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## Bandwidth Management

By default, the Concentrator line does not equitably manage packet traffic on a per-group or per-user basis. This means that any one group or user, given infinite bandwidth capability, could effectively steal almost all of a Concentrator's available bandwidth capacity. This can cause all other logged-in users to experience slower connections. In Figure 12-32 (omitted), the customer has T1 (1.544 Mbps) bandwidth at the central site. The two remote sites, B and C, each have 384 Kb of bandwidth. The two sets of remote users are system engineers and executives. The remote users have DSL and cable access to headquarters. If all 26 remote users connect at the same time and decide to download a large file, their actions could conceivably slow down connections between the headquarters and sites B and C.

The bandwidth management feature could be enabled on the Concentrator to distribute the bandwidth more equitably. One option is bandwidth reservation. The administrator could configure a minimum reserved bandwidth rate per session to prevent connection slowdown. For example, each remotely connected system engineer has a configured minimum bandwidth reservation of 56 Kbps. For another option, if the administrator is concerned about overutilization, the Concentrator could be configured for bandwidth policing. The Concentrator can place a bandwidth ceiling on data transfers (for example, a maximum transfer rate of 128 Kbps per session). The last option is aggregation. The administrator could choose to reserve a pool of bandwidth, an aggregation, for a group of users, or a site-to-site link. During peak periods, this site-to-site link, or group of users, can access bandwidth from this dedicated pool of bandwidth. The pool is reserved for their exclusive use.

## Bandwidth Policing

For the bandwidth policing feature, the Concentrator provides a maximum data transfer rate. Bandwidth policing sets a maximum limit (a cap) on the rate of tunneled traffic. For example, all system engineers can transfer data up to a sustained rate of 56 Kbps while remotely accessing the Concentrator. The Concentrator transmits traffic it receives below this rate; it drops traffic above this rate. Because traffic is bursty, some flexibility is built into policing. Policing involves two thresholds: the policing rate and the burst size. The policing rate is the maximum limit on the rate of sustained tunneled traffic. The burst size indicates the maximum size of an instantaneous burst of bytes allowed before traffic is capped back to the policing rate. The Concentrator allows for instantaneous bursts of traffic greater than the policing rate up to the burst rate. But should traffic burst consistently and exceed the burst rate, the Concentrator enforces the policing rate threshold. The Concentrator starts to drop frames.

Bandwidth policing can be configured on both a system and group basis. If group policing is configured, every member of the specified group can transmit data according to the group bandwidth policing policy. If a remote user is not a member of a predefined group, he or she can transmit data up to the system-wide policing rate. For example, there are two groups of remote users—system engineers and executives. The executives have a group policing rate defined at 128 Kbps. The system engineers do not have their own group policing rate defined. When executives connect to the Concentrator, they can transmit data up to 128 Kbps. When system engineers connect, they do not have a policing policy specifically defined for their group. They can transmit data up to the system-wide policing rate—in this example, 56 Kbps.

## Configuring Bandwidth Policing

Configuring the bandwidth policing feature is a two-step process. First, the policing policy (or policies) is defined. Next, the policies are assigned to an interface, and optionally to groups. To configure policing policies, go to the Configuration > Policy Management > Traffic Management > Bandwidth Policies window, as shown in Figure 12-33 (omitted). The bandwidth policy consists of two parts—bandwidth reservation in the top half and policing in the bottom half. (Bandwidth reservation is discussed later in the next section.) Policing involves two thresholds: the policing rate and the burst size. The policing rate is the maximum limit on the rate of sustained tunneled traffic. The burst size indicates the maximum size of an instantaneous burst of bytes allowed before traffic is capped at the

policing rate. The Concentrator allows for instantaneous bursts of traffic greater than the policing rate up to the burst rate. The policing policy parameters are as follows:

**Policy Name**—Enter a unique policy name that helps you remember the policy you are configuring. For example, if this policy focuses on the executive group, you could name it executive.

**Policing**—Check the Policing check box to enable the policing feature.

**Policing Rate**—Enter a value and select the unit of measurement. The Concentrator transmits traffic that is moving below the policing rate and drops all traffic that is moving above the policing rate. The range is between 56 kbps and 100 mbps. The default is 56 kbps. Policing rate is defined in the following units:

bps—Bits per second

kbps—Thousands of bits per second

mbps—Millions of bits per second

**Normal Burst Size**—Enter a value for the normal burst size. The normal burst size is the amount of instantaneous burst that the Concentrator can send at any given time. Use the following formula to set the burst size:  $(\text{policing rate}/8) * 1.5$ . For example, if you want to limit users to 250 Kbps of bandwidth, set the policing rate to 250 Kbps, and set the burst size to 46,875—that is,  $(250,000 \text{ bps}/8) * 1.5$ . Enter the Normal Burst Size and select the unit of measurement. The default is a normal burst size of 10,500 bytes. Normal burst size is defined in units as follows:

bytes—Unit of adjacent bits

kbytes—Thousands of bytes

mbytes—Millions of bytes

For example, suppose a policy named Normal Policy is configured for a policing rate of 56 Kbps and a normal burst size of 10,500 bytes. Any remote user assigned this policy has a maximum limit on the rate of sustained tunneled traffic of 56 Kbps. The Concentrator can support an instantaneous burst of 10,500 bytes before it starts to limit traffic by dropping packets.

After policies are defined, they are assigned to a Concentrator interface, public or private, or a user group. The interface policy defines the default policing rate for the Concentrator. If a remote user belongs to a group that is not specifically defined a policing rate, that person is assigned the policing rate defined for the interface. Go to the Configuration > Interfaces > Ethernet2 > window and select the Bandwidth tab to assign a policing policy to the interface. Enable bandwidth management on the selected interface, define the link rate for the interface, and assign the policy to be used on the interface. The interface bandwidth management parameters are as follows:

**Bandwidth Management**—Check this check box to enable bandwidth management on this interface.

**Link Rate**—Enter a value for the link rate, and select a unit of measurement. The defined link rate must be based on the available Internet bandwidth, not the physical LAN connection rate. The default is 1.544 Mbps. If the link rate is less than the sum of the policed rates, some remote users might not reach the police rate.

**Bandwidth Policy**—Select a policy from the drop-down list. If there are no policies in this list, you must choose Configuration > Policy Management > Traffic Management > Bandwidth Policies and define one or more policies.

If bandwidth policing is required in a network, a policing policy must be defined and applied to an interface before group policing policies are applied. The Concentrator does not allow a group policy to be applied first. If an administrator attempts to apply a group policy first, the Concentrator returns an error message.

In Figure 12-34 (omitted from this sample), the Internet link is a T1, 1.544 Mbps. The default policy for the interface is normal reservation. The normal reservation provides a maximum bandwidth allocation of 56 Kbps and a burst size of 10,500 bytes. System engineers are assigned a policing rate of 56 Kbps.

## Bandwidth Reservation

Bandwidth reservation reserves a minimum amount of bandwidth per session for tunneled traffic. As he or she connects to the Concentrator, each remote user receives a minimum amount of bandwidth. When there is little traffic on the box, users receive more than their allocated minimum of bandwidth. When the box becomes busy, they receive at least the minimum amount. When the combined total of the reserved bandwidth amounts of all active

tunnels on an interface approaches the limit of the total bandwidth available on that interface, the Concentrator refuses further connections to users who demand more reserved bandwidth than is available.

Suppose that the link rate on your public interface is 1.544 Mbps. Further suppose that you apply a reserved bandwidth policy to that interface that sets the reserved bandwidth to 64 Kbps per user. With this link rate and policy setting, only 24 users can connect to the Concentrator at one time. (1.544 Mbps per interface divided by 64 Kbps per user equals 24 connections.)

The first user who logs on to the Concentrator reserves 64 Kbps of bandwidth plus the remainder of the bandwidth (1480 Kbps).

The second user who logs on to the Concentrator reserves 64 Kbps of bandwidth and shares the remainder of the bandwidth (1416 Kbps) with the first user.

When the twenty-fourth concurrent user connects, all users are limited to their minimum of 64 Kbps of bandwidth per connection.

When the twenty-fifth user attempts to connect, the Concentrator refuses the connection. It does not allow any additional connections, because it cannot supply the minimum 64 Kbps reservation of bandwidth to more users.

You can think of bandwidth reservation as pieces of a pie. Each remote user is assigned a slice of pie (reserve bandwidth), as shown in Figure 12-35 (omitted). As tunnels are established, each user is assigned a slice of the pie until the pie is completely divided. At that point, any new connections requesting a slice of the pie are refused the opportunity to establish a connection.

## Configuring Bandwidth Reservation

Configuring bandwidth reservation is a two-step process. First, the bandwidth reservation policies are defined. Next, the policies are assigned to an interface, and optionally to groups.

Choose Configuration > Policy Management > Traffic Management > Bandwidth Policies to configure bandwidth reservation policies, as shown in Figure 12-36 (omitted).

The bandwidth policy window consists of two parts—bandwidth reservation in the top half and policing in the bottom half. Under bandwidth reservation, the administrator sets the minimum bandwidth assigned per session for remote users. The bandwidth reservation parameters are as follows:

**Policy Name**—Enter a policy name.

**Bandwidth Reservation**—Select this check box to enable the feature.

**Minimum Bandwidth**—Enter the amount of bandwidth reserved per user during periods of congestion. Enter a value for the minimum bandwidth, and select one of the following units of measure:

bps—Bits per second

kpbs—Thousands of bits per second

mbps—Millions of bits per second

In Figure 12-36, the administrator has created a policy called Normal Reservation. This reservation allocates a minimum of 64 kbps to each remote-access session.

Not all remote users have the same bandwidth requirements. The administrator can configure additional policies with different bandwidth reservations. In Figure 12-37 (omitted), the administrator has created a policy for the executive group. Each member of the executive group requires more bandwidth than the minimum allocation of 64 Kbps. A policy is defined that allocates 128 Kbps of bandwidth upon connection to the Concentrator.

As each executive connects, he or she is allocated part of the available bandwidth. The amount of bandwidth allocated to each executive is defined by the assigned policy, executive reservation. In this policy, each executive receives a minimum of 128 Kbps of reserved bandwidth.

## Public Interface Configuration

First, the administrator defines bandwidth reservation policies. Next, the policies are applied to interfaces, groups, and site-to-site tunnels. Go to the Configuration > Interfaces > Ethernet 1 2 3 screen (where 1, 2, or 3 is the required interface number), and choose the Bandwidth tab to apply a policy to an interface (see Figure 12-38). The Bandwidth tab parameters are as follows:

**Bandwidth Management**—Check this check box to enable the feature on the interface.

**Link Rate**—Set the link rate applied to all tunneled traffic. The defined link rate must be based on the available Internet bandwidth and not the physical LAN connection rate. The default is 1.544 Mbps.

**Bandwidth Policy**—Select a bandwidth policy for this interface. This policy is applied to all VPN tunnels that do not have a group-based bandwidth management policy.

If bandwidth reservation is required in a network, a bandwidth reservation policy must be defined and applied to an interface before group bandwidth reservation policies are applied. The Concentrator does not allow a group policy to be applied first. If an administrator attempts to apply a group policy first, the Concentrator returns an error message.

In Figure 12-38 (omitted), each remote user not assigned to a group bandwidth reservation policy receives the minimum bandwidth reservation defined by the normal reservation policy. In this example, the user is assigned 64 Kbps of bandwidth.

## Group Configuration

For groups that have different bandwidth requirements, the administrator can define group-based bandwidth requirements. Go to the Configuration > User Management > Groups window, select a group, and select Assign Bandwidth Policies. From the Policy drop-down menu, select the appropriate policy. The policy assigned to the interface reserves 64 Kbps of bandwidth for each remote user. This is fine for the system engineers, but the executives require a larger bandwidth reservation. From the Policy drop-down menu, the administrator selects the Executive Reservation policy. With this policy, each member of the executive group is allocated a minimum bandwidth reservation of 128 Kbps.

## Bandwidth Aggregation

Configuring bandwidth reservation alone might lead to a scenario in which high-priority, high-bandwidth users are unable to connect to a congested Concentrator because of their bandwidth requirements. The Concentrator provides a feature called bandwidth aggregation, which allows a particular group to reserve a fixed portion of the total bandwidth on the interface. (This fixed portion is called an aggregation.) Then, as users from that group connect, each receives a part of the total bandwidth allocated for that group. When one group makes a reserved bandwidth aggregation, it does not affect the bandwidth allocated to users who are not in that group. However, other users are now sharing a smaller amount of the total bandwidth. Fewer users can connect. You can think of bandwidth reservation as pieces of a pie. Each group is assigned a slice of pie (aggregate bandwidth). As tunnels are established, each user is assigned part of the slice until the slice is completely divided. At that point, any new connections requesting a piece of the slice are refused a connection. Go to the Configuration > User Management > Groups > Bandwidth Policy > Interfaces window to assign a bandwidth aggregation. Configure the following parameters:

**Policy**—Select a bandwidth policy from the Policy drop-down menu.

**Bandwidth Aggregation**—Enter a value for the maximum bandwidth to reserve for this group, and select a unit of measure.

In Figure 12-39 (omitted), the executive group is assigned a bandwidth aggregation of 384 Kbps. As each executive connects, he or she is allocated part of the 384 Kbps aggregated bandwidth. The amount of bandwidth allocated to each executive is defined by the assigned policy. In this case, each executive reserves bandwidth of 128 Kbps. Executive users are allocated bandwidth until their 384 Kbps slice of the bandwidth pie has been allocated.

## Monitoring the Bandwidth Statistics

Go to the Monitoring > Statistics > Bandwidth Management window, shown in Figure 12-40, to view bandwidth management session statistics. This window shows details of the effects of bandwidth management policies on each

tunnel. Only active tunnels on which bandwidth management policies are enabled appear in this window. The bandwidth management statistics parameters are as follows:

**Username**—The username identifying a tunnel using a bandwidth management policy

**Traffic Rate**—Measured in Kbps

**Conformed**—The current rate of session traffic (as set by the bandwidth management policy)

**Throttled**—The rate at which packets are being throttled to maintain the conformed rate

**Traffic Volume**—Measured in bytes

**Conformed**—The number of bytes of session traffic (as set by the bandwidth management policy)

**Throttled**—The number of bytes being throttled to maintain the conformed rate