

**Data Communications**

**AT&T Private Line Service OC-192**

**SERVICE DESCRIPTION  
AND  
INTERFACE SPECIFICATION**

**Issue 1.0  
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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-192 (Optical Carrier Level 192) 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-192 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

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	Basic Customer Provided Access
BIP	Bit Interleave Parity
BITS	Building Integrated Timing Source
CI	Customer Installation
CO	Central Office
CP	Customer Premise
CPE	Customer Premise Equipment
dB	Decibels
dBm	Decibels (referenced to milliwatt)
CV	Code Violations
CV-L	Code Violation Line
CV-LFE	Code Violation Line Far End
CV-P	Code Violation Path

CV-PFE	Code Violation Path Far End
CV-S	Code Violation Section
DCC	Data Communications Channel
DS1	Digital Signal Level 1
DS3	Digital Signal Level 3
%EFS	Percent Error Free Seconds
EIA	Electrical Institute of America
ES	Errored Second
ES-L	Errored Second Line
ES-LFE	Errored Second Line Far End
ES-P	Errored Second Path
ES-PFE	Errored Second Path Far End
ES-S	Errored Second Section
FC	Optical Connector Type Ferrule Connector
FCC	Federal Communications Commission
Gbps	Gigabits per second
IOC	Inter-Office Channel
IR	Intermediate Reach
ISO	International Standards Organization
ITU-T	International Telecommunications Union – Telecommunications Standardization Sector
LC	Local Channel
LGX	Light Guide Cross-connect
LOF	Loss of Frame
LOP	Loss of Pointer
LOP-P	Loss of Pointer Path
LOS	Loss of Signal
LR-3	Long Reach 3
LSA	Leased Space Arrangement
LTE	Line Terminating Equipment
Mbps	Megabits per second
NI	Network Interface
nm	nano-meter
OC-3	Optical Carrier Level 3
OC-12	Optical Carrier Level 12
OC-48	Optical Carrier Level 48
OC-192	Optical Carrier Level 192
POI	Point of Interface
POP	Point of Presence
PTE	Path Terminating Equipment
RDI-L	Remote Defect Indication Line
RDI-P	Remote Defect Indication Path
REI-L	Remote Error Indicator Line
REI-P	Remote Error Indicator Path
RFI-P	Remote Failure Indicator Path
SC	Optical Connector Type Square Connector
SEF	Severely Errored Frame
SES	Severely Errored Seconds
SES-L	Severely Errored Seconds Line
SES-LFE	Severely Errored Seconds Line Far End
SES-P	Severely Errored Seconds Path

SES-PFE	Severely Errored Seconds Path Far End
SES-S	Severely Errored Seconds Section
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-3	Synchronous Transport Signal Level 3
STS-3c	Synchronous Transport Signal Level 3 Concatenated
STS-12	Synchronous Transport Signal Level 12
STS-12c	Synchronous Transport Signal Level 12 Concatenated
STS-48	Synchronous Transport Signal Level 48
STS-48c	Synchronous Transport Signal Level 48 Concatenated
STS-192	Synchronous Transport Signal Level 192
STS-192c	Synchronous Transport Signal Level 192 Concatenated
STS-N	Synchronous Transport Signal Level N
STS-Nc	Synchronous Transport Signal Level N Concatenated
SWC	Serving Wiring Center
TR	Technical Reference

### **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<sup>[1]</sup>. Interface specifications pertaining to ACCUNET T1.5 Service can be found in TR 62411<sup>[2]</sup>. Access specifications for ACCUNET T1.5 and T45 can be found in TR 62415<sup>[3]</sup>.

Information about the optical interface and payload mappings can be found in (with supporting references):

- AT&T
  - TR 54018 OC-3 Optical Interface Specification<sup>[4]</sup>,
  - TR 54077 OC-12 Service Description and Interface Specification<sup>[5]</sup>,
  - TR 54078 OC-48 Service Description and Interface Specification<sup>[6]</sup>,
- ANSI
  - T1.101-1994 – Synchronous Interface Standards<sup>[7]</sup>,
  - T1.105.01-1994 Telecommunications – Synchronous Optical Network (SONET) – Automatic Protection Switching<sup>[8]</sup>,
  - T1.105.02-1995 Telecommunications – Synchronous Optical Network (SONET) – Payload Mappings<sup>[9]</sup>,
  - T1.105.03-1995 Telecommunications – Synchronous Optical Network (SONET) – Jitter at Network Interfaces<sup>[10]</sup>,
  - T1.105.03a-1995 Telecommunications – Synchronous Optical Network (SONET) – Jitter at Network Interfaces – DS1 Supplement<sup>[11]</sup>,
  - T1.105.03b-1997 Telecommunications – Synchronous Optical Communication (SONET) – Jitter at Network Interfaces – DS3 Wander Supplement<sup>[12]</sup>,
  - T1.105.04-1995 Telecommunications – Synchronous Optical Network (SONET) – Data Communication Channel Protocols and Architectures<sup>[13]</sup>,
  - T1.105.06-1995 Synchronous Optical Network (SONET) – Physical Layer Specifications<sup>[14]</sup>,
  - T1.105.09-1995 Telecommunications – Synchronous Optical Network (SONET) - Timing and Synchronization<sup>[15]</sup>,

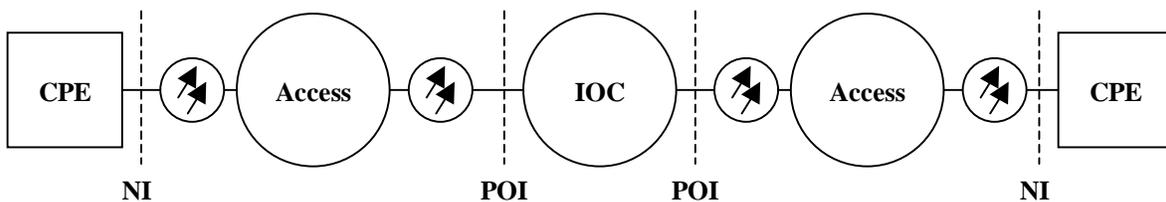
- T1.107-1995 Telecommunications - Digital Hierarchy - Formats Specifications<sup>[16]</sup>,
- T1.231-1997 – Digital Hierarchy – Layer 1 In-service Digital Transmission Performance Monitoring<sup>[17]</sup>,
- T1.514-1995 Network Performance Parameters and Objectives for Dedicated Digital Services – SONET Bit Rates<sup>[18]</sup>,
- Telcordia Technologies (formerly known as Bellcore)
  - Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria (GR-253-CORE)<sup>[19]</sup>,
  - SONET OC-192 Transport System Generic Criteria (GR-1377-CORE)<sup>[20]</sup>,
  - Transport Systems Generic Requirements (TSGR): Common Requirements (GR-499-CORE)<sup>[21]</sup>,
  - Clocks for the Synchronized Network: Common Generic Criteria (GR-1244-CORE)<sup>[22]</sup>,
  - SONET Private Line Service Interface Generic Criteria for End Users (GR-1365-CORE)<sup>[23]</sup>,
- ATM Forum
  - af-phy-0046.000 “2488.32 Mbps Physical Layer Specification,” January 1996<sup>[24]</sup>,
- SONET Interoperability Forum
  - SIF-010-1998 "Intercarrier Interface Requirements".

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-192 Inter-Office Channel Service

The AT&T Private Line Service (APLS) OC-192 Inter-Office Channel (IOC) Service is a service that provides dedicated point-to-point 9953.28 Megabits per second (Mbps), or 10 Gigabits per second (Gbps), line rate digital service for STS-192/192c (Synchronous Transport Signal Level 192/192 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-192c signals, the OC-192 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) and/or STS-48c (Synchronous Transport Signal Level 48 concatenated) tributary signals or combinations of these tributary signals as required per customer application<sup>1</sup>. 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 3 “Interface Specifications”. OC-192 service features optical interfaces at the NI and the POI. Figure 1 below illustrates a typical point-to-point OC-192 circuit with significant components and points of demarcation.



Note – All NI and POI interfaces are Optical.

**Figure 1 - Typical Point-to-point OC-192 Circuit**

<sup>1</sup> While there may be STS-1 tributaries in the payload, based on OC-192 network element capabilities, management of the payload will be at STS-3/3c and above.

### 2.1.1 Zero Mile IOC Service

Zero Mile IOC Service is a special configuration that supports OC-192 connectivity in the same office, i.e. access-to-access.

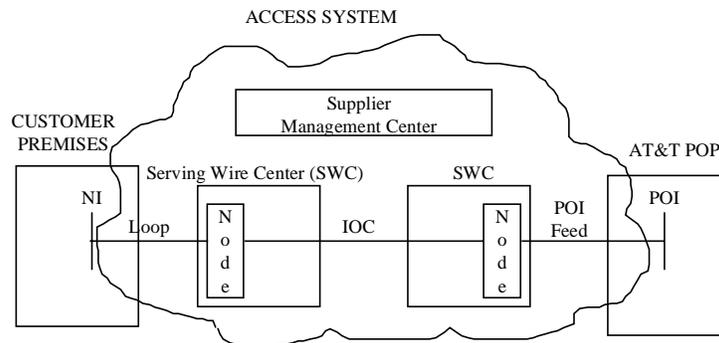
## 2.2 Network Interface and Point-Of-Interface

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-192 shall be optical. This signal shall be comprised of STS-1 and/or STS-3c, and/or STS-12c, and/or STS-48/48c, or STS-192c (as required by customer applications) formatted tributaries per GR-1377-CORE<sup>[20]</sup> Sections 3.2 and 3.4, GR-253-CORE<sup>[19]</sup> sections 3.2 and 3.4, and T1.105.02<sup>[9]</sup>. The signal at the NI and POI shall conform to the SONET standards per GR-1377-CORE<sup>[20]</sup> Sections 3 and 4. Path overhead shall only terminate at the CPE or equivalent end-point of the SONET channel. Two fiber interconnections only are supported for both NI and POI.

## 2.3 Access Architecture

Figure 2 illustrates a typical access connection. The CPE is connected to the OC-192 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-192 Line Terminating Equipment (LTE). The NI is typically located on customer premises. The Network Interface for OC-192 Local Channel (LC) is defined as a Fiber Distribution Bay.



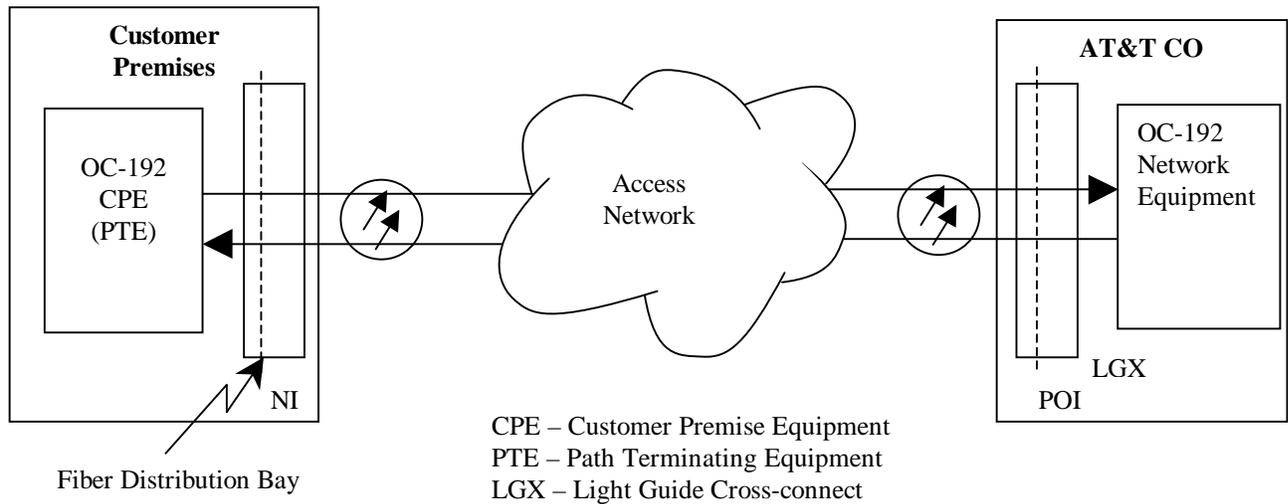
**Figure 2 - OC-192 LC Circuit and Access Network Components**

The 9953.28 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<sup>2</sup> per GR-1377-CORE<sup>[20]</sup> Section 4.1 and 4.2 are given in section 4.2.1. Also, the Customer Installation shall meet the loss requirements as specified in GR-1377-CORE<sup>[20]</sup> section 4.2. The CPE will determine the fiber type (single mode or multi-mode) to connect the CPE to the NI Fiber Distribution Bay. The NI Fiber Distribution Bay supports optical connector options as required by the customer application (i.e., SC, FC, ST, etc.). The NI configuration supports two fiber (one pair) duplex unprotected operation.

The 9953.28 Mbps signal at the POI shall be optical in both directions. The OC-192 POI is implemented via an AT&T owned Light Guide Cross-Connect (LGX) shelf with ST bulkhead connectors. Dispersion-

<sup>2</sup> Intermediate Reach (IR) optics may be used if the optical signal is properly attenuated to the Short Reach power levels.

unshifted Single-Mode Fibers (SMF) to AT&T assigned jacks on the rear of the LGX POI shelf shall be used. POI interconnections are implemented over a two fiber (one pair) configuration. Figure 3 illustrates the OC-192 connections at the NI and POI.



**Figure 3 - APLS OC-192 Access Connections**

The customer shall provide the STS-1, STS-3c, STS-12c, STS-48c, or STS-192c mapping into an OC-192 to AT&T, and shall conform to the permitted combinations per SONET OC-192 format specification in GR-1377-CORE<sup>[20]</sup> section 3, GR-253-CORE<sup>[19]</sup> section 3, and T1.105.06<sup>[14]</sup>.

## 2.4 Access Arrangements

Customers may provide their own access to OC-192 Service, or may acquire access through AT&T or a third party.

### 2.4.1 AT&T Total Service Access

The customer may purchase an OC-192 Total Service access arrangement from AT&T that provides connectivity from customer premises to the AT&T Point Of Presence (POP). Under this access arrangement, AT&T provides or is the customer of record of the access circuit(s), and assumes responsibility for the following functions: Design, Ordering, Installation coordination, Pre-service testing and service turn-up, Trouble sectionalization, Restoration coordination, and Bill end user customer.

### 2.4.2 AT&T Coordinated Service Access

For this access arrangement, access is coordinated by AT&T with the access provider. The access is ordered at the time that 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(s) used to provide customer connectivity to AT&T and is billed directly by the access provider.

### 2.4.3 Customer Provided Access

#### 2.4.3.1 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 the Customer Premises (CP) to the serving AT&T CO. The serving AT&T CO must be a designated OC-192 POP. The customer also has terminal equipment located in the AT&T POP. 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.

#### 2.4.3.2 Baseline Access

Under Baseline Access arrangement, the customer purchases their access directly from the access provider, and has it installed.

Under this arrangement, the customer, together with the access provider, has total responsibility for the engineering, installation, operation, and maintenance of the baseline facility terminating at the AT&T POP.

### 2.4.4 Licensed Space Arrangement (LSA)

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 arrangement, the Customer Installation (CI) is in the same office as the POI and is interconnected with intra-office optical fiber facility.

## 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 ( $\% \text{Availability} = 100 - \% \text{Outage}$ ). 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 for the OC-192 service are Coding Violations, Errored Seconds, Severely Errored Seconds and Percent Error Free Seconds. Error parameters have been defined for SONET Section layer, Line layer, and STS Path layer<sup>3</sup> in GR-1377-CORE<sup>[20]</sup> section 6, GR-253-CORE<sup>[19]</sup> section 6, T1.231<sup>[17]</sup>, T1.514<sup>[18]</sup>, and T1.105.04<sup>[13]</sup>. They are reproduced here for reference, and are described as measurements of corresponding events over a certain time interval. *Note: AT&T conforms to these standard; however, various equipment vendors and communications service providers may have implemented these definitions differently.*

The error parameters Errored Seconds and Severely Errored Seconds are defined in terms of the Coding Violations parameter and signal defect conditions. Coding Violations (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

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<sup>3</sup> Only the Section layer error performance parameters may be monitored by AT&T initially. These parameters for other layers may be monitored in the future.

for the Line layer, and CV-P for the STS Path layer. They are collected using the overhead bytes (e.g., B1, B2, and B3) in the SONET Overhead. Examples of signal defects are Loss Of Signal (LOS), Loss Of Frame (LOF), Severely Errored Framing (SEF) defect (4 or more consecutive errored framing patterns), Alarm Indication Signal for the Line layer (AIS-L), Alarm Indication Signal for the Path layer (AIS-P), and Loss Of Pointer for the Path layer (LOP-P).

- Errored 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 LOS, AIS, SEF or Loss Of Pointer (LOP) defect 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.
- Severely Errored Seconds (SESs) – The SES parameter is a count of one second intervals during which K or more BIP errors occurred, or one second intervals during which (at any point during the second) a LOS, AIS, SEF or LOP defect 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” are currently set in GR-1377-CORE<sup>[20]</sup> as follows: 8554 for SES-S (SES Section), 9835 for SES-L (SES Line), and 2400 for SES-P (SES Path).
- Percent Error Free Seconds (%EFS) – %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 %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 in GR-1377-CORE<sup>[20]</sup>, GR-253-CORE<sup>[19]</sup>, T1.231-1997<sup>[17]</sup>, and T1.514-1995<sup>[18]</sup> 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 via the K2 byte, Remote Defect Indication for the Line layer (RDI-L), and the M0 or M1 byte, Remote Error Indication for the Line layer (REI-L). Far-end STS Path layer performance is conveyed back to the near-end STS PTE (Path Terminating Equipment) via bits 1 through 4, Remote Error Indication for the Path layer (REI-P), and 5 through 7, Remote Defect Indication for the Path layer (RDI-P) of the G1 byte. The far-end performance parameters are defined with these remote indication signals.

## 4. INTERFACE SPECIFICATIONS

The signal at the NI and POI shall conform to the relevant SONET standards (see Sec. 1.3) for OC-192 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.

### 4.1 Physical Specifications

All physical connectivity to the POI shall be via two dispersion-unshifted Single-Mode Fibers (SMF)<sup>4</sup>. Physical connectivity to the NI will be two fibers. These fiber connections shall conform to GR-1365-CORE<sup>[23]</sup>, Section 3.4.

#### 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 POI<sup>5</sup>.

<sup>4</sup> Dispersion-shifted SMF is recommended ONLY for LR-3 (Long Reach-3) application.

If access is not provided by AT&T then the access supplier will have responsibility and ownership of all access facilities up to the LGX POI<sup>6</sup>. 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 and POI shall conform to the OC-192 signal characteristics described in GR-1377-CORE<sup>[20]</sup> Sec. 4.1 and 4.2 with sources at the nominal **1550 nano-meter (nm)** and **1310 nm<sup>7</sup>** wavelengths.

### 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-CORE<sup>[23]</sup>. At the customer installation the NI, as one point on the optical path between transmitter (Point S) and receiver (Point R)<sup>8</sup>, shall meet the optical power requirements as given in Table 1.

**Table 1. Optical Power Requirements at the NI**

Receive to CPE	Transmit from CPE
$P_{\max}$ : 0 dBm	$P_{\max}$ : 0 dBm
$P_{\min}$ : -8 dBm	$P_{\min}$ : -8 dBm

Note: AT&T expects that under most circumstances these levels can be achieved using SR<sup>9</sup> capable equipment with 6 dB fiber loss budget, with a 3 dB fiber loss from access equipment to the NI, and a 3 dB fiber loss budget from CPE to the NI.

### 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)<sup>8</sup>, meet the optical category specified as OC-192 SR<sup>9</sup> in GR-1377-CORE<sup>[20]</sup> Sec 4.2 and T1.105.06<sup>[14]</sup>. The required optical power levels at the POI are given in Table 2.

**Table 2. Optical Power Requirements at the POI**

Receive to AT&T	Transmit from AT&T
$P_{\max}$ : -0.2 dBm	$P_{\max}$ : -1.5 dBm
$P_{\min}$ : -6.6 dBm	$P_{\min}$ : -7.4 dBm

Note: AT&T expects that under most circumstances these levels can be achieved using SR capable equipment with 6 dB fiber loss budget, with a 2.1 dB fiber loss from access equipment to the POI, and a 3.9 dB fiber loss budget from AT&T equipment to the POI.

## 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

<sup>5</sup> A different connector may be used by the new LGX at the POI in the future.

<sup>6</sup> The access supplier here refers to the access vendor in all access arrangements except LSA. (see Sec. 2.4)

<sup>7</sup> Initially, only the 1550nm wavelength will be supported by AT&T.

<sup>8</sup> Point S and Point R are shown in GR-1377-CORE Figure 4-1.

<sup>9</sup> IR optics that is properly attenuated may be used in lieu of Short Reach optics.

shall conform to the STS-1 and/or STS-3c and/or STS-12c and/or STS-48c or STS-192c formats as defined in GR-1377-CORE<sup>[20]</sup> section 3, GR-253-CORE<sup>[19]</sup> section 3, and T1.105.02<sup>[9]</sup>. 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, AT&T reserves the right to use the section DCC. 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 and SIF-010-1998<sup>[25]</sup>.

### 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 standards for Line overhead and SIF-010-1998<sup>[25]</sup>. 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)

AT&T does not support Automatic Protection Switching (APS) at this time. GR-1377-CORE<sup>[20]</sup> section 5.3, GR-253-CORE<sup>[19]</sup> section 5.3 and T1.105.01<sup>[8]</sup> specify criteria for implementing APS. APS function requires a four fiber interface, AT&T does not support a four fiber interface.

### 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 T1.105.02<sup>[9]</sup> and GR-1377-CORE<sup>[20]</sup>. As per T1.105<sup>[8-15]</sup>, bytes Z3 and Z4 are reserved for future use<sup>10</sup>. At the time of this publication, AT&T does not support any functionality based on the use of these growth channels. This is consistent with the SONET standards for Path overhead and SIF-010-1998<sup>[25]</sup>. The service shall be STS-1 and/or STS-3c and/or STS-12c and/or STS-48c or STS-192c end-to-end. Path status and parity bytes may be monitored for performance information.

## 5. SYNCHRONIZATION AND TIMING

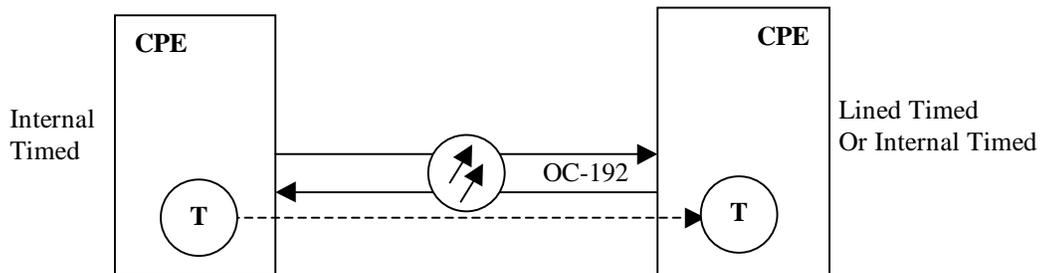
All CPE and network equipment providing AT&T OC-192 service shall conform to timing and synchronization specifications described in T1.105.09<sup>[15]</sup>, T1.101<sup>[6]</sup>, and GR-1244-CORE<sup>[22]</sup>. The access supplier equipment should be able to receive timing from a co-located external 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; either one CPE is designated

<sup>10</sup> Byte Z4 may be used for AT&T network maintenance in the future.

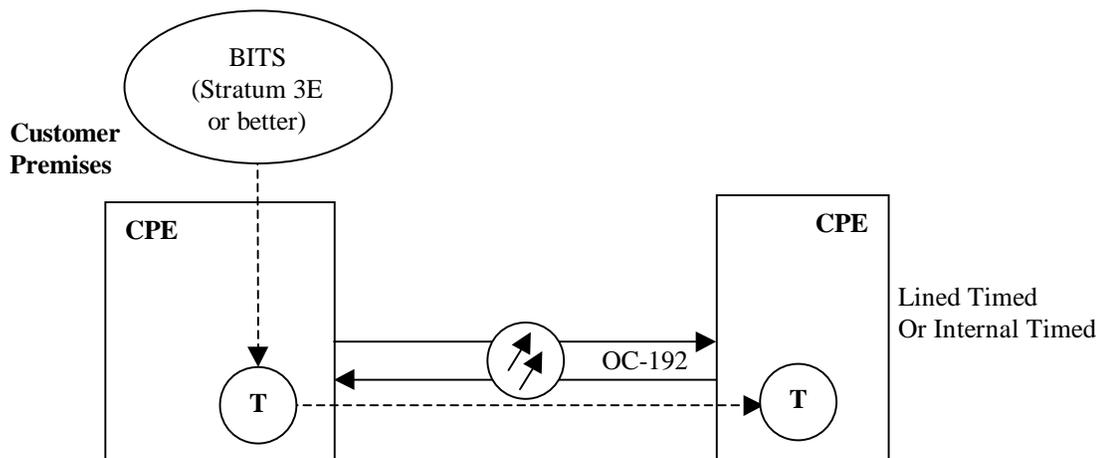
as internal and the other CPE designated as line timed or CPE at both ends would need to be designated as internal timed.



**Figure 4 - Internal Timing Mode**

## 5.2 External Timing Mode

CPE timed in external timing mode draws its synchronization from an independent timing source, e.g. Building Integrated Timing Source (BITS). This source shall be Stratum 3 or better and traceable to a Stratum 1 source. This configuration is shown in Figure 5. If external timing were available at both end-points, the CPE at each end would be designated as “external”. If external timing is available at only one location, the end-point with no external timing should be set to either line time or internal.



**Figure 5 - 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-1377-CORE<sup>[20]</sup> section 5.6, T1.105.03<sup>[10]</sup>, and T1.105.03a<sup>[11]</sup> 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-192 service is the following (per GR-1377-CORE<sup>[20]</sup> Sec. 5.6):

*Timing jitter at network interface shall not exceed **1.5 Unit Intervals peak-to-peak (UI<sub>pp</sub>)** when measured over a 60-second interval with a band pass filter having a high-pass cutoff frequency of **10kHz** (and a roll-off of 20dB/decade) and a low-pass cutoff frequency of at least **80MHz**.*

*Timing jitter at network interface shall not exceed **0.15 Unit Intervals peak-to-peak (UI<sub>pp</sub>)** when measured over a 60-second interval with a band pass filter having a high-pass cutoff frequency of **4MHz** (and a roll-off of 20dB/decade) and a low-pass cutoff frequency of at least **80MHz**.*

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-1244-CORE<sup>[22]</sup> sections 4.3 and 5.4, T1.105.09<sup>[15]</sup>, and T1.105.03b<sup>[12]</sup> 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). The access network equipment shall monitor SONET signals to detect LOS.

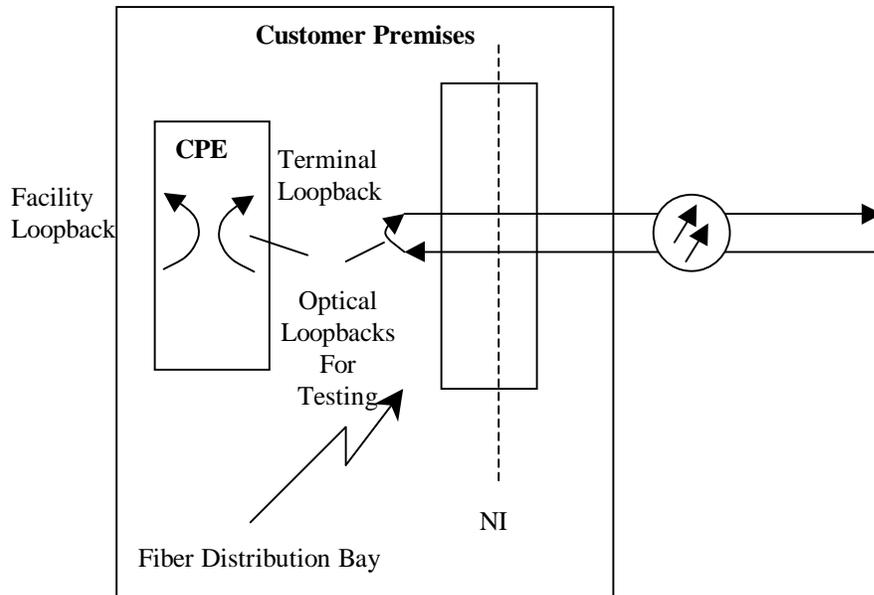
## **7. CUSTOMER PREMISES EQUIPMENT CHARACTERISTICS**

### **7.1 CPE Requirements**

CPE shall generate alarms as described in GR-1377-CORE<sup>[20]</sup> section 6 and GR-253-CORE<sup>[19]</sup> 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 (Remote Failure Indication-Path). For any unused STS-48c, 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 Loopbacks**

To conduct circuit testing and fault sectionalization of the two-way OC-192 circuit, an optical loopback on the CPE side of the NI toward the network shall be provided as shown in Figure 6. 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 6. AT&T will coordinate with the customer when loopbacks are required and will enlist the customer's support in establishing loopbacks at the NI. The customer must always get clearance from AT&T to enable any loopbacks. This optical loopback is not recommended when the CPEs use line timing.



**Figure 6 - Optical Loopbacks at NI and CPE**

### 7.3 Automatic Protection Switching

Protection switching is described in GR-1377-CORE<sup>[20]</sup> section 5.3, GR-253-CORE<sup>[19]</sup> section 5.3, and T1.105<sup>[14]</sup>, Section 13. APS is not support by AT&T.

## 8. TESTING AND MAINTENANCE

The OC-192 Service will be managed as a 9953.28 Mbps circuit transporting STS-1 and/or STS-3c and/or STS-12c, and/or STS-48c, or STS-192c tributaries as specified. Testing and maintenance may require the customer to relinquish the full circuit of 9953.28 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 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 6), 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 of 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 trouble report status at customer requested intervals.

## 9. REFERENCES

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