# Configuring Traffic Shaping on Frame Relay to ATM Service Interworking (FRF.8) PVCs

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# Introduction

Consider proper traffic shaping throughout the construction of wide−area network links that connect ATM on one end and Frame Relay on the other. Without it, you can create a mismatched link. Any time that a network link transfers data from a fast link to a relatively slower link, some packets can be dropped at the network device which buffers the additional data that comes from the fast link.

This document reviews the traffic shaping parameters defined for Frame Relay and ATM. It also explains the formulas that the Frame Relay Forum (FRF) recommends for matching the shaping parameters on both ends of an FRF.8 service interworking connection in order to ensure smooth network performance.

# Prerequisites

## Requirements

There are no specific requirements for this document.

## Components Used

This document is not restricted to specific software and hardware versions.

## Conventions

Refer to Cisco Technical Tips Conventions for more information on document conventions.

## Port Speed

A port speed, also known as the line rate, defines every physical interface. The port speed represents the maximum number of bits that the physical interface can transmit and receive each second. For example, the PA−A3−T3 ATM port adapter provides a single port of ATM at Layer 2 and DS−3 at Layer 1. The PA−A3−T3 has a port speed of 44209 kbps or 45 Mbps. Reduce the port speed with the **clock rate** command on a Cisco serial interface configured as data communications equipment (DCE). The port speed refers to the clocking rate of the access interface. By default, no clock rate is configured, and the network interface uses a hardware−dependent default.

## Default Traffic Shaping Parameters

During the configuration of an ATM permanent virtual circuit (PVC) without the specification of any traffic shaping parameters, the router creates a PVC with a peak cell rate (PCR) set to the port speed of the interface. This example illustrates how the specification of only the virtual circuit descriptor (VCD), virtual path identifier (VPI) and virtual circuit identifier (VCI) values create a PVC with the PeakRate parameter equal to the DS−3 port speed of 44209 kbps. Use the **show atm pvc {vpi/vci}** command in order to view the traffic shaping parameters of PVC.

```
interface atm1/1/0.300 multipoint

pvc 3/103

!−−− Use the new−style pvc command.


interface atm1/1/0.300 point

atm pvc 23 3 103 aal5snap

!−−− Use the old−style pvc command.


7500#show atm pvc 3/103
ATM1/1/0.300: VCD: 23, VPI: 3, VCI: 103
PeakRate: 44209, Average Rate: 0, Burst Cells: 0
AAL5−LLC/SNAP, etype:0x0, Flags: 0xC20, VCmode: 0x0
OAM frequency: 0 second(s), OAM retry frequency: 0 second(s)
OAM up retry count: 0, OAM down retry count: 0
OAM Loopback status: OAM Disabled
OAM VC state: Not Managed
ILMI VC state: Not Managed
InARP DISABLED
Transmit priority 4
```

The same rule applies to Frame Relay. The PVC uses a maximum transmission rate that the port speed defines, during the configuration of a Frame Relay PVC without the specification of any traffic shaping parameters .

One common misconception with Frame Relay traffic shaping is that the **bandwidth** command shapes the bit rate. This is not true. The **bandwidth** command sets an informational parameter only in order to communicate the current bandwidth to the higher−level protocols, such as Open Shortest Path First (OSPF) and Enhanced Interior Gateway Routing Protocol (EIGRP). You cannot adjust the actual bandwidth of a Frame Relay PVC with the **bandwidth** command.

# Frame Relay Traffic Shaping

This section introduces the concept of Frame Relay traffic shaping. A detailed discussion is outside the scope of this document. Refer to these documents for assistance with Frame Relay traffic shaping:

- Frame Relay Commands
- Configuring and Troubleshooting Frame Relay
- Configuring Generic Traffic Shaping

This table describes the parameters used with Frame Relay traffic shaping.

| Parameter | Description |
|---|---|
| Available rate (AR) | This is the physical line rate or port speed in bits per second (bps). |
| Time interval (T or Tc) | This is a serial interface that transmits a number of bits equal to Bc during each time interval on the Frame Relay virtual circuit (VC). The duration of this interval varies depending on the CIR and the Bc. It cannot exceed 125 milliseconds. |
| Committed information rate (CIR) | This is the average rate of transmission on the VC, and is also defined as the mean bps rate of traffic during each time interval. |
| Burst size committed (Bc) | This is the number of bits that the Frame Relay VC transmits during each time interval. Bc defines the number of committed bits within the CIR, not bits above CIR as its name implies. |
| Burst size excess (Be) | This is the number of bits that the Frame Relay VC can send above CIR during the first time interval. |

The bandwidth available for a Frame Relay VC is described in terms of port speed and CIR. As previously described, the port speed refers to the clock rate of the interface. The CIR refers to the end−to−end bandwidth that the Frame Relay carrier is committed to in order to provide for a VC. This bandwidth is independent of the clocking rate of the physical ports through which the VC is connected. A single serial interface typically supports many Frame Relay VCs.

On a serial interface defined with a clock rate of 64 k, a Frame Relay VC configured with a CIR of 32 k technically can send up to 64 k. Bandwidth above the CIR is called burst traffic.

# ATM Traffic Shaping

This section introduces the concepts of ATM traffic shaping, but does not discuss it in detail.

This table describes the parameters used in ATM traffic shaping.

| ATM Parameters | |
|---|---|
| **Parameter** | **Description** |

| | |
|---|---|
| Sustained cell rate (SCR) | Overall, this is the average cell rate for an ATM VC. It is defined in kbps on a router and in cells per second on many ATM WAN switches. |
| Peak cell rate (PCR) | This is the maximum rate for an ATM VC. It is defined in kbps on a router and in cells per second on many ATM WAN switches. |
| Maximum burst size (MBS) | This is the maximum amount of data that can be transmitted at the peak cell rate. It is defined in number of cells. |

Refer to these documents for assistance with ATM traffic shaping:

- Configuring VBR−nrt Traffic Shaping on ATM Interfaces
- Configuring ATM − Cisco IOS Configuration Guide

# Time Intervals on ATM and Frame Relay

Traffic shaping lets the router retain control of when to buffer or drop frames when the traffic load exceeds the guaranteed or committed shaping values. Both Frame Relay and ATM traffic shaping are designed in order to transmit frames at a regulated rate, so as not to exceed some bandwidth threshold. However, Frame Relay and ATM differ in their concept of a time interval.

Frame Relay VCs transmit the Bc number of bits at any time during each time interval (T). The interval is derived from CIR and BC, and can be a value between zero and 125 milliseconds. For example, assume a frame relay PVC with a CIR of 64 kb. If you set the BC to 8 kb:

```
Bc/CIR = Tc

8 kb/64 kb = 8 time intervals
```

During each of eight time intervals, the Frame Relay VC transmits 8 kb. At the end of the one−second period, the VC has transmitted 64 kb.

In contrast, ATM defines a time interval in cell units and over a sequence of received cells via the cell delay variation tolerance (CDVT) parameter. An ATM switch compares the actual arrival rate of adjacent cells with a theoretical arrival time, and expects a relatively consistent intercell gap and intercell arrival time. ATM switches use the CDVT value in order to account for arriving cell clumps with a less consistent intercell gap.

# ATM Forum Traffic Shaping Recommendations

The Frame Relay Forum defines implementation agreements in order to further the use of Frame Relay technology. The FRF.8 implementation agreement defines service interworking between a Frame Relay endpoint and an ATM endpoint.

Section 5.1 of FRF.8 describes traffic management procedures for the conversion between Frame Relay traffic conformance parameters and ATM traffic conformance parameters. Traffic conformance describes the process used to determine whether an ATM cell that comes from the user side of a User−to−Network Interface (UNI) conforms to the traffic contract. Normally, ATM switches on the network side of the UNI apply usage parameter control (UPC) algorithms that determine whether a cell conforms to the contract. The specific conformance definition varies with the ATM service class and the used traffic parameters. Section 4.3 of ATM Forum Traffic Management Specification 4.0 officially defines cell conformance and connection compliance.

FRF.8 traffic management procedures define how to map Frame Relay parameters like CIR, Bc, and Be into an equivalent value in an ATM network. The Frame Relay Forum defers to existent guidelines on such mappings:

- Appendix A of the ATM Forum B−ICI Specification
- Appendix B, Examples 2a and 2b of the ATM Forum UNI 3.1 Specification

The B−ICI guidelines are actually based on the guidelines defined in the ATM Forum UNI 3.1 specification. Thus, it is important in order to understand the UNI conformance examples.

This table illustrates the key differences between Examples 2a and 2b of the UNI specification. Example 2a defines three conformance definitions, while Example 2b defines only two such definitions. Both Examples determine conformance through the application of the Generic Cell Rate Algorithm (GCRA). The ATM Forum defines GCRA in Traffic Management Specification 4.0. GCRA is outside the scope of this document.

| Definition | Example 2a | Example 2b |
|---|---|---|
| PCR for CLP=0+1 | Yes | Yes |
| SCR for CLP=0 | Yes | Yes |
| SCR for CLP=1 | Yes | No |

The conformance definitions are defined in terms of the cell loss priority (CLP) bit. This bit is used in order to indicate whether a cell can be discarded if it encounters extreme congestion as it moves through the ATM network. A one−bit field means there are two values:

- The − 0 value indicates a higher priority.
- The 1 value indicates a lower priority.

The B−ICI builds on the conformance definitions of the UNI specification by the specification of the detailed equations for each example. Since Cisco Campus ATM switches, such as the Catalyst 8500, use the two Generic Call Rate Algorithm (GCRA) formula, the remainder of this document discusses the two−GCRA formula only.

Look at the two−GCRA equations from the B−ICI specification:

```
PCR(0+1) = AR /8 * [OHA(n)]

SCR(0) = CIR/8 * [OHB(n)]

MBS(0) = [Bc/8 * (1/(1−CIR/AR)) + 1] * [OHB(n)]
```

**Note:** PCR and SCR are expressed in cells per second. AR and CIR are expressed in bps. The parameter **n** is the number of information octects in a frame.

The objective of these equations is to ensure an equal amount of bandwidth for user traffic on both ends of the connection. Thus, the final argument in each equation is a formula that calculates the overhead factor (OH) on a VC. The overhead factor consists of three components:

- h1 two bytes of Frame Relay header
- h2 eight bytes of AAL5 trailer
- h3 four bytes of Frame Relay High−Level Data Link Control (HDLC) overhead of CRC−16 and flags

These are breakouts of the overhead formulas, which return a bytes/cell value:

```
OHA(n) = Overhead factor for AR = [(n + h1 + h2)/48] / (n + h1 + h3)

OHB(n) = Overhead factor for CIR = [(n + h1 + h2)/48] / n
```

**Note:** The brackets for OHA(n) and OHB(n) mean round it to the next integer. For example, if a value is 5.41, round it to 6.

The B−ICI overhead formulas account for fixed overhead. ATM VCs also introduce variable overhead of zero to 47 bytes per frame in order to pad the ATM Adaptation Layer 5 (AAL5) protocol data unit (PDU) to an even multiple of 48 bytes.

In the overhead formulas, **n** refers to the number of user information bytes in a frame. Use a value for **n** based on a typical frame size, mean frame size, or worst−case scenario. Use an estimate if you cannot calculate the exact packet distribution that your user traffic generates. The average size of IP packets on the Internet is 250 bytes. This value is derived from these three typical packet sizes:

- 64 bytes (such as control messages)
- 1500 bytes (such as file transfers)
- 256 bytes (all other traffic)

In summary, the overhead factor varies with packet size. Small packets result in higher padding, which results in increased overhead.

## Sample Calculation #1 − ATM to Frame Relay

This example assumes that you configured the ATM head end with a nrt−VBR PVC that has a PCR of 768 kbps and an SCR of 512 kbps.

| ATM Endpoint |
| --- |
| interface ATM4/0/0.213 multipoint ip address 10.11.48.49 255.255.255.252 pvc 5 0/105 protocol ip 10.11.48.50 broadcast vbr−nrt 768 512 |

| Frame Relay Endpoint |
| --- |
| interface Serial0/0 encapsulation frame−relay IETF frame−relay lmi−type cisco ! interface Serial0/0.1 point−to−point ip address 10.11.48.50 255.255.255.252 frame−relay interface−dlci 50 |

Complete these steps in order to determine the CIR on the Frame Relay side:

1. Convert the SCR from kbps to cells per second.

   ```
   512000 * (1/8) * (1/53) = 1207 cells/second
   ```
2. Apply the formula for the calculation of the SCR and fill in as many values as possible. Use a value of 6/250 for the overhead factor.

   ```
   1207 = CIR/8 * (6/250)
   ```
3. Change the equation in order to solve for the CIR.

```
1207 * 8 * (250/6) = 405,550 bits/sec
```

## Sample Calculation #2 − Frame Relay to ATM

This example shows the steps you use in order to determine the ATM shaping values from the Frame Relay values. In this example, the Frame Relay endpoint uses these values:

- AR = 256 kbps
- CIR = 128 kbps
- Bc = 8 kbps
- n = 250 (the average internet packet size)

1. Calculate the overhead factor for AR.

   ```
   OHA(n) = Overhead factor for AR = [(n + h1 + h2)/48]/(n + h1 + h3)
   OHA(250) = [(250 bytes + 2 bytes + 8 bytes)/48] / (250 bytes + 2 bytes + 4 bytes)
   OHA(250) = [260 bytes/ 48} / 256 bytes
   OHA(250) = 6/256
   OHA(250) = 0.0234
   ```
2. Calculate the overhead factor for CIR.

   ```
   OHB(n) = Overhead factor for CIR = [(n + h1 + h2)/48]/ n
   OHB(250) = [(250 bytes + 2 bytes + 8 bytes)/48]/(250 bytes)
   OHB(250) = [260 bytes/48]/ 250 bytes
   OHB(250) = 6/250
   OHB(250) = 0.0240
   ```
3. Determine the values of PCR, SCR and MBS in these equations now that you have OHA(n) and OHB(n):

   Calculate the PCR:

   ```
   PCR(0+1) = AR /8 * [OHA(n)]

   PCR = 256000 / 8 *(0.0234)
   PCR = 32000/0.0234

   PCR = 749 cells / sec


   And converting cells / sec to kbps, we have:

   PCR = (749 cells / sec) * (53 bytes/ cell) * (8 bits / 1 byte)
   PCR = 318 kbps
   Calculating the SCR:


   SCR(0) = CIR/8 * [OHB(n)]
   SCR = (128000 / 8 )* 0.240
   SCR =  384 cells / sec

   And converting  cells / sec to kbps, we have:

   SCR = (384 cells/ sec) * (53 bytes/ cell) * (8 bits / 1 byte)
   SCR =  163 kbps
   ```

   Calculate the MBS:

   ```
   MBS(0) = [ Bc/8 * (1/(1−CIR/AR)) + 1] * [OHB(n)]
   MBS = [8000/8*(1/(1−128/256)+1)]*0.0240
   MBS = [1000 * 3] *0.0240
   MBS = 72 cells
   ```

## Alternative Method

Frame Relay and ATM traffic−shaping parameters cannot be matched perfectly, but approximations with the recommended equations work well for most applications.

In the sample calculation in the previous section, the equations produced a difference of 20 percent between the SCR of the ATM VC and the CIR of the Frame Relay VC. Choose to avoid the equations and configure the traffic shaping parameters in order to be 15 to 20 percent higher on the ATM side.

Ensure that the configured values on the Frame Relay side are mapped properly into parameters on the ATM side during the configuration of ATM to Frame Relay interworking. Choose the values of PCR and SCR in order to include the extra margin required in order to accommodate the overhead introduced in the transference of the Frame Relay frames via an ATM network in order to deliver an equivalent bandwidth to actual user traffic.

# Related Information

- **Configuring Frame Relay to ATM Interworking Port Adapter Interfaces**
- **ATM forum − UNI Specification Document (Version 3.1) August 1993**
- **ATM forum − B−ICI Specification Document (Version 1.1) September 1994**
- **Sample Configuration: FRF.5**
- **Sample Configuration: FRF.8 − Translation Mode**
- **Tech Note: FRF.8 on WAN Switches**
- **ATM Technology Support Pages**
- **More ATM Information**
- **Technical Support & Documentation − Cisco Systems**




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