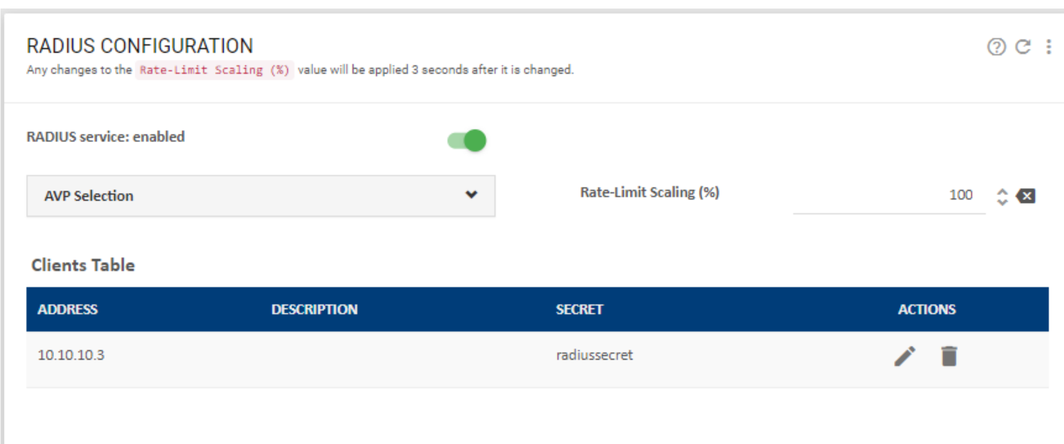


Figure 16: *The RADIUS Configuration page*

The supported **Radius** field specifies the rate policy that is Mikrotik Address List. The address list name must match the name given to the Subscriber Rate policy in the QoE.

REST API

A REST API allows QoE to be integrated into an external system (for example, a billing system) to receive instructions of which rate policy applies to the corresponding subscriber. The REST API is based on

HTTPS GET/POST /PUT/DELETE methods with JSON objects for exchanging information.

The REST API can be used to map policies configured in QoE to subscriber IP addresses. It also supports defining dynamic policies, that takes precedence over any local policy. To configure the REST API, navigate to **Configuration** > **REST API** in the UI.

> **Note**
>
> Add at least one user/password to authenticate rest requests and set the toggle ON. Optionally, the user can define the IP addresses from which the request will be allowed.

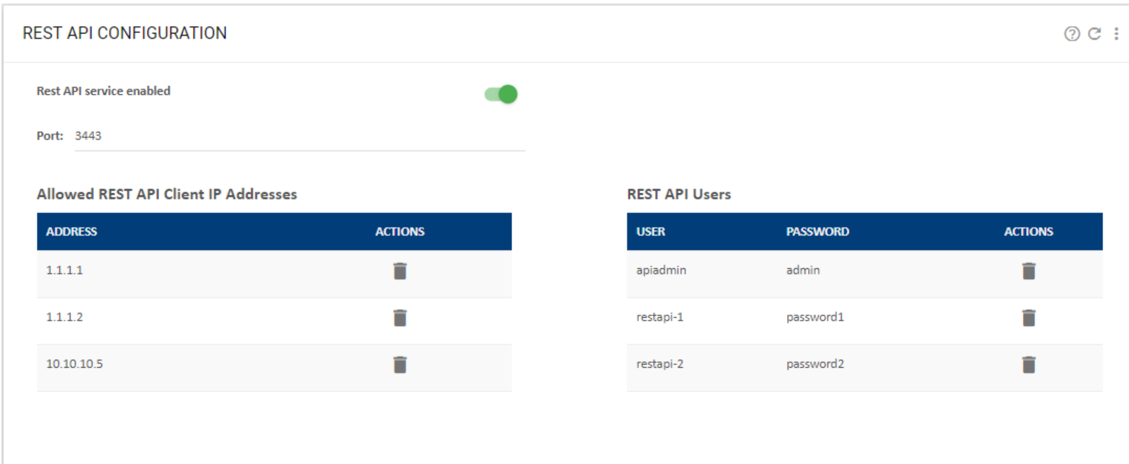


Figure 17: *REST API tab*

For more information on the QoE REST API definition, refer to *QoE Appliance REST API Guide*.

Subscriber identification

For QoE, traffic belongs to the same subscriber if it shares the same IP address on the access side (in IPv4), or if it is from the same /64 subnet on the access side (in IPv6).

If there is a NAT between the QoE server and real subscribers and subscribers whose IP address is translated to the same IP address does not considered as the same subscriber.

A new subscriber is identified when the first packet from an IP address is received. Hereby the subscriber rate rules are evaluated to choose the policies to be applied.

Subscriber flows decision tree

The evaluation of subscriber flow rules are, when a new traffic flow is created (for example, a TCP connection), the profiles in the subscriber flow rule set are checked to determine if the flow matches any of them, and to establish the flow policy to apply.

To view the subscriber flows decision tree, navigate to **Configuration** > **Subscriber Flows** > **Rules Tree View**.

For efficiency, profiles are evaluated in this pre-defined order:

1. Interface
2. VLAN
3. Policy Rate

4. Internet
5. Access
6. Throughput
7. DPI

The profile evaluation order defines a decision tree, whose nodes are the different profiles and with policies as leaves. The tree determines the final rule to be selected, because a rule can be excluded if it belongs to a branch that the decision tree does not follow. It may be the case that a flow matches more than one rule. In that case, the rule matching the Interface profile has a priority over the rule matching the VLAN profile, and so on in the previously specified order.

If two rules have a match with the same type of profile, then the more restrictive profile have the priority. For an example, a flow from a subscriber with IP address 192.168.0.1 matches a rule with an access profile with the 192.168.0.0/24 range and match another rule with an access profile with the 192.168.0.0/16 range, the one with the more restrictive range, is selected.

To facilitate the understanding of this order, the UI includes a graphic representation of the decision tree, where the top-most matching path leads to the selected policy (except when there is more than one match at the same profile level when the most restrictive wins). It is accessible in **Configuration** > **Subscriber Flows** > **Rules** and click the **Rules Tree-View** tab.

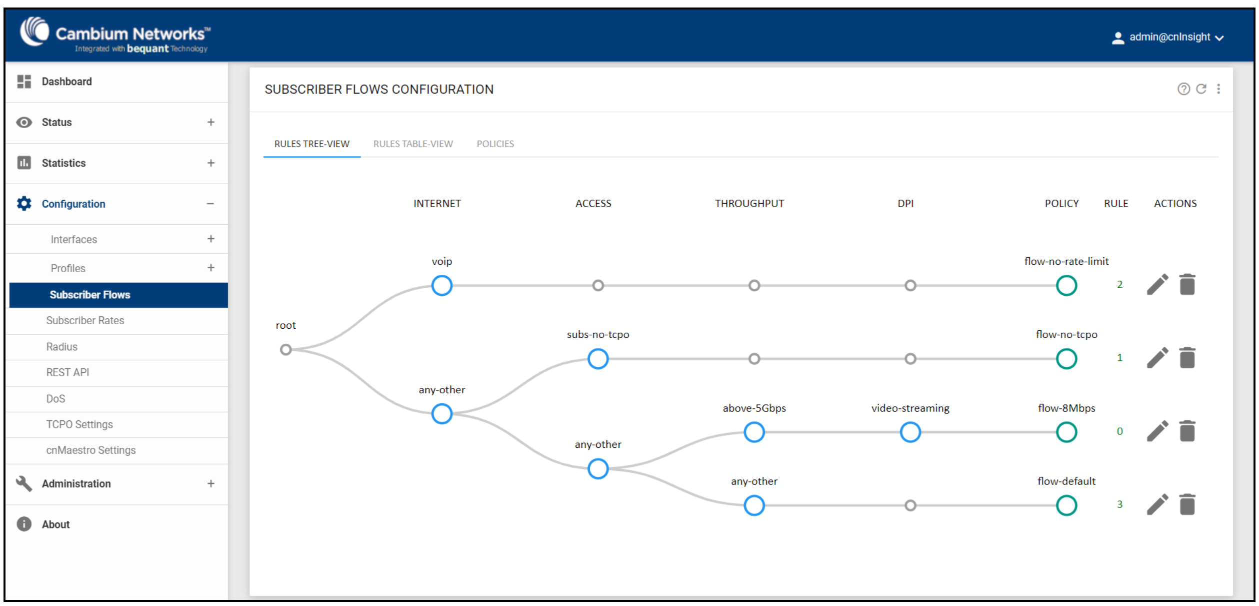


Figure 18: *Subscriber flows decision tree*

If there are common elements in two profiles of the same type and therefore a rule conflict, the decision tree flags it so the rules can be reviewed by the operator and the conflict corrected.

Subscriber rate decision tree

The evaluation of the subscriber rate rules happen if a new subscriber is detected. The profiles are checked to determine which ones are matched by the subscriber and to select the subscriber rate policy to apply. For efficiency, the profiles are evaluated in the following pre-determined order:

1. Interface

2. VLAN

3. Access

In subscriber rate rules, Internet profiles and DPI profiles cannot be used, because such profiles make no sense in policies that apply to all traffic of the same subscriber, regardless of the application.

The decision tree is like the one for subscriber flow rules. From the dashboard page, navigate to **Configuration** > **Subscriber Rate** and select **RULES TREE-VIEW** tab.

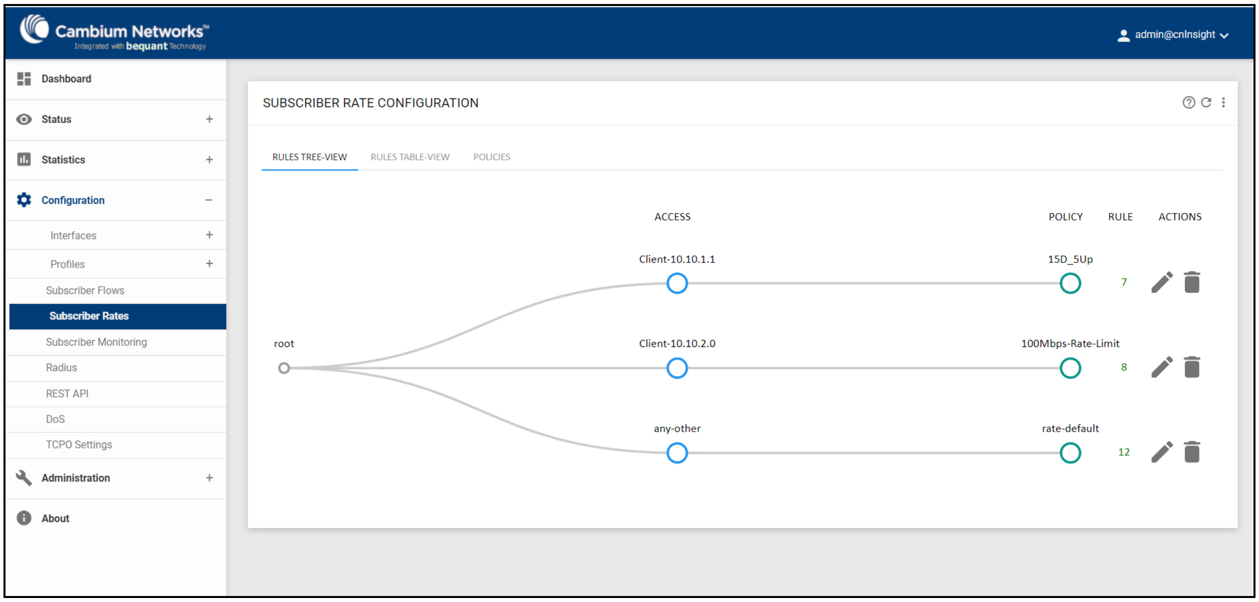


Figure 19: *Subscriber rate decision tree*

Checking the policy and subscribers

This section explains how to check the policy of a subscriber and a subscriber for a policy. From the UI, you can check the policies applied to a subscriber in **Status** > **Subscribers**, based on the IP address. It provides useful information such as:

- Applied subscriber rate policy (*Policy rate*).
- Applied subscriber monitor policy (*Policy monitor*).
- Last measurement of downlink retransmissions in TCP traffic (*Latest downlink TCP RTX rate*) and its average value (*Average downlink TCP RTX rate*).
- Last measurement in milliseconds of the minimum access RTT (*Latest RTT-min*) and historical minimum (*Absolute RTT-min*).

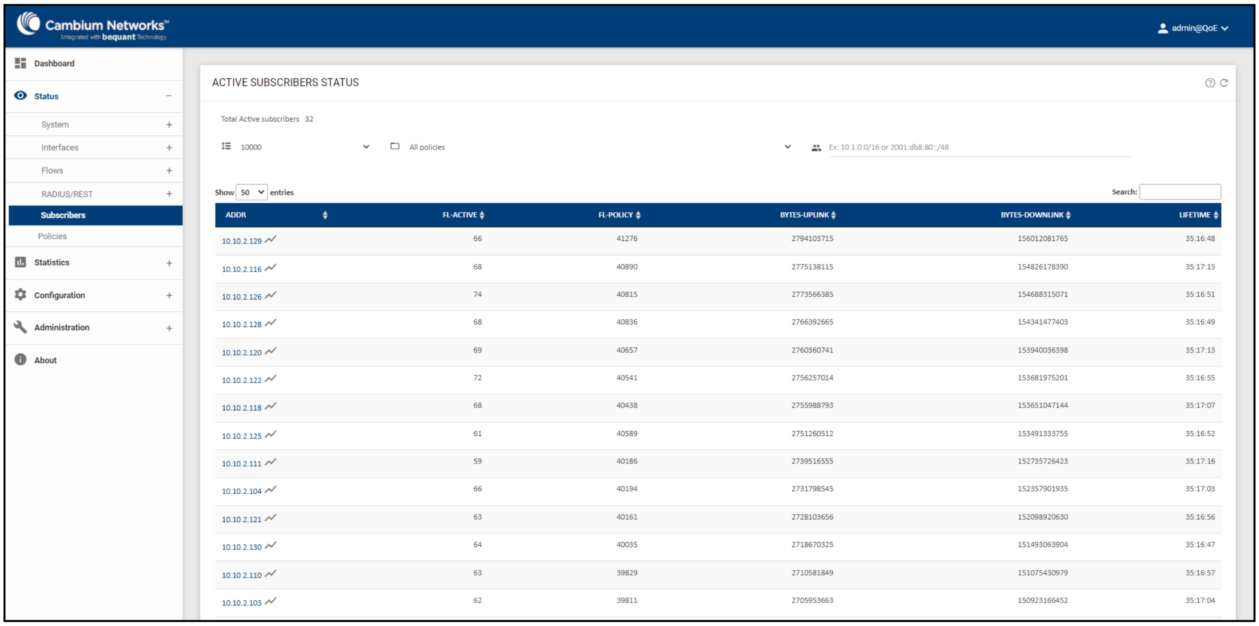
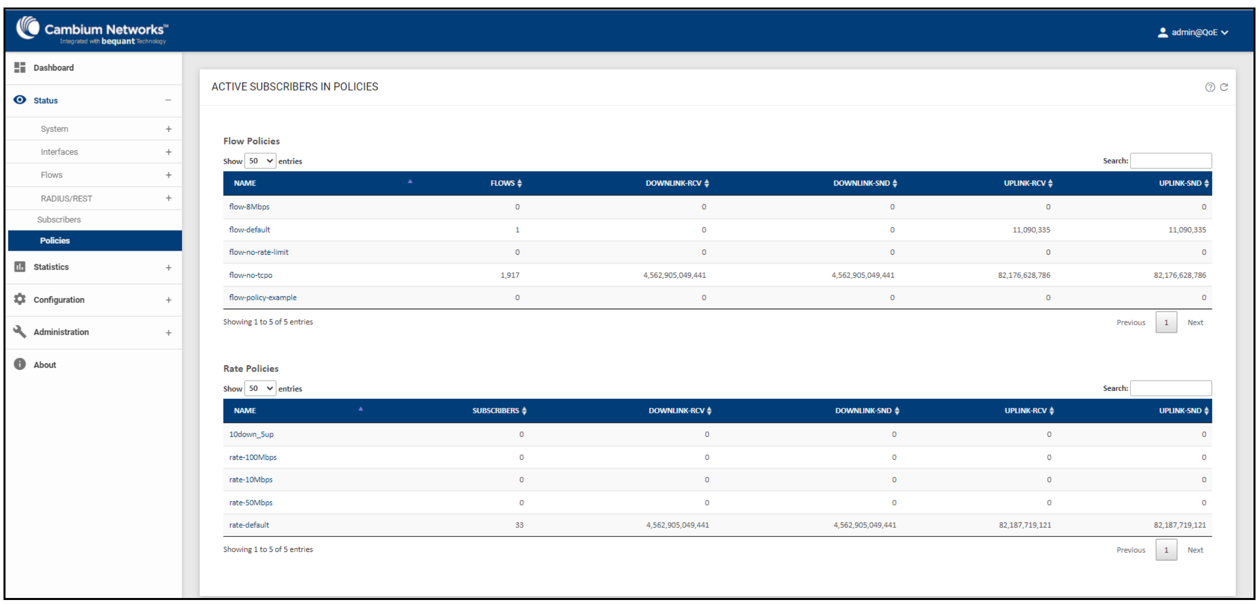
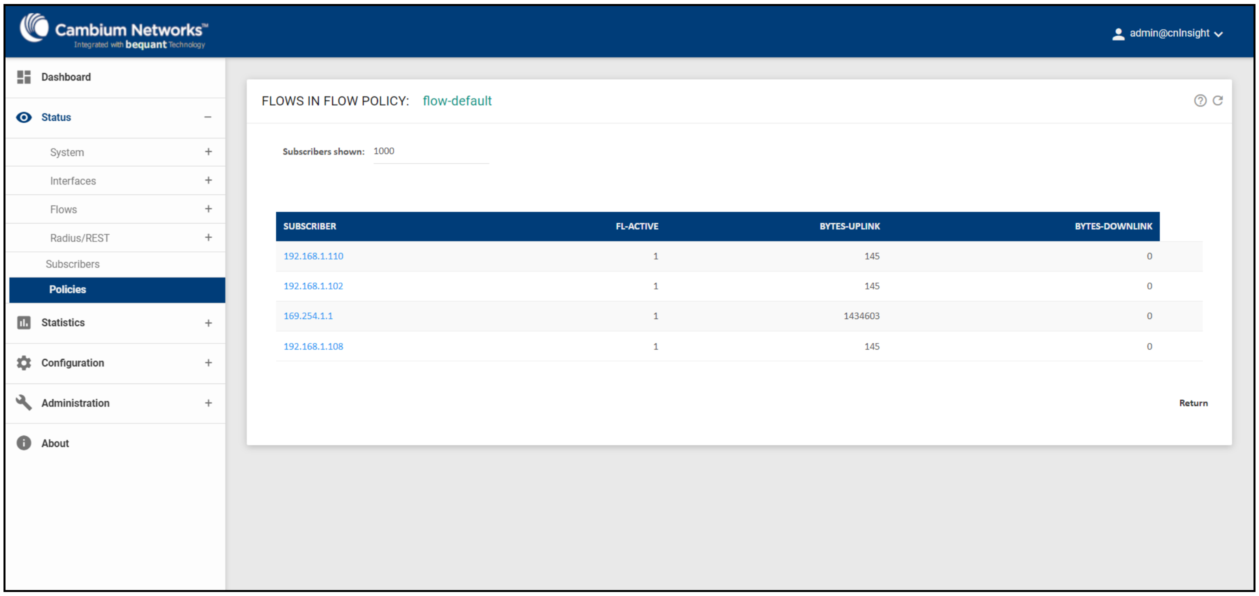


Figure 20: *Subscriber status*

For a given a policy, to view the number of subscriber IP addresses are under each policy, navigate to **Status** > **Policies**.



Click policy name to list the subscribers using that policy (more volume consumption is listed).



Policy examples

The following are the common examples of policies:

- Limiting the speed of some applications
- Exclude traffic from TCP optimization
- Implementing subscriber rate plans
- Services not limited by the subscriber rate

Limiting the speed of some applications

The goal is to reduce the network peak throughput to mitigate the congestion at rush hour. To that end, a DPI profile is defined (video in the example) to identify the applications to limit (streaming in this example). This example makes use of *video-streaming* pre-defined signatures. To include them, in **Add DPI profile**, select **Add Predefined Signatures** and choose the **Video-streaming** pre-defined signature.

Also, a throughput profile is created with the traffic load from which to start limiting (**above-5 Gbps** in this example). Then, a subscriber flow policy (*flow-8 Mbps* in the example) is created with a downlink limit (*Downlink shaping*) set at 8 Mbps. Finally, the DPI profile, the throughput profile, and the subscriber flow policy are tied together in a subscriber flow rule.

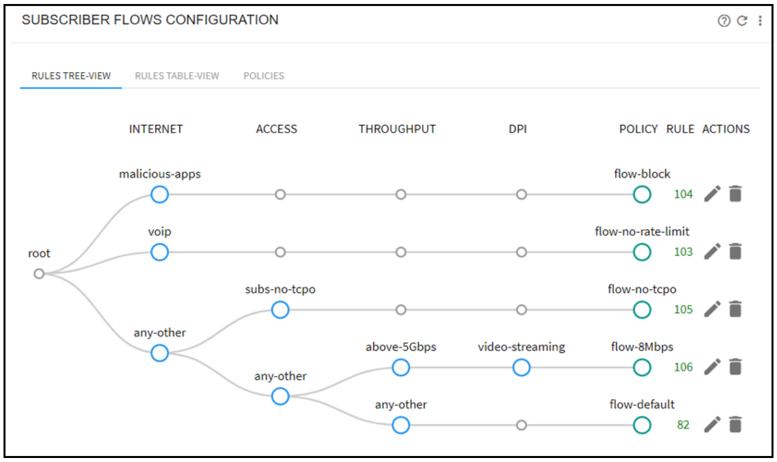


Figure 21: *Limiting the speed of some applications*

Exclude traffic from TCP optimization

QoE does not optimize certain traffic. To that end, an access profile is defined (*subs-no-tcpo* in the example), with the subscriber IP addresses to exclude. Next, a subscriber flow policy is defined with an optimization set to off (*flow-no-tcpo* in the example) and, then the access profile and the subscriber flow policy are combined in a subscriber flow rule.

Figure 22: *Editing subscriber flow policy*

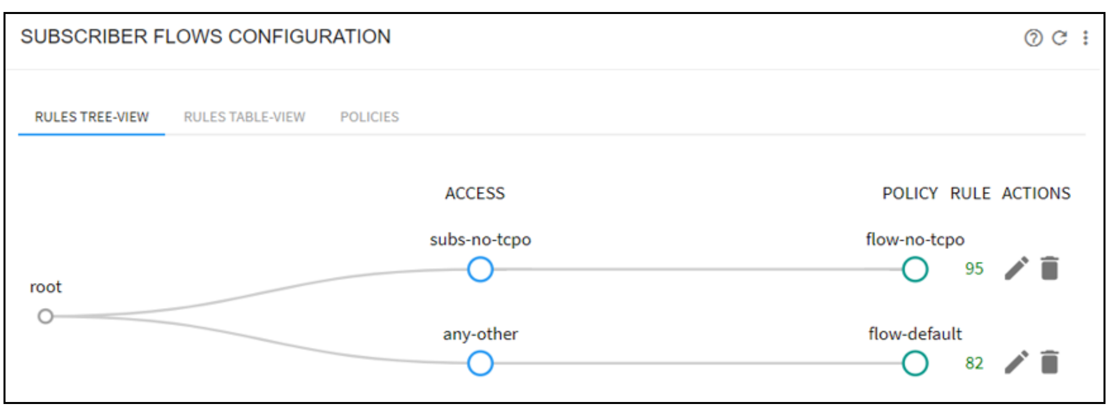


Figure 23: *Subscriber flows configuration*

Implementing subscriber rate plans

The objective is to apply the speed limits in each subscriber's data plan.

The QoE applies these limits better than a conventional shaping element, because for TCP traffic (the most common), it does not need to discard packets. Furthermore, it uses independent queues per flow and that makes application latencies independent of each other, which improves the experience of interactive applications. Figure 24 shows the queue structure, with a queue per flow and policy control at flow and subscriber levels.

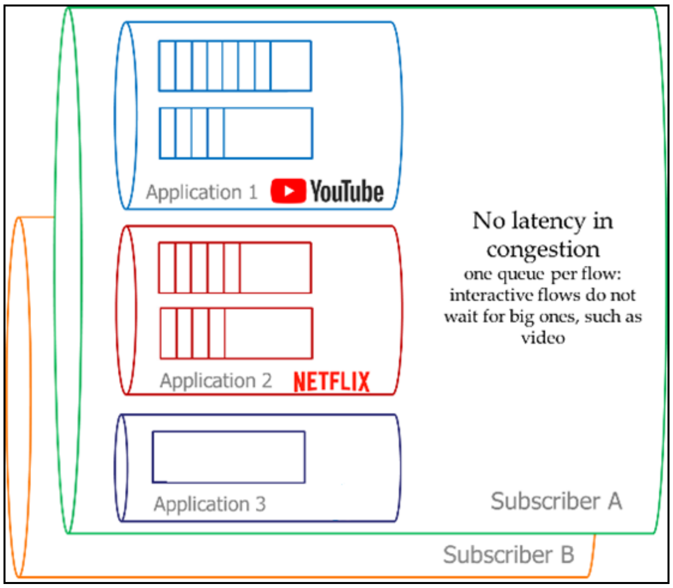


Figure 24: *Implementing subscriber rate plans*

Subscribers of each data plan must be identifiable by some of the profiles currently supported by the QoE, for example by VLAN or by IP address ranges. In the following example, three subscriber rate policies are defined, corresponding to three rate plans (rate-100 Mbps, rate-10 Mbps, and rate-50 Mbps in the example), and they are linked to their corresponding access profiles with three rules. Each of the access profiles consists of a list of IP address ranges belonging to each rate plan.

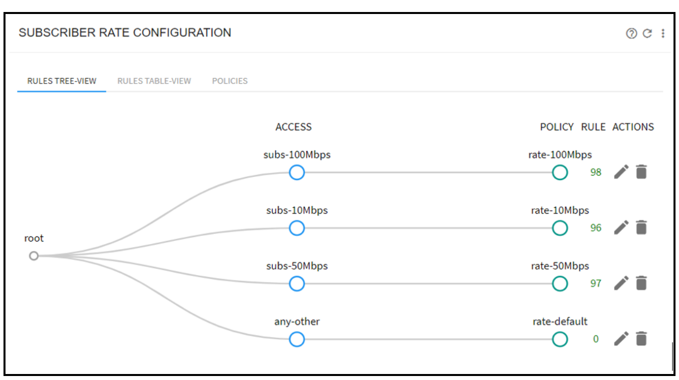


Figure 25: *Subscriber rate configuration*

Services not limited by the subscriber rate

To preserve the QoE of some services by granting throughput to them even the subscriber rate plan is being fully used, VoIP as an example. An Internet profile (*voip*) and a flow policy (with **Skip subscriber rate limitation** turned **ON**) are defined, then the Internet profile and the policy are linked by a subscriber flow rule.

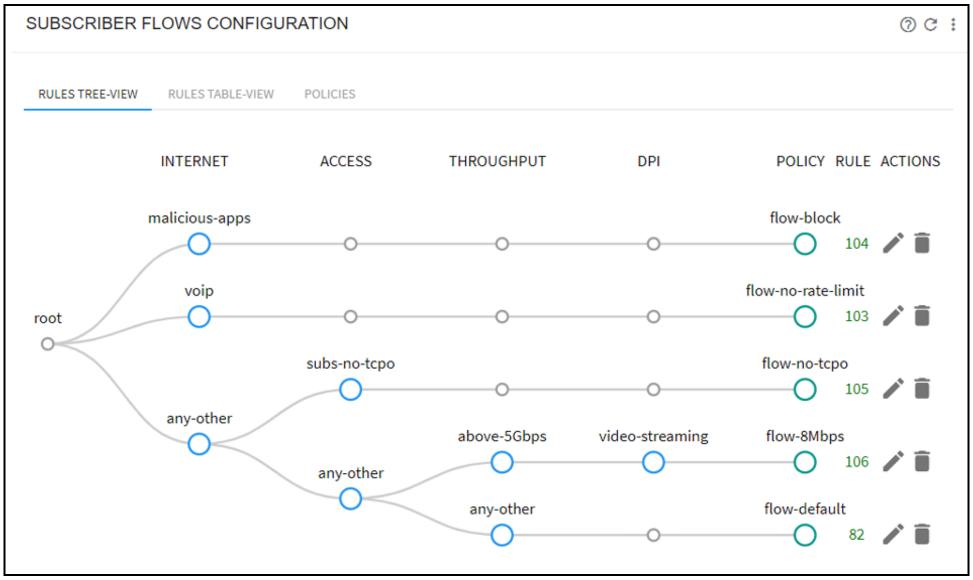
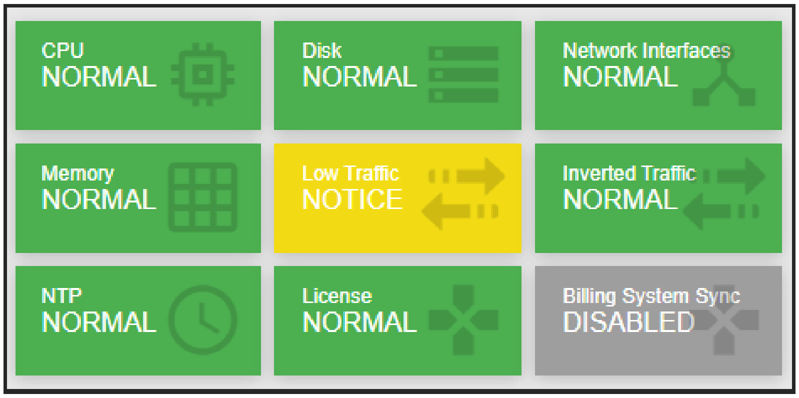


Figure 26: *Services not limited by the subscriber rate*

Chapter 8: Connecting to the QoE License Server

To enable the different functionalities in QoE, a license is acquired. The first step to acquire a license is, connect QoE to the cloud license server. The management port must have an access to the Internet until the license is acquired. The dashboard on the UI displays the status of the license server connection.



- If the color is not in **Green**, then the connection is not established, and QoE does not register with the license server to acquire the license.
- If there is a firewall, then open TCP port 13152 for the IP addresses **146.59.206.4** (primary) and **46.26.190.166** (backup). For steps to debug the license server connectivity issues, refer to *QoE Appliance User Interface Guide*.

Chapter 9: Traffic and Latencies

Traffic and Latencies displays the temporal evolution of total traffic throughput, adding both directions and all *wires*. To view the traffic and latencies, navigate to **Statistics** > **Throughput** > **Overview.**

Figure 27 shows the throughput over time graph.

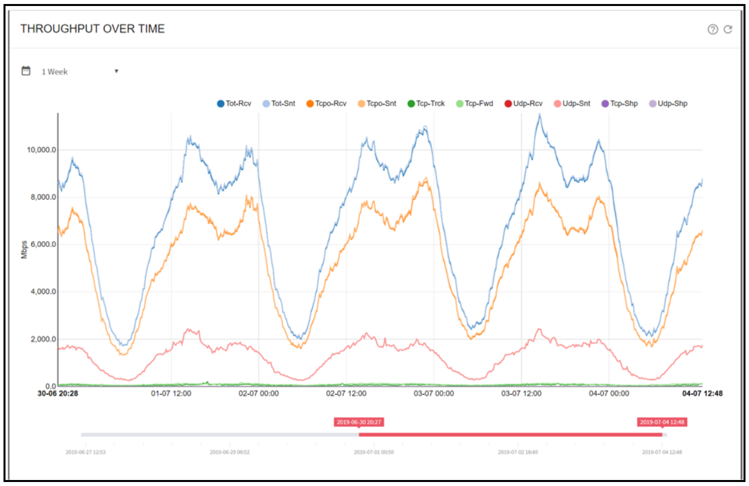


Figure 27: *Throughput over time graph*

The evolution over time per network interface is available in **Statistics** > **Throughput** > **Interfaces**.

Figure 28 shows the network interface throughput over time graph.

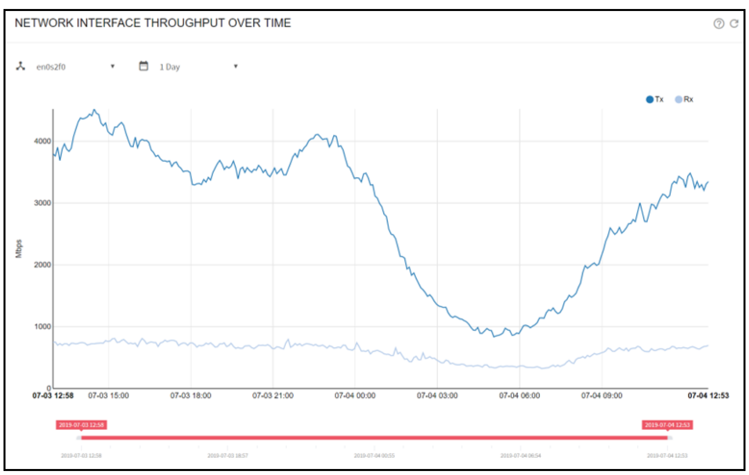


Figure 28: *Network interface throughput over time graph*

It is possible to check the status of processed traffic according to each of the configured policies. For subscriber flows policies, it can be checked in **Statistics** > **Throughput** > **Subscriber Flows Policies** and similarly for **Subscriber Rate Policies** and **Subscriber Monitoring Policies**.

The chart in **Statistics** > **System** > **Latencies** displays the access RTT (RTT-Down) and Internet RTT (RTT-Up). Average minimum values are provided.

Figure 29 shows the latency over time graph.

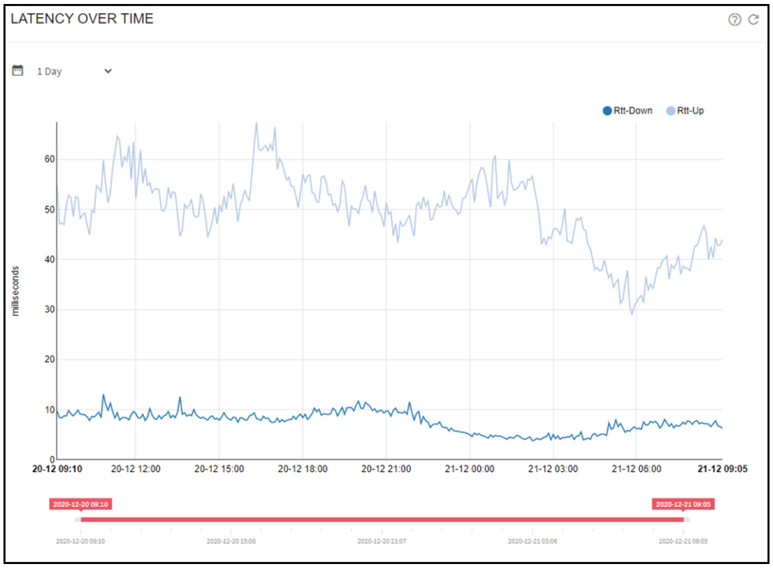


Figure 29: *Latency over time graph*

To see the number of flows per policy and per protocol, navigate to **Statistics** > **Flow** > **Per Policy and Statistics** > **Flow** > **Per Protocol** respectively.

Average Internet Latency per Service

Table of average Internet latencies (RTT) is measured from QoE to the servers in each service. The **all-average** category shows the average for all services.

For every category, you can get the distribution of the latencies (percentage of RTT samples in each latency bin) by clicking on the icon. You can also view the the distribution changes over the time. To view the percentage of samples in each bin at different times click icon. To see the latency per service, navigate to **Statistics** > **DPI Service Analysis** > **Latency per Service**. Figure 30 shows the Average Internet Latency per Service page.

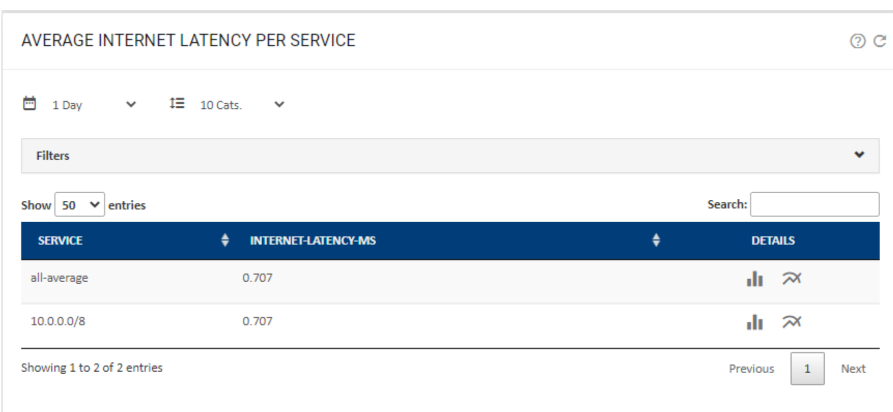


Figure 30: *Average Internet Latency per Service page*

Chapter 10: Analytics

QoE displays the current traffic composition per service. To view the current traffic composition, navigate to **Statistics** > **DPI Analysis** > **Total Volume per Service**.

Figure 31 shows the total volume per service chart.

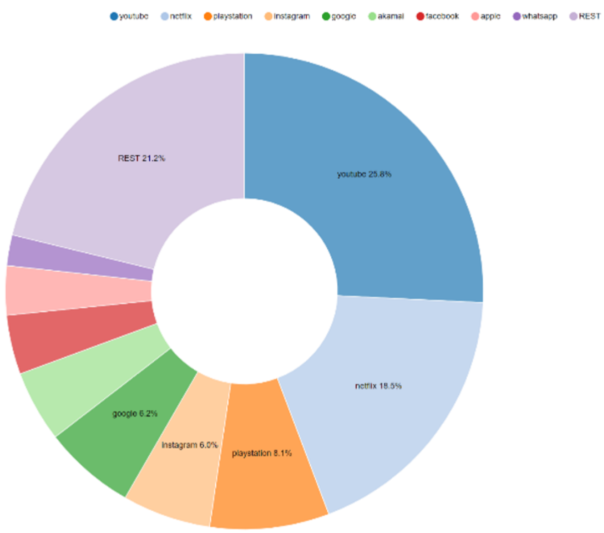


Figure 31: *Total Volume per Service chart*

The hourly evolution can be obtained in **Statistics** > **DPI Analysis** > **Hourly Volume per Service**.

Figure 32 shows the hourly volume per service chart.

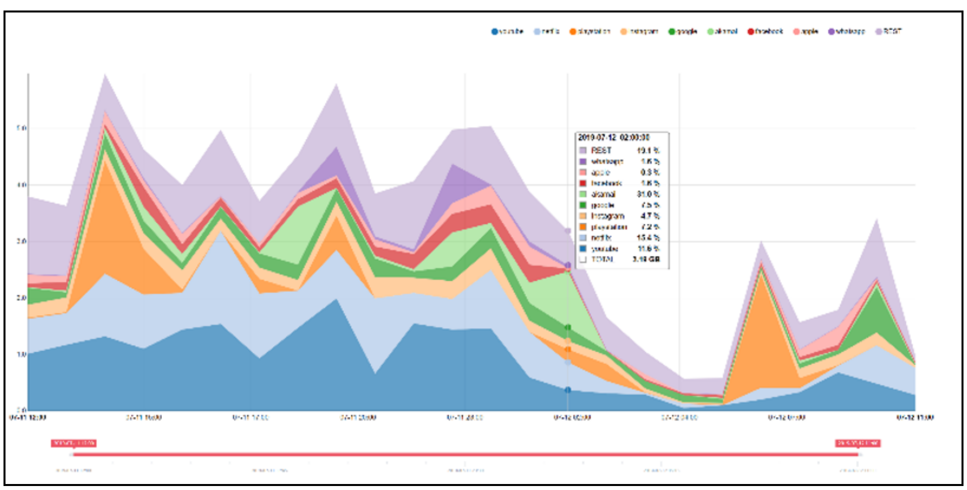


Figure 32: *Hourly Volume per Service chart*

When you navigate to **Statistics** > **Subscribers** > **Top by Time and Statistics** > **Subscribers** > **Top Total**, the subscriber IP addresses appears. With the biggest traffic consumption over time or the total in the given period, respectively.

Chapter 11: Denial of Service (DoS)

QoE detects DoS attacks. To perform this, configure the DoS thresholds. Navigate to **Configuration** > **DoS** from home page to configure the DoS thresholds:

- **Downlink failed handshake rate** — SYNs per second without an answer in the direction towards the subscribers (initialized from the Internet). The default value is 0 SYN/sec (feature is disabled). A typical value is 50 failed handshakes per second.
- **Uplink failed handshake rate** — SYNs per second without an answer initialized by a subscriber. The default value is 0 SYN/sec (feature is disabled). A typical value is 50 failed handshakes per second.
- **Minimum rate**— Minimum speed rate that can be considered a volumetric attack. The exact value depends on the network speed, but the default value is 50 Mbps.
- **Multiplier of subscriber rate policy**— If the subscriber has a known rate policy, a threshold is defined as multiplier * downlink limit. A typical multiplier is 3. For an example, a subscriber with a 20 Mbps plan has a DoS threshold of 3 * 20 = 60 Mbps. Figure 33 shows the DoS settings.

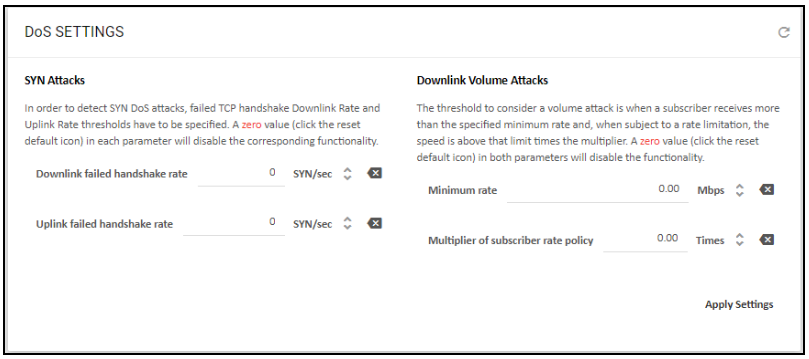


Figure 33: *DoS settings*

The DoS events are shown in **Statistics** > **DoS Attacks**. In DoS Attacks Over Time, the DoS attack events are displayed by showing its type, its duration, and parameters such as the affected subscriber IP and the main IP contributing the attack.

Figure 34 shows the DoS attacks over time.

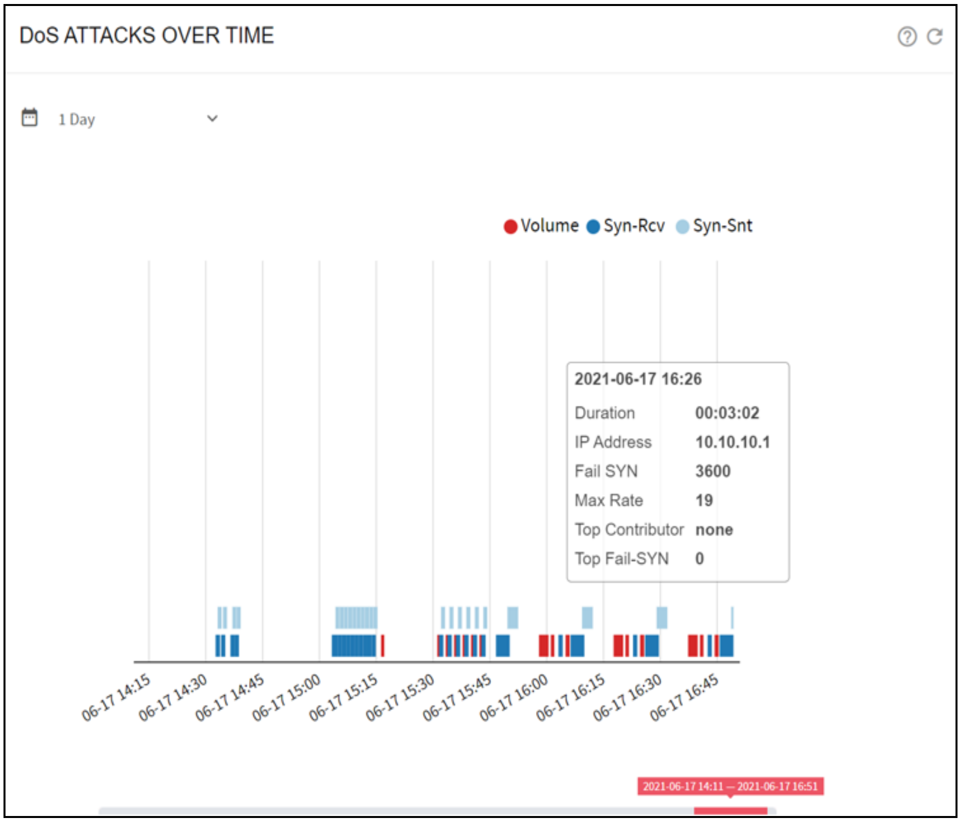


Figure 34: *DoS attacks over time*

In **Details of DoS Attacks** all DoS events are listed, with information about the time, event type, IP address affected, the direction of the attack (Ingress or Egress), and its duration. In **SYN Attacks** can be found attacks of SYN type, with the number of failed SYN and its rate per second. In **Volume Attacks**, there is a list of volumetric attacks with information on the traffic volume and its average rate.

Chapter 12: Updating the Software

To download and update the software, perform the following steps:

1. Visit https://support.cambiumnetworks.com/files/qoe_qoe/.

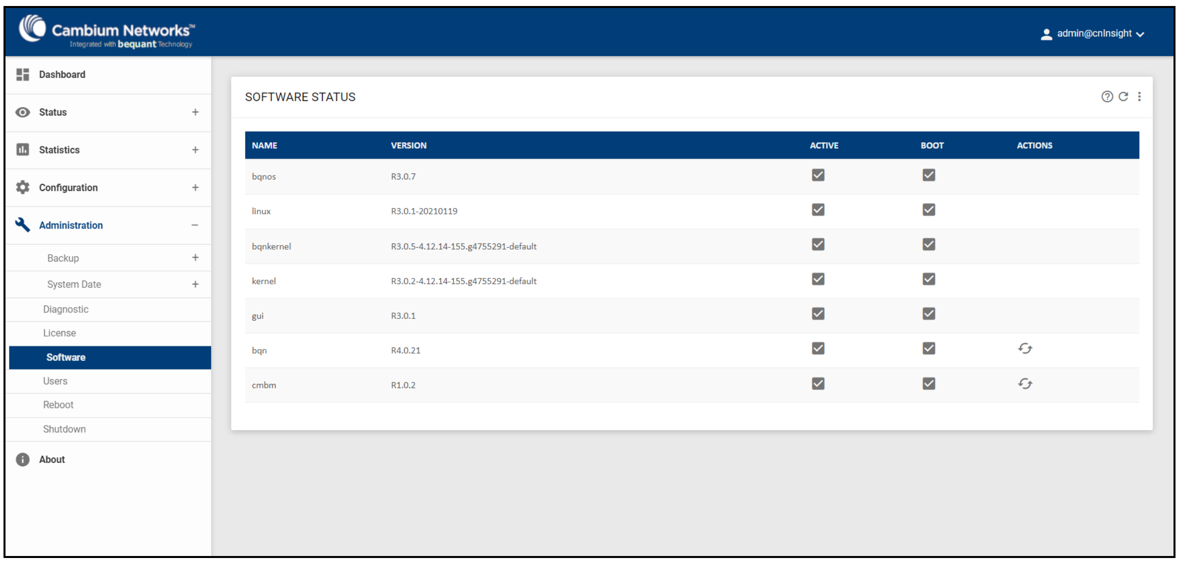
2. Download the **.bpkg** file to a local drive.

3. Access the UI from the management port using the configured management IP address.

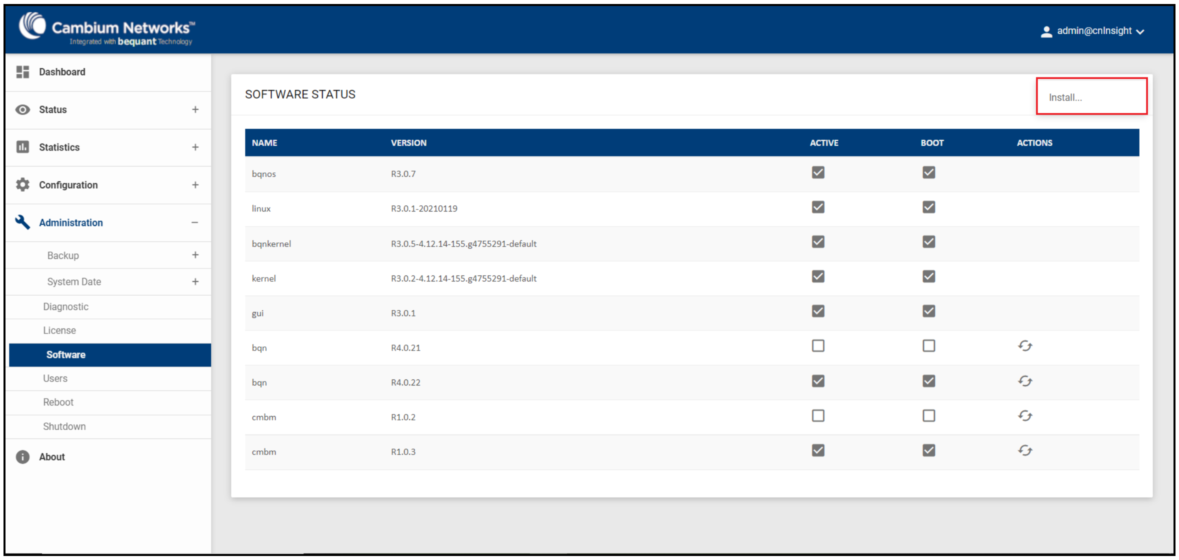
   The following are the default credentials:

   - IP address: **192.168.0.121**
   - Username: **admin**
   - Password: **cambium**

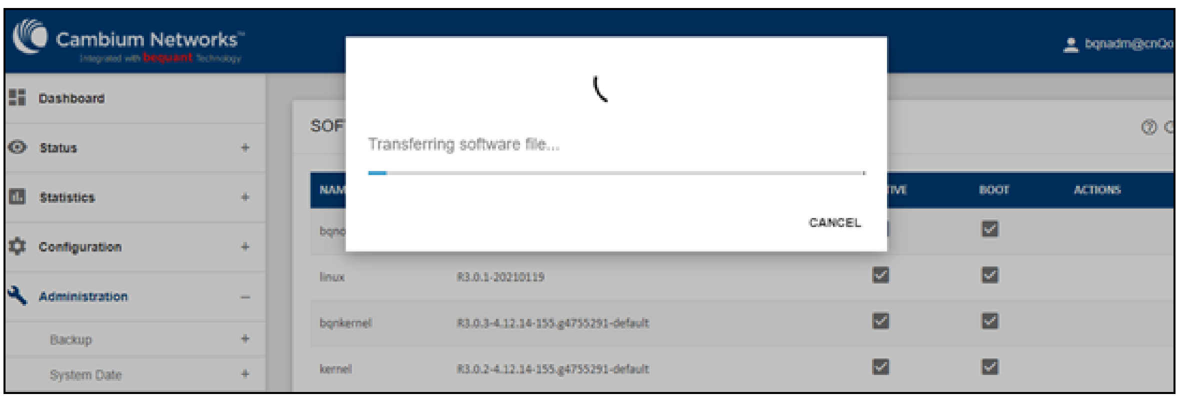
4. Navigate to **Administration** > **Software**.



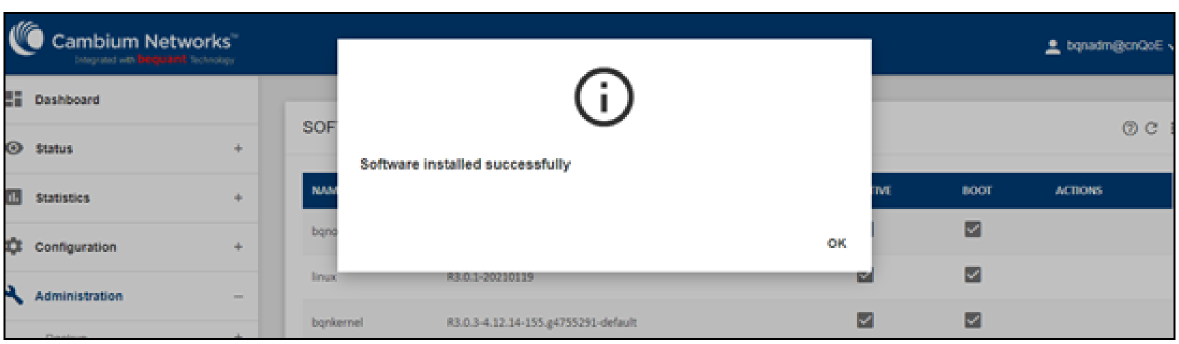
5. Click icon on the top-right, and click **Install...**.



6. Browse and select the appropriate **.bpkg** file.



7. After the software update is complete, the **Software Installed Successfully** message appears.



To activate the new software, reboot the system, or click  icon for the updated software.

Glossary

Term	Definition
DoS	Denial of Service
DPI	Deep Packet Inspection
QoE	Quality of Experience
TCPO	TCP Optimization
WISP	Wireless Internet Service Provider

Cambium Networks

Cambium Networks delivers wireless communications that work for businesses, communities, and cities worldwide. Millions of our radios are deployed to connect people, places and things with a unified wireless fabric that spans multiple standards and frequencies of fixed wireless and Wi-Fi, all managed centrally via the cloud. Our multi-gigabit wireless fabric offers a compelling value proposition over traditional fiber and alternative wireless solutions. We work with our Cambium certified ConnectedPartners to deliver purpose-built networks for service provider, enterprise, industrial, and government connectivity solutions in urban, suburban, and rural environments, with wireless that just works.

User Guides	http://www.cambiumnetworks.com/guides
Technical training	https://learning.cambiumnetworks.com/learn
Support website (enquiries)	https://support.cambiumnetworks.com
Main website	http://www.cambiumnetworks.com
Sales enquiries	solutions@cambiumnetworks.com
Warranty	https://www.cambiumnetworks.com/support/standard-warranty/
Telephone number list	http://www.cambiumnetworks.com/contact-us/
Address	Cambium Networks Limited, Unit B2, Linhay Business Park, Eastern Road, Ashburton, Devon, TQ13 7UP United Kingdom

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