ATM Flow-Control Processor User's Guide

Ascend Communications, Inc.

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About This Guide

The *ATM Flow-Control Processor User's Guide* provides both a technical overview of how Ascend implements ATM traffic management using the ATM Flow-Control Processor, and step-by-step instructions for configuring the ATM Flow-Control Processor.

What You Need to Know

The *ATM Flow-Control Processor User's Guide* is intended for Ascend network administrators responsible for configuring the CBX 500. Readers should have a working knowledge of ATM traffic management and be familiar with CascadeView network management software.

How to Use This Guide

The *ATM Flow-Control Processor User's Guide* is organized as follows:

Read	To Learn About...
Chapter 1	How Ascend implements ATM traffic management.
Chapter 2	How the ATM Flow-Control Processor operates.
Chapter 3	How to configure the ATM Flow-Control Processor.
Appendix A	The Minimum Cell Rate (MCR) parameter values for the Virtual Channels (VCs) subject to ATM flow control. The default MCR parameter values for each I/0 module are also included.

Related Documentation

Use the following manuals with the *ATM Flow-Control Processor User's Guide*:

- *CBX 500 Hardware Installation Guide*
  (Product Code: 80011)
- *Network Configuration Guide for CBX 500*
  (Product Code: 80049)
- *Diagnostic and Troubleshooting Guide for CBX 500*
  (Product Code: 80050)
- *Network Management Station Installation Guide*
  (Product Code: 80014)
- *Networking Services Technology Overview*
  (Product Code: 80001)
- ATM Forum's *Traffic Management Specification*, Version 4.0

Conventions

The *ATM Flow-Control Processor User's Guide* uses the following conventions to emphasize certain information, such as user input, screen options and output, and menu selections. For example:

Convention	Indicates	Example
Menu ⇒ Option	Select an option from the menu.	CascadeView ⇒ Logon
Blue border surrounding text	Notes and warnings.	See examples below.
Italics	Filenames, directories, book titles, new terms, and emphasized text.	*Network Configuration Guide for CBX 500*

Provides helpful suggestions or reference to materials not contained in this guide.

Warns the reader to proceed carefully in order to avoid equipment damage or personal harm.

1

Introduction

Asynchronous Transfer Mode (ATM) is intended to support a wide range of advanced high-speed data applications. ATM removes the barriers between local and wide-area networks by providing seamless interconnection for LAN interworking. ATM also removes data transmission speed as an issue and provides flexible bandwidth-on-demand.

The control of ATM network traffic is related to the network's ability to:

- Meet Quality of Service (QoS) objectives for network applications
- Protect the network and the end-systems from congestion, thereby achieving network performance objectives
- Promote efficient use of network resources

This chapter introduces the components and architecture of ATM traffic management. It is not intended to be an exhaustive overview of ATM traffic management. Refer to the *Networking Services Technology Overview* and the ATM Forum's *Traffic Management Specification*, Version 4.0, for detailed information about ATM and ATM traffic management.

ATM Service Architecture

The ATM services provided at the ATM layer of the OSI Reference Model include the following:

Constant Bit Rate (CBR) — The CBR service is used by connections that request a static amount of bandwidth that is continuously available during the connection. This amount of bandwidth is characterized by a Peak Cell Rate (PCR) value. Once the connection is established, the negotiated Quality of Service (QoS) objective is assured to all cells. CBR service supports real-time applications, such as voice and video that require tightly constrained delay variation.

Variable Bit Rate-Real Time (VBR-rt) — VBR-rt supports real-time applications, such as voice and video, that require low cell delay variation between endpoints. VBR-rt connections use PCR, Sustainable Cell Rate (SCR), and Maximum Burst Size (MBS) values.

Variable Bit Rate Non-Real Time (VBR-nrt) — VBR-nrt supports the packaging for transfer of long, bursty data streams over a pre-established ATM connection. This service is also used for short, bursty data such as LAN traffic. Customer Premise Equipment (CPE) protocols adjust for any delay or loss. VBR-nrt connections use PCR, SCR, and MBS values.

Unspecified Bit Rate (UBR) — UBR supports non-real time applications that do not require tightly constrained delay variation, such as file transfers and electronic mail. UBR does not specify traffic-related service guarantees.

Available Bit Rate (ABR) — ABR uses a flow-control mechanism that supports several types of feedback to control the source rate of traffic in response to changing ATM layer transfer characteristics. This feedback is conveyed to the source through specific control cells called Resource Management (RM) cells. On the establishment of an ABR connection, the end-system specifies to the network both a maximum required bandwidth and a minimum usable bandwidth, as designated by PCR and Minimum Cell Rate (MCR) values.

Refer to Chapter 2 for information about the specific ATM service classes supported by the ATM Flow-Control Processor.

ATM Flow Control

Early ATM implementations used open-loop flow control, where source nodes initiated a specified amount of traffic onto the network in a specified time interval. This technique relieved ATM sources of complex flow control, but pushed the congestion problems onto the network.

In contrast, the closed-loop or feedback method of flow control shifts flow control responsibility to the source of the traffic, thereby pushing congestion management to the source of the traffic as well. Feedback from the network allows the source to adjust cell transmission rates to a level at which users have assurance that data is not lost.

The ABR service class uses Binary or Explicit Rate (ER) control. ABR traffic can use bandwidth that is allocated for higher-priority traffic, but is currently not in use. The Resource Management (RM) cell provides a feedback mechanism for the network to notify the source that it must adjust cell transmission rates to avoid congestion and cell loss.

The goal of ABR is to provide source-to-destination flow control using in-band control mechanisms that use RM cells to distribute flow and congestion information throughout the network. Switches monitor their state of congestion and send RM cells back towards the source requesting an increase or decrease in the data rate so as to maximize data throughput with a minimum amount of congestion.

ATM Traffic Parameters and Descriptors

When you create either a Permanent Virtual Circuit (PVC) or a point-to-multipoint circuit, you can select one of several ATM traffic descriptors. ATM traffic descriptors specify which traffic parameters are used for traffic control. Traffic descriptors also determine the number and type of cells that are admitted into a congested queue, and whether or not high-priority cells are tagged as low-priority cells when traffic exceeds the traffic parameter thresholds.

ATM traffic descriptors are as follows:

Peak Cell Rate (PCR) — The PCR is the maximum allowed cell transmission rate (expressed in cells per second). It defines the shortest time period between cells, and provides the highest guarantee that all network performance objectives (based on cell loss ratio) are met.

Sustainable Cell Rate (SCR) — The SCR is the maximum average cell transmission rate allowed on a given circuit for the duration of that circuit. It allows the network to allocate sufficient resources to guarantee that all network performance objectives are met. This parameter applies only to VBR traffic; it does not apply to CBR or UBR traffic.

Maximum Burst Size (MBS) — The MBS is the maximum number of cells that can be received at the PCR. If the burst is larger than anticipated, the additional cells are either tagged or dropped if the Usage Parameter Control (UPC) is enabled for that circuit.

Minimum Cell Rate (MCR) — The MCR is the rate at which the source switch is always allowed to send data.

CLP=0 — Specifies the high-priority cell stream (cells whose Cell Loss Priority bit is set to 0).

CLP=1 — Specifies the low-priority cell stream (cells whose Cell Loss Priority bit is set to 1).

CLP=0+1 — Specifies the aggregate cell stream (cells whose Cell Loss Priority bit is set to either 0 or 1).

Tagging — Tagging refers to the method of identifying a high-priority cell (CLP=0) as a low-priority cell (CLP=1), as opposed to simply dropping the cells from the cell stream when the CLP=0 cell stream is non-conforming.

Best Effort — Sets a “Best Effort” bit in the cell header. The network attempts to deliver traffic that exceeds the limits of the traffic contract. However, there are no guarantees that traffic will be delivered.

Refer to the *Network Configuration Guide for CBX 500* for detailed information on ATM traffic descriptors.

ATM Traffic Management Functions

ATM networks can implement one or more traffic management functions to meet QoS objectives of compliant connections. For detailed information on the various ATM traffic management functions, refer to the ATM Forum's *Traffic Management Specification*, Version 4.0.

Traffic management functions include:

Connection Admission Control (CAC) — The CAC function performs connection admission control for all ATM service classes. Based on the CAC function, a connection request is accepted only when sufficient network resources are available at each successive network element to establish the connection through the network based on the connections service category, traffic contract, and QoS objectives. Refer to the *Network Configuration Guide for CBX 500* for more information on the CAC.

Usage Parameter Control (UPC) — UPC is defined as the set of actions taken by the network to monitor and control traffic. Its main purpose is to protect network resources from malicious as well as unintentional misbehavior that could affect the QoS objectives of other already established connections.

Traffic Shaping — Traffic shaping modifies the traffic characteristics of a stream of cells to achieve better network efficiency, while meeting all QoS objectives. Refer to "Traffic Shaping" on page 2-13 for more information on traffic shaping.

Explicit Forward Congestion Indication (EFCI) — A near congested or congested network element can set the EFCI in a cell header to notify the destination end-system of this condition. The destination end-system can then implement a protocol to lower the cell rate of the connection during congestion.

Resource Management using Virtual Path Connections (VPCs) — You can configure VPCs to do the following:

- Separate groups of virtual connections according to ATM services classes
- Indicate congestion in the network by distributing a single message for all Virtual Channel Connections (VCCs) comprising a VPC
- Enable the UPC mechanism to be applied to all the traffic for a network connection

Early Packet Discard (EPD) — When a network element needs to discard cells, it can be more effective to discard at the packet level rather than at the cell level. The network detects the packet boundaries by examining the Service Data Unit (SDU) type in the ATM cell header. Refer to "ATM Flow-Control Discard Mechanisms" on page 2-16 for more information on EPD.

Selective Cell Discarding — A congested network element can discard cells that either belong to a non-compliant ATM connection or cells whose CLP bit is set to 1. Refer to "ATM Flow-Control Discard Mechanisms" on page 2-16 for more information on Selective Discard (CLP1).

Available Bit Rate (ABR) Flow Control — In the ABR service class, the source end-system adjusts its rate of transmission based on changing network conditions, such as available bandwidth, impending congestion, and various degrees of congestion. This feedback is conveyed to the source end-system through specific control cells called Resource Management (RM) cells.

The ABR service provides rapid access to unused network bandwidth at up to Peak Cell Rate (PCR) whenever network bandwidth is available. With ABR, user data cells must have CLP=0. However, RM cells can have CLP=1. Since the Cell Loss Ratio (CLR) objectives for ABR include only cells with CLP=0, the network can selectively discard RM cells marked CLP=1.

The CBX 500 marks Cascade Communications Resource Management (CCRM) cells as CLP=0. Backward Congestion Message (BCM) cells are marked as CLP=1. Refer to Chapter 2 for more information on CCRM and BCM cells.

Refer to the ATM Forum's *Traffic Management Specification*, Version 4.0, for a complete description of ATM traffic management.

2

Implementing ATM Flow Control

Ascend's ATM Flow-Control Processor supports ATM traffic management through binary, hop-by-hop, closed-loop flow-control algorithms that shift network congestion to the edge of the network. In addition, Ascend uses several per-Virtual Circuit (VC) cell/packet queuing and discarding mechanisms for additional network congestion control.

Based on the ATM Forum's *Traffic Management Specification*, Version 4.0, Ascend's ATM Flow-Control Processor delivers a fair, deterministic service for bursty ATM traffic, including:

- Dynamically adjusting the Allowable Cell Rate (ACR) in response to Resource Management (RM) cell feedback
- Reducing congestion in the network by adjusting the data rate at which a VC sends cells
- Fair resource allocation based on the Minimum Cell Rate (MCR)
- Per VC-queuing

Supported ATM Service Classes

The ATM Flow-Control Processor supports three ATM service classes:

Enhanced Unspecified Bit Rate (UBR+) Class — The ATM Flow-Control Processor provides a UBR+ service for the UBR Quality of Service (QoS) class by applying:

- Closed-loop flow control
- Dynamic cell rate adjustment
- Minimum Cell Rate (MCR) guarantee

The MCR is set at the minimum rate of the ATM Flow-Control Processor. The Allowable Cell Rate (ACR) is adjusted by the Rate Increase Factor (RIF) and the Rate Decrease Factor (RDF). Both the RIF and the RDF are configurable through CascadeView. Refer to "Rate Decrease Factor (RDF) and Rate Increase Factor (RIF)" on page 2-12 for more information about configuring the RDF and RIF.

Available Bit Rate (ABR) Class — The MCR is configured during circuit admission. The ACR is adjusted by the RDF and RIF. The RDF and RIF can be configured in proportion to the MCR. Refer to "Rate Decrease Factor (RDF) and Rate Increase Factor (RIF)" on page 2-12 for more information about configuring the RDF and RIF.

Variable Bit Rate-Non-Real Time (VBR-nrt) Class — The ATM Flow-Control Processor can manage the VBR-nrt QoS class. VBR-nrt is selectable through CascadeView. The Sustainable Cell Rate (SCR) is configured during circuit admission. The SCR is used in the same way as the MCR during ACR adjustments. The ACR is adjusted by the RIF and RDF. The RIF and RDF can be configured in proportion to the SCR. Refer to "Rate Decrease Factor (RDF) and Rate Increase Factor (RIF)" on page 2-12 for more information about configuring the RDF and RIF.

For information about other types of ATM service classes, refer to "ATM Service Architecture" on page 1-2.

ATM Flow-Control Processor Architecture

The ATM Flow-Control Processor provides per-VC queuing, and supports the CBX 500 quad-plane buffer architecture. Figure 2-1 shows the ATM Flow-Control Processor output buffers relative to the CBX 500 quad-plane output buffers.

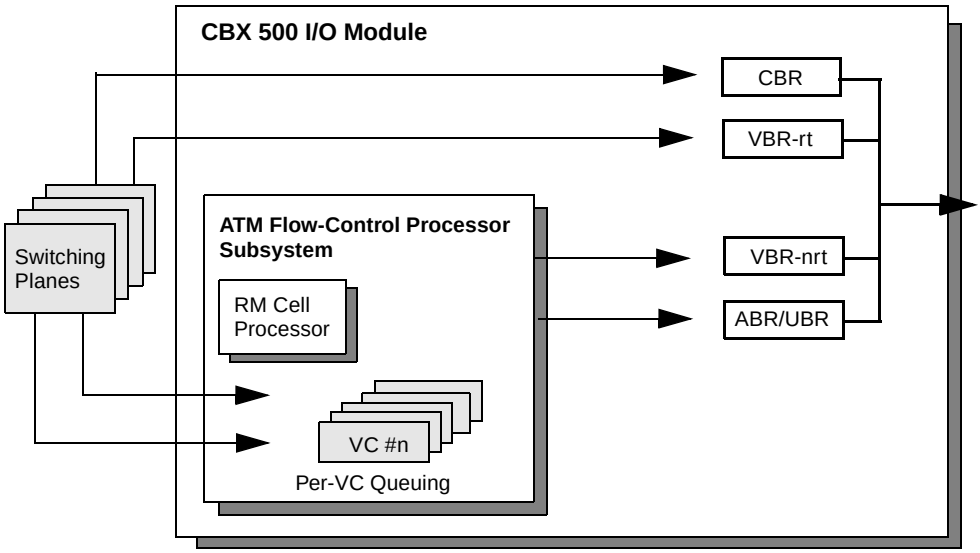


Figure 2-1. CBX 500 Queues and the ATM Flow-Control Processor

Cells entering the CBX 500 switching fabric are queued based on their QoS class. The cells are then dequeued from the CBX 500 switching fabric and queued at the ATM Flow-Control Processor queues. Note that the ATM Flow-Control Processor only queues non-real time QoS VCs.

Cells are queued and dequeued based on the configured rate for the VC. Each VC is subject to discard mechanisms. Cells entering the output CBX 500 quad-plane queues are scheduled based on the Connection Admission Control (CAC) scheduling algorithm. Refer to the *Network Configuration Guide for CBX 500* for more information about the CAC.

Closed-Loop Flow Control

Ascend's closed-loop flow-control architecture is based on hop-by-hop control loops with binary feedback. The hop-by-hop control loops push congestion at internal nodes to switches at the edge of the network, thereby providing more efficient use of network bandwidth. In addition, with less network congestion at internal nodes, there is increased network throughput.

The ATM Flow-Control Processor supports three, closed-loop flow-control mechanisms:

Cascade Communications Resource Management (CCRM) Cells — CCRM cells are a subset of the ATM Forum's *ATM Traffic Management Specification*, Version 4.0, ABR RM cells. The Protocol ID field in each RM cell is defined as the CCRM ID, indicating that it is a Cascade cell. The default value for the CCRM ID is 6. You can change the Protocol ID in the event that another switch vendor is using the default value for their proprietary loops. Refer to "Setting Flow-Control Processor Attributes" on page 3-2 for information about provisioning CCRM cells.

Backward Congestion Message (BCM) Cells — BCM cells provide for interoperability with other manufacturers' ATM switches. The Protocol ID field in each BCM cell is defined as the BCM ID. The default value for the BCM ID is 5. You can change the Protocol ID in the event that another switch vendor is using the default value for their proprietary loops. Refer to "Setting Flow-Control Processor Attributes" on page 3-2 for information about provisioning BCM cells.

Because the CBX 500 communicates with either CCRM or BCM cells for hop-by-hop control loops, both CCRM and BCM cells can be configured within a single network, allowing conversion between one closed-loop, flow-control algorithm to another.

Available Bit Rate (ABR) RM Cells — The ATM Flow-Control Processor marks ABR RM cells with binary notification as defined in the ATM Forum's *Traffic Management Specification*, Version 4.0. The Protocol ID for an ABR RM cell is 1. The ATM Flow-Control Processor identifies any RM cell with a Protocol ID of 1 as an ABR RM cell.

You can configure any port on an I/O module to generate:

- CCRM cells
- BCM cells
- No RM-type cells

This allows for different closed-loop, flow-control algorithms to be implemented on the same I/O module.

Because RM cells are generated in the backward direction, the type of RM cells generated depends on the configuration of the logical port through which they are transmitted.

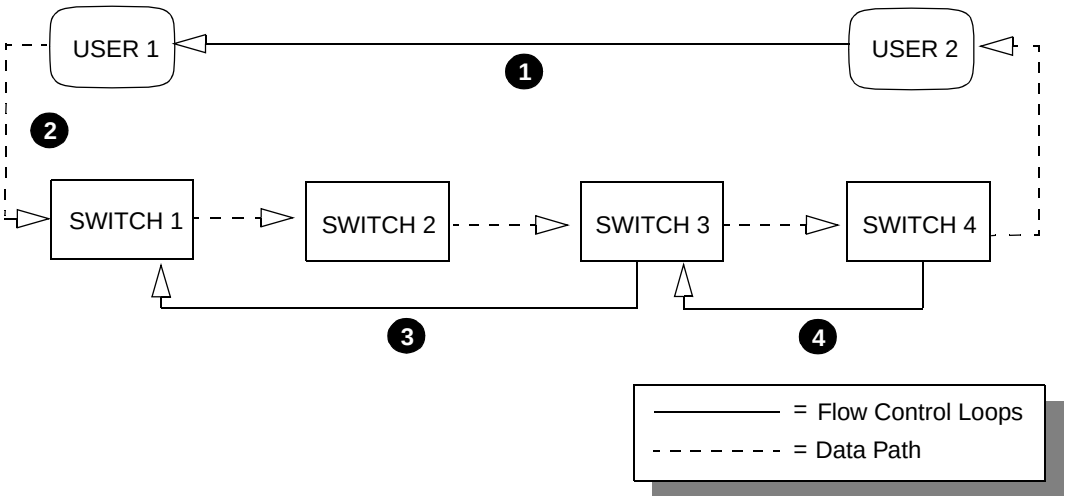
In general, RM-type cells can be generated at 30 to 250 millisecond (ms) intervals per VC. The default value for this parameter is 100 ms. Refer to "Setting Flow-Control Processor Attributes" on page 3-2 for information.

Table 2-1 shows an example of the minimum RM cell intervals and the number of supported VCs.

Table 2-1. Minimum RM Cell Intervals

Minimum RM Cell Interval	Maximum Supported VCs
100 ms	12K
50 ms	6K
30 ms	4K

Figure 2-2 on page 2-6 shows hop-by-hop, closed-loop flow control between four CBX 500 switches. The flow-control loops are shown as solid lines. The data paths are shown as dotted lines.



1 End-to-End User Control Loops

End-to-end user flow-control loops are “outer” loops. The switches do not change their cell rates in response to this flow-control loop. Rather, they mark the Congestion Indication (CI) and No Increase (NI) bits based on the local congestion state, as defined in the ATM Forum’s *Traffic Management Specification*, Version 4.0.

2 Different Logical Port Types on the same I/O Module

The ATM Flow-Control Processor supports different types of flow-control loops on the same I/O module. USER 1 has a User-Network Interface (UNI) connection. SWITCH 2 has a trunk connection to a different port on the same I/O module in SWITCH 1. Enabling and disabling of loop control is provisioned per port.

3 Switches without Flow-Control Loops

SWITCH 2 does not generate or terminate flow-control loops to the other switches. SWITCH 2 generates a forward notification of congestion to SWITCH 3. When SWITCH 2 marks EFCI in the data cells, SWITCH 3 can be configured to include EFCI notification in the decision of the backward notification to SWITCH 1.

4 Rate Control at the Output Switch

SWITCH 4’s cell rate fills the available bandwidth and is adjusted based on local congestion. The flow-control loop between SWITCH 4 and USER 2 can be configured as either BCM or CCRM termination. If configured as BCM, SWITCH 4 will adjust rates according to the port congestion. If configured as CCRM, SWITCH 4 will perform traffic shaping to the ICR of each VC.

Figure 2-2. Closed-Loop Flow Control

Note that Explicit Forward Congestion Indication (EFCI) marking can be configured on a CBX 500 switch through CascadeView. Refer to "Defining Logical Port Parameters" on page 3-21 for information.

CCRM Closed-Loop Flow Control

Ascend's closed-loop, flow-control architecture can use CCRM cells to notify CBX 500 switches of network congestion. Figure 2-3 shows an example of CCRM closed-loop flow control between two CBX 500 switches.

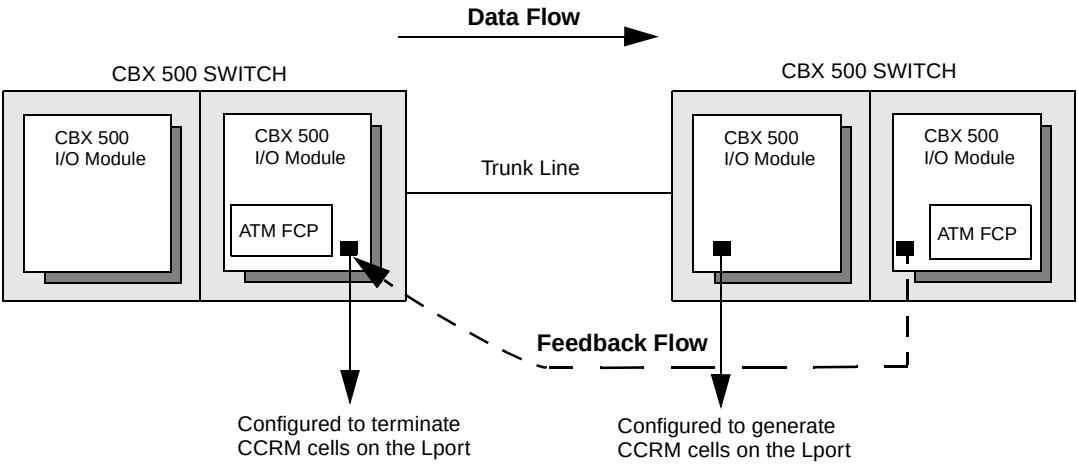


Figure 2-3. CCRM Closed-Loop Flow Control

Generating CCRM Cells

When a CCRM cell is generated:

1. The Direction (DIR) and Backward Indicator (BI) bits are set, indicating that this is a switch-generated backward RM cell.
2. The Congestion Indication (CI) and No Increase (NI) bits are set according to the current congestion status of the VC.

The destination ATM switch periodically sends backward binary notification through CCRM cells to the source ATM switch, indicating the state of the destination ATM switch's queue for a VC. The binary notification is reflected in the CI and NI bits of the CCRM cell. The CCRM cell indicates a cell rate increase, decrease, or no change. The source ATM switch then responds by adjusting the cell rate accordingly for that VC and terminates the CCRM cell.

BCM Closed-Loop Flow Control

The CBX 500 utilizes a BCM closed-loop, flow-control algorithm to interoperate with other manufacturers' ATM switches. Unlike CCRM cells, BCM cells only indicate cell rate decreases. BCM cells are sent on periodic intervals only when congestion exists.

During the RM cell generation interval, the Allowed Cell Rate (ACR) for a VC is increased if:

- A BCM cell is not received over the previous RM cell interval.
- The port is not congested.

Figure 2-4 shows an example of BCM closed-loop flow-control between two CBX 500 switches.

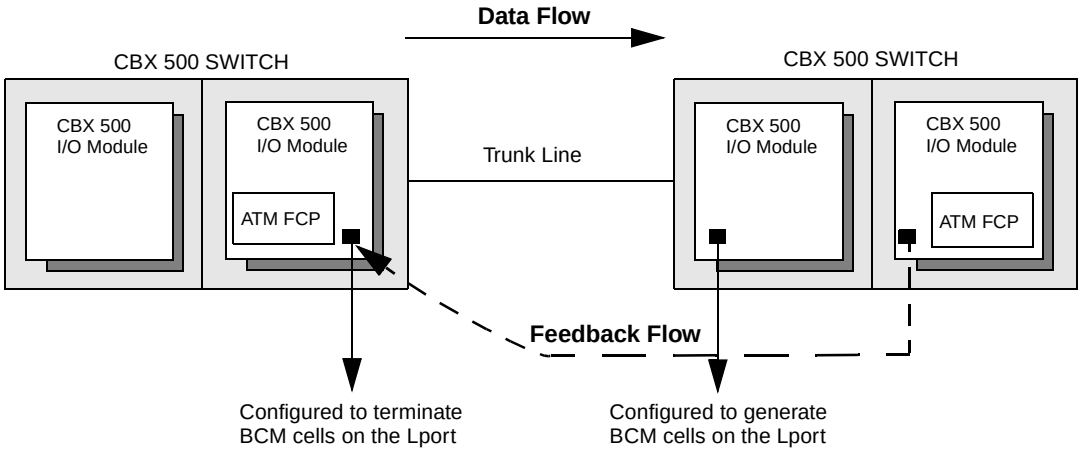


Figure 2-4. BCM Closed-Loop Flow Control

You can configure an output UNI logical port to allow ATM Flow-Control Processor-managed VCs going through that logical port to increase their cell rates. This enables the logical port to use all available non-real time bandwidth. This is done by setting the RM termination type on that logical port to BCM, as shown in Figure 2-5.

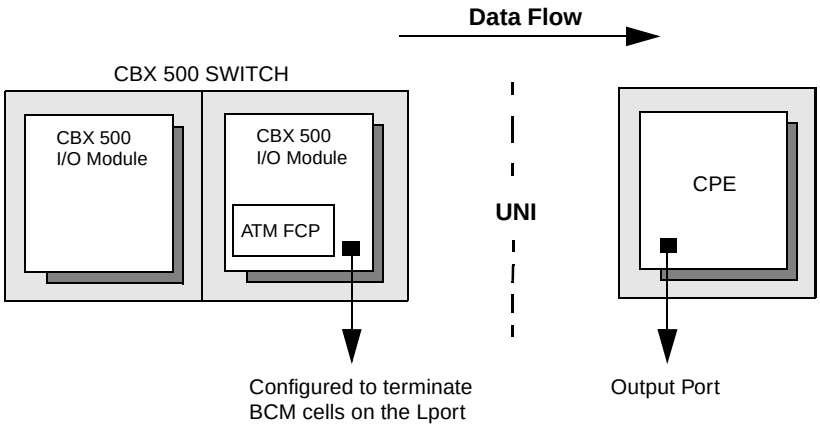


Figure 2-5. Output UNI Logical Port RM Termination

Because the logical port does not receive any BCM cells from the UNI, the ACR of the VCs keeps increasing until the logical port becomes congested. The ACR will increase fairly, corresponding to the RIF and PCR values of the VCs. Refer to "Defining Logical Port Parameters" on page 3-21 for information on setting the RM termination type.

Generating BCM Cells

You can configure any port on an I/O module to generate BCM cells. If you select the BCM generation option when configuring the ATM Flow-Control Processor, BCM cells are generated when the port is congested. Refer to Table 2-1 on page 2-5 for the RM cell intervals and the number of supported VCs. Refer to "Setting Flow-Control Processor Attributes" on page 3-2 for information on configuring the BCM generation option.

Terminating CCRM and BCM Cells

When the CBX 500 terminates either a CCRM or BCM cell, the CBX 500 makes a decision on whether or not to increase or decrease the ACR. This decision is based upon one or more of the following:

- The local port congestion state
- The current ACR being above the fair bandwidth for the VC
- The Congestion Indicator (CI) and No Increase (NI) state in the RM cell (if the port is configured for CCRM termination)
- If no BCM cells were received within the RM generation interval (if the port is configured for BCM termination)
- If BCM cells are received (if the port is configured for BCM termination)

If BCM cells are received, but the port is not configured for BCM termination, the BCM cells are forwarded.

The fair bandwidth for a VC is the proportional allocation of the total bandwidth for managed (non-real time) circuits, based on the MCR of the VC relative to all of the managed VCs. The total, non-real time bandwidth is the total port bandwidth, less the bandwidth allocated to unmanaged (real-time) circuits.

Note that the ATM Flow-Control Processor can increase the ACR well beyond its fair bandwidth. Once other circuits attempt to use that bandwidth, hence causing a congestion condition, the ATM Flow-Control Processor will throttle back the ACR towards the fair bandwidth for the circuit until the congestion condition is removed.

ABR RM Closed-Loop Flow Control

ABR RM closed-loop flow control is an additional flow-control loop for switches that generate ABR RM cells. Because the ABR RM flow-control loop is an end-to-end loop, the CBX 500 does not generate or terminate ABR RM cells. Instead, the ATM Flow-Control Processor marks the CI and NI bits in the ABR RM cell based on the local ATM Flow-Control Processor congestion state. The ATM Flow-Control Processor then forwards the ABR RM cells through the network.

Cell Rate Adjustment

When a VC initially becomes active, its Allowable Cell Rate (ACR) is set to its Initial Cell Rate (ICR). The ICR for a VC is determined by its:

- Peak Cell Rate (PCR)
- Minimum Cell Rate (MCR)
- ICR Constant

ICR Constant

The ICR Constant is configurable through CascadeView. The default value is 8. The following formula shows how to calculate the ICR Constant:

$$ICR = MCR + \frac{PCR - MCR}{2^{ICR\ CONSTANT}}$$

Refer to "Setting Flow-Control Processor Attributes" on page 3-2 for information on configuring the ICR Constant.

Idle VC Factor

The specified number of RM intervals for a VC to go idle is configurable through CascadeView. This is called the Idle VC Factor. The default value for the Idle VC Factor is 8. Refer to "Setting Flow-Control Processor Attributes" on page 3-2 for information about configuring the Idle VC Factor.

If no cells are received for a specified number of RM cell intervals, the VC is marked "idle," and the ACR is set to the ICR. RM cells are not generated for idle VCs.

Rate Decrease Factor (RDF) and Rate Increase Factor (RIF)

The cell rate of a VC is decreased according to the following formula:

```
ACR = ACR - (RDF x ACR)
```

Where: $1/32768 \leq RDF \leq 1$

The ACR is lower-bounded by the MCR.

The rate of a VC is increased according to the following formula:

```
ACR = ACR + (RIF x PCR)
```

Where: $1/32768 \leq RIF \leq 1$

The ACR is upper-bounded by the PCR.

The RDF and the RIF values are configurable through CascadeView. Refer to "Rate Profile Tables" on page 2-13 and "Downloading Buffer Threshold and Rate Profile Tables" on page 3-7 for information on configuring RDF and RIF values.

Table 2-2 lists the minimum allocated MCR for ABR and UBR circuits.

Table 2-2. Cell Scheduling

Port Bandwidth	Max. Port Cell Rate (cells/sec)	Max. Number of Circuits (connections/port)	Min. Allocated MCR (cells/sec)
OC12	1412830	16K	88
OC3	353207	4K	88
DS3	96000	2K	48
E3	8000	2K	40
DS1	3622	2K	1.8
E1	4528	2K	2.4

Rate Profile Tables

You can load two rate profile tables into the ATM Flow-Control Processor. The ATM Flow-Control Processor uses these tables to determine the Rate Increase Exponent (RIE) and the Rate Decrease Exponent (RDE) for each VC on a port. These, in turn, are used to compute the RIF and the RDF. Each table consists of 256 entries. Refer to "Downloading Buffer Threshold and Rate Profile Tables" on page 3-7 for information on downloading the tables using CascadeView.

The following define the RIE and RDE:

Rate Increase Exponent (RIE) — The RIE is a provisionable value that is the negative exponent for the RIF calculation ($RIF=2^{-RIE}$). For example, a RIE of 3 translates to a RIF of 1/8. The RIE must be less than 16.

Rate Decrease Exponent (RDE) — The RDE is a provisionable value that is the negative exponent for the RDF calculation ($RDF=2^{-RDE}$). For example, a value of 3 translates to a RDF of 1/8. The RDE must be less than 16.

The RIF and RDF value for any VC is obtained from indexing the corresponding rate profile table with the VC's MCR class. The MCR (SCR for VBR-nrt VCs) of any VC is mapped to one of 256 MCR classes. Note that MCR class 0 is reserved for UBR VCs. Refer to Appendix A, "MCR Class Parameters," for information about MCR class mappings per I/O module.

Traffic Shaping

You can configure the ATM Flow-Control Processor to perform traffic shaping for ATM Flow-Control Processor-managed VCs by turning off the control loops for these VCs. For any direction of data flow, you can:

1. Configure the RM cell generation of all input logical ports the VC passes through to "no loop." Refer to "Defining Logical Port Parameters" on page 3-21 for information.

2. Configure all output logical ports the VC passes through to terminate CCRM cells. Refer to "Defining Logical Port Parameters" on page 3-21 for information.

VCs are shaped at their Initial Cell Rate (ICR). Refer to "ICR Constant" on page 2-11 for a description of the ICR Constant. Because control loops are disabled, the ACR will stay at the ICR. Note that there is no guarantee of ICR if it is overbooked.

ATM Flow-Control Processor Queues

The ATM Flow-Control Processor provides per-VC queueing. Per-VC queuing provides independent buffer allocation to each VC, thereby isolating congestion on one VC from other VCs. Each per-VC queue has two configurable thresholds:

- Local congestion threshold
- Local discard threshold

The congestion and discard thresholds for a specific VC are obtained by indexing the congestion and discard tables with the MCR class of the VC. The MCR class of the VC is obtained from its MCR. Refer to Appendix A, “MCR Class Parameters,” for information about MCR classes.

MCR class 0 is reserved for UBR VCs.

The congestion and discard threshold tables are configurable through CascadeView. Refer to “Downloading Buffer Threshold and Rate Profile Tables” on page 3-7 for information.

In addition to the local thresholds, each port on an I/O module is assigned one:

- Global congestion threshold
- Global discard threshold
- Global CLP0+1 threshold

All of the above thresholds are configurable through CascadeView. Refer to “Defining Logical Port Parameters” on page 3-21 for information.

Both local and global thresholds are used for congestion notification and discarding. A VC is considered congested only if its queue is above the local congestion threshold, and the global queue length on the port is above the global congestion threshold.

Similarly, a VC enters a discard state only if the VC queue length is greater than the VC discard threshold, and the port queue length is greater than the global discard threshold.

Figure 2-6 shows the five ATM Flow-Control Processor buffer thresholds.

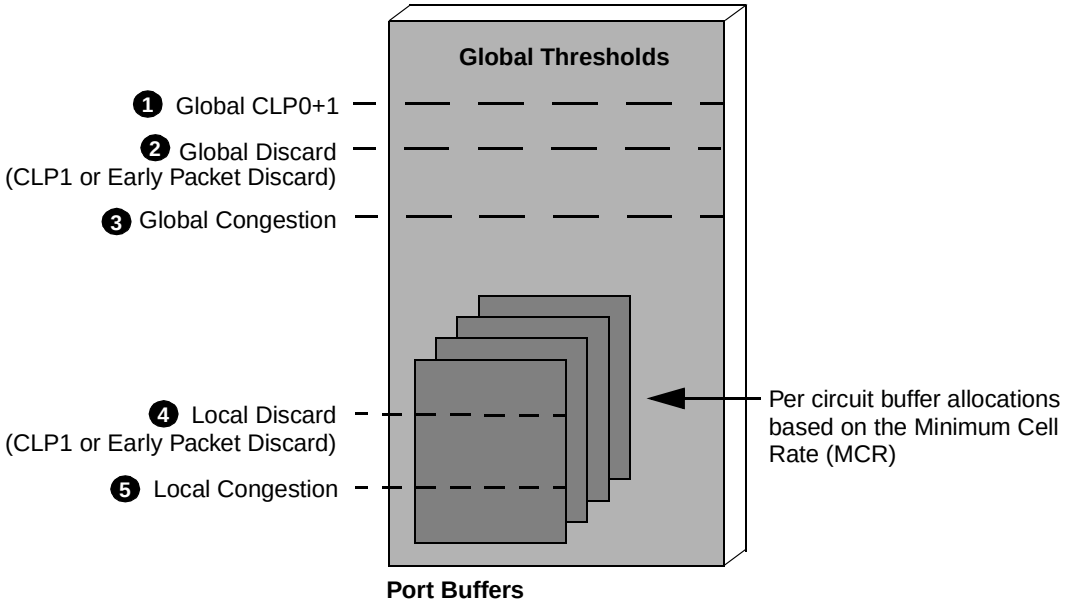


Figure 2-6. ATM Flow-Control Processor Buffers

The difference between the EPD and CLP0+1 threshold allows the VCs to continue to queue cells due to the EPD state. When the EPD threshold is exceeded, cells are queued on the current packet, and the next packet is discarded for the same VC.

The CLP0+1 threshold enables you to reserve buffers before the maximum buffer capacity is reached. It is recommend that you reserve a sufficient number of buffers to allow idle circuits to get access to buffers. Idle circuits are those that have temporarily stopped sending traffic.

ATM Flow-Control Discard Mechanisms

The ATM Flow-Control Processor supports three mechanisms for discarding cells:

Early Packet Discard (EPD) — The ATM Flow-Control Processor performs EPD for UBR, ABR, and VBR-nrt VCs. If a cell causes the queue for a VC to exceed the discard thresholds, the VC enters the EPD state. The cells in the current packet of the VC are admitted to the queue. However, when the end of the current packet is detected, all of the cells in the next packet are discarded for that VC.

Selective Discard (CLP1) — Selective CLP1 discard can be provisioned for UBR, ABR, and VBR-nrt VCs. If the current cell causes the queue for a VC to exceed the discard thresholds, and the cell has CLP set to 1, the cell is discarded. Note that EPD is not performed in this case.

Partial Packet Discard (PPD) — If the global CLP0+1 threshold for a port is reached, PPD is performed for circuits that are configured for EPD. Unlike EPD, however, all of the remaining cells in the current packet are discarded. Note that the EOF cell is discarded as well. This results in the loss of the next packet even if the packet is transmitted.

Multicast Cells

All Multicast cells are placed into a single queue. There is one queue per I/O module. Multicast cells are discarded when the ATM Flow-Control Processor multicast queue length reaches a certain threshold. You can configure this threshold for each installed I/O module. Refer to “Setting Flow-Control Processor Attributes” on page 3-2 for information.

Multicast cells are dequeued at the assigned Multicast cells shaping rate. This rate is configurable using CascadeView. Refer to “Setting Flow-Control Processor Attributes” on page 3-2 for information.

Statistics

The ATM Flow-Control Processor keeps track of the following statistics:

- Per-VC
  - The number of transmitted cells with CLP=0 discarded due to per-VC queue discards.
  - The number of transmitted cells with CLP=1 discarded due to per-VC queue discards.
- Per-Logical Port
  - The number of transmitted multicast cells with CLP0+1 discarded due to transmit buffer threshold limits.
  - The number of all received RM cells per port, including BCM, CCRM, and ABR RM cells. Note that RM cells with a CRC error are not counted.

Refer to “Displaying Logical Port Summary Statistics” on page 3-33 and “Displaying Circuit Summary Statistics” on page 3-37 for information about specific ATM Flow-Control Processor statistics fields.

3

Configuring the Flow-Control Processor

This chapter describes how to configure the ATM Flow-Control Processor.

Before You Begin

Before you begin to configure the ATM Flow-Control Processor, verify you have completed the following:

- ☑ The CBX 500 switch hardware is up and running. Refer to the *CBX 500 Hardware Installation Guide* for instructions.
- ☑ The CascadeView SPARCstation is properly connected to the CBX 500 switch. Refer to the *CBX 500 Hardware Installation Guide* for instructions.
- ☑ The CascadeView software is up and running on the CascadeView SPARCstation and you are logged in. The instructions in this chapter assume that you have created a network map, added the CBX 500 switch object to the map, and specified switch attributes. For instructions, refer to the *Network Configuration Guide for CBX 500.*

Keep in mind that the dialog boxes shown in this chapter may not contain the same information in certain fields as the dialog boxes displayed on your system.

You must log on to CascadeView before you can configure or modify any parameters for the selected CBX 500. If you are not already logged on, select the CBX 500 switch object, then select CascadeView ⇒ Logon from the Misc menu and enter the operator password.

Setting Flow-Control Processor Attributes

To configure ATM Flow-Control Processor attributes on an I/O module (IOM):

1. On the network map, select the CBX 500 object whose IOM you want to configure.
2. From the Administer menu, select Cascade Parameters ⇒ Set Parameters. The CBX 500 back panel display opens.
3. Double-click on the IOM you want to configure, or select the slot and then choose the Set Attr button. The Set Card Attributes dialog box opens.

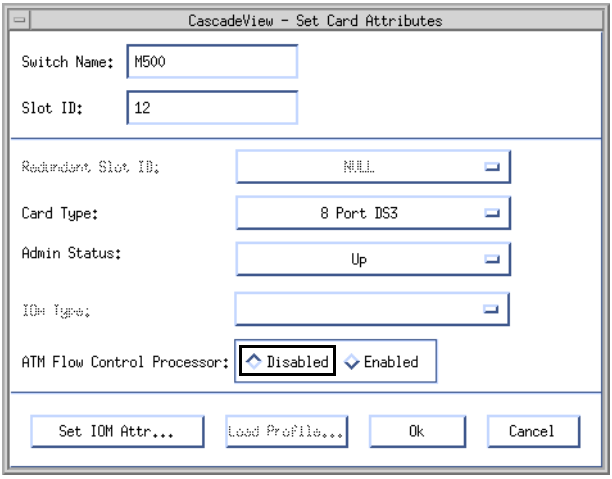


Figure 3-1. Set Card Attributes Dialog Box (Part 1)

4. At the ATM Flow Control Processor field, select Enabled. The lower portion of the Set Card Attributes dialog box opens.

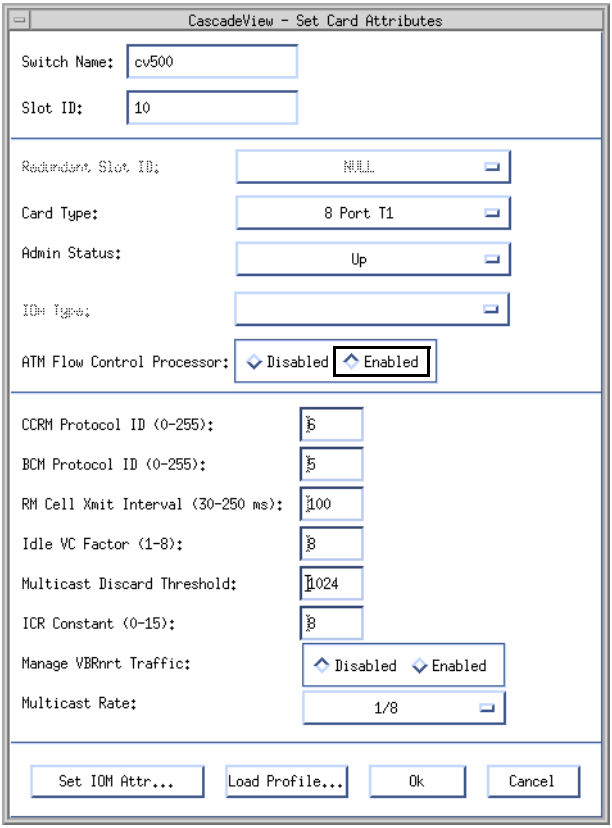


Figure 3-2. Set Card Attributes Dialog Box (Part 2)

If you change the ATM Flow-Control Processor parameter values (except for the RM Cell Xmit Interval), the switch object and the IOM turn yellow, indicating that the switch is "Marginal." You must perform a PRAM Sync. The Synchronize PRAM command enables you to correct inconsistencies between the NMS database and CBX 500 PRAM. Refer to the "Network Configuration Guide for CBX 500" for PRAM Sync instructions.

5. Complete the fields described in Table 3-1.

Table 3-1. Set Card Attributes Dialog Box Fields

Field	Action/Description
Switch Name	Displays the name of the CBX 500 switch.
Slot ID	Displays the CBX 500 back panel physical slot number where the IOM is installed.
Redundant Slot ID	This function is currently not supported.
Card Type	Displays the type of installed IOM.
Admin Status	Select the Admin Status as follows: *Up* — (Default) Activates the IOM at start-up. When activated, the IOM gets its application code from the Switch Processor (SP) and loads the drivers. *Down* — The IOM does not come online when you start the CBX 500. The configuration is saved in the database, but is not downloaded to the CBX 500. Use this option when you run foreground diagnostics. *Maintenance* — Sets this IOM in a state where only its boot flash is running; application code is not running. This setting enables you to reset the PRAM for an IOM that cannot boot due to invalid PRAM. You can also use this option to troubleshoot a hardware problem.
IOA Type	Displays the type of optical interface for the IOM, if applicable.
ATM Flow Control Processor	When this field is enabled, the dialog box displays the available attributes for the ATM Flow-Control Processor.

Table 3-1. Set Card Attributes Dialog Box Fields (Continued)

Field	Action/Description
CCRM Protocol ID: (0-255)	Enter the CCRM Protocol ID. The default value is 6. (Refer to "Closed-Loop Flow Control" on page 2-4 for information.)
BCM Protocol ID: (0-255)	Enter the BCM Protocol ID. The default value is 5. (Refer to "Closed-Loop Flow Control" on page 2-4 for information.)
RM Cell Xmit Interval (30-250 ms)	Enter the RM Cell Xmit Interval. The default value is 100. (Refer to "Generating CCRM Cells" on page 2-7 for information.)
Idle VC Factor (1-8)	Enter the Idle VC Factor. The default value is 8. (Refer to "Idle VC Factor" on page 2-11 for information.)
Multicast Discard Threshold	Enter the Multicast Discard Threshold. The default value is 1024. (Refer to "Multicast Cells" on page 2-16 for information.)
ICR Constant (0-15)	Enter the Initial Cell Rate (ICR) Constant. The default value is 8. (Refer to "Rate Profile Tables" on page 2-13 for information.)
Manage VBRnrt Traffic	Select the Enabled option if you want Variable Bit Rate-Non Real-Time (VBR-nrt) traffic to be treated as Available Bit Rate (ABR) traffic. (Refer to "Supported ATM Service Classes" on page 2-2 for information on VBR-nrt traffic.)

Table 3-1. Set Card Attributes Dialog Box Fields (Continued)

Field	Action/Description
Multicast Rate	The multicast rate parameter determines the rate at which the multicast queue is dequeued on the ATM Flow-Control Processor. The default value is 1/8 (12.5%) of the line rate. You can select the multicast shaping rate as a fraction of the line rate, from 1/15 to 1. The rate is configured per IOM. (Refer to "Multicast Cells" on page 2-16 for information.) ***Note:*** *There is only one multicast queue per ATM Flow-Control Processor.*

Push Buttons

The Set Card Attributes dialog box provides the following push buttons:

`Set IOM Attr...` Enables you to configure the attributes for this IOM. Refer to the *Network Configuration Guide for CBX 500* for information on the Set IOM Card Attributes dialog box.

`Load Profile...` Enables you to load the two buffer threshold tables and two rate profile tables into the ATM Flow-Control Processor.

Note: *This function is only available after the IOM attributes have been defined. Refer to "Downloading Buffer Threshold and Rate Profile Tables" on page 3-7 for instructions.*

`Ok` Returns you to the CBX 500 back panel display and saves your changes.

`Cancel` Closes the Set Card Attributes dialog box without saving any changes and returns you to the CBX 500 back panel display.

Downloading Buffer Threshold and Rate Profile Tables

You can load two buffer threshold tables and two rate profile tables into the ATM Flow-Control Processor. The ATM Flow-Control Processor uses these tables to determine the available bandwidth, the Rate Increase Exponent (RIE), and the Rate Decrease Exponent (RDE) for each VC on a port. Each table must consists of 256 entries. Refer to "Rate Profile Tables" on page 2-13 for information about these tables.

The Load Profile function is not available until you define the IOM attributes. Refer to "Setting Flow-Control Processor Attributes" on page 3-2.

To load the Buffer Threshold and Rate Profile tables:

1. On the network map, select the CBX 500 object whose IOM you want to configure.
2. From the Administer menu, select Cascade Parameters ⇒ Set Parameters. The CBX 500 back panel display opens.
3. Select the IOM you want to configure.
4. Choose the Set Attr button. The Set Card Attributes dialog box opens.
5. At the ATM Flow Control Processor field, select Enabled. The lower portion of the Set Card Attributes dialog box opens.
6. Choose the Load Profile button. The Load Rate Profile Tables dialog box opens.

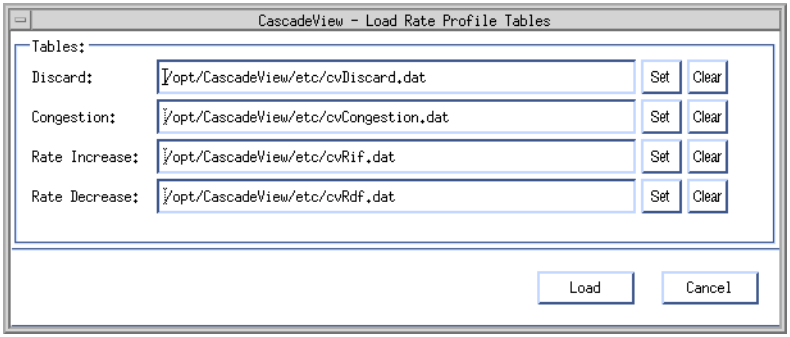


Figure 3-3. Load Rate Profile Tables Dialog Box

Refer to Appendix A, "MCR Class Parameters," for information on the contents of the tables.

If you change the parameter values in the Load Rate Profile Tables dialog box, the switch object and the IOM turn yellow, indicating that the switch is "Marginal." You must perform a PRAM Sync. The Synchronize PRAM command enables you to correct inconsistencies between the NMS database and CBX 500 PRAM. Refer to the "Network Configuration Guide for CBX 500" for PRAM Sync instructions.

7. Either complete the fields described in Table 3-2 or choose the Load button.

Table 3-2. Load Rate Profile Tables Dialog Box Fields

Table	Action/Description
Discard	Either accept the default filename or select Clear to erase the filename. If you erase the filename, go to Step 8 on page 3-9. (Refer to "ATM Flow-Control Discard Mechanisms" on page 2-16 for information.)

Table 3-2. Load Rate Profile Tables Dialog Box Fields (Continued)

Table	Action/Description
Congestion	Either accept the default filename or select Clear to erase the filename. If you erase the filename, go to Step 8. (Refer to "ATM Flow-Control Processor Queues" on page 2-14 for information.)
Rate Increase	Either accept the default filename or select Clear to erase the filename. If you erase the filename, go to Step 8. (Refer to "ATM Flow-Control Processor Queues" on page 2-14 for information.)
Rate Decrease	Either accept the default filename or select Clear to erase the filename. If you erase the filename, go to Step 8. (Refer to "ATM Flow-Control Processor Queues" on page 2-14 for information.)

8. Either enter a new filename and choose the Load button, or choose the Set button. The Load Rate Profile Table dialog box opens (Figure 3-4 on page 3-10).

9. Select the file you want to load into the ATM Flow-Control Processor. The complete pathname is displayed in the Selection text box.

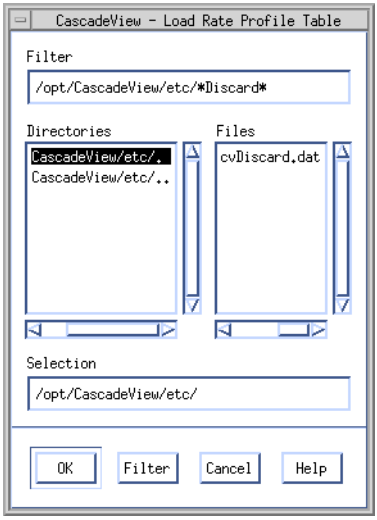


Figure 3-4. Load Rate Profile Table Dialog Box

10. Choose the OK button. The Load Rate Profile Table dialog box closes and returns you to Load Rate Profile Tables dialog box.

11. Choose the Load button. The file is loaded into the Sybase database. You must then perform a PRAM Sync. Refer to the *Network Configuration Guide for CBX 500* for PRAM Sync instructions.

Push Buttons

The Load Rate Profile Table dialog box provides the following push buttons:

OK	Returns you to the Load Rate Profile Tables dialog box and enters the specified file.
Filter	Enables you to display all the files in the directory with the file extension you enter in the Filter text box.
Cancel	Closes the Load Rate Profile Table dialog box without saving any changes and returns you to the Load Rate Profile Tables dialog box.
Help	Displays help information (not currently implemented).

The Load Rate Profile Tables dialog box provides the following push buttons:

Load	Loads the displayed files into the Sybase database. You must then perform a PRAM Sync. Refer to the *Network Configuration Guide for CBX 500* for PRAM Sync instructions.
Cancel	Closes the Load Rate Profile Tables dialog box without saving any changes and returns you to the Set Card Attributes dialog box.

Viewing I/O Module (IOM) Attributes

To display I/O module (IOM) attributes:

1. Select the appropriate CBX 500 object on the network map.
2. From the Monitor menu, select Cascade Objects ⇒ Show Detail.
   The CBX 500 back panel display opens.
3. Double-click on the desired IOM slot. The View Card Attributes dialog box opens (see Figure 3-5 on page 3-13).

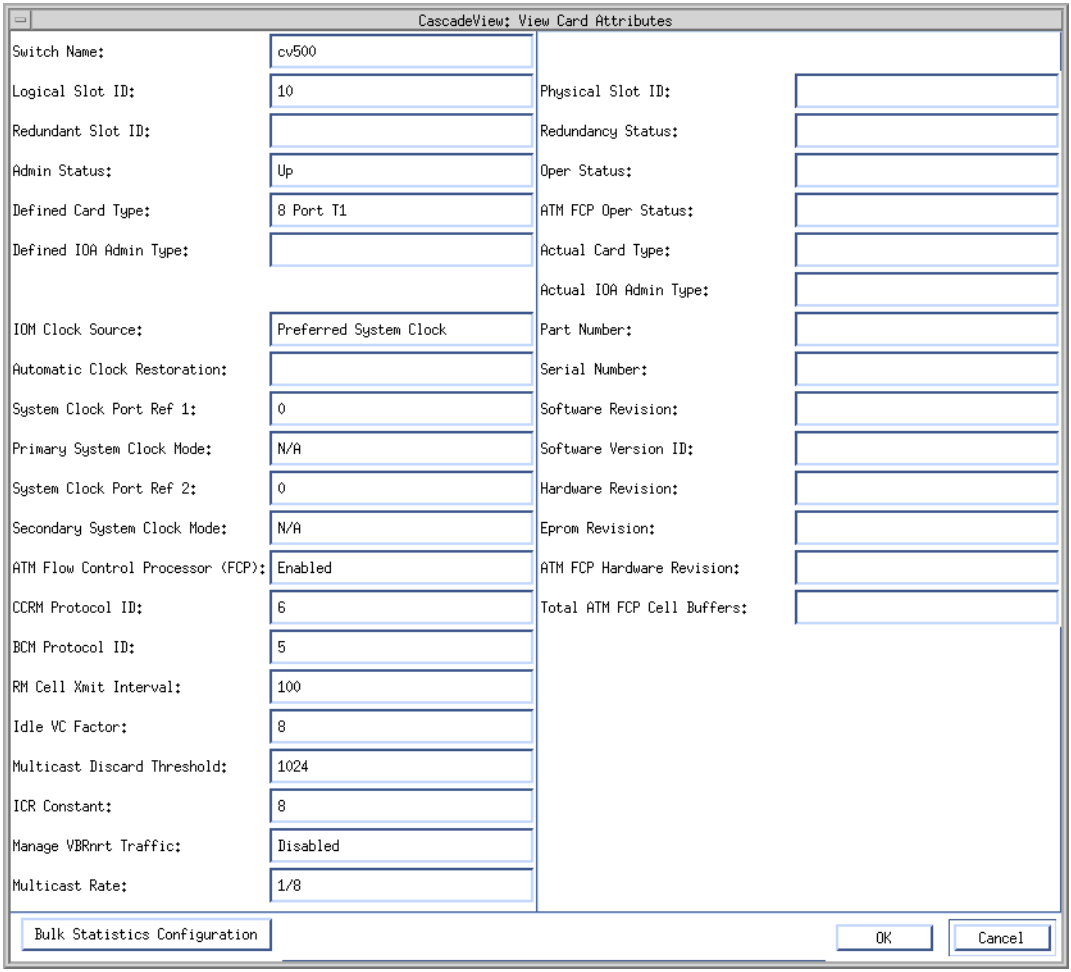


Figure 3-5. View Card Attributes Dialog Box

Table 3-3 describes each field in the View Card Attributes dialog box.

Table 3-3. View Card Attributes Dialog Box Fields

Field	Description
Switch Name	Displays the name of the CBX 500 entered at configuration time.
Logical Slot ID	Displays CBX 500 back panel logical slot number where the IOM is installed.
Redundant Slot ID	Displays the redundant module slot, if applicable.
Admin Status	A value of *Up* indicates the IOM is active. A value of *Down* indicates the IOM has never been active, or has been taken off-line to run diagnostics. A value of *Maintenance* indicates that the IOM can only run from boot code. This setting enables you to reset PRAM for an IOM that cannot boot due to invalid PRAM. You can also use this option to troubleshoot a possible hardware problem.
Defined Card Type	Displays the type of IOM configured for this slot.
Defined IOA Admin Type	Displays the type of optical interface for this slot, if applicable.

Table 3-3. View Card Attributes Dialog Box Fields (Continued)

Field	Description
IOM Clock Source	Displays the internal timing source for the IOM. This setting applies only to those physical ports on the IOM whose Xmit Clock Source is set to *Internal*. This field has no effect on physical ports where the Xmit Clock Source field is set to *Loop-Timed*, since the clock source for these ports is derived from the incoming clock source. This field displays one of the following options: *Local Clock* — The IOM's clock source is derived from the local clock on the IOM. *Primary System Clock Only* — The IOM's clock source is derived from the primary system clock source. You specify the primary system clock source in the Set Clock Sources dialog box. *Secondary System Clock Only* — The IOM's clock source is derived from the secondary system clock source. You specify the secondary system clock source in the Set Clock Sources dialog box. *Preferred System Clock* — The IOM's clock source is derived from the preferred system clock, which can be either the primary or secondary system clock (whichever of the two is currently up).
Automatic Clock Restoration	When *Enabled*, if the primary system clock fails (causing the system to switch-over to the secondary system clock), and then recovers, the switch reverts to the primary system clock source. When *Disabled*, if the primary system clock fails and then recovers, the switch does not revert to the primary system clock; it continues to use the secondary system clock.

Table 3-3. View Card Attributes Dialog Box Fields (Continued)

Field	Description
System Clock Port Ref 1	Determines whether or not the IOM provides the primary system clock source to the SP module. Options include: *No Physical Port* — The SP does not get its primary system clock source from a port on this IOM. *Physical Port n* — The physical port provides the primary system clock source to the SP. With this option, SP uses the incoming clock signal on the selected port as the primary system clock source. On a given switch, you can configure a maximum of two physical ports as clock sources (one primary and one secondary).
Primary System Clock Mode	Appears only if you selected a Physical Port in the System Clock Port Ref 1 field. Options include: *PLCP* — The IOM uses a PLCP frame, which transmits 12 ATM cells every 125 µs. *Line Rate* — The IOM uses the DS3 line rate as the clock mode. The DS3 line rate is 44.5 Mbps, while the E3 line rate is 36.8 Mbps. Line Rate is the only option for E3 modules.

Table 3-3. View Card Attributes Dialog Box Fields (Continued)

Field	Description
System Clock Port Ref 2	Determines whether or not the IOM provides the secondary system clock source to the SP module. Options include: *No Physical Port* — The SP does not get its secondary system clock source from a port on the IOM. *Physical Port n* — The physical port provides the secondary system clock source to the SP. With this option, the SP uses the incoming signal on the selected port as the secondary clock source. On a given switch, you can configure a maximum of two physical ports as clock sources (one primary and one secondary).
Secondary System Clock Mode	Appears only if you selected a Physical Port in the System Clock Port Ref 2: field. Options include: *PLCP* — The IOM uses a PLCP frame, which transmits 12 ATM cells every 125 µs. This item does not apply, and is not selectable for E3 IOMs. *Line Rate* — The IOM uses the DS3 (or E3) line rate as the clock mode. The DS3 line rate is 44.5 Mbps, while the E3 line rate is 36.8 Mbps. Line rate is the only option for E3 IOMs.
ATM Flow Control Processor (FCP)	Indicates the current status of the ATM Flow-Control Processor; either Enabled or Disabled.
CCRM Protocol ID	Displays the current CCRM Protocol ID. (Refer to "CCRM Closed-Loop Flow Control" on page 2-7 for information.)

Table 3-3. View Card Attributes Dialog Box Fields (Continued)

Field	Description
BCM Protocol ID	Displays the current BCM Protocol ID. (Refer to "BCM Closed-Loop Flow Control" on page 2-9 for information.)
RM Cell Xmit Interval	Displays the current RM Cell Xmit Interval. (Refer to "Closed-Loop Flow Control" on page 2-4 for information.)
Idle VC Factor	Displays the current Idle VC Factor. (Refer to "Idle VC Factor" on page 2-11 for information.)
Mulitcast Discard Threshold	Displays the current Multicast Discard Threshold. (Refer to "Multicast Cells" on page 2-16 for information.)
ICR Constant	Displays the current Initial Cell Rate (ICR) Constant. (Refer to "Rate Profile Tables" on page 2-13 for information.)
Manage VBRnrt Traffic	Displays "Enabled" if you want Variable Bit Rate Non-Real Time (VBR-nrt) traffic to be treated as Available Bit Rate (ABR) traffic. (Refer to "Supported ATM Service Classes" on page 2-2 for information on VBR-nrt traffic.)
Multicast Rate	Displays the current multicast shaping rate as a fraction of the line rate. The multicast rate parameter determines the rate at which the multicast queue is dequeued on the ATM Flow-Control Processor. The default value is 1/8 (12.5%) of the line rate. (Refer to "Multicast Cells" on page 2-16 for information.)
Physical Slot ID	Displays the physical slot number of the installed IOM that contains the selected physical port.
Redundancy Status	Displays the redundancy status, either active or standby.

Table 3-3. View Card Attributes Dialog Box Fields (Continued)

Field	Description
Oper Status	Displays the operational status of the selected IOM.
ATM FCP Oper Status	Displays the ATM Flow-Control Processor's operational status, either Enabled or Disabled.
Actual Card Type	Displays the actual IOM type as defined by the firmware.
Actual IOA Admin Type	Currently not implemented.
Part Number	Displays the part number of the selected IOM.
Serial Number	Displays the serial number of the selected IOM.
Software Revision	Displays the version of CBX 500 code software.
Software Version ID	Displays the build ID and date of the CBX 500 code software.
Hardware Revision	Displays the hardware revision number.
Eprom Revision	Displays the EPROM firmware revision number.
ATM FCP Hardware Revision	Displays the ATM Flow Control hardware revision number.
Total ATM FCP Cell Buffers	Displays the total number of ATM Flow-Control Processor cell buffers. (Refer to "ATM Flow-Control Processor Queues" on page 2-14 for information.)

Push Buttons

The View Card Attributes dialog box provides the following push buttons:

Bulk Statistics Configuration	Opens the Bulk Statistics Configuration dialog box. Refer to the *Bulk Statistics Collector for CBX 500 User's Guide* for information.
Ok	Closes the View Card Attributes dialog box and returns you to the CBX 500 back panel display.
Cancel	Closes the View Card Attributes dialog box and returns you to the CBX 500 back panel display.

Defining Logical Port Parameters

Cascade Communications Resource Management (CCRM) cells are a subset of the ATM Forum's *ATM Traffic Management, Version 4.0*, Available Bit Rate (ABR) Resource Management (RM) cells. Backward Congestion Message (BCM) cells provide for interoperability with other manufacturers' ATM switches.

Refer to "Closed-Loop Flow Control" on page 2-4 for more information on the ATM Flow-Control Processor's closed-loop, flow-control architecture.

If you change the CLP0+1, Discard, or Congestion parameter values, the switch object and the IOM turn yellow, indicating that the switch is "Marginal." You must perform a PRAM Sync. The Synchronize PRAM command enables you to correct inconsistencies between the NMS database and CBX 500 PRAM. Refer to the "Network Configuration Guide for CBX 500" for PRAM Sync instructions.

To configure the closed-loop, flow-control mechanisms at the logical port level:

1. From the network map, select the appropriate CBX 500 object.
2. From the Administer menu, select Cascade Parameters ⇒Set Parameters. The CBX 500 back panel display opens.
3. Select the desired IOM physical port and choose the Set Attr button. The Physical Port Attributes dialog box opens. Refer to the *Network Configuration Guide for CBX 500* for information on this dialog box.
4. Choose the Logical Port button to access the Set All Logical Ports in PPort dialog box. Refer to the *Network Configuration Guide for CBX 500* for information on this dialog box.
5. Choose the Add button. The Add Logical Port Type dialog box opens. Refer to the *Network Configuration Guide for CBX 500* for information on this dialog box.
6. Choose the Ok button. The Add Logical Port dialog box reopens.
7. From the Set Attributes option menu, select the ATM FCP option. The ATM Flow-Control Processor attributes are displayed.

The example dialog box may not display the same fields as the dialog box displayed on your system. The available fields depend on your network configuration.

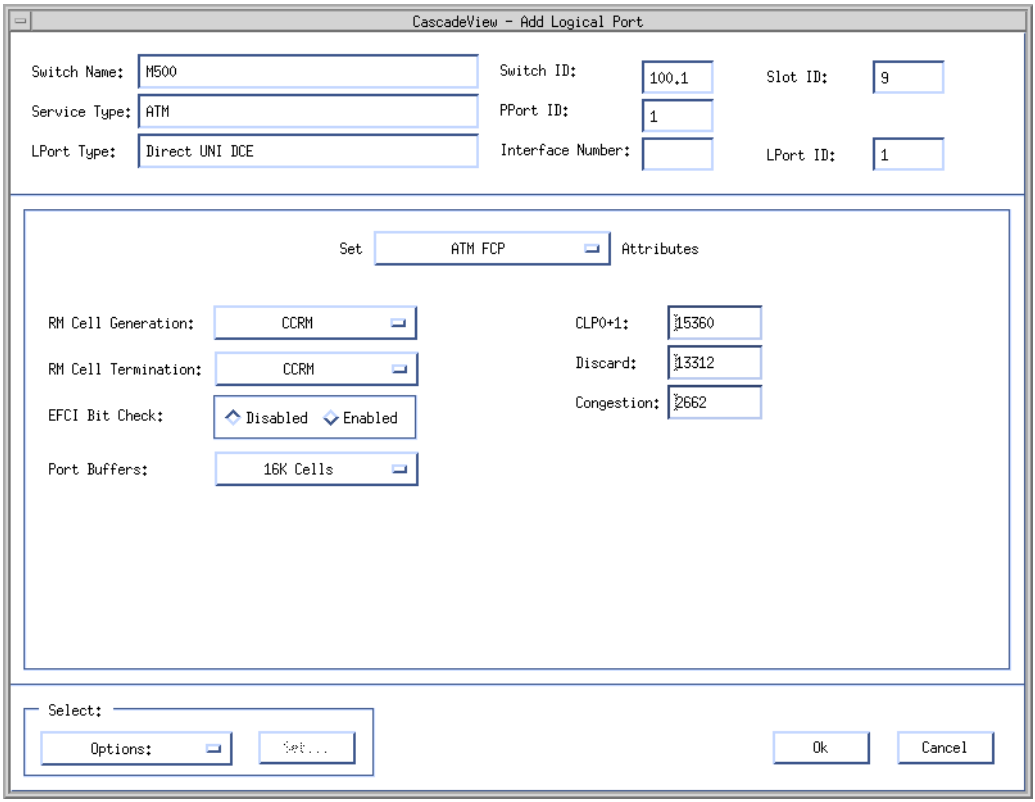


Figure 3-6. Add Logical Port Dialog Box

8. Complete the fields described in Table 3-4.

Table 3-4. Add Logical Port Dialog Box Fields

Field	Action/Description
Switch Name	Displays the name of the CBX 500 switch.
Service Type	Displays the service type.
LPort Type	Displays the logical port type.
Switch ID	Displays the CBX 500 ID.
PPort ID	Displays the physical port ID.
Interface Number	Displays the interface number.
Slot ID	Displays the CBX 500 back panel physical slot number where the IOM is installed.
LPort ID	Displays the logical port ID.
RM Cell Generation	Select the type of RM cell to generate for the VC; either CCRM or BCM. You can also configure the VC to generate no RM cells by selecting the No Loop option. (Refer to "Generating CCRM Cells" on page 2-7 for information.)
RM Cell Termination	Select the type of RM cell to terminate for the port, either CCRM, or CCRM and BCM. (Refer to "BCM Closed-Loop Flow Control" on page 2-8 and "Terminating CCRM and BCM Cells" on page 2-10 for information.)

Table 3-4. Add Logical Port Dialog Box Fields (Continued)

Field	Action/Description
EFCI Bit Check	Select either *Enabled* or *Disabled*. The EFCI Bit Check enables you to support control loops across switches that do not have the ATM Flow-Control Processor installed. These switches mark the EFCI bit in data cells to indicate network congestion. If the option is enabled on the next downstream ATM Flow-Control Processor, it takes into consideration these EFCI bits when it generates a backward RM cell.
Port Buffers	Select the number of desired cell buffers per port. Port buffers enable you to configure the number of cell buffers for each port. The entire 64K-cell buffers can be divided among the ports on an IOM. Options include: 1K, 2K, 4K, 8K, 16K, 32K, and 64K. (Refer to "ATM Flow-Control Processor Queues" on page 2-14 for more information.)
CLP0+1	Enter the desired value for the CLP0+1 threshold buffer. The CLP0+1 threshold enables you to reserve buffers before the maximum buffer capacity is reached. Refer to "ATM Flow-Control Processor Queues" on page 2-14 for more information on cell buffers. (Refer to the *Network Configuration Guide for CBX 500* for more information on the CLP0+1 traffic parameter.)
Discard	Enter the desired value for the Global Discard threshold buffer. Global Discard buffers enable you to reserve buffers for cell discard. (Refer to "ATM Flow-Control Processor Queues" on page 2-14 for more information.)

Table 3-4. Add Logical Port Dialog Box Fields (Continued)

Field	Action/Description
Congestion	Enter the desired value for the Congestion threshold. You can configure the Congestion threshold to allow for some margin before the Global Discard buffer threshold is reached. This margin compensates for some of the closed-loop, flow-control delay in the network prior to discarding cells. (Refer to "ATM Flow-Control Processor Queues" on page 2-14 for more information.)
Select	The available options for the Select option menu include: QoS Parameters, NTM Parameters, and ATM Accounting. Refer to the *Network Configuration Guide for CBX 500* for information on these dialog boxes.

Push Buttons

The Add Logical Port dialog box provides the following push buttons:

Ok	Saves your changes and returns you to the Set All Logical Ports in PPort dialog box.
Cancel	Closes the Add Logical Port dialog box without saving any changes and returns you to the Set All Logical Ports in PPort dialog box.

Defining Circuit Parameters

The ATM Flow-Control Processor supports ABR, UBR, and VBR-nrt traffic. Table 3-5 shows the ATM Flow-Control Processor managed traffic descriptors.

Table 3-5. ATM Flow-Control Processor Traffic Descriptors

QoS Class	Traffic Descriptor	Policing Discards	FCP Discard Method
UBR	Best Effort	None	EPD
	PCR0+1	All cells above PCR	EPD
ABR	PCR0, MCR0	None	EPD
VBR-nrt	SCR0, PCR0+1	CLP0 cells above SCR	CLP1 or EPD
	SCR0, PCR0+1, Tag	All cells above PCR	CLP1 or EPD
	SCR0+1, PCR0+1	All cells above SCR	CLP1 or EPD

Refer to the *Network Configuration Guide for CBX 500* for information about other ATM traffic descriptors.

For VBR-nrt circuits, it is recommended that the SCR0/PCR0+1 and the SCR0+1/PCR0+1 traffic descriptors not be used when EPD is the desired discard method. The UPC function will discard cells with no consideration to their packet affiliation.

To configure the ATM Flow-Control Processor for ABR, UBR, or VBR-nrt traffic:

1. On the network map, select the desired CBX 500 object.
2. From the Administer menu, select Cascade Parameters ⇒Set All Circuits ⇒ Point-to-Point. The Set All PVCs On Map dialog box opens. Refer to the *Network Configuration Guide for CBX 500* for information about this dialog box.

3. Choose the Add button. The Select End Logical Ports dialog opens. Refer to the *Network Configuration Guide for CBX 500* for information about this dialog box.

4. Choose the Ok button. The Add PVC dialog box opens.

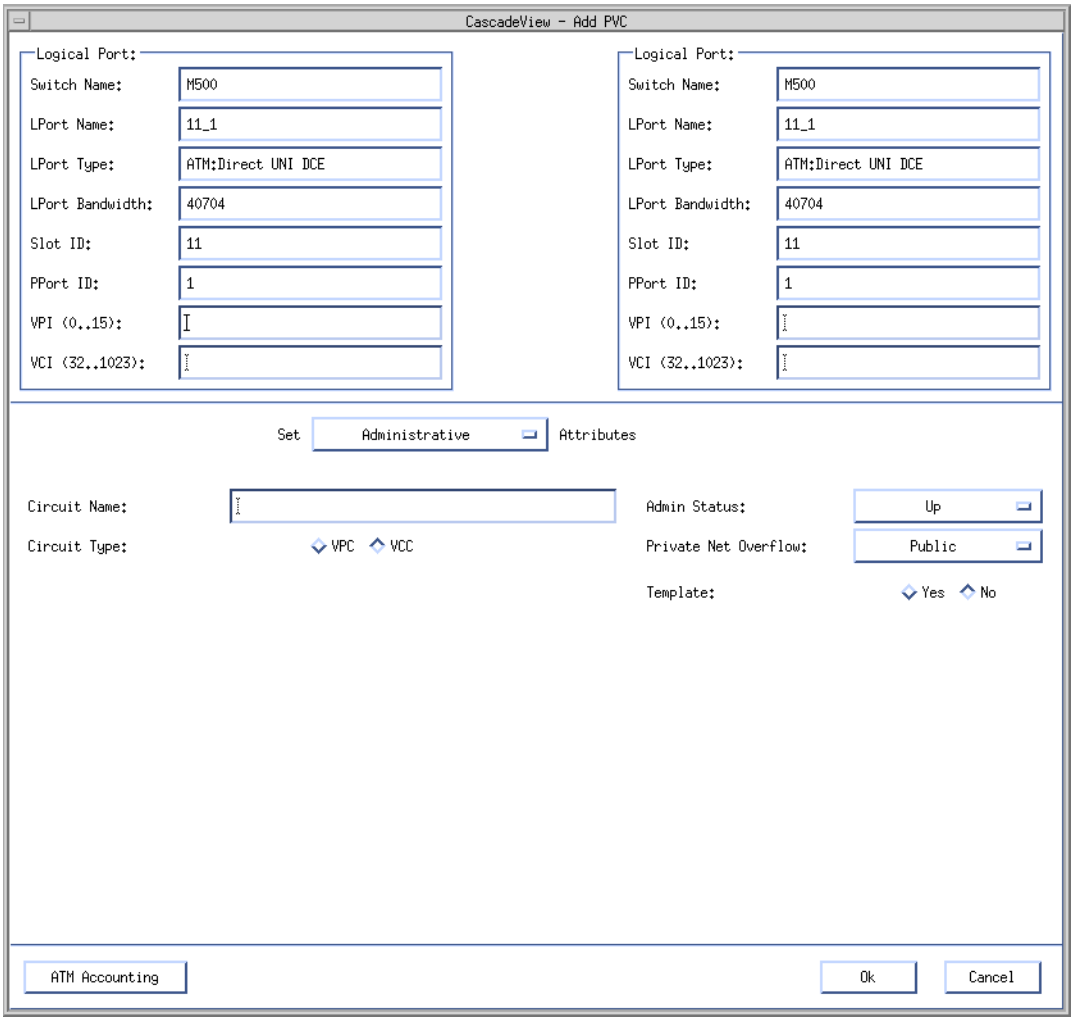


Figure 3-7. Add PVC Dialog Box (Part 1)

5. On the Set Attributes option menu, select Traffic Type. The lower portion of the Add PVC dialog box opens.

The example dialog box may not display the same fields as the dialog box displayed on your system. The available fields depend on your network configuration.

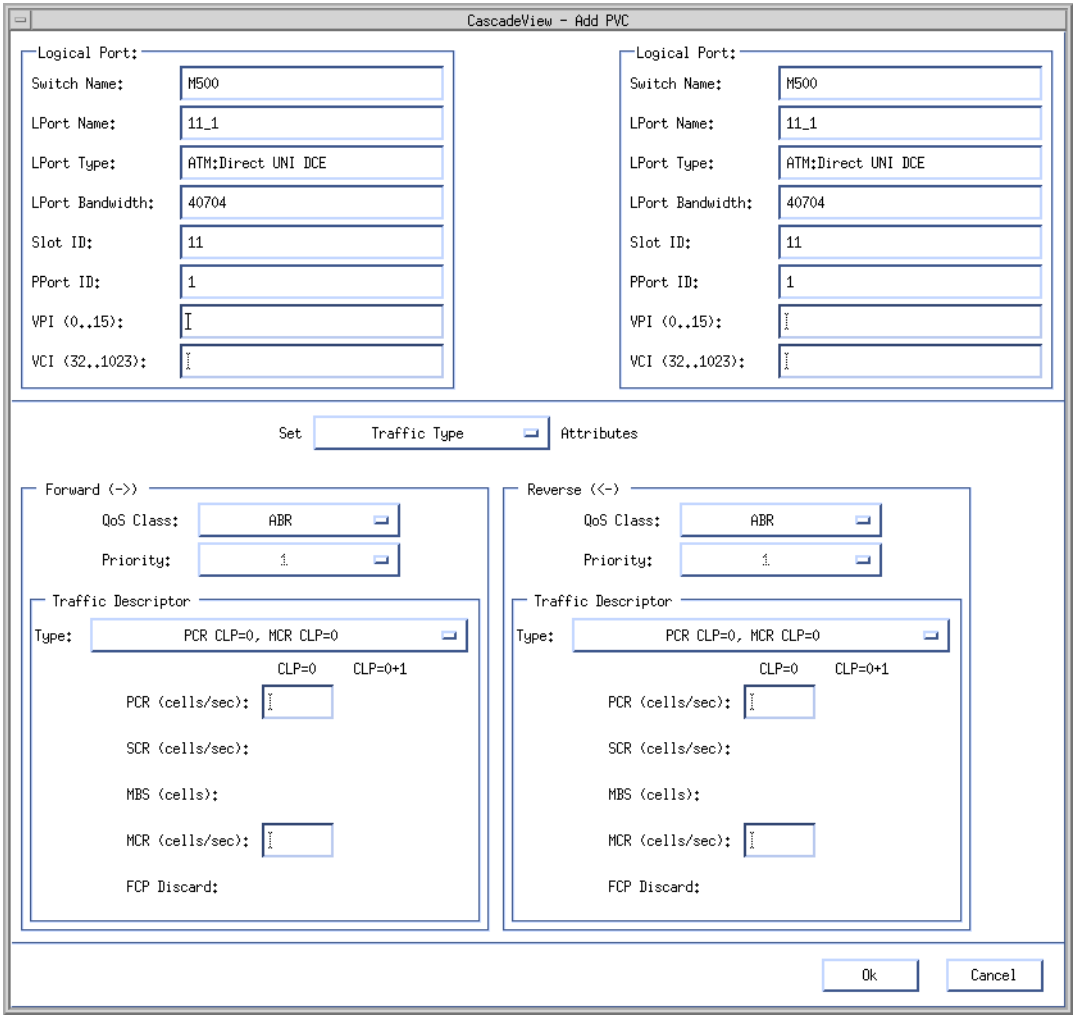


Figure 3-8. Add PVC Dialog Box (Part 2)

6. Select the desired QoS class in the QoS Class field.
7. Complete the fields described in Table 3-6.

Table 3-6. Add PVC Dialog Box Fields

Field	Action/Description
Switch Name	Displays the name of the CBX 500 on which Endpoints 1 and 2 reside.
LPort Name	Displays the name of the logical port for Endpoints 1 and 2.
LPort Type	Displays the logical port type for the selected logical ports.
LPort Bandwidth	Displays the logical port bandwidth for the selected logical ports. You are not required to select logical ports with equal bandwidth for each endpoint.
Slot ID	Displays the IOM slot number in which the selected logical ports' IOM resides.
PPort ID	Displays the port ID numbers for the selected logical ports.
VPI	Enter a value from 0-*nnn* to represent the Virtual Path Identifier for the PVC circuit. (Refer to the *Network Configuration Guide for CBX 500* for information on VPI values.)
VCI	Enter a value from 0-*nnn* to represent the Virtual Channel Identifier for the PVC circuit. (Refer to the *Network Configuration Guide for CBX 500* for information on VCI values.)

Table 3-6. Add PVC Dialog Box Fields (Continued)

Field	Action/Description
QoS Class	Select the desired QoS class. You can have different QoS classes in different directions. However, RM cells are sent in the backward direction. Consequently, they assume the QoS class of the other direction. For example, if the forward direction QoS class is ABR, and the backward direction QoS class is VBR-rt, the RM cells generated and sent in the backward direction for the ABR side of the VC travel through the network with a VBRrt QoS. (Refer to "Supported ATM Service Classes" on page 2-2 for more information.)
Priority	Displays the current priority level for the selected QoS class (either VBR-rt or VBR-nrt). (Refer to "Supported ATM Service Classes" on page 2-2 for more information.)
Traffic Descriptor	Select one of the six possible traffic descriptor combinations, depending on what kind of traffic descriptor the network supports for that VC. The CBX 500 uses these traffic descriptors for Usage Parameter Control (UPC) as well as for Connection Admission Control (CAC). (Refer to Table 3-5 on page 3-26 for more information.) ***Note:*** *The specified QoS class restricts the allowable combination for a VC. For example, if you select CBR, you can only configure the PCR for that VC.*
Type	Select the desired traffic descriptor combination. (Refer to Table 3-5 on page 3-26 for more information. Refer to "Supported ATM Service Classes" on page 2-2 for more information on ATM Flow-Control supported ATM service classes.)

Table 3-6. Add PVC Dialog Box Fields (Continued)

Field	Action/Description
PCR (cells/sec)	Enter a value for the Peak Cell Rate (PCR), if applicable. (Refer to the *Network Configuration Guide for CBX 500* for information about ATM traffic descriptors.)
SCR (cells/sec)	Enter a value for the Sustained Cell Rate (SCR), if applicable. (Refer to the *Network Configuration Guide for CBX 500* for information about ATM traffic descriptors.)
MBS (cells)	Enter a value for the Maximum Burst Size (MBS), if applicable. (Refer to the *Network Configuration Guide for CBX 500* for information about ATM traffic descriptors.)
MCR (cells/sec)	Enter a value for the Minimum Cell Rate (MCR), if applicable. (Refer to "Cell Rate Adjustment" on page 2-11 for information on MCR.)
FCP Discard	Select either the CLP1 or EPD option. (Refer to "ATM Flow-Control Discard Mechanisms" on page 2-16 for more information.)

Push Buttons

The Add PVC dialog box provides the following push buttons:

Ok	Saves your changes and returns you to the Set All PVCs On Map dialog box.
Cancel	Closes the Add PVC dialog box without saving any changes and returns you to the Set All PVCs On Map dialog box.

Displaying Logical Port Summary Statistics

You can use logical port summary statistics to display the error codes a logical port receives.

To display logical port summary statistics:

1. On the network map, select the appropriate CBX 500.
2. From the Monitor menu, select Cascade Objects ⇒ Show Detail. The CBX 500 back panel display opens.
3. Double click on the desired physical port. The View Physical Port Attributes dialog box opens. Refer to the *Diagnostic and Troubleshooting Guide for CBX 500* for information on this dialog box.
4. Choose Logical Port. The Show All Logical Ports in PPort dialog box opens.

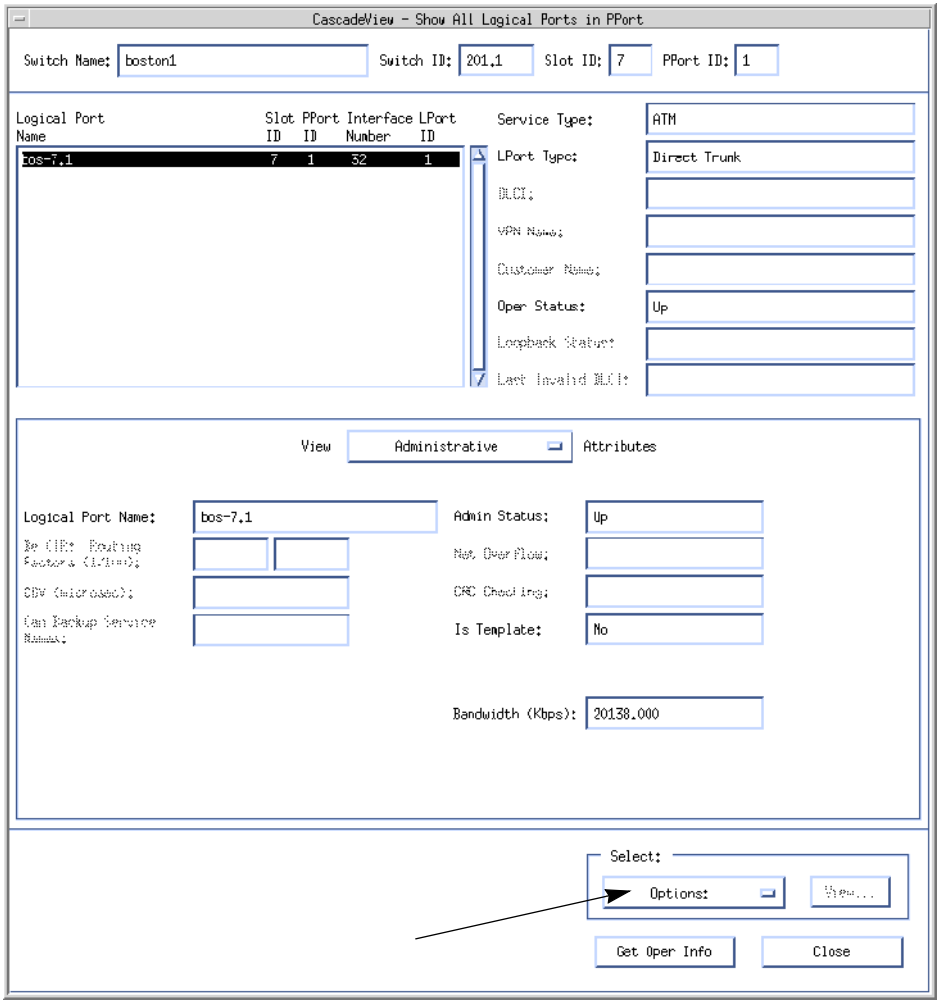


Figure 3-9. Show All Logical Ports in PPort Dialog Box

5. Select Options ⇒ Statistics.
6. Choose View. The Logical Port Summary Statistics dialog box opens.

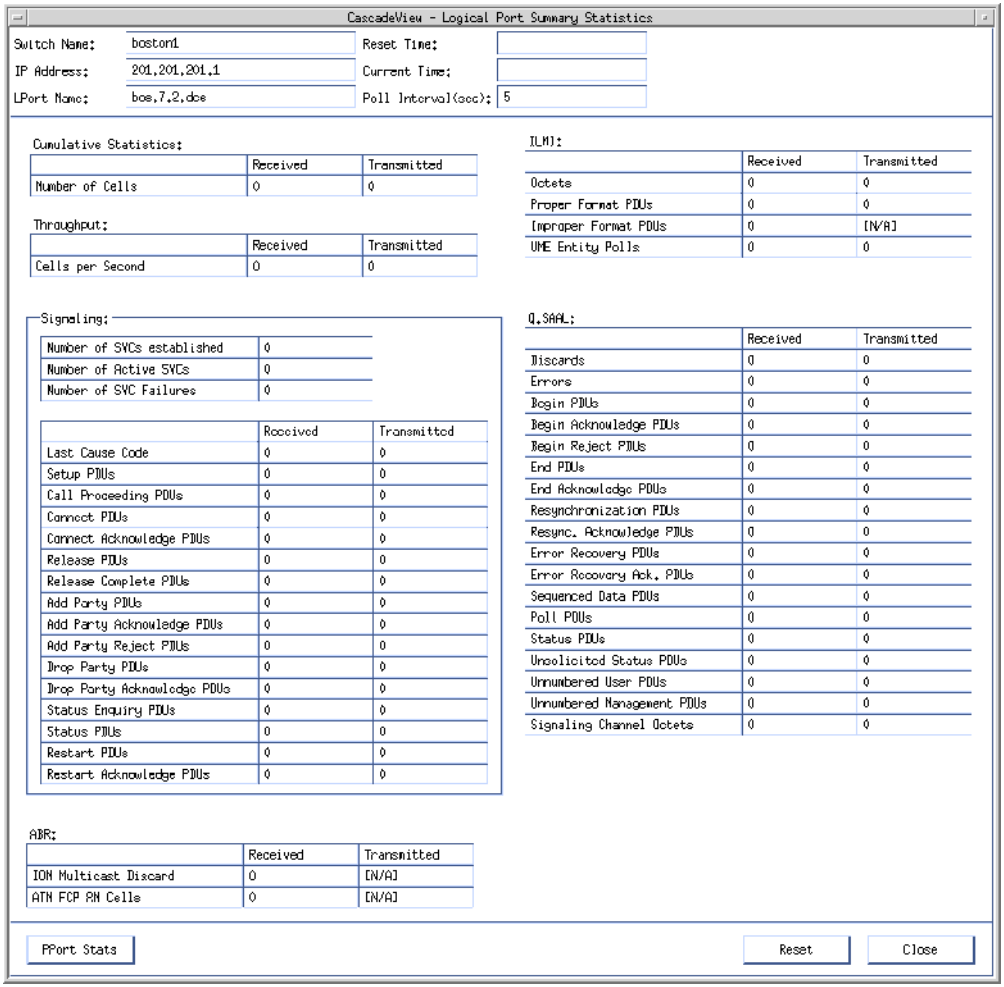


Figure 3-10. Logical Port Summary Statistics Dialog Box

Table 3-7 describes the ATM Flow-Control Processor Logical Port statistics. Refer to the *Diagnostic and Troubleshooting Guide for CBX 500* for information on general CBX 500 statistics.

Table 3-7. ATM Flow-Control Processor Logical Port Summary Statistics

ATM FCP Statistic	Description
IOM Multicast Discards	Displays the number of Multicast Cells discarded by the ATM Flow-Control Processor due to overflow of the Multicast queue. Note that the ATM Flow-Control Processor maintains one Multicast queue per I/O module.
ATM FCP RM Cells	Displays the number of RM Cells received on the logical port. This count includes all valid CCRM, BCM, and ABR RM Cells.

Displaying Circuit Summary Statistics

You can use circuit summary statistics to display the cells a circuit has sent and received, the round-trip delay, and other Quality of Service (QoS) statistics for the circuit.

To display circuit statistics:

1. From the Monitor menu, select Cascade Objects ⇒ Show Circuits.
2. Select one of the following options:

   All on Map — Displays a list of all the circuits configured for the current map. Choose the circuit for which you want to display status information.

   All on Switch — Select a switch on the current map, then use this option to display a list of all the circuits configured for this switch. Choose the circuit for which you want to display status information.

   All by Name — Use this option to enter a specific circuit name for which you want to display status information. You can use wild card characters; use an asterisk (*) to replace several characters or use a question mark (?) to replace one character.

   All on Switch and by Name — Select a switch on the current map, then use this option to enter a specific circuit name located in the switch. You can also search for a circuit by name using wild card characters. Use an asterisk (*) to replace several characters or use a question mark (?) to replace one character.
3. The Show [All] Circuits on Map dialog box opens.
4. Choose Statistics to display Circuit Summary Statistics. The Circuit Summary Statistics dialog box opens.

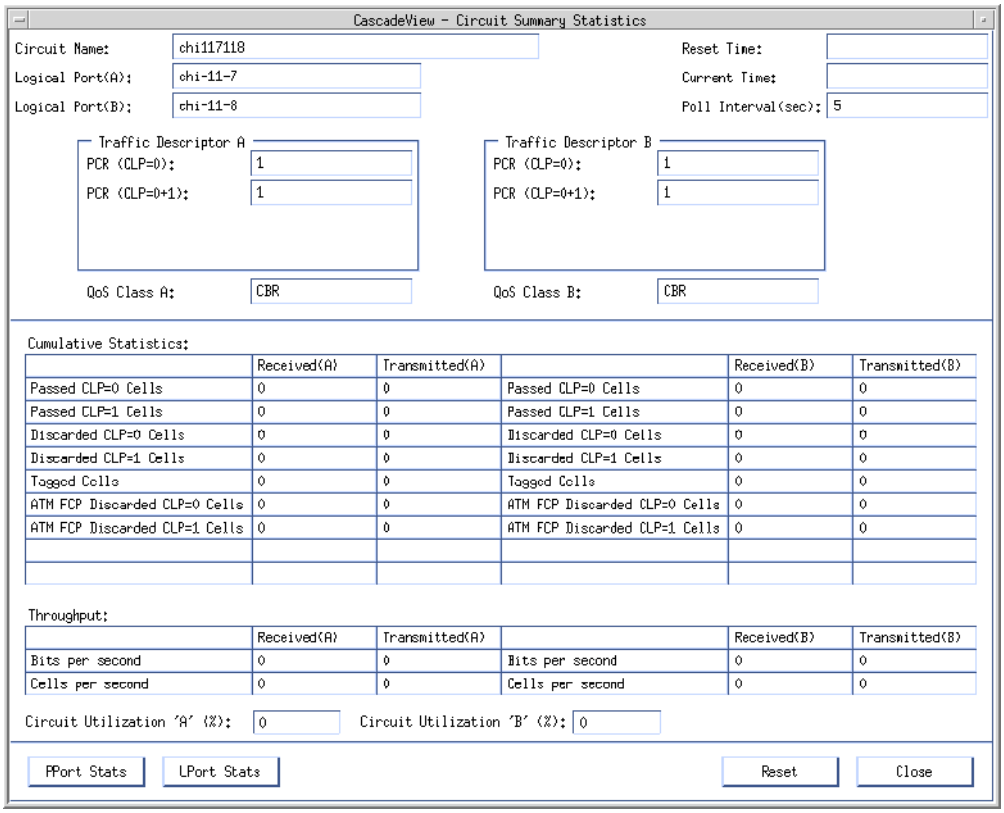


Figure 3-11. Circuit Summary Statistics Dialog Box

This dialog box displays statistics for transmitted and received data for each circuit endpoint. These statistics reflect how a circuit's data is used over the network.

Table 3-8 describes the ATM Flow-Control Processor Circuit Summary statistics. Refer to the *Diagnostic and Troubleshooting Guide for CBX 500* for information on general CBX 500 statistics.

Table 3-8. ATM Flow-Control Processor Circuit Summary Statistics

ATM FCP Statistic	Description
ATM FCP Discarded CLP=0 Cells	Displays the number of CLP=0 cells discarded by the ATM Flow-Control Processor due to overflow of the per-VC queue.
ATM FCP Discarded CLP=1 Cells	Displays the number of CLP=1 cells discarded by the ATM Flow-Control Processor due to overflow of the per-VC queue.

Displaying SVC Summary Statistics

To display SVC summary statistics:

1. From the Monitor menu, select Cascade Objects ⇒ Show All SVC Parameters⇒ Show All Active SVCs. The Show All Active SVCs dialog box opens.

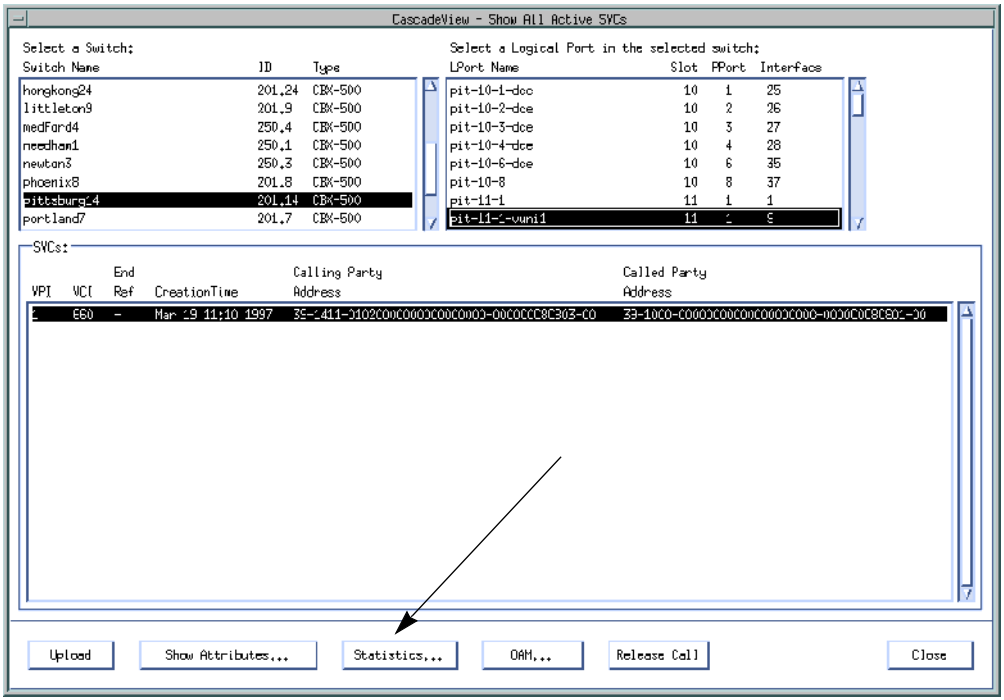


Figure 3-12. Show All Active SVCs Dialog Box

2. Select a switch from the list box on the left.
3. Select a corresponding logical port from the list box on the right.
4. Choose Statistics to display SVC summary statistics. The SVC Summary Statistics dialog box opens.

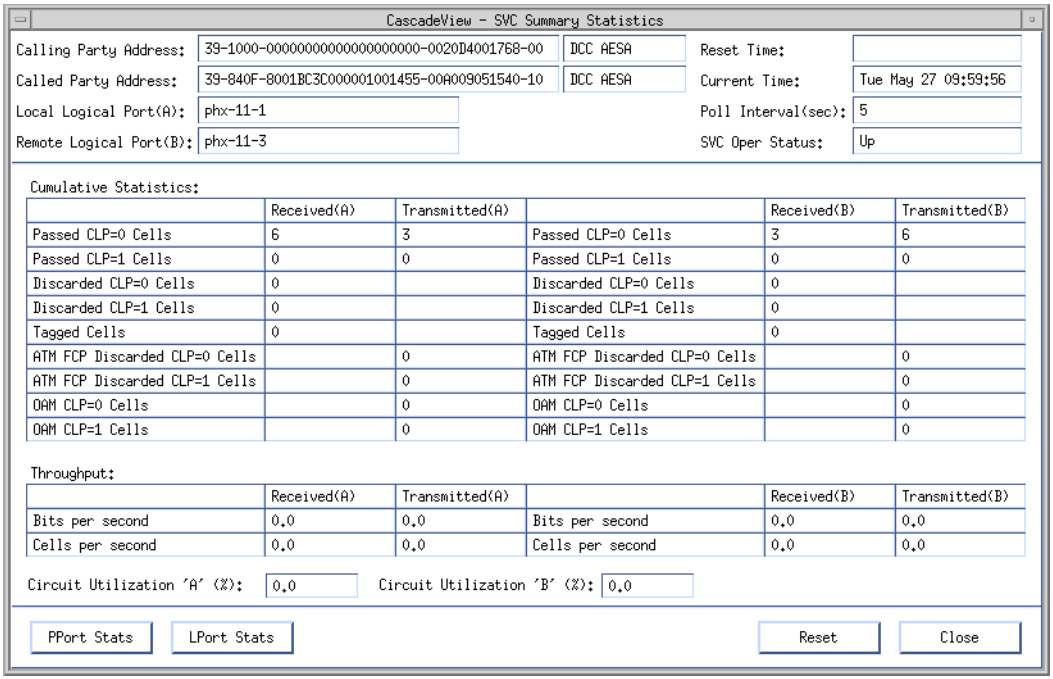


Figure 3-13. SVC Summary Statistics Dialog Box

Table 3-9 describes the ATM Flow-Control Processor SVC Summary statistics. Refer to the *Diagnostic and Troubleshooting Guide for CBX 500* for information on general CBX 500 statistics.

Table 3-9. ATM Flow-Control Processor SVC Summary Statistics

ATM FCP Statistic	Description
ATM FCP Discarded CLP=0 Cells	Displays the number of CLP=0 cells discarded by the ATM Flow-Control Processor due to overflow of the per-VC queue.
ATM FCP Discarded CLP=1 Cells	Displays the number of CLP=1 cells discarded by the ATM Flow-Control Processor due to overflow of the per-VC queue.

A

MCR Class Parameters

This appendix describes the Minimum Cell Rate (MCR) parameter values for the Virtual Channels (VCs) subject to ATM flow control.

Overview

ATM Flow-Control Processor parameters operating on a per-VC basis are organized into 256 classes. The classes are numbered 0, 1, 2, 3 … 255, and correspond to the MCR values of the VCs subject to ATM flow control. These per-class parameters include:

- Rate Increase Factor (RIF)
- Rate Decrease Factor (RDF)
- Discard Threshold
- Congestion Threshold

The above per-class parameters are provisionable as a file, and can be downloaded to the ATM Flow-Control Processor using CascadeView. Refer to “Downloading Buffer Threshold and Rate Profile Tables” on page 3-7 for more information.

Table A-1 shows the MCR class parameter default values. Keep in mind that the Discard Threshold and Congestion Threshold are expressed as a percentage of the total port buffer size.

In general, VCs belonging to an MCR class with a lower RIF will obtain more bandwidth under congestion. VCs belonging to an MCR class with a higher RDF will obtain more bandwidth under congestion.

The Discard Threshold parameter value should not be less than 100 cells. The Congestion Threshold value equals 20% of the Discard Threshold.

Table A-1. MCR Class Parameters

MCR Class	RIF	RDF	Discard Threshold (percentage of buffer)	Congestion Threshold (percentage of buffer)
0	6	3	0.5%	0.1%
1-27	11	3	0.5%	0.1%
28-55	10	4	1%	0.2%
56-83	9	5	2%	0.4%
84-110	8	5	3%	0.6%
111-138	7	6	5%	1%
139-166	6	6	10%	2%
167-194	5	7	20%	4%
195-221	4	8	40%	8%
222-255	3	8	80%	16%

DS3 IOM MCR Class Mapping

The following list shows the MCR range and the corresponding MCR class for the DS3 IOM.

MCR Range	MCR Class
100 - 127	3
128 - 159	4
160 - 191	5
192 - 223	6
224 - 255	7
256 - 287	8
288 - 319	9
320 - 351	10
352 - 383	11
384 - 415	12
416 - 447	13
448 - 479	14
480 - 511	15
512 - 543	16
544 - 575	17
576 - 607	18
608 - 639	19
640 - 671	20
672 - 703	21
704 - 735	22
736 - 767	23
768 - 799	24
800 - 831	25
832 - 863	26
864 - 895	27

MCR Range	MCR Class
896 - 927	28
928 - 959	29
960 - 991	30
992 - 1023	31
1024 - 1055	32
1056 - 1087	33
1088 - 1119	34
1120 - 1151	35
1152 - 1183	36
1184 - 1215	37
1216 - 1247	38
1248 - 1279	39
1280 - 1311	40
1312 - 1343	41
1344 - 1375	42
1376 - 1407	43
1408 - 1439	44
1440 - 1471	45
1472 - 1503	46
1504 - 1535	47
1536 - 1567	48
1568 - 1599	49
1600 - 1631	50
1632 - 1663	51
1664 - 1695	52
1696 - 1727	53
1728 - 1759	54
1760 - 1791	55
1792 - 1823	56

MCR Range	MCR Class
1824 - 1855	57
1856 - 1887	58
1888 - 1919	59
1920 - 1951	60
1952 - 1983	61
1984 - 2015	62
2016 - 2047	63
2048 - 2111	64
2112 - 2175	65
2176 - 2239	66
2240 - 2303	67
2304 - 2367	68
2368 - 2431	69
2432 - 2495	70
2496 - 2559	71
2560 - 2623	72
2624 - 2687	73
2688 - 2751	74
2752 - 2815	75
2816 - 2879	76
2880 - 2943	77
2944 - 3007	78
3008 - 3071	79
3072 - 3135	80
3136 - 3199	81
3200 - 3263	82
3264 - 3327	83
3328 - 3391	84

MCR Range	MCR Class
3392 - 3455	85
3456 - 3519	86
3520 - 3583	87
3584 - 3647	88
3648 - 3711	89
3712 - 3775	90
3776 - 3839	91
3840 - 3903	92
3904 - 3967	93
3968 - 4031	94
4032 - 4095	95
4096 - 4223	96
4224 - 4351	97
4352 - 4479	98
4480 - 4607	99
4608 - 4735	100
4736 - 4863	101
4864 - 4991	102
4992 - 5119	103
5120 - 5247	104
5248 - 5375	105
5376 - 5503	106
5504 - 5631	107
5632 - 5759	108
5760 - 5887	109
5888 - 6015	110
6016 - 6143	111
6144 - 6271	112

MCR Range	MCR Class
6272 - 6399	113
6400 - 6527	114
6528 - 6655	115
6656 - 6783	116
6784 - 6911	117
6912 - 7039	118
7040 - 7167	119
7168 - 7295	120
7296 - 7423	121
7424 - 7551	122
7552 - 7679	123
7680 - 7807	124
7808 - 7935	125
7936 - 8063	126
8064 - 8191	127
8192 - 8447	128
8448 - 8703	129
8704 - 8959	130
8960 - 9215	131
9216 - 9471	132
9472 - 9727	133
9728 - 9983	134
9984 - 10239	135
10240 - 10495	136
10496 - 10751	137
10752 - 11007	138
11008 - 11263	139

MCR Range	MCR Class
11264 - 11519	140
11520 - 11775	141
11776 - 12031	142
12032 - 12287	143
12288 - 12543	144
12544 - 12799	145
12800 - 13055	146
13056 - 13311	147
13312 - 13567	148
13568 - 13823	149
13824 - 14079	150
14080 - 14335	151
14336 - 14591	152
14592 - 14847	153
14848 - 15103	154
15104 - 15359	155
15360 - 15615	156
15616 - 15871	157
15872 - 16127	158
16128 - 16383	159
16384 - 16895	160
16896 - 17407	161
17408 - 17919	162
17920 - 18431	163
18432 - 18943	164
18944 - 19455	165
19456 - 19967	166
19968 - 20479	167

MCR Range	MCR Class
20480 - 20991	168
20992 - 21503	169
21504 - 22015	170
22016 - 22527	171
22528 - 23039	172
23040 - 23551	173
23552 - 24063	174
24064 - 24575	175
24576 - 25087	176
25088 - 25599	177
25600 - 26111	178
26112 - 26623	179
26624 - 27135	180
27136 - 27647	181
27648 - 28159	182
28160 - 28671	183
28672 - 29183	184
29184 - 29695	185
29696 - 30207	186
30208 - 30719	187
30720 - 31231	188
31232 - 31743	189
31744 - 32255	190
32256 - 32767	191
32768 - 33791	192
33792 - 34815	193
34816 - 35839	194
35840 - 36863	195

MCR Range	MCR Class
36864 - 37887	196
37888 - 38911	197
38912 - 39935	198
39936 - 40959	199
40960 - 41983	200
41984 - 43007	201
43008 - 44031	202
44032 - 45055	203
45056 - 46079	204
46080 - 47103	205
47104 - 48127	206
48128 - 49151	207
49152 - 50175	208
50176 - 51199	209
51200 - 52223	210
52224 - 53247	211
53248 - 54271	212
54272 - 55295	213
55296 - 56319	214
56320 - 57343	215
57344 - 58367	216
58368 - 59391	217
59392 - 60415	218
60416 - 61439	219
61440 - 62463	220
62464 - 63487	221
63488 - 64511	222
64512 - 65535	223
65536 - 67583	224

MCR Range	MCR Class
67584 - 69631	225
69632 - 71679	226
71680 - 73727	227
73728 - 75775	228
75776 - 77823	229
77824 - 79871	230
79872 - 81919	231
81920 - 83967	232
83968 - 86015	233
86016 - 88063	234
88064 - 90111	235
90112 - 92159	236
92160 - 94207	237
94208 - 96000	238

T1 IOM MCR Class Mapping

The following list shows the MCR range and the corresponding MCR class for the T1 IOM.

MCR Range	MCR Class
100 - 111	6
112 - 127	7
128 - 143	8
144 - 159	9
160 - 175	10
176 - 191	11
192 - 207	12
208 - 223	13
224 - 239	14
240 - 255	15
256 - 271	16
272 - 287	17
288 - 303	18
304 - 319	19
320 - 335	20
336 - 351	21
352 - 367	22
368 - 383	23
384 - 399	24
400 - 415	25
416 - 431	26
432 - 447	27
448 - 463	28
464 - 479	29

MCR Range	MCR Class
480 - 495	30
496 - 511	31
512 - 527	32
528 - 543	33
544 - 559	34
560 - 575	35
576 - 591	36
592 - 607	37
608 - 623	38
624 - 639	39
640 - 655	40
656 - 671	41
672 - 687	42
688 - 703	43
704 - 719	44
720 - 735	45
736 - 751	46
752 - 767	47
768 - 783	48
784 - 799	49
800 - 815	50
816 - 831	51
832 - 847	52
848 - 863	53
864 - 879	54
880 - 895	55
896 - 911	56
912 - 927	57
928 - 943	58

MCR Range	MCR Class
944 - 959	59
960 - 975	60
976 - 991	61
992 - 1007	62
1008 - 1023	63
1024 - 1055	64
1056 - 1087	65
1088 - 1119	66
1120 - 1151	67
1152 - 1183	68
1184 - 1215	69
1216 - 1247	70
1248 - 1279	71
1280 - 1311	72
1312 - 1343	73
1344 - 1375	74
1376 - 1407	75
1408 - 1439	76
1440 - 1471	77
1472 - 1503	78
1504 - 1535	79
1536 - 1567	80
1568 - 1599	81
1600 - 1631	82
1632 - 1663	83
1664 - 1695	84
1696 - 1727	85
1728 - 1759	86
1760 - 1791	87

MCR Range	MCR Class
1792 - 1823	88
1824 - 1855	89
1856 - 1887	90
1888 - 1919	91
1920 - 1951	92
1952 - 1983	93
1984 - 2015	94
2016 - 2047	95
2048 - 2111	96
2112 - 2175	97
2176 - 2239	98
2240 - 2303	99
2304 - 2367	100
2368 - 2431	101
2432 - 2495	102
2496 - 2559	103
2560 - 2623	104
2624 - 2687	105
2688 - 2751	106
2752 - 2815	107
2816 - 2879	108
2880 - 2943	109
2944 - 3007	110
3008 - 3071	111
3072 - 3135	112
3136 - 3199	113
3200 - 3263	114
3264 - 3327	115
3328 - 3391	116

MCR Range	MCR Class
3392 - 3455	117
3456 - 3519	118
3520 - 3583	119
3584 - 3647	120
3648 - 3711	121
3712 - 3775	122
3776 - 3839	123
3840 - 3903	124
3904 - 3967	125
3968 - 4031	126
4032 - 4095	127
4096 - 4223	128
4224 - 4351	129
4352 - 4479	130
4480 - 4534	131

OC3 IOM MCR Class Mapping

The following list shows the MCR range and the corresponding MCR class for the OC3 IOM.

MCR Range	MCR Class
100 - 255	1
256 - 383	2
384 - 511	3
512 - 639	4
640 - 767	5
768 - 895	6
896 - 1023	7
1024 - 1151	8
1152 - 1279	9
1280 - 1407	10
1408 - 1535	11
1536 - 1663	12
1664 - 1791	13
1792 - 1919	14
1920 - 2047	15
2048 - 2175	16
2176 - 2303	17
2304 - 2431	18
2432 - 2559	19
2560 - 2687	20
2688 - 2815	21
2816 - 2943	22
2944 - 3071	23
3072 - 3199	24
3200 - 3327	25

MCR Range	MCR Class
3328 - 3455	26
3456 - 3583	27
3584 - 3711	28
3712 - 3839	29
3840 - 3967	30
3968 - 4095	31
4096 - 4223	32
4224 - 4351	33
4352 - 4479	34
4480 - 4607	35
4608 - 4735	36
4736 - 4863	37
4864 - 4991	38
4992 - 5119	39
5120 - 5247	40
5248 - 5375	41
5376 - 5503	42
5504 - 5631	43
5632 - 5759	44
5760 - 5887	45
5888 - 6015	46
6016 - 6143	47
6144 - 6271	48
6272 - 6399	49
6400 - 6527	50
6528 - 6655	51
6656 - 6783	52
6784 - 6911	53
6912 - 7039	54

MCR Range	MCR Class
7040 - 7167	55
7168 - 7295	56
7296 - 7423	57
7424 - 7551	58
7552 - 7679	59
7680 - 7807	60
7808 - 7935	61
7936 - 8063	62
8064 - 8191	63
8192 - 8447	64
8448 - 8703	65
8704 - 8959	66
8960 - 9215	67
9216 - 9471	68
9472 - 9727	69
9728 - 9983	70
9984 - 10239	71
10240 - 10495	72
10496 - 10751	73
10752 - 11007	74
11008 - 11263	75
11264 - 11519	76
11520 - 11775	77
11776 - 12031	78
12032 - 12287	79
12288 - 12543	80
12544 - 12799	81
12800 - 13055	82
13056 - 13311	83

MCR Range	MCR Class
13312 - 13567	84
13568 - 13823	85
13824 - 14079	86
14080 - 14335	87
14336 - 14591	88
14592 - 14847	89
14848 - 15103	90
15104 - 15359	91
15360 - 15615	92
15616 - 15871	93
15872 - 16127	94
16128 - 16383	95
16384 - 16895	96
16896 - 17407	97
17408 - 17919	98
17920 - 18431	99
18432 - 18943	100
18944 - 19455	101
19456 - 19967	102
19968 - 20479	103
20480 - 20991	104
20992 - 21503	105
21504 - 22015	106
22016 - 22527	107
22528 - 23039	108
23040 - 23551	109
23552 - 24063	110
24064 - 24575	111
24576 - 25087	112

MCR Range	MCR Class
25088 - 25599	113
25600 - 26111	114
26112 - 26623	115
26624 - 27135	116
27136 - 27647	117
27648 - 28159	118
28160 - 28671	119
28672 - 29183	120
29184 - 29695	121
29696 - 30207	122
30208 - 30719	123
30720 - 31231	124
31232 - 31743	125
31744 - 32255	126
32256 - 32767	127
32768 - 33791	128
33792 - 34815	129
34816 - 35839	130
35840 - 36863	131
36864 - 37887	132
37888 - 38911	133
38912 - 39935	134
39936 - 40959	135
40960 - 41983	136
41984 - 43007	137
43008 - 44031	138
44032 - 45055	139
45056 - 46079	140
46080 - 47103	141

MCR Range	MCR Class
47104 - 48127	142
48128 - 49151	143
49152 - 50175	144
50176 - 51199	145
51200 - 52223	146
52224 - 53247	147
53248 - 54271	148
54272 - 55295	149
55296 - 56319	150
56320 - 57343	151
57344 - 58367	152
58368 - 59391	153
59392 - 60415	154
60416 - 61439	155
61440 - 62463	156
62464 - 63487	157
63488 - 64511	158
64512 - 65535	159
65536 - 67583	160
67584 - 69631	161
69632 - 71679	162
71680 - 73727	163
73728 - 75775	164
75776 - 77823	165
77824 - 79871	166
79872 - 81919	167
81920 - 83967	168
83968 - 86015	169
86016 - 88063	170

MCR Range	MCR Class
88064 - 90111	171
90112 - 92159	172
92160 - 94207	173
94208 - 96255	174
96256 - 98303	175
98304 - 100351	176
100352 - 102399	177
102400 - 104447	178
104448 - 106495	179
106496 - 108543	180
108544 - 110591	181
110592 - 112639	182
112640 - 114687	183
114688 - 116735	184
116736 - 118783	185
118784 - 120831	186
120832 - 122879	187
122880 - 124927	188
124928 - 126975	189
126976 - 129023	190
129024 - 131071	191
131072 - 135167	192
135168 - 139263	193
139264 - 143359	194
143360 - 147455	195
147456 - 151551	196
151552 - 155647	197
155648 - 159743	198
159744 - 163839	199

MCR Range	MCR Class
163840 - 167935	200
167936 - 172031	201
172032 - 176127	202
176128 - 180223	203
180224 - 184319	204
184320 - 188415	205
188416 - 192511	206
192512 - 196607	207
196608 - 200703	208
200704 - 204799	209
204800 - 208895	210
208896 - 212991	211
212992 - 217087	212
217088 - 221183	213
221184 - 225279	214
225280 - 229375	215
229376 - 233471	216
233472 - 237567	217
237568 - 241663	218
241664 - 245759	219
245760 - 249855	220
249856 - 253951	221
253952 - 258047	222
258048 - 262143	223
262144 - 270335	224
270336 - 278527	225
278528 - 286719	226
286720 - 294911	227
294912 - 303103	228

MCR Range	MCR Class
303104 - 311295	229
311296 - 319487	230
319488 - 327679	231
327680 - 335871	232
335872 - 344063	233
344064 - 352255	234
352256 - 353208	235

OC12 IOM MCR Class Mapping

The following list shows the MCR range and the corresponding MCR class for the OC12 IOM.

MCR Range	MCR Class
100 - 1023	1
1024 - 1535	2
1536 - 2047	3
2048 - 2559	4
2560 - 3071	5
3072 - 3583	6
3584 - 4095	7
4096 - 4607	8
4608 - 5119	9
5120 - 5631	10
5632 - 6143	11
6144 - 6655	12
6656 - 7167	13
7168 - 7679	14
7680 - 8191	15
8192 - 8703	16
8704 - 9215	17
9216 - 9727	18
9728 - 10239	19
10240 - 10751	20
10752 - 11263	21
11264 - 11775	22
11776 - 12287	23
12288 - 12799	24
12800 - 13311	25

MCR Range	MCR Class
13312 - 13823	26
13824 - 14335	27
14336 - 14847	28
14848 - 15359	29
15360 - 15871	30
15872 - 16383	31
16384 - 16895	32
16896 - 17407	33
17408 - 17919	34
17920 - 18431	35
18432 - 18943	36
18944 - 19455	37
19456 - 19967	38
19968 - 20479	39
20480 - 20991	40
20992 - 21503	41
21504 - 22015	42
22016 - 22527	43
22528 - 23039	44
23040 - 23551	45
23552 - 24063	46
24064 - 24575	47
24576 - 25087	48
25088 - 25599	49
25600 - 26111	50
26112 - 26623	51
26624 - 27135	52
27136 - 27647	53
27648 - 28159	54

MCR Range	MCR Class
28160 - 28671	55
28672 - 29183	56
29184 - 29695	57
29696 - 30207	58
30208 - 30719	59
30720 - 31231	60
31232 - 31743	61
31744 - 32255	62
32256 - 32767	63
32768 - 33791	64
33792 - 34815	65
34816 - 35839	66
35840 - 36863	67
36864 - 37887	68
37888 - 38911	69
38912 - 39935	70
39936 - 40959	71
40960 - 41983	72
41984 - 43007	73
43008 - 44031	74
44032 - 45055	75
45056 - 46079	76
46080 - 47103	77
47104 - 48127	78
48128 - 49151	79
49152 - 50175	80
50176 - 51199	81
51200 - 52223	82
52224 - 53247	83

MCR Range	MCR Class
53248 - 54271	84
54272 - 55295	85
55296 - 56319	86
56320 - 57343	87
57344 - 58367	88
58368 - 59391	89
59392 - 60415	90
60416 - 61439	91
61440 - 62463	92
62464 - 63487	93
63488 - 64511	94
64512 - 65535	95
65536 - 67583	96
67584 - 69631	97
69632 - 71679	98
71680 - 73727	99
73728 - 75775	100
75776 - 77823	101
77824 - 79871	102
79872 - 81919	103
81920 - 83967	104
83968 - 86015	105
86016 - 88063	106
88064 - 90111	107
90112 - 92159	108
92160 - 94207	109
94208 - 96255	110
96256 - 98303	111
98304 - 100351	112

MCR Range	MCR Class
100352 - 102399	113
102400 - 104447	114
104448 - 106495	115
106496 - 108543	116
108544 - 110591	117
110592 - 112639	118
112640 - 114687	119
114688 - 116735	120
116736 - 118783	121
118784 - 120831	122
120832 - 122879	123
122880 - 124927	124
124928 - 126975	125
126976 - 129023	126
129024 - 131071	127
131072 - 135167	128
135168 - 139263	129
139264 - 143359	130
143360 - 147455	131
147456 - 151551	132
151552 - 155647	133
155648 - 159743	134
159744 - 163839	135
163840 - 167935	136
167936 - 172031	137
172032 - 176127	138
176128 - 180223	139
180224 - 184319	140
184320 - 188415	141

MCR Range	MCR Class
188416 - 192511	142
192512 - 196607	143
196608 - 200703	144
200704 - 204799	145
204800 - 208895	146
208896 - 212991	147
212992 - 217087	148
217088 - 221183	149
221184 - 225279	150
225280 - 229375	151
229376 - 233471	152
233472 - 237567	153
237568 - 241663	154
241664 - 245759	155
245760 - 249855	156
249856 - 253951	157
253952 - 258047	158
258048 - 262143	159
262144 - 270335	160
270336 - 278527	161
278528 - 286719	162
286720 - 294911	163
294912 - 303103	164
303104 - 311295	165
311296 - 319487	166
319488 - 327679	167
327680 - 335871	168
335872 - 344063	169
344064 - 352255	170

MCR Range	MCR Class
352256 - 360447	171
360448 - 368639	172
368640 - 376831	173
376832 - 385023	174
385024 - 393215	175
393216 - 401407	176
401408 - 409599	177
409600 - 417791	178
417792 - 425983	179
425984 - 434175	180
434176 - 442367	181
442368 - 450559	182
450560 - 458751	183
458752 - 466943	184
466944 - 475135	185
475136 - 483327	186
483328 - 491519	187
491520 - 499711	188
499712 - 507903	189
507904 - 516095	190
516096 - 524287	191
524288 - 540671	192
540672 - 557055	193
557056 - 573439	194
573440 - 589823	195
589824 - 606207	196
606208 - 622591	197
622592 - 638975	198
638976 - 655359	199

MCR Range	MCR Class
655360 - 671743	200
671744 - 688127	201
688128 - 704511	202
704512 - 720895	203
720896 - 737279	204
737280 - 753663	205
753664 - 770047	206
770048 - 786431	207
786432 - 802815	208
802816 - 819199	209
819200 - 835583	210
835584 - 851967	211
851968 - 868351	212
868352 - 884735	213
884736 - 901119	214
901120 - 917503	215
917504 - 933887	216
933888 - 950271	217
950272 - 966655	218
966656 - 983039	219
983040 - 999423	220
999424 - 1015807	221
1015808 - 1032191	222
1032192 - 1048575	223
1048576 - 1081343	224
1081344 - 1114111	225
1114112 - 1146879	226
1146880 - 1179647	227
1179648 - 1212415	228

MCR Range	MCR Class
1212416 - 1245183	229
1245184 - 1277951	230
1277952 - 1310719	231
1310720 - 1343487	232
1343488 - 1376255	233
1376256 - 1409023	234
1409024 - 1440000	235

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