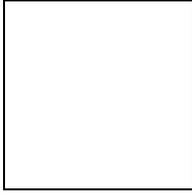


U S WEST
Communications, Inc.
Technical Publication

Self-Healing Alternate Route Protection (SHARP)

77340
Issue E
June 1994



U S WEST
Communications, Inc.
Technical Publication

Self-Healing Alternate Route Protection (SHARP)

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77340
Issue E
June 1994

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CONTENTS

Chapter and Section	Page
1. Introduction.....	1-1
1.1 General.....	1-1
1.2 Reason For Reissue.....	1-1
1.3 End-User and Carrier Customer Premises - Mandated DS1 Differences.....	1-1
1.4 Special Information about the End-User DSX-1 Interface.....	1-1
2. Description of Service.....	2-1
2.1 Applicability of Technical Specifications.....	2-1
2.2 Description of Service.....	2-1
2.3 Service Configurations.....	2-1
3. Network Interfaces (NIs).....	3-1
3.1 Description of Interface.....	3-1
3.1.1 DS3 Interface.....	3-1
3.1.2 DS1 Interface.....	3-1
3.1.3 Optical Interface.....	3-1
3.2 NCI Code Form and Components.....	3-3
3.3 NC Code Function and Formats.....	3-8
3.4 SPEC Code Function and Format.....	3-8
4. Performance Specifications.....	4-1
4.1 Error Performance Parameters.....	4-1
4.2 Error Performance Requirements.....	4-1
4.3 Service Availability.....	4-2
4.4 Jitter Performance.....	4-2
4.4.1 Definition of Timing Jitter.....	4-2
4.4.2 Network Interface Timing Jitter Specifications.....	4-2
4.5 Protection Switching.....	4-2
5. Maintenance.....	5-1
5.1 Customer Responsibilities.....	5-1
5.2 US WEST Responsibilities.....	5-1
6. Definitions.....	6-1
6.1 Acronyms.....	6-1
6.2 Glossary.....	6-2

CONTENTS (Continued)

Chapter and Section	Page
7. Reference.....	7-1
7.1 American National Standard Institute Documents.....	7-1
7.2 Bellcore Documents	7-1
7.3 U S WEST Technical Publications	7-1
7.4 Ordering Information.....	7-2

Figures

2-1 Standard DS3 Service Configurations	2-3
2-2 Self-Healing Alternate Route Protection (SHARP).....	2-4
2-3 End-to-End Circuit Protection (SHARP).....	2-5
2-4 Partial/One-End Only Facilities Protection (SHARP PLUS)	2-6
2-5 SHARP PLUS Interoffice Facility Protection Only	2-7
2-6 Transport Alternate Path Protection.....	2-8
3-1 Electrical/Optical Interface	3-2
3-2 SPEC Code Format.....	3-9

Tables

3-1 Electrical DS3 NCI Code Example	3-3
3-2 DS3 Compatible Network Channel Interface (NCI) Code Combinations	3-4
3-3 DS1 Compatible Network Channel Interface (NCI) Code Combinations	3-5
3-4 DS1 Compatible Network Channel (NC) Codes	3-10
3-5 DS3 Compatible Network Channel (NC) Codes	3-11

CONTENTS

Chapter and Section	Page
1. Introduction.....	1-1
1.1 General.....	1-1
1.2 Reason For Reissue	1-1
1.3 End-User and Carrier Customer Premises - Mandated DS1 Differences.....	1-1
1.4 Special Information about the End-user DSX-1 Interface	1-1

1. Introduction

1.1 General

This document describes U S WEST Self-Healing Alternate Route Protection Service offered by U S WEST Communications, Inc. It covers distinguishing service features, technical specifications, and defines valid interfaces.

The purpose of this document is to describe U S WEST Self-Healing Alternate Route Protection Service appropriate for the majority of applications. Sufficient technical detail is furnished to allow a customer, such as an Interexchange Carrier (IC) or End-User (EU), to select a service that 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.

1.2 Reason For Reissue

This document is being reissued at this time to:

- 1) add Network Interface (NI) information on additional DS3 Interoffice only alternate path protection options (SHARP PLUS Interoffice Protection Only, and Transport Alternate Path Protection);
- 2) add NI information on additional DS1 interface options;
- 3) add NI information on asynchronous fiber transport and SONET transport;
- 4) reformat document to the new U S WEST publication format.

1.3 End-User and Carrier Customer Premises - Mandated DS1 Differences

Both End-Users and Carriers may purchase 1.544 Mbit/s (DS1) channels with a number of optional enhancements.

Federal Regulations mandate certain technical differences between interfaces provided at End-User premises and at Carrier premises, and these differences are explained in Technical Publication 77375, Issue B, August 1993. The differences have no qualitative affect on the service being provided.

When a Carrier orders services, not for resale but for their own internal use, the appropriate End-User interface(s) should be ordered.

1.4 Special Information about the End-user DSX-1 Interface

U S WEST has developed a new interface to meet DS1 customer needs at end-user customer premises where the customer location is served by fiber facilities with associated multiplexer. This new interface eliminates the requirement for a customer provided Channel Service Unit. If copper facilities are the only access into your building, fiber facilities must be requested; however, Special Construction Charges will be assessed before the fiber construction can begin.

In order to determine whether this interface is an alternative for your location, please contact your U S WEST Marketing Representative or call the U S WEST Business Office. For further technical description please refer to U S WEST Technical Publication 77375.

CONTENTS

Chapter and Section	Page
2. Description of Service.....	2-1
2.1 Applicability of Technical Specifications	2-1
2.2 Description of Service.....	2-1
2.3 Service Configurations	2-1

Figures

2-1 Standard DS3 Service Configuration.....	2-3
2-2 Self-Healing Alternate Route Protection (SHARP).....	2-4
2-3 End-To-End Circuit Protection (SHARP PLUS)	2-5
2-4 Partial/One-End Only Facilities Protection (SHARP PLUS)	2-6
2-5 SHARP PLUS Interoffice Facility Protection Only	2-7
2-6 Transport Alternate Path Protection.....	2-8

2. Description of Service

2.1 Applicability of Technical Specifications

The technical specifications presented in this document are applicable to U S WEST Self-Healing Alternate Route Protection (SHARP) Service only . It does not attempt to describe the various types of transmission equipment used to provide this service.

2.2 Description of Service

Self-Healing Alternate Route Protection (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.

This added protection is provided by ensuring that backup electronics and two physically separate facility paths are used in the provisioning of the service. One primary (or working) service path is established between the SWC and the customer designated premises. In addition, a protect path is provisioned between the customer designated premises and the SWC via a U S WEST designated Alternate Wire Center (AWC) where available.

SHARP Interoffice Facility Protection, SHARP Plus, extends the local loop protection provided by the basic SHARP option to include protection of Transport Channel (interoffice) facilities between SWCs. This option, coupled with the SHARP option on each end of the circuit, will provide end-to-end service protection for DS1 and DS3 services.

SHARP PLUS Interoffice Facility Protection Only will provide an alternate path, in addition to a primary DS3 private line, on an "Interoffice Only" basis. SHARP PLUS Interoffice Facility Protection Only is available on DS3 services only. The primary and the alternate paths will be provided on fiber optic facilities and will require a minimum separation (25 feet) between the primary and alternate paths of transmission.

Transport Alternate Path Protection is also available on DS3 services only. Transport Alternate Path Protection will provide an alternate path for the DS3 circuit, in addition to the primary DS3 fiber optic private line, on an interoffice basis only. The alternate path will be provided on microwave radio facilities.

2.3 Service Configurations

The U S WEST Self-Healing Alternate Route Protection Service may utilize both interoffice and local loop facilities. It will interface at an electrical DS3 or DS1 level. An optical interface will also be offered on fiber optic systems dedicated to single customers. In the event that an optical interface is selected, the standard service interval offered for this service may not apply due to the incompatibility between the customer's equipment and equipment pre-provisioned by U S WEST at the SWC.

When DS3 or DS1 Service is normally provided over fiber optic facilities, the working and protection systems are in the same cable as shown in Figure 2-1.

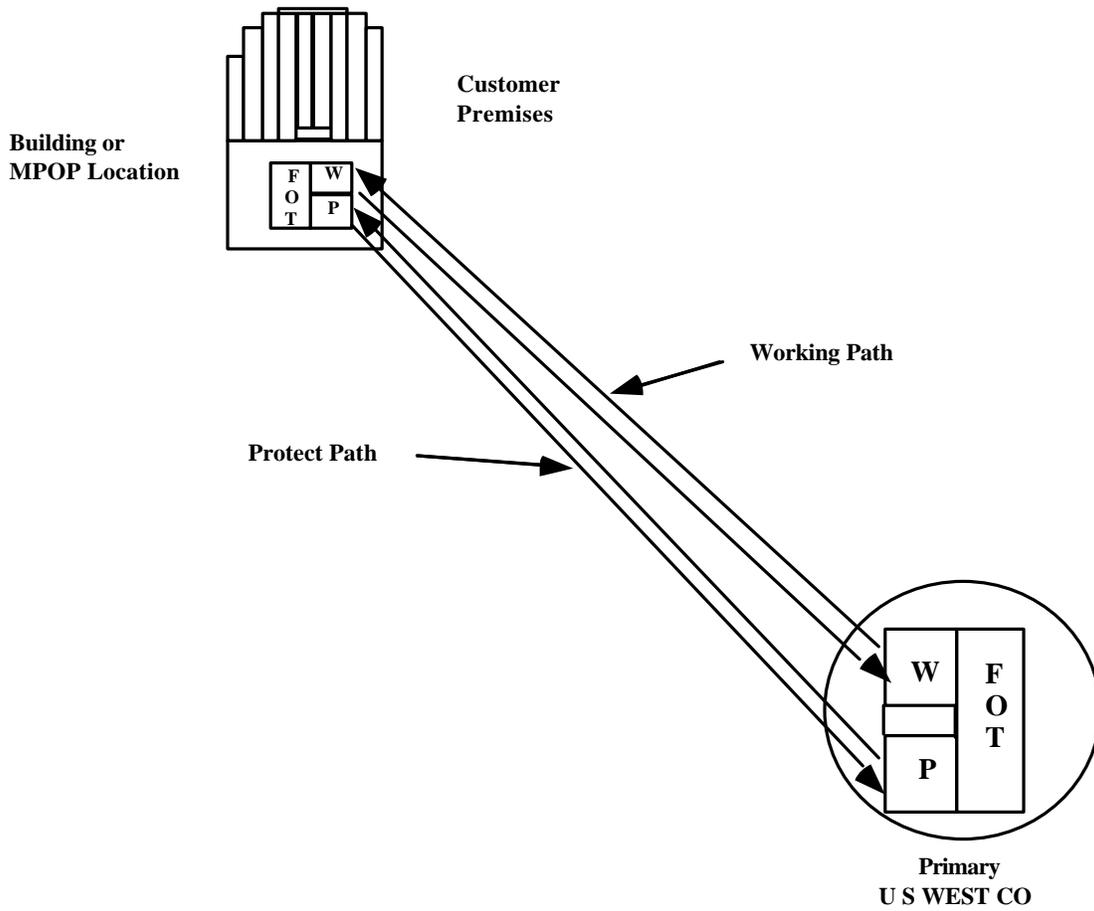
Customers electing SHARP will have their DS3 or DS1 Service routed to a protection system that takes a completely separate route back to the SWC. This configuration provides protection for the local loop or channel termination and is shown in Figure 2-2.

Equipment located on the customer's premises will have a single cable entrance unless the building owner elects to provide two physically separated cable entrances to the building.

SHARP Interoffice Facility Protection will consist of SHARP protection for the local loop portion of the circuit, SWC protection and protection of the Transport Channel Facilities used to connect each SWC. This option may be ordered to provide end-to-end circuit protection (SHARP Plus) as shown in Figure 2-3. Partial, or one-end facilities protection, terminating in a U S WEST Serving Wire Center may also be ordered and is shown in Figure 2-4.

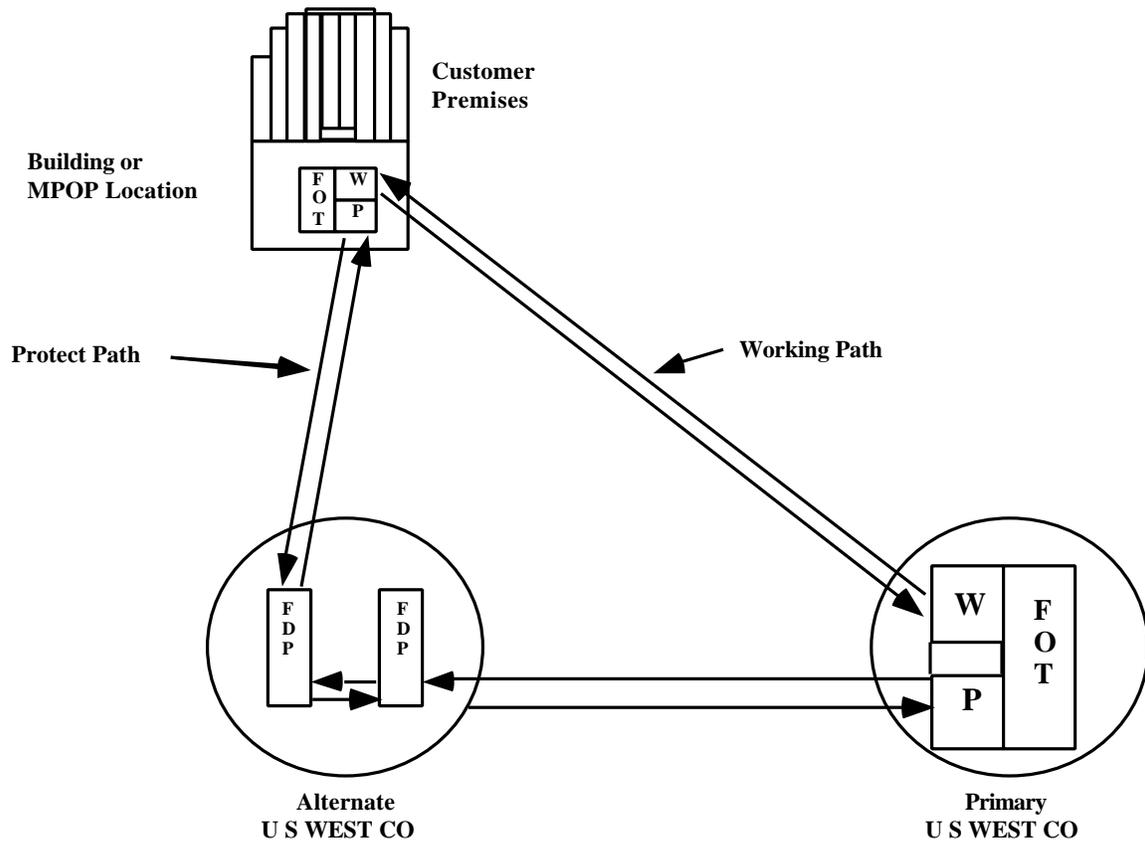
SHARP Interoffice Facility Protection Only will consist of SHARP protection for the DS3 Transport Channel Facilities used to connect each SWC. This option is shown in Figure 2-5.

Transport Alternate Path Protection will consist of SHARP protection for the DS3 Transport Channel Facilities used to connect each Wire Center (WC) with the protection channel provided on radio facilities. This option is shown in Figure 2-6.



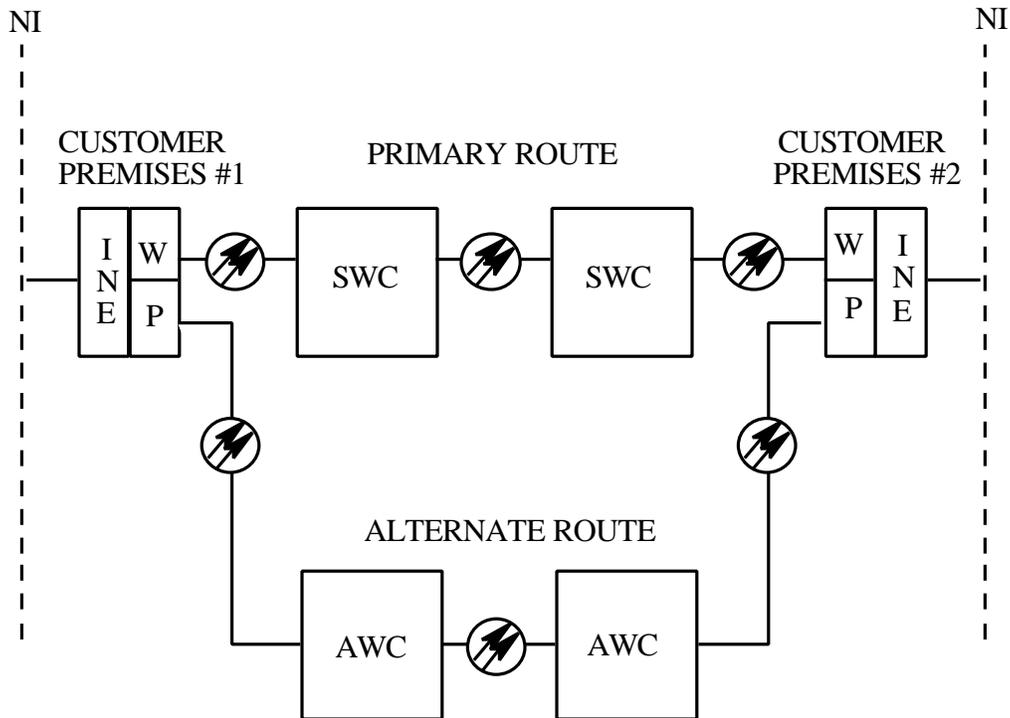
LEGEND	
FOT	= FIBER OPTIC TERMINAL
MPOP	= MAIN POINT OF PRESENCE
P	= PROTECTION TERMINAL
W	= WORKING

Figure 2-1 Standard DS3 Service Configuration



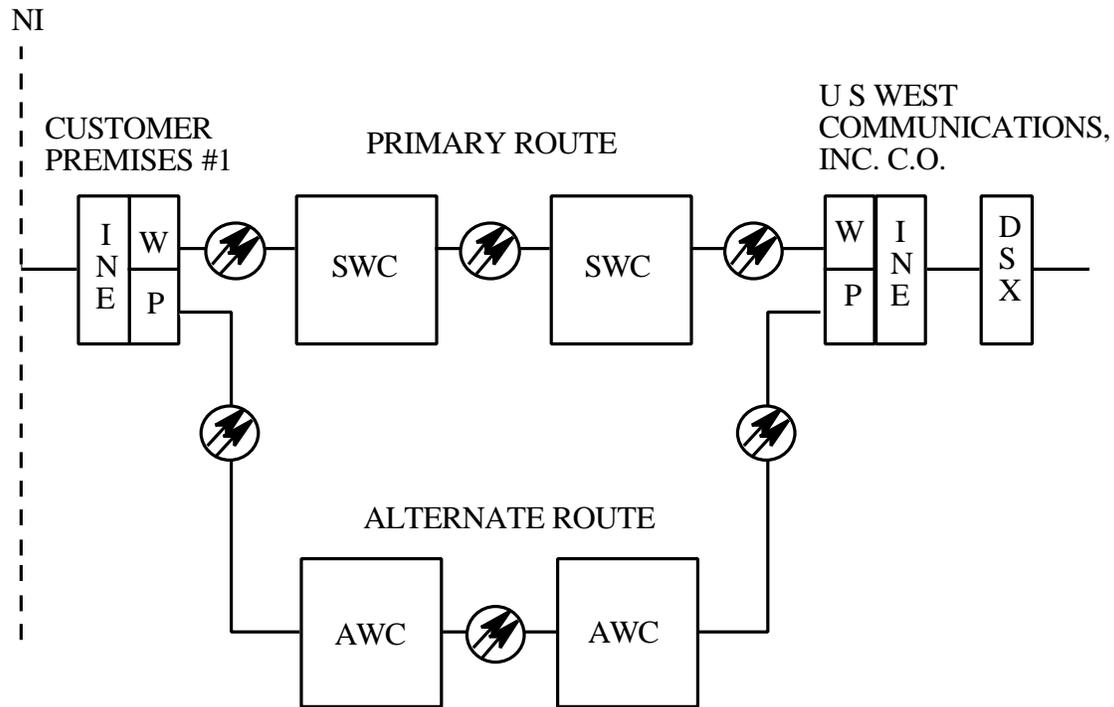
<u>LEGEND</u>	
FDP	= FIBER DISTRIBUTION PANEL
FOT	= FIBER OPTIC TERMINAL
MPOP	= MAIN POINT OF PRESENCE
W	= WORKING TERMINAL
P	= PROTECTION

Figure 2-2 Self-Healing Alternate Route Protection (SHARP)



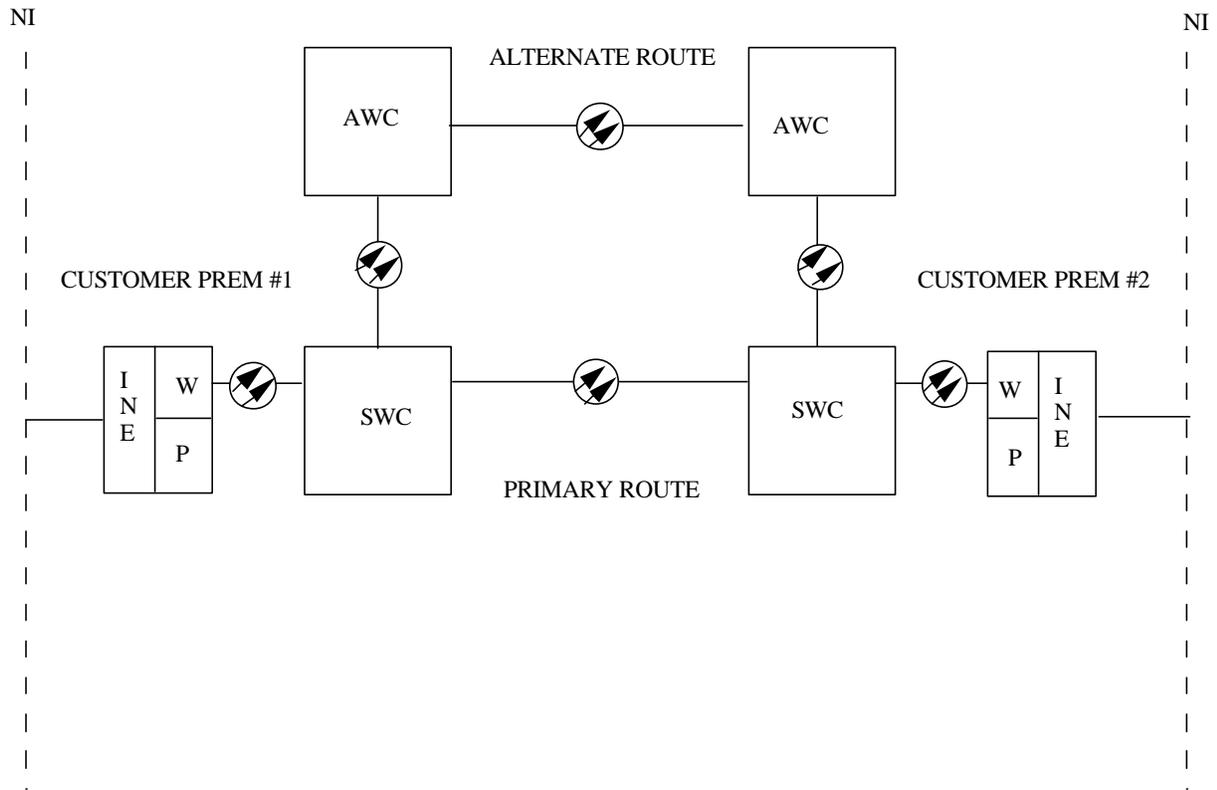
LEGEND	
AWC	= ALTERNATE WIRE CENTER
INE	= INTELLIGENT NETWORK ELEMENT
NI	= NETWORK INTERFACE
P	= PROTECTION TERMINAL
SWC	= SERVING WIRE CENTER
W	= WORKING TERMINAL
	= FIBER FACILITIES

Figure 2-3 End-To-End Circuit Protection (SHARP PLUS)



LEGEND	
AWC	= ALTERNATE WIRE CENTER
DSX	= DIGITAL SIGNAL CROSS-CONNECT
INE	= INTELLIGENT NETWORK ELEMENT
NI	= NETWORK INTERFACE
P	= PROTECTION TERMINAL
SWC	= SERVING WIRE CENTER
W	= WORKING TERMINAL
	= FIBER FACILITIES

Figure 2-4 Partial/One-End Only Facilities Protection (SHARP PLUS)



LEGEND	
AWC	= ALTERNATE WIRE CENTER
DSX	= DIGITAL SIGNAL CROSS-CONNECT
INE	= INTELLIGENT NETWORK ELEMENT
NI	= NETWORK INTERFACE
P	= PROTECTION TERMINAL
SWC	= SERVING WIRE CENTER
W	= WORKING TERMINAL
	= FIBER FACILITIES

Figure 2-5 SHARP PLUS Interoffice Facility Protection Only

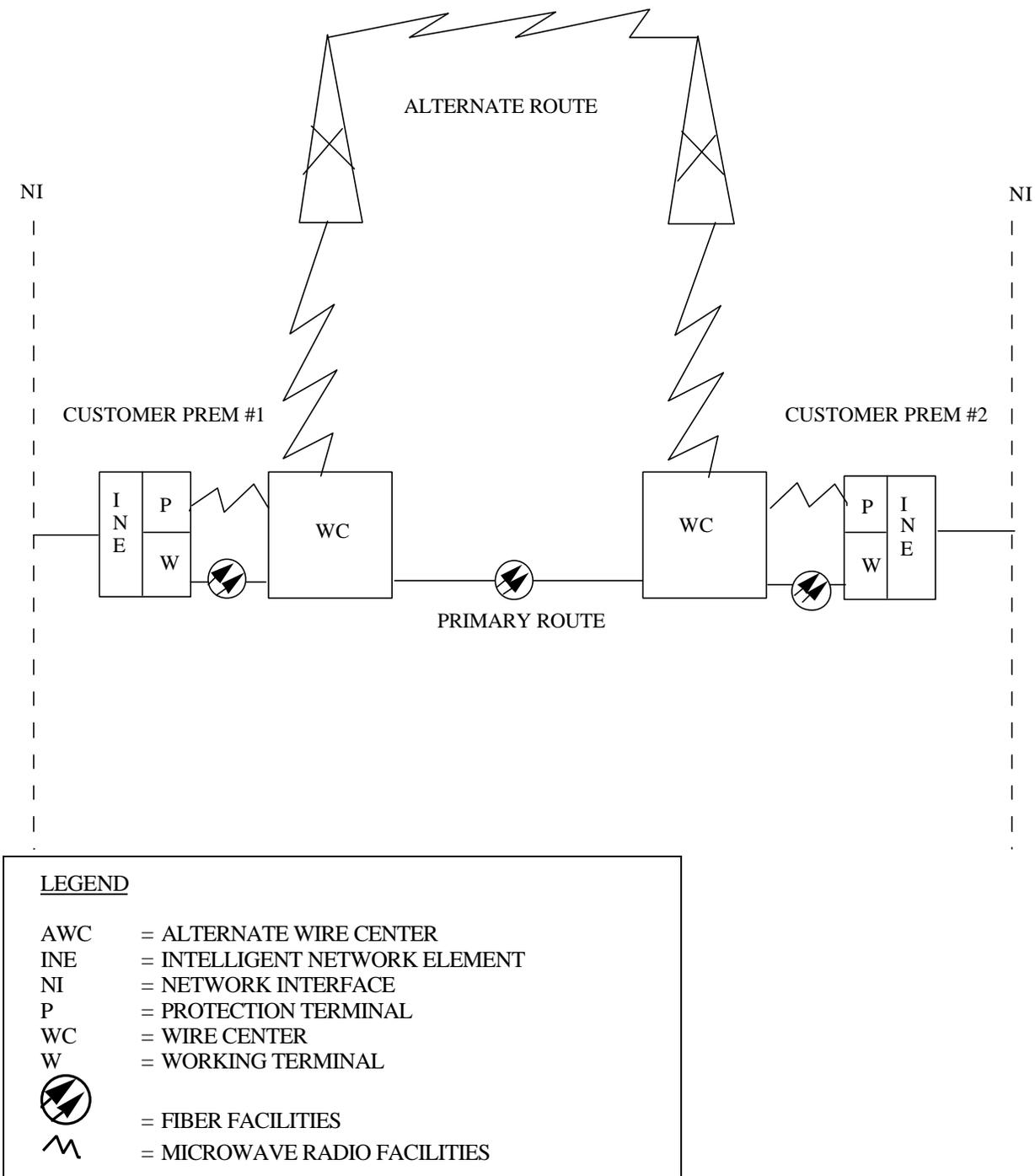


Figure 2-6 Transport Alternate Path Protection

CONTENTS

Chapter and Section	Page
3. Network Interfaces (NIs).....	3-1
3.1 Description of Interface.....	3-1
3.1.1 DS3 Interface.....	3-1
3.1.2 DS1 Interface.....	3-1
3.1.3 Optical Interface.....	3-1
3.2 NCI Code Form and Components	3-3
3.4 NC Code Function and Format	3-8
3.5 SPEC Code Function and Format	3-8

Figure

3-1 Electrical/Optical Network Interface	3-2
3-2 SPEC Code Format.....	3-9

Tables

3-1 Electrical DS3 NCI Code Example	3-3
3-2 DS3 Compatible Network Channel Interface (NCI) Code Combinations	3-4
3-3 DS1 Compatible Network Channel Interface (NCI) Code Combinations	3-5
3-4 DS1 Compatible Network Channel (NC) Codes	3-10
3-5 DS3 Compatible Network Channel (NC) Codes	3-11

3. Network Interfaces (NIs)

3.1 Description of Interface

The allowable interface for U S WEST Self-Healing Alternate Route Protection Service will be at the electrical DS3 level or DS1 level. An optical interface at the system level will also be available for customers with dedicated lightwave systems.

3.1.1 DS3 Interface

DS3 channels are provided to Carriers and to End-Users (EUs) premises.

The NI to a Carrier customer will be at the end of a DSX-3 jumper with signal characteristics described in U S WEST Technical Publication 77324, issue C. The NI to an EU customer will be SJA44 connectors with signal characteristics described in U S WEST Technical Publication 77324, issue C.

Permissible frame formats for Carriers and EUs are described in ANSI T1.107-1988 "Telecommunication - Digital Hierarchy - Format Specifications." and ANSI T1.404-1989 (see Reference Section) for the DS3 rate.

3.1.2 DS1 Interface

DS1 channels are provided to Carriers and to End-Users (EUs) premises.

The Network Interface (NI) at a Carrier premises will be at the end of a DSX-1 jumper wire or cable with signal characteristics described in U S WEST Technical Publication 77324. U S WEST Technical Publication 77324, issue C, provides additional information pertaining to the DS3 NI configuration. U S WEST Technical Publication 77324, issue C, provides additional information pertaining to the DS3 NI configuration.

The NI at an EU customer premises may be either a Conventional Interface or a DSX-1 interface. Signal characteristics, limitations, and the physical means of connection at the NI for each interface are described in U S WEST Technical Publication 77375, issue B, which should be studied before a selection is made. The Conventional Interface uses one of the Registration Jacks described by the three Universal Service Ordering Codes (USOC) RJ48C, RJ48M and RJ48H . The selection of one of these jacks is a customer option or that of their Vendor.

Permissible frame formats for Carriers and EUs are described in ANSI T1.107-1988 "Telecommunication - Digital Hierarchy - Format Specifications." and in ANSI T1.107-1988 and ANSI T1.403-1989 (see Reference Section) for the DS1 rate.

3.1.3 Optical Interface

The NI for this option will be at a U S WEST provided Fiber Distribution Panel (FDP) at the customer's location. The fiber optic cable will be terminated in fiber optic connectors by U S WEST. The type of connectors to be used will be jointly agreed upon by the customer's and U S WEST Transmission Engineers. The customer will provide the fiber optic patch cords to connect their equipment to the NI. The customer's equipment will be cross-connected at the U S WEST provided FDP as shown in Figure 3-1.

Currently, there are no standard optical signals deployed in asynchronous lightwave transport equipment. Each manufacturer of fiber optic transmission equipment uses their own specific format. This dictates the use of the same manufacturer's equipment at both ends of the system. U S WEST will identify the equipment types available and the customer will select and provide compatible equipment at their location.

U S WEST may choose to use Synchronous Optical Network (SONET) compliant equipment in some geographical areas to provision this service. As the SONET standards are still evolving, consultation between U S WEST Transmission Engineers and the Customer's Transmission Engineer will be required to ensure compatible equipment at both ends of the system. The transmission standard employed will be the SONET as defined in the ANSI T1.105.1991 which defines the North American version of the Synchronous Digital Hierarchy (SDH). This interface is also in accordance with ANSI T1.106-1988, the American National Standard for Optical Interface Specifications. This technology allows U S WEST to transport, provision and deliver the DS1 and DS3 interfaces over SONET transport.

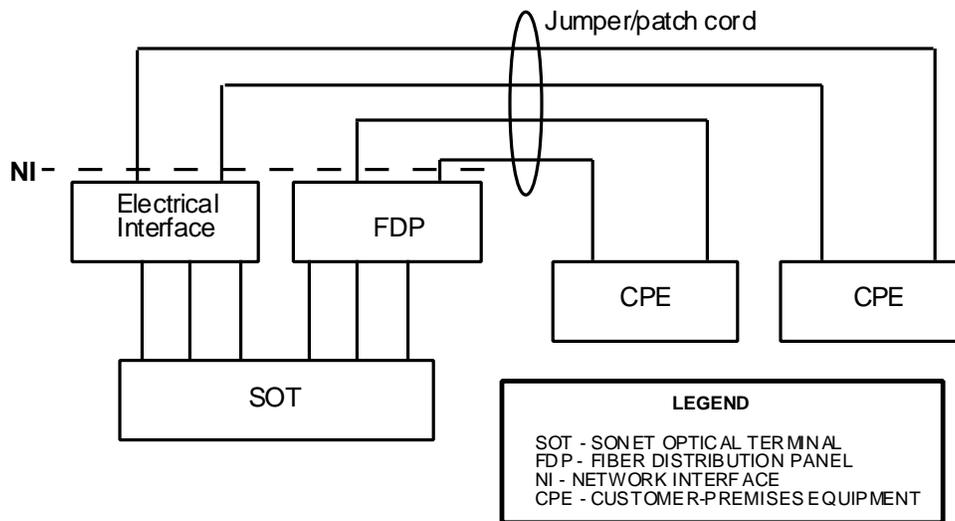


Figure 3-1 Electrical/Optical Network Interface

3.2 NCI Code Form and Components

The full NCI code format has fields not used for digital services. Only those fields relevant to digital interfaces are discussed here.

An NCI code has the form 04DS6.44. The period between the numbers is a delimiter, which is used for improved clarity. It causes the Protocol Option Code, discussed later, to stand out. An NCI code has no dashes (-).

Digital NCI Codes have four components. Table 3-1 provides an example of an electrical DS3 interface NCI code. For complete information on DS1, refer to Technical Publication 77375, 1.544 Mbit/s (DS1) Channels. For complete DS3 information, refer to Technical Publication 77324, Technical Specifications for 44.736 Mbit/s (DS3) Electrical, Optical and Radio Interfaces.

The following example, 04DS6.44, is the DS3 M23 multiplex application without C-Bit Parity

Table 3-1 Electrical DS3 NCI Code Example

DS3 Electrical Interface:	
04 =	4 Conductors - Number of wires at the interface. For DS3, the code is always 04 denoting a 4-wire interface.
DS =	Digital Hierarchy Interface - Protocol Code. This code is always DS for electrical DS3 interfaces.
6 =	75 Ohm Impedance - Impedance. For DS3 interfaces, the code is always 6 denoting 75 Ohms. The period following the 6 is a delimiter for clarity.
44 =	44.736 Mbit/s (DS3) Format per ANSI T1.102-1987 - Protocol Option Code. This code is a variable. 44 denotes the DS3 rate of 44.736 Mbit/s, and it denotes the application. A suffix may denote an application option or Capacity.

The compatible DS3 Network Channel Interface (NCI) codes for U S WEST Self-Healing Alternate Route Protection Service are listed in Table 3-2. This is a partial list consisting of what is viewed as the interface most likely to be used with this service. Refer to U S WEST Technical Publication 77324 - DS3 Electrical Interface for additional information.

Table 3-2 DS3 Compatible Network Channel Interface (NCI) Code Combinations

<u>Electrical Interface</u>	
<u>NCI</u>	<u>SECNCI</u>
04DS6.44	04DS6.44
<u>Asynchronous Optical Interface</u>	
<u>NCI</u>	<u>CAPACITY</u>
02FCF.90	(2 DS3)
02FCF.27	(3 DS3)
02FCF.40	(6 DS3)
02FCF.54	(9 DS3)
02FCF.81	(12 DS3)
02FCF.12	(18 DS3)
02FCF.16	(24 DS3)
	(36 DS3)
<u>SONET Optical Interface</u>	
<u>NCI</u>	<u>CAPACITY</u>
02FCF.B	(3 DS3)
02FCF.F	(12 DS3)
02FCF.H	(24 DS3)
	(48 DS3)

The compatible DS1 NCI codes for U S WEST Self-Healing Alternate Route Protection Service are listed in Table 3-2. This is a partial list consisting of what is viewed as the interfaces most likely to be used with this service. Refer to U S WEST Service Publication 77200 for additional information on the DS1 interface.

(Partial List - See Publication 77200, U S WEST DS1 Service, for complete DS1 Electrical Interface Information)

Table 3-3 DS1 Compatible Network Channel Interface (NCI) Code Combinations

<u>Carrier To Carrier</u>		
<u>NCI</u>	<u>SECNCI</u>	
04DS9.15	04DS9.15	DS1 Access (Carrier Premises) Interface, AMI/SF
04DS9.15K	04DS9.15K	DS1 Access (Carrier Premises) Interface, AMI/Non-ANSI ESF
04DS9.15S	04DS9.15S	DS1 Access (Carrier Premises) Interface, B8ZS/Non-ANSI ESF **
04DS9.15Z	04DS9.15Z	DS1 Access (Carrier Premises) Interface, ZBTSI/ESF **
** Provides Clear Channel Capability		

Table 3-3 continues to next page

Table 3-3 DS1 Compatible Network Channel Interface (NCI) Code Combinations

<u>Carrier To End-User</u>		
<u>NCI</u>	<u>SECNCI</u>	
04DS9.15	04DU9.B	DS1 Access (End-User Premises) Interface, SF/AMI, with Line Power
	04DU9.BN	DS1 Access (End-User Premises) Interface, SF/AMI, without Line Power
	04DU9.BX	DS1 Access (End-User Premises) Interface; SF/AMI/DSX-1 Interface
04DS9.15K	04DU9.C	DS1 Access (End-User Premises) Interface, non-ANSI ESF/AMI, with Line Power
	04DU9.CN	DS1 Access (End-User Premises) Interface, non-ANSI ESF/AMI, without Line Power
	04DU9.CX	DS1 Access (End-Use Premises) Interface; non-ANSI ESF/AMI/DSX-1 Interface
04DS9.15S	04DU9.S	DS1 Access (End-User Premises) Interface, B8ZS/Non-ANSI ESF, with Line Power **
	04DU9.SN	DS1 Access (End-User Premises) Interface, B8ZS/Non-ANSI ESF, without Line Power **
	04DU9.SX	DS1 Access (End-User Premises) Interface, B8ZS/Non-ANSI ESF/DSX-1 Interface **
04DS9.15Z	04DU9.Z	DS1 Access (End-User Premises) Interface, ZBTSI/ESF, with Line Power **
	04DU9.ZN	DS1 Access (End-User Premises) Interface, ZBTSI/ESF, without Line Power **
	04DU9.ZX	DS1 Access (End-User Premises) Interface, ZBTSI/ESF/DSX-1 Interface, **
** Provides Clear Channel Capability		

Table 3-3 continues to next page

Table 3-3 DS1 Compatible Network Channel Interface (NCI) Code Combinations

<u>End-User To End-User</u>		
<u>NCI</u>	<u>SECNCI</u>	
04DU9.B	04DU9.B	DS1 Access (End-User Premises) Interface, SF/AMI, with Line Power
04DU9.BN	04DU9.BN	DS1 Access (End-User Premises) Interface, SF/AMI, without Line Power
04DU9.BX	04DU9.BX	DS1 Access (End-User Premises) Interface; SF/AMI/DSX-1 Interface
04DU9.C	04DU9.C	DS1 Access (End-User Premises) Interface, non-ANSI ESF/AMI, with Line Power
04DU9.CN	04DU9.CN	DS1 Access (End-User Premises) Interface, non-ANSI ESF/AMI, without Line Power
04DU9.CX	04DU9.CX	DS1 Access (End-Use Premises) Interface; non-ANSI ESF/AMI/DSX-1 Interface
04DU9.S	04DU9.S	DS1 Access (End-User Premises) Interface, B8ZS/Non-ANSI ESF, with Line Power **
04DU9.SN	04DU9.SN	DS1 Access (End-User Premises) Interface, ANSI ESF/B8ZS without Line Power
04DU9.SX	04DU9.SX	DS1 Access (End-User Premises) Interface, ANSI ESF/B8ZS/DSX-1 Interface
04DU9.Z	04DU9.Z	DS1 Access (End-User Premises) Interface, ZBTSI/ESF, with Line Power **
04DU9.ZN	04DU9.ZN	DS1 Access (End-Use Premises) Interface; non-ANSI ESF/ZBTSI/AMI without Line Power **
04DU9.ZX	04DU9.ZX	DS1 Access (End-Use Premises) Interface; non-ANSI ESF/ZBTSI/AM I/DSX-1 Interface **
** Provides Clear Channel Capability		

Definitions of NCI Code Components

02	=	2 Conductors
04	=	4 Conductors
DS	=	Digital Hierarchy Interface
DU	=	Digital Access Interface
FC	=	Fiber Optic Interface
F	=	Fiber
6	=	75 Ohm Impedance
9	=	100 Ohm Impedance
15	=	1.544 Mbit/s (DS1) Superframe (SF) Format per Technical Reference TR-INS-000342 *
44	=	44.736 Mbit/s (DS3) Format per ANSI T1.102-1987

3.3 NC Code Function and Format

Primarily, service considerations are encoded into Network Channel (NC) codes. The 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. The NC code is specified by the customer to advise U S WEST of the required service connection of the channel.

An NC code consists of four alpha/numeric characters, which may include a dash (-). There are neither spaces nor delimiters between the characters.

- For electrical channel DS1 interfaces, the first two characters are HC. For additional information, see Technical Publication 77200.
- For electrical channel DS3 interfaces, the first two characters are HF. For additional information, see Technical Publication 77324.

The third and fourth characters are variable to denote additional protocols and service features as described in the following sections.

The NC codes for the service desired must be specified by the customer when ordering High Capacity Digital Special Access services. This section describes the NC codes which apply specifically to SHARP.

3.4 SPEC Code Function and Format

Service and Product Enhancement Codes (SPEC) will be used in conjunction with NC and NCI codes to order Transport Alternate Protection Path service. The SPEC code will be used to indicate a mixed technology situation. SPEC codes will be used to identify product features and options other than those identifiable by the NC and NCI codes. Figure 3-2 depicts the basic SPEC Format.

CHARACTER POSITION	1	2	3	4	5	6	7
CODE	A/N	A/N	A/N	A/N	A/N	A/N	A/N
DATA ELEMENT	BASE PRODUCT			PRODUCT OPTIONS			

Figure 3-2 SPEC Code Format

- The format of the SPEC consists of five, six, or seven alpha and/or numeric characters. To eliminate confusion, the letter 'O' is used, but the number '0' is not. The number '1' is used, but the letter 'l' is not.
- The first through third characters (positions 1-3) identify the base product. The fourth through seventh characters (positions 4-7) identify the features, options and/or rating elements of the base product.
- Character positions 1-5 are always populated. When positions 6 and/or 7 are not used, these positions should be left blank.
- The following SPEC code shall be used with the ordering of Transport Alternate Path Protection in conjunction with the applicable NC Code:

SRAMRG

The compatible DS1 Network Channel (NC) codes for U S WEST Self-Healing Alternate Route Protections Service are listed in Table 3-4

HC-1 SERVICES

Table 3-4 DS1 Compatible Network Channel (NC) Codes

NC CODE	OPTION BR 795-403-100, Iss. 5, August 1993	OPTION U S WEST
HCHA	Self-Healing and Disaster Recovery--Loop Protection--One End Only	Self-Healing Protection (One End Only)
HCHE	Self-Healing and Disaster Recovery--Loop and Facility Protection with DS1-DS0/Subrate Mux (e.g. D4 Format)	DS1-DS0 or Subrate Multiplexing and Self-Healing Protection and Disaster Recovery (SHARP) (One End Only)
HCHC	Self-Healing and Disaster Recovery--Route Protection--DS1-DS0/Subrate Mux (e.g. D4 Format)	DS1-Voice to Digital Data Multiplexing and Self-Healing Protection and Disaster Recovery (SHARP) (One End Only)
HCHS	Self-Healing and Disaster Recovery--Loop and Facilities Protection (i.e. SWC Protection) with DS1 Voice Mux	DS1-Voice Multiplexing and Self-Healing Protection and Disaster Recovery (SHARP) (One End Only), Including Interoffice Protection
HCHD	Self-Healing and Disaster Recovery--Loop (One End) and Facilities Protection (i.e. SWC Protection)	Self-Healing Protection and Disaster Recovery (SHARP) (One End Only) Including Interoffice Protection
HCHI	Self-Healing and Disaster Recovery--Loop Facilities Protection, i.e. SWC Protection with DS1-DS0 Mux (e.g. T1DM e/w Secondary Channel)	DS1-DS0 or Subrate Multiplexing and Self-Healing Protection and Disaster Recovery (SHARP) (One End Only), Including Interoffice Protection
HCH-	Self-Healing and Disaster Recovery--Loop Protection Both Ends of Circuit (w/o Switch Protection)	Self-Healing Protection and Disaster Recovery (SHARP) (Both Ends)
HCHK	Self-Healing and Disaster Recovery--Loop and Facilities Protection, i.e. SWC Protection	Self-Healing Protection and Disaster Recovery (SHARP) (Both Ends), Including Interoffice Protection
HCHL	Self-Healing and Disaster Recovery--Loop Protection Thru Connect Circuit (i.e. CO DSX-1 Term)	Self-Healing Protection and Disaster Recovery (SHARP) (One End Only) and CO Cross-connect at the DS1 Rate
HCHN	Self-Healing and Disaster Recovery--Loop and Facilities Protection (i.e. SWC Protection) for Thru Connect Circuit (i.e. DSX-1 term.)	Self-Healing Protection and Disaster Recovery (SHARP) (One End Only) and CO Cross-connect at the DS1 Rate Including Interoffice Protection

The compatible DS3 NC codes for U S WEST Self-Healing Alternate Route Protections Service are listed in Table 3.5.

Table 3-5 DS3 Compatible Network Channel (NC) Codes HC-3 Services

NC CODE	OPTION BR 795-403-100, Iss. 5, August 1993	OPTION U S WEST
HFHA	Self-Healing Disaster Recovery--Loop Protection--One End Only	Self-Healing Protection and Disaster Recover (SHARP) (One End Only)
HFHB	Self-Healing Disaster Recovery--Loop Protection and B8ZS Compatible CO Mux	B8ZS Compatible CO Multiplexing and Self-Healing Protection and Disaster Recovery (SHARP) (One End Only)
HFHM	Self-Healing Disaster Recovery--Loop Protection and CO Mux	Central Office Multiplexing and Self-Healing Protection and Disaster Recovery (SHARP) (One End Only)
HFH-	Self-Healing Disaster Recovery--Loop and Facility Protection, i.e. SWC Protection	Self-Healing Protection and Disaster Recovery (SHARP) (One End Only), Including Interoffice Protection
HFHI	Self-Healing Disaster Recovery--Loop and Facility Protection (i.e. SWC Protection) with B8ZS Compatible CO Mux	Self-Healing Protection and Disaster Recovery (SHARP) (One End Only), Including Interoffice Protection, CO Multiplexing and B8ZS Compatible
HFHJ	Self-Healing Disaster Recovery-- Loop and Facility Protection (i.e. SWC Protection) with CO Mux	Self-Healing Protection and Disaster Recovery (SHARP) (One End Only), Including Interoffice Protection and CO Multiplexing
HFHL	Self-Healing Disaster Recovery--Facility Protection (w/o Loop Protection) Thru Connect Circuit (i.e. CO DSX-3 Term) and Auto Hub Protection	Self-Healing Protection and Disaster Recovery (SHARP) (One End Only) and CO Cross-connect at the DS3 Rate
HFHC	Self-Healing Disaster Recovery--Loop and Facilities Protection (i.e. SWC Protection) for Thru Connect Circuit (i.e. DSX-1)	Self-Healing Protection and Disaster Recovery (SHARP) (One End Only) and CO Cross-connect at the DS3 Rate Including Interoffice Protection
HFHD	Self-Healing Disaster Recovery--Loop Protection Both Ends of Circuit w/o SWC Protection	Self-Healing Protection and Disaster Recovery (SHARP) (Both Ends)
HFHE	Self-Healing Disaster Recovery--Loop (Both Ends) and Facilities Protection (i.e.SWC)	Self-Healing Protection and Disaster Recovery (SHARP) (Both Ends), Including Interoffice Protection

Table 3-5 continues on the following page

Table 3-5 DS3 Compatible Network Channel (NC) Codes
HC-3 Services (continued)

NC CODE	OPTION BR 795-403-100, Iss. 5, August 1993	OPTION U S WEST
HFHK	Self-Healing Disaster Recovery-- CO to CO Mux Both Ends	Self-Healing Protection and Disaster Recovery (SHARP) Interoffice Protection Only, Central Office Multiplexing Both Ends
HFHN	Self-Healing Disaster Recovery-- CO to CO Mux Both Ends and B8ZS	Self-Healing Protection and Disaster Recovery (SHARP) Interoffice Protection Only, Central Office Multiplexing and B8ZS Compatible Both Ends
HFHT	Self-Healing Disaster Recovery--Facility Protection	Self-Healing Protection and Disaster Recovery (SHARP) Interoffice Protection Only
HFHV	Self-Healing Disaster Recovery--Facility Protection and B8ZS Compatible	Self-Healing Protection and Disaster Recovery (SHARP) Interoffice Protection Only, B8ZS Compatible Both Ends
HFHW	Self-Healing Disaster Recovery--B8ZS Compatible CO Mux	Self-Healing Protection and Disaster Recovery (SHARP) Interoffice Protection Only, Central Office Multiplexing and B8ZS Compatible One End
HFHX	Self-Healing Disaster Recovery--Cross Connect	Self-Healing Protection and Disaster Recovery (SHARP) Interoffice Protection Only, Central Office Cross Connect
HFHY	Self-Healing Disaster Recovery-- W + X--B8ZS Compatible and Cross Connect	Self-Healing Protection and Disaster Recovery (SHARP) Interoffice Protection Only, Central Office Multiplexing and B8ZS Compatible One End and Central Office Cross Connect

CONTENTS

Chapter and Section	Page
4 Performance Specifications	4-1
4.1 Error Performance Parameters	4-1
4.2 Error Performance Requirements	4-1
4.3 Service Availability	4-2
4.4 Jitter Performance.....	4-2
4.4.1 Definition Of Timing Jitter	4-2
4.4.2 Network Interface Timing Jitter Specifications	4-2
4.5 Protection Switching.....	4-2

4. Performance Specifications

4.1 Error Performance Parameters

The parameters for which performance is specified are as follows:

- Bit Error Rate (BER) - The BER is the ratio of the number of bits in error to the total number of bits transmitted during a measurement period.
- Errored Seconds - An Errored Second is any one second interval containing at least one error.
- Burst Errored Seconds - A Burst Errored Second is any Errored Second containing at least 100 errors.

4.2 Error Performance Requirements

The requirements given in this section are for all one-way system options and apply at the maximum short-haul design length of 250 miles. For shorter systems, the numerical values are to be reduced in direct proportion to route mileage. A measurement period consists of a series of one-second intervals.

The BER at the DS1 and DS3 interface levels will be $\leq 1 \times 10^{-9}$ excluding all Burst Errored Seconds in the measurement period. During a Burst Errored Second, neither the number of bit errors nor the number of bits is counted. This requirement applies in a normal operating environment, and should be met by every channel in each protection switching section.

The frequency of Burst Errored Seconds, other than those caused by protection switching induced by hard equipment failures, should average no more than 4 per day at the interface levels of DS1 and DS3. This requirement applies in a normal operating environment, and should be met by every channel in each protection switching section.

For systems interfacing at the DS3 level, the long-term percentage of Errored Seconds should not exceed 1.0%. This is equivalent to 99.0% Error Free Seconds (EFS). This requirement applies in a normal operating environment, and it is also an acceptance criterion. It equates to no more than 72 Errored Seconds during a two-hour one-way (loopback) test.

For systems interfacing at the DS1 level, the long-term percentage of Errored Seconds should not exceed 0.14%. This is equivalent to 99.86% EFS. This requirement applies in a normal operating environment, and it is also an acceptance criterion. It equates to no more than 10 Errored Seconds during a two-hour one-way (loopback) test.

Loopback acceptance tests should be made using the one-way limits because one direction is likely to be controlling. If these fail, then appropriate one-way tests should be made.

4.3 Service Availability

The availability requirement for U S WEST Self-Healing Alternate Route Protection Service (SHARP and SHARP Plus) is 99.99 percent. Unavailability is defined as any one second interval with a line BER worse than 1×10^{-3} . The corresponding outage equates to 52 minutes per year.

The availability requirement of 99.99% only applies to the portion of a circuit protected by U S WEST Self-Healing Alternate Route Protection Service. The standard availability requirement will apply for any portion of the circuit transported over non-SHARP circuits.

4.4 Jitter Performance

4.4.1 Definition Of Timing Jitter

Timing jitter is defined as the short term variations of the significant instances of a digital signal from their ideal positions in time, where short term implies phase oscillations of frequency greater than or equal to 10 Hertz.

4.4.2 Network Interface Timing Jitter Specifications

The limits given in Bellcore Technical Reference TR-TSY-000499, "Transport Systems Generic Requirements (TSGR): Common Requirements (A Module of TSGR, FR-NWT-000440)" represent the maximum permissible levels of output jitter for Carrier-to-Carrier Network Interfaces. The Carrier-to-End User Network Interface jitter requirements are addressed in ANSI T1.404-1989. The purpose of these limits is to limit broadband jitter appearing anywhere in the U S WEST Communications, Inc. Network.

4.5 Protection Switching

Automatic protection switching is used to improve the availability and reliability performance of U S WEST Self-Healing Alternate Route Protection Service by substituting standby equipment or alternate channels when failure occurs.

The protection switch will operate and switch the U S WEST DS3 or DS1 channel to the protection system when the BER on the transport system reaches 1×10^{-6} and operates at that BER for 10 consecutive seconds.

Once a decision is made to switch to a protection system, the additional time required to complete the switch will not exceed 50 milliseconds.

CONTENTS

Chapter and Section	Page
5. Maintenance.....	5-1
5.1 Customer Responsibilities.....	5-1
5.2 U S WEST Responsibilities	5-1

5. Maintenance

5.1 Customer Responsibilities

The customer is responsible for all equipment and cable on the customer side of the NI at their location.

The customers or their responsible agent must sectionalize the trouble and verify that the trouble is not in the customer owned equipment or cable before calling the U S WEST Customer Service Center (CSC).

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

Joint testing between the customer location and a U S WEST may sometimes be necessary to isolate the trouble.

5.2 U S WEST Responsibilities

U S WEST is responsible for all equipment and cable on the U S WEST side of the NI at the customer's location.

U S WEST is responsible for maintaining the transmission facility between customer locations and between the Central Office Hub and the customer location.

U S WEST will furnish the customer a trouble reporting telephone number.

Upon receipt of a trouble report, U S WEST Communications, Inc. will initiate action within twenty minutes to clear the trouble.

U S WEST is committed to 30 minute restoral in the event of a service interruption on Self-Healing Alternate Route Protection (SHARP) Services with the following two exceptions:

- Two (2) hours maximum restoral time in the event that the working or protection path fails as a result of an electronics failure.
- Eight (8) hours maximum restoral time if the path failure is a result of a cable failure.

CONTENTS

Chapter and Section	Page
6. Definitions	6-1
6.1 Acronyms	6-1
6.2 Glossary	6-2

6. Definitions

6.1 Acronyms

AWC	Alternate Wire Center
B8ZS	Bipolar with 8 Zero Substitution
BER	1) Basic Encoding Rules for ASN.1 2) Bit Errored Ratio 3) Bit Error Rate
CPE	Customer Provided Equipment
CO	Central Office
CSC	Customer Service Center
EU	End User
FDP	Fiber Distribution Panel
IEC	Interexchange Carrier (or IC) Interexchange Common Carrier
INE	Intelligent Network Element or Equipment
LEC	Local Exchange Carrier
NC	Network Channel
NCI	Network Channel Interface
NI	Network Interface
POP	Point Of Presence
POT	Point Of Termination
SHARP	Self-Healing Alternate Route Protection
SHNS	Self-Healing Network Services
SHS	Self-Healing Services
SONET	Synchronous Optical Network
SOT	SONET Optical Terminal
SWC	Serving Wire Center

6.2 Glossary

Alternate Mark Inversion (AMI)

A one (mark) pulse which is the opposite polarity as its predecessor.

American National Standard Institute (ANSI)

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

Asynchronous Transmission

Not synchronous: Data transmission in which the time of occurrence of specified significant instant of a data bit (usually the leading edge) is arbitrary, and occurs without necessarily having a fixed time relationship to preceding comparable instants.

Automatic Protection Switch (APS)

A device which monitors a channel and automatically switches the channel to another facility whenever the channel fails or when specified parameters go beyond a specified threshold.

Availability

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

Bipolar With 8 Zero Substitution (B8ZS)

Bipolar 8 Zero Substitution is an application of BPRZ and is an exception to the Alternate Mark Inversion (AMI) line-code rule. It is one method of providing bit independence for digital transmission by providing a minimum 1s density of 1 in 8 bits.

Bit (Binary Digit)

A binary unit of information. It is represented by one of two possible conditions, such as the value 0 or 1, on or off, high potential or low potential, conducting or not conducting, magnetized or demagnetized. A Bit is the smallest unit of information, by definition.

Bits/second (bit/s)

Bits per second, e.g., 1200 bps. 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 Rate (BER)

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

Carrier

An organization whose function is to provide telecommunications services. Examples are: Local Exchange Carriers, Interexchange Carriers, Cellular Carriers, etc.

Central Office (CO)

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

Channel

An electrical or photonic, in the case of fiber optic based transmission systems, communications path between two or more points of termination.

Channelize

The process of multiplexing-demultiplexing channels using analog or digital techniques.

Clear Channel Capability (CCC)

A characteristic of a transmission path in which the bit positions allocated for customer data may represent any combination of zeroes and ones.

Customers

Denotes any individual, partnership or corporation who subscribes to the services provided by US 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 Installation (CI)

Equipment and wiring at the customer's location on the customer side of the Network Interface.

Customer Interface

The interface with a customer at a point of termination.

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. In the U S WEST Digital Data Service application, CPE typically includes the DSU (CSU/DSU) and data terminal equipment which are connected to the channel.

Demarcation Point

See Network Interface

Demultiplexing

The opposite of multiplexing. That is, the multiplexer combines signals and the demultiplexer takes them apart again. Also see Multiplexing.

Digital Transmission Facilities

May include both loop and interoffice facilities which perform multiplexing, demultiplexing, and transport of digital signals between the SS Exchange Termination and the Subscriber Access Termination.

DS1 Clear Channel

Denotes that 1.535 Mbit/s of a 1.544 Mbit/s DS1 facility are available for customer information. The remaining 8 kilobits, or overhead, are for error correction, framing, and network performance/status/information.

End Office

A designation of a U S WEST switching system that occupies the lowest level of the public switched network hierarchy. it is the designation of a switching system that connects lines to lines, and lines to trunks (a local switching system).

End-User (EU)

The term "end-user" denotes any customer of telecommunications service that is not a carrier, except that a carrier shall be deemed to be an "end-user" to the extent that such carrier uses a telecommunications service for administrative purposes without making such service available to others, directly or indirectly. The term is frequently used to denote the difference between a Carrier interface and an interface subject to unique regulatory requirements at non-Carrier customer premises (FCC Part 68, etc.)

Error Free Second (EFS)

A one-second interval which does not contain any bit-errors. Usually expressed as a percent over a consecutive 24-hour period.

Errored Second (ES)

A one second interval with one or more bit errors.

Note - A period of no signal shall be considered a period of errored bits.

Exchange

A unit established by U S WEST for the administration of communications service in a specified geographic area that usually embraces a city, town, or village and its environs.

Expected Measured Loss (EML)

The calculated value of loss at a given reference frequency that one would expect to measure between two specified test points with the proper terminating impedance.

Extended Superframe (ESF) Format

An Extended Superframe consists of twenty-four consecutive DS1 frames. Bit one of each frame (the F-bit) is time shared during the 24 frames to describe a 6 bit frame pattern, a 6 bit Cyclic Redundancy Check (CRC) remainder, and a 12 bit data link. The transfer rate of each is 2 kbit/s, 2 kbit/s, and 4 kbit/s respectively.

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.

Intelligent Network Element (INE)

A software programmable network component.

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.

Interface Code

See Network Channel Interface

Isochronous Transmission

A transmission process in which there is always an integral number of unit intervals between any two significant instants. The transmission is characterized by a constant pulse rate, a constant time interval, or multiples thereof between voltage or electromagnetic field intensity transitions, and a gating by a controlled clock.

Jitter

Random timing distortions of a digital signal, whereby the appearance of a pulse differs from where the pulse should occur relative to time.

Kilobit/Second (kbit/s)

One thousand (1000) bits/second
management functions.

Line

The transport facility (cable pair or carrier channel) between the Central Office and Network Channel Interface.

Local Exchange Carrier (LEC)

The regulated entity providing Access and Intra-LATA services.

Multiplex

See multiplexer

Multiplexer (Mux)

An equipment unit to multiplex, or do multiplexing: Multiplexing is a technique of modulating (analog) or interleaving (digital) multiple, relatively narrow bandwidth channels into a single channel having a wider bandwidth (analog) or higher bit-rate (digital). the term Multiplexer implies the demultiplexing function is present to reverse the process so it is not usually stated.

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, Impedances, Protocol Options, and Transmission Level Points (TLP). (At a digital interface, the TLP element of the NCI code is not used.)

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.

Optical Carrier (OC)

Optical carrier, the nomenclature for the line rate of the optical transmission signal described in this document.

Optical Interface (OI)

The OI is the transmit point wherein light waves move away from the interface toward an optical receiver.

Phase Jitter

Intermittent, random displacements in time of digital bits, from their ideal placement in time.

Point of Presence (POP)

A physical location within a LATA at which an Interexchange Carrier (IC) establishes itself for the purpose of obtaining LATA access and to which U S WEST provides access service.

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).

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.

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.

Severely Errored Second (SES)

A one second interval having a Bit Error Ratio of 10^{-3} or worse

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 OC_n where n=3 through a number not yet firm, are possible.

SONET Optical Terminal (SOT)

A terminal which uses SONET multiplexing to interleave the lower rate payloads, thereby creating a high rate synchronous signal.

Superframe Format (SF)

A superframe consists of 12 consecutive DS1 frames. Bit one of each frame (the F-bit) is used to describe a 12-bit framing pattern during the 12 frames.

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 (OC-1) level. Other rates, defined as OC-n where n=3 through a number not yet firm, are possible.

Synchronous Test Line

An arrangement in a central office that performs marginal operational tests of supervisory and ring-tripping functions.

Synchronous Transmission

A transmission process such that between any two significant instants in the overall bit-stream there is always an integral number of unit intervals.

Transmission Path

Denotes a path capable of transporting signals within the range of the service offering. A transmission path is comprised of physical or derived facilities consisting of any form or configuration of plant typically used in the telecommunications industry.

Transmission Service Channel

A one-way transmission path between two designated points.

Trunk

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

Wire Center

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

ZBTSI

A method of providing DS1 Clear Channel Capability using the Extended Superframe (ESF) format and Alternate Mark Inversion (AMI) line code. See ANSI T1.107-1988.

CONTENTS

Chapter and Section	Page
7. References	7-1
7.1 American National Standards Institute Documents	7-1
7.2 Bellcore Documents	7-1
7.3 U S WEST Technical Publications	7-1
7.4 Ordering Information	7-2

7. References

7.1 American National Standards Institute Documents

- ANSI T1.102-1987 *Telecommunications - Digital Hierarchy - Electrical Interfaces*
- ANSI T1.105-1991 *Telecommunications - Digital Hierarchy - Optical Interface Rates and Formats Specifications (SONET)*
- ANSI T1.106-1988 *Telecommunications - Digital Hierarchy - Optical Interface Specifications (Single Mode)*
- ANSI T1.107-1988 *Telecommunications - Digital Hierarchy - Formats Specification*
- ANSI T1.223-1991 *Information Interchange - Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for the North American Telecommunications System*
- ANSI T1.403-1989 *Telecommunications - Carrier to Customer Installation - DS1 Metallic Interface.*
- ANSI T1.404-1989 *Telecommunications - Carrier-to-Customer Installation - DS3 Metallic Interface Specification*

7.2 Bellcore Documents

- TR-INS-000342 *Bellcore, High-Capacity Digital Special Access Service-Transmission Parameter Limits and Interface Combinations. Issue 1, February 1991*
- TR-TSY-000499 *Bellcore, Transport Systems Generic Requirements (TSGR): Common Requirements, Issue 3, December 1989*

7.3 U S WEST Technical Publications

- PUB 77200 *U S WEST Service Publication, U S WEST DS1 Service, Issue C, October 1993*
- PUB 77324 *U S WEST Technical Specifications for 44.736 Mbits (DS3) Electrical, Optical and Radio Interfaces, Issue C, April 1993*
- PUB 77346 *U S WEST Synchronous OpticalTransport Line Interface, Issue A, July 1993*
- PUB 77375 *U S WEST 1.544 Mbits Channels Interfaces, Issue B, August 1993*

7.4 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.

Ordering Information for Employees of U S WEST Communications, Inc.

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Denver, CO 80202
Telephone: (303) 298-1025 or (303) 298-1778
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