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U S WEST Communications, Inc. Technical Publication

ATM CELL RELAY SERVICE

77378
Issue D
March 1998

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1. Introduction

1.1 General

This document describes U S WEST ATM Cell Relay Service offered by U S WEST to its customers. The information provided in this document includes service features, technical specifications, performance objectives, and defines the valid User-Network Interfaces (UNIs).

1.2 Reason For Reissue

This document is being reissued due to service enhancements associated with U S WEST ATM Cell Relay Service. These service enhancements are outlined below, and further pertinent technical information is provided throughout this document. The information contained within this document applies to both intrastate and interstate applications.

- Addition of U S WEST ATM Cell Relay Service Unspecified Bit Rate Service (UBRS).
- A “best effort” service designed to support a connection carrying information flowing at uneven rates.

1.3 Purpose

The purpose of this document is to describe U S WEST ATM Cell Relay Service. Sufficient technical information is furnished to allow a customer, for example, an End-User (EU), to select a service which may be incorporated into an end-to-end communications channel. It is not the intent of this document to provide specific ordering information, but to describe the technical features of this service offering.

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2. Description Of Service

2.1 Applicability Of Technical Specifications

The technical specifications presented in this document are applicable to U S WEST Asynchronous Transfer Mode (ATM) Cell Relay Service only. It is not the intent of this document to describe the various types of transmission equipment, switching equipment, and Network Management Systems (NMS) used to provide ATM Cell Relay Service. The service as described in this document pertains to the presently deployed transport, cell relay switching, and associated NMS technology. As further ATM cell relay hardware and software enhancements become available for network deployment, additional U S WEST ATM Cell Relay Service features will be offered to the customer.

2.2 General U S WEST ATM Cell Relay Service Description

U S WEST ATM Cell Relay Service is a connection-oriented communications service that uses Asynchronous Transfer Mode technology to provide End-Users (EUs) with high-speed (1.544, 44.736 and 155.520 Mbit/s), low delay networking capabilities. U S WEST ATM Cell Relay Service is ideal for data intensive business computing applications that require near-real-time mixed media (e.g. data, video, & image) communications among multiple locations.

U S WEST ATM Cell Relay Service is implemented using the ATM cell transfer protocols running between Customer Provided Equipment (CPE) and the U S WEST ATM Cell Relay Service Network. Figure 2-1 illustrates how the U S WEST ATM Cell Relay Service Network performs only ATM and physical layer functions, while the EU customer's communication equipment is responsible for performing ATM Adaptation Layer (AAL) and higher layer protocol functions. Protocols running above the ATM layer (i.e., the cell payload) are passed transparently through the U S WEST ATM Cell Relay Service Network.

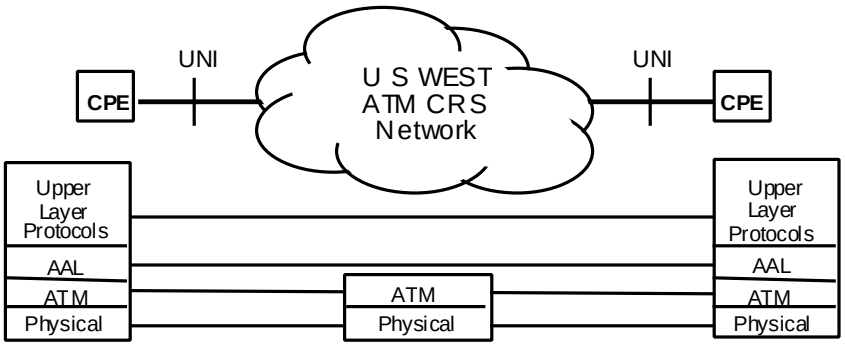


Figure 2-1 U S WEST ATM Cell Relay Service Protocol Relationships

ATM is a connection-oriented, cell-based switching technology. This technology provides high efficiency and flexibility because it provides multiple types of "virtual channels or logical connections" instead of a single dedicated physical channel per application.

2.2.1 U S WEST ATM Cell Relay Service Permanent Virtual Connections

U S WEST ATM Cell Relay Service utilizes logical connections referred to as Permanent Virtual Connections (PVCs). PVCs are relatively static and are established during the provisioning process. The UNI is the point at which a customer's data transmissions first enter the network supporting U S WEST ATM Cell Relay Service. It is the point of interconnection between U S WEST Communications facilities and customer terminal equipment. U S WEST ATM Cell Relay Service will support UNI physical connections with the access line rates of 1.544 Mbit/s, 44.736 Mbit/s and 155.520 Mbit/s.

Two types of logical PVCs are provided by U S WEST ATM Cell Relay Service: Virtual Channel Connections (VCCs) and Virtual Path Connections (VPCs). A VCC is a point to point logical connection between EU locations. Traffic parameters are assigned to each individual VCC. A VPC is a collection of VCCs routed together as one unit through the U S WEST ATM Cell Relay Service public network. All VCCs carried within a VPC are switched within that VPC transparently by the U S WEST ATM Cell Relay Service network. The customer has the ability to manage the attributes of the individual VCCs within a contracted aggregate bandwidth limit of the VPC. Peak Cell Rate Service (PCRS) (see Section 2.2.7) traffic is provided over a VPC or a VCC. Sustained Cell Rate Service (SCRS) (see Section 2.2.8) and Unspecified Bit Rate Service (UBRS) (see Section 2.2.9) traffic is only offered as a VCC.

Throughout this publication, the use of the term PVC refers to either of the two types: VCCs and/or VPCs.

2.2.2 U S WEST ATM Cell Relay Service Optical Access Link

A U S WEST ATM Cell Relay Service Optical Access Link (OAL) provides access to the U S WEST ATM Cell Relay Service Network, connecting customer facilities at the User-Network Interface (UNI) with a corresponding U S WEST ATM Cell Relay Service Cell Transfer element. The Cell Transfer service element transfers information between UNIs connected to the U S WEST ATM Cell Relay Service network at speed(s) selected by the customer for logical connections. The customer must designate whether the Cell Transfer for each logical connection is Peak Cell Rate Service, Sustained Cell Rate Service, or Unspecified Bit Rate Service. A U S WEST ATM Cell Relay Service Optical Access Link is only available at U S WEST ATM Cell Relay Service Points. There are two types of OAL: 45 Mbit/s and 155 Mbit/s.

- The 155 Mbit/s OAL is offered as an unprotected circuit or as a protected circuit. The unprotected 155 Mbit/s OAL utilizes two fibers for transport and the protected 155 Mbit/s OAL utilizes four fibers for transport. The 155 Mbit/s OAL delivers an optical interface to the EU (see Section 3.1.1 for more information).

- The 45 Mbit/s OAL is offered as an unprotected circuit or as a protected circuit. The unprotected 45 Mbit/s OAL utilizes two fibers for transport and the protected 45 Mbit/s OAL utilizes four fibers for transport. The 45 Mbit/s OAL delivers an electrical interface to the EU (see Section 3.1.2 for more information).

2.2.3 U S WEST ATM Cell Relay Service Optical Access Link Diversity

The two types of OAL, 45 Mbit/s and 155 Mbit/s, are both available with a protect path diversity option. OAL Diversity is provided over fiber optic facilities. This service provides a "standby" protect fiber path, which is routed over facilities separated, from the normal path, by 25 feet or more. Fiber optic facility separation is from the first utility vault outside the Serving Wire Center to the last utility vault or hand hole prior to the EU customer's premises. OAL Diversity is subject to availability of facilities. When facilities are not available, Special Construction charges may be assessed.

2.2.4 U S WEST ATM Cell Relay Service Port

ATM Cell Relay Service ports are the physical entry points into the ATM Cell Relay Service Network for Optical Access Links or other compatible private line facilities, such as Synchronous Service Transport (SST), DS3 Service, or DS1 Service. They are the originating and terminating points for Virtual Path Connections and Virtual Channel Connections. Ports include the electronic equipment used in connecting these service elements to the ATM Cell Relay Service Network. They enable customers to allocate bandwidth to applications at customer-designated transmission speeds of up to 1.5 Mbit/s, 45 Mbit/s or 155 Mbit/s. Note that the EU customer must choose either Physical Layer Convergence Protocol (PLCP) cell mapping or Direct Mapped ATM cells across a 45 Mbit/s access port. The two mapping methods are incompatible because transmission path transceiver pairs must use the same mapping method.

The PLCP method of mapping encapsulates ATM cells into a 125 microsecond frame defined by the PLCP which is defined inside the DS3 M-frame. A PLCP mapped 45 Mbit/s Port provides a maximum cell rate of 96,000 cells/sec (40.704 Mbit/s).

Direct mapping of ATM cells is accomplished by directly inserting 53 byte ATM cells into the DS3 information payload. A Direct Mapped 45 Mbit/s Port provides a maximum cell rate of 104,268 cells/sec (44.210 Mbit/s).

2.2.5 U S WEST ATM Cell Relay Service Point

ATM Cell Relay Service Points are geographic locations designated by the Company where the ATM Cell Relay Service Network can be accessed.

2.2.6 U S WEST ATM Cell Relay Service Cell Rates

Logical channels are established through the selection of cell rates. U S WEST ATM Cell Relay Service offers the flexibility for EUs to select different cell rates for each logical connection to match application needs. Therefore, the granularity of bandwidth choices for U S WEST ATM Cell Relay Service exceed bandwidth increments typically offered by private line services.

2.2.7 U S WEST ATM Cell Relay Service Peak Cell Rate Service

Peak Cell Rate Service (PCRS) traffic has been designed to support a connection carrying a constant flow of information. The ATM Forum refers to this type of information flow as Constant Bit Rate (CBR) traffic.

The traffic parameters chosen by the EU for their PCRS logical connections define the bandwidth characteristics available to the EU. The traffic parameter for PCRS connections is the Peak Cell Rate (PCR), which specifies the highest cell rate a customer is provided on a connection. The PCR of a PCRS logical connection must be less than the speed of the associated Port. When cells exceed the PCR for PCRS logical connections, the cells are discarded upon entry into the U S WEST ATM Cell Relay Network.

2.2.8 U S WEST ATM Cell Relay Service Sustained Cell Rate Service

Sustained Cell Rate Service (SCRS) has been designed to support a connection carrying information flowing at variable rates. The ATM Forum refers to this type of information as Variable Bit Rate (VBR) traffic.

For SCRS connections, three traffic parameters describe the bandwidth characteristics. The parameters are the PCR, the Sustained Cell Rate (SCR) and the Maximum Burst Size (MBS). The PCR of a SCRS logical connection may equal, but not exceed, the speed of the associated Port. The SCR is an upper bound on the conforming average cell rate, as measured using the Generic Cell Rate Algorithm (GCRA) in accordance with the ATM Forum UNI 3.1, including bursts above the average, that can be sustained over a SCRS logical connection. For SCRS connections the MBS may be 32, 100, or 200 cells. Although a customer may send bursts of 32, 100, or 200 cells over a SCRS logical connection at a rate up to the PCR, the averaged cell rate transmitted for that logical connection must not exceed the chosen SCR. Note that there is a minimum bandwidth requirement of 4 Mbit/s for a SCRS logical connection with a MBS of 200 cells.

The customer selects the bandwidth characteristics of a SCRS logical connection by choosing the appropriate SCR, PCR, and MBS. The traffic parameters chosen by the EU for their SCRS logical connections define the bandwidth characteristics available to the EU.

2.2.9 U S WEST ATM Cell Relay Service Unspecified Bit Rate Service

Unspecified Bit Rate Service (UBRS) is a “best effort” service designed to support a connection carrying information flowing at uneven rates. The ATM Forum refers to this type of information as Unspecified Bit Rate (UBR) traffic. It is intended for non-real-time applications that are very tolerant to delay, delay variation and cell loss.

UBRS does not specify traffic related service guarantees. Specifically, UBRS does not include the notion of a per-connection negotiated bandwidth. No numerical commitments are made by U S WEST with respect to the cell loss ratio experienced by a UBRS connection, or as to the cell transfer delay experienced by cells on the connection.

The traffic parameter for UBRS connections is the Peak Cell Rate (PCR), which specifies the highest cell rate a customer is provided on a connection. The customer selects the bandwidth characteristics of a UBRS logical connection by choosing the appropriate PCR. The traffic parameters chosen by the EU for their UBRS logical connections define the bandwidth characteristics available to the EU.

2.2.10 U S WEST ATM Cell Relay Service Stand Alone Optical Access Link

A U S WEST ATM Cell Relay Service Stand-Alone Optical Access Link (SAOAL) connects customer facilities to cell relay networks provided by service providers other than U S WEST. Private line transport mileage and/or a Central Office Connecting Channel (COCC) may be required in conjunction with a Stand-Alone Optical Access Link in order to connect the customer's Serving Wire Center (SWC) with the SWC of another ATM Cell Relay Service provider. U S WEST does not provide basic administration of PVCs on a SAOAL.

2.2.11 ATM Cell Relay Standards And Specifications

ATM Cell Relay Service is based on the following documents:

- TA-TSV-001408, Generic Requirements for PVC Cell Relay Service, Bellcore, Technical Advisory.
- SR-3330, Cell Relay Service Core Features, Bellcore, Special Report.
- SR-3445, Requirements for PVC Cell Relay Service, Bellcore, Special Report.
- ATM Forum, ATM User Network Interface Specification, Version 3.1, Prentice-Hall 1994.
- ATM Forum, DS1 Physical Layer Specification, The ATM Forum 1994.
- ATM Forum, DS3 Physical Layer Interface Specification, The ATM Forum 1996.
- ANSI T1.511, B-ISDN ATM Layer Cell Transfer - Performance Parameters.
- GR-1113-CORE, Asynchronous Transfer Mode (ATM) and ATM Adaptation Layer (AAL) Protocols, Bellcore.

- GR-1248-CORE, Generic Requirements for Operations of ATM Network Elements, Bellcore.
- GR-1117-CORE, Generic Requirements for Exchange PVC CRS Service, Bellcore.
- TR-NWT-001112, Broadband ISDN User to Network Interface and Network Node Interface Physical Layer Generic Criteria, Bellcore.

2.3 U S WEST ATM Cell Relay Service PVC Service Overview

U S WEST ATM Cell Relay Service is a connection-oriented communications service that uses ATM to provide EUs with high-speed (1.544, 44.736 and 155.520 Mbit/s), low delay networking capabilities. U S WEST ATM Cell Relay Service is ideal for data intensive business computing applications that require near-real-time mixed media (e.g. data, video, & image) communications among multiple locations. U S WEST ATM Cell Relay Service has been implemented utilizing PVCs only.

2.3.1 PVC Implementation

PVCs are logical connections that define a specific transmission path between a Data Terminal Equipment (DTE) source device and a DTE destination device. Two types of PVCs are provided by U S WEST ATM Cell Relay Service: VCCs and VPCs. A U S WEST ATM Cell Relay Service PVC, which is similar to a dedicated private line in today's circuit switched environment, is identified in the U S WEST ATM Cell Relay Service Network by Virtual Path Identifiers (VPI) and Virtual Channel Identifiers (VCI). Each VPI and VCI is located within the five byte header of the standard ATM cell format, which is described in Chapter 4.

PVC implementation with U S WEST ATM Cell Relay Service permits an EU to define logical connections among multiple EU locations using a single Cell Relay Port per location. Simultaneous connectivity to many remote locations can be established through the provisioning of multiple PVC's. Figure 2-2 illustrates the connectivity capability available with the U S WEST ATM Cell Relay Service PVC offering.

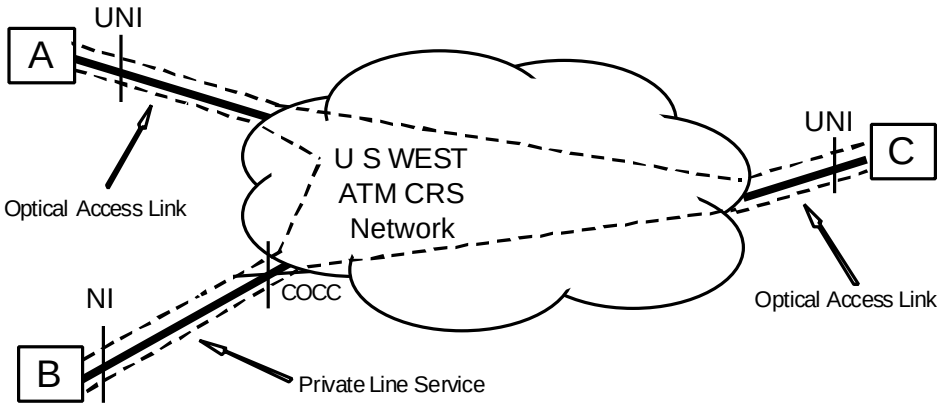


Figure 2-2 Example of EU Networking Using U S WEST ATM Cell Relay Service

Figure 2-2 shows three customer locations (A, B, and C) logically connected using PVC implementation with U S WEST ATM Cell Relay Service. Customers A and C are connected to the U S WEST ATM Cell Relay Service network via Optical Access Links. Customer B is connected to the U S WEST ATM Cell Relay Service network via a Private Line Service and Central Office Connecting Channel. These connections to the Network are represented by solid lines. The dashed lines represent a mesh of logical connections that can be supported across the access links using the native-mode ATM protocol. The logical connections shown in this example facilitate point-to-point communications between pairs of locations (i.e., A and B, A and C, or B and C).

2.3.2 Customer's Line Speed Requirements

The actual line speed requirements will be specified by the U S WEST ATM Cell Relay Service customer at service subscription time, and provisioned on appropriate transmission facilities and ATM Cell Relay Ports, while considering U S WEST Engineering procedures. U S WEST ATM Cell Relay Service Ports are the physical entry points into the U S WEST ATM Cell Relay Service Network for Optical Access Links or other compatible private line facilities (i.e., SST, DS3, or DS1). They are the originating and terminating points for VPCs and VCCs and enable customers to allocate bandwidth to applications at customer-designated line transmission speeds of up to 1.544 Mbit/s, 44.736 Mbit/s or 155.520 Mbit/s, which include appropriate overheads.

2.3.3 PVC Service Classes Supported

Peak Cell Rate Service

Peak Cell Rate Service (PCRS) has been designed to support a connection carrying a constant flow of information. The ATM Forum UNI Specification Version 3.1 refers to this type of information flow as CBR traffic. The traffic associated with such an application is best characterized as information that is transmitted (and received) at a fixed, steady and reliable rate. A PCRS connection will be provisioned to provide end-to-end performance comparable to that typically associated with a digital private line. PCRS PVC logical connections can be provisioned as VPCs or VCCs.

Sustained Cell Rate Service

Sustained Cell Rate Service (SCRS) has been designed to support a connection carrying information flowing at variable rates. The ATM Forum UNI Specification Version 3.1 refers to this type of information flow as VBR traffic. A U S WEST ATM Cell Relay Service connection carrying SCRS traffic will be provisioned to provide end-to-end performance comparable to that typically associated with Frame Relay Service. SCRS connections can be provisioned only as VCCs.

Unspecified Bit Rate Service

Unspecified Bit Rate Service (UBRS) has been designed to support a connection which does not specify traffic related service guarantees. The ATM Forum Traffic Management Specification Version 4.0 refers to this type of information flow as UBR traffic. The Unspecified Bit Rate (UBR) service category is intended for non-real-time applications, i.e., those not requiring tightly constrained delay, delay variation, and cell loss. Examples of such applications are traditional computer communications applications, such as file transfer and email, typically using TCP-IP. UBRS connections can be provisioned only as VCCs.

2.3.4 Service Class Traffic Parameters

U S WEST ATM Cell Relay Service traffic parameters are based on ATM Forum specifications. Table 2-1 indicates the traffic parameters for each of the Service Classes. The traffic parameters are defined following Table 2-1.

Table 2-1 Traffic Parameters

Service Class	Traffic Parameter(s)
Peak Cell Rate Service	Peak Cell Rate (PCR)
Sustained Cell Rate Service	Peak Cell Rate (PCR), Sustained Cell Rate (SCR), Maximum Burst Size (MBS)
Unspecified Bit Rate Service	Peak Cell Rate (PCR)

Peak Cell Rate (PCR)

The PCR traffic parameter specifies an upper bound on the cell rate that can be submitted across a connection. The PCR for a PCRS or UBRS connection is the associated bandwidth increment that is requested when the service is provisioned. The maximum allowable PCR for SCRS is described in Table 2-2.

Table 2-2 Maximum Allowable PCR for SCRS

Cell Relay Port (Mbits / second)	Maximum PCR (Mbits / second)	Maximum PCR (cells / second)
1.544 Mbit/second	1.536 Mbits/second	3,622 cells/second
45 Mbit/second (PLCP Mapped)	40.704 Mbits /second	96,000 cells/second
45 Mbit/second (Direct Mapped)	44.210 Mbits /second	104,268 cells/second
155 Mbit/second	149.760 Mbits /second	353,207 cells/second

Sustained Cell Rate (SCR)

The SCR defines an upper bound on the conforming average cell rate of a connection (i.e. rate averaged over a time interval). Along with PCR and Maximum Burst Size (MBS), SCR is used to describe a SCRS connection. The SCR is an upper bound on the conforming average cell rate, as measured using the Generic Cell Rate Algorithm (GCRA) in accordance with the ATM Forum UNI 3.1, including bursts above the average, that can be sustained over a SCRS logical connection. Provisioning of this limit requires allocation of sufficient network resources to meet the SCR, but less than those based on the PCR.

Maximum Burst Size (MBS)

Maximum Burst Sizes of 32, 100, or 200 cells will be used for U S WEST ATM Cell Relay Service (Table 2-3). The 32 cell burst size is the default value. It corresponds to one AAL5 encapsulated Ethernet frame. Note that there is a minimum bandwidth requirement of 4 Mbit/s for a SCRS logical connection with a MBS of 200 cells. It is expected that many customers may send bursts smaller than the MBS.

Table 2-3 Maximum MBS for U S WEST ATM Cell Relay Service

Maximum Burst Size (MBS) of Virtual Channel Connection (VCC)
32 cells
100 cells
200 cells

2.3.5 Individual PVC Subscription Quantities and Throughput

At service subscription time, each U S WEST ATM Cell Relay Service customer may request multiple VPCs and/or VCCs per Port. The maximum cell throughput achievable for each individual PVC provisioned on a given Cell Relay Port is selected from the values described in Tables 2-4 through 2-7. Cell throughput includes overheads added by customer provided equipment (i.e., ATM cell header and AAL header information). Section 2.4.6 will address the issue of maximum achievable throughput for all PVCs provisioned on a given Cell Relay Port.

By choosing appropriate cell rate values for the traffic parameters associated with a connection, a customer defines an equivalent bandwidth associated with each PVC U S WEST ATM Cell Relay Service logical connection. Table 2-4 lists the cell rates and corresponding cell throughput that will be supported for multiple PCRS or SCRS PVCs provisioned on a 1.544 Mbit/s port. Table 2-5 lists the cell rates and corresponding cell throughput that will be supported for multiple PCRS or SCRS PVCs provisioned on a 44.736 Mbit/s port. Table 2-6 lists the cell rates and corresponding cell throughput that will be supported for multiple PCRS or SCRS PVCs provisioned on a 155.520 Mbit/s port.

Table 2-7 lists the cell rates and corresponding cell throughput that will be supported for multiple UBRS PVCs provisioned on 1.544 Mbit/s, 44.736 Mbit/s, or 155.520 Mbit/s ports. The cell rates listed do not include an allowance for the AAL header and the Operations, Administration, and Maintenance (OAM) cell overhead. As illustrated in Table 2-8, for PCRS, a single logical connection configuration is also available. A customer may choose a single 1.536 Mbit/s (3,622 cells/second) logical connection on a 1.544 Mbit/s Port, a single 40.7 Mbit/s (96,000 cells/second) logical connection on a 44.736 Mbit/s PLCP mapped 44.736 Mbit/s Port, a single 44.210 Mbit/s (104,268 cells/sec) logical connection on a Direct mapped 44.736 Mbit/s Port, or a single 149 Mbit/s (353,207 cells/second) logical connection on a 155.520 Mbit/s Port. In these single PVC configurations, no allowance for the AAL header and the OAM cell overhead has been made.

Table 2-4 PCRS, SCRS, 1.544 Mbit/s Cell Relay Port Information

Cell Throughput	Cell Rate (cells/second)	Service Increments
N x 64 kbit/s	N x 150	N = 1 to 23 (sub-DS1)
N x 75 kbit/s *	N x 181	N = 1 to 20 (sub-DS1)
N x 1 Mbit/s	N x 2,358	N = 1

* Bandwidth needed for Structured Circuit Emulation with Channel Associated Signaling.

Table 2-5 PCRS or SCRS,44.736 Mbit/s Cell Relay Port Information

Cell Throughput	Cell Rate (cells/second)	Service Increments (PLCP Mapped)	Service Increments (Direct Mapped)
N x 64 kbit/s	N x 150	N = 1 to 23 (sub-DS1)	N = 1 to 23 (sub-DS1)
N x 75 kbit/s *	N x 181	N = 1 to 23 (sub-DS1)	N = 1 to 23 (sub-DS1)
N x 1 Mbit/s	N x 2,358	N = 1 to 40	N = 1 to 44
N x 1.544 Mbit/s	N x 3,641	N = 1 to 26	N = 1 to 28
N x 1.787 Mbit/s *	N x 4215	N = 1 to 22	N = 1 to 24

* Bandwidth needed for Structured Circuit Emulation with Channel Associated Signaling.

Table 2-6 PCRS or SCRS 155.520 Mbit/s Cell Relay Port Information

Cell Throughput	Cell Rate (cells/second)	Service Increments
N x 64 Kbit/s	N x 150	N = 1 to 23 (sub-DS1)
N x 75 kbit/s *	N x 181	N = 1 to 23 (sub-DS1)
N x 1 Mbit/s	N x 2,358	N = 1 to 149
N x 1.544 Mbit/s	N x 3,641	N = 1 to 96
N x 1.787 Mbit/s *	N x 4215	N = 1 to 83
N x 44.736 Mbit/s	N x 105,509	N = 1 to 3

* Bandwidth needed for Structured Circuit Emulation with Channel Associated Signaling.

Table 2-7 UBRS, Cell Relay Port Information

	Cell Throughput (N x 64 Kbit/s)	**Cell Throughput (N x 1 Mbit/s)**
Cell Rate (cells/second) (1.544 Mbit/s port)	N x 150	N x 2,358
Service Increments (1.544 Mbit/s port)	N = 1 to 23 (sub-DS1)	N = 1
Cell Rate (cells/second) (PLCP Mapped 45 Mbit/s port)	N x 150	N x 2,358
Service Increments (PLCP Mapped 45 Mbit/s port)	N = 1 to 23 (sub-DS1)	N = 40
Cell Rate (cells/second) (Direct Mapped 45 Mbit/s port)	N x 150	N x 2,358
Service Increments (Direct Mapped 45 Mbit/s port)	N = 1 to 23 (sub-DS1)	N = 1 to 44
Cell Rate (cells/second) (155 Mbit/s port)	N x 150	N x 2,358
Service Increments (155 Mbit/s port)	N = 1 to 23 (sub-DS1)	N = 1 to 149

Table 2-8 PCRS single PVC Information

Maximum Cell Throughput	Peak Cell Rate (cells/second)	Service Increments
1.536 Mbit/s	3,622 cells/second	N = 1
40.7 Mbit/s (PLCP Mapped)	96,000 cells/second	N = 1
44.21 Mbit/s (Direct Mapped)	104,268 cells/second	N = 1
149 Mbit/s	353,207 cells/second	N = 1

A customer defines the bandwidth of a PCRS connection by choosing an appropriate value for the PCR traffic parameter from Table 2-4, 2-5, 2-6, or 2-8 depending on the Cell Relay Port speed and number of PVCs. A customer establishes the bandwidth characteristics of a SCRS connection by choosing an appropriate value for the SCR traffic parameter from Table 2-4, 2-5, or 2-6 depending on the Cell Relay Port speed and number of PVCs. The PCR for a SCRS connection may be chosen by the customer or is equal to the Cell Relay Port speed if no PCR is chosen. A customer establishes the bandwidth characteristics of a UBRS connection by choosing an appropriate value for the PCR traffic parameter from Table 2-7, depending on the Cell Relay Port speed and number of PVCs. The PCR for a UBRS connection must be chosen by the customer. The maximum number of PVCs (VPCs and VCCs) per U S WEST ATM Cell Relay Port is stated in Table 2-8.

Table 2-9 Allocation of PVCs Per Cell Relay Port

Port Speed	Maximum Number of VPCs per U S WEST ATM Cell Relay Port	Maximum Number of VCCs per U S WEST ATM Cell Relay Port
1.544 Mbit/s	5	24
44.736 Mbit/s	50	500
155.520 Mbit/s	50	500

2.3.6 Individual UNI Subscription Quantities And Throughput For PCRS and SCRS

Each U S WEST ATM Cell Relay Service customer with multiple PCRS and/or SCRS VPCs and/or VCCs provisioned on a single Cell Relay Port must consider the maximum throughput achievable. The maximum achievable throughput for all PCRS and/or SCRS PVCs provisioned on a given Cell Relay Port is determined by completing the following calculations.

Maximum achievable throughput across a 1.544 Mbit/s Port with multiple PVCs:

[Total C.T. of all CBR PVCs] + [(Total C.T. of all VBR PVCs) x 1.25] < 1.536 Mbit/s

Maximum achievable throughput across a PLCP Mapped 44.736 Mbit/s Port with multiple PVCs:

[Total C.T. of all CBR PVCs] + [(Total C.T. of all VBR PVCs) x 1.25] < 40.704 Mbit/s

Maximum achievable throughput across a Direct Mapped 44.736 Mbit/s Port with multiple PVCs:

[Total C.T. of all CBR PVCs] + [(Total C.T. of all VBR PVCs) x 1.25] < 44.210 Mbit/s

Maximum achievable throughput across a 155.520 Mbit/s Port with multiple PVCs:

[Total C.T. of all CBR PVCs] + [(Total C.T. of all VBR PVCs) x 1.25] < 149.760 Mbit/s

where C.T. = Cell Throughput

CBR = Constant Bit Rate or PCRS

VBR = Variable Bit Rate or SCRS

PVCs = Permanent Virtual Connections (VPCs and/or VCCs)

An example is provided which may help clarify the above calculations. An EU customer has subscribed to a PLCP Mapped 44.736 Mbit/s U S WEST ATM Cell Relay Service Port with the following PCRS and SCRS PVCs:

- VCC with 10 Mbit/s Cell Throughput, VBR SCRS
- VCC with 1.5 Mbit/s Cell Throughput, CBR PCRS
- VCC with 6 Mbit/s Cell Throughput, VBR SCRS
- VPC with 5 Mbit/s Cell Throughput, CBR PCRS

Calculations:

- [Total C.T. of all CBR PVCs] + [(Total C.T. of all VBR PVCs) x 1.25] < 40.704 Mbit/s
- [1.5 Mbit/s + 5 Mbit/s] + [(10 Mbit/s + 6 Mbit/s) x 1.25] < 40.704 Mbit/s
- [6.5 Mbit/s] + [(16 Mbit/s) x 1.25] < 40.704 Mbit/s
- [6.5 Mbit/s] + [20 Mbit/s] < 40.704 Mbit/s
- 26.5 Mbit/s < 40.704 Mbit/s

Therefore, this 44.736 Mbit/s Port meets the parameters for maximum achievable throughput.

2.4 General Architecture

U S WEST ATM Cell Relay Service essentially establishes logical connectivity between the cell relay EU customers devices, using PVCs (VPCs and/or VCCs) which can be multiplexed over a single access path. The U S WEST ATM Cell Relay Network Architecture which supports and administers the U S WEST ATM Cell Relay Service Nodes, Optical Access Links, Ports and the virtual connections consists of the following elements:

- Fiber optic facility used to access the U S WEST ATM Cell Relay Network. Each U S WEST ATM Cell Relay Service Optical Access Link can operate at different line speeds (44.736 Mbit/s or 155.520 Mbit/s).
- Cell Relay Ports located within a Cell Relay Node.
- Cell Relay Nodes located within a U S WEST Wire Center.
- Digital Internodal Facilities between U S WEST Cell Relay Nodes.
- U S WEST Network Administration and Monitoring Systems.

2.4.1 EU Customer Provided Equipment (CPE) Data Terminal Equipment (DTE) Requirements

The EU's CPE Data Terminal Equipment (DTE) device accumulates customer traffic (e.g., LAN traffic, host computer, voice, video, multimedia), and inserts the customer data into an ATM cell relay format suitable for transmission over the U S WEST ATM Cell Relay Service Network (i.e., using ATM cell transfer protocols). The Network performs only ATM and physical layer functions, while the EU customer's communication equipment is responsible for performing AAL and higher layer protocol functions. Protocols running above the ATM layer (i.e., the cell payload) are passed transparently through the U S WEST ATM Cell Relay Service Network. The UNI provides access to the network for transport. Recommended customer CPE DTE options and the U S WEST ATM Cell Relay Service physical UNIs are addressed in Chapter 3.

2.4.2 Cell Relay Node

The administration and coordination of each PVC segment or link, and its associated VPI/VCI, is performed at U S WEST ATM Cell Relay Node locations (the administration and coordination of the overall PVC is performed at a U S WEST Operations Center). A Cell Relay Node examines each VPI/VCI to determine the cell's destination path based on the pre-subscribed PVC (VPC/VCC) information.

Due to the fact that each VPI/VCI has only local significance, each Cell Relay Node will associate each local VPI/VCI with a pre-defined path. The destination VPI/VCI may reside within a local or remote Cell Relay Node, or within another ATM Cell Relay Network Provider's Serving Area. If the Cell Relay Node determines the cell's destination is not local, the cell is transmitted over internodal facilities to the next appropriate Cell Relay Node, or the interconnecting Cell Relay Network. This process is reiterated until the cell reaches its final destination (i.e., EU CPE DTE device).

2.5 U S WEST ATM Cell Relay Service Configuration

The purpose of this section is to describe some of the typical service configurations associated with U S WEST ATM Cell Relay Service. U S WEST ATM Cell Relay Service may utilize both interoffice and local loop facilities to support the transport of U S WEST ATM Cell Relay Service customer traffic. The U S WEST ATM Cell Relay Service EU customer can access the U S WEST ATM Cell Relay Network via U S WEST ATM Cell Relay Service Optical Access Links, or private line transport, which is established between the customer premises location and the nearest U S WEST ATM Cell Relay Service Point. Service Points are geographic locations, designated by U S WEST, where the U S WEST ATM Cell Relay Network can be accessed. U S WEST ATM Cell Relay Service Ports are the physical entry points into the U S WEST ATM Cell Relay Service Network for Optical Access Links or other compatible private line facilities and are the originating and terminating points for VPCs and VCCs. Ports include the electronic equipment used in connecting these service elements to the U S WEST ATM Cell Relay Service Network. They enable customers to allocate bandwidth to applications at customer-designated transmission speeds of up to 1.544 Mbit/s, 44.736 Mbit/s or 155.520 Mbit/s.

2.5.1 U S WEST ATM Cell Relay Service Network And Service Points

The U S WEST ATM Cell Relay Service Network is considered to consist of Service Points, Cell Relay Nodes, Cell Relay Ports, and internodal facilities. U S WEST Interoffice Facilities will be utilized to transport U S WEST ATM Cell Relay Service internodal traffic within the same Local Access and Transport Area (LATA).

U S WEST will establish Cell Relay Nodes and designate certain Serving Wire Centers (SWCs) as Service Points to support U S WEST ATM Cell Relay Service.

If the U S WEST SWC of an EU customer is not a Service Point, U S WEST ATM Cell Relay Service access may be provided via:

- A customer ordered Private Line Service (i.e. DS1, DS3, SST), interoffice facilities, and Central Office (CO) terminations (e.g., CO connecting channels). See Subsection 2.6.5, Exhibit 2-3, and Section 3.8 for further details on this specific service configuration.

2.5.2 U S WEST ATM Cell Relay Service UNI

The EU UNI is the point at which a customer's data transmissions first enter the network supporting U S WEST ATM Cell Relay Service. It is the point of interconnection between U S WEST's facilities and customer terminal equipment. The UNIs offered to the EU customers will be at the following signal rates: 1.544 Mbit/s, 44.736 Mbit/s and 155.520 Mbit/s. Chapter 4 of this document describes the protocol structure of the ATM Layer for cell relay. The EU customer's physical interfaces for U S WEST ATM Cell Relay Service are described in Chapter 3. The UNI for cell relay signaling and its data transfer protocol are specified in the ATM Forum User Network Interface Specification 3.1. The U S WEST ATM Cell Relay Service Optical Access Link(s) which terminates on the EU customer's UNI may be provided over existing U S WEST Fiber Optic Facilities.

2.5.3 Single Wire Center Service Configuration

A single wire center configuration, shown in Exhibit 2-1, will support multiple U S WEST ATM Cell Relay Service EUs whose nearest Cell Relay Node (i.e., Service Point) is located within the same SWC. Multiple PVCs per Cell Relay Port will provide multiple VPCs/VCCs for U S WEST ATM Cell Relay EU customers within the same U S WEST ATM Cell Relay Node.

A single wire center service configuration consists of the following:

- Single Cell Relay Node
- Multiple Cell Relay Ports
- A single wire center which contains each EU customer's nearest Service Point.

2.5.4 Multiple Wire Center Service Configuration

A multiple wire center configuration, shown in Exhibit 2-2, will support multiple U S WEST ATM Cell Relay Service EUs whose nearest Cell Relay Nodes (i.e., Service Point) are located within different SWCs. Multiple PVCs per Cell Relay Port will provide multiple VPCs/VCCs for U S WEST ATM Cell Relay EU customers served from multiple U S WEST ATM Cell Relay Nodes.

A multiple wire center service configuration consists of the following:

- Multiple Cell Relay Nodes
- Multiple Cell Relay Ports
- Multiple wire centers which contain each EU customer's Service Point.
- Trunks between ATM Cell Relay Service Nodes.

2.5.5 Non-Local U S WEST ATM Cell Relay Service Point Service Configuration

A service configuration in which the nearest Service Point is not located within the U S WEST ATM Cell Relay Service customer's nearest U S WEST Serving Wire Center is shown in Exhibit 2-3. When a customer's SWC is not a U S WEST ATM Cell Relay Service Point, the customer may have the following option:

- Utilize a combination of a U S WEST ATM Cell Relay Service Port, a Central Office Connecting Channel, and customer ordered, Company-provided Private Line services (i.e. DS1, DS3, SST) to reach the nearest U S WEST ATM Cell Relay Service Point. If a customer utilizes Private Line services to access U S WEST ATM Cell Relay Service, the associated regulations, rates and charges for such Private Line services shall apply in addition to the rates and charges associated with the U S WEST ATM Cell Relay Service elements. See Exhibit 2-3 and Section 3.8.

A Non-Local U S WEST ATM Cell Relay Service Point service configuration may consist of the following:

- A customer's nearest SWC which is not a Service Point.
- A Private Line Service (DS1, DS3, or SST).
- CO Connecting Channels.
- An interoffice facility.
- Multiple Cell Relay Ports.
- Cell Relay Node.

2.5.6 Optical Access Link Diversity Service Configuration

A U S WEST ATM Cell Relay Service OAL Diversity service configuration, shown in Exhibit 2-4, provides a “standby” protect fiber path, which is routed over facilities separated, from the normal path, by 25 feet or more. Fiber optic facility separation is from the first utility vault outside the Serving Wire Center to the last utility vault or hand hole prior to the EU customer’s premises.

An OAL Diversity service configuration consists of the following:

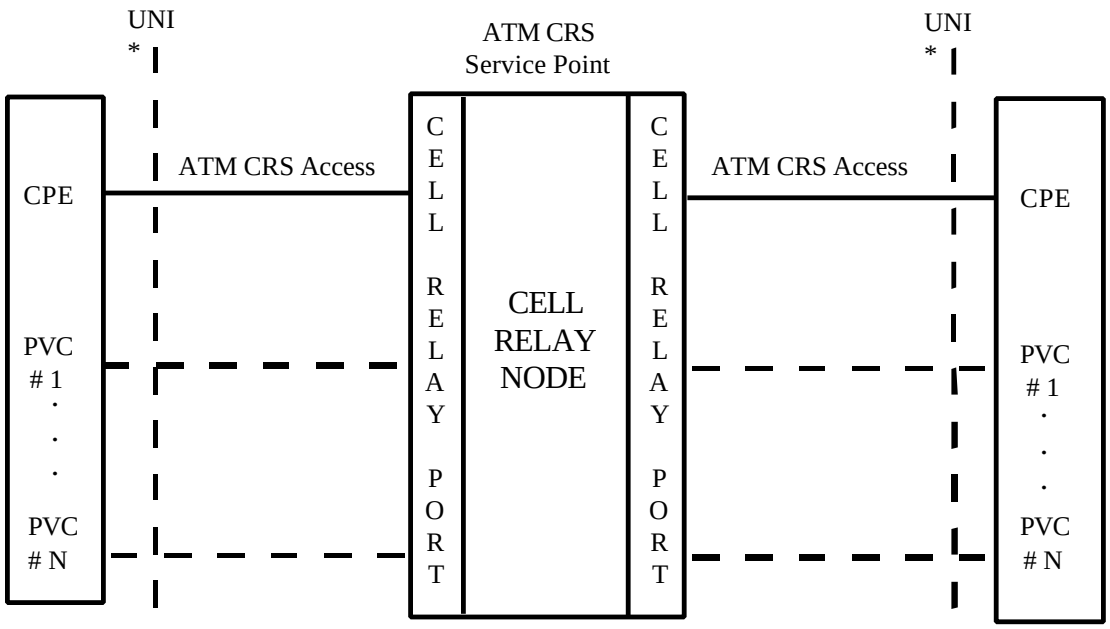
- A customer's nearest SWC.
- A U S WEST ATM Cell Relay Service OAL.
- A “Normal” fiber path.
- A “Protect” fiber path.

2.5.7 Stand-Alone Optical Access Link Service Configuration

A U S WEST ATM Cell Relay Service SAOAL service configuration, shown in Exhibit 2-5, provides access to cell relay networks provided by service providers other than U S WEST. Private line transport mileage and/or a COCC may be required in conjunction with a SAOAL in order to connect the customer's serving wire center, or node, with the serving wire center, or node of another ATM Cell Relay Service provider. U S WEST does not provide administration of PVCs on a SAOAL.

A SAOAL service configuration consists of the following:

- A customer's nearest SWC which may or may not be a Service Point.
- A U S WEST ATM Cell Relay Service SAOAL.
- May or may not include a COCC and private line transport mileage.



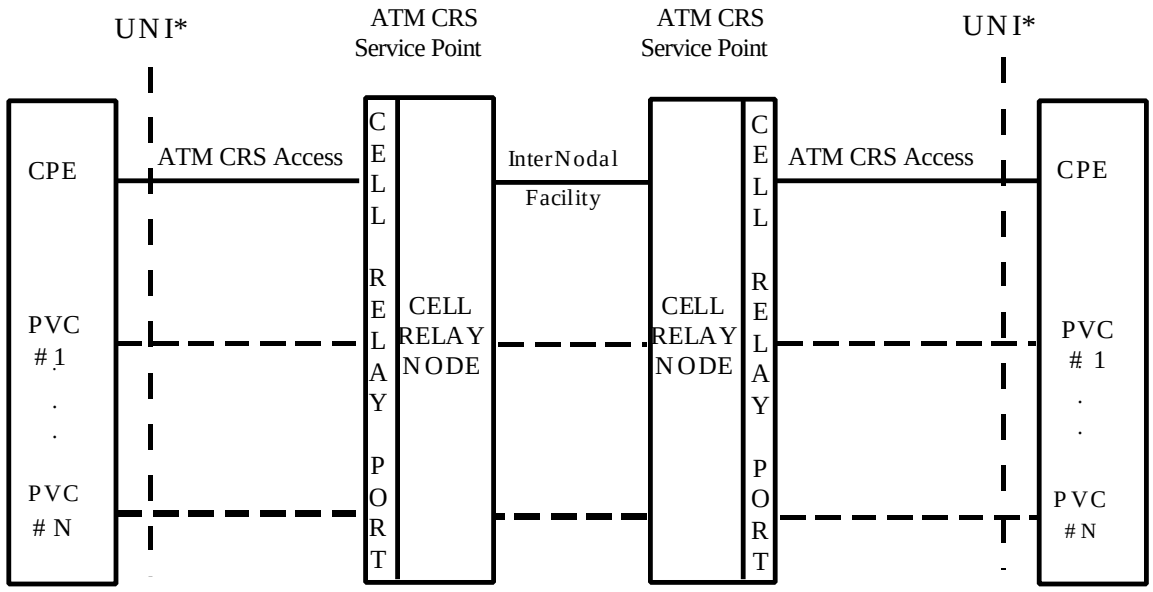
N = 1 thru 5 VPCs, 1 thru 24 VCCs for a 1.544 Mbit/s access line speed
N = 1 thru 50 VPCs, 1 thru 500 VCCs for a 44.736 Mbit/s access line speed
N = 1 thru 50 VPCs, 1 thru 500 VCCs for a 155.520 Mbit/s access line speed

* U S WEST ATM Cell Relay EU customer traffic will exchange information at the UNI based on the PVC cell relay signaling of the UNI defined in the ATM Forum User Network Interface Specification 3.1 (1994).

LEGEND:

CPE - Customer Provided Equipment
ATM CRS - ATM Cell Relay Service
UNI - User-Network Interface
PVC - Permanent Virtual Connection

Exhibit 2-1 Single Wire Center Configuration



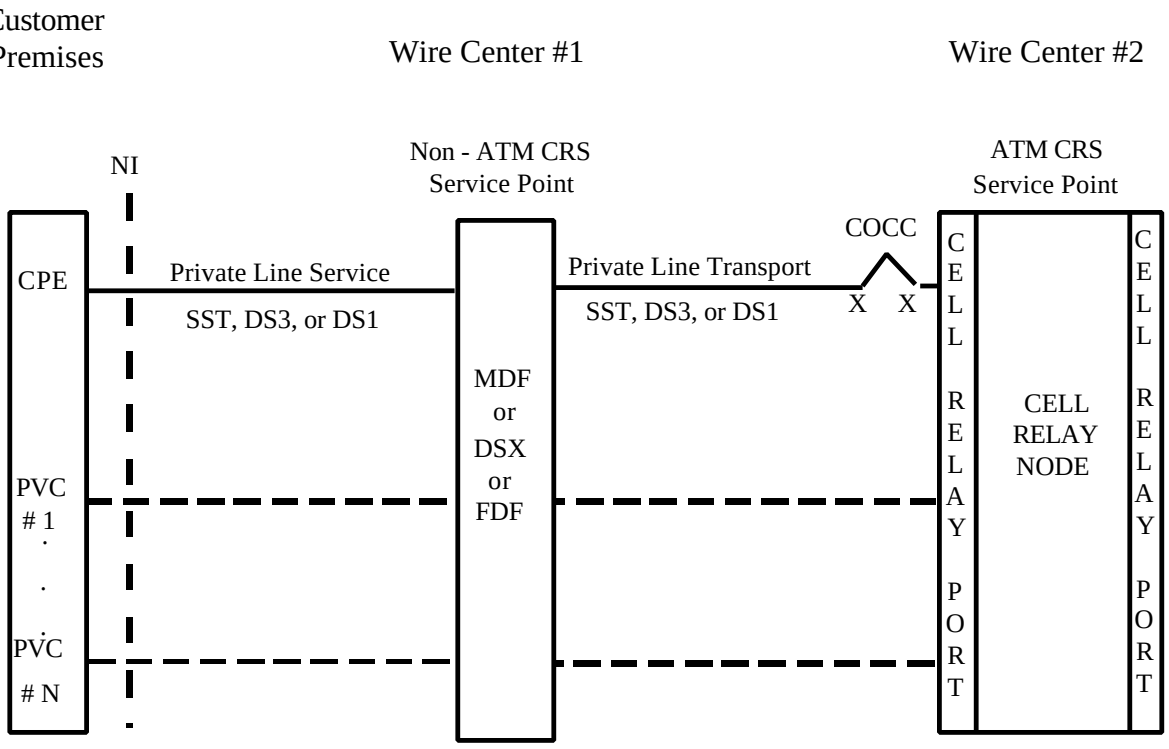
N = 1 thru 5 VPCs, 1 thru 24 VCCs for a 1.544 Mbit/s access line speed
N = 1 thru 50 VPCs, 1 thru 500 VCCs for a 44.736 Mbit/s access line speed
N = 1 thru 50 VPCs, 1 thru 500 VCCs for a 155.520 Mbit/s access line speed

*U S WEST ATM Cell Relay EU customer traffic will exchange information at the UNI based on the PVC cell relay signaling of the UNI defined in the ATM Forum User Network Interface Specification 3.1 (1994).

LEGEND:

CPE - Customer Provided Equipment
ATM CRS - ATM Cell Relay Service
UNI - User-Network Interface
PVC - Permanent Virtual Connection

Exhibit 2-2 Multiple Wire Center Configuration



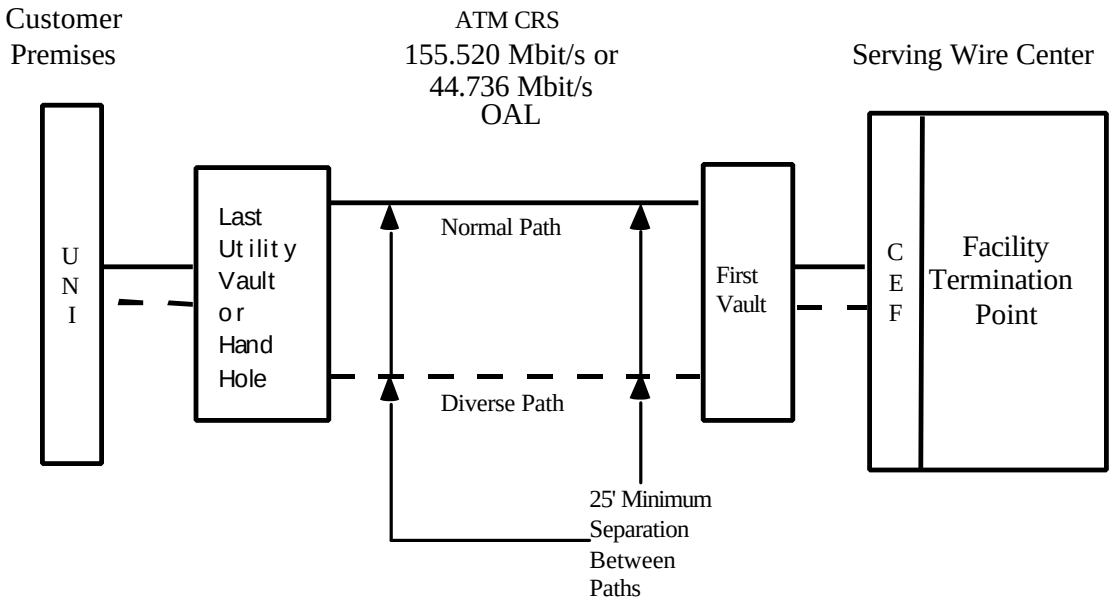
N = 1 thru 5 VPCs, 1 thru 24 VCCs for a 1.544 Mbit/s access line speed
N = 1 thru 50 VPCs, 1 thru 500 VCCs for a 44.736 Mbit/s access line speed
N = 1 thru 50 VPCs, 1 thru 500 VCCs for a 155.520 Mbit/s access line speed

* U S WEST ATM Cell Relay EU customer traffic will exchange information at the UNI based on the PVC cell relay signaling of the UNI defined in the ATM Forum User Network Interface Specification 3.1 (1994).

LEGEND:

CPE - Customer Provided Equipment
ATM CRS - ATM Cell Relay Service
NI - Network Interface
UNI - User-Network Interface
PVC - Permanent Virtual Connection
COCC - Central Office Connecting Channel

Exhibit 2-3 Non-Local U S WEST ATM Cell Relay Service Point Service Configuration (Private Line Service Option)

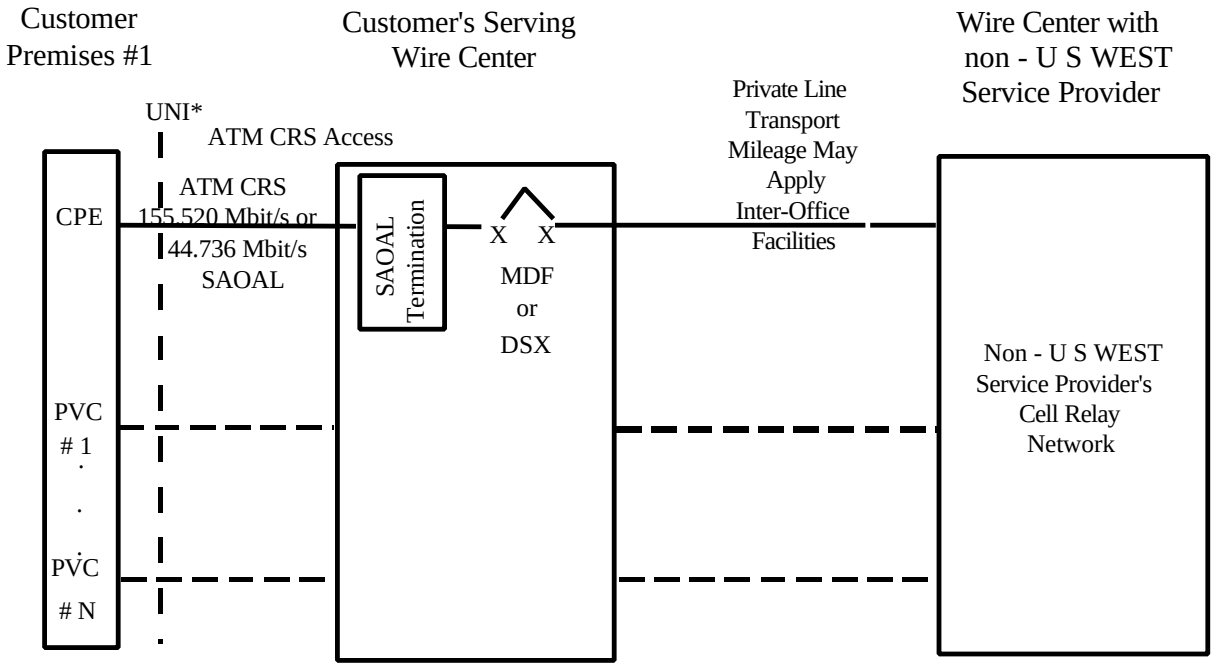


NOTE: There is no minimum separation from the vault/terminal into the wire center/customer premises.

LEGEND:

OAL - Optical Access Link
CEF - Cable Entrance Facility
ATM CRS - ATM Cell Relay Service
UNI - User-Network Interface

Exhibit 2-4 Optical Access Link Diversity Service Configuration



N = 1 thru 50 VPCs, 1 thru 500 VCCs for a 44.736 Mbit/s access line speed
N = 1 thru 50 VPCs, 1 thru 500 VCCs for a 155.520 Mbit/s access line speed

* U S WEST ATM Cell Relay EU customer traffic will exchange information at the UNI based on the PVC cell relay signaling of the UNI defined in the ATM Forum User Network Interface Specification 3.1 (1994).

LEGEND:

SAOAL - Stand-Alone Optical Access Link
CPE - Customer Provided Equipment
ATM CRS - ATM Cell Relay Service
UNI - User-Network Interface
PVC - Permanent Virtual Connection

Exhibit 2-5 Stand-Alone Optical Access Link Service Configuration

CONTENTS

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Figures

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3. Physical Layer

3.1 Description of Network Interfaces (NIs) for U S WEST ATM Cell Relay Service

3.1.1 155.520 Mbit/s User Network Interface

A U S WEST ATM Cell Relay Service 155.520 Mbit/s Optical Access Link is provided to a customer End-User (EU). The signal characteristics at the NI of an EU customer conform to ANSI T1.105, "Telecommunications - Digital Hierarchy Optical Interface Rates and Formats Specifications (SONET)" the standard for Digital Hierarchy - Optical Interface Rates and Formats Specifications (SONET). The optical characteristics at the UNI of an EU customer conform to GR-NWT-000253, “Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria.

The physical NI to an EU customer will be a fiber optic connector of type FC-PC. The FC-PC type connector is a 2.5 mm ferrule, keyed bayonet format connector. Wiring and application information for the FC-PC connector is shown in Exhibit 3-1.

3.1.2 44.736 Mbit/s User Network Interface

A U S WEST ATM Cell Relay Service 44.736 Mbit/s Optical Access Link is provided to a customer EU. The signal characteristics at the NI of an EU customer are described in ANSI T1.404, "Telecommunications - Carrier-to-Customer Installation - DS3 Metallic Interface Specifications".

The physical NI to an EU customer will be a connector of type SJA44. Wiring and application information for the SJA44 jack is shown in Exhibit 3-2.

3.1.3 1.544 Mbit/s User Network Interface

The U S WEST ATM Cell Relay Service 1.544 Mbit/s service offering is provided to a customer EU via U S WEST DS1 Service (see Section 3.8.1). The signal characteristics at the NI of an EU customer are described U S WEST Technical Publication 77375.

The physical NI to an EU customer will be a Registration Jack of type: RJ48C, RJ48H, RJ48M. The selection of one of the above physical connectors is a customer option.

3.2 155.520 Mbit/s Network Interface (NI) Power Levels

It is the responsibility of the transmitting party to achieve the minimum interface power. The optical power level at the 155.520 Mbit/s Interface should meet the following minimum fixed power point levels:

- Intermediate reach laser (1310 nm)

  The EU customer will receive not less than -27 dB at the NI.

  The EU customer will transmit not less than -16 dB at the NI.

- Long reach laser (1310 nm)

  The EU customer will receive not less than -33 dB at the NI.

  The EU customer will transmit not less than -6 dB at the NI.

These levels were developed to allow for maximum distances between the EU customer and the ATM Cell Relay Service Point. It is the responsibility of the receiving party to attenuate the optical signal level if required.

3.3 NC and NCI Code Definitions

3.3.1 NC Code

The NC code is an encoded representation used to identify both switched and non-switched services. Included in this code set are customer options associated with individual channel services, or feature groups and other switched services.

3.3.2 NCI Code

The NCI code is an encoded representation used to identify five (5) interface elements located at a POT in either a Central Office (CO) or a customer location. The interface elements include: Total Conductors, Protocol, Impedance, Protocol Options and Transmission Level Points (TLP).

3.3.3 Code Structure

The basic characteristic of a code; its length and generic representation.

3.3.4 Data Element

A uniquely named and defined category of data (e.g., Protocol Format Structure), a combination of data elements grouped in a prescribed sequence.

3.3.5 A = Alpha characters, A-Z

3.3.6 N = Numeric characters, 0-9

3.4 Network Channel (NC) Format Structure

An NC code is a four-character code with two data elements: Channel Code and Optional Feature Code. The format is illustrated in Figure 3-1.

Network Channel Code

Data Element	Channel Code		Optional Feature Code	
Character Position	1	2	3	4
Character Key	X	X	X or -	X or -

X = Alphanumeric
\- = Hyphen

Figure 3-1 Format Structure for NC Code

3.4.1 Channel Code

The **Channel Code** (character position 1 and 2) is a two character alpha or alphanumeric code that describes the channel service in an abbreviated form. The channel code will frequently, but not always, be specified as the service code of the special service circuits or the transmission grade of the message trunk circuit. The NC channel code field is always filled.

3.4.2 Optional Feature Code

The **Optional Feature** (character position 3 and 4) is a two character alpha or alphanumeric or hyphen code that represents the option codes available for each channel code. Varying combinations of this code will allow the customer to enhance the technical performance of the requested channel, or to further identify the type of service. It is also used to specify options such as conditioning, effective 4-wire, multiplexing, etc. The NC Optional Code field is always filled.

3.5 NC Codes

The NC Code is an encoded description of the channel provided by U S WEST. This channel is established between one of the following:

- Carrier, Interexchange Carrier (IC) or U S WEST Point of Termination (POT) and an EU-POT.
- Two EU-POTs
- Two Carrier POTs

The NC Code set contains customer options associated with individual channel services. The EU customer or Carrier must specify the NC codes for the desired service when ordering U S WEST ATM Cell Relay Service. This section describes the NC codes which apply specifically to U S WEST ATM Cell Relay Service. The ATM Cell Relay Service NC Code definitions emulate existing NC Code definitions, only differing by a "fast packet" identifier which signifies the transport of packets over a communications channel provided by U S WEST ATM Cell Relay Service.

3.5.1 NC Code Form

The NC code has the form XGBB. There are always four positions. There are neither spaces nor delimiters between the characters.

3.5.2 NC Code Components

An NC code consists of four alpha/numeric characters. The first two positions are the alpha Channel Codes used to define the basic channel type. The latter two positions are used to identify the channel options. The options positions may take the value of a dash (-).

3.5.3 Compatible NC Codes for the ATM Cell Relay Service 155.520 Mbit/s Optical Access Link

Table 3-1 lists the compatible STS3c, OC-3 NC codes for the 155.520 Mbit/s ATM Cell Relay Service Optical Access Link and Stand Alone Optical Access Link associated with U S WEST ATM Cell Relay Service. The NC Codes listed in Table 3-1 are applicable for access service applications of U S WEST ATM Cell Relay Service.

Note: OBBP should only be used for a 155.520 Mbit/s SAOAL. OBAP is the preferred NC code for a 155.520 Mbit/s OAL.

Table 3-1 **155.520 Mbit/s Access Compatible NC Codes**

Network Channel Code	Description
OB-P	OC-3 SONET, None / Point to Point, Optical termination on a switch (e.g., ATM)
OBAP	OC-3 SONET, Loop Timing / Point to Point, Optical termination on a switch (e.g., ATM)
OBBP	OC-3 SONET, External Timing / Point to Point, Optical termination on a switch (e.g., ATM)

3.5.4 Compatible NC Codes for the ATM Cell Relay Service 44.736 Mbit/s Optical Access Link

Table 3-2 lists the compatible NC codes for the 44.736 Mbit/s ATM Cell Relay Service Optical Access Link and Stand Alone Optical Access Link associated with U S WEST ATM Cell Relay Service. The NC Codes listed in Table 3-2 are applicable for access service applications of U S WEST ATM Cell Relay Service.

Table 3-2 **44.736 Mbit/s Access Compatible NC Codes**

Network Channel Code	Description
HFCA	High Capacity Channel Service HC3, C-Bit Parity M Framed, PLCP Mapped ATM Cells
HFCB	High Capacity Channel Service HC3, C Bit Parity M Framed, Direct Mapped ATM

3.6 Network Channel Interface (NCI) Format Structure

This section provides a brief description of the NCI format. The NCI code format contains a maximum of twelve characters that identify five (5) data elements (see Figure 3-2). A complete description of the NCI codes can be found in ANSI T1.223, "Telecommunications-Information Interchange - Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for the North American Telecommunications System." The NCI code identifies characteristics of the NI at the customers Point of Termination (POT).

The interface to the U S WEST Network is described by an interface code for each EU customer or carrier termination. The interface code must be specified by the customer when ordering the desired service. An ATM Cell Relay Service NCI code has four components as illustrated in Figure 3-1. The components of the NCI code format are illustrated in Figure 3-2, and are described below:

Network Channel Interface Code

Total Conductors		Protocol		Impedance	Delimeter	Protocol Options			Delimiter	TLP Level	
										Transmit	Receive
1	2	3	4	5	6	7	8	9	10	11	12
N	N	A	A	X	•	X	X	X	•	X or -	X or -

A = Alpha
N = Numeric
X = Alphanumeric
• = Delimiter (normally a period)
- = Hyphen

Figure 3-2 NCI Format Structure

3.6.1 Total Conductors

Total Conductors (character positions 1 and 2) is a two-character numeric code that represents the total number of physical conductors; e.g., wires, required at the interface. This field is always populated.

3.6.2 Protocol

Protocol (character positions 3 and 4) is a two-character alpha code that defines requirements for the interface regarding signaling and transmission. This field is always populated.

3.6.3 Impedance

Impedance (character position 5) is a one-character alpha or numeric code representing the nominal reference impedance that will terminate the channel for the purpose of evaluating transmission performance. This field is always populated.

3.6.4 Protocol Options

Protocol Options (character positions 7, 8, and 9) is a one to three character alpha, numeric, or alpha-numeric code that describes additional features; e.g., bit rate, bandwidth, etc., on the Protocol to be used. It is an optional field that is always left-justified when less than three characters are specified.

3.6.5 Transmission Level Points (TLPs)

TLPs do not apply for U S WEST ATM Cell Relay Service.

3.6.6 The NCI Delimiter Usage

Delimiters are required for overall code readability when using the NCI code format in a manual or mechanized mode. For purposes of this document and to be consistent with most service order and mechanized systems, delimiters will be counted as characters of information. The actual character used as the delimiter may differ from system to system, but is generally either a period (.) or a virgule (\ , /). Delimiter representation for the NCI code may not be specified as alpha, numeric, or hyphen.

The NCI code delimiters will be labeled as Delimiter #1 and #2 to show the difference between the delimiters (see Figure 3-2).

Delimiter #1 is used to indicate the start of the Protocol Option field if a Protocol Option code is assigned. When specified it will be in character position six (6).

Delimiter #2 is used to indicate the start of the TLP field if a TLP level is assigned to TRSG or RCVG or both. Delimiter #2 will not be assigned if both the TRSG and RCVG TLP character positions are blank.

If the Protocol Option Field is not coded and the TLP is coded, a double Delimiter #1 and #2 will be placed after character position five (5). In this case Delimiter #1 will be in character position six (6), and Delimiter #2 will be in character position seven (7). The TLP will be left-justified into character positions eight (8) and nine (9) accordingly.

If the Protocol Option Field is assigned, the Delimiter #2 character position will be dependent on the length of the Protocol Option code. Delimiter #2 is used in character position ten (10) if a three character Protocol Option code is assigned. Delimiter #2 will be in character position nine (9) if a two character Protocol Option code is assigned. Delimiter #2 will be in character position eight (8) if a one character Protocol Option code is assigned.

3.6.7 Applicable NCI Protocol Codes For ATM Cell Relay Service Optical Access Links

Existing NCI Codes for 1.544 Mbit/s, 44.736 Mbit/s and 155.520 Mbit/s NIs apply for U S WEST ATM Cell Relay Service. ATM Cell Relay Service uses all the existing NCI specifications to define the EU customer network access.

3.6.8 ATM Cell Relay Service 155.520 Mbit/s Optical Access Link NCI Codes at the Carrier Interface and IC-POP

These NCI Codes will be identified in a future issue of this publication, when U S WEST offers inter-Local Access Transport Area (inter-LATA) ATM Cell Relay Service.

3.6.9 ATM Cell Relay Service 155.520 Mbit/s Optical Access Link NCI Codes at the EU-POT

The SO protocol code is used to specify the interface at the EU-POT. The ATM Cell Relay Service 155.520 Mbit/s unprotected Optical Access Link NCI Codes with a SO protocol code may take the following forms:

- 02SOF.D.-- equals IR1-SLM (Intermediate Reach - Single-Longitudinal Mode)
- 02SOF.B.-- equals LR1-SLM (Long Reach - Single-Longitudinal Mode)

The ATM Cell Relay Service 155.520 Mbit/s protected Optical Access Link NCI Codes with a SO protocol code may take the following forms:

- 04SOF.D.-- equals IR1-SLM (Intermediate Reach - Single-Longitudinal Mode)
- 04SOF.B.-- equals LR1-SLM (Long Reach - Single-Longitudinal Mode)

3.6.10 ATM Cell Relay Service 44.736 Mbit/s Optical Access Link NCI Codes at the Carrier Interface and IC-POP

These NCI Codes will be identified in a future issue of this publication, when U S WEST offers Inter-LATA ATM Cell Relay Service.

3.6.11 ATM Cell Relay Service 44.736 Mbit/s Optical Access Link NCI Codes at the EU-POT

The DS protocol code is used to specify the interface at the EU-POT. The ATM Cell Relay Service 44.736 Mbit/s Optical Access Link NCI Codes with a DS protocol code may take the following form:

04DS6.44I	44.736 Mbit/s Electrical Interface, C-Bit Parity

3.6.12 Specifying NCI Codes for ATM Cell Relay Service Optical Access Links

The NCI codes specified by the customer when subscribing to the U S WEST ATM Cell Relay Service must be compatible. Section 3.6.13 provides additional NCI compatibility information based upon the NC Codes defined for the U S WEST ATM Cell Relay Service access rates (e.g., 1.544 Mbit/s, 44.736 Mbit/s and 155.520 Mbit/s).

3.6.13 Specifying NCI Codes for ATM Cell Relay Service Optical Access Links

Table 3-3 lists the recommended NC/NCI compatible combinations for U S WEST ATM Cell Relay Service Optical Access Links. A complete list of all NC/NCI valid combinations is beyond the scope of this publication due to the various levels of multiplexing which may be encountered when interconnecting other services with U S WEST ATM Cell Relay Service.

Table 3-3 **ATM Cell Relay Service NC/NCI Compatible Combinations**

NC Code	Characteristics	Compatible NCI Code
OB-P	Direct Mapped ATM Cells, Point to Point	02SOF.D.--, 02SOF.B.-- 04SOF.D.--, 04SOF.B.--
OBAP	Direct Mapped ATM Cells, Loop Timing	02SOF.D.--, 02SOF.B.-- 04SOF.D.--, 04SOF.B.--
OBBP	Direct Mapped ATM cells, External Timing	02SOF.D.--, 02SOF.B.-- 04SOF.D.--, 04SOF.B.--
HFCA	PLCP Mapped ATM Cells, C-Bit Parity	04DS6.44I
HFCB	Direct Mapped ATM Cells, C Bit Parity	04DS6.44I

3.7 Application of Cell Relay Service with other U S WEST Services

Interconnection to ATM Cell Relay Service from other U S WEST Services (e.g., U S WEST DS1, DS3, SHARP, SHNS, SST) is supported via a Central Office Connecting Channel arrangement. These arrangements are discussed in Subsections 3.8.1 - 3.8.5.

3.7.1 U S WEST DS1 Service with U S WEST ATM Cell Relay Service

U S WEST DS1 Service is described in Publication 77200 “U S WEST DS1 Service and U S WEST DS1 Rate Synchronization Service” as well as Publication 77375, “1.544 Mbit/s Channel Interfaces”. These publications should be consulted for a full description of the service. U S WEST Private Line Transport DS1 Service is a high capacity, high performance information channel designed for full duplex, point-to-point transmission at 1.544 Mbit/s. DS1 Clear Channel (DS1 CC) is required for connection to the U S WEST ATM Cell Relay Service Network. Clear Channel Capability fully utilizes the available 1.536 Mbit/s of a 1.544 Mbit/s channel. DS1 CC operation is enabled through the use of the Bipolar Eight Zero Substitution (B8ZS) line code. The DS1 signal must use Extended Superframe Format (ESF) for connection to the U S WEST ATM Cell Relay Service Network.

The Network Interface from the customer to the U S WEST Network is provided via the DS1 Service private line tariff. A COCC is required to implement a U S WEST DS1 Service connection to the U S WEST ATM Cell Relay Service Network. In order to provide DS1 Service with CRS, DS1 Service must be available to the customer.

The NC and NCI codes that are required for use in conjunction with the U S WEST DS1 Service portion of this service are listed in Table 3-4.

Table 3-4 **Compatible NC Codes for 1.544 Mbit/s Access**

NC Code	Characteristics	U S WEST CO Premises Compatible NCI Code	End User Premises Compatible NCI Code
HCEJ	ANSI ESF and B8ZS, ATM Termination	04DS9.1S	04DU9.1SN

3.7.2 U S WEST DS3 Service with U S WEST ATM Cell Relay Service

U S WEST DS3 Service is described in Technical Publication 77324, "U S WEST DS3 Service". The publication should be consulted for a full description of the service. U S WEST DS3 Service consists of a high capacity channel for the transmission of 44.736 Mbit/s isochronous serial data having a line code of Bipolar Three Zero Substitution (B3ZS).

The Network Interface from the customer to the U S WEST Network is provided via the DS3 Service private line tariff. A COCC is required to implement a U S WEST DS3 Service connection to the U S WEST ATM Cell Relay Service Network. In order to provide DS3 Service with CRS, DS3 Service must be available to the customer.

3.7.3 U S WEST Self-Healing Alternate Route Protection with U S WEST ATM Cell Relay Service

U S WEST Self-Healing Alternate Route Protection (SHARP) Service is described in Technical Publication 77340, "Self-Healing Alternate Route Protection (SHARP)". The publication should be consulted for a full description of the service.

SHARP is an optional service that improves the reliability of DS1 or DS3 services that are transported over fiber optic facilities. This feature provides a separate facility path for the protection system between the Serving Wire Center (SWC) and the U S WEST Point of Termination (POT) located in the same building as the customer designated premises.

The Network Interface from the customer to the U S WEST Network is provided via the SHARP Service private line tariff. A COCC is required to implement a U S WEST SHARP connection to the U S WEST ATM Cell Relay Service Network. In order to provide SHARP with CRS, SHARP must be available to the customer.

3.7.4 U S WEST Self Healing Network Service with U S WEST ATM Cell Relay Service

U S WEST Self Healing Network Service(SHNS) is described in Technical Publication 77332, "Self Healing Network Service". The publication should be consulted for a full description of the service.

U S WEST Self Healing Network Service offers a premium service arrangement designed to provide survivability of premises or between customer designated premises and U S WEST Wire Centers. The SHNS dedicates available bandwidth on the network exclusively to a single customer.

The Network Interface from the customer to the U S WEST Network is provided via the SHNS private line tariff. A COCC is required to implement a U S WEST SHNS connection to the U S WEST ATM Cell Relay Service Network. In order to provide SHNS with CRS, SHNS must be available to the customer.

3.7.5 U S WEST Synchronous Service Transport with U S WEST ATM Cell Relay Service

U S WEST Synchronous Service Transport (SST) Service is described in Technical Publication 77346, "Synchronous Service Transport". The publication should be consulted for a full description of the service.

The Network Interface from the customer to the U S WEST Network is provided via the SST Service private line tariff. A COCC is required to implement a U S WEST SST connection to the U S WEST ATM Cell Relay Service Network. In order to provide SST with CRS, SST must be available to the customer.

3.8 ATM CPE Card Information

Tables 3-5, 3-6, and 3-7 identify and recommend options for the customer provided ATM equipment. Note that not all customer provided ATM equipment may have the following options and/or features. However, an attempt has been made to identify and select the most common options. Often, ATM default settings will be acceptable when subscribing to U S WEST ATM Cell Relay Service. Peak Cell Rate (PCR) and Sustained Cell Rate (SCR) settings will not be known until the time of service subscription, and should be set equal to the subscribed parameters. Since U S WEST ATM Cell Relay Service offers optional Maximum Burst Sizes (32, 100, or 200 cells), it is recommended that the EU customer set their CPE buffer size appropriately. This should allow for maximum data transfer rates with no cell loss.

Table 3-5 ATM CPE Options for 1.544 Mbit/s

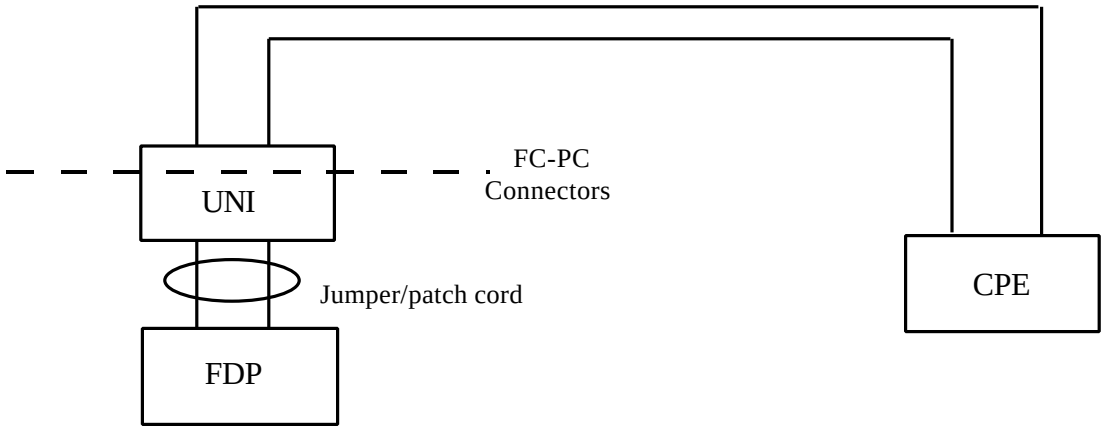
Basic Features / Options	Setting
Loop Timing	Enabled
Internal Timing	Disabled
Buffer Size	Dependent on Service Option
DS1 Frame Format	Extended Super Frame
DS1 Cell Mapping (customer option)	Direct Map (HEC)
DS1 Line Coding	B8ZS
ESF Performance Report Messages	ON
Cell Scrambling	OFF

Table 3-6 ATM CPE Options for 44.736 Mbit/s

Basic Features / Options	Setting
Loop Timing	Enabled
Internal Timing	Disabled
Buffer Size	Dependent on Service Option
DS3 Frame Format	C Bit Parity
DS3 Cell Mapping (customer option)	PLCP or Direct Map
Cell Scrambling	OFF

Table 3-7 ATM CPE Options for UBR Service, all port speeds

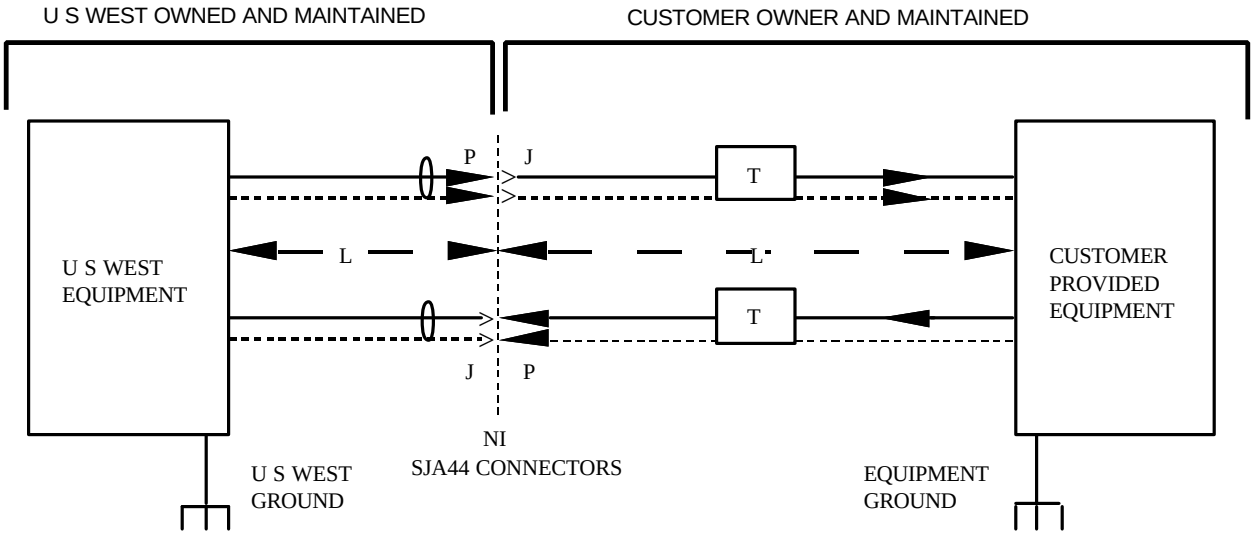
Basic Features / Options	Setting
Early Packet Discard (EPD)	ON
Minimum Cell Rate (MCR)	zero (0)
Peak Cell Rate (PCR) shaping	ON
PCR Oversubscription	yes - any (customer decision)



LEGEND

FDP - Fiber Distribution Panel
UNI - User-Network Interface
CPE - Customer Premises Equipment

Exhibit 3-1 155.520 Mbit/s Interface EU Premises



LEGEND:

T - Optional wideband transformers to mitigate ground currents.
P - TNC or BNC connector plug (see ANSI T1.404-1994, Section 8.2).
J - TNC or BNC connector jack (see ANSI T1.404-1994, Section 8.2).
L - Maximum distance, L = 450 feet of coaxial cable.

Notes:

1. This diagram indicates signal continuity arrangements and maximum allowable cable lengths. See ANSI Document ANSI T1.404-1994, Section 5 for electrical signal parameters.
2. Equipment grounding should follow recommended carrier/customer installation practices consistent with existing safety standards.
3. The BNC will be identified as the primary connector in the upcoming issue of ANSI T1.404.

Exhibit 3-2 44.736 Mbit/s Interface EU Premises

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4. ATM Layer Interface

4.1 General

The purpose of this section is to describe the cell structure and the embedded information of the cell relay ATM layer protocol. The material provided in this section represents an overview of the ATM layer protocol. More detailed information can be reviewed in the ATM Forum User Network Interface 3.1.

4.2 Protocol Structure

ITU-T Recommendation I.150, B-ISDN Asynchronous Transfer Mode Functional Characteristics, describes the functional characteristics of the ATM layer. ITU-T Recommendation I.361, B-ISDN ATM Layer Specifications, provides the ATM layer specifications.

4.3 Cell Structure

The ATM cell layer specifies the format of a 53 byte ATM cell. The ATM cell consists of a five (5) byte header and a forty-eight (48) byte information field. Figure 4-1 is a diagram of the basic cell format for the User Network Interface (UNI). Table 4-1 provides information regarding preassigned or reserved header values.

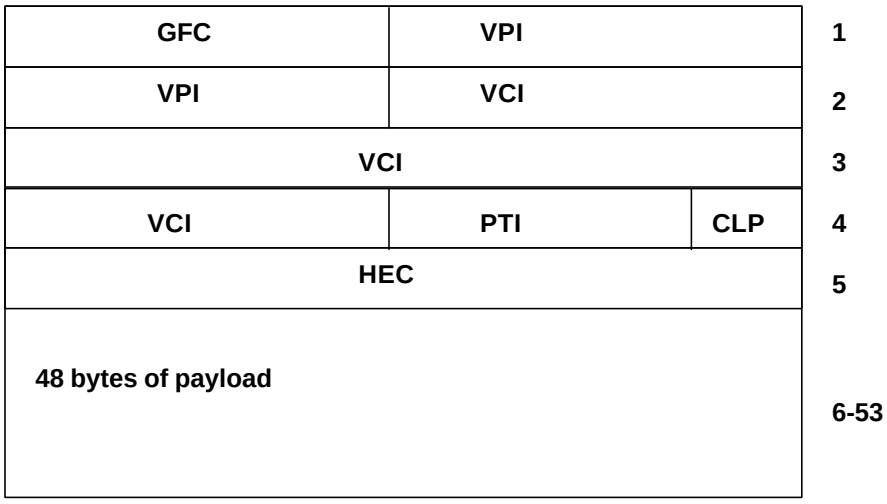

Figure 4-1 ATM Cell Format

Table 4-1 Preassigned or Reserved Header Values

Usage	VPI	VCI	PTI	CLP
Unassigned Cell	00000000	00000000 00000000	XXX	0
Idle Cell	00000000	00000000 00000000	000	1
Reserved for Physical Layer	00000000	00000000 00000000	PPP	1
Meta-signaling	XXXXXXXX	00000000 00000001	0A0	C
General Broadcast Signaling	XXXXXXXX	00000000 00000010	0AA	C
Point-to-Point Signaling	XXXXXXXX	00000000 00000101	0AA	C
Segment OAM F4 Flow Cell	YYYYYYYY	00000000 00000011	0A0	A
End-to-End OAM F4 Flow Cell	YYYYYYYY	00000000 00000100	0A0	A
Segment OAM F5 Flow Cell	YYYYYYYY	ZZZZZZZZ ZZZZZZZZ	100	A
End-to-End OAM F5 Flow Cell	YYYYYYYY	ZZZZZZZZ ZZZZZZZZ	101	A
Resource Management Cell	YYYYYYYY	ZZZZZZZZ ZZZZZZZZ	110	A

X= Doesn't Matter
Y = Any VPI value
Z = Any non-zero VCI
A = Use by appropriate function
C = Originator set CLP
P = Reserved for Physical Layer

4.3.1 Generic Flow Control (GFC)

Generic Flow Control is a four bit field reserved for flow control of a cell stream from an ATM connection at the UNI. It will be used locally to control access at the ATM level. The GFC may be used to alleviate short-term overload conditions, which may occur in the customer's network (it is not used inside the U S WEST ATM Cell Relay Service Network). The GFC will support both point-to-point and point-to-multipoint topologies. It should be noted that the exact GFC procedure has not been defined. Therefore, the only currently allowed coding for the GFC is 0000.

4.3.2 Virtual Path Identifier (VPI)

The VPI is an eight (8) bit field used for routing. The VPI labels the path or trunk number for a given ATM cell. There may be multiple connections across a single physical path. A VPI identifies/labels a group of channels (VCIs) between two points. A VPI may be used to "trunk together" related VCIs. All eight bits may not be required. Those that are used are referred to as allocated bits. All unused bits are set to 0. An all zeroes pattern indicates a physical layer cell or unassigned cell.

4.3.3 Virtual Channel Identifier (VCI)

The VCI is a sixteen- (16) bit field used for routing. The VCI labels the individual channel or line number for a given ATM cell. A VCI identifies/labels an individual connection between two ATM end points. This identifier has only local significance and the connection it labels may be only a piece of a complete virtual circuit. Along with the VPI, the VCI values contained in the cell header are used to uniquely identify individual ATM connections. All sixteen bits may not be required. Those that are used are referred to as allocated bits. All unused bits are set to 0. An all zeroes pattern indicates a physical layer cell or unassigned cell.

4.3.4 Payload Type Identifier (PTI)

The Payload Type Identifier (PTI) is a three- (3) bit field reserved to indicate whether the cell contains user data or various types of network management data.

Table 4-2 **PTI Code Points**

PTI Code Point (binary)	Explanation
000	User Data - SDU Type 0, no congestion experienced
001	User Data - SDU Type 1, no congestion experienced
010	User Data - SDU Type 0, congestion experienced
011	User Data - SDU Type 1, congestion experienced
100	Network management data
101	Network management data
110	Future network management data
111	Reserved for future

4.3.5 Cell Loss Priority (CLP)

The Cell Loss Priority (CLP) is a one (1) bit field that, when set, indicates that this cell may be discarded if conditions (e.g. switch congestion) require.

4.3.6 Header Error Control (HEC)

The Header Error Control (HEC) is an eight (8) bit field where a Cyclic Redundancy Check is computed over the five byte header to maintain the integrity of the data in the header. The integrity of data in the payload is left to a higher level protocol (e.g., TCP/IP) to ensure.

4.4 Cell Rate Decoupling

Unassigned cells must be added to the transmitted cell stream by the sending ATM entity. The reason for this is that a continuous cell stream matching the line rate of the UNI must be provided to the Physical Layer so that adequate cell delineation may be performed. An unassigned cell is an empty cell formatted according to the ATM Forum UNI 3. 1.

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5. Permanent Virtual Connection (PVC) Management

5.1 General

U S WEST ATM Cell Relay PVC Management Procedures will be evolving as the technology matures. The following sections describe PVC management procedures which may be utilized with U S WEST ATM Cell Relay Service deployment.

5.2 PVC Management Procedures

U S WEST ATM Cell Relay Service PVC Management Procedures are based on the following standards and specifications:

- ATM Forum, ATM User Network Interface Specification, Version 3.1, Prentice-Hall 1994.
- GR-1110-CORE, *Broadband Switching System (BSS) Generic Requirements*.
- GR-1248-CORE, Generic Requirements for Operations of ATM Network Element.
- TR-NWT-001112, *Broadband ISDN User to Network Interface and Network Node Interface Physical Layer Generic Criteria*.

The U S WEST ATM Cell Relay Nodes implement PVC Management Procedures based on the above standards in order to support the functions stated below:

- VPC/VCC Monitoring
- VPC/VCC Administration
- Fault Management

5.2.1 PVC Management Procedures at the UNI

The User-Network Management Procedures implemented by the U S WEST ATM Cell Relay Service Network at the User-Network Interface (UNI) are based on the principles set forth in ITU-T Recommendation I.610, B-ISDN Operation and Maintenance Principles and Functions. and further described in the ATM Forum document, User-Network Interface 3.1.

5.3 Congestion Admission Control (CAC)

Congestion Admission Control (CAC) is defined as the set of administrative procedures and actions taken by the U S WEST ATM Cell Relay Service Network to determine whether a request to establish a new ATM Cell Relay Service connection will be accepted or rejected. For example, a reason for rejecting a new ATM Cell Relay Service connection would be that its acceptance could result in the violation of Quality of Service (QoS) performance objectives either on this new connection or on other, already established connections. CAC functions apply to all ATM Cell Relay Service connections.

The CAC function uses the requested PCR and SCR values, the QoS Class and Cell Delay Variation Tolerance (CDV_{TOL}), together with known states of the U S WEST ATM Cell Relay Network and the attached Optical Access Links to estimate whether or not the requested ATM connection can be accepted.

The CAC function allows for a statistical multiplexing efficiency that is superior to peak rate allocation when operating on ATM Cell Relay Service connections having appropriate traffic characteristics.

5.4 Types of PVC Management Flows

The U S WEST ATM Cell Relay Service Network performs only ATM layer and physical layer Operation, Administration and Maintenance (OAM) functions. The End-User (EU) customer's communication equipment is responsible for performing ATM Adaptation Layer (AAL) and higher layer OAM functions. Protocols running above the ATM layer (i.e., the cell payload) are passed transparently through the U S WEST ATM Cell Relay Service Network. OAM functions of the physical layer and the ATM layer are structured according to OAM information flows. These information flows are described in Table 5-1.

Table 5-1 OAM Information Flows

Flow	Description	Layer
F1	Regenerator Section	Physical Layer (SONET)
F2	Digital Section	Physical Layer (SONET)
F3	Transmission Path	Physical Layer (SONET)
F4	Virtual Path	ATM Layer
F5	Virtual Channel	ATM Layer

5.4.1 Physical Layer OAM Information Flows

Physical layer (SONET) OAM functions can be divided into the following two types:

- Those dedicated to performance monitoring and reporting. This use of the F1, F2, and F3 flows is for OAM physical layer (SONET) management.
- Those dedicated to the detection and indication of unavailability states. This use of the F1, F2, and F3 flows is required for real-time failure information transfer towards the affected points within the network.

The U S WEST Cell Relay Network may utilize the F1 and F3 flows as illustrated in Table 5-2.

Table 5-2 **Physical Layer OAM Functions**

Flow	Function	Indicator
F1	Signal detection, cell recognition	Loss of signal
F1	Section error monitoring and reporting	Degraded or unacceptable error performance
F3	Cell rate decoupling	Failure of insertion
F3	Physical layer cell recognition	Loss of F3 cell recognition
F3	Cell delineation	Loss of cell synchronization
F3	Path error monitoring and reporting	Degraded error performance

5.4.2 ATM Layer OAM Information Flows

The U S WEST ATM Cell Relay Network may utilize ATM layer OAM functions to monitor Virtual Path Connection/Virtual Channel Connection (VPC/VCC) availability and/or perform Virtual Path and Virtual Channel level performance monitoring. The ATM layer OAM functions are described in Table 5-3.

Table 5-3 **ATM Layer OAM Functions**

Flow	Function	Indicator
F4	Monitoring path availability	Path not available
F4	Performance monitoring	Degraded performance
F5	Monitoring channel availability	Channel not available
F5	Performance monitoring	Degraded performance

5.5 ATM Cell Relay PVC Administration

Each U S WEST ATM Cell Relay Node is responsible for the administration of its own Cell Relay Network PVCs, and those of adjacent nodes. Each PVC is assigned an associated VPI/VCI for each end of a point-to-point logical connection at the time the customer subscribes to U S WEST ATM Cell Relay Service. During the service subscription process, the assignment(s) of VPI/VCI values at the UNI will require close coordination and cooperation to achieve conformity of VPI/VCI assignments. The VPI/VCI values at each end point of the ATM Cell Relay Service subscriber's PVC(s) may have different values, as the VPI/VCI values are of local significance only.

PVCs will remain in the U S WEST ATM Cell Relay Node(s) until each are individually removed, even in the case of a temporary unavailability of the virtual circuits due to a service failure.

It is the responsibility of each U S WEST ATM Cell Relay Service customer to populate and maintain its own CPE VPI/VCI routing tables. U S WEST will provide end point VPI/VCI information for each PVC at service subscription time. U S WEST will attempt to accommodate requests for specific VPI/VCI values at the end points whenever possible.

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6. Network Traffic Control and Congestion Management Responsibilities and Procedures

6.1 General

The manner in which traffic control and congestion management procedures are performed by U S WEST ATM Cell Relay Service is described in the following sections. The purpose of this information is to provide U S WEST ATM Cell Relay Service customers with a fundamental understanding of the traffic control and congestion management procedures which pertain to U S WEST ATM Cell Relay Service.

U S WEST ATM Cell Relay Service traffic control procedures will be performed in order to prevent congestion in the U S WEST ATM Cell Relay Network. U S WEST ATM Cell Relay Service congestion management procedures will be performed in order to alleviate congestion in the U S WEST ATM Cell Relay Network.

6.1.1 Purpose for U S WEST ATM Cell Relay Service Network Traffic Control and Congestion Management Procedures

U S WEST ATM Cell Relay Service Network Traffic Control and Congestion Management Procedures will be implemented with the following goals in mind:

- Provide fairness of service during congestion among the U S WEST ATM Cell Relay Service End Users' associated Cell Relay Ports, ATM Cell Relay Service Optical Access Links, and PVCs,
- Maximize throughput,
- Minimize loss of data,
- To relieve the congestion condition of the Cell Relay Module in a fast and effective manner.

U S WEST will also provision and monitor the cell relay internodal trunk thresholds in order to avoid excessive traffic congestion from occurring between Cell Relay Nodes.

6.2 Network Traffic Control

U S WEST ATM Cell Relay Service Network Traffic Control is performed via the Usage Parameter Control (UPC) function. UPC is defined as the set of actions taken by a U S WEST Cell Relay Node to monitor and control traffic at a UNI in terms of the traffic offered to the network over a U S WEST ATM Cell Relay Service Optical Access Link and/or Port. The U S WEST Cell Relay Node UPC functions are consistent with the definitions provided in the ATM Forum UNI 3.1.

The UPC function monitors the traffic offered to the network on a U S WEST ATM Cell Relay Service Optical Access Link and/or Port for conformance with the agreed upon traffic contract.

The UPC also monitors the traffic offered to the U S WEST ATM Cell Relay Network on an ATM Cell Relay Service Optical Access Link and/or Port for the validity of that connection, i.e., whether a cell's Virtual Path Identifier/Virtual Channel Identifier (VPI/VCI) values are associated with a Virtual Channel Connection (VCC) or Virtual Path Connection (VPC) which is assigned and active on that UNI. The UPC function shall discard any cell that carries an unassigned or inactive value of VPI/VCI for its UNI.

The UPC also operates on network-based measurements of the source traffic parameters Peak Cell Rate (PCR), Sustained Cell Rate (SCR) and Maximum Burst Size (MBS) used in the traffic contract associated with a given point-to-point VCC or VPC at the ingress of the U S WEST Cell Relay Node supporting the UNI. The U S WEST Cell Relay Node's UPC function will determine which cells associated with an active and assigned VCC or VPC are conforming or non-conforming.

6.2.1 U S WEST ATM Cell Relay Service Network Traffic Control Procedures for PCRS

Traffic control for U S WEST ATM Cell Relay Service PCRS, Constant Bit Rate (CBR) is based on the Peak Cell Rate (PCR). The PCR traffic parameter specifies an upper bound on the cell rate that can be submitted across a connection. The U S WEST Cell Relay Node UPC function will monitor the cell stream to test conformance with the connection's PCR.

All cells found to be non-conformant with the logical connection's provisioned characteristics, e.g., any cell exceeding the PCR by more than the allowed Cell Delay Variation Tolerance (CDV_{TOL}) will be discarded at the source UNI. GR-1110-CORE provides a detailed explanation of this function.

In theory, the PCR of a connection represents the precise rate at which cells should flow across a connection. However, in practice, the rate at which a stream of cells is transmitted across a connection may deviate from the connection's assigned PCR (i.e., an EU customer's CPE device may transmit cells in clusters with the cells arriving sooner than expected across the UNI). The UPC will allow a certain amount of cell clustering (i.e., cells arriving sooner than expected) on a connection before declaring cells to be non-conformant. The CDV_{TOL} parameter is used to gauge the amount of clustering permitted on a connection. This parameter will be used to specify the amount of variation from a connection's PCR that the U S WEST ATM Cell Relay Service Network will accept before declaring clustered cells to be non-conformant at the source UNI. The U S WEST Cell Relay Node UPC function will support the following values for CDV_{TOL} within PCRS: 50, 150, 250, or 500 microseconds for a 155.520 Mbit/s UNI, 150, 250, or 500 microseconds for a 44.736 Mbit/s UNI, and 250 or 500 microseconds for a 1.544 Mbit/s UNI.

6.2.2 EU Network Traffic Control Responsibilities for PCRS

U S WEST ATM Cell Relay Service PCRS EU Customers must perform traffic shaping within the EU Customer's CPE in order to conform with the traffic parameters agreed upon in the service contract. For PCRS connections, it is the responsibility of the EU Customer to not exceed the agreed upon PCR.

6.2.3 U S WEST ATM Cell Relay Service Network Traffic Control Procedures for SCRS

Traffic control for U S WEST ATM Cell Relay Service, SCRS, Variable Bit Rate (VBR) is based on the Peak Cell Rate (PCR), Sustained Cell Rate (SCR), and the Maximum Burst Size (MBS).

The PCR traffic parameter specifies an upper bound on the cell rate that can be submitted across a connection. The PCR for U S WEST ATM Cell Relay Service, SCRS connections, will be agreed upon in the service contract. The U S WEST Cell Relay Node UPC function will monitor the cell stream to test conformance with the connection's PCR. All cells found to be non-conformant with the logical connection's provisioned PCR will be discarded at the source UNI.

The SCR defines the "average cell rate" of a connection (i.e. rate averaged over a time interval). This SCR traffic parameter will be the primary mechanism used to allocate network bandwidth capacity associated with SCRS, VBR connections. The SCR of a connection represents the sustained rate at which cells can be transmitted across a VBR connection. In addition, momentary traffic bursts can be transmitted across a VBR connection at the connection's PCR. Maximum Burst Size options of 32, 100, or 200 cells will be available for U S WEST ATM Cell Relay Service. The UPC function will monitor and control the cell stream for conformance with the agreed upon traffic contract.

6.2.4 EU Network Traffic Control Responsibilities for SCRS

U S WEST ATM Cell Relay Service, SCRS EU Customers must perform traffic shaping within the EU Customer's CPE in order to conform with the traffic parameters agreed upon in the service contract. For SCRS connections, it is the responsibility of the EU Customer to not exceed the agreed upon SCR and PCR.

6.2.5 U S WEST ATM Cell Relay Service Network Traffic Control Procedures for UBRS

Unspecified Bit Rate Service (UBRS) is a "best effort" service designed to support a connection carrying information flowing at uneven rates. UBRS does not specify traffic related service guarantees. Specifically, UBRS does not include the notion of a per-connection negotiated bandwidth. No numerical commitments are made by U S WEST with respect to the cell loss ratio experienced by a UBRS connection, or as to the cell transfer delay experienced by cells on the connection.

Traffic control for U S WEST ATM Cell Relay Service UBRS, Unspecified Bit Rate (UBR) is based on the Peak Cell Rate (PCR). The PCR traffic parameter specifies an upper bound on the cell rate that can be submitted across a connection. The U S WEST Cell Relay Node UPC function will monitor the cell stream to test conformance with the connection's PCR. All cells found to be non-conformant with the logical connection's provisioned characteristics, e.g., any cell exceeding the PCR may be discarded at the source UNI.

6.2.6 EU Network Traffic Control Responsibilities for UBRS

U S WEST ATM Cell Relay Service UBRS EU Customers must perform traffic shaping within the EU Customer's CPE in order to conform with the traffic parameters agreed upon in the service contract. For UBRS connections, it is the responsibility of the EU Customer to not exceed the agreed upon PCR.

6.3 Network Congestion Management

U S WEST ATM Cell Relay Nodes will monitor the traffic volume of each U S WEST ATM Cell Relay Service Optical Access Link, and compare the Permanent Virtual Connections (PVCs) associated traffic volume with the negotiated data throughput parameters. In the event an End User's (EU) PVC(s) causes a Cell Relay Module to become congested, the EU customers which are assigned to the congested Cell Relay Module may experience network congestion conditions.

Network congestion conditions may cause the following conditions to be experienced by an ATM Cell Relay Service EU Customer:

- Receipt of explicit network congestion notifications
- Discarding of cells
- Excessive transit delay

If network congestion should occur due to the traffic volume of any particular EU PVC, U S WEST recommends that the EU customer implement its own network congestion procedures for the following reasons:

- To reduce the impact of network congestion upon the EU customer's application.
- To avoid the possibility that EU cells may be discarded by the Cell Relay Node(s).
- EU implemented congestion procedures should be exercised until the network congestion situation no longer exists.

The standard cell relay protocol imposes the burden upon the higher-layer protocol functionality of the EU applications to perform the functions of flow control and error correction that are not performed by the Cell Relay Network. The ATM cell relay protocol standards do not specify notification of errored cells. However, the typical network protocols of the EU application(s) do provide implicit flow control via an acknowledgment process between EU applications.

6.3.1 Explicit Forward Congestion Indication (EFCI)

The Explicit Forward Congestion Indication (EFCI) is a congestion notification scheme that an ATM layer service user may make use of to improve the utility that can be derived from the ATM layer. Since the use of this mechanism by Customer Provided Equipment (CPE) is optional, U S WEST ATM Cell Relay Service network equipment cannot rely on this mechanism to control congestion.

Nevertheless,

- The U S WEST Cell Relay Node may set the EFCI code points in each ATM cell header for all cells being routed when congestion may have and/or will occur during the exchange of information; and
- The U S WEST Cell Relay Node will not modify the EFCI code points in any ATM cell header when the U S WEST Cell Relay Node is not determined to be congested.

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Tables

7. Performance Specifications

7.1 General

This section describes the service objectives and transmission requirements for U S WEST Asynchronous Transfer Mode (ATM) Cell Relay Service.

The Service Class (Peak Cell Rate Service, Sustained Cell Relay Service, or Unspecified Bit Rate Service) defines the performance and service availability characteristics of a given U S WEST ATM Cell Relay Service connection. The parameters associated with a Service Class should be measurable by both the user and network at the access point (ATM Cell Relay Service UNI) to the U S WEST ATM Cell Relay Service Network. The Service Class (PCRS, SCRS, or UBRS) associated with a given ATM Cell Relay Service connection is indicated to the network at the time of connection establishment and will not change for the duration of that connection.

7.2 Objectives

7.2.1 Availability

The availability objective for U S WEST ATM Cell Relay Service is 99.967%. The availability of a service is a measure of the Scheduled Service Time that the service is usable by a customer. The availability is expressed as a percentage the service is performing in accordance with the service performance objectives over an average 12 month period. This percentage may be expressed as:

$$\text{Availability (\%)} = \frac{(\text{Scheduled Service Time} - \text{Outage Time}) \times 100}{\text{Scheduled Service Time}}$$

The Scheduled Service Time is 8,756 hours during an average 12 month period and outage time is expressed in hours.

Overall service availability is dependent on four main factors:

- The proportion of time in which the accuracy objectives are met;
- The frequency of switching equipment outages;
- The frequency of transport system outages;
- Restoral times for outages.

Scheduled Service Time is the length of time in hours that the U S WEST ATM Cell Relay Service Network is expected to provide U S WEST ATM Cell Relay Service. The Scheduled Service Time for U S WEST ATM Cell Relay Service is 8,756 hours during an average 12 month period. This allows for two hours every six months for maintenance of the Nodes (i.e., installation of software upgrades).

7.3 Performance Parameters Definitions

The service performance parameters for U S WEST ATM Cell Relay Service are shown in Table 7-1 and described below. Performance parameters for UBR Service are not specified.

- Cell Transfer Delay (CTD)

  CTD is defined as the time from when the first bit of a successfully delivered cell crosses the ingress User Network Interface (UNI) to when the last bit crosses the egress UNI. The components of CTD in a Virtual Channel Connection (VCC) or Virtual Path Connection (VPC) include:

  – Emission delay (e.g., at 44.736 Mbit/s, emission delay is approximately 10 microseconds)

  – Propagation delays (approximately 2 ms per 100 fiber miles)

  – Processing delays at intermediate ATM nodes (e.g., switching/multiplexing delays)

  – Queuing delays at intermediate ATM nodes.

- Cell Delay Variation (CDV)

  CDV is a measure of how much the cell transfer delay experienced by any cell differs from a reference value of cell transfer delay associated with a specific logical connection. Equivalently, CDV can be thought of as a measure of the variability of inter-cell arrival times. CDV is a key parameter for planning the performance of PCRS CBR applications (i.e., delay-sensitive applications). The objective for CDV is expressed in terms of a quantile of the cumulative distribution function of CDV between communicating UNIs across the ATM Cell Relay Service network. For PCRS VCCs and VPCs having a Cell Loss Ratio (CLR) objective of 10-9, the relevant level of CDV is the 10-9 Quantile.

- Cell Delay Variation Tolerance (CDV_{TOL})

  The Usage Parameter Control will allow a certain amount of cell clustering (i.e., cells arriving sooner than expected) on a connection before declaring cells to be non-conformant. The CDV_{TOL} parameter is used to gauge the amount of clustering permitted on a connection. This parameter will be used to specify the amount of variation from a connection's PCR that the network will accept before declaring clustered cells to be non-conformant at the source UNI.

- Cell Loss Ratio (CLR)

  CLR is defined as the ratio of the number of cells lost to the number of transmitted cells in a population of interest.

- Errored Cell Ratio (ECR)

  An errored cell event occurs when a successfully delivered cell contains one or more bit errors in its payload.

- Misinserted Cell Rate (MCR)

  A cell misinsertion event can occur when a line burst error causes multiple errors in a cell header in such a way as to 1) cause the Header Error Control (HEC) mechanism to pass the corrupted header, and 2) have the resultant corrupt VPI/VCI value be valid for some other active virtual connection. This event will be seen as a cell loss event on the VCC in which it was transmitted, and as a misinserted cell event on the VCC on which it is received.

Table 7-1 Service Performance Parameters

Performance Parameters	Peak Cell Rate Service	Sustained Cell Rate Service	Unspecified Bit Rate Service
Cell Transfer Delay	For 99% of all cells delivered, the Cell Transfer Delay will be < 4 ms between originating and terminating UNI, plus 2 ms per 100 fiber miles between the two UNIs.		not specified
Cell Delay Variation 10^{-9} Quantile, 44.736 Mbit/s UNI	<= 2.0 ms	not specified	not specified
Cell Delay Variation 10^{-9} Quantile, 155.520 Mbit/s UNI	<= 1.0 ms	not specified	not specified
Cell Delay Variation, Tolerance, 10^{-9} Quantile, 1.544 Mbit/s UNI	= 250 or 500 microseconds	not specified	not specified
Cell Delay Variation, Tolerance, 10^{-9} Quantile, 44.736 Mbit/s UNI	= 150, 250 or 500 microseconds	not specified	not specified
Cell Delay Variation, Tolerance, 10^{-9} Quantile, 155.520 Mbit/s UNI	= 50, 150, 250 or 500 microseconds	not specified	not specified
Cell Loss Ratio	<= 10^{-9}	<= 10^{-6}	not specified
Errored Cell Ratio	< 10^{-7}		
Misinserted Cell Rate	< 10^{-13}		
Availability	99.967 % (average 12 months)		

NOTE: ms = millisecond

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8. Maintenance

8.1 Customer Responsibilities

The customer is responsible for all equipment and cable beyond the User Network Interface at their location. The physical connector at the UNI will be one of the following jacks or connectors: SJA44 for a 44.736 Mbit/s UNI, FC-PC for a 155.520 Mbit/s UNI, or equivalent.

In the event of service trouble, the customer or their agent is responsible for sectionalizing the trouble, and verifying that the trouble is not in the customer owned equipment or cable before calling U S WEST *!NTER**PRISE*** Networking Services Customer Service Center at 1-800-227-2218.

If the service trouble is isolated to the customer owned equipment or cable, the customer or their agent is responsible for clearing the trouble and restoring the service to normal operation.

In the case of degraded service (e.g., discarded cells, excessive cell transmission delay), the customer should contact the Customer Service Center at 1-800-227-2218.

Joint testing between the customer and/or their agent, and U S WEST personnel may sometimes be necessary to isolate the trouble.

8.2 U S WEST Responsibilities

U S WEST is responsible for all equipment and cable on the U S WEST side (i.e., network side) of the User Network Interface (UNI) at the customer location, and also for maintaining the transmission facility between customer locations, and between the Serving Wire Center and the customer location.

U S WEST will furnish the customer a trouble reporting telephone number, and will commit to a two (2) hour objective for service restoral in the event of a service interruption due to an electronic component failure. If the trouble is caused by a cable failure, the objective for service restore time will be eight (8) hours. The objective for service restore time in the event of a node failure is 2.5 hours.

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9. Definitions

9.1 Acronyms

AAL	ATM Adaptation Layer
ABR	Available Bit Rate
AIS	Alarm Indication Signal
ANSI	American National Standards Institute
ATM	Asynchronous Transfer Mode
B-ICI	B-ISDN Inter Carrier Interface
B-ISDN	Broadband Integrated Services Digital Network
B-ISSI	Broadband Inter-Switching System Interface
BER	Bit Error Ratio
BOC	Bell Operating Company
BSS	Broadband Switching System
BT	Burst Tolerance
BW	Bandwidth
CAC	Congestion Admission Control
CBR	Constant Bit Rate
CDV	Cell Delay Variation
CDVTOL	Cell Delay Variation Tolerance
CLP	Cell Loss Priority
CLR	Cell Loss Ratio
CMIP	Common Management Information Protocol
CNM	Customer Network Management
CO	Central Office
COCC	Central Office Connecting Channel
CPE	Customer Premises Equipment
CPE	Customer Provided Equipment
CRC	Cyclic Redundancy Check
CRS	Cell Relay Service
CSC	Customer Service Center

CSPDN	Circuit Switched Public Data Network
CTD	Cell Transfer Delay
DSU	Data Service Unit
DSX	Digital Signal Cross-connect
DTE	Data Terminal Equipment
ECR	Errored Cell Ratio
EFCI	Explicit Forward Congestion Indication
EL	Element Layer
EML	Element Management Layer
EMS	Element Management System
EU	End-User
EU-POT	End-User-Point of Termination
FRS	Frame Relay Service
FTP	File Transfer Protocol
GCRA	Generic Cell Rate Algorithm
GFC	Generic Flow Control
HEC	Header Error Control
IC	Interexchange Carrier
ILMI	Integrated Local Management Interface
IOF	Inter-office Facilities
IP	Internet Protocol
ITU-T	International Telecommunication Union - Telecommunications Standardization Sector
Kbit/s	Kilobit per second (1,000 bit/s)
LAN	Local Area Network
LATA	Local Access and Transport Area
LEC	Local Exchange Carrier
LMI	Local Management Interface
LOS	Loss of Signal

MAN	Metropolitan Area Network
Mbit/s	Megabit per Second (1,000,000 bit/s)
MBS	Maximum Burst Size
MCR	Misinserted Cell Ratio
MDF	Main Distributing Frame
MIB	Management Information Base
MS	Millisecond
MTBSO	Mean Time Between Service Outages
MTTSR	Mean Time to Service Restoral
NI	Network Interface
nm	Nanometer
NML	Network Management Layer
NMS	Network Management System
NNI	Network-Network Interface
OAM	Operations, Administration and Maintenance
PCR	Peak Cell Rate
PCRS	Peak Cell Rate Service
PLCP	Physical Layer Convergence Protocol
POT	Point Of Termination
PSTN	Public Switched Telephone Network
Pt-Mpt	Point-to-Multipoint
Pt-Pt	Point-to-Point
PVC	Permanent Virtual Connection
QoS	Quality of Service
SA	Service Availability
SCR	Sustained Cell Rate
SCRS	Sustained Cell Rate Service
SNMP	Simple Network Management Protocol
SONET	Synchronous Optical Network
SR	Special Report
SST	Synchronous Service Transport

STM	Synchronous Transfer Mode
STS-3c	Synchronous Transport Signal level 3, concatenated
STS-12c	Synchronous Transport Signal level 12, concatenated
SVC	Switched Virtual Connection
SWC	Serving Wire Center
TC	Transmission Convergence
TCA	Threshold Crossing Alert
TCP/IP	Transmission Control Protocol/Internet Protocol
TLS	Transparent LAN Service
UBR	Unspecified Bit Rate
UBRS	Unspecified Bit Rate Service
UNI	User Network Interface
UPC	Usage Parameter Control
VBR	Variable Bit Rate
VC	Virtual Channel
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VCL	Virtual Channel Link
VP	Virtual Path
VPC	Virtual Path Connection
VPI	Virtual Path Identifier
VPL	Virtual Path Link
WAN	Wide Area Network

9.2 Glossary

American National Standard Institute (ANSI)

An organization supported by the telecommunications industry to establish performance and interface standards.

Asynchronous Transfer Mode (ATM)

An information transfer method in which the information is organized into fixed length (53 octet) cells. It is asynchronous in the sense that the recurrence of cells containing user information is not necessarily periodic.

ATM Adaptation Layer (AAL)

The protocol layer that provides service-dependent functions to the layer above the AAL and adapts various types of information streams (e.g., packets, circuits, etc.) to ATM streams.

ATM Cell

A digital information block of fixed length (53 octets) identified by a label at the ATM Layer of the B-ISDN protocol architecture.

ATM Node

An ATM switch that will be located in the U S WEST Serving Wire Center and will support a capacity of 1-10 Gbps and interface counts in the range 1-282.

Availability

The relative amount of time that a service is "usable" by a customer, represented as a percentage over a consecutive 12 month period.

Bandwidth

The range of frequencies that contain most of the energy or power of a signal; also, the range of frequencies over which a circuit of system is designed to operate.

Bits/second (bit/s)

Bits per second, e.g., 1200 bit/s. In data transmission, it is the number of binary zero and one bits transmitted in 1 second. Modern terminology uses "bit/s" e.g., 1200 bit/s.

Bit Error Ratio (BER)

The ratio of the number of bit errors to the total number of bits transmitted in a given time interval.

Broadband Inter-Carrier Interface (B-ICI)

An ATM-based, multiservices capable interface between two carriers providing public network service.

Broadband Inter-Switching System Interface (B-ISSI)

An ATM-based interface between two BSSs within a single LEC network capable of transporting SMDS, FRS, CRS, and other ATM-based services. The B-ISSI may be operated in a single service mode, or may carry multiple services depending on the application. In special circumstances, a B-ISSI may be used to interconnect two LEC networks in a single LATA.

Byte

A consecutive number of bits usually constituting a complete character or symbol. If the length of the byte is not specified, it is conventionally assumed to have a length of 8-bits. In the Digital Data System, a byte refers to an arbitrary group of 8 consecutive bits; it does not correspond to a byte of customer data.

Cell Delay Variation (CDV)

A network performance parameter that characterizes the variability in cell transfer delay experienced by cells being transferred over a given ATM Layer connection.

Cell Rate Adapter

A simple device that incorporates a DS3 and an OC3 interface. Cells are transferred between these two ports without inspection or alteration.

Cell Relay Logical Connections

ATM CRS logical connections are provided as unidirectional Permanent Virtual Connections (PVCs). ATM CRS will support a point-to-point logical connection configuration between two ports. Logical connections may be either symmetrical or asymmetrical. A symmetrical connection is one in which the same bandwidth is specified for each direction of the connection. An asymmetrical connection has a different bandwidth value specified for each direction of the connection.

Cell Relay Optical Access Link

A Cell Relay access channel used to connect customer facilities at the Network Interface with a corresponding ATM CRS Cell Transfer Element.

Cell Relay Module

A plug-in of a Cell Relay Node which may contain multiple Cell Relay Ports.

Cell Relay Port

A termination point on the Cell Relay Module for the ATM CRS Optical Access Link. ATM CRS ports are the physical entry points in the ATM CRS Network for Optical Access Links and are the originating and terminating points for Virtual Path Connections and Virtual Channel Connections.

Cell Relay Service Point

ATM CRS Service Points are geographic locations designated by the Company where the ATM CRS Network can be accessed.

Cell Relay Stand-Alone Optical Access Link (SAOAL)

An ATM CRS Stand-Alone Optical Access Link connects customer facilities to cell relay networks provided by service providers other than U S WEST Communications. Private line transport mileage and/or a Central Office Connecting Channel (COCC) may be required in conjunction with a Stand-Alone Optical Access Link in order to connect the customer's serving wire center, or node, with the serving wire center, or node of another ATM CRS provider.

Central Office (CO)

A local switching system (or a portion thereof) and its associated equipment located at a wire center.

Central Office Connecting Channel (COCC)

A tariff rate category which provides for connections, within the same Hub wire center, between the Private Line Transport Channel and other services provided by U S WEST. See FCC #1 for more information.

Character

Letter, numeral, punctuation, control figure or any other symbol contained in a message.

Constant Bit Rate (CBR)

An ATM Forum service category which supports a constant or guaranteed rate to transport services such as video or voice as well as circuit emulation which requires rigorous timing control and performance parameters.

Customers

Denotes any individual, partnership or corporation who subscribes to the services provided by U S WEST customers are divided into two distinct and separate categories: (1) carriers, who provide interexchange services for hire for others, and (2) end-users, who request services only for their own use.

Customer Premises

Denotes a building or portion(s) of a building occupied by a single customer or end-user either as a place of business or residence. Adjacent buildings and the buildings on the same continuous property occupied by the customer and not separated by a public thoroughfare, are also considered the customer's premises.

Customer Premises Equipment (CPE)

All telecommunication equipment located at a customers location.

Customer Provided Equipment (CPE)

Equipment owned and maintained by the customer and located on their side of the End-User Point of Termination (EU-POT) network interface.

Cyclic Redundancy Check (CRC)

A method of checking the integrity of received data, where the check uses a polynomial algorithm based on the content of the data.

Data Terminal Equipment (DTE)

A generic term for customer terminal equipment that connects to the network through a modem or through digital Network Channel Terminating Equipment (NTCE), e.g., a computer or a PBX.

dBm

A decibel in which the reference power is one milliwatt. Decibel reference to one milliwatt.

Digital Cross-Connect System (DCS)

An intelligent (processor controlled) digital terminal that provides the capability to perform electronic cross-connects on digital channels operating at or below the bit rate of the transport systems terminated on the unit. This unit may also provide other features, e.g., bridging.

Diversity

Routing of customer circuits or access lines over physically separated facilities.

End User

The human being, organization, or telecommunications system that accesses the network in order to communicate via the services provided by the network.

End-User POT (EU-POT)

The Network Interface at the end-user's premises at which U S WEST Communication, Inc.'s responsibility for the provision of service ends.

Ethernet

A packet-switched local network design (by Xerox Corp.) employing CSMA/CD as access control mechanism.

Exchange Access Service (XA-Service)

An access service provided by a LEC to an IXC to support the IC's interexchange service when the sending or receiving end user is served directly by the LEC network.

Exchange Service

Refers to end users served directly by LEC(s) communicating using a service in the exchange serving area, or LATA. The LEC offers the service to the end user.

Explicit Forward Congestion Indication (EFCI)

An indicator carried in the header of an ATM cell that shows whether or not that cell has passed through a BSS experiencing congestion.

Facilities

Facilities are the transmission paths between the demarcation points serving customer locations, a demarcation point serving a customer location and a U S WEST Central Office, or two U S WEST offices.

Fiber Optic Terminal (FOT)

The terminating or originating portion of a fiber optic system that performs both an electrical to optical conversion and a multiplexing function.

Independent LEC (ILEC)

A LEC that is not a Bell Operating Company.

Interexchange Carrier (IC)/(IEC) or Interexchange Common Carrier

Any individual, partnership, association, joint-stock company, trust, governmental entity or corporation engaged for hire in interstate or foreign communication by wire or radio, between two LATAs.

Interexchange Service

Refers to end users located in different LATAs communicating using a specific service. An IC offers the service to the end user.

Local Access and Transport Area (LATA)

A geographic area for the provision and administration of communications service. It encompasses designated exchanges that are grouped to serve common social, economic and other purposes.

Local Exchange Carrier (LEC)

A carrier that provides telecommunications services within an exchange serving area (or LATA). BOCs and ILECs are referred to as LECs.

Local Area Network (LAN)

Network permitting the interconnection and intercommunication of a group of computers, primarily for the sharing or resources such as data storage devices and printers.

Loop

The facility which connects the Serving Wire Center to the customer's location.

Network Channel (NC) Code

The Network Channel (NC) code is an encoded representation used to identify both switched and non-switched channel services. Included in this code set are customer options associated with individual channel services, or feature groups and other switched services.

Network Channel Interface (NCI) Code

The Network Channel Interface (NCI) code is an encoded representation used to identify five (5) interface elements located at a Point of Termination (POT) at a central office or at the Network Interface at a customer location. The Interface code elements are: Total Conductors, Protocol, Impedance, Protocol Options, and Transmission Level Points (TLP). (At a digital interface, the TLP element of the NCI code is not used.)

Network Element (NE)

An independent and identifiable piece of equipment closely associated with at least one processor, and with a single location.

Network Interface (NI)

The point of demarcation on the customer's premises at which U S WEST's responsibility for the provision of service ends.

Network-Network Interface (NNI)

For B-ISDN, the interface at a network node that is used to connect to another network node.

Packet Switched Network

A switched network which provides connection for forwarding standard data packets between user parties.

Parity

See Parity Check

Parity Check

Making the number of ones in a grouping of bits either always even or always odd. This permits detection of bit groups that contain single errors. It may be applied to characters or blocks.

Permanent Virtual Connection (PVC)

An ATM connection that is established and torn down through provisioning-based procedures.

Physical Layer

The protocol layer that allows the protocol to provide the transmission of information on the transmission facility. It is concerned with the physical and electrical characteristics of the interface.

Physical Layer Convergence Protocol

Physical Layer Convergence Protocol: The PLCP is defined by the IEEE 802.6. It is used for DS3 transmission of ATM. ATM cells are encapsulated in a 125 microsecond frame defined by the PLCP which is defined inside the DS3 M-frame.

Pipelining

A process whereby parts of a packet are forwarded before the entire packet has been received.

Point of Termination (POT)

The physical telecommunications interface that establishes the technical interface, the test point(s), and the point(s) of operational responsibility. (See Network Interface).

Point-To-Point

A circuit connecting two (and only two) points.

Port

A place at which energy or signals enter or leave a device, circuit, etc.

Premises

Denotes a building or portion(s) of a building occupied by a single customer or end-user either as a place of business or residence.

Protocol

The rules for communication system operation which must be followed if communication is to be effected; the complete interaction of all possible series of messages across an interface. Protocols may govern portions of a network, types of service, or administrative procedures.

Protocol Code

The Protocol (character positions 3 and 4 or the Network Channel Interface [NCI] Code) is a two-character alpha code that defines requirements for the interface regarding signaling and transmission.

Protocol Data Unit (PDU)

A unit of data that is exchanged between peer entities within a particular protocol level.

Reassembly

The process whereby no part of a packet is forwarded until the entire packet has been received.

Service Integration

The capability of providing multiple services using the same platform.

Service Interworking

The capability of interconnecting two customers that access different services (e.g., a Frame Relay customer communicating with a CRS customer.)

Service Point

Terminology used in tariff descriptions to describe geographic locations designated by U S WEST where the U S WEST ATM Cell Relay Network is to be accessed.

Serving Wire Center

The term "Serving Wire Center" denotes a U S WEST Central Office from which dial tone for the local Exchange Service would normally be provided to the demarcation point on the property at which the customer is served.

Signaling

The transmission of information to establish, monitor, or release connections and/or provide Network Control.

SONET

Synchronous Optical Network (SONET): A standard providing electrical and optical specifications for the physical and higher layers, the first stage of which is at 51.84 Mbit/s, the Optical Channel 1 (OC1) level. Other rates, defined as OCn where n=3 through a number not yet firm, are possible.

Switched Virtual Connection (SVC)

An ATM connection that is established and torn down through signaling-based procedures.

Token Ring

A local network access mechanism and topology in which a token is passed from station to station in sequential order. Stations wishing to transmit must wait for the token to arrive before transmitting data. Throughout this document, the term "Token Ring" is used interchangeably with the IEEE Std. 802.5-1992 Edition.

Transmission Control Protocol/Internet Protocol (TCP/IP)

Internetworking software suite originated on the Department of Defense's Arpanet network. IP corresponds to Open Systems Interconnection (OSI) network Level 3, TCP to OSI Layer 4 and 5.

Transparent LAN Service (TLS)

A basic transport element designed to extend islands of Local Area Networks (LANs) across a limited geographic area (within a LATA and single Wire Center).

Trunk

A communications path connecting two switching systems in a network, used in the establishment of an end-to-end connection.

Variable Bit Rate (VBR)

An ATM Forum defined service category which supports variable bit rate data traffic with average and peak traffic parameters.

Virtual Channel (VC)

A logical association between the end points of a link (e.g., an ISSI transmission path) that enables unidirectional transfer of ATM cells over that link.

Virtual Channel Connection (VCC)

A concatenation of virtual channel links that extends between the points where the ATM service users access the ATM layer.

Virtual Channel Link.(VCL)

A means of unidirectional transport of ATM cells between a point where a virtual channel identifier (VCI) value is assigned and the point where that value is translated or removed.

Virtual Path (VP)

A concept used to describe unidirectional transport of ATM cells belonging to virtual channels that are associated by a common identifier value.

Virtual Path Connection (VPC)

A concatenation of virtual path links that extends between the point where the values are assigned and the point where those virtual channel identifier values are translated or removed.

Virtual Path Link (VPL)

A means of unidirectional transport of ATM cells between the point where a VPI value is assigned and the point where that value is translated or removed.

Wire Center

A building in which one or more central offices, used for the provision of local exchange services, are located.

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ITU-T Recommendation I.150 *B-ISDN Asynchronous Transfer Mode Functional Characteristics.*

ITU-T Recommendation I.361 *B-ISDN ATM Layer Specifications.*

10.6 Ordering Information

All documents are subject to change and their citation in this document reflects the most current information available at the time of printing. Readers are advised to check status and availability of all documents.

Those who are not U S WEST employees may order:

- American National Standards Institute (ANSI) documents from:

  American National Standards Institute
  Attn: Customer Service
  11 West 42nd Street
  New York, NY 10036
  Phone: (212) 642-4900
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  ANSI has a catalog available which describes their publications.

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