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Self-Healing
Network Service (SHNS)

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NOTICE

The purpose of this document is to describe CenturyLink Self Healing Network Service appropriate for the majority of applications. It furnishes sufficient technical detail to allow a customer, such as an Interexchange Carrier or End-User, to select a service that may be incorporated into an end-to-end communications channel. It is not the intent of this document to provide specific ordering information, but to describe the technical features of this service offering.

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1. Introduction

1.1 General

The purpose of this document is to describe CenturyLink Self Healing Network Service as appropriate for the majority of applications. It furnishes sufficient technical detail to allow a customer, such as an Interexchange Carrier, Local Exchange Carrier or End-User, to select a service that may be incorporated into an end-to-end communications channel. It is not the intent of this document to provide specific ordering information, but to describe the technical features of this service offering.

1.2 Scope

This document describes CenturyLink Self Healing Network Service offered by CenturyLink Corporation to their customers. It covers distinguishing service features, technical specifications, and defines valid interfaces.

1.3 Reason for Reissue

- Change name of company from Qwest to CenturyLink
- Add STS-1-nv mapping options for 450, 600 and 1,000 Mb Ethernet bandwidths.

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

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

Federal Regulations mandate certain technical differences between interfaces provided at End-User premises and at Carrier premises, and these differences are explained in Technical Publication 77375, *1.544 Mbit/s Channel Interfaces*. The differences have no qualitative affect on the service being provided.

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

1.5 Organization of Document

Chapter 1 Introduction: Provides the purpose scope and summary of the Publication and its organization.

Chapter 2 Description of Service: Presents the available functions, features, interface options and configurations of SHNS.

Chapter 3 Network Interfaces: Describes the physical electrical and optical interfaces offered by this service. Also briefly addresses the form and function of Network Channel codes and Network Channel Interface codes as they pertain to this service.

Chapter 4 Ethernet Features: Describes the general Ethernet over SHNS capabilities as well as available interfaces and SONET transport bandwidth options.

Chapter 5 Performance Specifications: Furnishes expectations for accuracy, availability, and jitter.

Chapter 6 Maintenance Responsibilities: Provides the CenturyLink and corresponding customer responsibilities of this service.

Chapter 7 Definitions: Presents a glossary of terms and a listing of acronyms related to the Publication.

Chapter 8 References: Provides titles and ordering information for documents referenced in this Publication.

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2. Service Description

2.1 Applicability of Technical Specifications

Technical specifications presented in this document are applicable to CenturyLink Self Healing Network Service (SHNS) only. This document does not attempt to describe the various types of transmission equipment used to provide this service. It does not provide detailed ordering information.

2.2 Service Description

CenturyLink Self Healing Network Service offers a premium service arrangement designed to provide high capacity digital services between multiple, customer designated premises, between customer designated premises and CenturyLink Wire Centers or between CenturyLink Wire Centers. SHNS dedicates available bandwidth on the Network exclusively to a single customer. That bandwidth may be dedicated fiber optic facilities or dedicated spectrum (wavelengths) on fiber optic facilities.

- SHNS is an arrangement that automatically detects a fault in the Network and reconfigures itself to maintain a near continuous flow of information between locations. The arrangement can be described as two concentric rings (e.g., UPSR) that connect two or more customer specified locations (see Figure 2-1). Upon detection of a network failure, such as a cable cut, SHNS will automatically reconfigure itself to bypass the affected area thereby allowing continued communications.
- SHNS consists of drop and insert locations (also referred to as nodes) in a closed ring configuration. All nodes are interconnected with optical fibers that are configured into working (primary) and protection (alternate) systems. The nodes are designed into the system when the service is established. There is a minimum of three nodes required. Regenerators may be inserted in the network as required.
- Fiber optic facilities connecting each node are routed diversely from each other. That is, from the first terminal/ utility vault outside the customer premises/ CenturyLink Wire Center's Central Office to the last terminal/ utility vault prior to the customer premises/ CenturyLink Wire Center, the fiber paths of the closed loop are physically separated by 25 feet or more. A second entrance to the customer's premises affords further diversity protection. When desired, it is a customer's responsibility to provide a second entrance. That second entrance must meet existing CenturyLink entrance facility standards. For additional information see Publication 77344, *Diversity and Avoidance*.
    - Each Self Healing Network will include at least one CenturyLink Wire Center Hub Node. The purpose of this Hub Node is to provide an access connection between CenturyLink public network and a customer's private Network. It will also be used to provide access to the maintenance and performance monitoring functions.

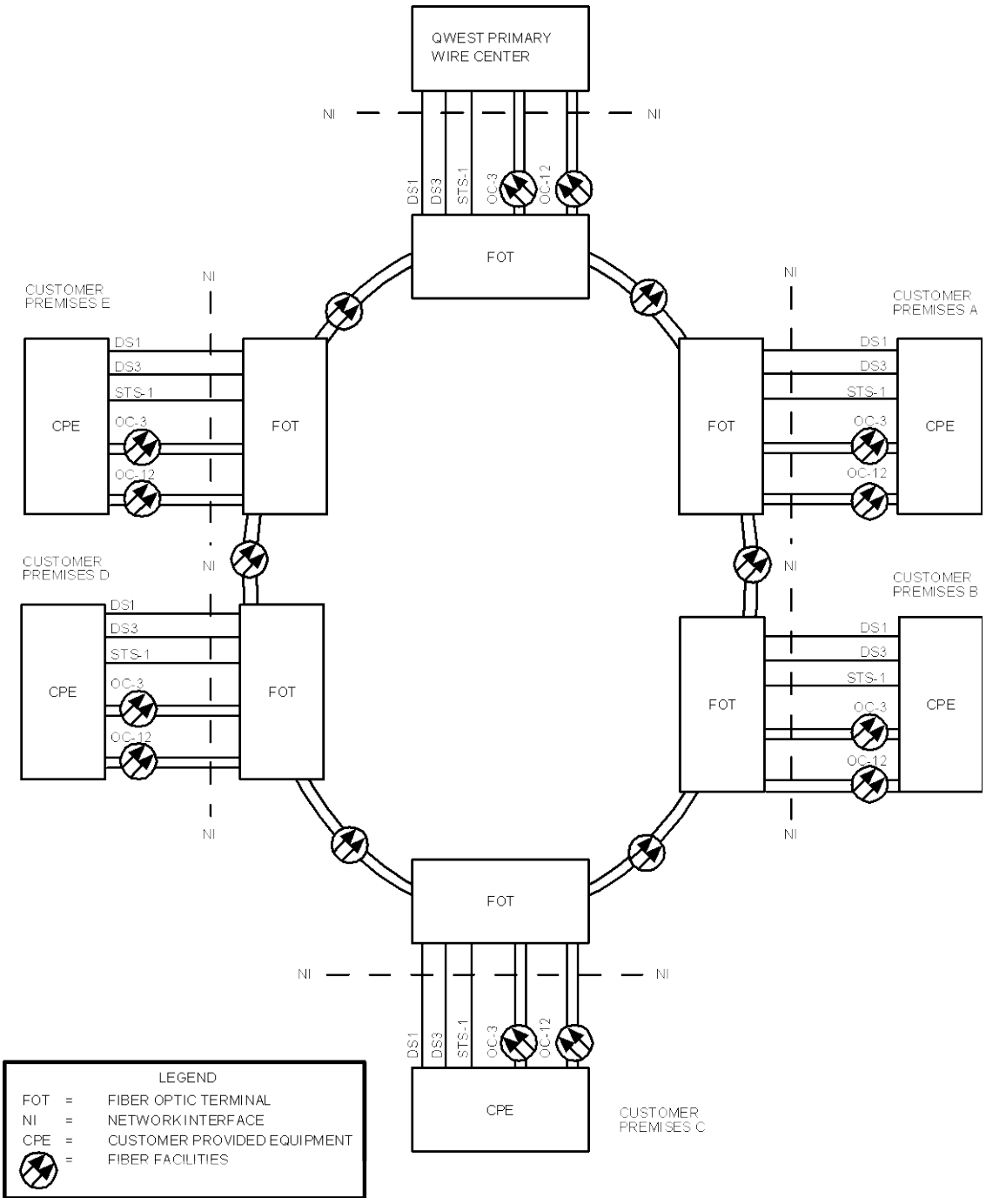

Figure 2-1 Self Healing Network Example

2.2.1 Interface Overview

- The SHNS is available with the capacity to transport the SONET rates of 155.52 Mbit/ s, 622.08 Mbit/ s, 2.488 Gbit/ s, or 9.953 Gbit/ s. Customers may order a combination of electrical DS1, 10Base-T (over STS-1), DS3, STS-1 and 100Base-TX/ LX10/ FX (over STS-1-1v, STS-1-2v or STS-3c-1v) interfaces. A Virtual Tributary 1.5 structured STS-1 may carry 28 DS1's. The STS-1 may also be arranged to carry an asynchronously mapped DS3 that could then carry 28 DS1's. Accessing DS1's within a DS3 carried by an STS-1 requires multiplexing equipment additional to basic SHNS arrangements. Interfaces at the customer premises will conform to standard IEEE and ANSI rate and format specifications. The STS-1 interface rate is 51.840 Mbit/ s, DS3 interface is 44.736 Mbit/ s, and the DS1 is 1.544 Mbit/ s. DS3 and DS1 interfaces are disclosed in CenturyLink Technical Publications 77324 and 77375, respectively.
- 10Base-T and 100Base-TX Ethernet interfaces will be delivered to the NI as IEEE 802.3 compliant with a RJ-45 connector receptacle.
- The STS-1 interface at an end user premises will be an SJA 44 connector interface, delivered from CenturyLink-owned Line Terminating Equipment (LTE). The STS-1 interface at a Carrier premises will be at a cross-connect panel dedicated for
  STS-1 use. The signal characteristics shall conform to those described in ANSI T1.102 and Telcordia GR-253-CORE.

  As with DS3 Service, Carriers have two options at their premises:

  - Terminate their cables on the CenturyLink cross-connect panel in the space provided for CenturyLink's transmission equipment.
  - Have CenturyLink terminate CenturyLink's cable on the Carrier's cross-connect panel located in the Carrier's, accessible workspace.
- OC-3 interfaces are available with SHNS capacities of 622.08 Mbit/ s, 2.488 Gbit/ s and 9.953 Gbit/ s. The OC-3 interface provides a high capacity channel for the transmission of 155.52 Mbit/ s, using optical interfaces, delivered from CenturyLink-owned Line Terminating Equipment.
- OC-12 interfaces are available with SHNS capacities of 2.488 Gbit/ s and 9.953 Gbit/ s. The OC-12 interface provides a high capacity channel for the transmission of 622.08 Mbit/ s, using optical interfaces, delivered from CenturyLink-owned Line Terminating Equipment.

- 1000Base-LX, 1310 nm Single-Mode Fiber; 1000Base-ZX, 1550 nm Single-Mode Fiber and 1000Base-SX, 850 nm (50 or 62.5 um) Multi-Mode Fiber interfaces are available with all SHNS capacities. A 1000Base-LX/ ZX/ SX interface provides an Ethernet over STS-1-1v,
  STS-1-2v, STS-3c-1v, STS-3c-2v, STS-1-9v, STS-3c-3v, STS-1-12v, STS-3c-4v, STS-1-12v or STS-3c-7v channel for the transmission of up to 1 Gbit/ s, using optical interfaces, delivered from CenturyLink-owned Line Terminating Equipment. 1000Base-SX Network Interfaces are available at customer premises locations only. See Chapter 4 for quantity restrictions.
- See Table 4-1 for available Ethernet over SONET transport bandwidth options.
- OC-48 interfaces are available with SHNS capacity of 9.953 Gbit/ s. The OC-48 interface provides a high capacity channel for the transmission of 2.488 Gbit/ s, using optical interfaces, delivered from CenturyLink-owned Line Terminating Equipment.
- Optical interfaces will be delivered to the Network Interface at a CenturyLink-provided Fiber Distribution Panel or equivalent and shall be equipped to terminate SC, FC or LC UPC duplex connectors. SC/ UPC (with Ultra Physical Contact polish) is the CenturyLink default connector for new SHNS optical interfaces whereas FC and LC are customer-specified options, where available at premises locations only. As there are no (e.g., NCI) codes for ordering, the customer should make the request to their Sales or Account Team, or the connector type would be determined during the field visit and captured on the site survey form.

  SC (Subscriber Connector) is a push-pull type of fiber optic connector with a square barrel that conforms to ANSI/ TIA/ EIA-604-3-B, *FOCIS (Fiber Optic Connector Intermateability Standard) 3, Type SC and SC-APC*. While SC, FC and LC UPC all have very good performance parameters for SONET, optical Fast and Gigabit Ethernet transport, SC connectors will be used to terminate all SHNS Single-Mode Fiber optical Network Interfaces in CenturyLink COs.

2.2.2 Synchronous Transport Signal (STS) Concatenation

Multiples of Synchronous Transport Signal level 1 (STS-1) rates are needed for Super-Rate services that require greater bandwidth. Super-Rate services can include Broadband Integrated Services Digital Network (B-ISDN) channels, or Asynchronous Transfer Mode (ATM) service. To provide Super-Rate services, the bandwidth of N STS-1's are linked (concatenated) to create an individual STS-Nc circuit of a greater bandwidth. The STS-Nc can be transported by an OC-N (or higher level) SONET signal.

CenturyLink currently offers the customer Network Interfaces listed below that are capable of carrying an STS-Nc payload, which will be provided using equipment that meets technical and operational requirements specified in GR-253-CORE, *Synchronous Optical Network (SONET) Transport Systems: Common Criteria*.

- OC-3 Network Interface - One STS-3c can be transported on an OC-3.
- OC-12 Network Interface - One STS-12c can be transported on an OC-12.
- OC-48 Network Interface - One STS-48c can be transported on an OC-48.

Customer-Provided Equipment (CPE) solutions using an STS-Nc SPE containing multiple payload mappings, which is outside of that currently defined in GR-253-CORE or ATIS-0900105.02 (and thus proprietary at the originating/ terminating SONET PTE or Path layer within the CPE), should also function with SHNS. Other potential options include customers using STS-1 inverse multiplexing (Virtual Concatenation) over an OD/ OF/ OG-- non-concatenated (STS-1 channelized) SONET circuit for example or ordering multiple individually concatenated point-to-point circuits from CenturyLink.

2.3 Service Configuration

Depending upon the design of the system, SHNS may use interoffice and/ or local loop facilities. Each SHNS shall be dedicated to a single customer and can provide customer interfaces using many combinations of electrical and/ or optical signal levels.

SHNS must have at least one Hub Node in a CenturyLink Wire Center. A customer premises or Access Node is not required. A typical network is shown in Figure 2-1.

SHNS will be available in the following service configurations:

2.3.1 Ring Bandwidth Capacity of 155.52 Mbit/s

An OC-3 SHNS consists of a Bandwidth Capacity of 155.52 Mbit/ s with DS1, 10Base-T, DS3, STS-1 and 100Base-TX electrical, 100Base-LX10/ FX and 1000Base-LX/ ZX/ SX optical interfaces. A combination of DS1, Ethernet, DS3 or STS-1 ports (where 28 DS1's are the equivalent of one DS3 or STS-1) may be ordered. This system can provide a capacity of up to 3 DS3's or STS-1's.

The total service bandwidth ordered shall not exceed the ring bandwidth capacity of 155.52 Mbit/ s. A point-to-point pair of Ethernet ports requires dedicated STS bandwidth on the ring. Multiple Ethernet pairs may share the same ring bandwidth. Service requirements at each node should be known or forecast to build an optimal ring network.

2.3.2 Ring Bandwidth Capacity of 622.08 Mbit/s

An OC-12 SHNS consists of a Bandwidth Capacity of 622.08 Mbit/s with DS1, 10Base-T, DS3, STS-1 and 100Base-TX electrical, 100Base-LX10/ FX, OC-3 and 1000Base-LX/ ZX/ SX optical interfaces. A combination of DS1, Ethernet, DS3, STS-1 and OC-3 ports may be specified. This system can provide a capacity of 12 STS-1's or 12 DS3's. Each DS3 or STS-1 may be channelized to provide up to 28 DS1's. This system will also provide four OC-3's.

The total service bandwidth ordered shall not exceed the ring bandwidth capacity of 622.08 Mbit/s for customer-specified OC-12 UPSR SHNS and will vary between 622.08 Mbit/s and a maximum of 622.08/ 2 * (# of Hub + Access Nodes) Mbit/s depending upon the provisioned working traffic patterns for customer-specified OC-12 2F BLSR SHNS. A point-to-point pair of Ethernet ports requires dedicated STS bandwidth on the ring. Multiple Ethernet pairs may share the same ring bandwidth. Service requirements at each node should be known or forecast to build an optimal ring network.

2.3.3 Ring Bandwidth Capacity of 2.488 Gbit/s

An OC-48 SHNS consists of a Bandwidth Capacity of 2.488 Gbit/s with DS1, 10Base-T, DS3, STS-1 and 100Base-TX electrical, 100Base-LX10/ FX, OC-3, OC-12 and 1000Base-LX/ ZX/ SX optical interfaces. This system capacity can provide a capacity of 48 DS3's or STS-1's. Additionally, some STSs may be configured to provide SHNS DS1's and Ethernet ports. This system can provide 16 OC-3's or 4 OC-12's. For the 2.488 Gbit/s capacity, a combination of DS1, Ethernet, DS3, STS-1, OC-3 and OC-12 ports may be specified.

The total service bandwidth ordered shall not exceed the ring bandwidth capacity of 2.488 Gbit/s for customer-specified OC-48 UPSR SHNS and will vary between 2.488 Gbit/s and a maximum of 2.488/ 2 * (# of Hub + Access Nodes) Gbit/s depending upon the provisioned working traffic patterns for customer-specified OC-48 2F BLSR SHNS. A maximum of 168 DS1 ports is available at an individual node. There is a ring system maximum of 336 DS1 ports. A point-to-point pair of Ethernet ports requires dedicated STS bandwidth on the ring. Multiple Ethernet pairs may share the same ring bandwidth. Service requirements at each node should be known or forecast to build an optimal ring network.

2.3.4 Ring Bandwidth Capacity of 9.953 Gbit/s

An OC-192 SHNS consists of a Bandwidth Capacity of 9.953 Gbit/s with DS1, 10Base-T, DS3, STS-1 and 100Base-TX electrical, 100Base-LX10/ FX, OC-3, OC-12, 1000Base-LX/ ZX/ SX and OC-48 optical interfaces. This system capacity can provide a capacity of 192 DS3's or STS-1's. Additionally, some STSs may be configured to provide SHNS Ethernet ports. This system can provide 64 OC-3's, 16 OC-12's or 4 OC-48's. For the 9.953 Gbit/s capacity, a combination of DS1, Ethernet, DS3, STS-1, OC-3, OC-12 and OC-48 ports may be specified.

The total service bandwidth ordered shall not exceed the ring bandwidth capacity of 9.953 Gbit/s for customer-specified OC-192 UPSR SHNS and will vary between 9.953 Gbit/s and a maximum of 9.953/2 * (# of Hub + Access Nodes) Gbit/s depending upon the provisioned working traffic patterns for customer-specified OC-192 2F BLSR SHNS. A maximum of 168 DS1 ports is available at an individual node. There is a ring system maximum of 672 DS1 ports. A point-to-point pair of Ethernet ports requires dedicated STS bandwidth on the ring. Multiple Ethernet pairs may share the same ring bandwidth. Service requirements at each node should be known or forecast to build an optimal ring network.

2.4 Interface Capacities Available

The following customer Network Interface types are available on the corresponding SHNS transport capacities:

Table 2-1 Interface Availability

INTERFACE TYPE	SHNS TRANSPORT CAPACITY			
	OC-3	OC-12	OC-48	OC-192
DS1	YES	YES[1]	YES[2]	YES[2]
10Base-T[3,4]	YES	YES	YES	YES
DS3	YES	YES	YES	YES
DS3 Transmux[4]	YES	YES	YES	YES
STS-1	YES	YES	YES	YES
STS-1 Transmux[4]	YES	YES	YES	YES
100Base-TX[3,4]	YES	YES	YES	YES
100Base-LX10[3,4]	YES	YES	YES	YES
100Base-FX[3,4,5,6]	YES	YES	YES	YES
OC-3	NO	YES	YES	YES
OC-12	NO	NO	YES	YES
1000Base-LX[3,7]	YES[8]	YES[8]	YES[9]	YES[9]
1000Base-ZX[3,4,10]	YES[8]	YES[8]	YES[9]	YES[9]
1000Base-SX[3,6,11]	YES[8]	YES[8]	YES[9]	YES[9]
OC-48	NO	NO	NO	YES
OC-192	NO	NO	NO	NO

Table 2-1 Notes:

1. For OC-12 SHNS, DS1 ports are limited in general to a maximum of 84 per Node and may be less depending upon the quantity of other interfaces ordered at a site as well as the equipment used by CenturyLink to provide the customer's service.
2. For OC-48/192 SHNS, DS1 ports are limited to a maximum of 168 per Node and 336/672 per OC-48/192 system respectively.
3. See Table 4-1 for available Ethernet over SONET transport bandwidth options.
4. Where available (equipment dependant)
5. 1310 nm, Multi-Mode Fiber
6. Available at customer premises locations only
7. 1310 nm, Single-Mode Fiber only
8. Data rate is bandwidth rate-limited.
9. There is a maximum of 20 Gigabit Ethernet ports per Node.
10. 1550 nm, Single-Mode Fiber
11. 850 nm, (50 or 62.5 um) Multi-Mode Fiber

2.5 VT Transmux and SONET Multiplexing Capabilities

VT Transmux and SONET multiplexing are optional SHNS features, which afford the customer the possibility to have high bandwidth interfaces at some locations connecting to multiple lower bandwidth interfaces at other locations. Traditional designs have been to ensure that circuits enter and leave a facility at the same bandwidth. Transmuxing allows multiple DS1 circuits to be aggregated into a single, larger DS3 or DS3 mapped into an STS-1 interface. An example of SONET multiplexing is DS1 services from multiple locations on a ring VT1.5 mapped into an STS-1 channel and passed to another location via an OC-3.

Tables 2-1 and 2-2 list the bandwidth options:

Table 2-2 VT Transmux High and Low Bandwidth Possibilities

High Bandwidth Interface	VT Transmuxed	Low Bandwidth Interface Possibilities
DS3	To	DS1
STS-1[1]	To	DS1

Table 2-3 SONET Multiplexing High and Low Bandwidth Possibilities

High Bandwidth Interface[2]	SONET Multiplexed	Low Bandwidth Interface Possibilities
STS-1	To	DS3/DS1
OC-3	To	STS-1/DS3/DS1
OC-12	To	OC-3/ STS-1/DS3/DS1
OC-48	To	OC-12/OC-3/ STS-1/DS3/DS1

Table 2-2 and 2-3 Notes:

1. This STS-1 interface option with embedded DS1s, DS3 mapped is equipment dependant and offered on a where available basis only.
2. All CenturyLink-provided DS1 interface combinations will be VT1.5 mapped.
3. Ethernet to SONET customer Network Interface combinations with or without other TDM circuits are also supported.

2.6 Software Reconfiguration Capability

Software Reconfiguration Capability is an optional SHNS feature, which affords the customer the ability to reconfigure their existing channels within the SHNS ring via software commands. Selection of this capability has a direct impact on how the service is provisioned. It must be either (1) ordered with the initial service, or (2) it must be stated that at some future point in time, the customer may want to add the remote reconfiguration capability feature. This will ensure the equipment capable of providing this feature, is ordered and installed.

This reconfiguration capability is customer accessible via a customer provided terminal compatible with the CenturyLink provided equipment used to provision the Self Healing Network.

2.7 Performance Monitoring Capability

Performance Monitoring Capability is an optional SHNS feature that affords customers access to detailed information pertaining to the performance of the Self Healing Network. The level of the performance monitoring capability will vary depending upon the transport equipment used to provide this service. This capability is available to the customer via a customer provided terminal compatible with the CenturyLink provided equipment used to provision the SHNS. This option must be specified when the service is initially ordered. Possible performance parameters include:

- Major and Minor Alarms
- Path Coding Violations (CV)
- Path Severely Errored Frame Seconds (SEFS)
- Line and Path Errored Seconds (ES).

Office alarms for failed conditions may additionally be made available when the Performance Monitoring Option is selected. This additional feature will always present an alarm circuit ground condition at the customer premises. The alarm will always be generated by extension of the visual alarm indicator from the network equipment installed to provide the Self Healing Network Service. When this option is selected, alarm cutoff circuitry shall be provided by the customer.

2.8 Secondary Serving Wire Center

The customer may additionally elect to be served from both a primary and a secondary Wire Center on the Self Healing Network as shown in Figure 2-2. With this arrangement, a customer could order customer premises services out of two different Wire Center nodes on the Network guarding against a single Wire Center node failure disrupting SHNS communications. The two-Wire Center option may be selected with any of the above listed configurations.

2.9 Central Office Multiplexing

Central Office Multiplexing option gives additional flexibility to STS-1, DS3, DS1 and DS0 services with its ability to interleave lower bit-rate channels into a higher bit-rate service, or perform the reverse. With the Secondary Serving Wire Center option, the channel between the two CenturyLink Wire Centers (the inter-Central Office channel) may be within the SHNS bandwidth or may be from another digital service.

Refer to Publications 77324; *CenturyLink DS3 Service*, 77375; *1.544 Mbit/s Channel Interfaces* and 77200; *CenturyLink DS1 Service and CenturyLink DS1 Rate Synchronization Service, Network Channel and Network Channel Interface Code Combinations* for additional information regarding this option.

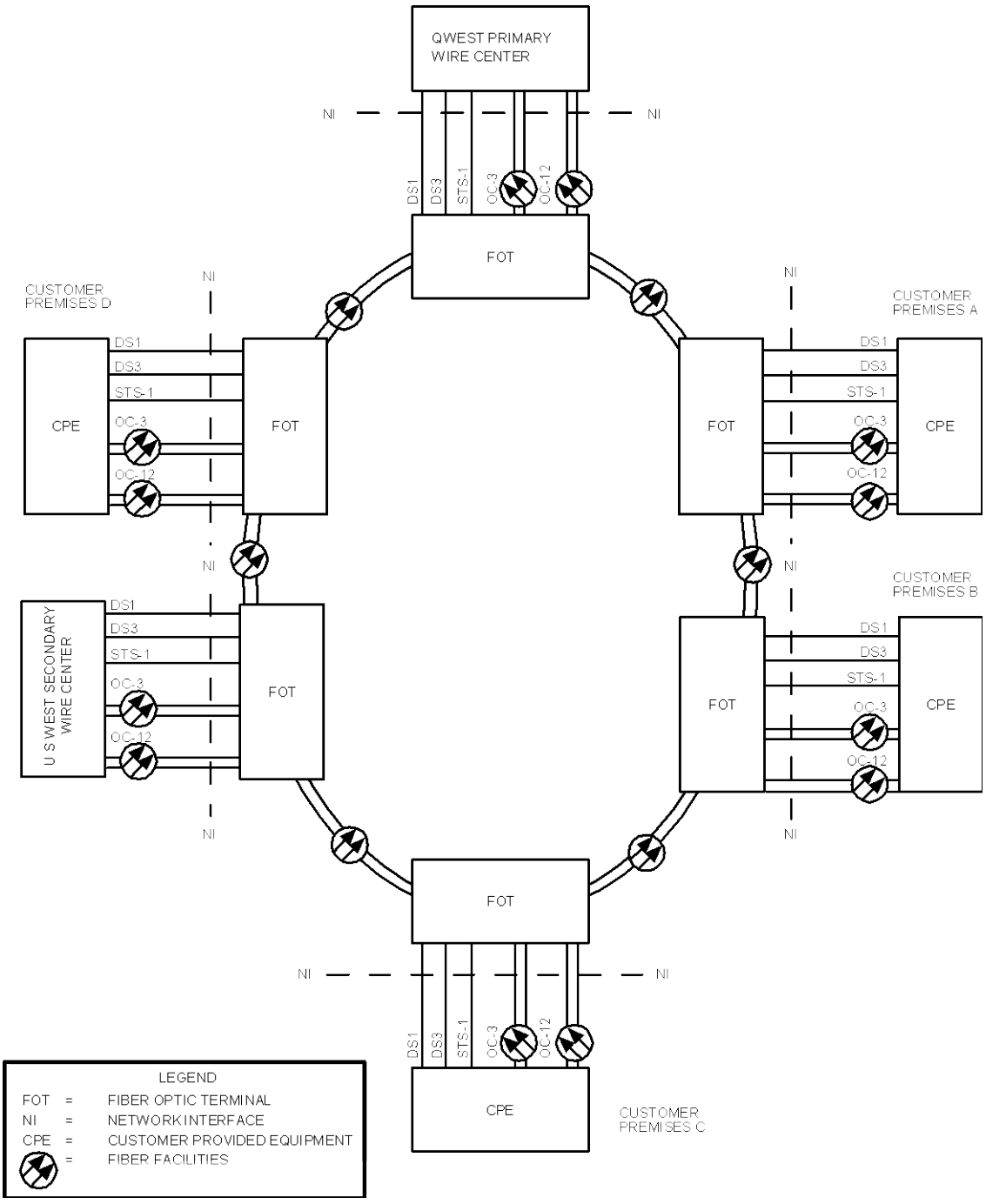

Figure 2-2 Network Example with Primary and Secondary Wire Centers

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3. Network Interfaces

3.1 Description of Interfaces

Allowable North American Digital Hierarchy interfaces to CenturyLink Self Healing Network Service are at electrical DS1, DS3 and STS-1 levels and at optical OC-3 and OC-12 levels. 10Base-T, 100Base-TX/ LX10/ FX and 1000Base-LX/ ZX Single-Mode Fiber and 1000Base-SX Multi-Mode Fiber Local Area Network (LAN) interfaces are as specified by the Institute of Electrical and Electronic Engineers (IEEE) Standard 802.3 for the physical layer.

3.2 Interface Overview

Electrical interfaces will be delivered to the Network Interface (NI) per this publication and CenturyLink Technical Publication 77375, *CenturyLink 1.544 Mbit/s Channel Interfaces* and Technical Publication 77324, *CenturyLink DS3 Service*.

Optical interfaces will be delivered to the NI at a Fiber Distribution Panel (FDP), equipped to terminate SC, FC or LC UPC duplex connectors. FC and LC connectors are an option, where available at customer premises locations. Additional information pertaining to the customer Network Interfaces is contained in Section 2.2.1 as well as Technical Publication 77346, *CenturyLink Synchronous Service Transport (SST).*

The Network Interface must be located in an accessible, environmentally controlled space. To be accessible, CenturyLink technicians must be able to work and perform tests at the NI without delay, at any time of day, any day of the year.

CenturyLink Tech Pub 77368, *CUSTOMER PREMISES ENVIRONMENTAL SPECIFICATIONS AND INSTALLATION GUIDE*, describes the environmental and installation requirements as well as the powering and grounding options for CenturyLink telecommunications equipment placed on customer premises.

CenturyLink Tech Pub 77419, *SPECIFICATIONS FOR THE PLACEMENT OF CENTURYLINK EQUIPMENT IN CUSTOMER-OWNED OUTDOOR CABINETS*, describes the environmental (including electromagnetic compatibility), power, and grounding requirements for customer-owned outdoor cabinets (if provided) in order to allow the placement of CenturyLink-owned equipment inside these cabinets for the provisioning of SHNS to the customer.

3.2.1 DS1 Interface

DS1 channels are provided to Carrier's and to End-User's (EU's) premises. The Network Interface (NI) at the premises will be at the end of a DSX-1 jumper wire or cable with DSX-1 templated, signal characteristics as described in CenturyLink Technical Publication 77375. DS1 interfaces, using Registration Jacks described by Universal Service Ordering Codes (USOC) RJ-48C, RJ-48H and RJ-48M can be made available with additional engineering and construction charges.

Detailed information on physical RJ-48 DS1 and DSX-1 NI configurations may be found in CenturyLink Technical Publication 77375.

3.2.2 10Base-T Interface

Point-to-point 10Base-T Ethernet over STS-1 channels are provided to Carrier's and End-User's (EU's) premises. The Network Interface (NI) will be at a Category 5 Patch Panel with physical layer signal characteristics as described in IEEE 802®.3-2002, *Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*.

Carrier Customers have two options at their premises:

- Carrier Customers may elect to terminate their cables on the CenturyLink Category 5 Patch Panel in the space provided for CenturyLink's transmission equipment.
- Have CenturyLink terminate CenturyLink cable on the Carrier's Category 5 Patch Panel located in the Carrier's workspace.

The NI to an EU customer will be at a Registration Jack, RJ-45 connector receptacle on a CenturyLink-provided Category 5 Patch Panel. Chapter 4 provides further information on SHNS Ethernet Network Interfaces including RJ-45 pinouts.

At the discretion of CenturyLink, 10Base-T Ethernet interfaces may be cross-connected in the Central Office via a fiber optic interface.

3.2.3 DS3 Interface

DS3 channel services terminate at NIs located at the premises of a Carrier or End-User (EU).

The Network Interface to a Carrier Customer will be at the DSX-3 cross connect panel with signal characteristics described in CenturyLink Technical Publication 77324.

Carrier Customers have two options at their premises:

- Carrier Customers may elect to terminate their cables on the CenturyLink DSX-3 cross-connect panel in the space provided for CenturyLink's transmission equipment.
- Have CenturyLink terminate CenturyLink cable on the Carrier's DSX-3 cross-connect panel located in the Carrier's workspace.

The NI to an EU customer will be SJA-44 connectors with signal characteristics described in CenturyLink Technical Publication 77324.

3.2.4 STS-1 Interface

STS-1 channel services terminate at NIs located at the premises of a Carrier or End-User.

For the DS1 multiplexing option, the STS-1 must be comprised of a bulk-mapped DS3 or be Virtual Tributary (VT) structured, containing 28 VT1.5's. Since there presently are no available VT1.5 interfaced service offerings, each VT1.5 (1.728 Mbit/ s) shall have a DS1 payload mapped into it. The signal mappings shall

conform to ANSI T1.105, *Synchronous Optical Network (SONET) – Basic Description including Multiplex Structure, Rates, and Formats* and Telcordia GR-253-CORE, *Synchronous Optical Network (SONET) Transport Systems: Common Criteria*.

The STS-1 interface at an end user's premises will be an SJA 44 connector interface, delivered from CenturyLink-owned Line Terminating Equipment (LTE). The STS-1 interface at a Carrier premises will be at a cross-connect panel dedicated for STS-1 use. The signal characteristics shall conform to those described in ANSI T1.102, *Digital Hierarchy – Electrical Interfaces* and Telcordia GR-253-CORE.

As with DS3 Service, Carrier Customers have two options at their premises:

- Terminate their cables on the CenturyLink cross-connect panel in the space provided for CenturyLink's transmission equipment.
- Have CenturyLink terminate CenturyLink's cable on the Carrier's cross-connect panel located in the Carrier's workspace.

3.2.5 100Base-TX, 100Base-LX10 and 100Base-FX Interfaces

Point-to-point 100Base-TX, 100Base-LX10and 100Base-FX Fast Ethernet over STS-1-1v, STS-1-2v or STS-3c-1v transport channels are provided to Carrier's and End-User's (EU's) premises. With 100Base-TX, the Network Interface (NI) will be at a Category 5 Patch Panel.

Carrier Customers have two options at their premises:

- Carrier Customers may elect to terminate their cables on the CenturyLink Category 5 Patch Panel in the space provided for CenturyLink's transmission equipment.
- Have CenturyLink terminate CenturyLink cable on the Carrier's Category 5 Patch Panel located in the Carrier's workspace.

The NI to an EU customer will be at a Registration Jack, RJ-45 connector receptacle on a CenturyLink-provided Category 5 Patch Panel. Chapter 4 provides further information on SHNS Ethernet Network Interfaces including RJ-45 pinouts.

With optical Fast Ethernet, the NI for all customers will be at a CenturyLink-provided Fiber Distribution Panel (FDP) designed to terminate 1310 nm Single-Mode Fiber for 100Base-LX10 (ex-100Base-FX over Single-Mode fiber) and1310 nm Multi-Mode Fiber for 100Base-FX interfaces via SC, FC or LC (at customer premises locations) UPC connectors. 100Base-FX Network Interfaces are available at customer premises locations only and not in CenturyLink COs. The physical layer signal characteristics will be as described in IEEE 802.3-2008.

3.2.6 OC-3 Interface

The OC-3 interface provides a high capacity channel for the transmission of 155.52 Mbit/ s, utilizing an optical interface, delivered from CenturyLink-owned Line Terminating Equipment. Additional information pertaining to the OC-3 Interface may be found in CenturyLink Technical Publication 77346, *CenturyLink Synchronous Service Transport.*

3.2.7 OC-12 Interface

The OC-12 interface provides a high capacity channel for the transmission of 622.08 Mbit/ s, using an optical interface, delivered from CenturyLink-owned Line Terminating Equipment. Additional information pertaining to the OC-12 Interface may be found in CenturyLink Technical Publication 77346.

3.2.8 1000Base-LX, 1000Base-ZX and 1000Base-SX Interfaces

Point-to-point 1000Base-LX, 1000Base-ZX and 1000Base-SX Gigabit Ethernet over STS-1-1v, STS-1-2v, STS-3c-1v, STS-3c-2v, STS-1-9v, STS-3c-3v, STS-1-12v, STS-3c-4v, STS-1-21v or STS-3c-7v channels are provided to Carrier's and End-User's (EU's) premises. The NI for all customers will be at a CenturyLink-provided Fiber Distribution Panel (FDP) designed to terminate 1310 nm Single-Mode Fiber for 1000Base-LX, 1550 nm Single-Mode Fiber for 1000Base-ZX and 850 nm Multi-Mode Fiber for 1000Base-SX Gigabit Ethernet optical interfaces via SC, FC or LC (at customer premises locations) UPC connectors. 1000Base-SX Network Interfaces are available at customer premises locations only and not in CenturyLink COs. The physical layer signal characteristics will be as described in IEEE 802.3-2008. Chapter 4 provides further information on SHNS Ethernet Network Interfaces.

3.2.9 OC-48 Interface

The OC-48 interface provides a high capacity channel for the transmission of 2.488 Gbit/ s, using an optical interface, delivered from CenturyLink-owned Line Terminating Equipment. Additional information pertaining to the OC-48 Interface may be found in CenturyLink Technical Publication 77346.

3.3 STS Concatenation

Multiples of Synchronous Transport Signal level 1 (STS-1) rates are needed for Super-Rate services that require greater bandwidth. Super-Rate services can include Broadband Integrated Services Digital Network (B-ISDN) channels, or Asynchronous Transfer Mode (ATM) service. To provide Super-Rate services, the bandwidth of N STS-1's are linked (concatenated) to create an individual STS-Nc circuit of a greater bandwidth. The STS-Nc can be transported by an OC-N (or higher level) SONET signal.

CenturyLink currently offers the customer Network Interfaces listed below that are capable of carrying an STS-Nc payload, which will be provided using equipment that meets technical and operational requirements specified in GR-253-CORE, *Synchronous Optical Network (SONET) Transport Systems: Common Criteria*.

- OC-3 Network Interface - One STS-3c can be transported on an OC-3.
- OC-12 Network Interface - One STS-12c can be transported on an OC-12.
- OC-48 Network Interface - One STS-48c can be transported on an OC-48.

For further information on SHNS STS concatenation options, see Section 2.2.2.

3.4 Performance Monitoring and Remote Reconfiguration

These functions are available to the customer via a customer provided terminal. The terminal will be connected to the transport equipment through an interface that meets the applicable requirements and specifications. The customer must also provide the interface cable that connects the terminal to the PM interface.

3.5 NC and NCI Codes

Network Channel (NC) and Network Channel Interface (NCI) codes convey service and technical parameters. The following sections explain the codes in a general manner and provide code combinations to aid in ordering the CenturyLink network interface for Self Healing Network Services. The NC and NCI codes are provided by the customer to the CenturyLink Service Representative at the time a request for service is initiated.

Additional information concerning NC/ NCI Codes is available in ANSI T1.223, *Structure and representation of Network Channel (NC) and Network Channel Interface (NCI) codes for North American Telecommunications System*. See Chapter 8 for ordering information.

In some instances, CenturyLink offerings differ from those described by Telcordia in their published Industry Support Interface, SR-307, *COMMON LANGUAGE NC/NCI Dictionary*. Furthermore, definitions of NC and NCI's evolve. Therefore, it is important to request CenturyLink Services as defined in this Publication.

3.6 NCI Code Form and Components

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

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

Digital NCI Codes have four components. Figure 3-1 provides an example of an electrical DS3 interface NCI code. For complete information on DS1, refer to Technical Publication 77375, *1.544 Mbit/s (DS1) Channel Interfaces*. For complete DS3 information, refer to Technical Publication 77324, *CenturyLink DS3 Service*. For complete information on OC-3 and OC-12 optical interfaces, refer to Technical Publication 77346, *CenturyLink Synchronous Service Transport (CenturyLink Synchronous Optical Transport Line Interface).*

The following example, 04DS6.44A, is the DS3 M-frame structured signal. It is an unchannelized application, supporting a user payload of 44.210 Mbit/ s per ANSI T1.107, *Digital Hierarchy – Formats Specifications*. It may or may not use the C-bit parity application per ANSI T1.107.

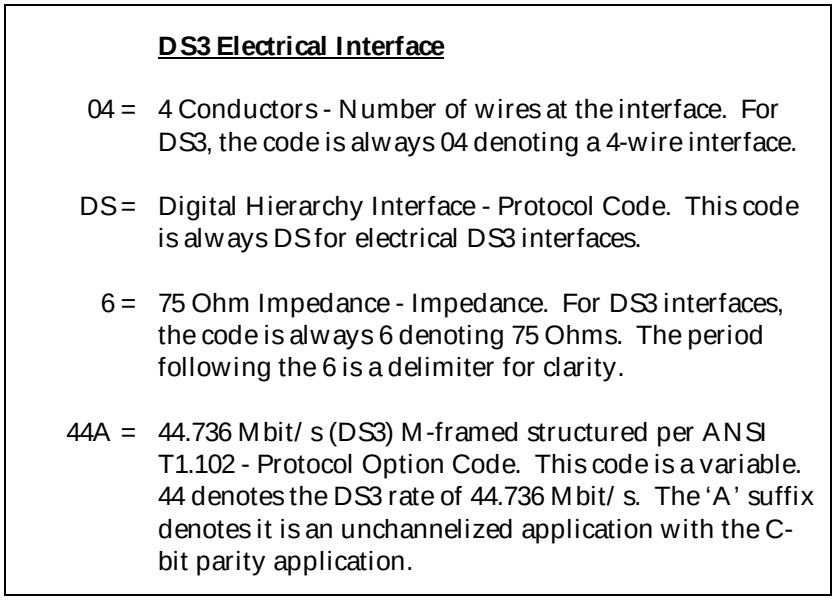

Figure 3-1 Electrical DS3 NCI Code Example

3.7 Network Channel Interface (NCI) Codes and Combinations

The compatible NCI codes for SHNS are listed in the following tables. Some locations may not have all codes available. Check with a CenturyLink representative to determine specific availability.

Table 3-1 Optical Network Channel Interface (NCI) Codes - CenturyLink Self Healing Network Service Ring Capacity - Synchronous (SONET)

NCI CODE	OPTION CenturyLink[1]	OPTION ISI-SR-STS-000307
Ring Description		
02SOF	Digital Fiber Optic: OC-3, OC-12, OC-48 or OC-192	SONET Optical
Low Speed SONET Interface to Ring (from Ring Description above)		
04SOF.B	Digital Fiber Optic interface, LR1-SLM: OC-3, OC-12 or OC-48	LR1-SLM (Long Reach - Single-Longitudinal Mode)
04SOF.D	Digital Fiber Optic interface, IR1-SLM: OC-3, OC-12 or OC-48	IR1-SLM (Intermediate Reach - Single - Longitudinal Mode)
04SOF.F	Digital Fiber Optic interface, SR-SLM: OC-3, OC-12 or OC-48	SR-SLM (Short Reach - Multi - Longitudinal Mode)

Notes:

1. An NC Code is required in addition to the NCI code for the Optical Interface to identify SONET capacities of OC-3, OC-12 or OC-48.
2. All interfaces expect Single Longitudinal Mode Fiber. Multi Mode Fiber (MMF) is not an available interface.
3. Additional information on the SONET optical interface options and NCI Codes may be found in Technical Publication 77346.

Table 3-2 lists the NCI code for CenturyLink Self Healing Service, SONET Next Generation Multiplexer to an OC-3 Ring, from ring description in Table 3-1.

Table 3-2 Configuration Network Channel Interface (NCI) Codes - OC-3 SONET Ring -- Next Generation Multiplexer

NCI Code	DESCRIPTION
One Code must be specified at each Multiplexer Site	
04SSF.	SONET Next Generation Multiplexer Supporting Drops of:
E20	GigE, 100 Mbps Ethernet, STS-1, DS3, DS3 Transmux, 10 Mbps Ethernet, DS1

Table 3-3 lists the NCI code for CenturyLink Self Healing Service, SONET Next Generation Multiplexer to an OC-12 Ring, from ring description in Table 3-1.

Table 3-3 Configuration Network Channel Interface (NCI) Codes - OC-12 SONET Ring -- Next Generation Multiplexer

NCI Code	DESCRIPTION
One Code must be specified at each Multiplexer Site	
04SSF.	SONET Next Generation Multiplexer Supporting Drops of:
E18	GigE, OC-3, 100 Mbps Ethernet, STS-1, DS3, DS3 Transmux, 10 Mbps Ethernet, DS1

Table 3-4 lists the NCI code for CenturyLink Self Healing Service, SONET Next Generation Multiplexer to an OC-48 Ring, from ring description in Table 3-1.

Table 3-4 Configuration Network Channel Interface (NCI) Codes - OC-48 SONET Ring -- Next Generation Multiplexer

NCI Code	DESCRIPTION
One Code must be specified at each Multiplexer Site	
04SSF.	SONET Next Generation Multiplexer Supporting Drops of:
E19	GigE, OC-12, OC-3, 100 Mbps Ethernet, STS-1, DS3, DS3 Transmux, 10 Mbps Ethernet, DS1

Table 3-5 lists the NCI code for CenturyLink Self Healing Service, SONET Next Generation Multiplexer to an OC-192 Ring, from ring description in Table 3-1.

Table 3-5 Configuration Network Channel Interface (NCI) Codes - OC-192 SONET Ring -- Next Generation Multiplexer

NCI Code	DESCRIPTION
One Code must be specified at each Multiplexer Site	
04SSF.	SONET Next Generation Multiplexer Supporting Drops of:
F14	OC-48, GigE, OC-12, OC-3, 100 Mbps Ethernet, STS-1, DS3, DS3 Transmux, 10 Mbps Ethernet, DS1

Table 3-6 Electrical Network Channel Interface (NCI) Codes
CenturyLink Self Healing Network Service

NCI Code	CenturyLink Self Healing Network Service – Electrical Interfaces DESCRIPTION
	STS-1 Electrical Interface
04ST6.A	STS-1 Synchronous Transmission Signal level 1
	DS3 Electrical Interfaces (See CenturyLink Technical Publication 77324)
04DS6.44	DS3 M-frame structured signal with M23 Multiplex format
04DS6.44R	DS3 M-frame structured signal – unchannelized
04DS6.44A	DS3 M-frame structured signal, C-bit parity – unchannelized
04DS6.44I	DS3 M-frame structured signal with M23 Multiplex format and C-bit parity
	DS1 Electrical Interfaces (See CenturyLink Technical Publication 77375)
04DS9.15	DS1 Carrier or CenturyLink CO Premises Interface, SF with AMI
04DS9.15B	DS1 Carrier or CenturyLink CO Premises Interface, SF with B8ZS
04DS9.15K	DS1 Carrier or CenturyLink CO Premises Interface, non-ANSI ESF with AMI
04DS9.15S	DS1 Carrier or CenturyLink CO Premises Interface, non-ANSI ESF with B8ZS
04DS9.1K	DS1 Carrier or CenturyLink CO Premises Interface, ANSI ESF with AMI
04DS9.1S	DS1 Carrier or CenturyLink CO Premises Interface, ANSI ESF with B8ZS
04DS9.15J	DS1 Carrier or CenturyLink CO Premises Interface, Free Framing with B8ZS
04DU9.AX	DS1 End-User Premises Interface, Free Framing/B8ZS/DSX-1
04DU9.BX	DS1 End-User Premises Interface, SF/AMI/DSX-1 Interface
04DU9.CX	DS1 End-User Premises Interface, non-ANSI ESF/AMI/DSX-1 Interface
04DU9.DX	DS1 End-User Premises Interface, SF with B8ZS/DSX-1 Interface
04DU9.SX	DS1 End-User Premises Interface, non-ANSI ESF/B8ZS/DSX-1 Interface
04DU9.1KX	DS1 End-User Premises Interface, ANSI ESF/AMI/DSX-1 Interface
04DU9.1SX	DS1 End-User Premises Interface, ANSI ESF/B8ZS/DSX-1 Interface

AMI = Bipolar Alternate Mark Inversion line code.

B8ZS = Binary, 8 zero substitution line code.

ESF = Extended Superframe format. ANSI ESF - Format: reference ANSI T1 403,
Non-ANSI ESF - Format: reference AT&T PUB 54016

SF = Superframe format.

Table 3-7 Ethernet Network Channel Interface (NCI) Codes
CenturyLink Self Healing Network Service

NCI Code	CenturyLink Self Healing Network Service – Ethernet Interfaces DESCRIPTION	Network Interface
	Customer Premises	
04LN9.10T	Local Area/Wide Area Network (LAN/WAN) Interface, 100 Ohms, 10Base-T Ethernet Connection	10Base-T
04LN9.1CT	Local Area/Wide Area Network (LAN/WAN) Interface, 100 Ohms, 100Base-T Ethernet Connection	100Base-TX
02LNF.A02	Local Area/Wide Area Network (LAN/WAN) Interface, 1310 nm, Single-Mode Fiber	100Base-LX10 1000Base-LX
02LNF.A03	Local Area/Wide Area Network (LAN/WAN) Interface, 1550 nm, Single-Mode Fiber	1000Base-ZX
02LNF.A04	Local Area/Wide Area Network (LAN/WAN) Interface, 850 nm, 50 micron Multi-Mode Fiber	1000Base-SX
02LNF.A05	Local Area/Wide Area Network (LAN/WAN) Interface, 1310 nm, 50 micron Multi-mode Fiber	100Base-FX
02LNF.A07	Local Area/Wide Area Network (LAN/WAN) Interface, 850 nm, 62.5 micron Multi-Mode Fiber	1000Base-SX
02LNF.A08	Local Area/Wide Area Network (LAN/WAN) Interface, 1310 nm, 62.5 micron Multi-mode Fiber	100Base-FX
	Central Office	
04QB9.10T	Central Office Manual Cross Connect Termination With No Sub-Rating Capability, 100 Ohms, Ethernet 10Base-T	10Base-T
02QBF.K02	Central Office Manual Cross Connect Termination With No Sub-Rating Capability, Ethernet, 1310 nm, Single-Mode Fiber	100Base-LX10 1000Base-LX
02QBF.K03	Central Office Manual Cross Connect Termination With No Sub-Rating Capability, Ethernet, 1550 nm, Single-Mode Fiber	1000Base-ZX

Note: See CenturyLink Technical Publication 77386 for Central Office Cross-Connect NC and NCI Codes.

3.8 NC Code Function and Format

Primarily, service considerations are encoded into Network Channel (NC) codes. The NC code is an encoded representation used to identify both switched and non-switched channel services. Included in this code set are customer options associated with individual channel services, or feature groups and other switched services. The NC code is specified by the customer to advise CenturyLink of the required service connection of the channel.

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

- For electrical channel DS1 interfaces, the first two characters are HC. For additional information, see *CenturyLink DS1 Service*, Publication 77200.
- For electrical channel DS3 interfaces, the first two characters are HF. For additional information, see Technical Publication 77324.
- For electrical channel STS-1 interfaces, the first two characters are JI.
- For optical channel interfaces, the first two characters are OB (OC-3), OD (OC-12) and OF (OC-48). For additional information, see Technical Publication 77346.

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

The customer must specify NC codes for the desired service when ordering High Capacity Digital Special Access services. This section describes the NC codes that apply specifically to SHNS.

3.9 NC Codes Used with CenturyLink SHNS

Table 3-8 Network Channel (NC) Codes - DS1, DS3 and STS-1 on SHNS

NC CODE	DESCRIPTION
DS1's on CenturyLink's Self Healing Network Service	
HCPS	DS1 Channel, Premium Service, Self Healing Network
HCPQ	DS1 Channel, Premium Service, Self Healing Network with Central Office Multiplexing
DS3's on CenturyLink's Self Healing Network Service	
HFPS	DS3 Channel, Premium Service, Self Healing Network
HFPQ	DS3 Channel, Premium Service, Self Healing Network with Central Office Multiplexing
HF-Q	DS3 Channel, Customer Premises Multiplexing
HFCQ	DS3 Channel, C-BIT Parity, Customer Premises Multiplexing
STS-1's on CenturyLink's Self Healing Network Service	
JI--	STS-1 Channel. Includes unspecified STS-1 mappings and asynchronously mapped DS3
JI-A	STS-1 Channel with an asynchronously mapped DS3 and Central Office Multiplexing to DS1 Services
JI-B	STS-1 Channel with an asynchronously mapped DS3 and Field End Multiplexing to DS1 Services
JIA-	STS-1 Channel, VT1.5 Structured
JIAA	STS-1 Channel, VT1.5 Structured with Central Office Multiplexing to DS1 Services
JIAB	STS-1 Channel, VT1.5 Structured with Field End Multiplexing to DS1 Services

Table 3-9 Network Channel (NC) Codes - Ethernet Transport on SHNS

NC CODE	DESCRIPTION
	Ethernet
KDAP	Ethernet at 10 Mbps, Full Duplex LAN, Protected
KQFM	Rate-Adjustable 100 Mbps Ethernet, Full Duplex - Rate based on SONET Transport, STS-3c-1v, 149.76 Mbps Nominal Payload Rate
KQP	Rate-Adjustable 100 Mbps Ethernet, Protected Full Duplex – Rate based on SONET Transport
C	STS-1-1v, 48.384 Mbps Nominal Payload Rate
D	STS-1-2v, 96.768 Mbps Nominal Payload Rate
KRP	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Protected, Rate based on STS Transport
I	STS-1-9v, 435.46 Mbps Nominal Payload Rate
Y	STS-1-1v, 48.384 Mbps Nominal Payload Rate
KRQ	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Protected, Rate based on STS Transport
O	STS-1-12v, 580.608 Mbps Nominal Payload Rate
U	STS-1-21v, 1016.064 Mbps Nominal Payload Rate
KRS	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on SONET transport level
B	STS-1-2v, 96.768 Mbps Nominal Payload Rate
KRR	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on SONET transport with Hi-Order VCAT
A	STS-3c-1v, 149.76 Mbps Nominal Payload Rate
B	STS-3c-2v, 299.52 Mbps Nominal Payload Rate
C	STS-3c-3v, 449.28 Mbps Nominal Payload Rate
D	STS-3c-4v, 599.04 Mbps Nominal Payload Rate
Q[1]	Protected, STS-3c-7v, 1048.32 Mbps Nominal Payload Rate

Note: Protected = over SHNS SONET transport and applies to all EoS circuits whether explicitly identified in the NC Code or not.

Table 3-10 shows the Ethernet over SONET Network Channel codes with available SHNS transport bandwidth.

Table 3-10 EoS NC Codes and SHNS Transport Bandwidth

Ethernet Port	Transport Bandwidth								
	10 Mbps	**48 Mbps**	**97 Mbps**	**100 Mbps**	**150 Mbps**	**300 Mbps**	**435 or 449 Mbps**	**580 or 599 Mbps**	**1000 Mbps**
10 Mbps	KDAP								
100 Mbps		KQPC	KQPD	KQFM					
1000 Mbps		KRPY	KRSB		KRRA	KRRB	KRPI or KRRC	KRQO or KRRD	KRQU or KRRQ

Note: See Section 5.5.1 for actual customer Ethernet throughput.

Table 3-11 Network Channel (NC) Codes - SONET

NC CODE	DESCRIPTION
SHNS Ring	
OBU-	SONET OC-3 Ring Segment, Uni-Directional
OBUA	SONET OC-3 Ring Segment, Uni-Directional, with Customer Network Management
ODU-	SONET OC-12 Ring Segment, Uni-Directional
ODUA	SONET OC-12 Ring Segment, Uni-Directional, with Customer Network Management
ODV-	SONET OC-12 Ring Segment, Bi-Directional
ODVA	SONET OC-12 Ring Segment, Bi-Directional, with Customer Network Management
OFU-	SONET OC-48 Ring Segment, Uni-Directional
OFUA	SONET OC-48 Ring Segment, Uni-Directional, with Customer Network Management
OFV-	SONET OC-48 Ring Segment, Bi-Directional
OFVA	SONET OC-48 Ring Segment, Bi-Directional, with Customer Network Management
OGU-	SONET OC-192 Ring Segment, Uni-Directional
OGUA	SONET OC-192 Ring Segment, Uni-Directional, with Customer Network Management
OGV-	SONET OC-192 Ring Segment, Bi-Directional
OGVA	SONET OC-192 Ring Segment, Bi-Directional, with Customer Network Management

Notes:

1. Uni-Directional = UPSR
2. Bi-Directional = 2F BLSR

Table 3-11 Network Channel (NC) Codes – SONET (Continued)

NC CODE	DESCRIPTION
Low Speed SONET Interface to Ring	
OBB-	SONET OC-3, External Timing
OB-R	SONET OC-3, STS-3c Payload
OB--	SONET OC-3
OBAQ	SONET OC-3, Point-to-Point, Loop Timing, Termination on a higher bit rate Add-Drop Multiplexer
ODB-	SONET OC-12, External Timing
OD-R	SONET OC-12, STS-12c Payload
OD--	SONET OC-12
ODAQ	SONET OC-12, Point-to-Point, Loop Timing, Termination on a higher bit rate Add-Drop Multiplexer
OFB-	SONET OC-48, External Timing
OF-R	SONET OC-48, STS-48c Payload
OF--	SONET OC-48
OFAQ	SONET OC-48, Point-to-Point, Loop Timing, Termination on a higher bit rate Add-Drop Multiplexer

Note: Terminates at the SONET Optical Terminal, or in the CO on a Fiber Distribution Panel if dropped from a higher rate, ring system. May cross-connect via Central Office Connecting Channel, or through a Connecting Facility Arrangement order to higher rate systems.

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Tables

4. Ethernet Features

4.1 General

- The CenturyLink-provided Next Generation multiservice SONET ADM equipment will encapsulate and adapt the customers' incoming Ethernet frames via a 10Base-T, 100Base-TX/ LX10/ FX or 1000Base-LX/ ZX/ SX Network Interface into a customer-orderable (via NC code) Synchronous Transport Signal (STS)-1-1v, STS-1-2v, STS-3c-1v, STS-3c-2v, STS-1-9v, STS-3c-3v, STS-1-12v, STS-3c-4v, STS-1-21v or STS-3c-7v Synchronous Payload Envelope (SPE).
- Point-to-point, bidirectional, full duplex (only) Ethernet circuits over SONET provide for SHNS Layer 1 protected, low latency packet transport.
- The customers' Ethernet frames will be delivered with the header information/ MAC addresses and frame contents unchanged.
- With GFP-F, the Ethernet Preamble and Start of Frame Delimiter as well as Inter-Packet Gap characters within the customer's Ethernet bit stream will not be transported across the SHNS network.
- Layer 2 (including IEEE 802.1Q VLAN tagged frames) as well as Layer 3 protocols that can be encapsulated and transported over standard Ethernet frames such as IP or IPX, will be tunneled or transparently forwarded across the SONET network. The customer will handle the specific applications with CenturyLink providing a Layer 1 pipe, which is agnostic to the higher levels of customer data being carried.
- This service will support the transport of all standard Ethernet frame sizes up to the IEEE 802.3/ 802.1Q maximum untagged/ VLAN tagged frame size of 1518/ 1522 bytes. In general, jumbo frames up to at least 9000 bytes will also be delivered across the SHNS network.
- The Ethernet interface cards in the SONET ADMs are (0:1) unprotected. Customers desiring further redundancy could order for example, two (or more) parallel, identical data rate, full duplex Ethernet over SONET (EoS) circuits and run Link Aggregation Control Protocol in order to provide line-level redundancy and interface port/ card protection.

4.2 Ethernet Interfaces and SONET Transport Bandwidth Options

Table 4-1 lists the Ethernet interfaces and corresponding SONET transport bandwidth options available on SHNS.

Table 4-1 Available Ethernet Interfaces and SONET Transport Bandwidth Increments[1]

ETHERNET INTERFACE	SONET TRANSPORT CAPACITY			
	OC-3	**OC-12**	**OC-48**	**OC-192**
10Base-T	STS-1-1v	STS-1-1v	STS-1-1v	STS-1-1v
100Base-TX 100Base-LX10 100Base-FX	STS-1-1v	STS-1-1v	STS-1-1v	STS-1-1v
	STS-1-2v	STS-1-2v	STS-1-2v	STS-1-2v
		STS-3c-1v	STS-3c-1v	STS-3c-1v
1000Base-LX[2] 1000Base-ZX 1000Base-SX	STS-1-1v	STS-1-1v	STS-1-1v[3]	STS-1-1v[3]
	STS-1-2v	STS-1-2v	STS-1-2v[3]	STS-1-2v[3]
		STS-3c-1v	STS-3c-1v	STS-3c-1v[3]
		STS-3c-2v	STS-3c-2v	STS-3c-2v[3]
		STS-1-9v or STS-3c-3v	STS-1-9v or STS-3c-3v	STS-1-9v[3] or STS-3c-3v[3]
			STS-1-12v or STS-3c-4v	STS-1-12v or STS-3c-4v
			STS-1-21v or STS-3c-7v	STS-1-21v or STS-3c-7v

Notes:

1. Per Ethernet port, where each port or customer Network Interface maps to a unique dedicated point-to-point STS circuit
2. Over Single-Mode Fiber
3. There is a maximum of 20 Gigabit Ethernet ports per SHNS Node.

The customer may order either an identical speed physical Ethernet interface at both ends of an EoS circuit, which will be delivered from CenturyLink-owned Next Generation SONET ADM/ DCS, or an Ethernet over SONET (EoS) virtual interface at one end of the service with a CenturyLink-provided Ethernet interface at the other.

In general, EoS interfaces or Ethernet virtual OC-M/ N ports will require far-end destination Customer-Provided SONET Path Terminating Equipment with matching encapsulation type, framing mode, Frame Check Sequence/ Cyclic Redundancy Check size, Contiguous or Virtual Concatenation Group (VCG) Synchronous Payload Envelope mappings, multi-frame STS Path Overhead usage (H4 bytes) for High Order VCG indicators & control messages (if/ where applicable) and Ethernet link integrity (Automatic Laser Shutdown/ Loss of Carrier) implementations. While CenturyLink will deploy ITU-T G.7041/ Y.1303 standards based GFP-F, where available it's important to note that other of these EoS interface attributes may be vendor specific and impact Customer-Provided Equipment (CPE) termination of an Ethernet circuit.

The Ethernet over SONET SPE or VCAT Group encapsulation and framing standard protocols associated with the CenturyLink Next Generation SONET ADM/ DCS are listed in the EoS Network Interface disclosure available at: http/ / www.CenturyLink.com/ disclosures/ netdisclosure478.html.

It is the customer's responsibility to provide equipment which is compatible with any SHNS Network Interfaces, and should work with CenturyLink to appropriately option and ensure a successful end-to-end Ethernet transport service.

Table 4-2 indicates the Synchronous Payload Envelope (SPE) capacity or maximum SONET bandwidth available for transport of customer Ethernet frames per Ethernet over SHNS circuit, including that required for encapsulation and framing.

Table 4-2 EoS Payload Mapping Capacities

SPE Mapping Increment	Payload Capacity
STS-1	48.38 Mbps
STS-1-2v	96.76 Mbps
STS-3c-1v	149.76 Mbps
STS-3c-2v	299.52 Mbps
STS-1-9v	435.46 Mbps
STS-3c-3v	449.28 Mbps
STS-1-12v	580.608 Mbps
STS-3c-4v	599.04 Mbps
STS-1-21v	1.016 Gbps
STS-3c-7v	1.048 Gbps

Note: Where required, STS-3c-Xv mappings may be provided by CenturyLink using the equivalent, but slightly lower payload capacity STS-1-Xv increments.

Table 4-3 Ethernet Interface Details

Interface	Data Rate	Transport Bandwidth	Mode	Impedance or Central Wavelength	Cable or Fiber Type	Modal Bandwidth (MHz/km)	Maximum Distance[1]	Connector
10Base-T	10 Mbps	STS-1-1v	Full Duplex	100 ohms	Two pairs of twisted-pair telephone or Category 3, 4 or 5/5E (recommended[2]) copper wire	NA	100 m (328 ft)	RJ-45
100Base-TX	100 Mbps	STS-1-1v STS-1-2v STS-3c-1v	Full Duplex	100 ohms	Two pairs of Category 5/5E Unshielded Twisted-Pair (UTP) or Shielded Twisted-Pair (STP) copper wire	NA	100 m (328 ft)	RJ-45
100Base-LX10	100 Mbps[3]	STS-1-1v STS-1-2v STS-3c-1v	Full Duplex	1310 nm	One pair of Single-Mode Fiber	NA	10 km (6.2 mi)	Duplex SC, FC or LC UPC[4]
100Base-FX[5]	100 Mbps[3]	STS-1-1v STS-1-2v STS-3c-1v	Full Duplex	1310 nm	One pair of 50 micron Multi-Mode Fiber	500	2 km (1.2 mi)	Duplex SC, FC or LC UPC[4]
					One pair of 62.5 micron Multi-Mode Fiber	200		

Table 4-3 Ethernet Interface Details (Continued)

Interface	Data Rate	Transport Bandwidth	Mode	Impedance or Central Wavelength	Cable or Fiber Type	Modal Bandwidth (MHz/km)	Maximum Distance[1]	Connector
1000Base-LX	1000 Mbps[3]	STS-1-1v STS-1-2v STS-3c-1v STS-3c-2v STS-1-9v STS-3c-3v STS-1-12v STS-3c-4v STS-1-21v STS-3c-7v	Full Duplex	1310 nm	One pair of Single-Mode Fiber	NA	5 km[6] (3.1 mi)	Duplex SC, FC or LC UPC[4]
1000Base-ZX	1000 Mbps[3]	STS-1-1v STS-1-2v STS-3c-1v STS-3c-2v STS-1-9v STS-3c-3v STS-1-12v STS-3c-4v STS-1-21v STS-3c-7v	Full Duplex	1550 nm	One pair of Single-Mode Fiber	NA	70 km (43.5 mi)	Duplex SC, FC or LC UPC[4]

Table 4-3 Ethernet Interface Details (Continued)

Interface	Data Rate	Transport Bandwidth	Mode	Impedance or Central Wavelength	Cable or Fiber Type	Modal Bandwidth (MHz/km)	Maximum Distance[1]	Connector
1000Base-SX[5]	1000 Mbps[3]	STS-1-1v STS-1-2v STS-3c-1v STS-3c-2v STS-1-9v STS-3c-3v STS-1-12v STS-3c-4v STS-1-21v STS-3c-7v	Full Duplex	850 nm	One pair of 50 micron Multi-Mode Fiber	400	500 m (1,640 ft)	Duplex SC, FC or LC UPC[4]
						500	550 m (1,804 ft)	
					One pair of 62.5 micron Multi-Mode Fiber	160	220 m (722 ft)	
						200	275 m (902 ft)	

Table 4-3 Notes:

1. Including CenturyLink cable from the SHNS Ethernet port to customer Network Interface
2. Although the customer may use Category 3, 4 or 5 copper wire when connecting to 10Base-T ports, CenturyLink will use Category 5E balanced copper cabling from the SHNS Ethernet port to the Category 5 Patch Panel NI for all electrical Ethernet interfaces.
3. While the data rate for 100Base-LX10/FX and 1000Base- LX/ZX/SX Network Interfaces is 100 and 1000Mbps respectively, the actual signaling rate is 125 and 1250 Mbps.
4. FC and LC connectors are not an available customer option in CenturyLink COs.
5. 100Base-FX or 1000Base-SX User-Network Interfaces are not an available customer option in CenturyLink COs.
6. The guaranteed maximum distance is as specified in the IEEE 802.3-2008 standard, although most 1000Base-LX Gigabit Ethernet Interface Converter (GBIC) or Small Form-factor Pluggable (SFP) modules have a higher optical quality allowing a reach of up to 10 kilometers (6.2 miles) over 1310 nm Single-Mode Fiber. See Table 3-1 for the minimum interface power level.
7. In general, Auto-negotiation will be enabled along with flow control (for subrates) at the customer Network Interface. Without flow control, packet loss can occur if the input customer traffic data rate is higher than the available bandwidth of the STS circuit for an extended period of time or when the buffer memory on the Ethernet port exceeds capacity.
8. Single-Mode Fiber is 9 or 10/125 µm and shall meet the requirements in GR-20-CORE, *Generic Requirements for Optical Fiber and Optical Fiber Cable* and ITU-T Recommendation G.652, *Characteristics of a single-mode optical fibre and cable*.
9. Multimode fiber is either or 50 or 62.5/125 µm and shall meet the requirements in GR-20-CORE, ANSI/TIA-492AAAB-A-2009, *Detail Specification for 50-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers* and ANSI/TIA-492AAAA-B-2009, *Detail Specification for 62.5-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers*.
10. Customer Network Interfaces shall meet the electrical, optical, mechanical and environmental performance requirements of ISO/IEC 11801: 2002+A1:2008, *Information technology - Generic cabling for customer premises*.
11. nm = nanometer
12. UPC = Ultra Physical Contact

4.3 Connecting to 10Base-T and 100Base-TX Network Interfaces

The CenturyLink SHNS 10/ 100 Mbps electrical interfaces use standard RJ-45 connectors at the Network Interface (NI). Table 4-4 shows the pinouts.

Table 4-4 10/ 100 Mbps Electrical NI RJ-45 Pinouts

Pin	Assignment/Label
1	TX/TP0+
2	TX/TP0-
3	RX/TP1+
6	RX/TP1-

CenturyLink will always use a straight-through cable to connect to the Category 5 Patch Panel for electrical Ethernet NIs and the customer will use either a straight-through or crossover cable depending upon the equipment they are connecting to the NI. For connecting to servers, workstations and routers a straight-through cable is required, and for switch connections a crossover cable is required. The NI associated with CenturyLink Self Healing Network Service for LAN interconnection will not provide the repeater functionality as described in IEEE 802.3-2008.

When connecting to 10Base-T and 100Base-TX compatible devices, the customer will use a two twisted-pair cable. Table 4-5 shows the two twisted-pair, straight-through cable and Table 4-6 shows the two twisted-pair, crossover cable RJ-45 connections at the NI.

Table 4-5 Two Twisted-Pair Straight-Through Cable RJ-45 Connections for 10/ 100 Mbps Electrical NIs

RJ-45	RJ-45
1 RD+	1 TD+
2 RD–	2 TD–
3 TD+	3 RD+
6 TD–	6 RD–

Table 4-6 Two Twisted-Pair Crossover Cable RJ-45 Connections for 10/ 100 Mbps Electrical NIs

RJ-45	RJ-45
1 RD+	3 TD+
2 RD–	6 TD–
3 TD+	1 RD+
6 TD–	2 RD–

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Tables

5. Performance Specifications

5.1 Error Performance Parameters

Error performance parameters are:

5.1.1 Background Block Error (BBE)

An errored block is not occurring as part of an SES.

5.1.2 Background Block Error Ratio (BBER)

The ratio of Background Block Errors (BBE) to total blocks in available time during a fixed measurement interval. No blocks that occur during an SES shall be used for the computation of BBER.

5.1.3 Block

A block is a set of consecutive bits associated with the connection; each bit belongs to one and only one block.

The following block sizes are applied in assessing SONET performance.

Table 5-1 SONET Block Sizes

Rate	51.84 Mbit/s (STS-1)	155.52 Mbit/s (STS-3c)	622.08 Mbit/s (STS-12c)	2.488 Gbit/s (STS-48c)	9.865 Gbit/s (STS-192c)
Bits/block	6,264	18,792	75,168	300,672	1,202,688

The block size corresponds to the number of bits in 125 microseconds for the SONET path (equivalent to synchronous payload envelope (SPE)); 50.112 Mbit/ s, 150.336 Mbit/ s, 601.344 Mbit/ s, 2.405 Gbit/ s and 9.622 for STS-1, STS-3c, STS-12c, STS-48c and STS-192c paths respectively. Performance objectives apply at these rates to the SONET path that is not constrained to a particular physical signal type (i.e., objectives apply for electrical (STS-n) or optical (OC-n) signals).

5.1.4 Bit Error Ratio (BER)

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

5.1.5 Errored Second (ES)

An Errored Second is any one-second interval containing at least one error.

5.1.6 Severely Errored Second DS1/DS3 (SES)

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

Note: A period of loss of signal shall be considered a period of errored bits.

5.1.7 Severely Errored Second STS-n (SES)

A one-second period that contains $\geq$ 30% errored blocks or at least one severely disturbed period.

A severely disturbed period occurs when, over a period of time equivalent to 1 ms, all the contiguous blocks are affected by a high bit error density.

Note: A period of loss of signal or a bit error density of $\geq 10^{-2}$ shall be considered a period of errored blocks with high bit error density. It is not required to verify this BER by an actual in-service or out-of-service measurement. SONET overhead capabilities will indicate the condition of the STS-n.

5.1.8 Percent Errored Seconds (% ES)

100 X the ratio of ES to the total seconds in available time during a fixed measurement period.

5.1.9 Percent Severely Errored Seconds (% SES)

100 X the ratio of SES to the total seconds in available time during a fixed measurement period.

5.2 Error Performance

Objectives given in this section are for all one-way system options and apply at the maximum short-haul design length.

For systems interfacing at the DS1 level, the long-term percentage of Errored Seconds (measured at the DS1 rate) shall not exceed 0.14%. This is equivalent to 99.86% Error Free Seconds. This requirement applies in a normal operating environment *and is also an acceptance criterion.* It is equivalent to not more than 10 Errored Seconds during a 2-hour, one-way (loopback) test.

For end-to-end systems interfacing at the DS3 level, the long-term percentage of Errored Seconds (measured at the DS3 rate) shall not exceed 1.0%. This is equivalent to 99.0% Error Free Seconds (EFS). These requirements apply in a normal operating environment, and *are also an acceptance criterion*. An EFS measure of 99.0% is equivalent to not more than 72 Errored Seconds during a 2-hour, one-way (loopback) test. Access DS3 systems shall meet or exceed 99.5% EFS.

For systems interfacing at the STS-n performance objectives are stated in terms of the parameters provided in Table 5-2. Accuracy performance should be evaluated relative to a measurement period of 30 days or more. As determination of compliance with the performance objectives would require excessively long test periods, the objectives are also used in deriving timed test limits. Background Block Error Ratio (BBER), Percent Errored Second (% ES), and Percent Severely Errored Second (% SES) characterize the transmission quality of the service.

The long term accuracy objectives are expressed as a ratio (or percentage) because they apply over long periods of time.

Table 5-2 STS-n Long-Term Accuracy Objectives

PARAMETER	51.84 Mbit/s (STS-1)	155.52 Mbit/s (STS-3c)	622.08 Mbit/s (STS-12c)	2.488 Gbit/s (STS-48c)
BBER	(NOTE 1)	(NOTE 1)	10^{-5}	10^{-5}
% ES	0.25	0.5	(NOTE 2)	(NOTE 2)
% SES	0.035	0.035	0.035	0.035

NOTE 1: BBER is only specified for rates above 160 Mbit/ s.

NOTE 2: Due to the lack of information on the performance of paths operating above 160 Mbit/ s, no % ES objectives are recommended at this time. Nevertheless, ES processing should be implemented within any error performance measuring device operating at these rates for maintenance or monitoring purposes (including SONET section and line layer monitoring).

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

5.3 Service Availability

Availability requirement for SHNS is 99.99 percent minimum. The service is available when it is in a state where it is fully useable. 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.

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 an SES.

Each direction of 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.

STS-n availability objectives are stated in terms of the parameter in Table 5-3. Percent (%) Availability, the same as applies to DS1 and DS3 services, characterize usability of STS-n services over time.

Table 5-3 STS-n Availability Objectives

PARAMETER	51.84 Mbit/s (STS-1)	155.52 Mbit/s (STS-3c)	622.08 Mbit/s (STS-12c)	2488 Gbit/s (STS-48c)	9.865 Gbit/s (STS-192c)
% Service Availability (Monthly)	99.99	99.99	99.99	99.99	99.99

Availability requirement of 99.99% applies only to SHNS. For channels connecting to the Network at Central Office (CO) Hub nodes, the standard availability requirement will apply for the portion of the circuit not on the Self Healing Network.

5.4 Jitter Performance

5.4.1 Definition of Timing Jitter

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

5.4.2 Timing Jitter Specifications - Electrical Interfaces

The limits given in Telcordia Technical Reference GR-499-CORE, *Transport Systems Generic Requirements (TSGR): Common Requirements*, represent the maximum permissible levels of output jitter for Carrier-to-Carrier Network Interfaces. Carrier-to-End-User (EU) Network Interface jitter requirements are addressed in ANSI T1.403, *Network and Customer Installation Interfaces – DS1 Electrical Interface;* ANSI T1.404, *Network and Customer Installation Interfaces – DS3 Metallic Interface Specification* and ANSI T1.105.03, *Synchronous Optical Network (SONET) - Jitter and Wander at Network and Equipment Interfaces*. The purpose of these limits is to limit broadband jitter appearing anywhere in the CenturyLink Network.

5.4.3 Timing Jitter Specifications - Optical Interfaces

Optical interface jitter performance will follow the standards as stated in ANSI T1.105.03, *Synchronous Optical Network (SONET) - Jitter and Wander at Network and Equipment Interfaces;* GR-253-CORE, *Synchronous Optical Network (SONET) Transport Systems: Common Criteria* and GR-499-CORE, *Transport Systems Generic Requirements (TSGR): Common Requirements*.

5.5 Ethernet Performance

For Ethernet over SONET (EoS) circuits on SHNS, the following additional performance parameters will apply. It's recommended that customers rate limit or shape their traffic to the subscribed STS capacity before transmission to CenturyLink otherwise increased latency or packet loss may occur.

5.5.1 Throughput

The customer-orderable EoS transport bandwidth is a physical layer limit on the rate at which the customer's Ethernet frames can traverse the SONET network and represents the STS payload capacity available for customer data including that required for encapsulation and framing protocols. The SHNS Ethernet throughput objectives for 10Base-T, 100Base-TX/ LX10/ FX and 1000Base-LX/ ZX/ SX are shown in Table 5-4 as a function of the STS mapping increment as well as incoming untagged MAC frame size (and would be adjusted accordingly if the customer has inserted any VLAN tags). The throughput was derived using GFP-F and is based on the maximum MAC bit rate after removal of the 12-byte Inter-Packet Gap (IPG), 7-byte Preamble and 1-byte Start of Frame Delimiter fields (which are subsequently restored by the GFP terminating node) relative to the SPE capacity with 8 bytes of overhead per frame. See ITU-T G.7041/ Y.1303, *Generic framing procedure (GFP)* Appendix W – Bandwidth requirements for Ethernet transport for further information. Where required, STS-3c-Xv mappings may be provided by CenturyLink using the equivalent, but slightly lower payload capacity STS-1-Xv increments.

Table 5-4 Ethernet Throughput Objectives

ETHERNET INTERFACE	SPE Mapping Increment	Payload Capacity	MAC Frame Size (bytes)	Maximum Throughput
10Base-T	STS-1-1v	48.38 Mbps	All	100%
100Base-TX; 100Base-LX10; 100Base-FX	STS-1-1v	48.38 Mbps	64	56.4%
			128	52.7%
			256	50.6%
			512	49.5%
			1,024	48.9%
			1,518	48.8%
			9,000	48.4%
	STS-1-2v	96.76 Mbps	64	100.0%
			128	100.0%
			256	100.0%
			512	99.0%
			1,024	97.9%
			1,518	97.5%
			9,000	96.9%
	STS-3c-1v	149.76 Mbps	All	100%

Table 5-4 Ethernet Throughput Objectives (Continued)

ETHERNET INTERFACE	SPE Mapping Increment	Payload Capacity	MAC Frame Size (bytes)	Maximum Throughput
1000Base-LX; 1000Base-ZX; 1000Base-SX	STS-1-1v	48.38 Mbps	64	5.6%
			128	5.3%
			256	5.1%
			512	5.0%
			1,024	4.9%
			1,518	4.9%
			9,000	4.8%
	STS-1-2v	96.76 Mbps	64	11.3%
			128	10.5%
			256	10.1%
			512	9.9%
			1,024	9.8%
			1,518	9.8%
			9,000	9.7%
	STS-3c-1v	149.76 Mbps	64	17.5%
			128	16.3%
			256	15.7%
			512	15.3%
			1,024	15.2%
			1,518	15.1%
			9,000	15.0%
	STS-3c-2v	299.52 Mbps	64	34.9%
			128	32.6%
			256	31.3%
			512	30.6%
			1,024	30.3%
			1,518	30.2%
			9,000	30.0%

Table 5-4 Ethernet Throughput Objectives (Continued)

ETHERNET INTERFACE	SPE Mapping Increment	Payload Capacity	MAC Frame Size (bytes)	Maximum Throughput
1000Base-LX; 1000Base-ZX; 1000Base-SX	STS-1-9v	435.46 Mbps	64	50.8%
			128	47.4%
			256	45.5%
			512	44.6%
			1,024	44.1%
			1,518	43.9%
			9,000	43.6%
	STS-3c-3v	449.28 Mbps	64	52.4%
			128	48.9%
			256	47.0%
			512	46.0%
			1,024	45.5%
			1,518	45.3%
			9,000	45.0%
	STS-1-12v	580.608 Mbps	64	67.7%
			128	63.2%
			256	60.6%
			512	59.4%
			1,024	58.7%
			1,518	58.5%
			9,000	58.1%
	STS-3c-4v	599.04 Mbps	64	69.9%
			128	65.2%
			256	62.6%
			512	61.3%
			1,024	60.6%
			1,518	60.4%
			9,000	60.0%
	STS-1-21v	1.016 Gbps	All	100%
	STS-3c-7v	1.048 Gbps	All	100%

5.5.2 Latency

Latency or delay is defined as the time interval between the transmission of a signal at one point and the reception or detection of the same signal at another point. Unidirectional or One-Way Delay (OWD) is the elapsed time between when a node sends a packet and when the packet is received by another node. OWD is also referred to as end-to-end transit delay.

For store-and-forward devices including CenturyLink Self Healing Network Service with EoS Layer 1 transport using GFP-F, the one-way delay is the time measured between when the first bit of a customer Ethernet frame enters the ingress Network Interface to when the last bit of the same frame leaves the egress Network Interface. The latency performance objective across a single SHNS network will be as indicated in Table 5-5.

Table 5-5 SHNS Ethernet Latency

Performance Parameter	Objective
Latency (one-way)	Less than 5 milliseconds

The EoS latency applies to all supported Ethernet interfaces, STS transport bandwidth increments, frame sizes, alternate fiber routes and represents the total delay attributable to the CenturyLink SHNS network. As diverse or Split Routing of the VCAT Group members is not supported, the latency objective does not include that for Differential Delay.

5.5.3 Packet Loss

The packet or frame loss performance parameter identifies the percentage of in-profile Ethernet frames not reliably delivered between Network Interfaces (NIs) over a given measurement interval. Specifically, over any calendar month the CenturyLink SHNS network will successfully deliver at least 99.99% of a customer's packets from NI to NI.

Any customer frames that are out-of-profile may be blocked or discarded at the Network Interface and will not be counted towards the packet loss objective such as:

- Exceeding the customer-ordered EoS transport bandwidth
- Frame sizes less than 64 bytes
- Jumbo frames (see Section 4.1)
- Corrupted frames with Cyclic Redundancy Check (CRC), Frame Check Sequence (FCS) or alignment errors

5.6 Protection Switching

Automatic protection switching improves the availability and reliability performance of CenturyLink Self Healing Network Service by substituting standby equipment or alternate channels when failure occurs.

The protection switch will operate and switch the DS1, DS3, STS-1, OC-3, OC-12 or OC-48 channel to the protection system when the BER on the transport system exceeds 1 X 10^{-6} and operates at that BER for 10 consecutive seconds or longer.

Once a decision is made to switch to a protection system, the additional time required to complete the switch will not exceed 50 milliseconds. (If the Remote Reconfiguration Option is chosen, the switching time may be longer and result in a possible temporary service interruption.)

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6. Maintenance

6.1 Customer Responsibilities

Customers are responsible for all equipment and cable on the customer side of the Network Interface (NI) at their locations.

Customers or their responsible agent shall sectionalize the trouble and verify that the trouble is not in the customer-owned equipment or cable before calling the CenturyLink Customer Service Center.

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

Joint testing between the customer locations and a CenturyLink Wire Center may sometimes be necessary to isolate the trouble.

6.2 CenturyLink Responsibilities

CenturyLink is responsible for all equipment and cable on the CenturyLink side of the NI at the customer premises.

CenturyLink is responsible for maintaining the transmission facility between customer locations and between the Wire Center Hub and the customer locations.

CenturyLink will furnish the customer a trouble reporting telephone number.

Upon receipt of a trouble report, CenturyLink Corporation will initiate action within twenty minutes to clear the trouble. Trouble reports include autonomous, CenturyLink, system generated reports.

Note: For customers who choose to order off-net services in conjunction with SHNS at Central Office Hub Nodes via a single service order, the CenturyLink response time for the end-to-end (on-net <--> off-net) circuit will be as specified above.

CenturyLink is committed to 30 minute restoral in the event of a service interruption on Self Healing Network Services with the following two exceptions:

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

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7. Definitions

7.1 Acronyms

ANSI	American National Standards Institute
BBER	Background Block Error Ratio
BER	Bit Error Ratio
Cat-5	Category 5 balanced cable
CECO	Civil Enforcement Consent Order
CFA	Connecting Facility Arrangement
CLLI	COMMON LANGUAGE Location Identification
CO	Central Office
COCC	Central Office Connecting Channel
CPE	Customer Provided Equipment
CSS	Controlled Slip Seconds
CV	Coding Violations
DS1	Digital Signal Level 1 (1.544 Mbit/s)
DS3	Digital Signal Level 3 (44.736 Mbit/s)
EC	Exchange Carrier
EDIMS	Electronic Documentation Information Management System
EoS	Ethernet-over-SONET
ES	Errored Seconds
ESP	Enhanced Service Provider
EU	End-User
FC	Fiber Connector
FCC	Federal Communications Commission
FDP	Fiber Distribution Panel
GBIC	Gigabit Interface Converter
Gbit/s	Gigabits per second
IC	Interexchange Carrier
IEEE	Institute for Electrical and Electronic Engineers
IP	Internet Protocol
IPX	Internetwork Packet Exchange

IR1	Intermediate Reach
ISO/ IEC	International Organization for Standardization/ International Electrotechnical Commission
ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
LAN	Local Area Network
LATA	Local Access and Transport Area
LC	Lucent or Local Connector
LR1	Long Reach
LTE	Line Terminating Equipment
Mbit/ s	Megabits per Second
MFJ	Modification of Final Judgment
MMF	Multi-Mode Fiber
NC	Network Channel
NCI	Network Channel Interface
NI	Network Interface
OC-n	Optical Carrier level n. The optical counter part of STS-n. It is the direct optical conversion of an STS-n after frame synchronous scrambling.
ONA	Open Network Architecture
OSIRM	Open Systems Interconnect Reference Model
OWD	One-Way Delay
PV	Path Coding Violations
SC	Subscriber Connector
SEFS	Severely Errored Frame Seconds
SHNS	Self Healing Network Service
SIE	Short Interruption Event
SIEC	Short Interruption Event Count
SLM	Single Longitudinal Mode
SMF	Single-Mode Fiber
SONET	Synchronous Optical NET-work
STP	Shielded Twisted-Pair
STS-1	Synchronous Transport Signal level 1 (51.840 Mbit/ s)

STS-n	Synchronous Transport Signal level n. Integer multiple of an STS-1 signal. It is the rate of an STS-n is equal to n times the rate of an STS-1.
TAG	Technical Advisory Group
TIA/ EIA	Telecommunications Industry Association/ Electronic Industries Alliance
TOC	Table of Contents
µm	Micron
UPC	Ultra Physical Contact
UTP	Unshielded Twisted-Pair
VT	Virtual Tributary
VTx	VT of size x (currently x = 1.5, 2, 3, or 6)

7.2 Glossary

Auto-Negotiation

The algorithm that allows two devices at either end of a link segment to negotiate common data service functions.

Balanced Cable

A cable consisting of one or more metallic symmetrical cable elements (twisted pairs or quads).

Bandwidth

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

Digital - The amount of information that a signal can carry over a fixed time interval. A system with a high bandwidth can carry more information over a fixed time interval than a low bandwidth system.

Binary *n*- Zero Substitution (B*n*ZS)

Binary *n*- Zero Substitution is an application of BPRZ, and is an exception to the Alternate Mark Inversion (AMI) line-code rule. It is one method for providing bit independence for digital transmission, by providing a minimum 1's density of 1 in *n*-bits. For DS3, *n*=3; for DS1, *n*=8; for 56 kbit/ s service, *n*=7, and for subrates, *n*=6. The rule of B*n*ZS is:

- Successional binary 1s (Marks) will be of opposite polarity (AMI) unless they are separated by *n* consecutive binary zeros, in which case the *n* 0s will be replaced by an *n*-bit byte containing 1s, having or causing, an intentional bipolar violation (bpv).

- For example in B6ZS, if the preceding binary 1 was +, then binary 100000011 is transmitted as signal voltage values: -000+0+-+ (the B6ZS byte is underlined). Assume the leftmost bit is transmitted first.
- In the decoding process, the B*n*ZS signature is recognized and replaced by an all zero *n*-bit byte.

Bit (Binary Digit)

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

Category 5 Balanced Cabling

Balanced 100 (and 120) ohm cables and associated connecting hardware whose transmission characteristics are specified up to 100 MHz.

Central Office (CO)

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

Channel

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

Customer Premises Equipment (CPE)

All telecommunication equipment located at a customer's location.

Customers

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

Customer Installation (CI)

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

Customer Premises

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

Customer Provided Equipment (CPE)

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

End-User (EU)

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

End-User POT (EU-POT)

The Network Interface at the end-user's premises at which CenturyLink Corporation's responsibility for the provision of service ends.

Error Free Second (EFS)

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

Errored Second (ES)

A one second interval with one or more bit errors.

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

Ethernet

A packet-switched local network design (by Xerox Corp.) employing Carrier Sense Multiple Access with Collision Detection (CSMA/ CD) as access control mechanism.

Exchange

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

Extended Superframe (ESF) Format

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

Facilities

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

Frame

A unit of data transmission on an IEEE 802 LAN MAC that conveys a Protocol Data Unit (PDU) between MAC Service users.

Full Duplex

Simultaneous transmission in both directions between two points.

Gigabit Interface Converter (GBIC)

Hot-swappable input/ output devices that plug into a Gigabit Ethernet port to link the port to the fiber-optic network.

Gigabits per Second (Gbit/s)

One billion (1,000,000,000) bits per second

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

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

Interface Code

See Network Channel Interface

Internetwork Packet Exchange (IPX)

Novell's Layer 3 protocol that is similar to IP, and is used in NetWare networks.

Jitter

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

Layer 1

Physical Layer of the OSI model which allows the protocol to provide the transmission of information on the transmission facility. It is concerned with the physical and electrical characteristics of the interface.

Line Terminating Equipment (LTE)

Network elements that originate and/ or terminate line (OC-N) signals. LTEs can originate, access, modify, or terminate the transport overhead, or can perform any combination of these actions.

Link

The transmission path between any two interfaces of generic cabling

Local Area Network (LAN)

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

Local Exchange Carrier (LEC)

The regulated entity providing Access and Intra-LATA services.

Megabits per Second (Mbit/s)

One million (1,000,000) bits per second

Micron (μm)

One millionth (10^{-6}) of a meter and commonly used to express the geometric dimensions of optical fiber.

Multiplex

See multiplexer

Multiplexer (Mux)

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

Network Channel (NC) Code

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

Network Channel Interface (NCI) Code

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

Network Interface (NI)

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

Optical Carrier (OC)

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

Optical Interface (OI)

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

Packet

A unit of data, consisting of binary digits including data and call-control signals, that is switched and transmitted as a composite whole.

Port

The physical point at which energy or signals enter or leave a device, circuit, etc.

Protocol

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

Protocol Code

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

Serving Wire Center

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

Shielded Twisted-Pair (STP) Cable

An electrically conducting cable, comprising one or more elements, each of which is individually shielded.

Signaling

The transmission of information to establish, monitor, or release connections and/ or provide network control.

SONET

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

SONET Optical Terminal (SOT)

A terminal that uses SONET multiplexing to interleave the lower rate payloads, thereby creating a high rate synchronous signal. It is the terminating or originating portion of a fiber optic system that performs both an electrical to optical conversion and a multiplexing function.

STS Synchronous Payload Envelope (SPE)

A 125-microsecond frame structure composed of STS Path Overhead and bandwidth for payload. The term generically refers to STS-1 SPEs and STS-nc SPEs.

Superframe Format (SF)

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

Synchronous Transport Signal Level 1 (STS-1)

The Basic logical building block signal with a rate of 51.840 Mbit/ s.

Synchronous Optical NET-work (SONET)

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

Synchronous Transmission

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

Throughput

The total capability of equipment to process or transmit data during a specified time period.

Transmission Path

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

Transmission Service Channel

A one-way transmission path between two designated points.

Transparent

In communication systems, that property which allows transmission of signals without changing the electrical characteristics or coding beyond the specified limits of the system design.

Twisted-Pair

A cable element that consists of two insulated conductors twisted together in a regular fashion to form a balanced transmission line.

Twisted-Pair Cable

A bundle of multiple twisted pairs within a single protective sheath.

Unshielded Twisted-Pair Cable (UTP)

An electrically conducting cable, comprising one or more pairs, none of which is shielded.

Untagged Frame

An untagged frame is a frame that does not contain a tag header immediately following the Source MAC Address field of the frame or, if the frame contained a Routing Information field, immediately following the Routing Information field.

Virtual Local Area Network (VLAN)

A group of devices on one or more LANs that are configured (using management software) so that they can communicate as if they were attached to the same wire, when in fact they are located on a number of different LAN segments.

Virtual Tributary (VT)

A structure designed for transport and switching of sub-STS-1 payloads. There are currently four VT sizes.

VLAN-Tagged Frame

A tagged frame whose tag header carries both VLAN identification and priority information.

VT Group

A 108-byte structure that carries one or more VT's of the same size. Seven VT groups are byte-interleaved within the VT-organized SPE.

Wire Center

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

CONTENTS

Chapter and Section **Page**

8. References

8.1 American National Standards Institute Documents

ANSI T1.102-1993 (R1999)	*Digital Hierarchy – Electrical Interfaces*
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ANSI T1.105.03-2003	*Synchronous Optical Network (SONET) – Jitter and Wander at Network and Equipment Interfaces*
ANSI T1.105.06-2002	*Synchronous Optical Network (SONET): Physical Layer Specifications*
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ANSI/ TIA/ EIA-758-A-2004	*Customer-Owned Outside Plant Telecommunications Cabling Standard*
ATIS-0900105.02-2007	*Synchronous Optical Network (SONET) – Payload Mappings*

8.2 Telcordia Documents

GR-20-CORE	*Generic Requirements for Optical Fiber and Fiber Optical Cable*
GR-253-CORE	*Synchronous Optical Network (SONET) Transport Systems: Common Criteria*
GR-342-CORE	*High-Capacity Digital Special Access Service Transmission Parameter Limits and Interface Combinations*
GR-378-CORE	*Generic Requirements for Timing Signal Generators*
GR-436-CORE	*Digital Network Synchronization Plan*
GR-496-CORE	*SONET Add-Drop Multiplexer (SONET ADM) Generic Criteria*

GR-499-CORE *Transport Systems Generic Requirements (TSGR): Common Requirements*

GR-1230-CORE *SONET Bidirectional Line Switched Ring Equipment Generic Criteria*

GR-1377-CORE *SONET OC-192 Transport System Generic Criteria*

GR-1400-CORE *SONET Dual-Fed Unidirectional Path Switched Ring (UPSR) Equipment Generic Criteria*

SR-307 *COMMON LANGUAGE NC/NCI Dictionary*

8.3 CenturyLink Technical Publications

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PUB 77375 *1.544 Mbit/s Channel Interfaces*, Issue G, June 2008

PUB 77386 *Interconnection and Collocation for Transport and Switched Unbundled Network Elements and Finished Services*, Issue M, October 2007

PUB 77419 *SPECIFICATIONS FOR THE PLACEMENT OF CENTURYLINK EQUIPMENT IN CUSTOMER-OWNED OUTDOOR CABINETS*, Issue A, June 2010

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G.7041 *Generic framing procedure (GFP)*

8.6 International Organization for Standardization/International Electrotechnical Commission Publications

ISO/ IEC 11801: 2002+A1:2008 *Information technology – Generic cabling for customer premises*

8.7 Ordering Information

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

Those who are not CenturyLink employees may order;

- ANSI documents and ISO/ IEC publications from:

  American National Standards Institute
  Attn.: Customer Service
  11 West 42nd Street
  New York, NY 10036
  Phone: (212) 642-4900
  Fax: (212) 302-1286
  Web: http://www.ansi.org/

  ANSI has a catalog available that describes their publications.

- Telcordia documents from:

  Telcordia Customer Relations
  8 Corporate Place, PYA 3A-184
  Piscataway, NJ 08854-4156
  Fax: (908) 336-2559
  Phone: (800) 521-CORE (2673) (U.S. and Canada)
  Phone: (908) 699-5800 (Others)
  Web: http://www.telcordia.com

- CenturyLink Technical Publications from:

  http://www.CenturyLink.com/techpub/

- IEEE documents may be obtained from:

  Institute of Electrical and Electronics Engineers
  445 Hoes Lane
  P.O. Box 1331
  Piscataway, NJ08855
  Web: http:/ / standards.ieee.org/

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