

Data Communications

AT&T Private Line Service OC-48

**SERVICE DESCRIPTION
AND
INTERFACE SPECIFICATION**

**Issue 1.0
November 1998**



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1. INTRODUCTION

This Technical Reference provides Network Interface (NI) and Point of Interface (POI) Specifications for the AT&T Private Line OC-48 (Optical Carrier Level 48) Service. The document includes a description of the service, technical parameters, physical interface requirements, logical interface requirements, and other necessary criteria for connecting Customer Premises Equipment (CPE) and/or access to AT&T OC-48 circuits to obtain the performance characteristics identified in Section 3.

In conformance with the approach used in Industry Standards, this document uses "shall" to signify a mandatory requirement, and the word "should" to indicate recommended or advisory criteria.

1.1 Contents

The document consists of 8 sections that cover the following subjects:

Section 1. Introduction

Section 2. Service Description

Section 3. Service Availability and Performance

Section 4. Interface Specifications

Section 5. Synchronization and Timing

Section 6. Network Alarm and Status Conditions

Section 7. Customer Premises Equipment Characteristics

Section 8. Testing and Maintenance

1.2 Acronyms

ABMSC	AT&T Bandwidth Management Service Center
ADM	Add/Drop Multiplexer
AIS	Alarm Indication Signal
AIS-L	Alarm Indication Signal Line
AIS-P	Alarm Indication Signal Path
ANSI	American National Standards Institute
APLS	AT&T Private Line Service
APS	Automatic Protection Switching
BCPA	Baseline Customer Provided Access
BCRC	Business Continuity Recovery Center
BIP	Bit Interleave Parity
BITS	Building Integrated Timing Source
CAP	Competitive Access Provider
CO	Central Office
CP	Customer Premise
CPA	Customer Provided Access
CPE	Customer Premise Equipment
dBm	Decibels (referenced to milliwatt)
CV-P	Code Violation Path
DCC	Data Communications Channel

DS1	Digital Signal Level 1
DS3	Digital Signal Level 3
EFS	Error Free Seconds
%EFS	Percent Error Free Seconds
EIA	Electrical Institute of America
ES-P	Error Second Path
FC	Optical Connector Type Ferrule Connector
FCC	Federal Communications Commission
IOC	Inter-Office Channel
IR	Intermediate Reach
ISO	International Standards Organization
ITU-T	International Telecommunications Union – Telecommunications Standardization Sector
LC	Local Channel
LEC	Local Exchange Carrier
LGX	Light Guide Cross-connect
LOF	Loss of Frame
LOP	Loss of Pointer
LOP-P	Loss of Pointer Path
LOS	Loss of Signal
LTE	Line Terminating Equipment
Mbps	Megabits per second
NE	Network Element
NI	Network Interface
nm	nano-meter
OC-12	Optical Carrier Level 12
OC-3	Optical Carrier Level 3
OC-48	Optical Carrier Level 48
POI	Point of Interface
POP	Point of Presence
PTE	Path Terminating Equipment
RDI-L	Remote Defect Indication Line
REI-L	Remote Error Indicator Line
RFI-P	Remote Failure Indicator Path
SC	Optical Connector Type Square Connector
SCPA	Shared Customer Provided Access
SES-P	Severely Error Seconds Path
SMF	Single-Mode dispersion-unshifted Fiber
SONET	Synchronous Optical NETWORK
SR	Short Reach
ST	Optical Connector Type Straight Tip
STS	Synchronous Transport Signal
STS-1	Synchronous Transport Signal Level 1
STS-12	Synchronous Transport Signal Level 12
STS-12c	Synchronous Transport Signal Level 12 Concatenated
STS-3	Synchronous Transport Signal Level 3
STS-3c	Synchronous Transport Signal Level 3 Concatenated
STS-48	Synchronous Transport Signal Level 48
STS-48c	Synchronous Transport Signal Level 48 Concatenated
STS-N	Synchronous Transport Signal Level N
STS-Nc	Synchronous Transport Signal Level N Concatenated

SWC	Serving Wiring Center
T1	DS1 Electrical Interface and Carrier
T3	DS3 Electrical Interface and Carrier
TCPA	Turnkey Customer Provided Access
TR	Technical Reference
VT1.5	Virtual Tributary containing a DS1

1.3 Relationship With Other AT&T Technical References And Industry Standards

Interface specifications pertaining to ACCUNET® T45 Service can be found in Technical Reference (TR) 54014 and its addenda^[1]. Interface specifications pertaining to ACCUNET T1.5 Service can be found in TR 62411^[2]. Access specifications for ACCUNET T1.5 and T45 can be found in TR 62415^[3].

Information about the optical interface and payload mappings can be found in (with their supporting references): AT&T TR 54018 OC-3 Optical Interface Specifications^[4], AT&T TR 54077 OC-12 Service Description and Interface Specification^[5], ANSI T1.101-1994 – Synchronous Interface Standards^[6], ANSI T1.105.01-1994 Telecommunications – Synchronous Optical Network (SONET) – Automatic Protection Switching^[7], ANSI T1.105.02-1995 Telecommunications – Synchronous Optical Network (SONET) – Payload Mappings^[8], ANSI T1.105.03-1995 Telecommunications – Synchronous Optical Network (SONET) – Jitter at Network Interfaces^[9], ANSI T1.105.03a-1995 Telecommunications – Synchronous Optical Network (SONET) – Jitter at Network Interfaces – DS1 Supplement^[10], and ANSI T1.105.03b-1997 Telecommunications – Synchronous Optical Communication (SONET) – Jitter at Network Interfaces – DS3 Wander Supplement^[11], ANSI T1.105.04-1995 Telecommunications – Synchronous Optical Network (SONET) – Data Communication Channel Protocols and Architectures^[12], ANSI T1.105.06-1995 Synchronous Optical Network (SONET) – Physical Layer Specifications^[13], ANSI T1.105.09-1995 Telecommunications – Synchronous Optical Network (SONET) - Timing and Synchronization^[14], ANSI T1.107-1995 Telecommunications - Digital Hierarchy - Formats Specifications^[15], ANSI T1.231-1997 – Digital Hierarchy – Layer 1 In-service Digital Transmission Performance Monitoring^[16], ANSI T1.514-1995 Network Performance Parameters and Objectives for Dedicated Digital Services – SONET Bit Rates^[17], Bellcore Synchronous Optical Network (SONET) Transport Systems Common Generic Criteria (GR-253-CORE)^[18], Bellcore Transport Systems Generic Requirements (TSGR): Common Requirements (GR-499-CORE)^[19], Bellcore Clocks for the Synchronized Network: Common Generic Criteria (GR-1244-CORE)^[20], Bellcore SONET Private Line Service Interface Generic Criteria for End Users (GR-1365 CORE)^[21], ATM Forum af-phy-0046.000 “2488.32 Mbps Physical Layer Specification,” January 1996^[22].

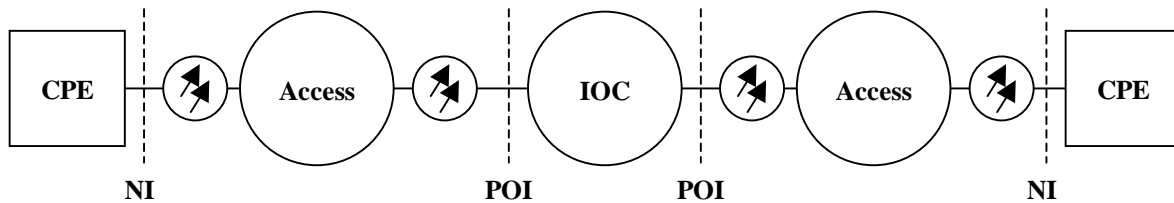
AT&T intends to continue to review the emerging SONET (Synchronous Optical NETWORK) standards as they are defined and adopt them as appropriate.

2. SERVICE DESCRIPTION

2.1 OC-48 Inter-Office Channel Service

The AT&T Private Line Service (APLS) OC-48 Inter-Office Channel (IOC) Service is a service that provides dedicated point-to-point 2488.32 Megabits per second (Mbps), or 2.48 Gbps, line rate digital service for STS-48/48c (Synchronous Transport Signal Level 48/48 concatenated) signals. A point-to-point service is defined as a two-way service where traffic originates (or terminates) in one location and terminates (or originates) in the other. Besides STS-48c signals, the OC-48 IOC may be comprised of STS-1 (Synchronous Transport Signal Level 1), and/or STS-3c (Synchronous Transport Signal Level 3 concatenated), and/or STS-12c (Synchronous Transport Signal Level 12 concatenated) tributary signals as

required per customer application. The differences between the line rates and effective customer payloads are due to bits reserved for SONET overhead signaling. More details about SONET format standards are given in Section 4 “Interface Specifications”. OC-48 service features optical interfaces at the NI and the POI. Figure 1 below illustrates a typical point-to-point OC-48 circuit with significant components and points of demarcation.



Note – All NI and POI interfaces are Optical.

Figure 1 - Typical Point-to-point OC-48 Circuit

2.1.1 Zero Mile IOC Service

Zero Mile IOC Service is a special configuration that supports OC-48 connectivity in the same office, i.e. access-to-access.

2.2 Network Interface and Point-Of-Interface

Per Federal Communications Commission (FCC) Tariff 9, the definition of the NI is the point of demarcation on the end user’s premises at which the access supplier’s responsibility for the provision of access ends. The POI is defined as the point of demarcation between AT&T and an access supplier. The POI located in an AT&T Central Office (CO) establishes the service demarcation between access and the IOC.

The NI and POI for OC-48 shall be optical. This signal shall be comprised of STS-1 and/or STS-3c, and/or STS-12c, or STS-48/48c (as required by customer applications) formatted tributaries per Bellcore GR-253-CORE^[18] Section 3.2, ANSI T1.105.02^[8]. The signal at the NI and POI shall conform to the SONET standards per GR-253-CORE^[18] Section 3, ANSI T1.105.02^[8]. Path overhead shall only terminate at the CPE or equivalent end-point of the SONET channel. 2-fiber and 4-fiber interconnections are supported for both NI and POI. The 4-fiber POI interconnection shall be used to support SONET APS (Automatic Protection Switching)¹.

2.3 Access Architecture

Figure 2 illustrates a typical access connection. The CPE is connected to the OC-48 service via the NI. The NI should allow test access to all of the fiber pairs interconnecting the CPE with the access supplier’s OC-48 Line Terminating Equipment (LTE). The NI is typically located on customer premises. The Network Interface for OC-48 Local Channel (LC) is defined as an Optical Fiber Connection Panel.

¹ This APS function shall be performed by customer premise equipment or access vendor (AV) equipment at NI, and only by AV equipment w/ Local Channel access at POI (see Sec. 2.4).

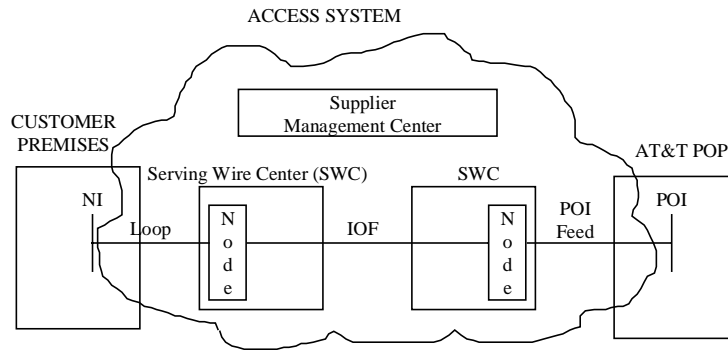


Figure 2 - OC-48 LC Circuit and Access Network Components

The 2488.32 Mbps signal at the NI shall be Optical in both directions. The optical power levels required at the NI should be compliant with standards for Short Reach (SR) optics per GR-253-CORE^[18] Section 4.1 and 4.2 and ANSI T1.105.06^[25] and are given in Table 1 in dBm (decibels milliwatt reference). Also, the Customer Installation shall meet the loss requirements as specified in GR-253-CORE^[18] section 4.2. The CPE will determine the fiber type (single mode or multi-mode) to connect the CPE to the NI Optical Fiber Connection Panel. Table 1 shows the AT&T required levels. The NI Optical Fiber Connection Panel supports optical connector options as required by the customer application (i.e., SC, FC, ST, etc.). The NI configuration supports 2 fiber (one pair) duplex unprotected operation, or 4 fiber (two pairs) operation, that can be either duplex unprotected² or 1+1³ SONET automatic protection switching (APS) operation based on customer application needs, and the Access Provider infrastructure capabilities¹.

Table 1. Optical Power Requirements at the NI

Receive to CPE	Transmit from CPE
P_{max} : -3 dBm	P_{max} : -3 dBm
P_{min} : -18 dBm	P_{min} : -10 dBm

The OC-48 POI is implemented via an AT&T-owned Light Guide Cross-Connect (LGX) shelf with ST bulkhead connectors. Single mode fiber to AT&T assigned jacks on the rear of the LGX POI shelf shall be used. POI interconnections are implemented over 2 fibers (one pair) and 4 fibers (two pairs) configuration. The 4-fiber POI interconnection shall be used to support SONET APS (Automatic Protection Switching)¹ with Local Channel access only (see Sec. 2.4.1).

The 2488.32 Mbps signal at the POI shall be Optical in both directions. Signal power levels at the POI are to be within the following range:

Table 2. Optical Power Requirements at the POI

Receive to AT&T	Transmit from AT&T
P_{max} : -3 dBm	P_{max} : -3 dBm
P_{min} : -14 dBm	P_{min} : -14 dBm

² For 4-fiber DWDM applications at the NI only, but not at the POI.

³ The term 1+1 protection means one active service line plus one protection line.

Note: AT&T expects that under most circumstances these levels can be achieved using SR capable equipment with a 4 dB fiber loss budget from access vendor equipment to POI, and a 4 dB fiber loss budget from AT&T equipment to POI.

Figure 3 illustrates the OC-48 connections at the NI and POI.

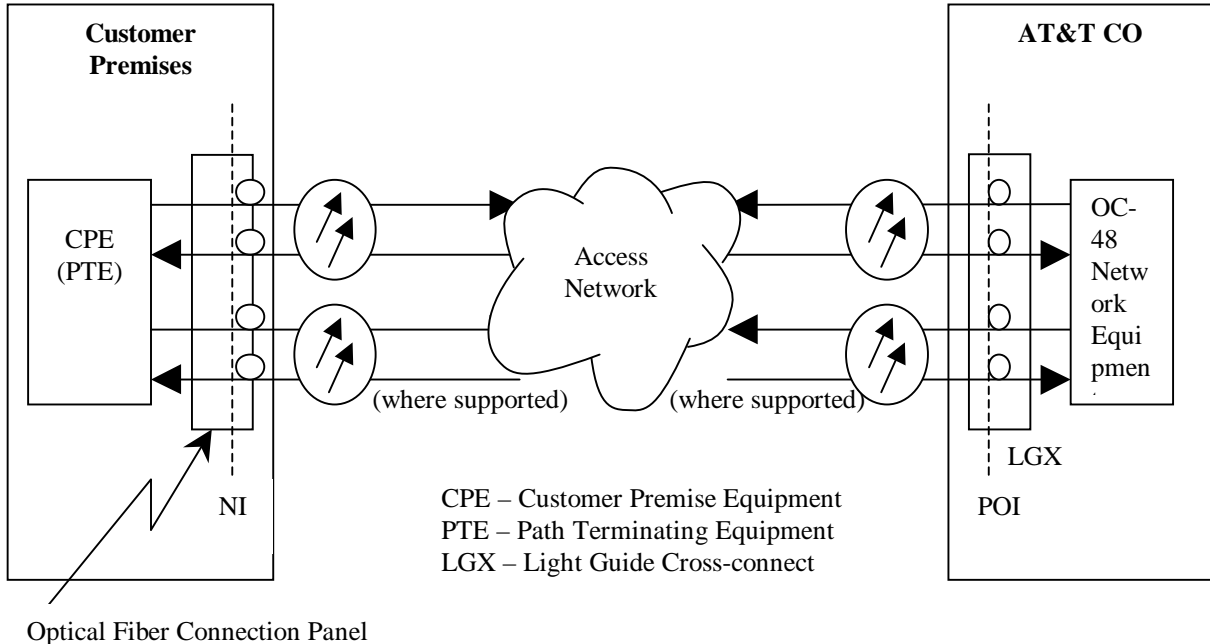


Figure 3 - APLS OC-48 Access Connections

The customer shall provide the STS-1, STS-3c, STS-12c, or STS-48c mapping into an OC-48 to AT&T, and shall conform to the permitted combinations per SONET OC-48 format specification in GR-253-CORE^[18], Sec. 3.

2.4 Access Arrangements

Customers may provide their own access to OC-48 Service, or may acquire access through AT&T or a third party.

2.4.1 Local Channel

Note: This is the ONLY access arrangement that can be used to support 4-fiber interface at the POI.

2.4.1.1 Total Service - AT&T Provided Access

The customer may purchase an OC-48 in Total Service arrangement from AT&T, that provides access and customer premises to customer premises connectivity. Under this access arrangement, AT&T is the customer of record for the access circuit used to provide customer access to the AT&T POP. AT&T is responsible for maintenance.

2.4.1.2 Coordinated Service - AT&T Coordinated Access

For this access arrangement, access is coordinated by AT&T with the access provider. The access is ordered at the time the customer initiates a Service Order. When providing *coordinated access*, AT&T

assumes responsibility to work with the access provider for the following functions: Design, Ordering, Installation coordination, Pre-service testing and service turn-up, Trouble sectionalization and Restoration coordination. Under this access arrangement, the end-customer is the customer of record for the access circuit used to provide customer access to AT&T.

2.4.2 Customer Provided Access

Note: This access arrangement CANNOT be used to support 4-fiber interface at the POI.

2.4.2.1 Basic Customer Provided Access (BCPA)

Under Basic Customer Provided Access (BCPA), the access facilities are furnished and owned by the customer from the Customer Installation (CI) at CP to the servicing AT&T CO. The servicing AT&T CO must be a designated OC-48 Point Of Presence (POP). The customer also has terminal equipment located in the AT&T POP (i.e., the end-user is the customer of record). The customer pays for space, power, light, etc.

Under this arrangement, the customer has total responsibility for the engineering, installation, operation, and maintenance of the BCPA facility terminating at the AT&T POP. AT&T provides the installation, maintenance, and testing support required to interconnect the BCPA to the OC-48 POI.

2.4.2.2 Common Interface Arrangement (CIA)

Under Common Interface Arrangement (CIA)⁴, the access facilities are acquired by the customer from the Customer Installation (CI) at CP to the servicing AT&T CO. Similarly, the servicing AT&T CO must be a designated OC-48 Point Of Presence (POP). The access is provided by licensed/regulating telecommunication providers (i.e., the LEC or AAV is the customer of record). Access Provider has terminal equipment in the AT&T POP, and the access provider pays for space, power, light, etc. The access provider can provide access for multiple, different customer circuits via such an arrangement.

Under this arrangement, the customer, together with the access provider, has total responsibility for the engineering, installation, operation, and maintenance of the CIA facility terminating at the AT&T POP. AT&T provides the installation, maintenance, and testing support required to interconnect the CIA facility to the OC-48 POI.

2.4.2.3 Baseline Access

Under Baseline Access arrangement, the customer purchases their access directly from the access provider, and has it installed. Baseline is the same as CIA (see above), as customer purchases the access circuit from an access provider that in turn provides the customer access to AT&T POP via an CIA arrangement.

2.4.3 Licensed Space Arrangement (LSA)

Note: This access arrangement CANNOT be used to support 4-fiber interface at the POI.

This access arrangement allows the customer to lease space in the AT&T servicing CO for customer owned equipment, that is interconnected to AT&T equipment in that CO. Under this access arrangement, the Customer Installation (CI) is in the same office as the POI and are interconnected with intra-office optical fiber facility.

⁴ This used to be called SCPA (Shared Customer Provided Access).

3. SERVICE AVAILABILITY AND PERFORMANCE

3.1 Service Availability

Availability is a measure of the time during which the circuit is available for useful transmission. This measurement is the complement of unavailability or Outage (%Availability = 100 - %Outage). An outage begins when the customer releases a circuit to AT&T for repair and ends when AT&T returns the circuit to the customer.

3.2 Service Performance Parameters

The error performance parameters Code Violations, Error Seconds, and Severely Error Seconds have been defined for SONET Section layer, Line layer, and STS Path layer⁵ in GR-253-CORE^[18] section 6.2.2, ANSI T1.231^[16], ANSI T1.514^[17], and ANSI T1.105.04^[12]. They are reproduced here for reference, and are described as measurements of corresponding events over a certain time interval. *Note that various equipment vendors and communications service providers may have implemented these definitions differently.*

- Code Violations (CVs) – The CV parameter is a count of Bit Interleave Parity (BIP) errors detected at the incoming SONET signal: CV-S for the Section layer, CV-L for the Line layer, and CV-P for the STS Path layer. They are collected using the overhead bytes (e.g., B1, B2, B3) in various SONET Overhead.
- Error Seconds (ESs) – The ES parameter is a count of one second intervals during which at least one BIP error occurred, or one second intervals during which (at any point during the second) a defect or failure was detected at the incoming SONET signal. They are ES-S for the Section layer, ES-L for the Line layer, and ES-P for the STS Path layer. Examples of defects are LOS, SEF, AIS-L, AIS-P, and LOP-P.
- Severely Error Seconds (SESs) – The SES parameter is a count of one second intervals during which K or more BIP error occurred, or one second intervals during which (at any point during the second) a defect or failure was detected at the incoming SONET signal. They are SES-S for the Section layer, SES-L for the Line layer, and SES-P for the STS Path layer. The values of “K” have changed several times in the past and are currently set in GR-253-CORE^[18] as follows: 2,392 for SES-S, 2,459 for SES-L, and 2,400 for SES-P. Examples of defects are LOS, SEF, AIS-L, AIS-P, and LOP-P.
- Percent of Error Free Seconds (%EFS) – Percent EFS is defined as the ratio of one-second intervals not containing any bit errors to the total number of seconds in an observation period, which is usually 24 hours. The percent EFS calculation applies only to time intervals over which the circuit is available.

It is noted that both near-end and far-end parameters are defined for the Line layer and STS Path layer parameters: CV-L, CV-LFE, ES-L, ES-LFE, SES-L, SES-LFE, CV-P, CV-PFE, ES-P, ES-PFE, SES-P, and SES-PFE. Far-end Line layer performance is conveyed back to the near-end LTE (Line Terminating Equipment) via the K2 byte (RDI-L) and the M0 or M1 byte (REI-L). And far-end STS Path layer performance is conveyed back to the near-end STS PTE (Path Terminating Equipment) via bits 1 through 4 (REI-P) and 5 through 7 (RDI-P) of the G1 byte.⁶ The far-end performance parameters are defined with these remote indication signals.

⁵ Only the Section layer error performance parameter may be monitored by AT&T initially. These parameters for other layers may be monitored in the future.

⁶ It is noted that REI-L, REI-P and RDI-P may not be fully supported with the SONET Multiplex Function (SMF) service option.

4. INTERFACE SPECIFICATIONS

The signal at the NI and POI shall conform to the relevant SONET standards (see Sec. 1.3) for OC-48 signals as cited in the following sections. The NI and POI are specified in terms of three layers: Physical, Optical, and Logical. The logical level is further broken down into Section, Line, and Path layers.⁷

4.1 Physical Specifications

All physical connectivity to the POI shall be via dispersion-unshifted Single-Mode Fiber (SMF)⁸. Physical connectivity to the NI may be over one or two fiber pairs. These fiber connections shall conform to GR-1365^[21], Section 3.4. Two pairs of fiber (one pair for service and one pair for protection) are used to support protected switching operation (see Sec. 2.2).

4.1.1 Network Interface

The physical interface at the NI shall be an optical fiber connector panel, that supports optical connector options as required by the customer application (e.g., SC, FC, ST, etc.). The connector panel will allow ease of CPE connection and the ability to create a manual loopback for testing.

4.1.2 Point of Interface

The physical interface at the POI shall be the AT&T LGX. The pair assignment on the LGX will be administered by AT&T. ST connectors shall be used for the LGX at the POI⁹.

The access supplier will have responsibility and ownership of all access facilities up to the LGX POI¹⁰. Access supplier entry will be allowed for installation and maintenance activities up to the POI. AT&T will provide space, environment and power (for equipment required in the AT&T building) for the access supplier to deliver access.

4.2 Optical Signal Specifications

Optical signals at the NI & POI shall conform to the OC-48 signal characteristics described in GR-253-CORE^[18] Sec. 4.1 and 4.2 and ANSI T1.105.06^[13] with sources at the nominal **1310 nano-meter (nm)** wavelength.

4.2.1 Network Interface

CPE shall follow the optical interface specifications for the application category relevant to the CPE vendor requirements. The customer shall provide a system compatible with the access facility. CPE should follow the optical interface specifications for the application category as given in GR-1365^[21].

4.2.2 Point of Interface

The AT&T equipment at the POI, as one point on the optical path between transmitter (Point S) and receiver (Point R), meet the optical category specified as OC-48 SR MLM in GR-253-CORE^[18] Sec 4.2 and ANSI T1.105.06^[13].

4.3 Logical Signal Specifications

The logical signal (Synchronous Transport Signal Level N (STS-N/Nc)) contains the customer payload along with the section, line, and path overhead required by the SONET standard. The STS-N/Nc signal shall conform to the STS-1 and/or STS-3c and/or STS-12c or STS-48/48c formats as defined in GR-253-

⁷ Initially, only the Section layer interface will be observed by AT&T.

⁸ Dispersion-shifted SMF is recommended ONLY for LR-3 (Long Reach-3) application.

⁹ A different connector may be used by the new LGX at the POI in the future.

¹⁰ The access supplier here refers to the access vendor in all access arrangements except LSA. (see Sec. 2.4)

CORE^[18] Section 3 and ANSI T1.105.02^[8]. The customer shall notify AT&T of the signaling format and tributary configuration. The customer shall keep a valid signal on the circuit in order to maintain performance monitoring. The CPE or network equipment shall not be turned off without notifying AT&T.

4.3.1 Section Overhead

The STS-N shall provide all Section overhead functions with the possible exception of the Section Data Communications Channel (DCC) (bytes D1-D3), Section Orderwire (byte E1), and Section User Channel (byte F1). To manage network integrity and sustain service quality, section DCC capabilities through the AT&T network and access segment is not supported. Therefore, any information contained in the bytes reserved for Section DCC (D1-D3), Section Orderwire (E1), and Section User Channel (F1) may not be transported end-to-end (NI-to-NI). This is consistent with SONET standards for section overhead.

4.3.2 Line Overhead (for future use)

The STS-N shall provide all Line overhead functions with the possible exception of Line DCC (bytes D4-D12), Synch Status Messaging (byte S1), and Line Orderwire (byte E2). To manage network integrity and sustain service quality, line DCC capabilities through the AT&T network is not supported. Line overhead is terminated at or before the AT&T network, therefore, any information contained in the bytes reserved for Line DCC (D4-D12) and Line Orderwire (E2) will not be transported end-to-end (NI-to-NI). This is consistent with the SONET standard for Line overhead. At the time of this publication, AT&T does not support any functionality based on the use of growth bytes. Information contained in these bytes may not be transported.

4.3.2.1 Automatic Protection Switching (APS)

GR-253-CORE^[18] Section 5.3 and ANSI T1.105.01^[7] specify criteria for implementing Automatic Protection Switching (APS). When APS function is supported via the 4-fiber interface (see Sec. 2.2), the STS-N shall conform to linear 1+1, unidirectional, non-revertive protection switching. The term “unidirectional” means that only the impaired direction of service will be restored.

4.3.3 Path Overhead (for future use)

The STS-N or STS-Nc shall provide all Path overhead functions with the possible exception of Path User Channel (byte F2), and Growth Channels (bytes Z3 and Z4). Use of bytes F2 and H4 is optional, but must be in accordance with ANSI T1.105.02^[25] and GR-253-CORE^[18]. As per ANSI T1.105, bytes Z3 and Z4 are reserved for future use¹¹. At the time of this publication, AT&T does not support any functionality based on the use of these growth channels. The service shall be STS-1 and/or STS-3c and/or STS-12c or STS-48/48c end-to-end. Path status and parity bytes may be monitored for performance information.

5. SYNCHRONIZATION AND TIMING

All CPE and network equipment providing AT&T OC-48 service shall conform to timing and synchronization specifications described in ANSI T1.105.09^[14], ANSI T1.101^[6], and GR-1244^[20]. The access supplier equipment should be able to receive timing from a co-located external reference clock of Stratum 3 or higher accuracy traceable to a Stratum 1 source. CPE may be timed to an internal clock or a co-located external reference clock of Stratum 3 or higher accuracy traceable to a Stratum 1 source.

5.1 Internal Timing Mode

CPE timed in internal timing mode draws its synchronization from its own timing source. This source shall not exceed the maximum free run deviation of $\pm 20\text{ppm}$. In this case, CPE at one of the two ends would need to be designated as the master.

¹¹ Byte Z4 may be used for AT&T network maintenance in the future.

5.2 External Timing Mode

CPE timed in external timing mode draws its synchronization from an independent timing source. This source shall be Stratum 3 or better and traceable to a Stratum 1 source. This configuration is shown in Figure 4. In this case, CPE at one of the two ends would need to be designated as the master as well.

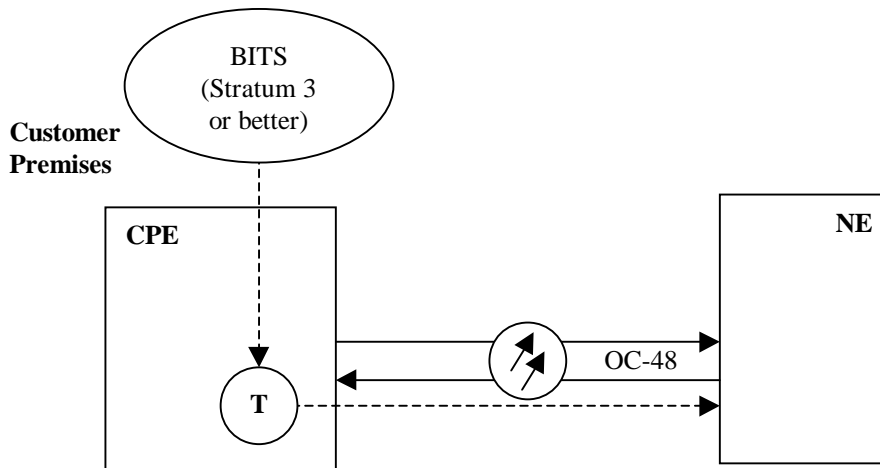


Figure 4 - External Timing Mode

5.3 Timing Variation

5.3.1 Jitter

Timing jitter is the short term (> 10 Hz) variation in the significant instances of a digital signal as compared to an ideal clock. GR-253-CORE^[18] section 5.6, ANSI T1.105.03^[9], and ANSI T1.105.03a^[10] contains equipment jitter specifications (i.e. jitter transfer, jitter tolerance, and jitter generation) that are to be used to engineer CPE to the Network Interface Jitter Specification. In particular, the Network Interface Jitter Specification for OC-48 service is the following (per GR-253-CORE^[18] Sec. 5.6):

Timing jitter at network interface shall not exceed 1.5 Unit Intervals peak-to-peak (UI_{pp}) when measured over a 60-second interval with a band pass filter having a lower cutoff frequency of 5000Hz (and a roll-off of 20dB/decade) and an upper cutoff frequency of at least 20MHz.

Timing jitter at network interface shall not exceed 0.15 Unit Intervals peak-to-peak (UI_{pp}) when measured over a 60-second interval with a band pass filter having a lower cutoff frequency of 1000kHz (and a roll-off of 20dB/decade) and an upper cutoff frequency of at least 20MHz.

CPE designs shall be engineered to have a tolerance specification which is better than the requirements represented above to ensure problem free operation.

5.3.2 Wander

Timing wander is the long-term (< 10 Hz) variation in the significant instances of a digital signal as compared to an ideal clock. GR-253-CORE^[18] section 5.4.4.3.2, GR-1244^[20] sections 4.3 and 5.4, ANSI T1.105.09^[14], and ANSI T1.105.03b^[11] contains equipment wander specifications (i.e. wander transfer, wander tolerance, and wander generation) that are to be used to engineer CPE to the Network Interface

Specification. CPE designs shall be engineered to have a wander specification which is better than the requirements represented by the standard to ensure problem free operation.

6. NETWORK ALARM AND STATUS CONDITIONS

AT&T will detect LOS and monitor the SONET Section layer overhead (see Sec. 4.3.1). And the access network equipment shall monitor SONET signals to detect LOS.

7. CUSTOMER PREMISES EQUIPMENT CHARACTERISTICS

7.1 CPE Requirements

CPE shall generate alarms as described in GR-253-CORE^[18] Section 6. CPE shall monitor SONET signals to detect LOS, LOF, and LOP. And the CPE shall transmit maintenance signals when failure states are detected in the network. Maintenance signals include AIS-L, RDI-L, RFI-L, AIS-P, RDI-P, and RFI-P. For any unused STS-12c, STS-3c and/or STS-1 channels, the CPE shall transmit a valid idle code and set the path label to unequipped.

7.2 Loopback

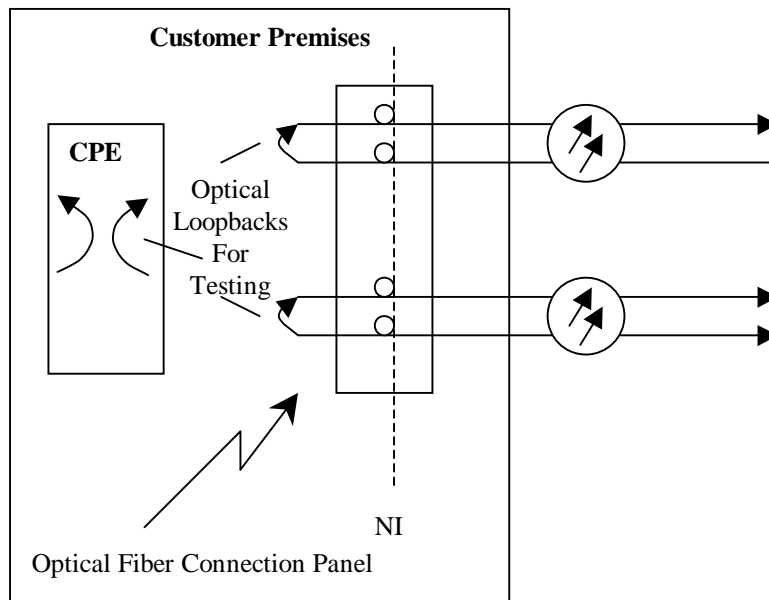


Figure 5 - Optical Loopback at NI

To conduct circuit testing and fault sectionalization of the two-way OC-48 circuit, an optical loopback on the CPE side of the NI toward the network *shall* be provided as shown in Figure 5. To aid in the sectionalization, an optical loopback on the CPE side of the NI toward the CPE (facility loopback) and one toward the network (terminal loopback) *should* be provided as shown in Figure 5. AT&T will coordinate with the customer when loopbacks are required and will enlist the customer's support in establishing loopbacks at the NI. This optical loopback is not recommended when the CPEs use internal timing.

7.3 Automatic Protection Switching

Protection switching is described in GR-253-CORE^[18] and ANSI T1.105^[13], Section 13. When APS is provided, all CPE should be designed to tolerate an upstream protection-switching event without declaring a failure.

8. TESTING AND MAINTENANCE

The OC-48 Service will be managed as an 2488.32 Mbps circuit transporting STS-1 and/or STS-3c and/or STS-12c, or STS-48c tributaries as specified. Testing and maintenance may require the customer to relinquish the full circuit of 2488.32 Mbps.

A point of contact for testing and maintenance issues will be provided by AT&T at the time of service installation. AT&T can perform testing and repair most efficiently when a complete and accurate description of the trouble is provided by the customer. Information such as date, time, and nature of the problem should be provided in reporting trouble.

In addition, the customers should be acquainted with the basic equipment layouts, visual indicators on CPE, and be knowledgeable in fundamental maintenance techniques. For customer provided access arrangements (i.e., BCPA, CIA, and Baseline), the customer should also know how to work with the access provider for the maintenance (including trouble shooting) of the access facilities. When problems are encountered by the customer, it is essential that the CPE (and access facilities that are non-AT&T maintained) be checked for proper operation before reporting the trouble. Diagnostics capabilities of the CPE, such as loopbacks (shown in Figure 5), can also be useful in trouble isolation. This action will eliminate unnecessary dispatches of repair personnel by AT&T. For such dispatches; the customer may be required to pay a "maintenance or service charge" if the problem is isolated to the customer's segment of the circuit.

Once the customer reports a trouble to AT&T, the customer should provide a contact for assistance at CP during trouble shooting and any necessary repair, as well as for verification of trouble resolution before the circuit is put back in normal service. AT&T will provide periodic status report of the customer reported trouble.

9. REFERENCES

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