CHAPTER 3

Traffic Management

The following traffic management functions are supported on the PNNI node:

- Asymmetrical traffic requirements.
- Connection Admission Control (CAC).
- Qbin for AutoRoute and PNNI
- Mapping of SVC/SPVC Traffic Parameters to UPC capabilities.
- Dual leaky bucket UPC (GCRA 1 and GCRA2).
- ABR EFCI marking, Relative Rate marking, Explicit Rate marking and VS/VD control.
- Frame Discard for AAL5.

Service Categories

The following service categories as defined in ATM Forum Traffic Management 4.0 are supported:

- constant bit rate (CBR)
- real-time VBR (rt-VBR)
- non-real-time VBR (nrt-VBR)
- unspecified bit rate (UBR)
- available bit rate (ABR)

Note ABR is currently only supported in SPVCs. ABR will be supported in SVCs when UNI 4.0 is supported.

Table 3-1 Supported Service Categories

Attribute	**CBR**	**rt-VBR**	**nrt-VBR**	**UBR**	**ABR**
PCR, CDVT	yes	yes	yes	yes	yes
SCR, MBS	N/A	yes	yes	N/A	N/A
MCR (UNI 4.0)	N/A	N/A	N/A	N/A	yes
RAIG CLP (PNNI 1.0)	Yes	yes	yes	N/A	N/A

Table 3-1 Supported Service Categories (continued)

Attribute	CBR	rt-VBR	nrt-VBR	UBR	ABR
peak-to-peak CDV (UNI 4.0)	yes	yes	no	no	no
max CTD (UNI 4.0)	yes	yes	no	no	no
CLR (UNI 4.0)	yes	yes	yes	no	network specific

Connection Admission Control

Each connection between an ATM CPE (ATM end user) and the WAN switching network establishes a contract with the network based on Quality of Service (QoS) parameters. This contract specifies an envelope that describes the intended traffic flow, including values for peak bandwidth, average sustained bandwidth, and burst size.

The ATM CPE device is responsible for adhering to the contract by means of traffic shaping. Traffic shaping is the use of queues to constrain data bursts, limit peak data rate, and smooth jitter so that the traffic complies with the criteria specified in the envelope.

The SES PNNI nodes have the option of using traffic policing to enforce the networking contract. The SES PNNI node uses the following two methods to police traffic from ATM CPE into the network:

- Connection Admission Control
- Usage Parameter Control

Connection Admission Control (CAC) verifies that sufficient network resources are available to accept the call. The desired ATM traffic contract is specified in the Bearer Capability, the Traffic Descriptor, and Quality of Service (QoS) information elements of the Setup message. These UNI signaling Setup message elements are mapped to Usage Parameter Control (UPC) parameters in the SES PNNI node.

G-CAC and A-CAC

CAC functions are performed on each individual node. G-CAC (Generic CAC) is performed by the routing protocol when it selects a routing path for a call. The PNNI routing protocol needs to make sure that the routing path it selected will satisfy the basic traffic parameter requirement specified by the call. The checking performed by the routing protocol at border node is called G-CAC. For G-CAC description, refer to “ATM Forum PNNI 1.0 Spec. af-pnni-0055.000”. A routing path which satisfied the G-CAC checking may not guarantee the call will have traffic resource on each node of its routing path. This is attributed to the routing data base synchronization delay in the network. To ensure a call has traffic resource it requested on each node of its routing path, a local CAC (A-CAC) must be performed when the call arrived on the node. A call will be released or cranked back if it fails on A-CAC. A-CAC performance is described in the section below.

A-CAC

Both resource-related criteria and policy-related criteria are used for CAC. And the CAC is performed per service category. The CAC is applied to all types of interfaces, UNI, NNI, and IISP.

Resource-based CAC

For resource-related CAC, the CAC algorithm calculates the Equivalent Cell Rate (ECR) of a connection prior to establishing the connection, and ensures high efficiency of network resources in accordance with the following criteria:

- Requested service category
- Requested conformance definition
- Traffic descriptor, PCR, SCR, MCR, and MBS
- CDVT
- Requested UPC conformance
- QoS parameters (namely, CDV, CTD, and CLR)
- Buffer size at each of the QBIN
- Line speed at each port
- Policy-related parameters, minimum and maximum bandwidth, booking factor for a service category

When a call is admitted with the ECR, the requested QoS for the connection is guaranteed even under the worst scenario as described by the traffic descriptors of the connection.

Policy-based CAC

For policy-related CAC, the following parameters are configurable per service category.

- Booking factor per service category per interface
- Guaranteed minimum bandwidth per service category per interface
- Maximum bandwidth allowed per service category per interface
- Guaranteed minimum number of connections per service category per interface
- Maximum number of connections allowed per service category per interface
- Maximum bandwidth allowed for a single connection per service category per interface

Qbin for AutoRoute and PNNI

BPX/SES support per CoS queuing. The BXM supports 16 qbin for each port. Qbin 0 to Qbin 9 are reserved for AutoRoute. Qbin 10 to Qbin 15 are reserved for VSI applications such as PNNI and MPLS service. For detail Qbin description and configuration, refer to Appendix D, *Virtual Switch Interface*, and Chapter 10, *Configuring ATM SVCs, PNNI Routing, and SPVCs*.

Control Qbin

Prior to SES Release 1.0.10, the control VCs share the same Qbin as the connection VCs for data traffic. For example, the SSCOP VC shares the Qbin of nrtVBR traffic. In case of congestion, switchcc, massive reroutes or resetcd, signalling messages may be dropped either due to lack of Qbin resource or due to policing done by a switch on the path. Although the control messages are handled by reliable message delivery mechanisms, dropping control cells can lead to trunks/ports going down and connections get rerouted. Without having a dedicated Qbin for control VCs, control VC messages are subject to being dropped as are other data messages with the same service type when the network is congested.

A dedicated Qbin for all control VC traffic is supported in SES Release 1.0.10. The control VC Qbin on BXM use two previously unused Qbins, 0 and 4, to queue the control VC traffic. The data on the control VC Qbin has higher priority for servicing. This will guarantee that control traffic does not get dropped when the trunk is congested.

A new VC_Type, SIG, is defined to represent control VC traffic. It behaves like a NRT_VBR type VC, but it will not share the same queue with other NRT_VBR type VCs. The default CDVT for control VC is based on UNI 3.1 recommendation. When UNI 4.0 is available in later release, the default value may get changed based on UNI 4.0 standard.

In BPX, a user should load the latest FW in BXM first and then load the new SW in BCC, after that, setrev in PXM1 to use the new image. A user can configure bandwidth for SIG type VCs. No bookfactor is supported for the SIG type traffic and it is always set to be 100%.

Usage Parameter Control

Usage Parameter Control (UPC) may be performed at the ingress of network edge nodes only, or alternatively may be performed at every intermediate node. UPC is enabled on a per interface basis as specified by a service class template on the switches. The traffic contracts are defined in the ATM Forum Traffic Management Specification 4.0 and UNI 3.x, and are summarized in the following table.

Table 3-2 Traffic Contracts

Service Category	**CBR**	**CBR**	**rt, nrt, VBR**	**rt, nrt VBR**	**CBR**	**rt, nrt VBR**	**UBR**	**UBR**	**ABR**
UNI 4.0 Conform-ance	[1] **CBR.2**	**CBR.3**	**VBR.2**	**VBR.3**	**CBR.1**	**VBR.1**	**UBR.1**	**UBR.2**	**ABR**
Parameters									
PCR (0+1)	x	x	x	x	x	x	x	x	x
PCR (0)	x	x							
CDVT(0+1)	x	x	x	x	x	x	x	x	x
CDVT(0)	x	x							
SCR (0+1)						x			
SCR (0)			x	x					
MBS (0+1)						x			
MBS(0)			x	x					
Tagging		x		x				x	
Best Effort							x	x	
MCR									x
Transmit ATC[2]	5	5	9, 10	9, 10	7	19, 11	10	10	12
ILMI Traffic Descriptor Type	NoClpNoScr	NoClpNoScr	ClpNoTagginGScr	ClpTaggingScr	NoClpNoScr	NoClpScr	NoClpNoScr	NoClpNoScr	ClpNoTagi-Mcr

Table 3-2 Traffic Contracts

Service Category	CBR	CBR	rt, nrt, VBR	rt, nrt VBR	CBR	rt, nrt VBR	UBR	UBR	ABR
UNI 4.0 Conform-ance	[1] **CBR.2**	**CBR.3**	**VBR.2**	**VBR.3**	**CBR.1**	**VBR.1**	**UBR.1**	**UBR.2**	**ABR**
ILMI Best Effort Indicator	false	false	false	false	false	false	true	true	false
Specification	3.x	3.x	3.x 4.0	3.x 4.0	3.x 4.0	3.x 4.0	3.x 4.0	4.0	4.0

1. This traffic definition applies to the CBR traffic sets specified in TM 3.x.
2. Transmit ATC is defined in TM 4.0, which is not supported in the current release.

Available Bit Rate

Available Bit Rate (ABR) can operate in the following modes, all of which are supported by the BPX switch:

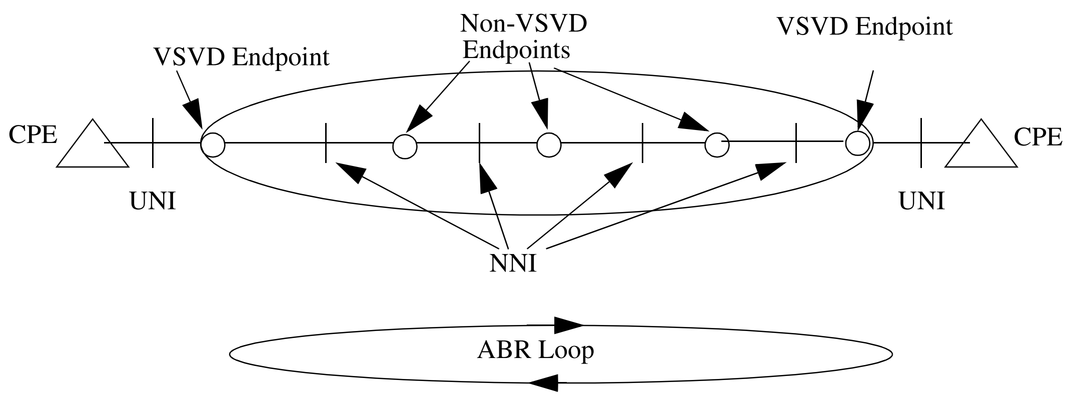
- EFCI marking
- Relative Rate marking
- Explicit Rate marking
- VS/VD control.

EFCI marking and VS/VD control are configured by the service template for an interface. SPVC supports VS/VD on a per connection basis. Relative Rate marking (CI control) and Explicit Rate marking are configured on a per slot basis, and this configuration applies to both AutoRoute and PNNI ABR connections on the slot.

ABR VS/VD Control

The ABR closed loop virtual source/virtual destination (VS/VD) control is set up between the originating and terminating UNIs which are set up as VSVD endpoints. An interface is provisioned so that ABR endpoints on that interface operate as a VSVD endpoints.

Figure 3-1 ABR VS/VD Control Loop



The ABR parameters (Table 3-3) are obtained from the following SETUP message information:

- Broadband Bearer Capability — Bearer Class must be set to ABR and User Plane Connection Configuration must be point-to-point.
- Traffic Descriptor — IE contains the forward and backward MCR and PCR values.
- ABR Setup Parameters — Mandatory IE contains the forward and backward ICR, TBE, RIF and RDF values, and the CRM value.
- ABR Additional Parameters — Optional IE contains the forward and backward Nrm, Trm, CDF and ADTF parameters.

If ABR parameters are not supplied in the SETUP message then default values are used.

Table 3-3 ABR Signal Parameters

Parameter	Default	Value Range	Units	Description	IE
PCR	mandatory	50 - Line Rate	cells/s	Peak Cell Rate	Traffic Descriptor
MCR	0	50 - Line Rate	cells/s	Minimum Cell Rate	Traffic Descriptor
ICR	PCR	MCR - PCR	cells/s	Initial Cell Rate	ABR Setup Parameters
RIF	1/16	Power of 2: 1/32768 - 1	-	Rate Increase Factor	ABR Setup Parameters
RDF	1/16	Power of 2: 1/32768 - 1	-	Rate Decrease Factor	ABR Setup Parameters
TBE	16777215	0 - 16777215	cells	Transient Buffer Exposure	ABR Setup Parameters
FRTT	-	0 - 16777215	usec	Fixed Round Trip Time	ABR Setup Parameters
Nrm	32	Power of 2: 2 - 256	cells	Maximum cells per forward RM-cell	ABR Additional Parameters
ADTF	0.55	0.01-10.23	sec	ACR Decrease Time Factor	ABR Additional Parameters
Trm	100	100 times power of 2: $100*2^{-7}$ - $100*2^{0}$	msec	Time between Forward RM-cells	ABR Additional Parameters
CDF	1/16	Power of 2: 1/64 - 1	-	Cutoff Decrease Factor	ABR Additional Parameters
CRM	TBE/Nrm	1 - 4095	cells	Cumulative RM-cell Count	Computed

When the SES node receives a Setup message, the following processing, which includes Connection Admission Control (CAC), occurs:

- Validate the Bearer Class and Traffic Descriptor combinations.
- Determine the SES PNNI controller Service Category from the Bearer Capability information element and the Traffic Descriptor information element. The SES PNNI controller Service Category is either CBR, rt-VBR, nrt-VBR, ABR, or UBR.
- Verify that the required bandwidth is less than the Available Cell Rate. CAC is performed on the BXM.
- Verify that a channel is available on the port by obtaining a free LCN.

- Verify that a VPCI is available.
- Map the Traffic Parameters to the port UPC capabilities.

Frame Discard for AAL5

BPX/SES support frame discard for AAL5 on PNNI 1.0 signaling to support SPVC applications. This can be configured per SPVC. Frame discard for SVC is configured on per port basis (on or off). Control of frame discard for individual SVC will be supported in later release when UNI4.0 is supported.

Overbooking

PNNI Controller supports both overbooking and underbooking when it sets up a port's CAC policy parameters. The CLI to change booking factor is cnfpnportcac portid service_category -bookfactor utilization-factor. The Service Category Utilization Factor (SCUF) is in the range of 1 to 200. The default is 100. An SCUF = 1 means the controller book 1% of requested bandwidth (i.e. request 100M BW on a call, the controller records only 1 M of bandwidth is reserved). This is an overbooking. On other hand, an SCUF = 200 means the controller book 200% of requested bandwidth. This is an underbooking.

Definitions:

- GCAC: Generic CAC. PNNI performs GCAC for a connection to select a path with sufficient BW for a newly configured connection.
- ACAC: Actual CAC. An ATM interface module performs the ACAC for a connection to verify there are sufficient resources on the interface prior to adding the connection on the individual interface. If ACAC fails for an interface that passed GCAC, crankback occurs.
- Oversubscription: results from overbooking of connection BW on a link so that the sum of configured BW for connections on the link exceeds the actual link BW. This is configured using a booking factor of 1-99. Over subscription = booking value 1-99 = overbooking.
- Undersubscription: results from underbooking of connection BW on a link so that the sum of configured BW for connections on the link will always be less than the actual link BW. This is configured using a booking factor of 101-200. Under subscription = booking value 101-200 = underbooking.
- %util: term used in AR. The %util corresponds directly to the booking factor. A %util of 10 causes 10% of configured BW for a connection to be used in the CAC algorithm. Therefore, a booking factor of 10 equals %util of 10.

A different connection BW is used for the GCAC and ACAC algorithms to deal with booking factor. For GCAC, the booking factor is considered at the time link BW is advertised to the network. For ACAC, the booking factor is considered at the time a connection is added to a link. With that in mind, here are some examples of how over and undersubscription works:

Overbooking Examples:

1. No overbooking or oversubscription

Suppose a user has a 100 MB link and the booking factor is 100.

- PNNI advertises 100 MB to the network.
- The link is configured on the service module for 100MB.
- For a call of 10 MB, GCAC CACs 10 MB, and ACAC CACs 10 MB.

2. Overbooking/Oversubscription

Suppose for the same 100MB link, the booking factor is 10.

- PNNI advertises 1000 MB (calculated by 100 * 100/10 = 1000)
- The link is configured on the service module for 100MB.
- For a call of 10 MB, GCAC CACs 10MB, and ACAC CACs 1MB (using 10 * 10/100).

3. Underbooking/Undersubscription

Suppose for the same 100 MB link, the booking factor is 200.

- PNNI advertises 50 MB (calculated as 100 * 100/200 = 50)
- The link is configured on the service module for 100MB.
- For a call of 10 MB, GCAC CACs 10MB, and ACAC CACs 20 MB (using 10 * 200/100).

PNNI advertises the effective link BW by taking into consideration the actual link BW and the booking factor. Therefore, GCAC will always CAC the configured connection BW w/o considering the booking factor.

The ATM interface is configured for the actual link BW, so in its ACAC, it adjusts the connection BW as required by the booking factor.

Booking factors less than 100% result in link oversubscription since the BW booked for each connection is less than the configured BW for the connection. This is also referred to as overbooking.

Booking factors greater than 100% result in link undersubscription, and the BW booked for a connection is greater than the connection's configured BW. This is also referred to as underbooking.

We should also note that the policing BW is still based on the configured bandwidth, not book factor. That is, for a 10MB connection, no matter what the booking factor is, the policing is still 10MB.

Infinite oversubscription is not currently supported in PNNI since the booking factor can not be set to zero (range 1-200).