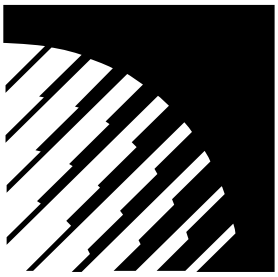

The ATM Forum

Technical Committee

ATM Usage Measurement Requirements

AF-NM-0154.000

As approved, this document will become an addendum to af-nm-0020.001

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Table of Contents

List Of Figures

List Of Tables

1 Introduction

This document presents functional requirements for the treatment of usage measurements at an M4 interface. The interface labeled "M4" in the ATM Forum Management Interface Reference Architecture is shown in Figure 1-1. This document also defines managed entities of a logical, protocol-independent Management Information Base (MIB) for the M4 Interface that models the exchange of information between ATM devices and the systems that manage them.

These requirements supplement the existing material [af-nm-0020.001] by providing a fuller treatment of usage measurements.

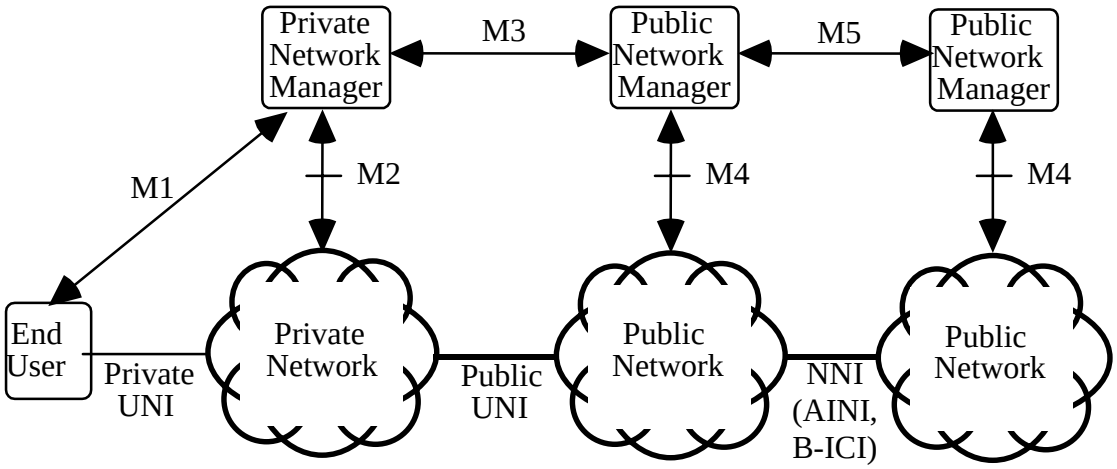

Figure 1-1 The ATM Forum Management Interface Reference Architecture

This document is the sole repository of Usage Measurement requirements for ATM connections. This document is a replacement for section 12 of the [af-bici-0013.003] specification. The scope of the document was also expanded to address the recording of Usage Measurements at both Network-Network Interfaces (NNIs) and User Network Interfaces (UNIs).

This treatment of usage measurement addresses the organized collection of usage-related data in support of accounting and traffic engineering functions. The support of multiple functions with a common set of usage measurements is believed to promote economies in the collection and exchange of usage-related data.

Usage measurement is the collection of usage information pertaining to services supported by a Network-Network Interface (NNI). (Please see Figure 1-1). The collection of usage information could occur at an NNI and/or at a public User-Network Interface (UNI). Usage information is not expected/intended to be collected at interfaces between two ATM Network Elements that are in the same network. The specific types of NNIs explicitly addressed herein are the ATM Inter-Network Interface (AINI) and Broadband Inter-Carrier Interface (B-ICI). The requirements contained herein are relevant to other NNI types/protocols (e.g., Private Network Network Interface [af-pnni-0055.000]). However, to facilitate presentation of the contained material, only the AINI and B-ICI are referenced.

Usage information is used to support billing between different network providers and for studying traffic performance characteristics at an NNI, as well as for network planning, customer network management, and marketing.

NOTE: In this document, requirements containing the phrase “shall be capable of recording” is to be understood as ‘mandatory’ requirements for the supplier of ATM Network Elements (NEs), but ‘optional’ requirements for the ATM Service Provider (ASP).

The requirements contained herein are placed on the ATM NEs deployed by an ASP. It would be highly beneficial for ASPs to deploy downstream systems (e.g., Element Management Systems) that provide additional capabilities that enhance the use of the usage information generated by the ATM NEs. Example capabilities include: filtering out unwanted usage information and aggregating cell counts into rate periods. Requirements for these downsteam systems is out of the scope of this document.

1.1 Scope

The M4 Interface requirements defined in this document are intended to support Usage Measurement of Permanent Virtual Connections (PVCs) , Switched Virtual Connections (SVCs), and Soft Permanent Virtual Connections (SPVCs).

This document addresses the following areas of ATM Usage Measurement:

- PVC Usage Measurement: The Usage Measurement requirements for PVCs contained in this document address the configuration of Usage Measurement parameters, generation of usage information, and assembly of this information.
- SVC Usage Measurement: The Usage Measurement requirements for SVCs contained in this document address the configuration of Usage Measurement parameters, generation of usage information, and assembly of this information. The generated data includes: application-independent usage information, and traffic engineering-specific usage information.
- SPVC Usage Measurement. The Usage Measurement capabilities for PVCs and SVCs are leveraged for SPVCs.

The primary objective of this document is to identify a set of usage data to be collected to support PVC, SVC and SPVC services (e.g., Cell Relay Service, Circuit Emulation Service, Frame Relay Service) providing point-to-point ATM connections. Point-to-multipoint ATM connections are also addressed.

The usage information generated by the ATM NEs for PVCs must account for both common ATM transport and service-specific functions (if performed). Consequently, ATM NEs must be capable of generating both service-independent (common) and service-specific usage information. The document addresses both types of usage information for PVCs.

The reader, however, is advised to consult the following documents for more comprehensive descriptions of underlying concepts:

1. [GR-1110-CORE]
2. [af-cs-0125.000]
   Section 3 contains some basic description of the AINI model.
3. [Q.825]
4. [af-bici-0013.003]

1.2 Document Organization

The document is organized as follows:

- Section 2, PVC Service-Independent Usage Measurement – defines the service-independent Usage Measurement capabilities for PVCs
- Section 3, PVC Service-Specific Usage Measurement – defines the service-specific Usage Measurement capabilities for PVCs

- Section 4, SVC Usage Measurement – defines the Usage Measurement capabilities for SVCs
- Section 5, SPVC Usage Measurement – defines the Usage Measurement capabilities for SPVCs
- Section 6, SVC Usage Measurements for Traffic Engineering and Performance Management
- Section 7, Acronyms
- Section 8, Definitions
- Section 9, References
- Appendix A – Summary of Recorded Data Elements– presents a table that summarizes the data elements that are recorded for PVCs, SVCs, and SPVCs
- Appendix B – Requirement Validity for SPVCs – contains a table that presents the applicability to SPVCs of the PVC and SVC requirements contained herein.
- Appendix C – Point-to-Multipoint SVCs informational appendix.

1.3 Presentation Style

The following presentation rules apply to the requirements contained in this document:

- When a requirement refers to a “recording interface” without further specification of the type of interface, then the requirement is meant to apply to the AINI, B-ICI and UNI.
- When a requirement refers to an “NNI” without further specification of the type of NNI, then the requirement is meant to apply to both the AINI and the B-ICI.
- When a whole requirement or a part of a requirement is specific to a particular type of recording interface, then “AINI”, “B-ICI” or “UNI” is included in the requirement.

2 PVC Service-Independent Usage Measurement

Data generation is the process of determining if usage information is needed for each PVC and, if needed, producing the necessary data elements. The data generation function is performed by the generation functionality of the ATM NE. The *generation functionality* assembles the data elements generated into a usage record, referred to as *data assembly*. The usage record generated by the generation functionality may be unformatted or may be in a NE/vendor proprietary format.

Thus, ATM NEs at the User-Network Interfaces (UNIs) or Network-Network Interfaces (NNIs) collect data elements for usage information, determine if these data elements need to be assembled into a record and if so, produce usage information in the form of data records. Figure 2-1 illustrates three example Inter Network PVC configurations.

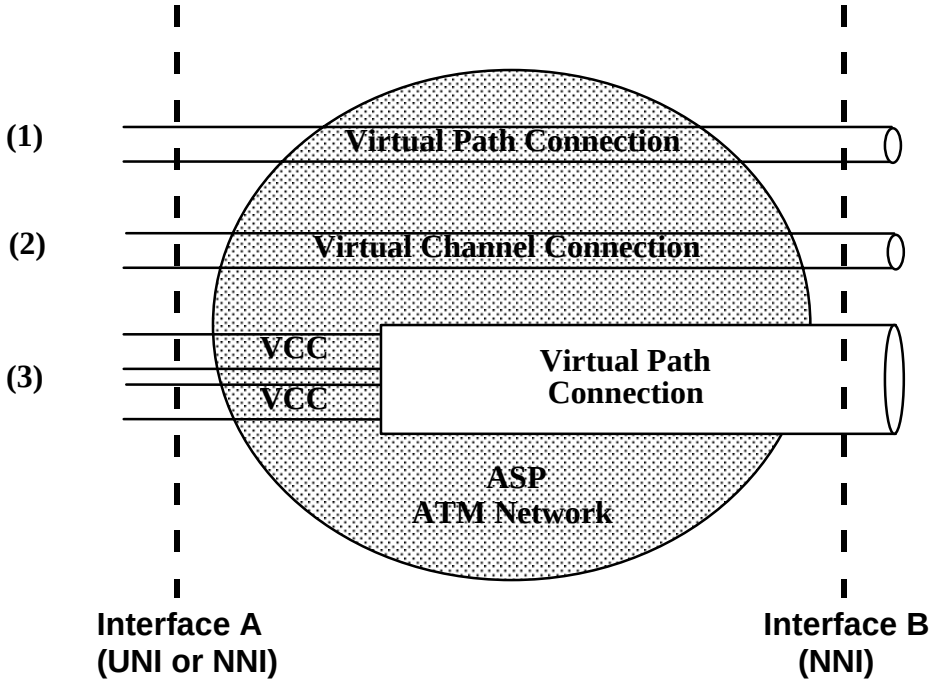

Figure 2-1 Examples of PVC Configurations

The data generation point is at the recording interface.The term *recording interfaces* means those network interfaces where usage information is generated by ATM NEs. In general, usage information may be generated at ATM UNIs and/or NNIs (e.g., AINI or B-ICI). Depending on the usage measurement needs, usage information for Point-to-Point ATM connections may be generated at a single recording interface (i.e., either the NNI or the UNI), at both recording interfaces (i.e., the NNI as well as the UNI), or at no recording interface (i.e., no usage information is generated for the ATM PVC).

A related term is the remote interface. A *remote interface* represents the interface to the ASP network involved in a PVC that is other than the particular recording interface in consideration. As shown in Figure 2-2, when the usage information is generated at the NNI, the AINI or B-ICI is the recording interface and the involved UNI is the remote interface. Furthermore, when the usage information is generated at a UNI, the UNI is the recording interface and the involved NNI is the remote interface. The data generation requirements in this document apply to a recording interface. NOTE: The recording interfaces shown in Figure 2-2 were chosen only to illustrate the concept of a remote interface, and **not** to specify where Usage Measurement must be performed for a PVC.

The unformatted usage records need to be formatted before further processing. *Data formatting* is the process of formatting the unformatted usage records. The *formatting functionality* in the ATM NE performs data formatting. The subject of Data Formatting is highly implementation specific and may be proprietary and is, therefore, beyond the scope of ATM Forum documents. Formatting is usually performed according to the requirements of the ASP.

A PVC at a recording interface has two cell flows: ingress and egress. These cell flows are illustrated in Figure 2-2. As shown, the *ingress cell flow* is towards the network supporting the recording interface, and the *egress cell flow* is away from this network (i.e., to a connected network or to a UNI).

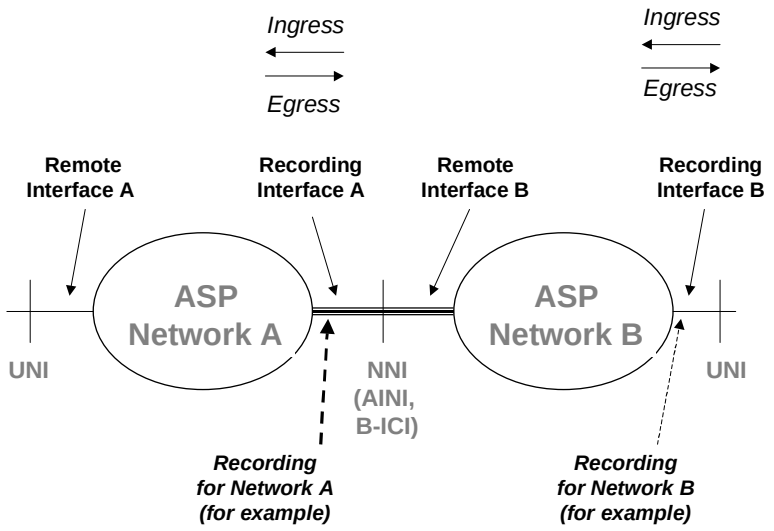

Figure 2-2 PVC Usage Measurement Reference Model

This section is organized as follows:

- Section 2.1 defines the configuration of Usage Measurement capabilities
- Section 2.2 defines the usage information to be generated
- Section 2.3 defines the procedures for assembling usage information for forwarding to the formatting functionality
- Section 2.4 presents data formatting considerations
- Section 2.5 defines the integrity of the usage information generation process

The requirements contained in Section 2 apply to both Permanent Virtual Channel Connections (PVCCs) and Permanent Virtual Path Connections (PVPCs).

The following presentation rules apply to the requirements contained in this section:

- **When a requirement refers to a "recording interface" without further specification of the type of interface, then the requirement is meant to apply to the AINI, B-ICI and UNI.**
- **When a requirement refers to an "NNI" without further specification of the type of NNI, then the requirement is meant to apply to both the AINI and the B-ICI.**

- **When a whole requirement or a part of a requirement is specific to a particular type of recording interface, then "AINI", "B-ICI" or "UNI" is included in the requirement.**

2.1 Configuration Management

This section defines configuration management in support of Usage Measurement for ATM PVCs.

2.1.1 Data Generation Control

This section defines configuration management for controlling the generation of data.

2.1.1.1 Usage Information

An ASP uses the Usage Information generation parameter to control the recording of all Usage Information (e.g., identifiers, timing data, cell counts, traffic parameters).

(R) PVC-1 The generation functionality shall enable the ASP to set, via an operations interface, the Usage Information generation parameter for each PVC at a recording interface. The allowable values shall be *active* and *inactive*. The default value shall be *active*. The activation/deactivation of the Usage Information generation parameter shall not effect user traffic flow.

2.1.1.2 Connection Administration Information

For some ASPs, it may be desirable for the ATM NE to produce additional usage records for a PVC when, through administration, the status of the PVC is changed or the profile of the PVC (e.g., traffic parameters) is modified. Usage records would be produced upon creation, activation, deactivation and deletion of the PVC, as well as upon modification of the PVC's profile. These activities are associated with the administrative states defined in [af-nm-0020.001].

The generation of usage records upon PVC administration is controlled by the Connection Administration Information generation parameter. Connection Administration Information will only be generated for PVCs at a recording interface if the Connection Administation Information generation parameter for the ATM NE is set to "active". The recording of Connection Administration Information is not affected by the Usage Information generation parameter.

(R) PVC-2 The generation functionality shall enable the ASP to set, via an operations interface, the Connection Administration Information generation parameter per ATM Network Element. The allowable values shall be *active* and *inactive*. The default value shall be *inactive*.

2.1.2 Usage Information Provisioning

An ASP is enabled to provision information regarding a PVC that is assembled along with dynamic information (e.g., cell counts) for the PVC. This section defines the provisioning of information that is specific to Usage Measurement. The provisioning of information that also pertains to other subjects (i.e., in addition to Usage Measurement) is defined in [af-nm-0020.001].

The Network Provider Identification is used to identify the interconnected ASP associated with the PVC at a recording interface. The Network Provider Identification set at an NNI for a PVC is the identity of the ASP who's network is connected via the NNI. The Network Provider Identification set at a UNI for a PVC is the identity of the ASP who's network is connected via the NNI associated with the PVC.

(R) PVC-3 The generation functionality shall enable the ASP to set, via an operations interface, a Network Provider Identification for each NNI and for each Inter-Network Provider PVC at the UNI.

Figure 2-2 in Section 2 illustrates a recording interface and a remote interface for a PVC in a particular ASP network. When usage information is generated at the NNI, the NNI is the recording interface and the UNI is the

remote interface. When usage information is generated at the UNI, the UNI is the recording interface and the NNI is the remote interface.

The data generation point for an Inter Network PVC is at the recording interface. One data element is necessary to identify the recording interface (NNI or UNI). All PVCs carried over a particular recording interface will have the same value of the Recording Interface Identifier.

(R) PVC-4 The generation functionality shall enable the ASP to set, via an operations interface, an identifier for each recording interface. The same Recording Interface Identifier is used for all PVCs carried over the recording interface.

The Type of Service Supported is used to identify the Inter Network service provided by the Inter Network PVC.

(O) PVC-5 The generation functionality may enable the ASP to set, via an operations interface, the Type of Service Supported for each PVC at the recording interface. Valid values for the Type of Service Supported at the recording interface include: *PVC CRS*, *PVC CES*, *PVC FRS*, and *SMDS*.

The ASP needs the capability to indicate when the usage information generated for an ATM PVC is used for study purposes. The Study Indication provides this capability. Note that the value of the Study Indication does not suggest that the usage information is billable or non-billable; it only indicates that usage information is generated for study purposes.

(R) PVC-6 The generation functionality shall be settable so that the ASP can designate the Study Indication for any ATM PVC at a recording interface. Valid values for the Study Indication are:

- *No Study* (default)
- *Study Generated Record*

For some ASPs, it is desirable to identify the chargeable party for the ATM PVC in the usage information generated for it. The Chargeable Party Identifier provides this capability.

(CR) PVC-7 If the ASP requires the capability to designate a Chargeable Party, the generation functionality shall be settable so that the ASP can designate the Chargeable Party Identifier for any ATM PVC at a recording interface.

A summary of these parameters and their status at the UNI and NNI is provided in Table 2-1.

Table 2-1 Configured Parameters for Usage Measurement of a PVC

Parameter	Settable at the UNI		Settable at the NNI	
	Per PVC	Per UNI	Per PVC	Per NNI
Recording Interface Identifier		X		X
Network Provider Identification	X			X
Type of Service Supported	X		X	
Study Indication	X		X	
Chargeable Party Identifier	X		X	

2.1.3 Recording Interval Definition

The service-independent (common) usage information for a PVC is collected during ASP-defined *recording intervals*. To support a wide variety of Inter Network service arrangements, the recording intervals are settable by the ASP via an operations interface. An ASP is enabled to define an *Interval Period* for each day of the week. This Interval Period applies throughout the given day. Since the first recording interval of every day begins at midnight, the allowed Interval Period values are time lengths that are divisible into 1440 minutes, with the minimum value being 30 minutes.

(**R) PVC-8** For PVCs, the generation functionality shall be settable for each ATM NE, via an operations interface, such that an ASP can set the Interval Period for each day of the week. The valid values for an Interval Period are: 30, 60, 90, 120, 180, 240, 360, 480, 720 and 1440 minutes.

Note that for unscheduled closings (as described in Section 2.3.1.2), the *Interval Elapsed Time*, which is the actual length of a recording interval, will not be the length of the corresponding Interval Period, and the next *Interval Start Time*, which is the time of day that a recording interval began, will probably not fall on a half or whole hour.

Although the above 30-minute minimum Interval Period for recording intervals is sufficient for many needs, more granular counts are necessary for specific applications. The recording needs of these applications require further study.

(R) PVC-9 For PVCs, the generation functionality shall be settable so that the ASP can specify, via an operations interface, a 15-minute Interval Period for a limited number of simultaneous ATM PVCs.

2.2 Data Generation

When the Usage Information generation parameter is set to *active* for a PVC, the generation functionality will generate Usage Information for the PVC. This Usage Information includes all data elements for which data generation is defined in this section with the exception of any data elements for which data generation has been disabled through the use of another generation parameter (i.e., Connection Administration Information generation parameter). The activation/deactivation of the Usage Information generation parameter shall have no effect on user traffic flow. The configuration of the Usage Information generation parameter is defined in Section 2.1.1.

(R) PVC-10 If the Usage Information generation parameter is set as *active* for a PVC, then the generation functionality shall generate Usage Information for the PVC at the recording interface during the recording interval.

(R) PVC-11 If the Usage Information generation parameter is set as *inactive* for a PVC, then the generation functionality shall ensure that Usage Information is not generated for the PVC at the recording interface during the recording interval.

When the Usage Information generation parameter is *active*, the generation functionality begins recording usage information when the PVC has been activated via an operations interface. Correspondingly, the generation functionality ceases recording for the PVC when the PVC has been deactivated, or deleted prior to deactivation, via an operations interface.

(R) PVC-12 If the Usage Information generation parameter is set as *active* for a PVC, when a PVC is activated via an operations interface, the generation functionality shall begin recording for the PVC.

(R) PVC-13 If the Usage Information generation parameter is set as *active* for a PVC, when a PVC is deactivated via an operations interface, the generation functionality shall cease recording for the PVC.

(R) PVC-14 If the Usage Information generation parameter is set as *active* for a PVC, when a PVC is deleted via an operations interface, if the recording for the PVC has not been ceased (due to PVC deactivation), the generation functionality shall cease recording for the PVC.

2.2.1 Connection Identification and Type

The Connection Type is used to indicate whether the connection is a Virtual Path (VP) or Virtual Channel (VC). The configuration of the Connection Type is defined in [af-nm-0020.001].

(R) PVC-15 The generation functionality shall record the Connection Type for each PVC at a recording interface**.**

Figure 2-2 in Section 2 illustrates a recording interface and a remote interface for a PVC in a particular ASP network. When usage information is generated at the NNI, the NNI is the recording interface and the UNI is the remote interface. When usage information is generated at the UNI, the UNI is the recording interface and the NNI is the remote interface.

The recording interface is identified by the Recording Interface Identifier. The configuration of the Recording Interface Identifier is defined in Section 2.1.2.

(R) PVC-16 The generation functionality shall record the Recording Interface Identifier for each PVC at a recording interface**.**

The Recording Interface Type is used to indicate the type of interface used at the recording interface. The configuration of the Recording Interface Type is defined in [af-nm-0020.001]. However, not all of the values for Recording Interface Type (e.g., Frame Relay UNI) needed for usage measurements are addressed. The missing values are expected to be added to [af-nm-0020.001] in the near future.

(R) PVC-17 The generation functionality shall record the Recording Interface Type for each PVC at a recording interface. The valid values are: *ATM UNI*, *AINI*, *B-ICI*, *PNNI* and *Frame Relay UNI*.

Each individual PVC carried over a recording interface is identified by a Recording Connection Identifier. The configuration of the Recording Connection Identifier is defined in [af-nm-0020.001].

(R) PVC-18 The generation functionality shall identify each PVC at a recording interface by the Recording Connection Identifier as follows, and shall record this Recording Connection Identifier for each PVC at a recording interface:

- For PVCs configured as Virtual Path Connections (VPCs) at the recording interface (e.g., AINI, UNI), the Recording Connection Identifier is the Virtual Path Identifier (VPI) at the recording interface.
- For PVCs configured as Virtual Channel Connections (VCCs) at the recording interface (e.g., AINI, UNI), the Recording Connection Identifier is the Virtual Path Identifier (VPI) and the Virtual Channel Identifier (VCI) at the recording interface.

The configuration of the Network Provider Identification is defined in Section 2.1.2.

(R) PVC-19 The generation functionality shall record the Network Provider Identification for each PVC at a recording interface**.**

The configuration of the Type of Service Supported is defined in Section 2.1.2.

(O) PVC-20 The generation functionality may record the Type of Service Supported for each PVC at a recording interface**.**

Support of usage measurement for Transit Inter Network PVC service is under study.

The configuration of the Study Indication is defined in Section 2.1.2.

(R) PVC-21 The generation functionality shall record the Study Indication for each PVC at a recording interface**.**

The configuration of the Chargeable Party Identifier is defined in Section 2.1.2.

(R) PVC-22 The generation functionality shall record the Chargeable Party Identifier for each PVC at a recording interface**.**

The ASP needs to be able to identify an ATM PVC as being a Point-to-Point PVC or a Point-to-Multipoint PVC, which is accomplished through the User Plane Connection Configuration. The configuration of the User Plane Connection Configuration is defined in [af-nm-0020.001].

(R) PVC-23 The generation functionality shall record the User Plane Connection Configuration for each PVC at a recording interface. Valid values for the User Plane Connection Configuration are *point-to-point* and *point-to-multipoint*.

2.2.2 PVC Connection Administration Information

When the Connection Administration Information generation parameter is set to *active*, the generation functionality records information regarding the creation, activation, deactivation and deletion of a PVC.

(R) PVC-24 For a PVC at a recording interface for which the Connection Administration Information generation parameter is set to *active*, when a PVC is created via an operations interface, the generation functionality shall record the Creation Time.

(R) PVC-25 For a PVC at a recording interface for which the Connection Administration Information generation parameter is set to *active*, when a PVC is activated via an operations interface, the generation functionality shall record the Activation Time.

(R) PVC-26 For a PVC at a recording interface for which the Connection Administration Information generation parameter is set to *active*, when a PVC is deactivated via an operations interface, the generation functionality shall record the Deactivation Time.

(R) PVC-27 For a PVC at a recording interface for which the Connection Administration Information generation parameter is set to *active*, when a PVC is deleted via an operations interface, the generation functionality shall record the Deletion Time.

2.2.3 Cell Counts

This section addresses the counting of ATM cells in the ingress and egress directions.

2.2.3.1 Ingress Cell Counts

For the ingress cell counts, a *Measurable Ingress Cell* is defined as any assigned cell received by the ATM Network Element across the ingress interface (NNI or UNI) that is not discarded by Cell Validation Procedures, Usage Parameter Control (UPC) procedures, or Network Parameter Control (NPC) procedures. NOTE: There is some overlap between the measured parameters in the requirements in this subsection and certain requirements in af-nm-0020.001. The emphasis here is, however, on exchange of information between networks.

(R) PVC-28 For a PVC at a recording interface, the generation functionality shall count all Measurable Ingress Cells during the recording interval. This count is referred to as *Ingress Total Cells*.

(R) PVC-29 For a PVC at a recording interface, the generation functionality shall count all Measurable Ingress Cells with CLP = 0 during the recording interval. This count is referred to as *Ingress High Priority Cells*.

The generation functionality also counts the number of ingress cells that were tagged, the total number of ingress cells that were discarded, and the number of high priority ingress cells that were discarded.

(R) PVC-30 For a PVC at a recording interface, when the UPC/NPC function is activated, the generation functionality shall count all tagged ingress cells with CLP = 0 during the recording interval. This count is referred to as *Ingress Tagged High Priority Cells*.

(R) PVC-31 For a PVC at a recording interface, when the UPC/NPC function is activated, the generation functionality shall count all discarded ingress cells (including cells with CLP = 0 and CLP =1) during the recording interval. This count is referred to as *Ingress Discarded Total Cells*.

(R) PVC-32 For a PVC at a recording interface, when the UPC/NPC function is activated, the generation functionality shall count all discarded ingress cells with CLP = 0 during the recording interval. This count is referred to as *Ingress Discarded High Priority Cells*.

2.2.3.2 Egress Cell Counts

For the egress cell counts, a *Measurable Egress Cell* is defined as any assigned cell transported by the ATM Network Element across the egress interface (e.g., AINI, UNI). If an ATM Network Element employs egress shaping at an interface, then any cells lost or discarded by the egress shaping process are not measurable. Measurable egress cells do not include unassigned cells added to the user cell stream. NOTE: There is some overlap between the measured parameters in the two requirements above and certain requirements in [af-nm-0020.001]. The emphasis here is, however, on exchange of information between networks.

(R) PVC-33 For a PVC at a recording interface the generation functionality shall count all Measurable Egress Cells during the recording interval. This count is referred to as *Egress Total Cells*.

(R) PVC-34 For a PVC at a recording interface, the generation functionality shall count all Measurable Egress Cells with CLP = 0 during the recording interval. This count is referred to as *Egress High Priority Cells*.

2.2.4 Frame Counts

This section addresses the counting of ATM Adaptation Layer (AAL) frames in the ingress and egress directions for a PVC at a recording interface. A main driver behind counting AAL frames is to support recording for the use of TCP/IP. Only AAL types that use the “end of frame” bit in the ATM cell header (e.g., AAL5) are addressed.

2.2.4.1 Ingress Frame Counts

It is desirable to count the number of ingress AAL frames and the number of discarded ingress AAL frames.

(O) PVC-35 For a PVC at a recording interface, the generation functionality may count the number of AAL frames in the ingress direction , during the recording interval. The count is referred to as the *Ingress AAL Frames*.

(O) PVC-36 For a PVC at a recording interface, the generation functionality may count the number of discarded AAL frames in the ingress direction , during the recording interval. The count is referred to as the *Ingress Discarded AAL Frames*.

2.2.4.2 Egress Frame Counts

It is desirable to count the number of egress AAL frames.

(O) PVC-37 For a PVC at a recording interface, the generation functionality may count the number of AAL frames in the egress direction , during the recording interval. The count is referred to as the *Egress AAL Frames*.

2.2.5 Traffic Descriptor

The generation functionality records parameters associated with the Traffic Descriptor for the PVC. These parameters are defined when a PVC is configured. The configuration of these parameters is defined in af-nm-0020.001. In practice, not all parameters will be set for all connections, if a parameter is not set it will not be recorded.

(R) PVC-38 For a PVC at a recording interface, the generation functionality shall record the following data elements for the PVC (if the data elements are set for the PVC):

- Conformance definition (CBR.1, VBR.1, VBR.2, etc.)

- Service Category
- Ingress Peak Cell Rate (CLP = 0+1)
- Ingress Peak Cell Rate (CLP = 0)
- Ingress Sustainable Cell Rate (CLP = 0+1)
- Ingress Sustainable Cell Rate (CLP = 0)
- Ingress Maximum Burst Size (CLP = 0+1)
- Ingress Maximum Burst Size (CLP = 0)
- Ingress Minimum Cell Rate
- Ingress Maximum Frame Size
- Ingress Acceptable Peak-to-Peak Cell Delay Variation
- Ingress Acceptable Cell Loss Ratio
- Ingress Cell Delay Variation Tolerance
- Egress Peak Cell Rate (CLP = 0+1)
- Egress Peak Cell Rate (CLP = 0)
- Egress Sustainable Cell Rate (CLP = 0+1)
- Egress Sustainable Cell Rate (CLP = 0)
- Egress Maximum Burst Size (CLP = 0+1)
- Egress Maximum Burst Size (CLP = 0)
- Egress Minimum Cell Rate
- Egress Maximum Frame Size
- Egress Acceptable Peak-to-Peak Cell Delay Variation
- Egress Acceptable Cell Loss Ratio
- Egress Cell Delay Variation Tolerance

2.2.6 Transit Connections

A transit inter-network connection is supported if the PVC is established between two NNIs. Additional parameters for transit inter-network connections may apply.

(R) PVC-39 The generation functionality shall indicate to the formatting functionality any usage information generated for transit inter-network PVCs at a recording interface.

2.2.7 Recording Intervals

During a recording interval, usage information is collected for each PVC at the recording interface for which usage information generation is active. At the end of each recording interval, the usage information is sent to the formatting functionality. Recording intervals normally begin and end at scheduled times. Procedures for *scheduled closings*, which are closings that occur when a recording interval ends at the scheduled time, are described in Section 2.3.1.1. Recording intervals may close at unscheduled times for many reasons, including system failure and reaching memory exhaustion or counter overflow thresholds. Procedures for *unscheduled closings*, which are closings that occur before a recording interval is scheduled to end, are described in Section 2.3.1.2.

To illustrate recording intervals, assume that the recording intervals for an ATM Network Element are hourly (e.g., from midnight to 0:59:59.9, from 1:00:00.0 to 1:59:59.9, etc.). For a PVC at the recording interface, usage information is generated and sent to the formatting functionality for each hourly interval (i.e., 24 separate instances of usage information are forwarded to the formatting functionality). The Interval Elapsed Time of each is one hour.

(R) PVC-40 For PVCs, the generation functionality shall record for each recording interval an Interval Start Date, an Interval Start Time, and an Interval Elapsed Time, as defined below.

- The *Interval Start Date* and *Interval Start Time* shall contain the date and time of day that the recording interval begins.
- The *Interval Elapsed Time* shall contain the length of the recording interval.

The Interval Start Time shall be recordable in hours, minutes, seconds, and tenths of seconds. The Interval Elapsed Time shall be recordable in minutes, seconds, and tenths of seconds.

(R) PVC-41 For PVCs, to support recording intervals, the generation functionality shall have access to a duration timer and a date and time-of-day clock that conform to the following timing accuracy standards:

- The accuracy objective for the Interval Start Time and Interval Start Date is ± 1 second of the actual start of the recording interval.
- The Interval Elapsed Time should not be overstated.
- The accuracy objective for the Interval Elapsed Time should be + 0 seconds to - 0.1 seconds.

(R) PVC-42 For PVCs, the generation functionality shall ensure that recording intervals cover all time during a day and that the intervals do not overlap. A recording interval shall include its Interval Start Time and exclude the Interval Start Time of the next recording interval.

For example, if one recording interval starts at 2:00 AM with an Interval Elapsed Time of 60 minutes, it begins at 2:00:00.0 and ends at 2:59:59.9, inclusive. The next recording interval starts at 3:00 AM.

Recording intervals cannot overlap days because an ASP needs to be able to determine the number of usage measurements generated for a given day.

(R) PVC-43 For PVCs, the generation functionality shall ensure that the first recording interval of a given day begins at 0:00:00.0.

2.3 Data Assembly

In-progress connection data generated for PVCs is assembled at scheduled closings and unscheduled closings. PVC connection administration information is assembled upon occurrence of a PVC creation, activation, deactivation and deletion.

This section addresses the assembly of Usage Information for PVCs.

2.3.1 In-progress Connection Information

Usage information pertaining to the in-progress connection is assembled at scheduled and unscheduled closings.

The data elements recorded for PVCs, and therefore to be assembled for PVCs, are summarized in Appendix A. The generation of these data elements is defined in Section 2.2.

2.3.1.1 Scheduled Closings

Normally, usage information is assembled at the scheduled closing for each recording interval. The scheduled closing for a recording interval is at the end of the Interval Period. For instance, if the Interval Period is 30 minutes, the first recording interval for the day will have an Interval Start Time of 0:00:00.0, an Interval Elapsed Time of 30

minutes, and a scheduled closing at 0:29:59.9. At the scheduled closing, the usage information is sent to the formatting functionality.

(R) PVC-44 For PVCs, the generation functionality shall assemble a usage record and forward it to the formatting functionality.

(R) PVC-45 For PVCs, at the scheduled closing of each recording interval, the generation functionality shall assemble the usage information recorded for each PVC at the recording interface and send it to the formatting functionality.

Based on this requirement, a usage record would be produced at the end of every configured recording interval for the life of the PVC.

2.3.1.2 Unscheduled Closings

Abnormal recording intervals occur when the interval does not begin at a scheduled start time or does not end at the scheduled closing. Requirements on the generation functionality associated with abnormal recording intervals are described below.

It is likely that the usage measurement functionality will not be enabled (i.e., the ATM Network Element put into live service) exactly at the start of a scheduled recording interval. In other words, the service may have been turned on but usage measurement may not have been enabled. The date and time at which the usage measurement functionality is enabled are referred to as the *enabled date and time.*

(R) PVC-46 For PVCs, when the usage measurement functionality is enabled, the generation functionality shall create a recording interval with an Interval Start Date and Time equal to this enabled date and time.

The Interval Elapsed Time of this recording interval shall include all time up to, but not including, the Interval Start Time of the next scheduled recording interval.

The generation functionality shall indicate this occurrence to the formatting functionality.

For example, if the usage measurement functionality is enabled at 10:05 AM and the next scheduled recording interval starts at 11:00 AM, a recording interval is created with an Interval Start Time of 10:05:00.0 and an Interval Elapsed Time of 55:00.0.

In some instances, the generation functionality closes the recording interval before its scheduled closing. This is referred to as an *unscheduled closing*. Unscheduled closings can occur when memory is near exhaustion or after a system failure. Two types of unscheduled closings may occur: (1) those that affect the usage information for all PVCs at the recording interface, or (2) those that affect the usage information associated with only one or a subset of PVCs at the recording interface.

In both cases, the treatment is to end the recording interval for the affected PVC at the recording interface and to start a new recording interval for the affected PVCs. This treatment helps replenish memory if it is near exhaustion and indicates that counts for the interval may be in error.

(R) PVC-47 For PVCs, the generation functionality shall perform an unscheduled closing of a recording interval associated with a PVC at the recording interface in any of the following situations:

- When memory usage by the usage measurement functionality reaches the Usage Measurement Memory Exhaustion Threshold which implies unscheduled closings for recording intervals for all PVCs at the recording interface.
- When any counter associated with a PVC at the recording interface reaches the usage information Cell Count Overflow Threshold which implies an unscheduled closing only for the recording interval associated with that PVC at the recording interface.
- When the usage measurement functionality is restored after a failure, which implies unscheduled closings for recording intervals for all PVCs at the recording interface.

- When the PVC has been deleted.

Note that if a single count for a PVC at the recording interface reaches the Cell Count Overflow Threshold (situation #2 in the **(R) PVC-47** above), the unscheduled closing applies to all counts that are being generated for that PVC at the recording interface. For example, if both the Ingress Total Cells and Ingress High Priority Cells are being collected for the PVC and the Ingress Total Cells reaches the Cell Count Overflow Threshold, both counts are assembled and sent to the formatting functionality.

(R) PVC-48 For PVCs, when the generation functionality determines that an unscheduled closing will occur for a recording interval, it shall:

- Change the Interval Elapsed Time to the elapsed time between the original Interval Start Time and the time at which the unscheduled closing occurs.
- Assemble the usage information for all affected PVCs at the recording interface.
- Send assembled usage information to the formatting functionality.
- Indicate the reason for the unscheduled closing to the formatting functionality.

(R) PVC-49 For PVCs, after an unscheduled closing, the generation functionality shall create a new recording interval for the affected PVCs at the recording interface.

The Interval Start Date and Time of the new recording interval shall be the date and time of the unscheduled closing of the original recording interval.

The Interval Elapsed Time of the new recording interval shall be the elapsed time between the time that the unscheduled closing of the original recording occurred and the start time of the next scheduled recording interval.

Unscheduled closing of a recording interval should not result in the loss of recorded data.

Since usage information created for the new recording interval described in the above requirement results from an unscheduled closing, it is not associated with a scheduled recording interval. The usage information indicates that the recording interval is abnormal.

(R) PVC-50 For PVCs, the generation functionality shall indicate to the formatting functionality that it created a new recording interval.

2.3.2 Connection Administration Information

When the Connection Administration Information generation parameter is set to *active*, the generation functionality generates usage records regarding the creation, activation, deactivation and deletion of a PVC.

(R) PVC-51 For a PVC at a recording interface for which the Connection Administration Information generation parameter is set to *active*, when a PVC is created via an operations interface, the generation functionality shall generate a Creation usage record.

(R) PVC-52 For a PVC at a recording interface for which the Connection Administration Information generation parameter is set to *active*, when a PVC is activated via an operations interface, the generation functionality shall generate an Activation usage record.

(R) PVC-53 For a PVC at a recording interface for which the Connection Administration Information generation parameter is set to *active*, when a PVC is deactivated via an operations interface, the generation functionality shall generate a Deactivation usage record.

(R) PVC-54 For a PVC at a recording interface for which the Connection Administration Information generation parameter is set to *active*, when a PVC is deleted via an operations interface, the generation functionality shall generate a Deletion usage record.

2.4 Data Formatting

Data formatting is the process of formatting the usage information into a format that can be processed by the ASP operations systems. Data formatting is performed by the formatting functionality. The usage measurement format is ASP-specific and beyond the scope of this document. An example format is Billing AMA Format (BAF) [GR-1100-CORE], which is used by U.S. Local Exchange Carriers for current telecommunications services.

2.5 Usage Information Integrity

The usage information defined in this section is intended to support connecting inter-ASP serving arrangements for PVC services. Traditionally, these serving arrangements are based on availability of high integrity usage information.

Integrity standards address the accuracy of the usage information and the reliability and quality of the software and hardware that support the Usage Measurement functions. Accuracy standards may include limits on the amount of usage information misproduced (e.g., with the wrong parameters or with incorrect counts). Reliability and quality standards may include limits on the amount of usage information that is lost in the event of equipment failure and guidelines for making back-ups of the usage information.

Integrity standards for usage information are assumed to be mostly ASP-specific and beyond the scope of this specification. However, the following requirement is presented in order to capture the guiding principle that the loss of usage information be minimized.

(R) PVC-55 A single failure or error for any component that supports the generation functionality shall not cause a loss of usage information (including cell counts) that are 15 minutes old or more.

Additional ASP-specific requirements related to the loss of partial or complete usage records may also apply.

3 PVC Service-Specific Usage Measurement

This section presents service-specific Usage Measurement capabilities for services supported by ATM PVCs. The services addressed are:

- Cell Relay Service (CRS)
- Circuit Emulation Service (CES)
- Frame Relay Service (FRS)
- Switched Multi-megabit Data Service (SMDS)

The requirements contained in Section 3 apply to both Permanent Virtual Channel Connections (PVCCs) and Permanent Virtual Path Connections (PVPCs).

The following presentation rules apply to the requirements contained in this section:

- **When a requirement refers to a "recording interface" without further specification of the type of interface, then the requirement is meant to apply to the AINI, B-ICI and UNI.**
- **When a requirement refers to an "NNI" without further specification of the type of NNI, then the requirement is meant to apply to both the AINI and the B-ICI.**
- **When a whole requirement or a part of a requirement is specific to a particular type of recording interface, then "AINI", "B-ICI" or "UNI" is included in the requirement.**

3.1 PVC Inter-Network CRS

The usage information for PVC CRS includes service-independent (common) and service-specific usage information. The service-independent (common) usage information are addressed in Section 2. This usage information will indicate that the Type of Service Supported is "PVC CRS." The service-specific usage information are addressed in this section. Figure 3-1 illustrates recording for PVC CRS.

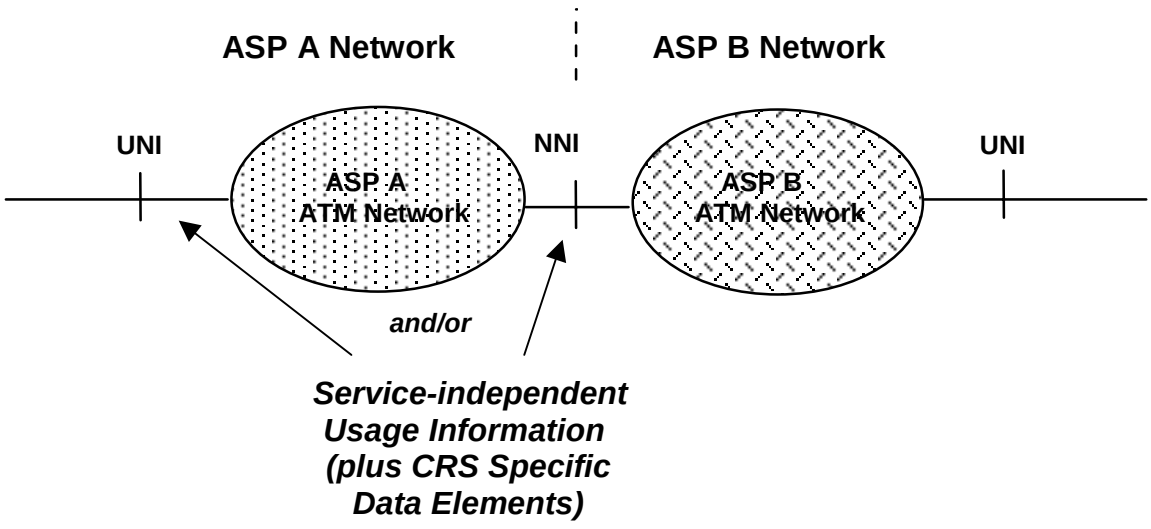

Figure 3-1 PVC CRS Usage Measurements

Figure 2-2 in Section 2 illustrates a Recording Interface and a Remote Interface for a PVC in a particular ASP network. When usage information is generated at the NNI, from the NNI's perspective, the NNI is the Recording

Interface and the UNI is the Remote Interface. When usage information is generated at the UNI, from the UNI's perspective, the UNI is the Recording Interface and the NNI is the Remote Interface. The recording of a Recording Interface Identifier is defined in Section 2.

(R) PVC-56 The generation functionality shall enable the carrier to set, via an operations interface, a Remote Interface Identifier for each PVC at the recording interface.

(R) PVC-57 The generation functionality shall record the Remote Interface Identifier for each PVC at a recording interface**.**

The Remote Interface Type is used to indicate the type of interface used at the remote interface.

(R) PVC-58 The generation functionality shall enable the ASP to set, via an operations interface, a Remote Interface Type for each ATM PVC at a recording interface. Valid values for the Remote Interface Type at the recording interface include: *ATM UNI*, *AINI*, *B-ICI*, and *PNNI*.

(R) PVC-59 The generation functionality shall record the Remote Interface Type for each PVC at a recording interface.

The Remote Connection Identifier is intended to be the VPI (for PVCs configured as Virtual Path Connections at the remote interface) or the VPI/VCI (for PVCs configured as Virtual Channel Connections at the remote interface) of the PVC.

(R) PVC-60 The generation functionality shall enable the carrier to set, via an operations interface, a Remote Connection Identifier for each PVC at the recording interface.

(R) PVC-61 The generation functionality shall record the Remote Connection Identifier for each PVC at a recording interface**.**

Usage information for point-to-multipoint CRS PVCs are for further study.

3.2 PVC Inter-Network CES

Circuit Emulation Service (CES) provides support for transporting Constant Bit Rate (CBR) signals using ATM technology. An example of this service is DS1 or DS3 circuit emulation. For usage metering purposes, CES is being provided by a provider's network if it performs the CES-ATM Inter-Working Function (IWF).

Service-independent usage information may be generated by equipment supporting the NNI or UNI for any PVC that transports CES. This usage information (as defined in Section 2), may include ingress and egress counts of cells transported on the PVC. The service-independent usage information will indicate that the Type of Service Supported is "PVC CES." Figure 3-2 illustrates recording for PVC CES.

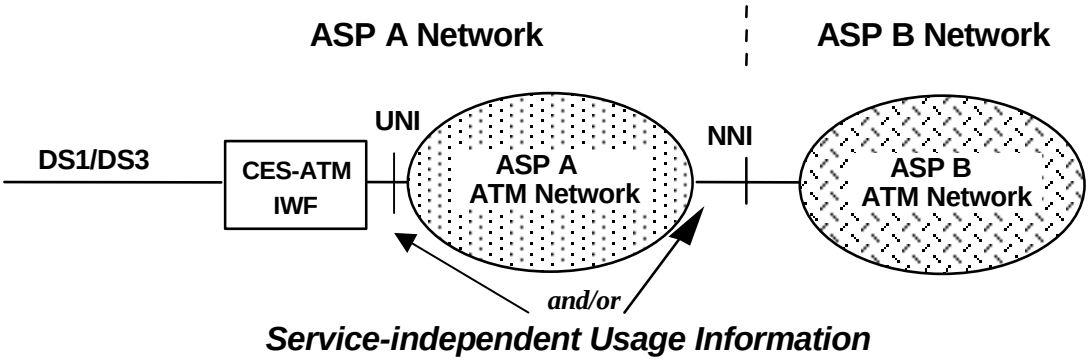

Figure 3-2 PVC CES Usage Measurements

No CES-specific usage measurement capabilities are proposed at this time for the CES-ATM IWF. The need for such usage information is for further study.

3.3 PVC Inter-Network FRS

Inter-network PVC Frame Relay Service (FRS) is a connection-oriented data transport service that provides for the bi-directional transfer of variable-length packets for LAN interconnection and terminal-host applications. For Usage Measurement purposes, PVC FRS is provided by a provider network if it performs the FRS-ATM Inter-Working Function (IWF). This section assumes one-to-one connection multiplexing (i.e., each Frame Relay logical connection [DLCI] is mapped to a single ATM VCC). Multiplexing is performed at the ATM layer using VPI/VCI.

Service-independent usage information may be generated by equipment supporting the NNI or UNI for an ATM PVC that supports FRS. This usage information (as defined in Section 2) may include ingress and egress counts of cells transported on the ATM PVC. The service-independent usage information will indicate that the Type of Service Supported is "PVC FRS." Additionally, the usage information generated by equipment supporting the NNI or UNI for an ATM PVC that supports FRS must include the following FRS-specific usage information. Figure 3-3 illustrates recording for PVC FRS.

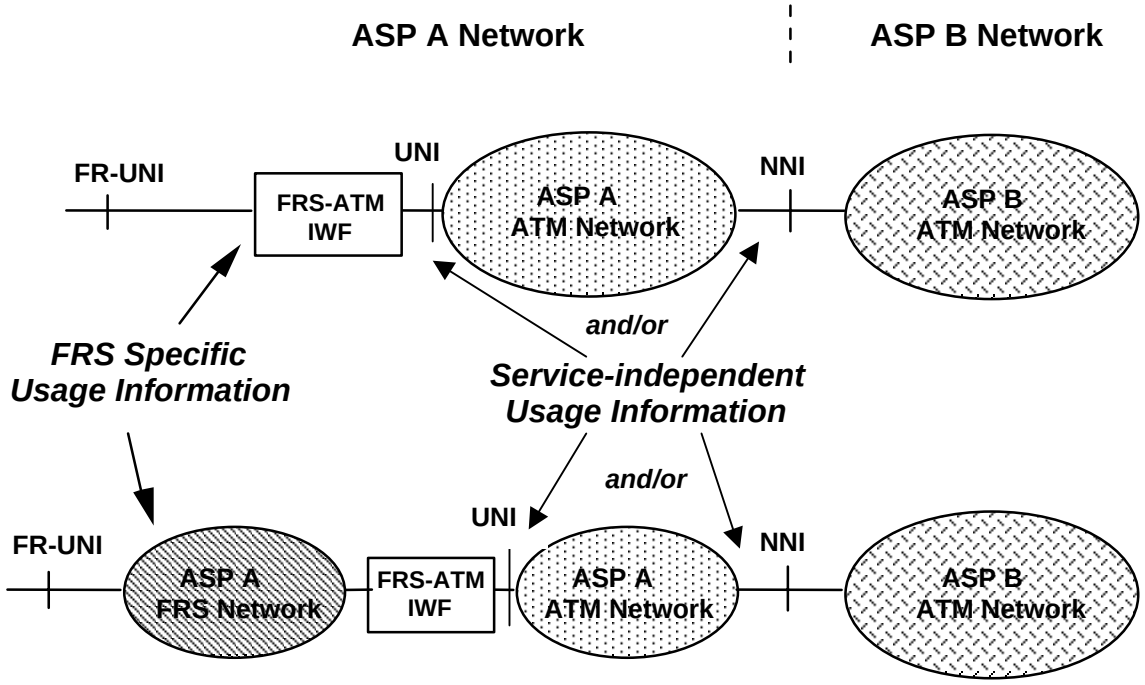

Figure 3-3 PVC FRS Usage Measurements

(R) PVC-62 The generation functionality shall enable the carrier to set, via an operations interface, a Frame Relay Interface Identifier for each ATM PVC that supports PVC FRS at the recording interface.

(R) PVC-63 The generation functionality shall record the Frame Relay Interface Identifier for each ATM PVC that supports PVC FRS at the recording interface.

For FRS PVCs supported by a Frame Relay Interface (referred to as the *FR-UNI*) connected to a provider's FRS network, it is assumed that the FRS switching equipment in the FRS network generates the FRS-specific usage information at the FR-UNI. The FRS-specific usage information is defined in Telcordia Technologies's Document [TR-TSV-001370]. For these FRS PVCs, the FRS-ATM IWF is assumed to generate no usage information.

For FRS PVCs supported by a FR-UNI directly connected to the FRS-ATM IWF, it is assumed that the FRS-ATM IWF generates the FRS-specific usage information defined in the following requirements. These requirements (except for the capability to activate or deactivate usage measurement generation) are summarized from [TR-TSV-001370].

FRS-specific usage information may be generated by the FRS-ATM IWF for each FRS PVC. The generation functionality may be activated or deactivated by the carrier via an operations interface for each FRS PVC for each recording interval.

(R) PVC-64 The generation functionality shall enable the carrier to set, via an operations interface, the FRS Usage Information Generation parameter for each FRS PVC supported by the FRS-ATM IWF. The allowable values shall be *active* and *inactive*. The default value shall be *active*.

- If the FRS Usage Information Generation is set as *active*, then the generation functionality shall generate the FRS-specific usage information for the FRS PVC during the recording interval.
- If the FRS Usage Information Generation is set as *inactive*, then the generation functionality shall ensure the FRS-specific usage information is not generated for the FRS PVC during the recording interval.

The FRS-specific usage information is defined in the following requirements, which are summarized from Telcordia Technologies's Document [TR-TSV-001370]. This usage information is generated during recording intervals. These intervals have the same characteristics as the recording intervals defined in Section 2.1.3 for the service-independent usage information. The generation functionality is assumed to be part of the FRS-ATM IWF.

For inter-network PVC FRS, the FRS-ATM IWF measures the amount of end-user data transported on each PVC in the ATM-to-FRS direction during a recording interval. End-user data include only the information payload of the frame. The headers and trailers are not considered end-user data by the usage measurement functionality. The amount of end-user data is measured in terms of *Measurement Units*. The Measurement Unit is a fixed-length unit determined jointly by the ASP and FRS-ATM IWF supplier. Example units include octets and cells.

(R) PVC-65 The generation functionality shall record the fixed-length Measurement Units used to measure the end-user data.

(R) PVC-66 During the recording interval, the generation functionality shall accumulate the number of Measurement Units of user data transported from the FRS-ATM IWF across the destination interface (FR-UNI) for each FRS PVC on the interface. The user data shall be all data in the information payload of a frame. This count is referred to as the *Received Count*.

Note that the Received Count is an egress count of the amount of user data transported in the ATM-to-FRS direction to a FR-UNI (i.e., received by the user). It includes both discard-eligible (DE = 1) and discard-ineligible (DE = 0) user data.

Each Received Count is identified by the following data elements:

- **Destination Interface Identifier:** A 16-decimal-digit number that identifies the destination interface. This identifier is provisioned for each FR-UNI. All Received Counts at a given interface are identified by the same Destination Interface Identifier.
- **Destination DLCI:** The Data Link Connection Identifier (at the destination interface) of the FRS PVC for which the Received Count is being generated. This DLCI is used to distinguish between Received Counts generated for the same destination interface. For the FRS-specific usage information generated by the FRS-ATM IWF, the destination interface is the FR-UNI.
- **Source Interface Identifier:** A 16-decimal-digit number that identifies the source interface of the PVC for which the Received Count is being generated. This identifier is provisioned separately for each FRS PVC. For the FRS-specific usage information generated by the FRS-ATM IWF, the source interface is the UNI or NNI (wherever recording is occurring in the ATM Network).

These data elements are illustrated in Figure 3-4.

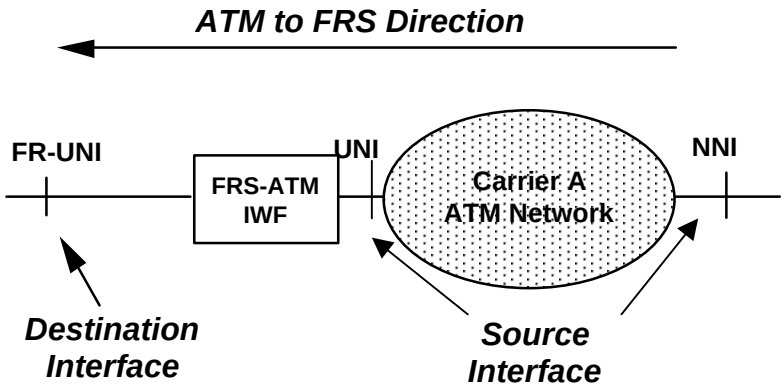

Figure 3-4 Types of Interfaces for PVC FRS Usage Measurement

It is assumed that FR-UNIs are identified by 16-decimal-digit numbers to facilitate processing of the usage information by applications.

(R) PVC-67 For the FRS-specific usage information generated by the FRS-ATM IWF, the generation functionality shall record the Destination Interface Identifier, which shall be the 16-decimal-digit memory-administrable numeric address that is associated with the terminated FR-UNI path for which the Received Count is being generated.

(R) PVC-68 The generation functionality shall enable the carrier to set, via an operations interface, a 16-decimal-digit numeric Source Interface Identifier for each FRS PVC.

(R) PVC-69 The generation functionality shall record the Source Interface Identifier for each FRS PVC.

(R) PVC-70 The generation functionality shall record the Destination DLCI for each Received Count.

Note that the PVC FRS usage information defined in Telcordia Technologies' [TR-TSV-001370] also includes the source DLCI for the FRS PVC. For the usage information generated at the FRS-ATM IWF, the source interface is the multi-service NNI. Consequently, the source DLCI is not needed.

The Remote Interface Type is used to indicate the type of interface used at the remote interface.

(R) PVC-71 The generation functionality shall enable the ASP to set, via an operations interface, a Remote Interface Type for each ATM PVC that supports PVC FRS at the recording interface. Valid values for the Remote Interface Type at the recording interface include: *ATM UNI*, *AINI*, *B-ICI*, *PNNI* and *Frame Relay UNI*.

(R) PVC-72 The generation functionality shall record the Remote Interface Type for each ATM PVC that supports PVC FRS at the recording interface.

At the end of a recording interval, the usage information is assembled and forwarded to the formatting functionality.

(R) PVC-73 At the end of the recording interval, the generation functionality shall assemble usage information for each Received Count that contains the following data elements:

- Interval Start Date
- Interval Start Time
- Interval Elapsed Time
- Source Interface Identifier
- Destination Interface Identifier

- DLCI (at the Destination Interface) of the FRS PVC for which the Received Count is being generated
- Recording Interface Type
- Measurement Unit
- Received Count.

Data formatting requirements related to the FRS-specific usage information are company-specific and beyond the scope of this specification.

3.4 SMDS

SMDS is a public packet-switched service that provides for the transfer of variable length data units at high speeds, without the need for call establishment procedures. To support SMDS, a provider may provide processing at several different levels. These levels range from point-to-point traffic transport between providers to full processing and routing of SMDS packets (e.g., ICIP_CLS PDUs) based on their packet level addresses.

Service-independent usage information may be generated by equipment supporting the NNI or UNI for any PVC that transports SMDS traffic. This usage information (as defined in Section 2) may include ingress and egress counts of cells transported on the PVC. The service-independent usage information will indicate that the Type of Service Supported is "SMDS." Figure 3-5 illustrates recording for ATM PVCs that support SMDS.

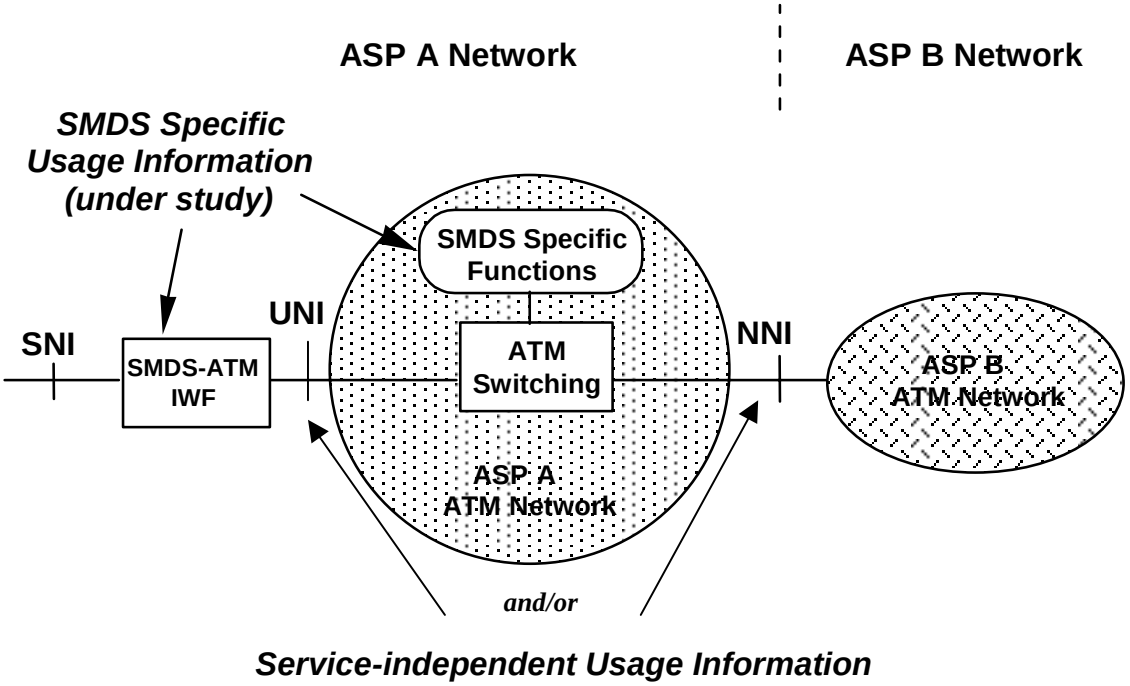

Figure 3-5 Usage Measurements for ATM PVCs Supporting SMDS

SMDS-specific usage information may be generated by the SMDS-ATM IWF or SMDS Specific Functionality. SMDS usage information is defined in Telcordia Technologies' Document [TR-TSV-001060] for the SMDS ICI. The SMDS-specific usage information is generated for SMDS Level 3 Protocol Data Units (L3_PDUs) transported between an SMDS Source Address and SMDS Destination Address. It is generated at the last point of SMDS protocol processing within the provider network (for a service-specific platform, this point is the egress interface).

The usage information includes a count of the number of L3_PDUs and L2_PDUs transported by the provider network from the source to destination during an aggregation interval. For XA-SMDS, the usage information also includes the Network Identification and the ICI Transmission Path Set to identify the interconnected carrier. Two additional data elements, the Condition Code and SNI Identifier, are used to measure partially-transmitted L3_PDUs and group addressed L3_PDUs.

SMDS-specific usage information for inter-network SMDS is under study. This includes usage measurements for both cases, SMDS-ATM IWF and the SMDS network interconnected to SMDS-ATM IWF.

4 SVC Usage Measurement

As explained in the previous section, *usage measurement* is the collection of usage information pertaining to services supported by an NNI (AINI or B-ICI), and can occur at an NNI and/or a UNI for a particular connection. Usage information is used to support billing between different network providers and for studying traffic performance characteristics at an NNI, as well as for network planning, customer network management, and marketing.

Inter-network provider billing arrangements themselves and charging principles are beyond the scope of this document.

The objective of this section is to identify a set of usage data to be collected to support SVC services providing point-to-point ATM connections. Point-to-multipoint connections are introduced in an informational appendix, see Appendix C – Point-to-Multipoint SVCs. In order to support Inter Network SVC services, each ASP will need to provide a set of usage measurement capabilities as detailed in this section.

It is the objective that all usage information generated by a Network for an Inter Network SVC be assembled as a single usage record and made available to the formatting functionality.

Figure 4-1 illustrates the usage measurement model for Inter Network SVCs. As shown, the network serving the calling party is termed the *Preceding Network*, and the network serving the called party is termed the *Succeeding Network*. These terms are defined in conformity with the definitions given in Section 6.1 of PNNI 1.0 Specification of ATM Forum [af-pnni-0055.000]. Within a network, recording of usage measurements for an Inter Network SVC could occur at a UNI and/or NNI (termed *recording interfaces* from a usage measurement perspective). Recording for an incoming SVC is termed *originating recording*, and recording for an outgoing SVC is termed *terminating recording*. Hence, in the Preceding Network, originating recording occurs at the calling party's UNI and terminating recording occurs at the NNI. Correspondingly, in the Succeeding Network, originating recording occurs at the NNI and terminating recording occurs at the called party's UNI. Cells originated by the calling party are considered to flow in the *forward direction*, and cells originated by the called party are considered to flow in the *backward direction*. As shown, from the perspective of an interface where recording is occurring, the *ingress* cell flow is towards the interface and the *egress* cell flow is away from this interface.

Figure 4-2 shows how the Usage Measurement model for Inter Network SVCs applies to individial ATM NEs within the Preceding and Succeeding Networks.

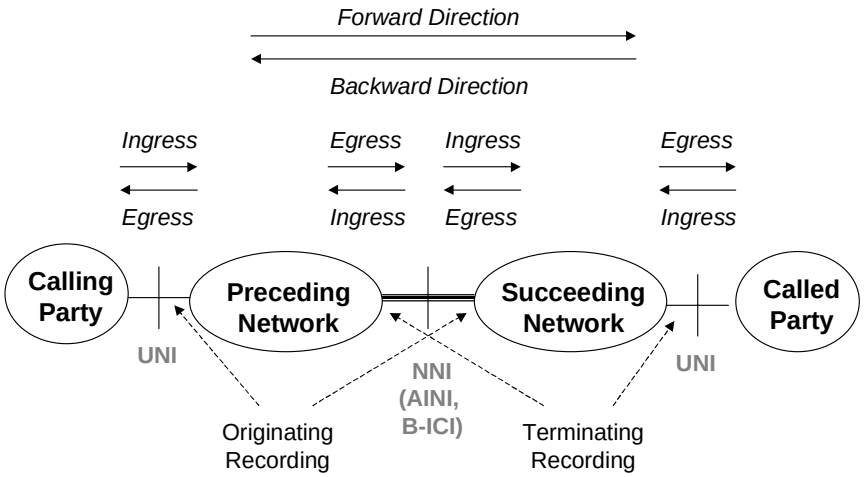

Figure 4-1 SVC Usage Measurement Reference Model – Network View

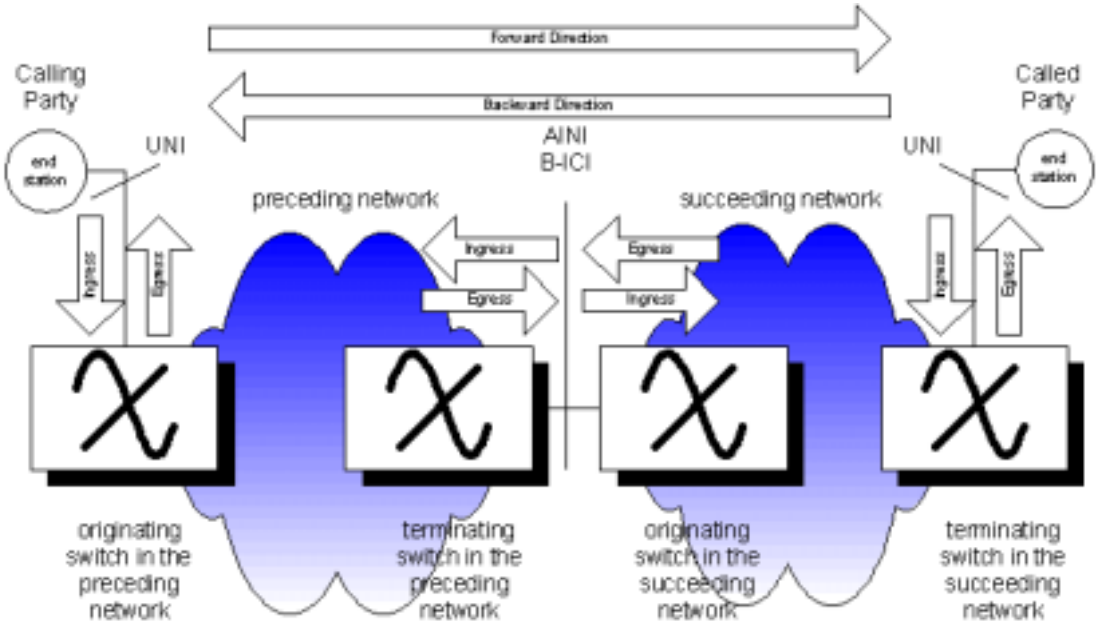

Figure 4-2 SVC Usage Measurement Reference Model – Switch View

This section is organized as follows:

- Section 4.1 defines the configuration of Usage Measurement capabilities
- Section 4.2 defines the usage information to be generated
- Section 4.3 defines the procedures for assembling usage information for forwarding to the formatting functionality

The requirements contained in Section 4 apply to both Switched Virtual Channel Connections (SVCCs) and Switched Virtual Path Connections (SVPCs), with the exception that SVPCs are not relevant at the B-ICI.

The following presentation rules apply to the requirements contained in this section:

- **When a requirement refers to a "recording interface" without further specification of the type of interface, then the requirement is meant to apply to the AINI, B-ICI and UNI.**
- **When a requirement refers to an "NNI" without further specification of the type of NNI, then the requirement is meant to apply to both the AINI and the B-ICI.**
- **When a whole requirement or a part of a requirement is specific to a particular type of recording interface, then "AINI", "B-ICI" or "UNI" is included in the requirement.**

4.1 Configuration Management

This section defines the configuration of Usage Measurement capabilities. Addressed are control of data generation and definition of recording intervals.

4.1.1 Data Generation Control

This section defines an ASP's ability to control what usage information is recorded.

4.1.1.1 Originating/Terminating Recording

An ASP is enabled to specify if originating and terminating recording are to be performed at a UNI and NNI, through the use of the Originating Recording generation parameter and Terminating Recording generation parameter.

(R) SVC-1 For Inter Network SVCs, the generation functionality shall enable the ASP to set, via an operations interface, the Originating Recording generation parameter for each recording interface. The allowable values shall be *active* and *inactive*. The default value shall be *active*.

(R) SVC-2 For Inter Network SVCs, the generation functionality shall enable the ASP to set, via an operations interface, the Terminating Recording generation parameter for each recording interface. The allowable values shall be *active* and *inactive*. The default value shall be *active*.

4.1.1.2 Service Category

An ASP is enabled to specify if usage information is to be generated for an SVC having a particular Service Category, through the use of the Service Category generation parameter.

(R) SVC-3 For Inter Network SVCs, the generation functionality shall enable the ASP to set, via an operations interface, the Service Category generation parameter for each recording interface. The allowable values shall be *active* and *inactive*. The default value shall be *active*.

4.1.1.3 Cell Counting

An ASP is enabled to specify if cell counts are to be generated for an SVC having a particular Service Category, through the use of the Cell Counting generation parameter.

(R) SVC-4 For Inter Network SVCs, the generation functionality shall enable the ASP to set, via an operations interface, the Cell Counting generation parameter for each Service Category supported by the ATM NE. The allowable values shall be *active* and *inactive*. The default value shall be *active*, for every Service Category.

4.1.1.4 Recordable Events

Sections 4.2.1.2 and 4.2.2 define various types of SVC attempts, which can be successful or unsuccessful. The ATM NE always records successful SVC attempts. Since an ASP might not bill for unsuccessful SVC attempts, recording for these SVC attempts is controlled by configuration parameters.

(R) SVC-5 For Inter Network SVCs, the generation functionality shall enable the ASP to set, via an operations interface, the Unsuccessful Originating SVC Attempt generation parameter for the ATM NE. The allowable values shall be *active* and *inactive*. The default value shall be *inactive*.

(R) SVC-6 For Inter Network SVCs, the generation functionality shall enable the ASP to set, via an operations interface, the Unsuccessful Originating Inter Network SVC Attempt generation parameter for the ATM NE. The allowable values shall be *active* and *inactive*. The default value shall be *inactive*.

(R) SVC-7 For Inter Network SVCs, the generation functionality shall enable the ASP to set, via an operations interface, the Unsuccessful Terminating SVC Attempt generation parameter for the ATM NE. The allowable values shall be *active* and *inactive*. The default value shall be *inactive*.

4.1.2 Recording Interval Definition

The ASP is enabled to define recording intervals for SVCs for each recording interface, in the same way as for PVCs. An ASP is enabled to define an *Interval Period* for each day of the week. This Interval Period applies throughout the given day. Since the first recording interval of every day begins at midnight, the allowed Interval Period values are time lengths that are divisible into 1440 minutes, with the minimum value being 30 minutes.

Sections 4.2.3 and 4.3 describe the use of recording intervals for SVCs.

(**R) SVC-8** For Inter Network SVCs, the generation functionality shall be settable for each ATM NE, via an operations interface, such that an ASP can set the Interval Period for each day of the week. The valid values for an Interval Period are: 30, 60, 90, 120, 180, 240, 360, 480, 720 and 1440 minutes.

4.2 Data Generation

This section defines the usage information to be generated for Inter Network SVCs by generation functionality in a Preceding ASP Network and Succeeding ASP Network.

4.2.1 Preceding ASP Network

This section proposes usage measurement capabilities that apply to the Preceding NetworkThe followingrequirements apply to a Preceding Network for Point-to-Point Inter Network Switched Virtual Connections (SVCs).

4.2.1.1 Data Generation Control

The generation functionality generates usage information for incoming SVCs and outgoing SVCs when the Originating Recording and Terminating Recording generation parameters are set to *active*, respectively. The configuration of these parameters is defined in Section 4.1.1.1.

(R) SVC-9 For Inter Network SVCs, when the Originating Recording generation parameter is set to *active* for a particular recording interface, the generation functionality in the Preceding Network shall generate usage information for incoming SVCs to that interface.

(R) SVC-10 For Inter Network SVCs, when the Originating Recording generation parameter is set to *inactive* for a particular recording interface, the generation functionality in the Preceding Network shall ensure that usage information is not generated for incoming SVCs to that interface.

(R) SVC-11 For Inter Network SVCs, when the Terminating Recording generation parameter is set to *active* for a particular recording interface, the generation functionality in the Preceding Network shall generate usage information for outgoing SVCs from that interface.

(R) SVC-12 For Inter Network SVCs, when the Terminating Recording generation parameter is set to *inactive* for a particular recording interface, the generation functionality in the Preceding Network shall ensure that usage information is not generated for outgoing SVCs from that interface.

The generation of usage information when the Originating Recording and Terminating Recording generation parameters are *active* is affected by the value of the relevant Service Category generation parameter.

The generation functionality generates usage information for a particular Service Category when the corresponding Service Category generation parameters is set to *active*. The configuration of this parameter is defined in Section 4.1.1.2.

(R) SVC-13 For Inter Network SVCs, when the Service Category generation parameter is set to *active* for a particular Service Category, the generation functionality in the Preceding Network shall generate usage information for SVCs having that Service Category.

(R) SVC-14 For Inter Network SVCs, when the Service Category generation parameter is set to *inactive* for a particular Service Category, the generation functionality in the Preceding Network shall ensure that usage information is not generated for SVCs having that Service Category.

The generation of usage information when a Service Category generation parameters is *active* is affected by the status of the Originating Recording and Terminating Recording generation parameters.

4.2.1.2 Recordable Events

The point at which recording for an SVC begins and ends is dictated solely by the usage information that an ATM NE is required to record, per the requirements contained herein. However, the decision on whether or not to record usage information for an ATM SVC is based on how far the SVC progresses.

For the Preceding Network, an *originating SVC attempt* is an SVC attempt for which an (end) ATM NE interface receives a SETUP message (or equivalent message) from a calling party. A *successful originating SVC attempt* is an originating SVC attempt for which the (end) ATM NE interface sends a CONNECT message (or equivalent message) to the calling party. An *unsuccessful originating SVC attempt* is an originating SVC attempt that is cleared before the (end) ATM NE interface sends a CONNECT message (or equivalent message) to the calling party.

(R) SVC-15 When the value of the Unsuccessful Originating SVC Attempt generation parameter is enabled, for Inter Network SVCs, the generation functionality in the Preceding Network shall collect usage information for unsuccessful originating SVC attempts.

For the Preceding Network, a *terminating SVC attempt* is an SVC attempt for which an ATM NE interface sends a SETUP message (or equivalent message) to a Succeeding Network. A *successful terminating SVC attempt* is a terminating SVC attempt for which the ATM NE interface receives a CONNECT message (or equivalent message) from the Succeeding Network. An *unsuccessful terminating SVC attempt* is a terminating SVC attempt that is cleared before the ATM NE interface receives a CONNECT message (or equivalent message) from the Succeeding Network.

(R) SVC-16 When the value of the Unsuccessful Terminating SVC Attempt generation parameter is *enabled*, for Inter Network SVCs, the generation functionality in the Preceding Network shall collect usage information for unsuccessful terminating SVC attempts.

4.2.1.3 Provider and Party Identification

The generation functionality records information regarding the connected ASP, calling party and called party for an SVC.

The Network Provider Identification identifies the provider on the other side of an NNI. The Network Provider Identification is configured for an interface. The Carrier Identification Code (CIC) identifies the provider to which a connection must be routed. The CIC is signaled during connection setup.

(R) SVC-17 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the identity of the ASP associated with access ("Network Provider Identification") Note: Content and format of this identifier are out of the scope of this document. They depend on the requirements of the network providers. This parameter is not part of the signaling protocol. This requirement applies when usage information is generated by the ATM NE in the Preceding Network that directly supports the NNI for the SVC.

(R) SVC-18 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the Carrier Identification Code corresponding to the Transit Network (if present) from the Transit Network Selection IE of the SETUP message associated with the SVC.

Note that if multiple Transit Networks transport the Inter Network SVC, more than one Carrier Identification Code may be needed. This issue is for further study.

(R) SVC-19 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the Calling Party associated with the SVC. The Calling Party is the address from the Calling Party Number IE of the SETUP message associated with the SVC.

(R) SVC-20 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the Default Address configured for the interface associated with the SVC in the following cases:

- When the signaled Calling Party Number is invalid
- When a Calling Party Number is not signaled.

This requirement applies when usage information is generated by the Originating ATM NE in the Preceding Network.

(R) SVC-21 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the Terminating Address for the SVC. The Terminating Address is the address from the Called Party Number IE of the SETUP message associated with the SVC.

(CR) SVC-22 For SVCs, when the Calling Party Subaddress Information Element is present, the generation functionality in the Preceding Network shall record the ATM address (in AESA format). When multiple Calling Party Subaddress IEs exist, the generation funtionality in the Preceding Network shall record all the addresses from each Calling Party Subaddress IE.

(CR) SVC-23 For SVCs, when the Called Party Subaddress Information Element is present, the generation functionality in the Preceding Network shall record the ATM address (in AESA format). When multiple Called Party Subaddress IEs exist, the generation funtionality in the Preceding Network shall record all the addresses from each Called Party Subaddress IE.

The following requirement is further explained in Section 4.4 B-ICI Specific SVC Usage Measurement, the requirement is included here for completeness.

The requirement ***(R) SVC-68*** requires the recording of Charge Number if it is signaled within BISUP signaling. Since some ASPs will use Charge Number as the definitive billing identifier, a provisioned Charge Number should be recorded even if it is not signaled. Also, a Charge Number could be provisioned independent of the use of BISUP.

(R) SVC-24 For Inter Network SVCs, the generation functionality in the Preceding Network shall record the provisioned Charge Number (if configured) for the interface associated with the SVC whenever the Charge Number is not already being recorded per **(R) SVC-68**. This requirement applies when usage information is generated by the Originating ATM NE in the Preceding Network.

4.2.1.4 Timestamps and Elapsed Times

Figure 4-3 illustrates the connection timestamps and elapsed times relevant to Inter Network SVCs. The following definitions apply for these time-related data elements from the perspective of the Preceding Network:

- For ATM NEs that directly support a UNI:
  - *Carrier Connect Date and Time*: date and time when the originating (end) ATM NE in the Preceding Network sends a SETUP message destined for the Succeeding Network for the SVC
  - *Connect Date and Time*: date and time when the originating (end) ATM NE in the Preceding Network sends a CONNECT message to the calling party for the SVC
  - *Disconnect Date and Time*: date and time when the originating (end) ATM NE in the Preceding Network sends a RELEASE message to the calling party or receives a RELEASE message from the calling party, for the SVC
- For ATM NEs that directly support an NNI:
  - *Carrier Connect Date and Time*: date and time when the Preceding Network sends a SETUP message across the NNI for the SVC
  - *Connect Date and Time*: date and time when the Preceding Network receives a CONNECT message across the NNI for the SVC
  - *Disconnect Date and Time*: date and time when the Preceding Network sends or receives a RELEASE message across the NNI for the SVC
- For all ATM NEs:
  - *Wait for Carrier Connect Elapsed Time*: duration between the Carrier Connect Date and Time and the Connect Date and Time
  - *Carrier Elapsed Time*: duration between the Carrier Connect Date and Time and the Disconnect Date and Time
  - *Elapsed Time*: duration between the Connect Date and Time and the Disconnect Date and Time

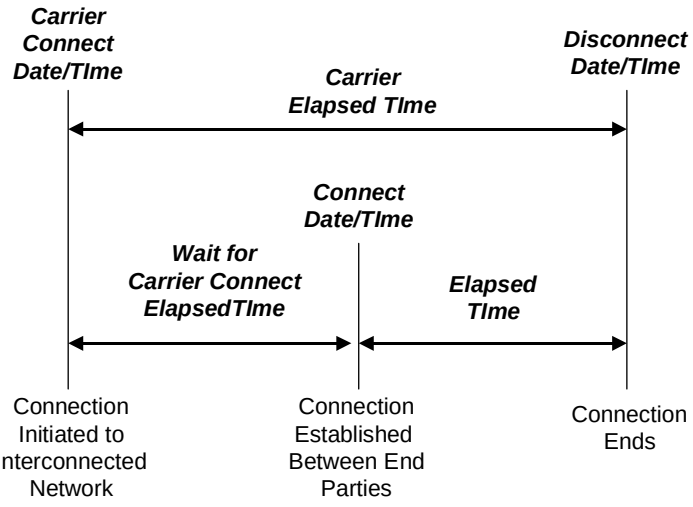

Figure 4-3 Timestamps and Elapsed Times for Inter-Network SVCs

The generation functionality records timestamps and/or elapsed times that enable the determination of time-related usage measurements.

(R) SVC-25 For Inter Network SVCs, the generation functionality in the Preceding Network shall record timestamps and/or elapsed times that enable the determination of the Carrier Connect Date and Time, Connect Date and Time, Disconnect Date and Time, Wait for Carrier Connect Elapsed Time, Carrier Elapsed Time, and Elapsed Time.

4.2.1.5 Cell Counts

Cell counts may also be generated for Inter Network SVCs. Counts are collected for a certain Service Category of the SVCs only if the ASP activates cell counting for that particular Service Category, through the use of the Cell Counting generation parameter. The configuration of this parameter is defined in Section 4.1.1.3.

(R) SVC-26 For Inter Network SVCs, when the Cell Counting generation parameter is set to *active* for a particular Service Category, the generation functionality in the Preceding Network shall collect cell counts for SVCs having that Service Category.

(R) SVC-27 For Inter Network SVCs, when the Cell Counting generation parameter is set to *inactive* for a particular Service Category, the generation functionality in the Preceding Network shall ensure that cell counts are not collected for SVCs having that Service Category.

SVC measurement is viewed from the calling party to the called party. Cells that flow from the calling party to the called party are considered forward direction cells, cells that flow from the called party to the calling party are considered backward direction cells.

Cell counts are generated in the Preceding Network. The NNI (e.g., AINI) is the ingress interface for the backward cell flow (from the Succeeding Network to the calling party), and is the egress interface for the forward cell flow (from the calling party to the Succeeding Network). The cell counts reflect only measurable cells. A *Measurable Ingress Cell* is defined as any cell received by the ASP network across the ingress interface that is not discarded by Cell Validation Procedures or Network Parameter Control (NPC) procedures. A *Measurable Egress Cell* is defined as any cell transported by the ASP network across the egress interface. If the ASP network employs egress shaping at an interface, then any cells lost or discarded by the egress shaping process are not measurable. Measurable cells do not include unassigned cells added to the user cell stream, but do include OAM cells.

(R) SVC-28 When cells are counted at a recording interface for an Inter Network SVC, the generation functionality in the Preceding Network shall count all Measurable Ingress Cells (including cells with CLP = 0 and CLP = 1) for the SVC. For the Preceding Network, this count is referred to as *Backward Total Cells* at an NNI and *Forward Total Cells* at a UNI.

(R) SVC-29 When cells are counted at a recording interface for an Inter Network SVC, the generation functionality in the Preceding Network shall count all Measurable Ingress Cells with CLP = 0 for the SVC. For the Preceding Network, this count is referred to as *Backward High Priority Cells* at an NNI and *Forward High Priority Cells* at a UNI.

(R) SVC-30 When cells are counted at a recording interface for an Inter Network SVC, the generation functionality in the Preceding Network shall count all Measurable Egress Cells (including cells with CLP = 0 and CLP = 1) for the SVC. For the Preceding Network, this count is referred to as *Forward Total Cells* at an NNI and *Backward Total Cells* at a UNI.

(R) SVC-31 When cells are counted at a recording interface for an Inter Network SVC, the generation functionality in the Preceding Network shall count all Measurable Egress Cells with CLP = 0 for the SVC. For the Preceding Network, this count is referred to as *Forward High Priority Cells* at an NNI and *Backward High Priority Cells* at a UNI.

The generation functionality also counts the number of ingress cells that were tagged, the total number of ingress cells that were discarded, and the number of high priority ingress cells that were discarded.

(R) SVC-32 When cells are counted at a recording interface for an Inter Network SVC and the UPC/NPC function is activated for the SVC, the generation functionality shall count all tagged ingress cells

with CLP = 0 for the SVC. For the Preceding Network, this count is referred to as *Backward Tagged High Priority Cells* at an NNI and *Forward Tagged High Priority Cells* at a UNI.

(R) SVC-33 When cells are counted at a recording interface for an Inter Network SVC and when the UPC/NPC function is activated for the SVC, the generation functionality shall count all discarded ingress cells (including cells with CLP = 0 and CLP = 1) for the SVC. For the Preceding Network, this count is referred to as *Backward Discarded Total Cells* at an NNI and *Forward Discarded Total Cells* at a UNI.

(R) SVC-34 When cells are counted at a recording interface for an Inter Network SVC and when the UPC/NPC function is activated for the SVC, the generation functionality shall count all discarded ingress cells with CLP = 0 for the SVC. For the Preceding Network, this count is referred to as *Backward Discarded High Priority Cells* at an NNI and *Forward Discarded High Priority Cells* at a UNI.

4.2.1.6 Frame Counts

This section addresses the counting of AAL frames in the ingress and egress directions for an SVC. A main driver behind counting AAL frames is to support recording for the use of TCP/IP. Only AAL types that use the "end of frame" bit in the ATM cell header (e.g., AAL5) are addressed.

It is desirable to count the number of ingress AAL frames and the number of discarded ingress AAL frames.

(O) SVC-35 The generation functionality may count all ingress AAL frames for the SVC. For the Preceding Network, this count is referred to as *Backward AAL Frames* at an NNI and *Forward AAL Frames* at a UNI.

(O) SVC-36 The generation functionality may count all discarded ingress AAL frames for the SVC. For the Preceding Network, this count is referred to as *Backward Discarded AAL Frames* at an NNI and *Forward Discarded AAL Frames* at a UNI.

It is desirable to count the number of egress AAL frames.

(O) SVC-37 The generation functionality may count all egress AAL frames for the SVC. For the Preceding Network, this count is referred to as *Forward AAL Frames* at an NNI and *Backward AAL Frames* at a UNI.

4.2.1.7 Traffic Parameters

Several traffic parameters are recorded by the generation functionality for an SVC. These traffic parameters are defined in the ATM Forum's Traffic Management Specification, Version 4.0 [af-tm-0056.000].

(R) SVC-38 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the following subfields in the Broadband Bearer Capability IE from the SETUP message associated with the SVC:

- Bearer Class
- ATM Transfer Capability
- Susceptibility to Clipping
- User Plane Connection Configuration

(R) SVC-39 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the QoS Class Forward and QoS Class Backward subfields in the Quality of Service IE from the SETUP message associated with the SVC, if present.

(R) SVC-40 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the following traffic parameters from the corresponding subfields in the Extended Quality of Service IE from the SETUP message associated with the SVC , if present:

- Forward Acceptable Peak-to-Peak Cell Delay Variation

- Forward Acceptable Cell Loss Ratio
- Backward Acceptable Peak-to-Peak Cell Delay Variation
- Backward Acceptable Cell Loss Ratio

Requirements **(R) SVC-41** through **(R) SVC-44** use information from the ATM Traffic Descriptor IE. The ATM Traffic Descriptor IE can be retrieved from either the SETUP message or the CONNECT message. If the ATM Traffic Descriptor IE is present in the CONNECT message, then that information should be used instead of the ATM Traffic Descriptor IE from the SETUP message. Please see section 8.3.3 of the UNI 4.0 specification [af-sig-0061.000] for an explanation of the connection negotiation confirmation procedure.

(R) SVC-41 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the Best Effort Indicator from the corresponding subfield in the ATM Traffic Descriptor IE from the CONNECT message associated with the SVC (if present), otherwise from the corresponding subfield in the ATM Traffic Descriptor IE from the SETUP message associated with the SVC (if present).

(R) SVC-42 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the Tagging Indicator Forward and the Tagging Indicator Backward from the corresponding subfields in the ATM Traffic Descriptor IE from the CONNECT message associated with the SVC (if present), otherwise from the corresponding subfields in the ATM Traffic Descriptor IE from the SETUP message associated with the SVC (if present).

(R) SVC-43 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the following traffic parameters from the corresponding subfields in the ATM Traffic Descriptor IE from the CONNECT message associated with the SVC (if present), otherwise from the corresponding subfields in the ATM Traffic Descriptor IE from the SETUP message associated with the SVC (if present):

- Forward Peak Cell Rate (CLP = 0+1)
- Forward Peak Cell Rate (CLP = 0)
- Forward Sustainable Cell Rate (CLP = 0+1)
- Forward Sustainable Cell Rate (CLP = 0)
- Forward Maximum Burst Size (CLP = 0+1)
- Forward Maximum Burst Size (CLP = 0)
- Forward Minimum Cell Rate
- Forward Maximum Frame Size

(R) SVC-44 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the following traffic parameters from the corresponding subfields in the ATM Traffic Descriptor IE from the CONNECT message associated with the SVC (if present), otherwise from the corresponding subfields in the ATM Traffic Descriptor IE from the SETUP message associated with the SVC (if present):

- Backward Peak Cell Rate (CLP = 0+1)
- Backward Peak Cell Rate (CLP = 0)
- Backward Sustainable Cell Rate (CLP = 0+1)
- Backward Sustainable Cell Rate (CLP = 0)
- Backward Maximum Burst Size (CLP = 0+1)
- Backward Maximum Burst Size (CLP = 0)

- Backward Minimum Cell Rate
- Backward Maximum Frame Size

NOTE: There is some overlap between the measured parameters in the two requirements above and certain requirements in [af-nm-0020.001]. The emphasis here is, however, on exchange of information between networks.

(R) SVC-45 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the following traffic parameters from the corresponding subfields in the End-to-End Transit Delay IE from the SETUP message associated with the SVC, if present:

- Forward Maximum End-to-End Transit Delay
- Backward Maximum End-to-End Transit Delay

The type of connection (VC or VP) is recorded for each SVC.

(R) SVC-46 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording whether an SVC is a Virtual Channel or a Virtual Path. This is referred to as the *Connection Type*.

A unique identifier of an SVC is recorded to enable correlation of multiple usage records produced for the SVC.

(CR) SVC-47 If the signaling protocol being used for Inter Network SVCs supports the Network Call Correlation Identifier (NCCI), the generation functionality in the Preceding Network shall be capable of recording the NCCI associated with the SVC, when the NCCI is present.

If an NCCI is not present for an ATM SVC, the ATM NE must record other information that uniquely identifies the connection (e.g., the VC identity [interface identifier, VPI and VCI] or VP identity [interface identifier, VPI]).

(R) SVC-48 For Inter Network SVCs, if the NCCI is not present for an ATM SVC, the generation functionality in the Preceding Network shall be capable of recording a unique identifier of the SVC.

(R) SVC-49 For Inter Network SVCs, the generation functionality in the Preceding Network shall be capable of recording the Cause Value subfield from the Cause IE from the RELEASE or RELEASE COMPLETE messages associated with the SVC.

4.2.2 Succeeding ASP Network

This section proposes usage measurement capabilities that apply to the Succeeding Network. The following requirements apply to a Succeeding Network for Point-to-Point Inter Network Switched Virtual Connections (SVCs).

The usage information required to be generated in the Succeeding Network is the same of the usage information required to be generated in the Preceding Network. In a few cases, the definition of the data elements is different from the perspective of the Succeeding Network. Hence, for most usage information generated by the generation functionality in the Succeeding Network, this section references requirements contained in Section 4.2.1.

(R) SVC-50 For Inter Network SVCs, the generation functionality in the Succeeding Network shall perform data generation in accordance with **(R) SVC-9** through **(R) SVC-49**, with the following exceptions:

- **(R) SVC-53** applies
- **(O) SVC-54** applies
- **(R) SVC-20** does not apply
- **(R) SVC-24** does not apply
- **(R) SVC-15** and **(R) SVC-16** are replaced with **(R) SVC-51** and **(R) SVC-52.**

4.2.2.1 Recordable Events

The point at which recording for an SVC begins and ends is dictated soley by the usage information that an ATM NE is required to record, per the requirements contained herein. However, the decision on whether or not to record usage information for an ATM SVC is based on how far the SVC progresses.

For the Succeeding Network, an *originating SVC attempt* is an SVC attempt for which an ATM NE interface receives a SETUP message (or equivalent message) from a Preceding Network. A *successful originating SVC attempt* is an originating SVC attempt for which the ATM NE interface sends a CONNECT message (or equivalent message) to the Preceding Network. An *unsuccessful originating SVC attempt* is an originating SVC attempt that is cleared before the ATM NE interface sends a CONNECT message (or equivalent message) to the Preceding Network.

(R) SVC-51 When the value of the Unsuccessful Originating SVC Attempt generation parameter is *enabled*, for Inter Network SVCs, the generation functionality in the Succeeding Network shall collect usage information for unsuccessful originating SVC attempts.

For the Succeeding Network, a *terminating SVC attempt* is an SVC attempt for which an ATM NE interface sends a SETUP message (or equivalent message) to a called party. A *successful terminating SVC attempt* is a terminating SVC attempt for which the ATM NE interface receives a CONNECT message (or equivalent message) from the called party. An *unsuccessful terminating SVC attempt* is a terminating SVC attempt that is cleared before the ATM NE interface receives a CONNECT message (or equivalent message) from the called party.

(R) SVC-52 When the value of the Unsuccessful Terminating SVC Attempt generation parameter is *enabled*, for Inter Network SVCs, the generation functionality in the Succeeding Network shall collect usage information for unsuccessful terminating SVC attempts.

4.2.2.2 Cell Counts

SVC measurement is viewed from the calling party to the called party. Cells that flow from the calling party to the called party are considered forward direction cells, cells that flow from the called party to the calling party are considered backward direction cells. The Preceeding Network is the network that serves the calling party and the Succeeding Network serves the called party. The calling party is connected to the Preceeding Network at the UNI and the Preceeding Network is connected to the Succeeding Network over the NNI. The called party is connected to the Succeeding Network over the UNI. Cell counts are collected as they enter the network. Cells in the Preceeding Network in the forward direction enter at the UNI and cells in the backward direction enter at the NNI. In the Succeeding Network the definitions are reversed. Cells in the forward direction enter the Succeeding Network at the NNI and cells in the backward direction enter the Succeeding Network at the UNI.

(R) SVC-53 The generation functionality in the Succeeding Network shall record cell counts for Inter Network SVCs as specified by **(R) SVC-28** through **(R) SVC-34**, where the following definitions apply to the Succeeding Network:

- The count in **(R) SVC-28** is referred to as the *Forward Total Cells* for the NNI *and Backward Total Cells* for the UNI.
- The count in **(R) SVC-29** is referred to as the *Forward High Priority Cells* for the NNI and *Backward High Priority Cells* for the UNI.
- The count in **(R) SVC-30** is referred to as the *Backward Total Cells* for the NNI *and Forward Total Cells* for the UNI.
- The count in **(R) SVC-31** is referred to as the *Backward High Priority Cells* for the NNI and *Forward High Priority Cells* for the UNI.
- The count in **(R) SVC-32** is referred to as the *Forward Tagged High Priority Cells* for the NNI and *Backward Tagged High Priority Cells* for the UNI.
- The count in **(R) SVC-33** is referred to as the *Forward Discarded Total Cells* for the NNI and *Backward Discarded Total Cells* for the UNI.

- The count in **(R) SVC-34** is referred to as the *Forward Discarded High Priority Cells* for the NNI and *Backward Discarded High Priority Cells* for the UNI.

4.2.2.3 Frame Counts

The names of frame counts differ from the names used for the Preceding Network.

(O) SVC-54 The generation functionality in the Succeeding Network shall record frame counts for Inter Network SVCs as specified by **(O) SVC-35** through **(O) SVC-37**, where the following definitions apply to the Succeeding Network:

- The count in **(O) SVC-35** is referred to as the *Forward AAL Frames* for the NNI *and Backward AAL Frames* for the UNI.
- The count in **(O) SVC-36** is referred to as the *Forward Discarded AAL Frames* for the NNI and *Backward Discarded AAL Frames* for the UNI.
- The count in **(O) SVC-37** is referred to as the *Backward AAL Frames* for the NNI *and Forward AAL Frames* for the UNI.

4.2.2.4 Timestamps and Elapsed Times

Pertaining to **(R) SVC-25**, the following definitions for the time-related data elements are different for the Succeeding Network (Figure 4-3 Timestamps and Elapsed Times for Inter-Network SVCs illustrates these timestamps):

- For ATM NEs that directly support a UNI:
  - *Carrier Connect Date and Time*: date and time when the terminating (end) ATM NE in the Succeeding Network receives a SETUP message for the SVC
  - *Connect Date and Time*: date and time when the terminating (end) ATM NE in the Succeeding Network receives a CONNECT message from the called party for the SVC
  - *Disconnect Date and Time*: date and time when the terminating (end) ATM NE in the Succeeding Network sends a RELEASE message to the called party or receives a RELEASE message from the called party, for the SVC
- For ATM NEs that directly support an NNI:
  - *Carrier Connect Date and Time*: date and time when the Succeeding Network receives a SETUP message across the NNI for the SVC
  - *Connect Date and Time*: date and time when the Succeeding Network receives a CONNECT message originated by the called party for the SVC

4.2.3 Recording Intervals

Usage information for SVCs is generated and assembled for formatting based on recording intervals, using the approach employed for PVCs (see detailed description in Section 2.3.1). During a recording interval, usage information is recorded for each SVC at the recording interface for which usage information generation is active. Usage information is sent to the formatting functionality at the end of each recording interval and at the termination of the SVC. At the end of the first recording interval relevant to the SVC (if any), the generated usage information represents the duration of the SVC from the start of the connection until the end of the recording interval. The usage information generated at disconnect represents the duration of the SVC from the start of the connection (if the end of a recording interval was not encountered during a connection) or the end of the previous recording interval until the termination of the connection.

When assembling usage information pertaining to elapsed times (e.g., Carrier Elapsed Time) or cell counts, the generation functionality only reflects the portion of elapsed time and cell counts pertaining to the duration of the

connection for which usage information is being assembled. For example, if the Carrier Connect Time for an SVC is 2:40:00.0, the Disconnect Time is 3:10:00.0 and the recording intervals begin each hour, the usage information assembled at 2:59:59.9 (scheduled closing) would indicate a Carrier Elapsed Time of 19minutes/59 seconds/9 tenths of second, and the usage information assembled at 3:10:00.0 (termination of connection) would indicate a Carrier Elapsed Time of 10 minutes/0 seconds/0 tenths of second.

(R) SVC-55 For Inter Network SVCs, the generation functionality shall record an elapsed time such that the elapsed time only pertains to the portion of the connection for which usage information is being assembled.

(R) SVC-56 For Inter Network SVCs, the generation functionality shall record a cell count such that the cell count only pertains to the portion of the connection for which usage information is being assembled.

As for PVCs, the generation functionality manages recording interval information.

(R) SVC-57 For Inter Network SVCs, the generation functionality shall record for each recording interval an Interval Start Date, an Interval Start Time, and an Interval Elapsed Time, as defined below.

- The *Interval Start Date* and *Interval Start Time* shall contain the date and time of day that the recording interval begins.
- The *Interval Elapsed Time* shall contain the length of the recording interval.

The Interval Start Time shall be recordable in hours, minutes, seconds, and tenths of seconds. The Interval Elapsed Time shall be recordable in minutes, seconds, and tenths of seconds.

(R) SVC-58 For Inter Network SVCs, to support recording intervals, the generation functionality shall have access to a duration timer and a date and time-of-day clock that conform to the following timing accuracy standards:

- The accuracy objective for the Interval Start Time and Interval Start Date is ± 1 second of the actual start of the recording interval.
- The Interval Elapsed Time should not be overstated.
- The accuracy objective for the Interval Elapsed Time should be + 0 seconds to - 0.1 seconds.

(R) SVC-59 For Inter Network SVCs, the generation functionality shall ensure that recording intervals cover all time during a day and that the intervals do not overlap. A recording interval shall include its Interval Start Time and exclude the Interval Start Time of the next recording interval.

(R) SVC-60 For Inter Network SVCs, the generation functionality shall ensure that the first recording interval of a given day begins at 0:00:00.0.

The requirements contained in this section applies to the generation functionality in both the Preceding Network and Succeeding Network.

4.3 Data Assembly

Usage information is assembled for the SVCs at a recording interface upon occurrence of the following events:

- Scheduled closing of a recording interval
- Unscheduled closing of a recording interval
- Termination of the connection

Each of these events is addressed below.

The data elements recorded for SVCs, and therefore to be assembled for SVCs, are summarized in Appendix A. The generation of these data elements is defined in Section 4.2.

4.3.1 Scheduled Closings

Usage information is assembled at the scheduled closing of each recording interval for each active SVC at a recording interface. The scheduled closing for a recording interval is at the end of the Interval Period. For instance, if the Interval Period is 30 minutes, the first recording interval for the day will have an Interval Start Time of 0:00:00.0, an Interval Elapsed Time of 30 minutes, and a scheduled closing at 0:29:59.9. At the scheduled closing, the usage information is sent to the formatting functionality. The usage information assembled for each SVC is defined in Section 4.2.

(R) SVC-61 For Inter Network SVCs, at the scheduled closing of each recording interval, the generation functionality shall assemble the usage information collected for each SVC at the recording interface and send it to the formatting functionality.

4.3.2 Unscheduled Closings

Abnormal recording intervals occur when the interval does not begin at a scheduled start time or does not end at the scheduled closing. Requirements on the generation functionality associated with abnormal recording intervals are described below.

It is likely that the usage measurement functionality will not be enabled (i.e., the ATM Network Element put into live service) exactly at the start of a scheduled recording interval. In other words, the service may have been turned on but usage measurement may not have been enabled. The date and time at which the usage measurement functionality is enabled are referred to as the *enabled date and time.*

(R) SVC-62 For Inter Network SVCs, when the usage measurement functionality is enabled, the generation functionality shall create a recording interval with an Interval Start Date and Time equal to this enabled date and time.

The Interval Elapsed Time of this recording interval shall include all time up to, but not including, the Interval Start Time of the next scheduled recording interval.

The generation functionality shall indicate this occurrence to the formatting functionality.

For example, if the usage measurement functionality is enabled at 10:05 AM and the next scheduled recording interval starts at 11:00 AM, a recording interval is created with an Interval Start Time of 10:05:00.0 and an Interval Elapsed Time of 55:00.0.

In some instances, the generation functionality experiences an unscheduled closing. Unscheduled closings can occur when memory is near exhaustion or after a system failure. Two types of unscheduled closings may occur: (1) those that affect the usage information for all SVCs at the recording interface, or (2) those that affect the usage information associated with only one or a subset of SVCs at the recording interface.

In both cases, the treatment is to end the recording interval for the affected SVC at the recording interface and to start a new recording interval for the affected SVCs. This treatment helps replenish memory if it is near exhaustion and indicates that counts for the interval may be in error.

(R) SVC-63 For Inter Network SVCs, the generation functionality shall perform an unscheduled closing of a recording interval associated with a SVC at the recording interface in any of the following situations:

- When memory usage by the usage measurement functionality reaches the Usage Measurement Memory Exhaustion Threshold which implies unscheduled closings for recording intervals for all SVCs at the recording interface.
- When any counter associated with a SVC at the recording interface reaches the usage information Cell Count Overflow Threshold which implies an unscheduled closing only for the recording interval associated with that SVC at the recording interface.
- When the usage measurement functionality is restored after a failure which implies unscheduled closings for recording intervals for all SVCs at the recording interface.

Note that if a single count for a SVC at the recording interface reaches the Cell Count Overflow Threshold (situation #2 in the **(R) SVC-63** above), the unscheduled closing applies to all counts that are being generated for that SVC at the recording interface. For example, if both the Forward Total Cells and Forward High Priority Cells are being collected for the SVC and the Forward Total Cells reaches the Cell Count Overflow Threshold, both counts are assembled and sent to the formatting functionality.

(R) SVC-64 For Inter Network SVCs, when the generation functionality determines that an unscheduled closing will occur for a recording interval, it shall:

- Change the Interval Elapsed Time to the elapsed time between the original Interval Start Time and the time at which the unscheduled closing occurs.
- Assemble the usage information for all affected SVCs at the recording interface.
- Send assembled usage information to the formatting functionality.
- Indicate the reason for the unscheduled closing to the formatting functionality.

(R) SVC-65 For Inter Network SVCs, after an unscheduled closing, the generation functionality shall create a new recording interval for the affected SVCs at the recording interface.

The Interval Start Date and Time of the new recording interval shall be the date and time of the unscheduled closing of the original recording interval.

The Interval Elapsed Time of the new recording interval shall be the elapsed time between the time that the unscheduled closing of the original recording occurred and the start time of the next scheduled recording interval.

Unscheduled closing of a recording interval must not result in the loss of recorded data.

Since usage information created for the new recording interval described in the above requirement results from an unscheduled closing, it is not associated with a scheduled recording interval. The usage information indicates that the recording interval is abnormal.

(R) SVC-66 For Inter Network SVCs, the generation functionality shall indicate to the formatting functionality that it created a new recording interval.

The usage information assembled for each SVC is defined in Section 4.2.

4.3.3 Connection Termination

Usage information is assembled at the termination of a connection. The usage information assembled for each SVC is defined in Sections 4.2.

(R) SVC-67 For Inter Network SVCs, at the termination of an SVC, the generation functionality shall assemble the usage information collected for the SVC since either the previous closing (if a closing has occurred since the connection began) or the beginning of the connection (if a closing has not occurred since the connection began), and send it to the formatting functionality.

4.4 B-ICI Specific SVC Usage Measurement

The requirements in this section are specific to the B-ICI.

The Charge Number is recorded from BISUP signaling (when present) to support charging to an account identified other than by the Calling Party Number.

(R) SVC-68 For the B-ICI, for Inter Network SVCs, in North American Networks, the generation functionality in the Preceding Network shall be capable of recording the Charge Number associated with the SVC. The Charge Number is the Address Digits from the Charge Number parameter (when present) from the IAM associated with the SVC.

Originating Line Information Parameter (OLIP) is recorded from BISUP signaling (when present) to capture information about special types of originating interfaces.

(R) SVC-69 For the B-ICI, for Inter Network SVCs, in North American Networks, the generation functionality in the Preceding Network shall be capable of recording Originating Line Information Parameter (OLIP) (when present) from the IAM associated with the SVC.

The requirement **(R) SVC-69** requires the recording of OLIP if it is signaled within BISUP signaling. A provisioned OLIP should be recorded even if it is not signaled. OLIP is specific to BISUP.

(R) SVC-70 For BISUP signaling, for Inter Network SVCs, in North American Networks, the generation functionality in the Preceding Network shall record the provisioned Originating Line Information Parameter (if configured) for the interface associated with the SVC whenever OLIP is not already being recorded per **(R) SVC-69**. This requirement applies when usage information is generated by the Originating ATM NE in the Preceding Network.

The Outgoing Facility Identifier identifies the facility over which connections are carried between networks.

(R) SVC-71 For the B-ICI, for Inter Network SVCs, in North American Networks, the generation functionality in the Preceding Network shall be capable of recording the Outgoing Facility Identifier for the SVC.

The Outgoing Facility Identifier for the SVC includes the Signaling Point Code of the Intermediate ATM NE in the Succeeding Network and the VPCI which transports the ATM SVC between the Preceding and Succeeding Networks. At the Originating ATM NE in the Preceding Network, the Outgoing Facility Identifier is recorded from the EXM associated with the SVC. At the Intermediate ATM Switch in the Preceding Network, the Outgoing Facility Identifier is determined by the ATM NE from internal processes.

The signaled Charge Number and OLIP also apply to the Succeeding Network.

(R) SVC-72 For the B-ICI, for Inter Network SVCs, in North American Networks, the generation functionality in the Succeeding Network shall perform data generation in accordance with **(R) SVC-68** and **(R) SVC-69**.

(R) SVC-73 For the B-ICI, for Inter Network SVCs, in North American Networks, the generation functionality in the Succeeding Network shall be capable of recording the Incoming Facility Identifier for the SVC.

The Incoming Facility Identifier for the SVC includes the Signaling Point Code of the Intermediate ATM NE in the Preceding Network and the VPCI which transports the ATM SVC between the Preceding and Succeeding Networks.

At the Intermediate ATM NE in the Succeeding Network, the Incoming Facility Identifier is determined by the ATM NE from internal processes. Determining the Incoming Facility Identifier at the Terminating ATM NE in the Succeeding Network requires further study.

5 SPVC Usage Measurement

Usage measurement is performed for Soft PVCs (SPVCs) using a combination of the usage measurement procedures used for PVCs (as defined in Sections 2 and 3) and the usage measurement procedures used for SVCs (as defined in Section 4). Please refer to Appendix B – Requirement Validity for SPVCs for details on the PVC and SVC requirements that are applicable to SPVCs. Figure 5-1 illustrates the architecture for an SPVC. From a usage measurement perspective, the SPVC is treated as a PVC at the *Originating Interface* and *Terminating Interface* (i.e., at the UNIs), and as an SVC at the NNI (i.e., AINI or B-ICI).

The SPVC could span multiple networks as a pure SPVC (i.e., the SPVC is an SVC at the NNI) or could have SVC characteristics only within a given network (i.e., the SPVC is a PVC at the NNI). Figure 5-1 illustrates the first case.

Usage information is recorded at the boundary(ies) of a network. From the perspective of an ATM NE that is performing Usage Measurement, the interface for which recording is being performed is considered the *Recording Interface*, and the interface at the other side of the ***same network*** (i.e., ***not*** at the other side of the SPVC) is considered the *Remote Interface*. For example, in Figure 5-1, from the perspective of Node A and in the context of the recording being performed at the Originating Interface, the Recording Interface is the Originating Interface and the Remote Interface is the Inter Network Interface to Network B.

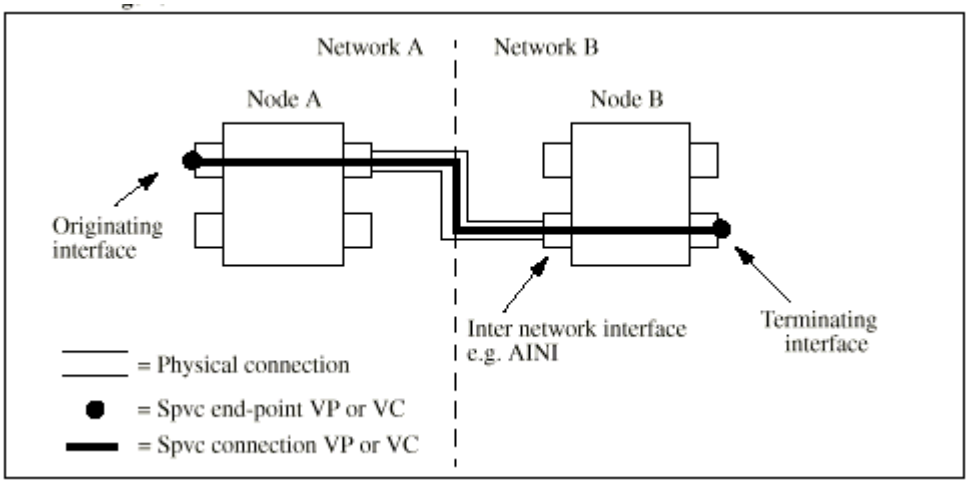

Figure 5-1 SPVC Usage Measurement Reference Model

The requirements contained in Section 5 apply to both Soft Permanent Virtual Channel Connections (SPVCCs) and Soft Permanent Virtual Path Connections (SPVPCs), with the exception that SPVPCs are not relevant at the B-ICI.

The following presentation rules apply to the requirements contained in this section:

- **When a requirement refers to a "recording interface" without further specification of the type of interface, then the requirement is meant to apply to the AINI, B-ICI and UNI.**
- **When a requirement refers to an "NNI" without further specification of the type of NNI, then the requirement is meant to apply to both the AINI and the B-ICI.**
- **When a whole requirement or a part of a requirement is specific to a particular type of recording interface, then "AINI", "B-ICI" or "UNI" is included in the requirement.**

5.1 Existing PVC Usage Measurements

Most of the PVC Usage Measurement requirements defined in Sections 2 and 3 apply to SPVCs at the UNIs. Table B-1 of Appendix B presents the relevance of these requirements to SPVCs.

(R) SPVC-1 For Inter Network SPVCs, the generation functionality supporting an Originating Interface shall perform Usage Measurement for the SPVC in accordance with the procedures defined in the PVC requirements that are indicated in Table B-1 of Appendix B as being valid for the Originating Interface.

(R) SPVC-2 For Inter Network SPVCs, the generation functionality supporting a Terminating Interface shall perform Usage Measurement for the SPVC in accordance with the procedures defined in the PVC requirements that are indicated in Table B-1 of Appendix B as being valid for the Terminating Interface.

Additional capabilities (beyond the capabilities defined in the PVC Usage Measurement requirements) are needed for SPVCs at the Originating Interface and Terminating Interface.

5.2 Existing SVC Usage Measurements

Most of the SVC Usage Measurement requirements defined in Section 4 apply to SPVCs at the NNI. Table B-1 of Appendix B presents the relevance of these requirements to SPVCs.

(R) SPVC-3 For Inter Network SPVCs, the generation functionality supporting an NNI shall perform Usage Measurement for the SPVC in accordance with the procedures defined in the SVC requirements that are indicated in Table B-1 of Appendix B as being valid for the NNI.

5.3 SPVC-Specific Usage Measurements

There are additional requirements necessary to achieve a complete Usage Measurement solution for SPVCs.

(**R) SPVC-4** For Inter Network SPVCs, the generation functionality shall be settable for each ATM NE, via an operations interface, such that an ASP can set the Interval Period for each day of the week. The valid values for an Interval Period are: 30, 60, 90, 120, 180, 240, 360, 480, 720 and 1440 minutes.

(R) SPVC-5 For Inter Network SPVCs, the generation functionality supporting an Originating Interface shall be capable of recording the Calling Party Number of the SPVC. The Calling Party Number is the address from the Calling Party Number IE of the SETUP message associated with the SPVC.

(R) SPVC-6 For Inter Network SPVCs, the generation functionality supporting an Originating Interface shall be capable of recording the Terminating Address of the SPVC. The Terminating Address is the address from the Called Party Number IE of the SETUP message associated with the SPVC.

(R) SPVC-7 For Inter Network SPVCs, the generation functionality supporting an Originating Interface shall be capable of recording the Remote Connection Identifier of the SPVC as given by the VPI (and VCI) in the Called Party Soft PVPC or PVCC Information Element (if present). If the Called Party Soft PVPC or PVCC Information Element is not present, **(R) PVC-60 & (R) PVC-61** shall apply.

(R) SPVC-8 For Inter Network SPVCs, the generation functionality supporting an Originating Interface shall record timestamps and/or elapsed times that enable the determination of the Carrier Connect Date and Time, Connect Date and Time, Disconnect Date and Time, Wait for Carrier Connect Elapsed Time, Carrier Elapsed Time, and Elapsed Time, using the definitions of these timing data elements contained in Section 4.2.1.4.

(R) SPVC-9 For Inter Network SPVCs, the generation functionality supporting an Originating Interface shall be capable of recording traffic parameters as defined in **(R) SVC-38** to **(R) SVC-45**.

(R) SPVC-10 For Inter Network SPVCs, the generation functionality supporting an Originating Interface shall be capable of recording the Cause Value received at the release of the SPVC. The Cause Value is

obtained from the Cause Value subfield of the Cause IE of the RELEASE or RELEASE COMPLETE message associated with the SPVC.

(R) SPVC-11 For Inter Network SPVCs, the generation functionality supporting an Originating Interface shall be capable of recording the Network Call Correlation Identifier (NCCI) associated with the SPVC, when the NCCI is present.

(R) SPVC-12 For Inter Network SPVCs, the generation functionality supporting an Originating Interface shall perform an unscheduled closing when an SPVC is released due to a network failure or other problem.

(R) SPVC-13 For Inter Network SPVCs, the generation functionality supporting a Terminating Interface shall perform data generation in accordance with **(R) SPVC-5, (R) SPVC-6**, and **(R) SPVC-9** through **(R) SPVC-12**.

(R) SPVC-14 For Inter Network SPVCs, the generation functionality supporting a Terminating Interface shall record timestamps and/or elapsed times that enable the determination of the Carrier Connect Date and Time, Connect Date and Time, Disconnect Date and Time, Wait for Carrier Connect Elapsed Time, Carrier Elapsed Time, and Elapsed Time, using the definitions of these timing data elements contained in Sections 4.2.1.4 and 4.2.2.

(R) SPVC-15 For Inter Network SPVCs, the generation functionality supporting a Terminating Interface shall be capable of recording the Remote Connection Identifier of the SPVC as given by the VPI (and VCI) in the Calling Party Soft PVPC or PVCC Information Element (if present). If the Calling Party Soft PVPC or PVCC Information Element is not present, **(R) PVC-60 & (R) PVC-61**shall apply.

6 SVC Usage Measurements for Traffic Engineering and Performance Management

The requirements in this section support performance management, including traffic engineering, for SVCs. Except where otherwise stated, these requirements apply to all NNI links that carry ATM SVC traffic, regardless of the signaling used. While these requirements may have use for interoffice links which are not NNIs, it is noted that such links are beyond the scope of this document.

These requirements specify periodically collected measurement data for ATM SVCs that provide information analogous to the usage, peg count and overflow data which is generally collected for other switched telecommunications services. In accomplishing this, it is necessary to account for the diverse capacities and the various service categories that ATM SVCs can have.

In these requirements, the capacity of an SVC is characterized by classifying its declared peak cell rate value (available from its traffic descriptor) into one of a limited number of cell rate ranges. An SVC is also characterized by its declared service category in accordance with the ATM Forum's currently defined set of service categories.

(R) SVC-74 The ATM NE shall support a minimum of four (4) cell rate categories, whose numerical values are to be configurable by the Management System. These cell rate categories shall be available to classify declared peak cell rate values of SVCs in support of requirements **(R) SVC-75,** (**R) SVC-76, (R) SVC-80**, and (**R) SVC-81**.

An example of such cell rate categories is:

1) 0 to 200 cells/second
2) 201 to 5,000 cells/second
3) 5,001 to 120,000 cells/second
4) 120,001 or more cells/second

Some rational (drawn from [1]) for these example values is:

1) 173 cells/second supports 64 kbps (the DS0 rate) with allowance for AAL Type 1 and OAM cell overheads. This falls within the 200 cells/second upper limit example for the first rate category.
2) 4,140 cells/second supports 1.544 Mbps (the T1 rate) with allowance for AAL Type 1 and OAM cell overheads. This falls within the 5,000 cells/second upper limit example for the second rate category.
3) 119,910 cells/second supports 44.736 Mbps (the T3 rate) with allowance for AAL Type 1 and OAM cell overheads. This falls within the 120,000 cells/second upper limit example for the third rate category.
4) The 120,001 cells/second lower limit example for the fourth rate category would include only applications involving a larger capacity than the T3 rate.

(R) SVC-75 The generation functionality shall provide periodic counts, for each NNI link carrying SVC traffic, of call requests (whether or not successful) by each combination of rate category and service category, where:

- The rate categories are provided in accordance with **(R) SVC-74**, and
- the service categories are: CBR, rt-VBR, nrt-VBR, UBR, ABR and GFR.

This count is referred to as the *Call Request Count*.

The periodicity of these counts is nominally 15 minutes.

(**R) SVC-76** The generation functionality shall provide periodic counts, for each NNI link carrying SVC traffic, of call requests that were rejected due to lack of resources by each combination of rate category and service category, where:

- The rate categories are provided in accordance with **(R) SVC-74**, and
- the service categories are: CBR, rt-VBR, nrt-VBR, UBR, ABR and GFR.

This count is referred to as the *Call Rejection Count*.

The rejection of a call request due to other causes, for example signaling protocol errors, would not be counted here.

(R) SVC-77 The generation functionality shall record, for every 100 seconds, the total of the declared Peak Cell Rate values allocated to all active SVCs on each NNI carrying SVC traffic, and shall provide periodic averages of these totals per NNI.

This average is referred to as the *Declared Cell Rate Average*.

(O) SVC-78 The generation functionality may record, for every 100 seconds, the total of the declared Peak Cell Rate values allocated to all active SVCs having the same service category on each NNI carrying SVC traffic, and shall provide periodic averages of these totals per NNI.

These averages are referred to as the *Granular Declared Cell Rate Averages*.

The periodicity with which these averages are generated is nominally 15 minutes.

For NNIs where B-ISUP signaling is used, traffic engineering and other performance management functions are also needed for the "special" PVCs having the associated Originating Point Codes (OPCs) and Destination Point Codes (DPCs) used to support the B-ISUP-associated B-ISDN call configuration management procedures. Requirements **(R) SVC-79** through **(O) SVC-83** apply only to NNIs where B-ISUP signaling is used.

(R) SVC-79 The generation functionality shall enable the ASP to designate, via an opeations interface, the OPC/DPC pairs to be monitored at the ATM NE in accordance with **(R) SVC-80** through **(O) SVC-83**, provided that the number of designated OPC/DPC pairs does not exceed a limit to be specified by the ATM NE supplier.

(R) SVC-80 The generation functionality shall provide periodic counts, for each designated OPC/DPC pair, of call requests (whether or not successful) by each combination of rate category and service category, where:

- The rate categories are provided in accordance with **(R) SVC-74**, and
- the service categories are: CBR, rt-VBR, nrt-VBR, UBR, ABR and GFR.

This count is referred to as the *BISUP-specific Call Request Count*.

The periodicity of these counts is nominally 15 minutes.

(**R) SVC-81** The generation functionality shall provide periodic counts, for each designated OPC/DPC pair, interoffice link carrying SVC traffic, of call requests that were rejected due to lack of resources by each combination of rate category and service category, where:

- The rate categories are provided in accordance with **(R) SVC-74**, and
- the service categories are: CBR, rt-VBR, nrt-VBR, UBR, ABR and GFR.

This count is referred to as the *BISUP-specific Call Rejection Count*.

The rejection of a call request due to other causes, for example signaling protocol errors, would not be counted here.

(R) SVC-82 The generation functionality shall record, for every 100 seconds, the total of the declared Peak Cell Rate values allocated to all active SVCs on each designated OPC/DPC pair, and shall provide periodic averages of these totals per OPC/DPC pair.

This average is referred to as the *BISUP-specific Declared Cell Rate Average*.

(O) SVC-83 The generation functionality may record, for every 100 seconds, the total of the declared Peak Cell Rate values allocated to all active SVCs having the same service category on each designated OPC/DPC pair, and shall provide periodic averages of these totals per OPC/DPC pair.

These averages are referred to as the *BISUP-specific Granular Declared Cell Rate Averages*. The periodicity with which these averages are generated is nominally 15 minutes.

7 Acronyms

AAL	ATM Adaptation Layer
ABR	Available Bit Rate
AINI	ATM Inter-Network Interface
ATM	Asynchronous Transfer Mode
ATMF	ATM Forum
ASP	ATM Service Provider
BICI	Broadband Inter Carrier Interface
BISDN	Broadband Integrated Services Digital Network
BISUP	Broadband ISDN User Part
CBR	Constant Bit Rate
CES	Circuit Emulation Service
CIC	Carrier Identification Code
CIP	Carrier Identification Parameter
CLP	Cell Loss Priority
CR	Conditional Requirement
CRS	Cell Relay Service
DPC	Destination Point Code
FRS	Frame Relay Service
NCCI	Network Call Correlation Identifier
NE	Network Element
NNI	Network-to-Network Interface
NPC	Network Parameter Control
OLIP	Originating Line Information Parameter
OPC	Originating Point Code
PCR	Peak Cell Rate
PVC	Permanent Virtual Connection
PVCC	Permanent Virtual Channel Connection
PVPC	Permanent Virtual Path Connection
QoS	Quality of Service
SCR	Sustainable Cell Rate
SMDS	Switched Multi-Megabit Data Services
SPVC	Soft Permanent Virtual Connection
SPVCC	Soft Permanent Virtual Channel Connection
SPVPC	Soft Permanent Virtual Path Connection

SVC	Switched Virtual Connection
SVCC	Switched Virtual Channel Connection
SVPC	Switched Virtual Path Connection
UBR	Unspecified Bit Rate
UNI	User-to-Network Interface
UPC	Usage Parameter Control
VBR	Variable Bit Rate
VCI	Virtual Channel Identifier
VPCI	Virtual Path Connection Identifier
VPI	Virtual Path Identifier

8 Definitions

Backward cell flow – direction of cell flow for cells originated by the called party for an SVC.

Data assembly – process of gathering usage information generated by the generation functionality.

Data generation - process of determining if usage information is needed for each connection and, if needed, producing the necessary data elements.

Egress cell flow – cell flow that is away from a recording interface (NNI or UNI), from the perspective of that interface.

Formatting functionality – functionality of an ATM NE that generates a formatted usage record from the set of usage information recorded for a connection.

Forward cell flow - direction of cell flow for cells originated by the calling party for an SVC.

Generation functionality – functionality of an ATM NE that records and assembles the usage information generated for a connection.

Ingress cell flow - cell flow that is towards a recording interface (NNI or UNI), from the perspective of that interface.

Originating recording – recording of usage information for incoming SVCs.

Preceding Network – network serving the calling party for an SVC**.**

Recording interface – NNI or UNI at which usage information is generated for a connection.

Recording interval – interval of time over which recording of usage information is performed.

Remote interface – for a PVC, the other network interface (NNI or UNI) within the same network that is involved in a connection.

Scheduled closing – completion of recording for a recording interval such that the recording interval ends at the scheduled time.

Succeeding Network - network serving the called party for an SVC.

Terminating recording - recording of usage information for outgoing SVCs.

Unscheduled closing - completion of recording for a recording interval such that the recording interval ends prior to the scheduled time.

9 References

At the time of publication, the revisions indicated were valid. All docuements referenced are subject to revision.

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[8] [TR-TSV-001370]

- Telcordia Technologies, “Generic Requirements for Exchange Access Frame Relay PVC Service”, Document Number TR-TSV-001370, Issue 1, May 1993.

[9] [TR-TSV-001060]

- Telcordia Technologies, “Switched Multi-megabit Data Service Generic Requirements for Exchange Access and Intercompany Serving Arrangements”, Document Number TR-TSV-001060, Issue 1, December 1991; plus Revision 1, August 1992; plus Revision 2, March 1993.

[10] [af-sig-0061.000]

- The ATM Forum Technical Committee, “ATM User-Network Interface (UNI) Signalling Specification Version 4.0”, Document Number af-sig-0061.000, July 1996.

[11] [GR-1110-CORE]

- Telcordia Technologies, "Broadband Switching Systems (BSS) Generic Requirements" Document Number GR-1110 CORE, Issue 2, December 1998. Section 10 contains Usage Measurement Requirements for Accounting Management.

[12] [af-tm-0056.000]

- The ATM Forum Technical Committee, "Traffic Management Specification Version 4.0" Document Number af-tm-0056.000, April 1996.

A Appendix A – Summary of Recorded Data Elements

Table A-1 Summary of Recorded Data Elements for Billing summarizes the data elements that are recorded for PVCs and SVCs in support of billing (recording for SPVCs is addressed in Appendix B). The recording of these data elements is governed by various configurable generation parameters, as presented in Sections 2 through 4.

Table A-2 Summary of Recorded Data Elements for Traffic Engineering and Performance Management summarizes the data elements that are recorded for SVCs in support of traffic engineering and performance management.

Table A-1 Summary of Recorded Data Elements for Billing

Usage Parameter	*PVC Reqts*	*SVC Reqts*	*Notes*	*Reference*
Connection Type	**(R) PVC-15**		VP, VC	
Recording Interface Identifier	**(R) PVC-16**			
Recording Interface Type	**(R) PVC-17**			af-nm-0020.001 October 1998
Recording Connection Identifier	**(R) PVC-18**			af-nm-0020.001 October 1998
Remote Interface Identifier	**(R) PVC-57**		CRS only	
Remote Interface Type	**(R) PVC-59** **(R) PVC-72**		CRS and FRS only	
Remote Connection Identifier	**(R) PVC-61**		CRS only	
Network Provider Identification	**(R) PVC-19**	**(R) SVC-17** **(R) SVC-50**		btd-cs-pnni-ncci-01.03 July 1999
Frame Relay Interface Identifier	**(R) PVC-63**		FRS only	
Measurement Units	**(R) PVC-65**		FRS only	
Received Count	**(R) PVC-66**		FRS only	
Source Interface Identifier	**(R) PVC-69**		FRS only	
Destination Interface Identifier	**(R) PVC-67**		FRS only	
Destination DLCI	**(R) PVC-70**		FRS only	
Charge Number		**(R) SVC-24** **(R) SVC-68**	Signaled: B-ICI only Configured: Any	af-nm-0020.001 October 1998
Originating Line Information Parameter		**(R) SVC-69**	B-ICI only	
Carrier Identification Code		**(R) SVC-18** **(R) SVC-50**		
Outgoing Facility Identifier		**(R) SVC-71**	B-ICI only	
Incoming Facility Identifier		**(R) SVC-73**	B-ICI only	
Calling Party		**(R) SVC-19** **(R) SVC-50**		

Default Address		**(R) SVC-20**		
Called Party		**(R) SVC-21** **(R) SVC-50**		
Calling Party Subaddress		**(CR) SVC-22**		
Called Party Subaddress		**(CR) SVC-23**		
Service Category	**(R) PVC-38**		CBR, rtVBR, nrtVBR, ABR, UBR, GFR	af-nm-0020.001 October 1998
Type of Service Supported	**(O) PVC-20**		PVC CRS, PVC CES, PVC FRS, SMDS	
Study Indicator	**(R) PVC-21**			
Chargeable Party Identifier	**(R) PVC-22**			
User Plane Connection Configuration	**(R) PVC-23**	**(R) SVC-38**	point-to-point, point-to-multipoint	af-nm-0020.001 October 1998
Creation Time	**(R) PVC-24**			
Activation Time	**(R) PVC-25**			
Deactivation Time	**(R) PVC-26**			
Deletion Time	**(R) PVC-27**			
Carrier Connect Date		**(R) SVC-25** **(R) SVC-50**		
Carrier Connect Time		**(R) SVC-25** **(R) SVC-50**		
Connect Date		**(R) SVC-25** **(R) SVC-50**		
Connect Time		**(R) SVC-25** **(R) SVC-50**		
Disconnect Date		**(R) SVC-25** **(R) SVC-50**		
Disconnect Time		**(R) SVC-25** **(R) SVC-50**		
Wait for Carrier Connect Elapsed Time		**(R) SVC-25** **(R) SVC-50**		
Carrier Elapsed Time		**(R) SVC-25** **(R) SVC-50**		
Elapsed Time		**(R) SVC-25** **(R) SVC-50**		
Ingress Total Cells	**(R) PVC-28**		Measurable cells (CLP 0 + CLP 1)	

			CLP 1)	
Ingress High Priority Cells	**(R) PVC-29**		Measurable CLP 0 cells	
Ingress Tagged High Priority Cells	**(R) PVC-30**		Cell changed from CLP 0 to CLP 1	
Ingress Discarded Total Cells	**(R) PVC-31**		Discarded CLP 0 + 1 cells	
Ingress Discarded High Priority Cells	**(R) PVC-32**		Discarded CLP 0 cells	
Egress Total Cells	**(R) PVC-33**		Measurable cells (CLP 0 + CLP 1)	
Egress High Priority Cells	**(R) PVC-34**		Measurable CLP 0 cells	
Ingress AAL Frames	**(O) PVC-35**		Total AAL frames	
Ingress Discarded AAL Frames	**(O) PVC-36**		Discarded AAL frames	
Egress AAL Frames	**(O) PVC-37**		Total AAL frames	
Forward Total Cells		**(R) SVC-28** **(R) SVC-30** **(R) SVC-53**	Measurable cells (CLP 0 + CLP 1)	
Backward Total Cells		**(R) SVC-28** **(R) SVC-30** **(R) SVC-53**	Measurable cells (CLP 0 + CLP 1)	
Forward High Priority Cells		**(R) SVC-29** **(R) SVC-31** **(R) SVC-53**	Measurable CLP 0 cells	
Backward High Priority Cells		**(R) SVC-29** **(R) SVC-31** **(R) SVC-53**	Measurable CLP 0 cells	
Forward Tagged High Priority Cells		**(R) SVC-32** **(R) SVC-53**	Cell changed from CLP 0 to CLP 1	
Backward Tagged High Priority Cells		**(R) SVC-32** **(R) SVC-53**	Cell changed from CLP 0 to CLP 1	
Forward Discarded Total Cells		**(R) SVC-33** **(R) SVC-53**	Discarded CLP 0 + 1 cells	
Backward Discarded Total Cells		**(R) SVC-33** **(R) SVC-53**	Discarded CLP 0 + 1 cells	
Forward Discarded High Priority Cells		**(R) SVC-34** **(R) SVC-53**	Discarded CLP 0 cells	
Backward Discarded High Priority Cells		**(R) SVC-34**	Discarded CLP 0 cells	

Cells		**(R) SVC-53**		
Forward AAL Frames		**(O) SVC-35** **(O) SVC-37** **(O) SVC-54**	Total AAL frames	
Backward AAL Frames		**(O) SVC-35** **(O) SVC-37** **(O) SVC-54**	Total AAL frames	
Forward Discarded AAL Frames		**(O) SVC-36** **(O) SVC-54**	Discarded AAL frames	
Backward Discarded AAL Frames		**(O) SVC-36** **(O) SVC-54**	Discarded AAL frames	
Conformance Definition	**(R) PVC-38**		CBR.1, VBR.1, VBR.2, VBR.3, ABR, GFR.1, GFR.2, UBR.1, UBR.2	
Ingress Peak Cell Rate CLP 0+1	**(R) PVC-38**			
Ingress Peak Cell Rate CLP 0	**(R) PVC-38**			
Ingress Sustainable Cell Rate CLP 0+1	**(R) PVC-38**			
Ingress Sustainable Cell Rate CLP 0	**(R) PVC-38**			
Ingress Maximum Burst Size CLP 0+1	**(R) PVC-38**			
Ingress Maximum Burst Size CLP 0	**(R) PVC-38**			
Ingress Minimum Cell Rate	**(R) PVC-38**			
Ingress Maximum Frame Size	**(R) PVC-38**			
Ingress Acceptable Peak-to-Peak Cell Delay Variation	**(R) PVC-38**			
Ingress Acceptable Cell Loss Ratio	**(R) PVC-38**			
Ingress Cell Delay Variation Tolerance	**(R) PVC-38**			
Egress Peak Cell Rate CLP 0+1	**(R) PVC-38**			
Egress Peak Cell Rate CLP 0	**(R) PVC-38**			
Egress Sustainable Cell Rate CLP 0+1	**(R) PVC-38**			
Egress Sustainable Cell Rate CLP 0	**(R) PVC-38**			
Egress Maximum Burst Size CLP 0+1	**(R) PVC-38**			
Egress Maximum Burst Size CLP 0	**(R) PVC-38**			
Egress Minimum Cell Rate	**(R) PVC-38**			
Egress Maximum Frame Size	**(R) PVC-38**			

Egress Acceptable Peak-to-Peak Cell Delay Variation	**(R) PVC-38**			
Egress Acceptable Cell Loss Ratio	**(R) PVC-38**			
Egress Cell Delay Variation Tolerance	**(R) PVC-38**			
Forward Peak Cell Rate CLP 0+1		**(R) SVC-43** **(R) SVC-50**		
Forward Peak Cell Rate CLP 0		**(R) SVC-43** **(R) SVC-50**		
Forward Sustainable Cell Rate CLP 0+1		**(R) SVC-43** **(R) SVC-50**		
Forward Sustainable Cell Rate CLP 0		**(R) SVC-43** **(R) SVC-50**		
Forward Maximum Burst Size CLP 0+1		**(R) SVC-43** **(R) SVC-50**		
Forward Maximum Burst Size CLP 0		**(R) SVC-43** **(R) SVC-50**		
Forward Minimum Cell Rate		**(R) SVC-43** **(R) SVC-50**		
Forward Maximum Frame Size		**(R) SVC-43** **(R) SVC-50**		
Forward Maximum End-to-End Transit Delay		**(R) SVC-45** **(R) SVC-50**		
Backward Peak Cell Rate CLP 0+1		**(R) SVC-44** **(R) SVC-50**		
Backward Peak Cell Rate CLP 0		**(R) SVC-44** **(R) SVC-50**		
Backward Sustainable Cell Rate CLP 0+1		**(R) SVC-44** **(R) SVC-50**		
Backward Sustainable Cell Rate CLP 0		**(R) SVC-44** **(R) SVC-50**		
Backward Maximum Burst Size CLP 0+1		**(R) SVC-44** **(R) SVC-50**		
Backward Maximum Burst Size CLP 0		**(R) SVC-44** **(R) SVC-50**		
Backward Minimum Cell Rate		**(R) SVC-44**		

		(R) SVC-50		
Backward Maximum Frame Size		**(R) SVC-44** **(R) SVC-50**		
Backward Maximum End-to-End Transit Delay		**(R) SVC-45** **(R) SVC-50**		
Bearer Class		**(R) SVC-38** **(R) SVC-50**	BCOB-A, BCOB-C, BCOB-X, Transparent VP Service	
ATM Transfer Capability		**(R) SVC-38** **(R) SVC-50**	A UNI 4.0 bit mask combining the Traffic Type and Timing Requirements from UNI 3.0/3.1	
Susceptibility to Clipping		**(R) SVC-38** **(R) SVC-50**	Not susceptible to clipping, Susceptible to clipping	
Forward QoS Class		**(R) SVC-39** **(R) SVC-50**	Class0, Class 1, Class 2, Class 3, Class 4	I.356 (1996) af-sig-0061.000
Backward QoS Class		**(R) SVC-39** **(R) SVC-50**	Class0, Class 1, Class 2, Class 3, Class 4	I.356 (1996) af-sig-0061.000
Forward Acceptable Peak-to-Peak Cell Delay Variation		**(R) SVC-40** **(R) SVC-50**		
Forward Acceptable Cell Loss Ratio		**(R) SVC-40** **(R) SVC-50**		
Backward Acceptable Peak-to-Peak Cell Delay Variation		**(R) SVC-40** **(R) PVC-48**		
Backward Acceptable Cell Loss Ratio		**(R) SVC-40** **(R) SVC-50**		
Best Effort		**(R) SVC-41** **(R) SVC-50**		
Tagging		**(R) SVC-42** **(R) SVC-50**	Forward, Backward, Both	
Network Call Correlation Identifier		**(CR) SVC-47** **(R) SVC-50**		
Connection Identity		**(R) SVC-48** **(R) SVC-50**		
Release Cause Value		**(R) SVC-49** **(R) SVC-50**		
Interval Start Date	**(R) PVC-40**	**(R) SVC-57**		

Interval Start Time	**(R) PVC-40**	**(R) SVC-57**		
Interval Elapsed Time	**(R) PVC-40**	**(R) SVC-57**		

Table A-2 Summary of Recorded Data Elements for Traffic Engineering and Performance Management

Usage Parameter	***SVC Reqts.***	***Notes***	***Reference***
Call Request Count	**(R) SVC-75**		
Call Rejection Count	(**R) SVC-76**		
Declared Cell Rate Average	**(R) SVC-77**		
Granular Declared Cell Rate Average	**(O) SVC-78**		
BISUP-specific Call Request Count	**(R) SVC-80**		
BISUP-specific Call Rejection Count	(**R) SVC-81**		
BISUP-specific Declared Cell Rate Average	**(R) SVC-82**		
BISUP-specific Granular Declared Cell Rate Average	**(O) SVC-83**		

B Appendix B – Requirement Validity for SPVCs

Table B-1 Requirement Validity for SPVCs presents whether the PVC requirements contained in Sections 2 and 3, and the SVC requirements contained in Section 4, are valid for SPVCs.

Table B-1 Requirement Validity for SPVCs

Requirement number	Requirement context	Originating SPVC Interface	Terminating SPVC Interface	Intermediate Interface (NNI)
(R) PVC-1	PVC Usage measurement control	Yes	Yes	-
(R) PVC-2	Administrative information control	Yes	Yes	-
(R) PVC-3	Network provider configuration	Yes	Yes	-
(R) PVC-4	Recording interface configuration	Yes	Yes	-
(O) PVC-5	Type of service configuration	Yes	Yes	-
(R) PVC-6	Study indication configuration	Yes	Yes	-
(CR) PVC-7	Chargeable party id. configuration	Yes	Yes	-
(**R) PVC-8**	Defining recording intervals	(**R) SPVC-4**	(**R) SPVC-4**	-
(R) PVC-9	15 minutes intervals	Yes	Yes	-
(R) PVC-10 **(R) PVC-11**	Condition for data generation	Yes	Yes	-
(R) PVC-12	Activation of PVC	Not valid	Not valid	-
(R) PVC-13	Deactivation of PVC	Not valid	Not valid	-
(R) PVC-14	Deletion of PVC	Yes	Yes	-
(R) PVC-15	Connection Type	Yes	Yes	-
(R) PVC-16	Recording interface identifier	Yes	Yes	-
(R) PVC-17	Recording interface type	Yes	Yes	
(R) PVC-18	Connection identifier	Yes	Yes	-
(R) PVC-19	Network provider identity	Yes	Yes	-

Requirement number	Requirement context	Originating SPVC Interface	Terminating SPVC Interface	Intermediate Interface (NNI)
	identity			
(O) PVC-20	Type of service	Yes	Yes	-
(R) PVC-21	Study indication	Yes	Yes	-
(R) PVC-22	Chargeable party identifier	Yes	Yes	-
(R) PVC-23	User plane configuration	Yes	Yes	-
(R) PVC-24	Recording of creation time	Yes	Not valid	-
(R) PVC-25	Recording of activation time	Yes	Not valid	-
(R) PVC-26	Recording of deactivation time	Yes	Not valid	-
(R) PVC-27	Recording of deletion time	Yes	Not valid	-
(R) PVC-28 to **(R) PVC-34**	Cell counts	Yes	Yes	-
(O) PVC-35 to **(O) PVC-37**	Frame counts	Yes	Yes	-
(R) PVC-38	Traffic descriptor	**(R) SVC-38** to **(R) SVC-45**	**(R) SVC-38** to **(R) SVC-45**	
(R) PVC-39	Transit inter-network. Info.	Yes	Yes	-
(R) PVC-40 to **(R) PVC-43**	Recording intervals	Yes	Yes	-
(R) PVC-44	Handling of Zero cell counts	Yes	Yes	-
(R) PVC-45	Scheduled closing	Yes	Yes	-
(R) PVC-46	Special handling at start of UM	Yes	Yes	-
(R) PVC-47	Unscheduled closing	Yes	Yes	-
(R) PVC-48	Actions at unsched. closing	Yes	Yes	-

Requirement number	Requirement context	Originating SPVC Interface	Terminating SPVC Interface	Intermediate Interface (NNI)
(R) PVC-49	Recording interval at unsched. closing	Yes	Yes	-
(R) PVC-50	Info about changed recording interval	Yes	Yes	-
(R) PVC-51	Creation record	Yes	Not valid	-
(R) PVC-52	Activation record	Yes	Not valid	-
(R) PVC-53	Deactivation record	Yes	Not valid	-
(R) PVC-54	Deletion record	Yes	Not valid	-
(R) PVC-55	Single failure error	Yes	Yes	-
(R) PVC-56	Remote interface configuration	Yes	Yes	-
(R) PVC-57	Remote interface identifier	Yes	Yes	-
(R) PVC-58	Remote interface type configuration for PVC CRS	Yes	Yes	-
(R) PVC-59	Remote interface type for PVC CRS	Yes	Yes	-
(R) PVC-60	Remote connection id. configuration	**(R) SPVC-7**	**(R) SPVC-15**	-
(R) PVC-61	Remote connection identifier	**(R) SPVC-7**	**(R) SPVC-15**	
(R) PVC-62	Frame relay interface id. configuration	Yes	Yes	-
(R) PVC-63	Recording of frame relay interface id.	Yes	Yes	-
(R) PVC-64	Frame relay recording control	Yes	Yes	-
(R) PVC-65	Fixed length measurement unit	Yes	Yes	-
(R) PVC-66	Number of measurement units	Yes	Yes	-
(R) PVC-67 to **(R) PVC-70**	Identifiers for frame relay	Yes	Yes	-
(R) PVC-71	Remote interface type configuration for PVC FRS	Yes	Yes	-

Requirement number	Requirement context	Originating SPVC Interface	Terminating SPVC Interface	Intermediate Interface (NNI)
(R) PVC-72	Remote interface type for PVC FRS	Yes	Yes	-
(R) PVC-73	Frame relay output record	Yes	Yes	-
(R) SVC-1	Originating recording config.	-	-	Yes
(R) SVC-2	Terminating recording config.	-	-	Yes
(R) SVC-3	Service category recording config.	-	-	Yes
(R) SVC-4	Cell counting configuration	-	-	Yes
(R) SVC-5 to **(R) SVC-7**	Configuration of unsuccessful call recording	Yes	Yes	Yes
(R) SVC-8	Defining recording intervals	-	-	Yes
(R) SVC-9 to **(R) SVC-12**	Originating or terminating recording	-	-	Yes
(R) SVC-13 to **(R) SVC-14**	Service category recording	-	-	Yes
(R) SVC-15 to **(R) SVC-16**	Unsuccessful attempts	Yes	Yes	Yes
(R) SVC-17	Network provider identity	-	-	Yes
(R) SVC-18	Carrier identification code	-	-	Not valid
(R) SVC-19	Calling party number	**(R) SPVC-5**	**(R) SPVC-13**	Yes
(R) SVC-20	Default address	-	-	Not valid
(R) SVC-21	Called party number	**(R) SPVC-6**	**(R) SPVC-13**	Yes
(CR) SVC-22	Calling party subaddress	Yes	Yes	Yes
(CR) SVC-23	Called party subaddress	Yes	Yes	Yes

Requirement number	Requirement context	Originating SPVC Interface	Terminating SPVC Interface	Intermediate Interface (NNI)
	subaddress			
(R) SVC-24	Charge number	Yes	Not valid in succeeding network	Yes in preceding network
(R) SVC-25	Recording of timestamps and elapsed time	**(R) SPVC-8**	**(R) SPVC-8**	Yes
(R) SVC-26 to **(R) SVC-27**	Condition for cell counting	-	-	Yes
(R) SVC-28 to **(R) SVC-34**	Cell counters	-	-	Yes
(O) SVC-35 to **(O) SVC-37**	Frame counters	-	-	Yes
(R) SVC-38 to **(R) SVC-45**	Traffic parameters	Yes	Yes	Yes
(R) SVC-46	VP or VC connection	-	-	Yes
(CR) SVC-47	NCCI	**(R) SPVC-11**	**(R) SPVC-13**	Yes
(R) SVC-48	Connection identifier	-	-	Yes
(R) SVC-49	Release cause	**(R) SPVC-10**	**(R) SPVC-13**	Yes
(R) SVC-50	Requirements for succeeding side	-	-	Yes
(R) SVC-51 to **(R) SVC-52**	Unsuccessful attempts	Yes	Yes	Yes
(R) SVC-53	Cell counts succeeding network	-	-	Yes
(O) SVC-54	Frame counts succeeding network	-	-	Yes
(R) SVC-55 to **(R) SVC-60**	Recording intervals	-	-	Yes
(R) SVC-61	Scheduled closing	-	-	Yes

Requirement number	**Requirement context**	**Originating SPVC Interface**	**Terminating SPVC Interface**	**Intermediate Interface (NNI)**
(R) SVC-62	Special handling at start of UM	-	-	Yes
(R) SVC-63 to **(R) SVC-66**	Unscheduled closing	-	-	Yes
(R) SVC-67	Connection termination	**(R) SPVC-12**	**(R) SPVC-13**	Yes
(R) SVC-68	Charge number BICI	-	-	Yes
(R) SVC-69	Signaled OLIP	-	-	Not valid
(R) SVC-70	Provisioned OLIP	-	-	Yes
(R) SVC-71	Outgoing facility identifier	-	-	Yes
(R) SVC-72	Succeeding network BICI	-	-	Yes
(R) SVC-73	Incoming facility identifier	-	-	Yes

C Appendix C – Point-to-Multipoint SVCs

The usage measurement capabilities for Inter Network SVCs are specified for the Preceding ASP Network in Section 4.2.1 and for the Succeeding ASP Network in Section 4.2.2. These capabilities also apply to Point-to-Multipoint SVCs. An example Point-to-Multipoint SVC is illustrated in Figure C-1.

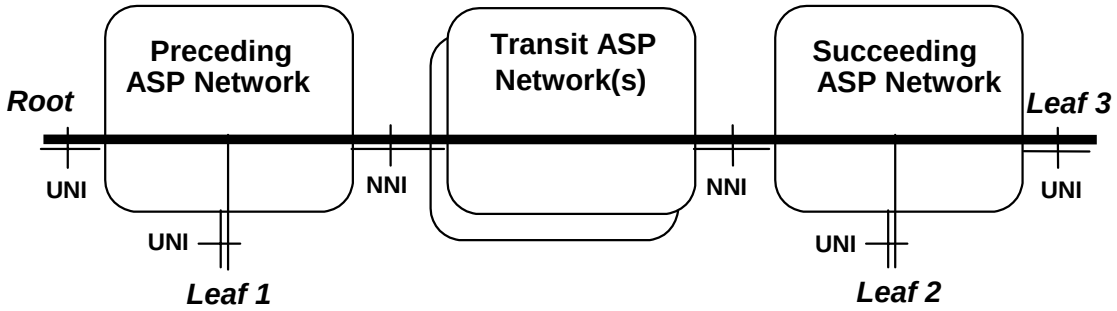

Figure C-1 Point-to-Multipoint SVC Configuration

This Point-to-Multipoint SVC includes one root and three leaves. For usage measurement purposes, this Point-to-Multipoint SVC provides three *communication paths*. A communication path is defined between the root and a leaf. The three communication paths provided by the above Point-to-Multipoint SVC are as follows:

- a communication path from the Root to Leaf 1
- a communication path from the Root to Leaf 2
- a communication path from the Root to Leaf 3

Note that these communication paths share connection links at different points within the networks. For instance, all three communication paths use the same user plane connection link (i.e., the same VPCI/VCI) at the UNI between the Root and the Preceding ASP Network.

Usage information is collected for each communication path. The ATM NEs are capable of recording the specified usage measurement data elements for the communication paths they support. These data elements should indicate that the communications path is part of a Point-to-Multipoint SVC. For instance, the User Plane Connection Configuration in the Broadband Bearer Capability Parameter from the IAM should indicate "Point-to-Multipoint". The usage information generated for the above Point-to-Multipoint SVC is illustrated in Figure C-2 and Figure C-3.

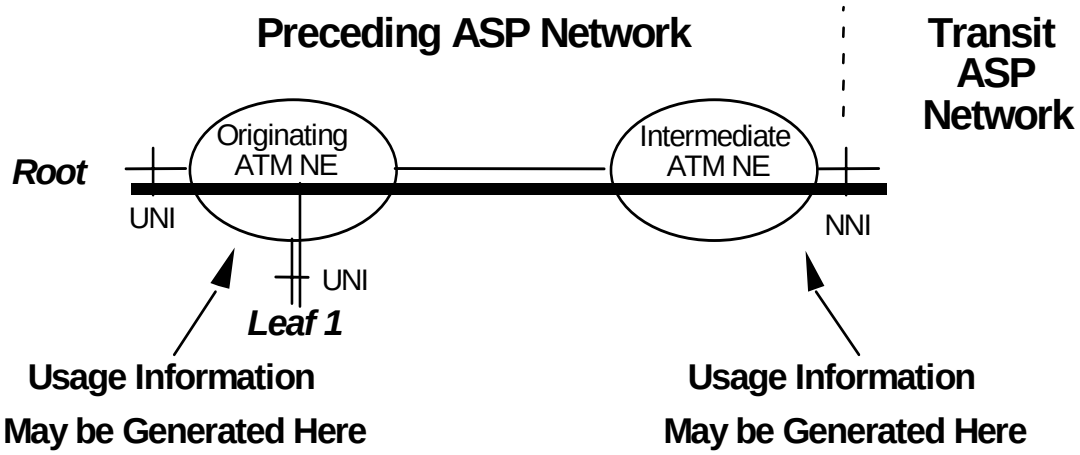

Figure C-2 Point-to-Multipoint SVC Recording in the Preceding ASP Network

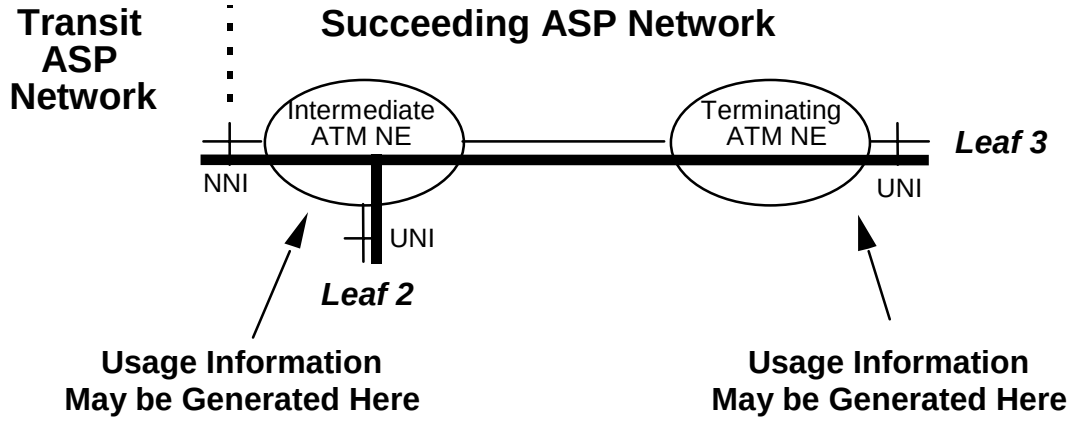

Figure C-3 Point-to-Multipoint SVC Recording in the Succeeding ASP Network

As illustrated in these figures, each network is capable of generating usage information for the listed communication paths.

Originating ATM NE in the Preceding ASP Network:

- the communication path from the Root to Leaf 1
- the communication path from the Root to Leaf 2
- the communication path from the Root to Leaf 3

Intermediate ATM NE in the Preceding ASP Network:

- the communication path from the Root to Leaf 2
- the communication path from the Root to Leaf 3

Intermediate ATM NE in the Succeeding ASP Network:

- the communication path from the Root to Leaf 2
- the communication path from the Root to Leaf 3

Terminating ATM NE in the Succeeding ASP Network:

- the communication path from the Root to Leaf 3

The usage information generated for the communication paths will have many common data elements. For instance, the following usage measurement data elements are the same for all communication paths provided by the Point-to-Multipoint SVC:

- Broadband Bearer Capability
- Quality of Service parameters (when present)
- ATM Cell Rate Parameters

The following usage measurement data elements may vary (i.e., may be different for each communication path provided by the Point-to-Multipoint SVC):

- Calling Party (when present)
- Terminating Address
- Cause Value
- Network Provider Identification
- Carrier Identification Code
- Facility Identifiers (Incoming and Outgoing) [for BISUP]
- OLIP (when present) [for BISUP]
- Charge Number (when present)
- Connect Date and Time
- Carrier Connect Date and Time
- Cell Counts
- AAL Frame Counts

The usage measurement data elements collected for the Point-to-Multipoint SVC may be formatted as one or more usage records by each ATM NE that generates usage measurement data. Data formatting is beyond the scope of this specification.