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SMARTGate® Service
Interface and Performance Specifications

Technical
Reference

NOTICE

This Technical Reference describes SMARTGateSM Service (a.k.a. BellSouth SPA Managed Shared Ring Network) DS1, DS3 and Synchronous Optical Network (SONET) Optical Carrier level 12 (OC-12) interfaces. It describes signals as they appear at the Network Interface (NI), between BellSouth Telecommunications, Inc. (BST) and Customer Installations or Carriers for SMARTGateSM Service (a.k.a. BellSouth SPA Managed Shared Ring Network) SONET based services.

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SMARTGateSM Service
(a.k.a. BellSouth SPA Managed Shared Ring Network)
Interface and Performance Specification

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SMARTGateSM Service

(a.k.a. BellSouth SPA Managed Shared Ring Network)

Interface and Performance Specification

1. General

The requirements in this document were developed to establish a practical interface. Compliance with these specifications should provide a satisfactory interface in a high percentage of installations. If cases arise that have not been adequately addressed in this document, any resulting problems should be resolved through the cooperation of the user, BellSouth Telecommunications, Inc. (BST) and equipment suppliers. BST encourages customer participation to ensure an orderly, functional and mutually trouble-free interface at all locations.

1.1 Scope

This Technical Reference (TR) describes physical, protocol and performance requirements at the Network Interface (NI) necessary for compatible operation between BST and the Carrier or Customer Installation (CI) for SMARTGateSM Service (a.k.a. BellSouth SPA Managed Shared Ring Network). This TR describes the SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) DS1, DS3 and optical interfaces offered by BST. An optical interface may not be available initially. Customers should consult the appropriate tariff or a Marketing Representative for availability.

1.2 Use of this Document

Network Interface (NI) specifications have been established based upon Industry Standards developed by the American National Standards Institute (ANSI) and Bellcore. This TR articulates BST variations from these standards and provides clarification of interface requirements as necessary.

1.3 Reason for Reissue

This Technical Reference (TR) is being reissued to generally update the original issue and specifically includes the following:

- Specifications for 4 fiber interface
- Network Channel Interface (NCI) codes for 4 fiber interface
- Provision of Carrier provided optical Network Interface device
- Provision of DS3 BNC connectors at Network Interface
- Recommendation that the customer's DS1 NCTE LBO be set to 0 dB, unless the customer is advised otherwise by BST
- Revision of Table 5-1 Overhead Bytes Active Across Interface based upon latest information contained in American National Standards Institute (ANSI) T1.105

2. Service Description

SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) is a managed high capacity network service capable of providing a shared transport link with high performance and reliability, and a level of redundancy/diversity designed to limit a single event from interrupting service. Within a SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) Area, BST will aggregate a customer's high capacity traffic (e.g., DS1 or DS3 high capacity traffic) and manage its delivery to a primary aggregation location. Where the customer provides an alternate aggregation location on the same physical fiber ring as the primary aggregation location, SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) may provide for simultaneous delivery of the customer's traffic to both the primary and alternate aggregation locations.

The traffic will be collected and managed as (1) on-net DS1 SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network), (2) off-net DS1 SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network), (3) on-net DS3 SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) or (4) off-net DS3 SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network), as applicable. An on-net DS1 or DS3 SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) is one that originates at a collection location that is on the SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) network. An off-net SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) DS1 or DS3 is one that originates at a collection location which is not on the SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) network as a service other than SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) and connects to the SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) network at a SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) wire center.

SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) provides as an inherent characteristic of the service fault and performance monitoring. The monitoring information will be delivered to the customer via a BST provided circuit.

Wire centers comprising a SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) Area will be identified in National Exchange Carrier (NECA) Tariff FCC. No. 4, as either available for on-net and off-net DS1 and DS3 service or available only for off-net DS1 and DS3 services.

2.1 Service Architecture

SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) is based on fiber facilities configured in ring architectures and is available only in those locations within specified metropolitan areas which BST determines can be incorporated into the SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) network enabling BST to provide the specified level of performance and reliability. Within the wire center serving areas that comprise a SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) Area, the customer's high capacity special access traffic will be collected and managed for delivery to a customer's aggregation location(s).

At aggregation locations where the high capacity traffic terminates, SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) will be delivered at an OC-12 optical interface – unless the customer has an existing DS3 interface established as provided for in the tariff.

2.2 Off-Net Connections

Off-net DS1 SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) may connect, at the connection point, to DS1 High Capacity (a.k.a. BellSouth SPA High Capacity) Service, FlexServ® Service (a.k.a. BellSouth SPA Customer Reconfiguration), DS1 Basic Channelization or a DS1 interface on LightGate® Service (a.k.a. BellSouth SPA Point to Point Network), SMARTRing Service (a.k.a. BellSouth SPA Dedicated Ring), BellSouth Virtual Expanded Interconnection Services, Exchange Access Frame Relay Service (a.k.a. BellSouth Exchange Access Frame Relay Service) or Exchange Access Connectionless Data Service (a.k.a. BellSouth Exchange Access Connectionless Data Service).

Off-net DS3 SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) may connect, at the connection point, to FlexServ® Service (a.k.a. BellSouth SPA Customer Reconfiguration), LightGate 1 Service (a.k.a. BellSouth SPA Point to Point Network 1 DS3 Capacity), SMARTRing Service (a.k.a. BellSouth SPA Dedicated Ring), BellSouth Virtual Expanded Interconnection Services, Exchange Access Frame Relay Service (a.k.a. BellSouth Exchange Access Frame Relay Service) or Exchange Access Connectionless Data Service (a.k.a. BellSouth Exchange Access Connectionless Data Service).

2.3 Limitations

For locations where a customer requests SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) and facilities are not available, special construction charges will apply as set forth in the BST's Special Construction Tariff, FCC No. 2. SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) Areas are identified in the NECA Tariff FCC No. 4.

SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) interconnection restrictions are covered in the applicable tariffs, consult a Marketing Representative for assistance.

2.4 Floor Space and Entrance Facilities

The customer must provide suitable floor space, including an environment controlled for humidity and temperature, and a source of non-switched AC power to support SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) at termination points.

Where the customer provides two separate entrance facility cable routes for SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network), the primary and alternate facilities will be separate and will enter the customer location over such different routes.

3. DS1 Interface

This section defines the DS1 Network Interface (NI) requirements. It denotes existing documentation which details electrical and signal specifications and provides BST variations and clarifications. The physical layer of the DS1 NI is delineated in the following specifications.

ANSI T1.403–1995 *Draft American National Standard for Telecommunications – Network–to–Customer Installation – DS1 Metallic Interface*

GR–342–CORE *High–Capacity Digital Special Access Service Transmission Parameter Limits and Interface Combinations*

ANSI T1.403 applies to End–User (EU) interfaces and GR–342 applies to Carrier interfaces. A sketch of the DS1 EU customer NI is shown in Figure 1. The signal delivered to the NI by BST is identified as the BST signal, and the signal delivered to the NI by the customer is identified as the CI signal.

3.1 Framing Format

The DS1 signal must be framed, and it is strongly recommended that all DS1s utilize the Extended Superframe Format (ESF) described in ANSI T1.403.

3.2 Clear Channel Capability

BST uses the Bipolar with Eight Zero Substitution (B8ZS) method to provide a Clear Channel Capability (CCC). This supports transport of a framed DS1 signal with unconstrained payload information bits. BST does not support the Zero–Byte Time Slot Interchange (ZBTSI) method of providing CCC.

3.3 Maintenance Signals

Maintenance signals are transmitted in–band and in the data link of the ESF format. ANSI T1.403 and BST TR 73525, *MegaLink and MegaLink Channel Service Exchange Network Interface Specifications* provides additional information regarding specific maintenance, alarm and loopback signals.

3.4 DS1 End–User Interface

DS1 End–User (EU) interface requirements are defined in ANSI T1.403. At an EU customer NI, some of the electrical requirements for the BST signal differ from corresponding requirements for the CI signal.

3.4.1 BST Signal at Network Interface

The signal requirements will be met at the signal regenerator output nearest the NI. An isolated pulse will have a peak–to–base amplitude of between 2.25 and 3.6 volts. At the NI, the pulse characteristics will be those of this BST standard pulse transmitted through a cable pair with a loss in the range of 0 to 16.5 dB at 772 kHz between 100 ohm terminations as shown in Figure 1.

3.4.2 Customer Signal at Network Interface

The signal requirements will be met at the output of the customer Network Channel Terminating Equipment (NCTE) when its Line Buildout (LBO) is set to 0 dB. An isolated pulse shall have a peak-to-base amplitude of between 2.4 and 3.6 volts. At the NI, the pulse characteristics shall be those of a standard pulse transmitted through a cable pair with a loss in the range of 0 to 5.5 dB at 772 kHz between 100 ohm terminations as shown in Figure 1. When additional customer attenuation is required, it may be inserted by selecting the appropriate LBO setting in the customer NCTE (0, 7.5 or 15 dB). For SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) the NCTE LBO should be set to 0 dB, unless the customer is advised otherwise by BST. It is the customer's responsibility to properly option the NCTE to provide the required LBO setting. Failure to provide the specified LBO will jeopardize performance of the customer's service and has the potential to adversely impact the performance of other BST provided services.

3.4.3 Mechanical Interface

One balanced twisted pair shall be used for each direction of transmission. Interconnection at the DS1 End-User NI is through one of four Universal Service Order Code (USOC) connectors, RJ48C, RJ48X, RJ48M, RJ48H, as shown in ANSI T1.403 and Part 68 of the FCC Rules and Regulations as revised by Public Notice Numbers 4609 (September 21, 1988) and 4572 (October 3, 1988). The RJ48C or RJ48X jack is used for single DS1 line installations, and the RJ48M (8 DS1s) or RJ48H (12 DS1s) may be used for multiple circuit installations.

Alternatively, an appropriate DS1 rate digital cross connect panel may function as the interconnection arrangement at the NI.

3.4.4 Customer Responsibility

The customer is required to provide network protection, signal recovery, LBO (as specified by BST) and test access functionality. These functions are normally included in a device called a Channel Service Unit (CSU).

3.5 DS1 Carrier Interface

DS1 Carrier interface requirements are contained in Bellcore GR-342-CORE. BST and Carrier signals at the NI shall be those of a standard DSX-1 cross-connect pulse.

3.5.1 Mechanical Interface

One balanced twisted pair shall be used for each direction of transmission. Interconnection at the DS1 Carrier NI is through an appropriate DS1 rate digital cross-connect panel. Alternatively, suitable mechanical connecting arrangements may be the RJ48C, RJ48X, RJ48M or RJ48H connectors.

4. DS3 Interface

This section defines the DS3 Network Interface (NI) requirements. It denotes existing documentation which details electrical and signal specifications and provides BST variations and clarifications. At the NI the electrical requirements for the BST and customer signal are the same. The physical layer of the DS3 NI is delineated in the following specifications.

ANSI T1.404–1994 *Network–to–Customer Installation – DS3 Metallic Interface Specification*

ANSI T1.404a–1996 *Network–to–Customer Installation – DS3 Metallic Interface Specification (supplement)*

GR–342–CORE *High–Capacity Digital Special Access Service Transmission Parameter Limits and Interface Combinations*

ANSI T1.404 applies to End–User (EU) interfaces and GR–342 applies to Carrier interfaces. A sketch of the DS3 EU customer NI is shown in Figure 2. The signal delivered to the NI by BST is identified as the BST signal, and the signal delivered to the NI by the customer is identified as the CI signal.

4.1 Framing Format

The DS3 signal must be framed utilizing the framing structure defined in ANSI T1.107–1995, *Digital Hierarchy Formats Specifications*. The asynchronous M13 multiplex format (combination of M12 and M23 formats) is specified for terminal equipment that multiplexes 28 DS1s into a DS3.

4.2 Mechanical Interface

One coaxial cable is provided for each direction of transmission. The reference cable is 75 ohm coaxial cable with tinned copper meeting the requirements specified in ANSI T1.102–1993, *Digital Hierarchy – Electrical Interfaces*. Interconnection at the DS3 NI is through Universal Service Order Code (USOC) connector, SJA 44 as shown in ANSI T1.404–1994. The SJA 44 was originally defined as a 75 ohm plug and jack coaxial connector meeting the requirements in MIL–C–39012 and MIL–STD–202 – TNC connector. Currently, the preferred method of interconnection is via two BNC connectors.

4.3 Customer Responsibility

The customer is required to provide network protection, signal recovery, Line Buildout and test access functionality. These functions are normally included in a device called a Channel Service Unit (CSU).

4.4 Maintenance Considerations

Customer Premises Equipment (CPE) shall provide the capability of generating and interpreting standard DS3 signals, alarm/defect indication signals and P–bit performance monitoring as defined in ANSI T1.404.

5. SONET OC–12 Interface

This section defines the Synchronous Optical Network (SONET) OC–12 Optical Network Interface (NI) requirements. It denotes existing documentation which details signal specifications and provides BST variations and clarifications. The physical layer of the OC–12 NI is delineated in the following specifications.

GR–253–CORE	<i>Synchronous Optical Network (SONET) Transport Systems: Common Criteria Physical Layer</i>
GR–1365–CORE	<i>SONET Private Line Service Interface Generic Criteria for End Users</i>
ANSI T1.105–1995	<i>Synchronous Optical Network (SONET) – Basic Description including Multiplex Structure, Rates, and Formats</i>

At this time, it is recommended that SONET optical interfaces be jointly engineered by BST and the customer.

5.1 SONET Rates

SONET defines a progressive hierarchy of optical signal and line rates. The basic building block is the STS–1 (Synchronous Transport Signal at level 1), operating at 51.840 Mb/s. All higher rate signals (STS–N) are multiples (N) of the basic STS–1 signal rate. One example of forming a STS–N signal is by synchronously byte–interleaving N STS–1 signals.¹ The values of N currently recognized in Industry Standards are 1, 3, 12, 24, 48, and 192. The optical counterpart of a STS–N is the OC–N, operating at the same rate as the corresponding STS–N.

SONET takes a layered approach, starting with the lowest layer called the Physical Media Dependent (PMD) layer, followed by the logical layers called the Section, Line and Path² layers in ascending order. These layers together constitute the lowest layer, the Physical layer, in the 7–layer Open Systems Interconnection (OSI) Reference Model. The layers are largely independent. Each NE (Network Element) terminates at least the PMD³, which provides for the optical or electrical transmission of bits. Each logical layer has an associated overhead which is generated and terminated by NEs operating at the respective level. These NEs are called Section Terminating Equipment (STE), Line Terminating Equipment (LTE⁴) and Path Terminating Equipment (PTE) in ascending order. A NE may terminate one or more than one layer; for example, STE and LTE functions may be combined in one piece of equipment.

¹In more general terms, an STS–N signal may consist of an appropriate number of STS–M signals, where $M < N$. An STS–M signal in turn may consist of multiple STS–1 signals or it may be a concatenated STS–Mc or STS–Xc signal, where $X < M$, or a mixture thereof.

²The path layer is subdivided into the STS (Synchronous Transport Signal) Path layer and depending on multiplexing arrangements, VT (Virtual Tributary) Path layer.

³Except the Physical layer regenerator.

⁴Line Terminating Equipment (LTE) from two different vendors is only compatible if transmission as well as Physical overhead and operational characteristics match.

5.2 SONET Signal Format

The signal format at the SONET interface is based on the SONET frame structure as specified in GR-253-CORE and ANSI T1.105. The STS-1 frame structure consists of the Transport Overhead with Section and Line Overhead portions, the Path Overhead, and the payload. The payload and the Path Overhead together are also referred to as the STS SPE (Synchronous Payload Envelope).

5.3 Overhead Bytes Active Across NI

The function of overhead bytes active across the NI shall be consistent with the specifications contained in GR-253-CORE and ANSI T1.105. Transport and Path Overhead bytes active across the interface are summarized in Table 5-1. It is not anticipated that the Data Communications Channel (DCC) will be active across the interface at this time.

Table 5-1. Overhead Bytes Active Across NI

Transport Overhead				Path Overhead	
Section Overhead	Framing A1	Framing A2	Section Trace J0	PathTrace J1	
	Section BIP-8 B1			Path BIP-8 B3	
				Signal Label C2	
Line Overhead	Pointer H1	Pointer H2	Pointer Action H3	Path Status G1	
	Line BIP-8 B2	APS K1	APS K2		
				Indicator H4*	
		M1 STS-N Line REI			

* These bytes could be active across the interface for specific applications.

Some of the Overhead bytes specified in GR-253-CORE and ANSI T1.105 are not required to be active across the interface. Therefore, receiving equipment must be capable of ignoring their content. Any future utilization of those Overhead bytes is expected to be consistent with SONET Industry Standards.

5.3.1 Framing Information

Framing information is contained in the A1 and A2 bytes. Equipment on either side of the NI shall meet the requirements for going from an in-frame condition to an out-of-frame condition and for going from an out-of-frame condition to an in-frame condition, as well as for entering and exiting the loss of frame state, as specified in GR-253-CORE.

5.3.2 Automatic Protection Switching

Automatic Protection Switching (APS) is controlled by the K1 and K2 bytes. For SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) with a 4 fiber interface, unidirectional 1+1 non-revertive APS will be provided across the NI. Use of the K1 and K2 bytes is specified in GR-253-CORE and ANSI T1.105.01-1994, *Synchronous Optical Network (SONET) – Automatic Protection Switching*.

5.3.3 Data Communications Channel

The Section Data Communications Channel (DCC) consists of 192 kbps located in bytes D1, D2 and D3, and the Line DCC consists of 576 kbps located in bytes D4–D12. The Section DCC and Line DCC will not be active across the SONET Interface – receiving equipment must be capable of ignoring their content.

5.4 Payload Compatibility

For payloads terminated within the BST network, payload compatibility must be assured. Payload mappings for Synchronous Payload Envelopes (SPEs) terminated in the BST network are defined in ANSI T1.105.02, *Synchronous Optical Network (SONET) – Payload Mappings* and currently limited to the following:

- Asynchronous mapping for DS1 signals into floating VT1.5 SPE.
- Asynchronous mapping for DS3 signals with DS3 framing structure into STS-1 SPE.

The OC-12 interface supports transport of properly mapped STS-1, STS-3, STS-3c (concatenated) and STS-12 signals. Payloads which are transported, but not terminated in the BST network, must be contained in one of the supported frame structures. Industry Standard mappings have been defined for ATM, FDDI, and DQDB. In addition to these standard mappings, proprietary mappings (provided they comply with standard frame, format and overhead structure) may also be acceptable for transport.

5.5 Fiber Transmission Media

The optical interface shall use single-mode fiber with a nominal zero dispersion wavelength at 1310 nanometers. The conventional dispersion-unshifted single-mode fiber (also known as EIA/TIA Class IVa fiber) shall meet the requirements detailed in Bellcore GR-20-CORE, *Generic Requirements for Optical Fiber and Optical Fiber Cables*, and ITU Recommendation G.652, *Characteristics of a Single-Mode Optical Fiber Cable*.

The 2 fiber interface provides a working fiber pair which uses one fiber for each direction of transmission as shown in Figure 3. The 4 fiber interface provides a working and protection fiber pair (4 individual fibers – 2 working and 2 protection) as shown in Figure 4.

5.6 Mechanical Interface

At the NI, BST will provide duplexable SC type (EIA/TIA SCFOC/2.5) plug and jack type connectors which will be used to support transmission over single-mode fiber with a nominal zero dispersion wavelength at 1310 nanometers. BST will install the connector jack to serve as the NI. BST and the Carrier must each provide connector plugs to terminate their fibers at the NI. Each connector plug will contain 2 fibers, one for each direction of transmission. The connector jack will be the demarcation point between BST and the Carrier installation.

Alternatively, the Carrier may want to provide interconnection components at their location to serve as the NI. BST and the Carrier must agree upon a mutually acceptable test point at the Carrier's location which will serve as the NI. The Carrier provided NI should be functionally consistent with BST provided NIs and BST technicians must be allowed to access and test from the NI. The use of components such as the Value-Added Connector Module System (VAM System) from ADC Telecommunications can add flexibility and a monitoring capability. The Carrier would provide and install the NI – which would consist of a VAM chassis and monitor module (95/5 splitter). BST would provide a fiber jumper from its terminal equipment to the VAM module. This jumper could accommodate different connectors on each end. In a specific application it is proposed to use a SC type connector at the BST terminal equipment and a FCPC type connector at the Carrier provided VAM module.

5.7 Physical Media Characteristics

The interface shall meet the physical media characteristics defined in GR-253-CORE for Short Reach (SR), Intermediate Reach-1 (IR-1) or Long Reach (LR) applications. Transmitter, optical path and receiver parameters are summarized in Table 5-2.

Table 5-2. OC-12 Optical Parameters

Parameter	SR	IR-1	LR-1		Units
Transmitter	MLM/LED	MLM	MLM	SLM	
$\lambda_{Tmin} - \lambda_{Tmax}$	1261-1360	1293-1334 (1274-1356) ¹	1300-1325 (1296-1330) ¹	1280-1335	nm
$\Delta\lambda_{rms}$	14.5/35	4.0 (2.5) ¹	2.0 (1.7) ¹	NA	nm
$\Delta\lambda_{20}$	NA	NA	NA	1	nm
SSR _{min}	NA	NA	NA	30	dB
P _{tmax}	-8	-8	+2	+2	dBm
P _{tmin}	-15	-15	-3	-3	dBm
r _{emin}	8.2	8.2	10	10	dB
Optical Path					
System ORL _{min} ²	NA	NA	20	20	dB
D _{SRmax}	13/14	46 (74) ¹	92 (109) ¹	NA	ps/nm
Attenuation	0-7	0-12	10-24	10-24	dB
Max. Reflectance between S and R	NA	NA	-25	-25	dB
Receiver					
P _{rmax}	-8	-8	-8	-8	dBm
P _{rmin}	-23	-28	-28	-28	dBm
P _O	1	1	1	1	dB
Max. Receiver Reflec- tance	NA	NA	-14	-14	dB

Note 1: Transmitters meeting the narrower spectral width objective are allowed a wider central wavelength range ($\lambda_{Tmin} - \lambda_{Tmax}$).

Note 2: For all applications, it is an objective that the optical system suffer a power penalty less than 1 dB in the presence of -8.5 dB reflectance.

5.7.1 Optical Parameter Definitions

The following definitions apply to the parameter values listed in Table 5–2.

LED	Light Emitting Diode
MLM	Multi–Longitudinal Mode laser
SLM	Single–Longitudinal Mode laser
$\lambda_{Tmin}, \lambda_{Tmax}$	The range of central operating wavelengths – minimum and maximum central operating wavelengths, under worst–case variations due to manufacturing, temperature, aging, and reflections.
$\Delta\lambda_{rms}$	Root–Mean–Square (RMS) spectral width under worst–case reflection conditions.
$\Delta\lambda_{20}$	Full spectral width measured 20 dB down from the maximum of the central wavelength peak of a single–longitudinal mode (SLM) transmitter operating fully modulated in the presence of worst–case reflections.
P_{Tmax}, P_{Tmin}	The maximum and minimum coupled transmitter power at point S in Figure 5, with a pseudo–random data sequence.
r_{emin}	The minimum value of the extinction ratio – ratio of the average optical energy in a logic one level to a logic zero level, under fully modulated conditions in the presence of worst–case reflections.
ORL_{min}	The minimum ratio in dB of optical power arriving downstream at a system interface to the optical power reflected back upstream to the same interface.
D_{SRmax}	The maximum dispersion between points S & R in Figure 5.
P_{Rmax}, P_{Rmin}	The maximum and minimum receiver power at point R in Figure 5 for 1×10^{-10} BER.
P_O	Optical path power penalty between points S and R in Figure 5.

5.8 System Budget – Joint Engineering

The establishment of optical interfaces will require joint engineering between BST and the Carrier or customer using commonly accepted engineering practices. The design approach should be based on ANSI/EIA/TIA–559, *Single–Mode Fiber Optic System Transmission Design*, or GR–253–CORE procedures.

For the purpose of optical parameter specifications, optical interfaces are referred to a optical system reference diagram as shown in Figure 5. Point S is a reference point on the optical fiber just after the transmitter (Tx) optical connector (CTx). Point R is a reference point on the optical fiber just before the receiver (Rx) optical connector (CRx). Points S and R provide a convenient separation of the optical link into a transmitter subsection, a receiver subsection, and an optical path subsection. Optical parameters are specified for the transmitter at point S, for the receiver at point R, and for the optical path between Points S and R. All parameter values specified are worst–case values and are to be met over the ranges of standard operating conditions (i.e., temperature and humidity ranges); they include aging effects. The parameters are specified relative to an optical section design objective of a bit error ratio (BER) better than 1×10^{-10} .

To ensure proper system performance it is necessary to specify attenuation and dispersion characteristics of the optical path. Attenuation shall be in the range of 0–7 dB for SR applications, 0–12 dB for IR applications, and 10–24/28 dB for LR applications. This specification is assumed to represent worst–case values including losses due to splices, connectors, optical attenuators (if used), or other passive optical devices, and any additional cable margin to cover allowances for the following:

- (1) Future modifications to the cable configuration (additional splices, increased cable lengths, etc.),
- (2) fiber cable performance variations due to environmental factors, and
- (3) degradation of any connector, optical attenuator (if used), or other passive optical device when provided.

5.9 Operations and Maintenance

The SONET interface may terminate in the network at three hierarchical layers: the Section, Line, and Path. The SONET path termination may include STS–Path, VT Path, or DS_n Path. Maintenance capabilities associated with the Section, Line, and Path layers include Performance Monitoring (PM), alarm surveillance, and facility testing. Such maintenance capabilities are performed by Section, Line, and Path termination equipment contained within SONET network elements and are made possible by maintenance tools built into the Section, Line, and Path overhead fields of the SONET framing structure.

The SONET overhead bytes required to perform such operations and maintenance functions for SONET are identified in GR–253–CORE and ANSI T1.105 and have previously been defined as active across the interface.

5.9.1 Fault and Alarm Management

Alarm surveillance deals with the detection and reporting of certain failure conditions in the network. SONET CI equipment is required to detect certain failure conditions relevant to the layer of functionality they provide. Detection of a failure in the network is often communicated throughout relevant portions of the network via maintenance signals built into the SONET frame structure. STS Path level maintenance signals include STS Path Alarm Indication Signal (AIS) and STS Path Remote Defect Indication (RDI). RDI is a performance indicator that is initiated immediately upon detection of a defect.

5.9.2 Failure States

The failure states, Loss of Signal (LOS), Loss of Frame (LOF), and Loss of Pointer (LOP) are defined in GR-253-CORE. SONET equipment shall detect failure states relevant to the layer of SONET overhead functionality it provides.

5.9.3 Equipment Failures

SONET CI equipment failures should be detected and reported according to the equipment failure conditions specified in GR-253-CORE.

5.9.4 Maintenance Signals

Failure states that persist for a defined period of time lead to indications that are reported to SONET equipment using the following maintenance signals.

Alarm Indication Signal (AIS)

SONET provided equipment provides different AISs for various layers of functionality including DS1, DS3, Path, and Line AISs. The Line AIS, STS Path AIS, and/or VT Path AIS generation and detection shall meet the criteria stated in GR-253-CORE.

In many applications, SONET will be a transport medium for lower speed digital signals such as DS1 and DS3. Because of this, SONET CPE that has these DS_n digital interfaces may need to detect and generate DS_n AISs associated with these interfaces. On detection of a failure (Line AIS, STS Path AIS, and/or VT Path AIS) STS PTE (or VT PTE) shall generate downstream DS_n AIS depending on the composition of the STS SPE (or VT PTE) or the functionality of the STS or VT PTE. SONET STS PTE, or VT PTE shall detect DS_n AIS at all DS_n interfaces at which DS_n path is terminated. GR-253-CORE and TR-TSY-000191 specify requirements for DS1 and DS3 AIS.

Line Remote Defect Indication

Line Remote Defect Indication (RDI), formerly line Far End Receive Failure, alerts the upstream equipment that a failure has been detected. SONET terminals shall generate, detect, deactivate (remove) STS Line RDI according to GR-253-CORE.

DSN Remote Failure Indication

Certain SONET payload mappings may require CPE with digital signal interfaces to detect and generate DS_n Remote Failure Indication (RFI), formerly Yellow. DS_n RFI shall be detected or generated for DS_n paths that are terminated according to GR-253-CORE.

STS-Path Remote Defect Indication

STS-Path RDI, formerly Far End Receive Failure (FERF), alerts the upstream equipment that a failure state has been detected. It is an objective for SONET to meet the STS-Path RDI as described in GR-253-CORE.

5.10 Performance Monitoring

In order to support effective maintenance and maintain high service levels, it is desirable that BST and CI SONET equipment provide the same performance monitoring capabilities.

BST will support performance monitoring (PM) in accordance with the strategies and set of layered PM parameters contained in the GR-253-CORE. Except as specifically noted, the layered PM requirements in GR-253-CORE apply to BST SONET interfaces.

SONET STS-Path terminated equipment shall provide Section, Line, and Path performance monitoring on incoming OC-N facilities and be capable of reporting threshold crossings according to the generic requirements in GR-253-CORE.

SONET equipment, if terminating the VT-Path level, shall also provide VT-Path performance monitoring according to GR-253-CORE.

SONET Customer Installation (CI) equipment interfacing with a DS1 or DS3 signal shall detect Loss of Signal (LOS) on those signals according to the requirements in Bellcore TR-TSY-000191, *Alarm Indication Signals Requirements and Objectives*.

6. Performance

The performance objectives for SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) are stated in terms of Error Free Seconds (EFS), Severely Errored Seconds (SES), Service Availability and Service Continuity.

6.1 Error Free Seconds

An EFS is defined as any second in which there is no bit errors. Conversely, an Errored Second (ES) is one in which there is one or more bit errors. ES are typically transient in nature, arise from a variety of causes, and have a small probability of occurring at any given time. EFS objectives are long term, i.e. 30 days or more.

6.2 Severely Errored Second

A SES is defined as any second in which the Bit Error Ratio (BER) is 1×10^{-3} or worse. SES objectives are long term.

6.3 Annual Service Availability

Circuit Availability is a measure of the amount of time that the service is “usable” by the customer. According to the American National Standards Institute (ANSI) a service is assumed to be in the available state unless a transition to the unavailable state is observed without a subsequent transition to the available state. The transitions between the available and unavailable states are:

- Transition to the unavailable state occurs at the beginning of 10 consecutive SES.
- Transition to the available state occurs at the beginning of 10 consecutive seconds none of which is a SES.

6.4 Service Continuity

The Service Continuity performance objective is that in the event of primary facility failure, service will switch to the alternate facility path.

6.5 Quality Objectives

Performance quality objectives on the network side of the NI are stated in terms of: Error Free Seconds (EFS), Severely Errored Seconds (SES), Service Availability and Service Continuity. SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) On–Net DS3 and DS1 performance objectives are summarized in Table 6–1.

Table 6–1. SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) On–Net Quality Performance Objectives

Performance Parameter	DS3 Objectives (Long Term)	DS1 Objectives (Long Term)
%Error Free Seconds (%EFS)	EFS > 99.5%	EFS > 99.95%
%Severely Errored Seconds (%SES)	SES < 0.009%	SES < 0.009%
%Annual Service Availability	Availability > 99.99%	Availability > 99.99%
Service Continuity On–Net	Single Event Restoration < 60 seconds	Single Event Restoration < 60 seconds

7. Synchronization

To insure proper operation when connected to the BST digital network, channelized DS1 circuits should follow the guidelines of Bellcore GR–436–CORE, *Digital Network Synchronization Plan*. Timing information may be transmitted as part of the DS1 signal. Improper timing will result in transmission impairing slips which can cause loss of data information.

End–User synchronization may be achieved by deriving timing from a BST channelized DS1, by deriving timing from a different DS1 traceable to a Primary Reference Source (PRS) and timing all other facilities from it, or by providing timing traceable to a PRS. For BST services with central office channelization, it has been recommended that the customer equipment be loop–timed (slaved) to the incoming bit stream from the network.

It is important to note that Synchronous Optical Network (SONET) facilities will be used to transport SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network). SONET facilities may introduce DS1 phase transients as a result of pointer adjustments. Characteristics of the phase transients at the network interface have been addressed in the latest version of ANSI T1.403. Customer equipment must be capable of accommodating these phase transients. Further information about phase transients due to SONET pointer adjustments is contained in ANSI T1.403.

8. Interface Descriptions

This section provides information on Network Channel Interface (NCI) codes including interface descriptions. The NCI code describes the number of conductors, protocol, impedance, protocol options and transmission level point(s) reflecting characteristics at the Network Interface (NI)/Point of Termination (POT). Existing Network Channel (NC) codes will be used for SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network). The appropriate interface ordering procedures, which use these NCI and NC codes, are covered in other publications such as Bellcore SR–STS–000307.

8.1 Network Channel Interface (NCI) Code Components

The electrical characteristics of the interface are identified by an NCI code. Compatible NCI codes for the service desired must be specified by the customer when ordering SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) and other network special access services. Definitions of specific NCI codes that apply to SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) are covered in this section. Descriptions of the component parts of the NCI code are provided to aid the customer in understanding the relationship of these codes to the electrical characteristics of the interface.

The components of an NCI code furnish the information concerning the electrical characteristics for the Network Interface at the POT. Positions 1 and 2 of the NCI code are numeric characters indicating the total number of conductors at the interface. Positions 3 and 4 are two alphabetic characters indicating the protocol code. Position 5 indicates the reference impedance. Position 6, if used, is a delimiter and indicates the start of the protocol option code. Positions 7, 8, and 9, if used, indicate options available for the protocol code in use. The component parts of the NCI codes and their definitions are listed in the tables in this Section. Additional information about Network Channel Interface Codes may be found in Bellcore SR–STS–000307.

8.1.1 Number of Conductors

This component describes the number of conductors required to provide the service. Table 8–1 lists some of the allowable entries for this component. For DS1 and DS3 SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network), code 04 would be used to indicate 4 conductors. For an optical SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) interface, code 02 would be used to indicate 2 working fibers – one for each direction of transmission and code 04 would be used to indicate a 4 fiber interface – 2 working and 2 protection fibers.

Table 8–1. Number of Conductors⁵

Number of Conductors	Code
2	02
4	04

8.1.2 Protocol Code

The protocol code is the most significant component of the NCI code, since it is associated with the basic electrical function of the interface. The protocol code broadly describes the technical capabilities of the interface at the EU–POT, CXR–POT or serving wire center.

The protocol code combinations specified for the CXR–POT and the EU–POT may be the same or different. However, only certain combinations are technically possible. Table 8–2 lists the protocol codes that apply to SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network).

⁵Wire Code is in Character Positions 1 & 2.

Table 8–2. Selected Protocol Codes and Options⁶

Code	Option	Definition
DS1 Digital Hierarchy Interface at the CXR–POT		
DS	1 K	1.544 Mbit/s (DS1) “ANSI” T1.403 Extended Superframe (ESF) format per TR–INS–000342
	1 S	1.544 Mbit/s (DS1) “ANSI” T1.403 Extended Superframe (ESF) format and B8ZS Clear Channel Capability per TR–INS–000342
	15	1.544 Mbit/s (DS1) Superframe (SF) format per TR–INS–000342
	15 B	1.544 Mbit/s (DS1) Superframe (SF) format and B8ZS Clear Channel Capability per TR–INS–000342
DS1 Digital Hierarchy Interface at EU–POT		
DU	1 K N	1.544 Mbit/s (DS1) “ANSI” T1.403 Extended Superframe (ESF) format per TR–NPL–000054 without line power
	1 S N	1.544 Mbit/s (DS1) “ANSI” T1.403 Extended Superframe (ESF) format and B8ZS Clear Channel Capability per TR–NPL–000054 without line power
	BN	1.544 Mbit/s (DS1) Superframe (SF) format per TR–PL–000054 without line power
	DN	1.544 Mbit/s (DS1) Superframe (SF) format and B8ZS Clear Channel Capability per TR–NPL–000054 without line power
DS3 Digital Hierarchy Interface at CXR–POT		
DS	44	44.736 Mbit/s (DS3)
DS3 Digital Hierarchy Interface at EU–POT		
DS	44	44.736 Mbit/s (DS3)
SONET Optical		
SO	A	LR1–MLM
	B	LR1–SLM
	C	IR1–MLM
	D	IR1–SLM
	F	SR–MLM

⁶Protocol Code is in Character Positions 3 & 4.
Option Code is in Character Positions 7, 8 & 9.

8.1.3 Nominal Reference Impedance

The nominal reference impedance is the third component of the NCI code. This is the impedance at which the customer will terminate the service for the purpose of evaluating transmission performance. Table 8–3 lists some allowable values. For SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) interfaces the appropriate codes are as follows: DS1 code 9 – 100 ohms, DS3 code 6 – 75 ohms and Fiber code F.

Table 8–3. Reference Impedance Code⁷

Impedance Value ⁸	Code
75	6
100	9
Fiber	F

8.2 Compatible NCI Code Combinations

NCI code selection for SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network) should be coordinated between the customer and BST during the initial service order discussion. Table 8–4 lists compatible SMARTGate Services (a.k.a. BellSouth SPA Managed Shared Ring Network) NCI interface combinations. DS1 interfaces can be interconnected with DS3 interfaces or vice/versa. For codes associated with interconnecting High Capacity Digital Access services consult existing technical publications or a Marketing Representative.

The following is a current listing of the NCI codes for OC–12, DS3, and DS1 SMARTGate Service (a.k.a. BellSouth SPA Managed Shared Ring Network).

⁷Reference Impedance Code is in Character Position 5.

⁸The reference impedance is the impedance the customer is expected to use to terminate the channel for the purpose of evaluating transmission performance

Table 8.4 NCI Interface Combinations

02SOFA	SONET Optical LR1 – MLM (2 Fiber)
04SOFA	SONET Optical LR1 – MLM (4 Fiber)
02SOFB	SONET Optical LR1 – SLM (2 Fiber)
04SOFB	SONET Optical LR1 – SLM (4 Fiber)
02SOFC	SONET Optical IR1 – MLM (2 Fiber)
04SOFC	SONET Optical IR1 – MLM (4 Fiber)
02SOFD	SONET Optical IR1 – SLM (2 Fiber)
04SOFD	SONET Optical IR1 – SLM (4 Fiber)
02SOFF	SONET Optical SR – MLM (2 Fiber)
04SOFF	SONET Optical SR – MLM (4 Fiber)
04DS6.44	DS3 Electrical
04DS9.15	DS1 Electrical (SF & AMI) – DSX–1 Interface
04DS9.1K	DS1 Electrical (ESF & AMI) – DSX–1 Interface
04DS9.1S	DS1 Electrical (ESF & B8ZS) – DSX–1 Interface
04DS9.15B	DS1 Electrical (SF & B8ZS) – DSX–1 Interface
04DU9.BN	DS1 Electrical (SF & AMI) – Smart Jack Interface
04DU9.1KN	DS1 Electrical (ESF & AMI) – Smart Jack Interface
04DU9.1SN	DS1 Electrical (ESF & B8ZS) – Smart Jack Interface
04DU9.DN	DS1 Electrical (SF & B8ZS) – Smart Jack Interface
04CS9.10R	DS1/DS0 FlexServ Termination in Central Office
04CS9.11R	DS1/DS1 FlexServ Termination in Central Office
04CS6.31R	DS3/DS1 FlexServ Termination in Central Office
04CS6.33R	DS3/DS3 FlexServ Termination in Central Office
04QB9.11	DS1 to DS1 Interconnection
04QB6.33	DS3 to DS3 Interconnection
04CM9.1	SONET ADM DS1 Port Termination (for Customer Reconfiguration)
04CM6.3	SONET ADM DS3 Port Termination (for Customer Reconfiguration)

9. Acronyms

AIS	Alarm Indication Signal
ANSI	American National Standards Institute
APS	Automatic Protection Switching
ATM	Asynchronous Transfer Mode
B3ZS	Bipolar with Three–Zero Substitution
BIP	Bit Interleaved Parity
CI	Customer Installation
CXR	Carrier
DCC	Data Communications Channel
DCS	Digital Cross–Connect System
DSR _{max}	Maximum Dispersion Between Points S & R
DQDB	Distributed Queue Dual Bus
DSO	Digital Signal Level 0
DS1	Digital Signal Level 1
DS3	Digital Signal Level 3
DSX–1	Cross Connect for DS1 Signals
DSX–3	Cross Connect for DS3 Signals
EU	End User
FDDI	Fiber Distributed Data Interface
FEBE	Far End Block Error
FERF	Far End Receive Failure
IEC	Interexchange Carrier
IR	Intermediate Reach (Optical Standard)
ITU/TSS	International Telecommunication Union/Telecommunication Standardization Sector
LEC	Local Exchange Carrier
LED	Light Emitting Diode
LTE	Line Terminating Equipment
MLM	Multi–Longitudinal Mode
NE	Network Element
OC–12	Optical Carrier level 12
OC–N	Optical Carrier level–N
ORL _{min}	Minimum System Optical Return Loss
OSI	Open Systems Interconnection
PMD	Physical Medium Dependent
P _O	Optical Path Power Penalty Between Points S and R

POH	Path OverHead
PPM	Parts per Million
P_{Rmax}, P_{Rmin}	Maximum and Minimum Receiver Power at Point R for 1×10^{-10} BER
PRS	Primary Reference Source
PTE	Path Terminating Equipment
P_{Tmax}, P_{Tmin}	Maximum and Minimum Coupled Transmitter Power at Point S
RDI	Remote Defect indicator
re_{min}	Minimum Value of the Extinction Ratio
REI	Remote Error Indication
RFI	Remote Failure Indication (Formerly Yellow)
SDH	Synchronous Digital Hierarchy
SLM	Single Longitudinal Mode
SOH	Section OverHead
SONET	Synchronous Optical Network
SPE	Synchronous Payload Envelope
SR	Short Reach (Optical Standard)
SSR_{min}	Minimum Acceptable Side–Mode Suppression Ratio (SSR)
STE	Section Terminating Equipment
STM	Synchronous Transfer Mode
STS–N	Synchronous Transport Signal level N
STS–Nc	Concatenated Synchronous Transport Signal level N
TA	Technical Advisory
TR	Technical Requirement
VT1.5	Virtual Tributary at 1.5 Mb/s
$\lambda_{Tmin}, \lambda_{Tmax}$	Minimum and Maximum Central Operating Wavelengths
$\Delta\lambda_{rms}$	Root–Mean–Square (RMS) Spectral Width
$\Delta\lambda_{20}$	Full Spectral Width Measured 20 dB Down

10. References

ANSI T1.101–1994	American National Standard for Telecommunications – <i>Synchronization Interface for Digital Networks</i>
ANSI T1.102–1993	American National Standard for Telecommunications – <i>Digital Hierarchy – Electrical Interfaces</i>
ANSI T1.105–1995	American National Standard for Telecommunications – <i>Synchronous Optical Network (SONET) – Basic Description including Multiplex Structure, Rates, and Formats</i>

ANSI T1.105.01–1995	American National Standard for Telecommunications – <i>Synchronous Optical Network (SONET) – Automatic Protection Switching</i>
ANSI T1.105.02–1995	American National Standard for Telecommunications – <i>Synchronous Optical Network (SONET) – Payload Mappings</i>
ANSI T1.105.03–1994	American National Standard for Telecommunications – <i>Synchronous Optical Network (SONET) – Jitter at Network Interfaces</i>
ANSI T1.105.03a–1995	American National Standard for Telecommunications – <i>Synchronous Optical Network (SONET) – Jitter at Network Interfaces – DS1 Supplement</i>
ANSI T1.107–1995	American National Standard for Telecommunications – <i>Digital Hierarchy – Formats Specifications</i>
ANSI T1.403–1995	American National Standard for Telecommunications – <i>Network-to-Customer Installation – DS1 Metallic Interface</i>
ANSI T1.404–1994	American National Standard for Telecommunications – <i>Network-to-Customer Installation – DS3 Metallic Interface Specification</i>
ANSI T1.404a–1996	American National Standard for Telecommunications – <i>Network-to-Customer Installation – DS3 Metallic Interface Specification (supplement)</i>
GR–20–CORE	<i>Generic Requirements for Optical Fiber and Optical Fiber Cables, Issue 1, December, 1994</i>
GR–253–CORE	<i>Synchronous Optical Network (SONET) Transport Systems: Common Criteria Physical Layer, Issue 1, December 1994</i>
GR–342–CORE	<i>High-Capacity Digital Special Access Service Transmission Parameter Limits and Interface Combination, Issue 1, December, 1995</i>
GR–436–CORE	<i>Digital Network Synchronization Plan, Issue 1, June 1994</i>
GR–1365–CORE	<i>SONET Private Line Service Interface Generic Criteria for End Users, Issue 1, December 1994</i>
TR–TSY–000191	<i>Alarm Indication Signals Requirements and Objectives, Issue 1, May, 1986</i>
TR 73575	<i>MegaLink® and MegaLink Channel Service Exchange Network Interface Specifications, Issue C, 1996</i>

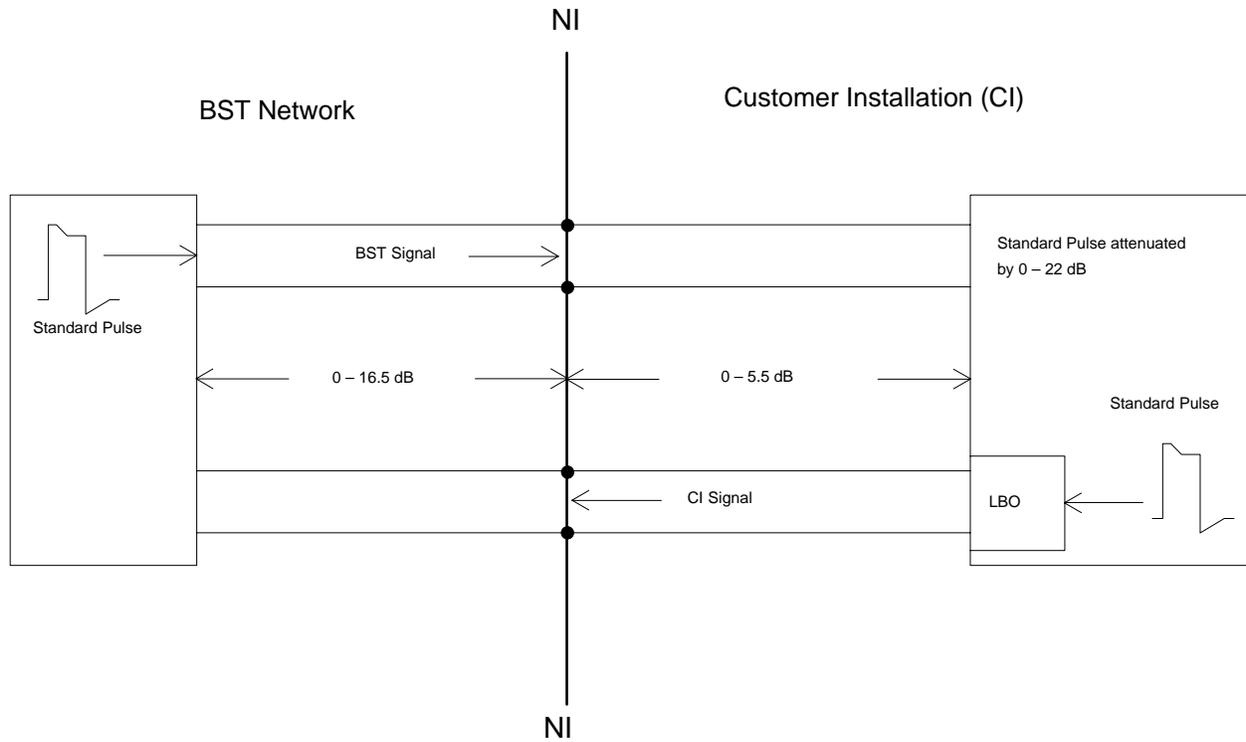
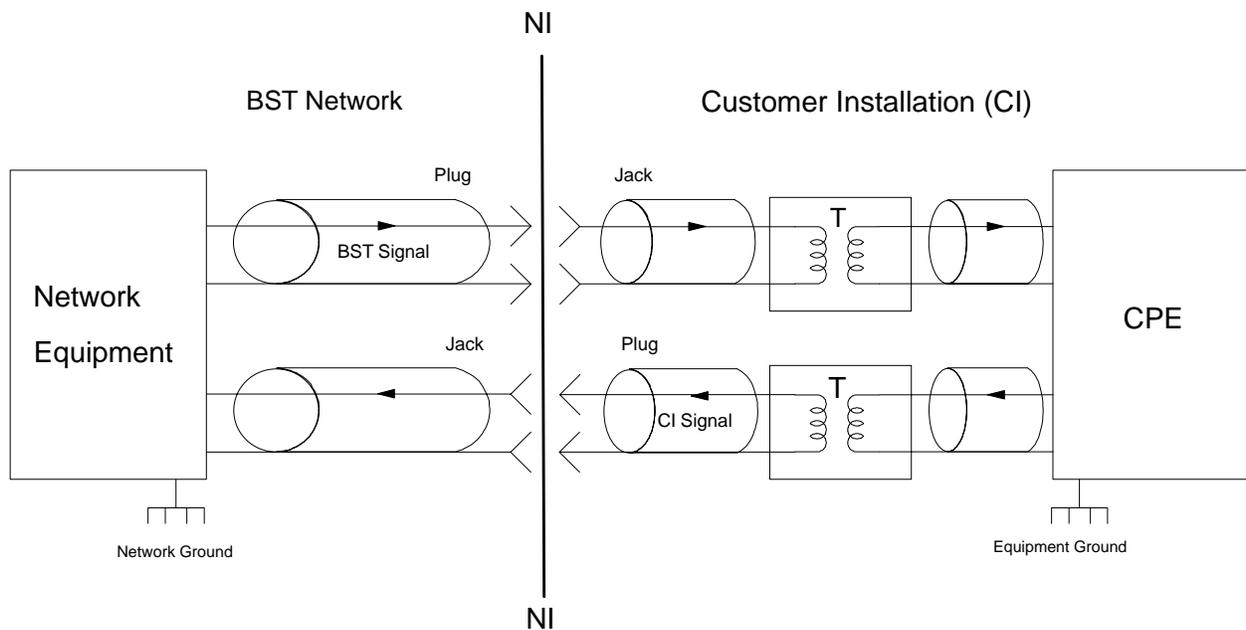
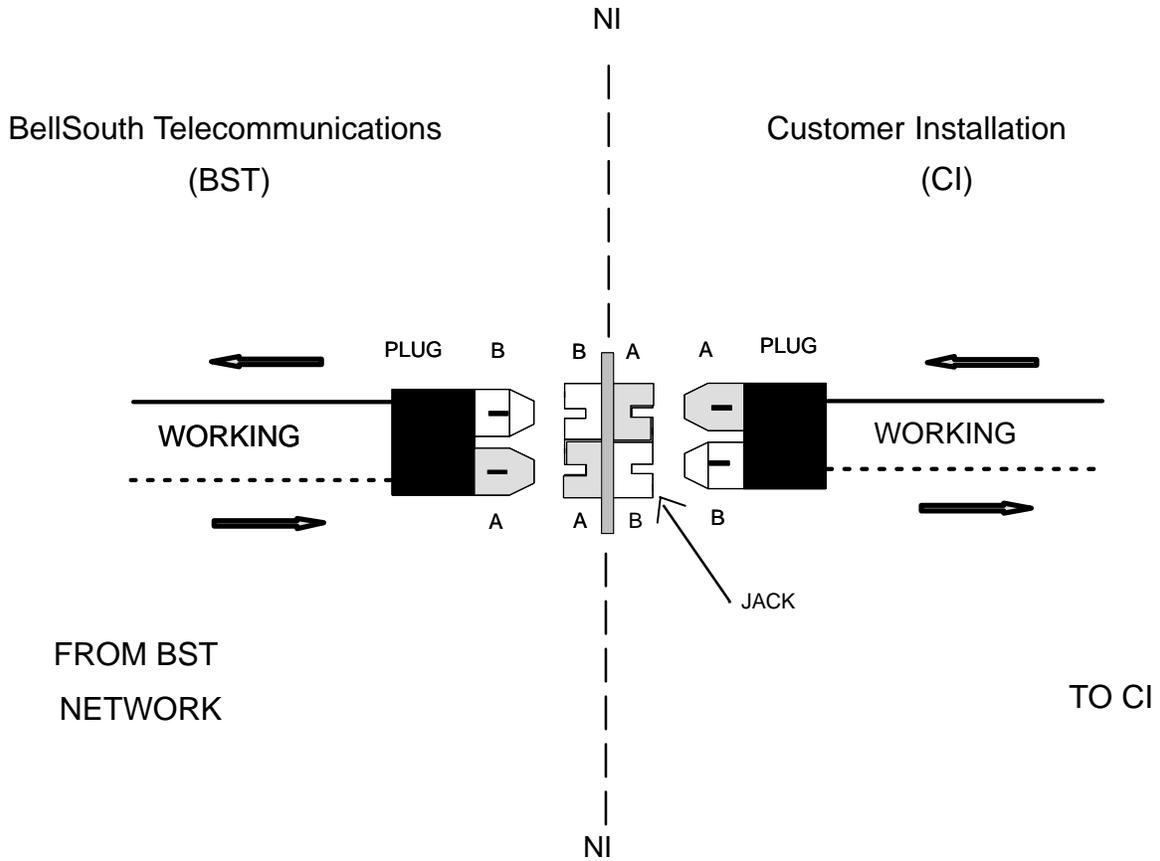


Figure 1 – DS1 Network Interface



- 1) This diagram indicates signal continuity arrangements.
- 2) Equipment grounding should follow appropriate installation practices consistent with existing safety standards.
- 3) T – optional wideband transformers to mitigate ground currents.

Figure 2 – DS3 Network Interface

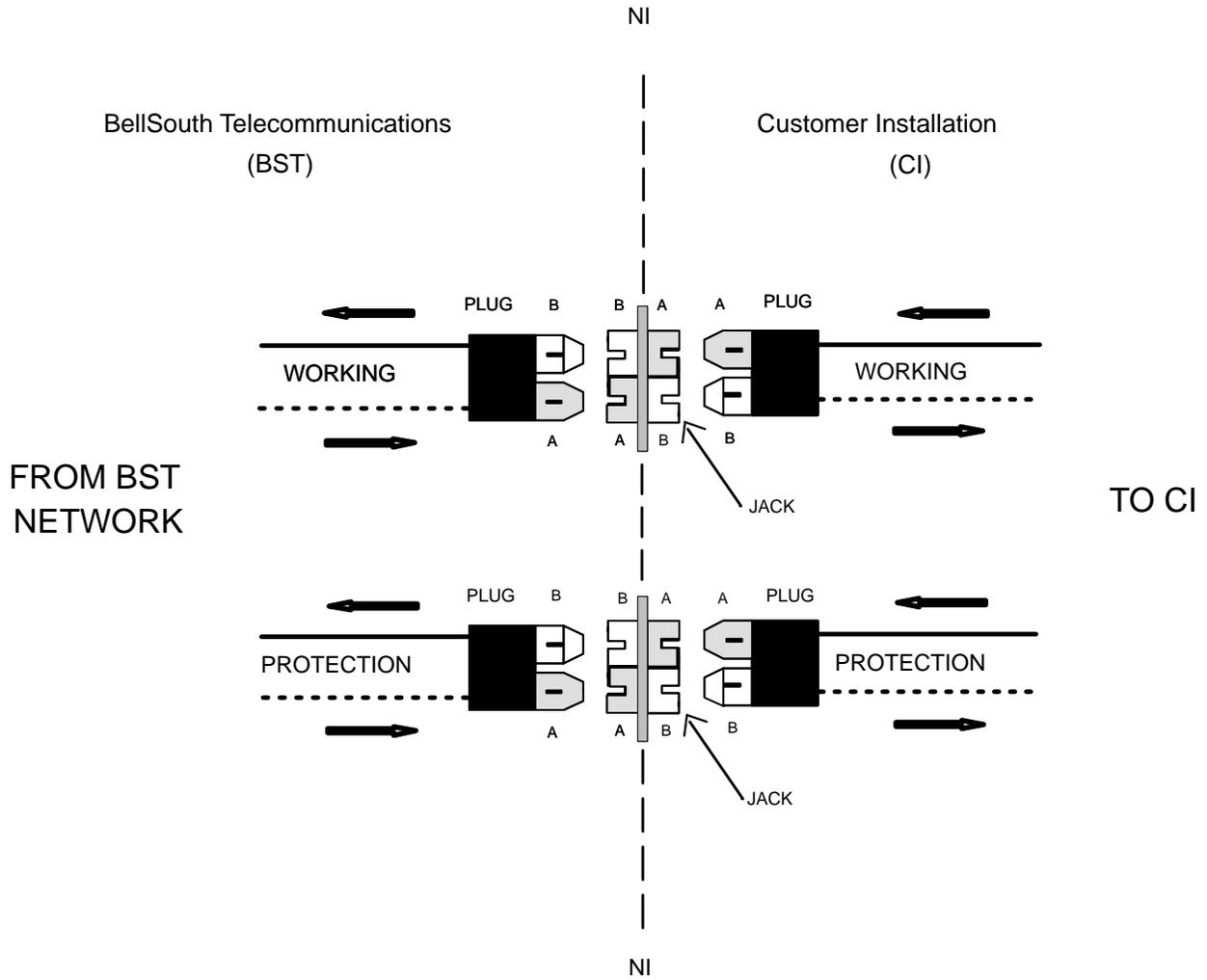


NOTES:

- 1 LIGHT LEAVES "A" PLUG AND ENTERS "A" JACK
- 2 LIGHT LEAVES "B" JACK AND ENTERS "B" PLUG
- 3 JACK AT NI PROVIDED BY BST (OPTIONALLY MAY BE PART OF NETWORK EQUIPMENT)
- 4 A SINGLE FIBER IS USED FOR EACH DIRECTION OF TRANSMISSION

 DIRECTION OF LIGHT

Figure 3 – 2 Fiber Optical Mechanical Network Interface



NOTES:

- 1 LIGHT LEAVES "A" PLUG AND ENTERS "A" JACK
- 2 LIGHT LEAVES "B" JACK AND ENTERS "B" PLUG
- 3 JACK AT NI PROVIDED BY BST (OPTIONALLY MAY BE PART OF OTHER NETWORK EQUIPMENT)
- 4 A SINGLE FIBER IS USED FOR EACH DIRECTION OF TRANSMISSION
- 5 FOR 2 FIBER INTERFACE ONLY WORKING PROVIDED
- 6 FOR 4 FIBER INTERFACE BOTH WORKING AND PROTECTION PROVIDED

➡ DIRECTION OF LIGHT

Figure 4 – 4 Fiber Optical Mechanical Network Interface

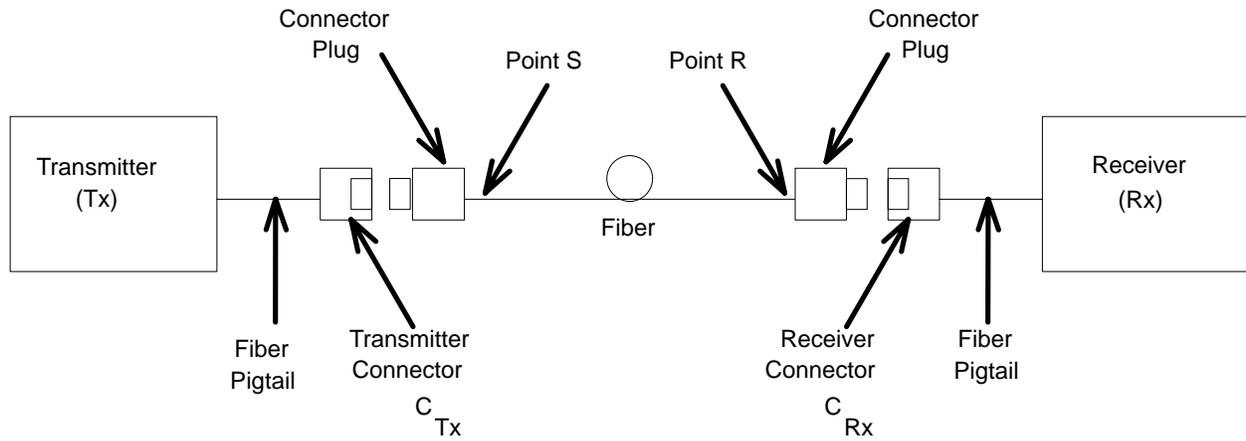


Figure 5 – Optical System Interfaces (Points S and R)

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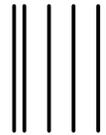
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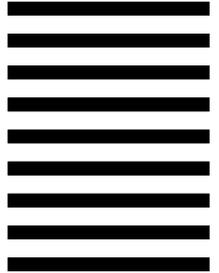
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