



# Bandwidth Control

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This section describes how to control the bandwidth that is used for calls within your Local Zone, as well as calls out to other zones (**Configuration > Local Zone** and **Configuration > Bandwidth**).

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## About Bandwidth Control

The Expressway allows you to control the amount of bandwidth used by endpoints on your network. This is done by grouping endpoints into subzones, and then using [Configuring Links](#) and [Configuring Pipes](#) to apply limits to the bandwidth that can be used:

- Within each subzone
- Between a subzone and another subzone
- Between a subzone and a zone

Bandwidth limits may be set on a call-by-call basis and/or on a total concurrent usage basis. This flexibility allows you to set appropriate bandwidth controls on individual components of your network.

Calls will fail if links are not configured correctly. You can check whether a call will succeed, and what bandwidth will be allocated to it, using the command **xCommand CheckBandwidth**.

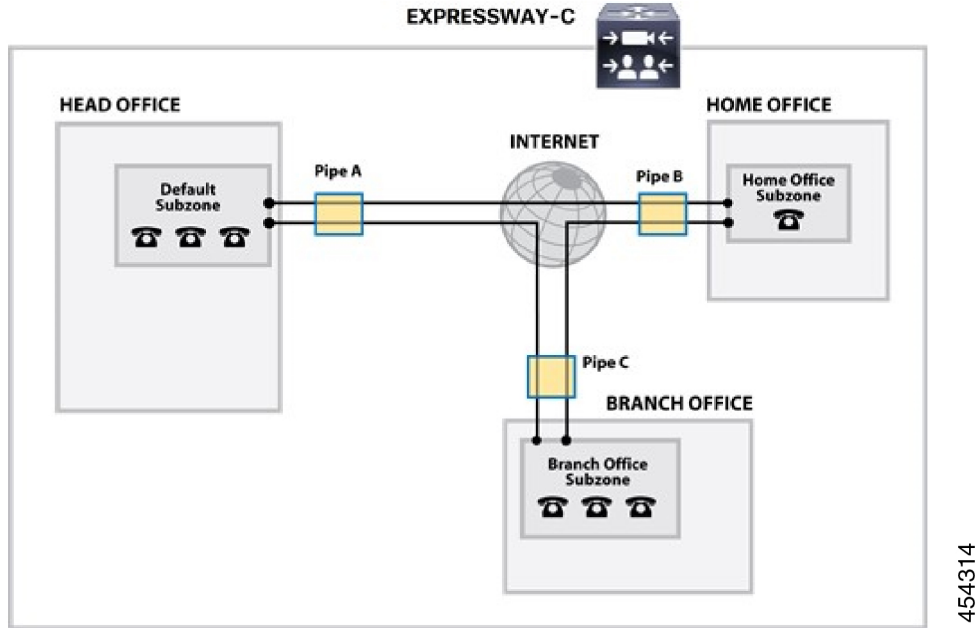
For specific information about how bandwidth is managed across peers in a cluster, see [Sharing Bandwidth Across Peers](#).

### Example network deployment

The following diagram shows a typical network deployment:

- A broadband LAN between the Enterprise and the internet, where high bandwidth calls are acceptable
- A pipe to the internet (Pipe A) with restricted bandwidth
- Two satellite offices, Branch and Home, each with their own internet connections and restricted pipes

In this example each pool of endpoints has been assigned to a different subzone, so that suitable limitations can be applied to the bandwidth used within and between each subzone based on the amount of bandwidth they have available via their internet connections.



## Configuring Bandwidth Controls

The **Bandwidth configuration** page (**Configuration > Bandwidth > Configuration**) is used to specify how the Expressway behaves in situations when it receives a call with no bandwidth specified, and when it receives a call that requests more bandwidth than is currently available.

The configurable options are:

Field	Description	Usage tips
<b>Default call bandwidth (kbps)</b>	<p>The bandwidth to use for calls for which no bandwidth value has been specified by the system that initiated the call.</p> <p>It also defines the minimum bandwidth to use on SIP to H.323 interworked calls.</p> <p>This value cannot be blank. The default value is 384kbps.</p>	<p>Usually, when a call is initiated the endpoint will include in the request the amount of bandwidth it wants to use.</p>

Field	Description	Usage tips
<b>Downspeed per call mode</b>	Determines what happens if the <b>per-call</b> bandwidth restrictions on a subzone or pipe mean that there is insufficient bandwidth available to place a call at the requested rate.  <i>On</i> : The call will be downspeeded. <i>Off</i> : The call will not be placed.	
<b>Downspeed total mode</b>	Determines what happens if the <b>total</b> bandwidth restrictions on a subzone or pipe mean that there is insufficient bandwidth available to place a call at the requested rate.  <i>On</i> : The call will be downspeeded. <i>Off</i> : The call will not be placed.	

## About Downspeeding

If bandwidth control is in use, there may be situations when there is insufficient bandwidth available to place a call at the requested rate. By default (and assuming that there is some bandwidth still available) the Expressway will still attempt to connect the call, but at a reduced bandwidth – this is known as **downspeeding**.

Downspeeding can be configured so that it is applied in either or both of the following scenarios:

- When the requested bandwidth for the call exceeds the lowest per-call limit for the subzone or pipes.
- When placing the call at the requested bandwidth would mean that the total bandwidth limits for that subzone or pipes would be exceeded.

You can turn off downspeeding, in which case if there is insufficient bandwidth to place the call at the originally requested rate, the call will not be placed at all. This could be used if, when your network is nearing capacity, you would rather a call failed to connect at all than be connected at a lower than requested speed. In this situation endpoint users will get one of the following messages, depending on the system that initiated the search:

- “Exceeds Call Capacity”
- “Gatekeeper Resources Unavailable”

## About Subzones

The Local Zone is made up of subzones. Subzones are used to control the bandwidth used by various parts of your network, and to control the Expressway's registration, authentication and media encryption policies.

When an endpoint registers with the Expressway it is allocated to an appropriate subzone, determined by [Configuring Subzone Membership Rules](#) based on endpoint IP address ranges or alias pattern matches.

You can create and configure subzones through the [Configuring Subzones](#) page (**Configuration > Local Zone > Subzones**).

The Expressway automatically creates the following special subzones, which you cannot delete:

- The Default Subzone
- The Traversal Subzone
- The Cluster Subzone (only applies if the Expressway is in a cluster)

#### Default links between subzones

The Expressway is shipped with the Default Subzone and Traversal Subzone (and Default Zone) already created, and with links between them. If the Expressway is added to a cluster then default links to the Cluster Subzone are also established automatically. You can delete or amend these [Default Links](#) if you need to model restrictions of your network.

## About the Traversal Subzone

The Traversal Subzone is a conceptual subzone. No endpoints can be registered to the Traversal Subzone; its sole purpose is to control the bandwidth used by traversal calls.

The **Traversal Subzone** page (**Configuration > Local Zone > Traversal Subzone**) allows you to place bandwidth restrictions on calls being handled by the Traversal Subzone and to configure the range of ports used for the media in traversal calls.

## Configuring Bandwidth Limitations

All traversal calls pass through the Traversal Subzone, so by applying bandwidth limitations to the Traversal Subzone you can control how much processing of media the Expressway will perform at any one time. These limitations can be applied on a total concurrent usage basis, and on a per-call basis.

See [Applying Bandwidth Limitations to Subzones](#) for more details.

## Configuring the Traversal Subzone Ports

On **Configuration > Local Zone > Traversal Subzone** you can configure the range of ports used for media in traversal calls.

#### What is a valid range to use?

You can define the media port range anywhere within the range 1024 to 65533. **Traversal media port start** must be an even number and **Traversal media port end** must be an odd number, because ports are allocated in pairs and the first port allocated in each pair is even.

#### How big should the range be?

Up to 48 ports could be required for a single traversal call, and you can have up to 75 concurrent traversal calls on a small system (M5-based), 100 on a medium system, or 500 on a large system. The default range is thus  $48 \times 500 = 24000$  ports.

If you want to reduce the range, be aware that Expressway raises an alarm if the range is not big enough to meet the nominal maximum of 48 ports per call for the licensed number of rich media sessions. You may need to increase the range again if you add new licenses.

### Why are 48 ports required for each call?

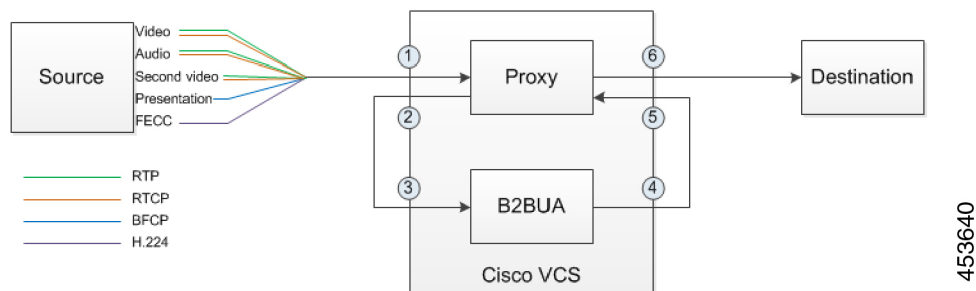
The nominal maximum number of ports allocated per call = max number of ports per allocation \* max number of allocation instances. This is  $8 * 6 = 48$ , and those numbers are derived as follows:

Each call can have up to 5 types of media; video (RTP/RTCP), audio (RTP/RTCP), second/duo video (RTP/RTCP), presentation (BFCP), and far end camera control (H.224). If all these media types are in the call, then the call requires 8 ports; 3 RTP/RTCP pairs, 1 for BFCP, and 1 for H.224.

Each call has at least two legs (inbound to Expressway and outbound from Expressway), requiring two instances of port allocation. A further four instances of allocation are required if the call is routed via the B2BUA. In this case, ports are allocated at the following points:

1. Inbound to the local proxy from the source
2. Outbound from the local proxy to the local B2BUA
3. Inbound to the local B2BUA from the local proxy
4. Outbound from the local B2BUA to the local proxy
5. Inbound to the local proxy from the local B2BUA
6. Outbound from the local proxy to the destination

**Figure 1: Maximum port allocation for a media traversal call**



In practice, you probably won't reach the maximum number of concurrent traversal calls, have them all routed through the B2BUA, and have all the possible types of media in every call. However, we defined the default range to accommodate this extreme case, and the Expressway raises an alarm if the total port requirement *could* exceed the port range you specify.

### What is the default range?

The default media traversal port range is 36000 to 59999, and is set on the Expressway-C at **Configuration > Local Zones > Traversal Subzone**. In Large Expressway systems the first 12 ports in the range – 36000 to 36011 by default – are always reserved for multiplexed traffic. The Expressway-E listens on these ports. You cannot configure a distinct range of demultiplex listening ports on Large systems: they always use the first 6 pairs in the media port range. On Small/Medium systems you can explicitly specify which 2 ports listen for multiplexed RTP/RTCP traffic, on the Expressway-E (**Configuration > Traversal > Ports**). If you choose not to configure a particular pair of ports (**Use configured demultiplexing ports = No**), then the Expressway-E will listen on the first pair of ports in the media traversal port range (36000 and 36001 by default).



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**Note** Changes to the **Use configured demultiplexing ports** setting need a system restart to take effect.

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## Configuring the Default Subzone

The **Default Subzone** page (**Configuration > Local Zone > Default Subzone**) is used to place bandwidth restrictions on calls involving endpoints in the Default Subzone, and to specify the Default Subzone's registration, authentication and media encryption policies.

When an endpoint registers with the Expressway, its IP address and alias is checked against the subzone membership rules and it is assigned to the appropriate subzone. If no subzones have been created, or the endpoint's IP address or alias does not match any of the subzone membership rules, it is assigned to the Default Subzone (subject to the Default Subzone's **Registration policy** and **Authentication policy**).

The use of a Default Subzone on its own (without any other manually created subzones) is suitable only if you have uniform bandwidth available between all your endpoints.



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**Note** Your Local Zone contains two or more different networks with different bandwidth limitations, you should configure separate subzones for each different part of the network.

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### Default Subzone configuration options

The Default Subzone can be configured in the same manner as any other [Configuring Subzones](#).

## Configuring Subzones

The **Subzones** page (**Configuration > Local Zone > Subzones**) lists all the subzones that have been configured on the Expressway, and allows you to create, edit and delete subzones. For each subzone, it shows how many membership rules it has, how many devices are currently registered to it, and the current number of calls and bandwidth in use. Up to 1000 subzones can be configured.

After configuring a subzone you should set up the [Configuring Subzone Membership Rules](#) which control which subzone an endpoint device is assigned to when it registers with the Expressway as opposed to defaulting to the [Configuring the Default Subzone](#).

The configurable options are:

Field / section	Description
<b>Registration policy</b>	<p>When an endpoint registers with the Expressway, its IP address and alias is checked against the subzone membership rules and it is assigned to the appropriate subzone. If no subzones have been created, or the endpoint's IP address or alias does not match any of the subzone membership rules, it is assigned to the Default Subzone.</p> <p>In addition to using a <a href="#">registration restriction policy</a> to control whether an endpoint can register with the Expressway, you can also configure a subzone's <b>Registration policy</b> as to whether it will accept registrations assigned to it via the subzone membership rules.</p> <p>This provides additional flexibility when defining your registration policy. For example you can:</p> <ul style="list-style-type: none"> <li>• Deny registrations based on IP address subnet. You can do this by creating a subzone with associated membership rules based on an IP address subnet range, and then setting that subzone to deny registrations.</li> <li>• Configure the Default Subzone to deny registrations. This would cause any registration requests that do not match any of the subzone membership rules, and hence fall into the Default Subzone, to be denied.</li> </ul> <p><b>Note</b> Registration requests have to fulfill any registration restriction policy rules before any subzone membership and subzone registration policy rules are applied.</p>
<b>Authentication policy</b>	<p>The <b>Authentication policy</b> setting controls how the Expressway challenges incoming messages to the Default Subzone. See <a href="#">Authentication policy</a> for more information.</p>
<b>Media encryption mode</b>	<p>The <b>Media encryption mode</b> setting controls the media encryption capabilities for SIP calls flowing through the subzone. See <a href="#">Configuring Media Encryption Policy</a> for more information.</p> <p><b>Note</b> If H.323 is enabled and the subzone has a media encryption mode of <i>Force encrypted</i> or <i>Force unencrypted</i>, any H.323 and SIP to H.323 interworked calls through this subzone will ignore this mode.</p>
<b>ICE support for media</b>	<p>Controls whether ICE messages are supported by the devices in this subzone.</p>
<b>Bandwidth controls</b>	<p>When configuring your subzones you can apply bandwidth limits to:</p> <ul style="list-style-type: none"> <li>• Individual calls between two endpoints within the subzone.</li> <li>• Individual calls between an endpoint within the subzone and another endpoint outside of the subzone.</li> <li>• The total of calls to or from endpoints within the subzone.</li> </ul> <p>See <a href="#">Applying Bandwidth Limitations to Subzones</a> for information about how bandwidth limits are set and managed.</p>

## Configuring Subzone Membership Rules

The **Subzone membership rules** page (**Configuration > Local Zone > Subzone membership rules**) is used to configure the rules that determine, based on the address of the device, to which [Configuring Subzones](#) an endpoint is assigned when it registers with the Expressway.

The page lists all the subzone membership rules that have been configured on the Expressway, and lets you create, edit, delete, enable and disable rules. Rule properties include:

- Rule name and description
- Priority
- The subnet or alias pattern matching configuration
- The subzone to which endpoints whose addresses satisfy this rule are assigned



**Note** If an endpoint’s IP address or registration alias does not match any of the membership rules, it is assigned to the [Configuring the Default Subzone](#).

Up to 3000 subzone membership rules can be configured.

The configurable options are:

Field	Description	Usage tips
<b>Rule name</b>	A descriptive name for the membership rule.	
<b>Description</b>	An optional free-form description of the rule.	The description appears as a tooltip if you hover your mouse pointer over a rule in the list.
<b>Priority</b>	The order in which the rules are applied (and thus to which subzone the endpoint is assigned) if an endpoint's address satisfies multiple rules.	The rules with the highest priority (1, then 2, then 3 and so on) are applied first. If multiple <i>Subnet</i> rules have the same priority, the rule with the largest prefix length is applied first. <i>Alias pattern match</i> rules at the same priority are searched in configuration order.
<b>Type</b>	Determines how a device's address is checked: <i>Subnet</i> : assigns the device if its IP address falls within the configured IP address subnet. <i>Alias pattern match</i> : assigns the device if its alias matches the configured pattern.	Pattern matching is useful, for example, for home workers on dynamic IP addresses; rather than having to continually update the subnet to match what has been allocated, you can match against their alias instead.



Field	Description	Usage tips
<b>Subnet address and Prefix length</b>	These two fields together determine the range of IP addresses that will belong to this subzone.  The <b>Address range</b> field shows the range of IP addresses to be allocated to this subzone, based on the combination of the <b>Subnet address</b> and <b>Prefix length</b> .	Applies only if the <b>Type</b> is <i>Subnet</i> .
<b>Pattern type</b>	How the <b>Pattern string</b> must match the alias for the rule to be applied. Options are:  <i>Exact</i> : The entire string must exactly match the alias character for character.  <i>Prefix</i> : The string must appear at the beginning of the alias.  <i>Suffix</i> : The string must appear at the end of the alias.  <i>Regex</i> : Treats the string as a <a href="#">regular expression</a> .	Applies only if the <b>Type</b> is <i>Alias pattern match</i> .
<b>Pattern string</b>	The pattern against which the alias is compared.	Applies only if the <b>Type</b> is <i>Alias pattern match</i> .
<b>Target subzone</b>	The subzone to which an endpoint is assigned if its address satisfies this rule.	
<b>State</b>	Indicates if the rule is enabled or not.	Use this setting to test configuration changes, or to temporarily disable certain rules. Any disabled rules still appear in the rules list but are ignored.

## Applying Bandwidth Limitations to Subzones

You can apply bandwidth limits to the Default Subzone, Traversal Subzone and all manually configured subzones. The limits you can apply vary depending on the type of subzone, as follows:

Limitation	Description	Can be applied to
Total	Limits the total concurrent bandwidth being used by all endpoints in the subzone at any one time. In the case of the Traversal Subzone, this is the maximum bandwidth available for all concurrent traversal calls.	Default Subzone Traversal Subzone Manually configured subzones
Calls entirely within...	Limits the bandwidth of any individual call between two endpoints within the subzone.	Default Subzone Manually configured subzones
Calls into or out of...	Limits the bandwidth of any individual call between an endpoint in the subzone, and an endpoint in another subzone or zone.	Default Subzone Manually configured subzones

Limitation	Description	Can be applied to
Calls handled by...	The maximum bandwidth available to any individual traversal call.	Traversal Subzone

For all the above limitations, the **Bandwidth restriction** setting has the following effect:

- *No bandwidth*: No bandwidth is allocated and therefore no calls can be made.
- *Limited*: Limits are applied. You must also enter a value in the corresponding bandwidth (kbps) field.
- *Unlimited*: No restrictions are applied to the amount of bandwidth being used.

Use subzone bandwidth limits if you want to configure the bandwidth available between one specific subzone and **all other** subzones or zones.

Use pipes if you want to configure the bandwidth available between one specific subzone and **another specific** subzone or zone.

If your bandwidth configuration is such that multiple types of bandwidth restrictions are placed on a call (for example, if there are subzone bandwidth limits and pipe limits), the lowest limit will always apply to that call.

#### How different bandwidth limitations are managed

In situations where there are differing bandwidth limitations applied to the same link, the lower limit will always be the one used when routing the call and taking bandwidth limitations into account.

For example, Subzone A may have a per call inter bandwidth of 128. This means that any calls between Subzone A and any other subzone or zone will be limited to 128kbps. However, Subzone A also has a link configured between it and Subzone B. This link uses a pipe with a limit of 512kbps. In this situation, the lower limit of 128kbps will apply to calls between the two, regardless of the larger capacity of the pipe.

In the reverse situation, where Subzone A has a per call inter bandwidth limit of 512kbps and a link to Subzone B with a pipe of 128kbps, any calls between the two subzones will still be limited to 128kbps.

#### Bandwidth consumption of traversal calls

A non-traversal call between two endpoints within the same subzone would consume from that subzone the amount of bandwidth of that call.

A traversal call between two endpoints within the same subzone must, like all traversal calls, pass through the Traversal Subzone. This means that such calls consume an amount of bandwidth from the originating subzone's total concurrent allocation that is equal to twice the bandwidth of the call – once for the call from the subzone to the Traversal Subzone, and again for the call from the Traversal Subzone back to the originating subzone. In addition, as this call passes through the Traversal Subzone, it will consume an amount of bandwidth from the Traversal Subzone equal to that of the call.

# Links and Pipes

## Configuring Links

Links connect local subzones with other subzones and zones. For a call to take place, the endpoints involved must each reside in subzones or zones that have a link between them. The link does not need to be direct; the two endpoints may be linked via one or more intermediary subzones.

Links are used to calculate how a call is routed over the network and therefore which zones and subzones are involved and how much bandwidth is available. If multiple routes are possible, your Expressway will perform the bandwidth calculations using the one with the fewest links.

The **Links** page (**Configuration > Bandwidth > Links**) lists all existing links and allows you to create, edit and delete links.

The following information is displayed:

Field	Description
<b>Name</b>	The name of the link. Automatically created links have names based on the nodes that the link is between.
<b>Node 1 and Node 2</b>	The Traversal Subzone and the zone that the link is between. The two subzones, or one subzone and one zone, that the link is between.
<b>Pipe 1 and Pipe 2</b>	Any pipes that have been used to apply bandwidth limitations to the link. See <a href="#">Applying Pipes to Links</a> for more information. <b>Note</b> In order to apply a pipe, you must first have created it via the <a href="#">Configuring Pipes</a> page.
<b>Calls</b>	Shows the total number of calls currently traversing the link.
<b>Bandwidth used</b>	Shows the total amount of bandwidth currently being consumed by all calls traversing the link.

You can configure up to 3000 links. Some links are created automatically when a subzone or zone is created.

## Default Links

If a subzone has no links configured, then endpoints within the subzone are only able to call other endpoints within the same subzone. For this reason, the Expressway comes shipped with a set of pre-configured links and will also automatically create new links each time you create a new subzone.

### Pre-configured links

The Expressway is shipped with the Default Subzone, Traversal Subzone and Default Zone already created, and with default links pre-configured between them as follows: *DefaultSZtoTraversalSZ*, *DefaultSZtoDefaultZ* and *TraversalSZtoDefaultZ*. If the Expressway is in a cluster, an additional link, *DefaultSZtoClusterSZ*, between the Default Subzone and the Cluster Subzone is also established.

You can edit any of these default links in the same way you would edit manually configured links. If any of these links have been deleted you can re-create them, either:

- Manually through the web interface
- Automatically by using the CLI command **xCommand DefaultLinksAdd**

**Automatically created links**

Whenever a new subzone or zone is created, links are automatically created as follows:

New zone/subzone type	Default links are created to...
Subzone	Default Subzone and Traversal Subzone
Neighbor zone	Default Subzone and Traversal Subzone
DNS zone	Default Subzone and Traversal Subzone
ENUM zone	Default Subzone and Traversal Subzone
Traversal client zone	Traversal Subzone
Traversal server zone	Traversal Subzone

Along with the pre-configured default links this ensures that, by default, any new subzone or zone has connectivity to all other subzones and zones. You may rename, delete and amend any of these default links.



**Note** Calls will fail if links are not configured correctly. You can check whether a call will succeed, and what bandwidth will be allocated to it, using the CLI command **xCommand CheckBandwidth**.

## Configuring Pipes

Pipes are used to control the amount of bandwidth used on calls between specific subzones and zones. The limits can be applied to the total concurrent bandwidth used at any one time, or to the bandwidth used by any individual call.

To apply these limits, you must first create a pipe and configure it with the required bandwidth limitations. Then when configuring links you assign the pipe to one or more links. Calls using the link will then have the pipe’s bandwidth limitations applied to them. See [Applying Pipes to Links](#) for more information.

The **Pipes** page (**Configuration > Bandwidth > Pipes**) lists all the pipes that have been configured on the Expressway and allows you to create, edit and delete pipes.

The following information is displayed:

Field	Description
<b>Name</b>	The name of the pipe.
<b>Total bandwidth</b>	The upper limit on the total bandwidth used at any one time by all calls on all links to which this pipe is applied.

Field	Description
<b>Per call bandwidth</b>	The maximum bandwidth of any one call on the links to which this pipe is applied.
<b>Calls</b>	Shows the total number of calls currently traversing all links to which the pipe is applied.
<b>Bandwidth used</b>	Shows the total amount of bandwidth currently being consumed by all calls traversing all links to which the pipe is applied.

You can configure up to 1000 pipes.

See [Applying Bandwidth Limitations to Subzones](#) for more information about how the bandwidth limits are set and managed.

## Applying Pipes to Links

Pipes are used to restrict the bandwidth of a link. When a pipe is applied to a link, it restricts the bandwidth of calls made between the two nodes of the link - the restrictions apply to calls in either direction. Normally a single pipe would be applied to a single link. However, one or more pipes may be applied to one or more links, depending on how you want to model your network.

### One pipe, one link

Applying a single pipe to a single link is useful when you want to apply specific limits to calls between a subzone and another specific subzone or zone.

### One pipe, two or more links

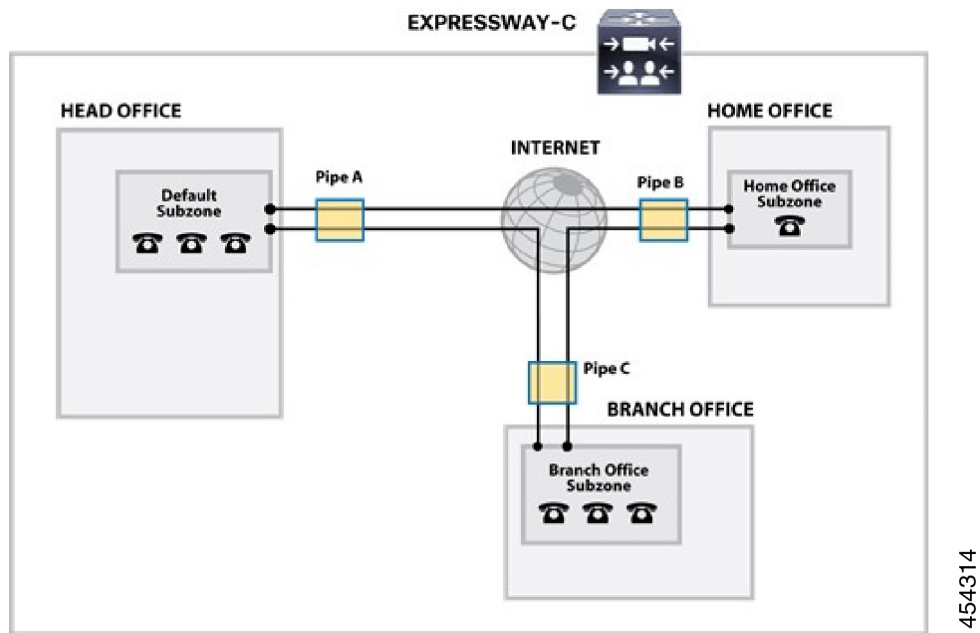
Each pipe may be applied to multiple links. This is used to model the situation where one site communicates with several other sites over the same broadband connection to the Internet. A pipe should be configured to represent the broadband connection, and then applied to all the links. This allows you to configure the bandwidth options for calls in and out of that site.

In the diagram below, Pipe A has been applied to two links: the link between the Default Subzone and the Home Office subzone, and the link between the Default Subzone and the Branch Office subzone. In this case, Pipe A represents the Head Office's broadband connection to the internet, and would have total and per-call restrictions placed on it.

### Two pipes, one link

Each link may have up to two pipes associated with it. This is used to model the situation where the two nodes of a link are not directly connected, for example two sites that each have their own broadband connection to the Internet. Each connection should have its own pipe, meaning that a link between the two nodes should be subject to the bandwidth restrictions of both pipes.

In the diagram below, the link between the Default Subzone and the Home Office Subzone has two pipes associated with it: Pipe A, which represents the Head Office's broadband connection to the internet, and Pipe B, which represents the Home Office's dial-up connection to the internet. Each pipe would have bandwidth restrictions placed on it to represent its maximum capacity, and a call placed via this link would have the lower of the two bandwidth restrictions applied.



## Bandwidth Control Examples

### Without a Firewall

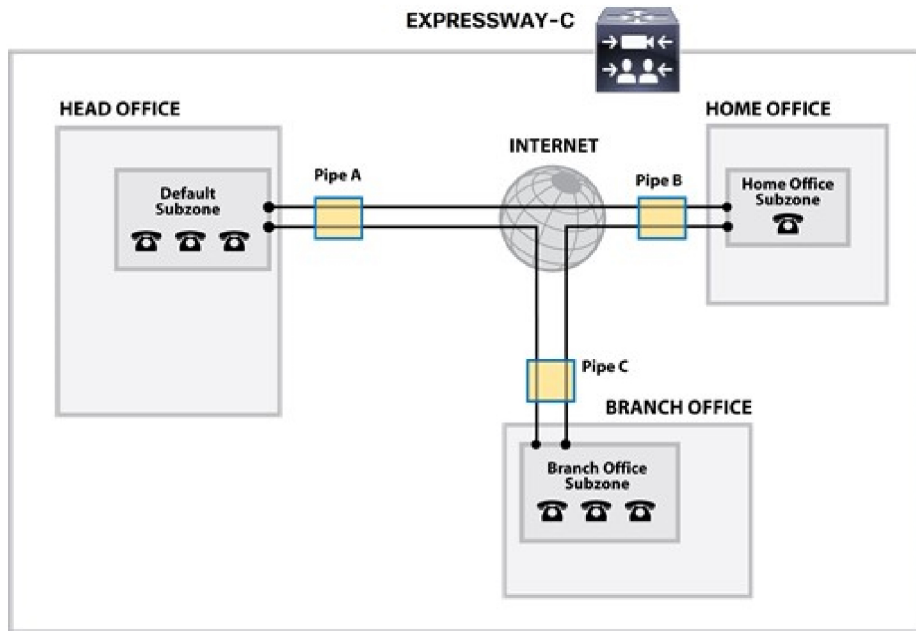
In the example below, there are three geographically separate offices: Head, Branch and Home. All endpoints in the Head Office register with the Expressway-C, as do those in the Branch and Home offices.

Each of the three offices is represented as a separate subzone on the Expressway, with bandwidth configured according to local policy.

The enterprise's leased line connection to the Internet, and the DSL connections to the remote offices are modeled as separate pipes.

There are no firewalls involved in this scenario, so direct links can be configured between each of the offices. Each link is then assigned two pipes, representing the Internet connections of the offices at each end of the link.

In this scenario, a call placed between the Home Office and Branch Office will consume bandwidth from the Home and Branch subzones and on the Home and Branch pipes (Pipe B and Pipe C). The Head Office's bandwidth budget will be unaffected by the call.



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