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Chapter and Section **Page**

1. Introduction

1.1 General

This document describes CenturyLink® Metro Ethernet service as offered by CenturyLink to its customers. The information provided in this document includes service features, technical specifications, performance objectives, and defines the valid User-Network Interfaces (UNIs) and Network Interfaces (ENNIs).

1.2 Reason for Reissue

- Rewrote Service Description Overview
- Completely updated Architecture Sections
- Remove Ethernet with Extended Transport (EwET)
- Remove TLS Plus UNI
- Additional ENNI information
- Added new Protect Routing description
- Minor technical corrections
- Update QOS and CoS description
- Added company name to E-Line and E-LAN Figures
- Added new 20-100-Gig NC, NCI and SEC NCI Codes
- Created hyperlinks for all Tables of Contents
- Reformatting of the document

1.3 Purpose

The purpose of this document is to describe CenturyLink Metro Ethernet service. Technical detail is furnished to enable a customer to select options, bandwidth and interfaces suitable for their application needs. This document describes the technical features of the offering. It is not the intent of this document to provide ordering information beyond specific, available Network Channel and Network Channel Interface Codes.

1.4 Organization of Document

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

Chapter 2 Service Description: Describes the features, functions and available options of CenturyLink Metro Ethernet service. Chapter 3 Network Interfaces: Details the physical electrical and optical User-Network Interfaces offered by this service. Also, briefly addresses the form and function of Network Channel (NC) Codes and Network Channel Interface (NCI) Codes as they pertain to this service. Finally, it presents the valid NC and NCI as well as NC/NCI Code combinations available for ordering this service.

Chapter 4 Performance Specifications: Furnishes expectations for service availability, throughput, latency, etc.

Chapter 5 Maintenance: Provides the CenturyLink and corresponding customer maintenance responsibilities of this service.

Chapter 6 Definitions: Presents a listing of acronyms along with a glossary of terms related to this Publication.

Chapter 7 References: Provides titles and ordering information for applicable standards and documents as referenced in this Publication.

2 Service Description

2.1 General

This chapter provides a comprehensive description of CenturyLink Metro Ethernet service using the Service Attributes of the User-Network Interface (UNI) and the Ethernet Virtual Connection (EVC), and is intended to help customers understand the various types and characteristics of CenturyLink Metro Ethernet, and to clearly communicate the service capabilities. While this document describes Metro Ethernet as provided by CenturyLink to its customers**, other non-standard designs may be considered on a case-by-case basis.**

2.2 CenturyLink Metro Ethernet Service Points

CenturyLink Metro Ethernet Service Points are geographic locations, designated by CenturyLink, where the company's Metro Ethernet Network (MEN) is accessible via Institute of Electrical and Electronics Engineers (IEEE) 802.3-2008 standard twisted-pair, single-mode and/or multimode fiber Local Area Network (LAN) interfaces. Service Points are those Serving Wire Centers (SWCs), which are defined as entry points into the CenturyLink MEN. CenturyLink Interoffice Facilities (IOF) will be utilized where required to provide access to the nearest Metro Ethernet core switch and transport customer traffic between Wire Centers within the same Local Access and Transport Area (LATA). Connection to the MEN is available at CenturyLink Metro Ethernet Service Points or at customer building locations served by CenturyLink Network Disclosed Central Offices (COs) in selected metropolitan areas. CenturyLink Metro Ethernet service to buildings without access facilities will be considered on a case-by-case basis.

CenturyLink Metro Ethernet:

- Is a Layer 2 Virtual Private Network (L2VPN) service
- Provides both point to point connectivity and multipoint-to-multipoint connectivity between geographically-dispersed customer sites across a Metropolitan or Wide Area Network (MAN or WAN), as if they were attached to a single LAN
- Enables standard Ethernet point-to-point (E-Line) and multipoint (E-LAN) services using Metro Ethernet Forum (MEF) constructs for UNI, EVC, ENNI and OVC Service Attributes

- Offers 10BASE-T, 100BASE-T, 1000BASE-T, 1000BASE-LX, 1000BASE-SX and 10G BASE-LR, 10GBASE ER, 10GBASE ZR full duplex customer Network Interfaces on a "where available" basis.
- Offers UNIs with 100GBASE-ER4 and 100GBASE-LR4 where available.
- Combines advanced LAN technology with the scalability and Traffic Engineering (TE) capabilities of Multi-Protocol Label Switching (MPLS)
- Supports multiplexing which allows a user to reach multiple destinations through a single physical or logical Ethernet connection at each location
- Delivers Carrier Ethernet over a core IP/MPLS Packet Switched Network (PSN) infrastructure
- Provides a separate Layer 2 broadcast domain for secure transport of customer CE-VLAN tagged or untagged frames with dedicated Ethernet Virtual Circuits and pseudo-wires per customer service instance
- Can transport higher-layer protocols such as IP or IPX encapsulated within standard Layer 2 frames
- Leaves control of IP routing to the customer
- Supports QoS and Class of Service options for mission-critical Enterprise traffic
- Is MEF CE 1.0 certified

Figure 2-1 illustrates two customers; A and B, each having CE devices located at different sites that are connected to the CenturyLink Metro Ethernet Network (MEN). Shown is the User-Network Interface (UNI), which is the physical demarcation point between the responsibility of CenturyLink and the responsibility of the Subscriber (customer). In addition to a UNI being the point of interconnection between the customer network and CenturyLink Metro Ethernet Service, the UNI will host one or more than one EVC associating (connecting) that UNI to one or more than one other UNIs. UNI Service Attributes are described in Section 2.11 and as indicated in Section 2.11.1, UNIs are standard Ethernet interfaces available with a customer-specified Billed Bandwidth Profile from 5 Mbps up to 1 Gbps and up to 100Gbps where available. The UNI and Bandwidth Profile Service Attributes may be different at each UNI in an EVC.

Connectivity between UNIs is specified by the Ethernet Virtual Connection (EVC). An Ethernet service that is based on a Point-to-Point EVC, such as in Figure 2-1 with Customer B's (pink) connection to the ISP POP, is defined as E-Line; and an Ethernet service based upon a Multipoint-to-Multipoint EVC, as with Customer A's (red)

connection to three of their sites and Customer B's (blue) connection to four of their sites, is defined as E-LAN. EVC Service Attributes are further described in Section 2.12, while other aspects such as Service Points are defined in Section 2.2. CenturyLink will assign a separate Service VLAN Tag (S-Tag) to isolate each customer's service instance in the access network, which then maps or cross-connects to a unique VPLS VPN at the ingress Serving N-PE. The MEN will bind these two technologies into a composite service (VLAN and VPLS Virtual Forwarding Instance with associated pseudo-wires) to form an end-to-end Ethernet Virtual Connection. From the customer's perspective, the entire VPN looks like a single Ethernet LAN, with the CenturyLink PEs acting as a bridge that forwards customer frames within the EVC (Layer 2 broadcast domain) based the Destination MAC Address. See Section 2.6 Architecture for further information.

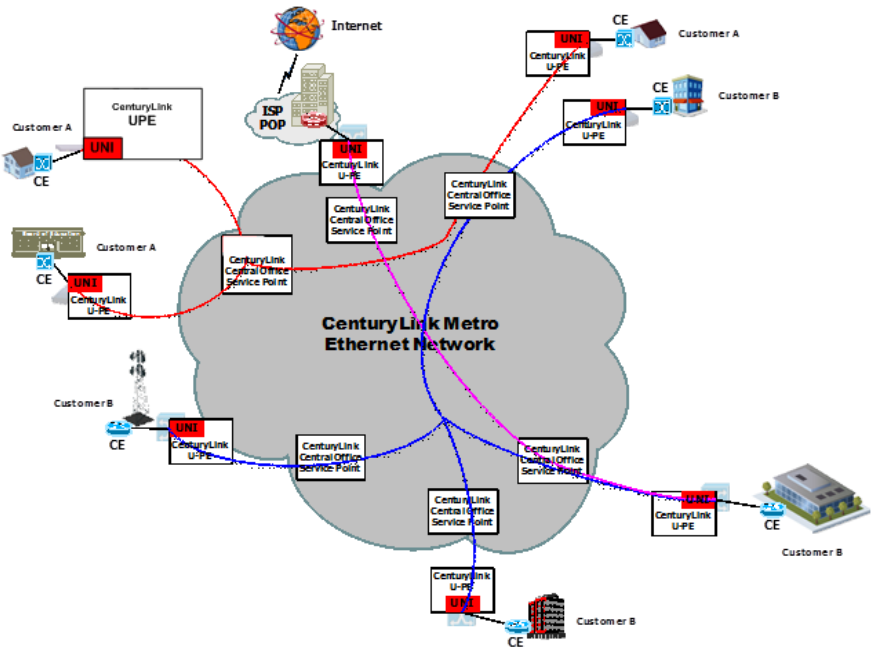

Figure 2-1 CenturyLink Metro Ethernet Network Example

2.3 CenturyLink Metro Ethernet Customer and Operator Access Ports

CenturyLink Metro Ethernet supports multiple Access Port configurations. The access port is either a UNI or an ENNI. A customer will typically connect to CenturyLink Metro Ethernet Services at a UNI, a wholesale Operator may use either a UNI or an ENNI. The SEC NCI code will be used when ordering to specify whether the access port is a UNI or an ENNI (see Section 3.6.5).

2.3.1 UNI interfaces

The UNI is the access port where the customer network connects to the CenturyLink Metro Ethernet Service. CenturyLink Metro Ethernet has four different types of customer access ports which are listed in Table 2-1. The Access Port types refer to how customer edge VLAN ID values are mapped to each EVC at the UNI as well as how the access port forwards or discards customer Layer 2 Control Protocol frames. The User-Network Interface (UNI) and EVC per UNI service attributes of the port types are further described in Sections 2.10 with restrictions noted in Table 2-12 Additional Service Attributes for Metro Ethernet Access Ports in an EVC. Service attributes for the Ethernet Virtual Connection (EVC) are described in Section 2.12.

Customer Access Port	Description
Non-TLS	Supports one EVC per UNI Untagged customer frames only Customer Layer 2 Control Protocol frames are dropped
TLS	Supports one EVC per UNI Untagged and VLAN tagged customer frames Transparent to customer VLAN tags Tunnels Customer Layer 2 Control Protocols – STP, CDP and VTP
Service Multiplexer	Supports more than one EVC per UNI Untagged customer frames dropped May be Transparent to customer VLAN tags Customer Layer 2 Control Protocol frames are dropped
Service Provider	Supports more than one EVC per UNI Untagged customer frames dropped May be Transparent to customer VLAN tags Customer Layer 2 Control Protocol frames are dropped

Table 2-1 Metro Ethernet Customer Access Ports

Table 2-1 Notes:

1. TLS = Transparent LAN Service
2. VLAN = Virtual LAN
3. STP = Spanning Tree Protocol
4. CDP = Cisco Discovery Protocol
5. VTP = VLAN Trunking Protocol
6. See Section 2.11.4 for additional information on Layer 2 Control Protocol Processing with TLS.

2.3.2 ENNI interfaces

The MOE ENNI is an access port type that another network operator can use when connecting to CenturyLink Metro Ethernet Services. The ENNI allows another operator (typically wholesale) to peer with CenturyLink Metro Ethernet services at a Network level (UNIs peer at a customer/user level). The ENNI is consistent with MEF 26 and will support services consistent with MEF 51. The characteristics of an ENNI access port are listed in Table 2-2. When a virtual connection is used to associate a UNI to an ENNI or an ENNI to an ENNI that virtual connection is referred to as an OVC (operator virtual connection). The S VLAN ID values within an operator frame will be used to map the operator frame to an OVC at the ENNI, S-VLAN Tagged Operator Layer 2 Control Protocol frames are typcially pased transparently at the ENNI to the associated OVC.

- An ENNI will peer at an outer or Service VLAN Tag (S-Tag) as defined in IEEE 802.1ad-2005, whereas the roles of Service Provider and customer (subscriber) need to be defined.
- When ordering an OVC at an ENNI the operator may assign the S-VLAN value or request CenturyLink to provide the S-VLAN value at the ENNI.

Operator Access Port	Description
ENNI	Supports more than one OVC at ENNI Untagged Operator frames are dropped Transparent to Customer VLAN tags (from UNI) Should forward S VLAN Tagged Operator Layer 2 Control Protocol frames Supports S-VLAN tags using TPID of 88a8

Table 2-2 Metro Ethernet ENNI Port

Customers must consult with CenturyLink Engineering and Operations for specific details including availability and configuration requirements

2.4 Rate-Limiting and Committed and Excess Information Rates

At each customer's individual CenturyLink Metro Ethernet UNI or Operator ENNI, the traffic will be rate limited in relation to the billed bandwidth purchased.

The customer or operator traffic will be rate limited in both ingress (entry) and egress (exit) directions. For any access port the applied ingress and egress rate limiting with be equal (symmetric). When Port Bandwidth limiting is applied at the UNI the billed bandwidth at a UNI is shared by all EVC at the UNI. When a UNI hosts more than one EVC (SP and SM port types) the billed bandwidth can be divided among the individual EVCs hosted at the UNI (each EVC will receive a customer specified bandwidth rate at that UNI). Port Bandwidth rate limiting is not available at an ENNI. For an ENNI the billed bandwidth will be divided among the individual OVCs hosted at the ENNI as specified by the Operator ordering services from CenturyLink (each OVC will receive a specified bandwidth rate at the ENNI).

Non-TLS, TLS customer access ports host only a single EVC therefore the billed bandwidth will be rate-limited at the UNI level. Since Service Multiplexer and Service Provider ports can support one or more than one EVC the billed bandwidth rate could be applied at the port (shared by all EVC at the UNI) or an individual bandwidth rate applied to each EVC at the UNI. When an SP or SM access port is rate limited at the Port there may be restrictions to how QOS can be applied to each EVC at the UNI. Both UNIs and ENNIs are capable of performing rate-limiting via Committed Information Rate (CIR) functionality that is:

- Equal to the (fractional Ethernet) Bandwidth Profile ordered per UNI/ENNI or EVC/OVC
- Generically available from 5 Mbps up to 1000 Mbps
- Higher Rates 10 Gbps and 100 Gbps where available

Traffic that exceeds the Committed Information Rate will be discarded.

2.5 Architecture

While the following describes the general architecture of CenturyLink's Metro Ethernet service, it doesn't mandate implementation of a specific technology, equipment configuration or protocols (which will be at the discretion of the company) to provide a customer's service.

2.5.1 Introduction

In Metro Ethernet Forum (MEF) Technical Specification 12.1, *Carrier Ethernet Network Architecture Framework Part 2: Ethernet Services Layer - Base Elements*, the Metro Ethernet Network (MEN) at the Ethernet Services (ETH) Layer is viewed as a multi-hop Ethernet network consisting of a collection of Network Elements (NEs) with Ethernet bridge functionality, e.g. Ethernet Layer 2 Control Protocol processing, forwarding, etc. whereas the connectivity between these NEs may be via IEEE 802.3 compliant Ethernet segments or virtual Ethernet (e.g., emulated IEEE bridge) segments such as in using IETF Layer 2 Virtual Private Network (L2VPN) constructs. So while the Customer VLAN (C-) component of IEEE 802.1Q-2005, *Virtual Bridged Local Area Networks*, and the Service VLAN (S-) component of IEEE 802.1ad-2005, *Provider Bridges*, are the base sub-layering technologies used by the UNI and ENNI, the MEN may use different transport and service delivery technologies including IP/MPLS with Q-in-Q (VLAN Stacking) and Ethernet over (active) fiber, SONET, CWDM/DWDM, ROADM, PDH (e.g., DS3), Copper (EFM with EoSHDSL or EoDS1), Ethernet rings (ITU-T G.8032 ERPS), etc. The capacity (Bandwidth Profiles), port types and QoS achievable may be dependent on the specific access or underlying transport technology in use.

2.5.2 Network Topology

The typical CenturyLink Metro Ethernet architecture is based on a two-tier Hierarchical Virtual Private LAN Service (H-VPLS) network topology with pseudo-wires that ride over Traffic Engineered (TE) Tunnels on a routed backbone between Network-facing Provider Edge (N-PE) devices, augmented with an Ethernet Edge and IEEE 802.1ad Q-in-Q tunnels configured between the Serving N-PE and User-facing Provider Edge (U-PE) devices. N-PE's act as a hub with U-PE's forming the spokes, which can include intermediate connections to Provider Edge Aggregation (PE-AGG) or other N-PE devices. Figure 2-2 illustrates an example of the MEN architecture.

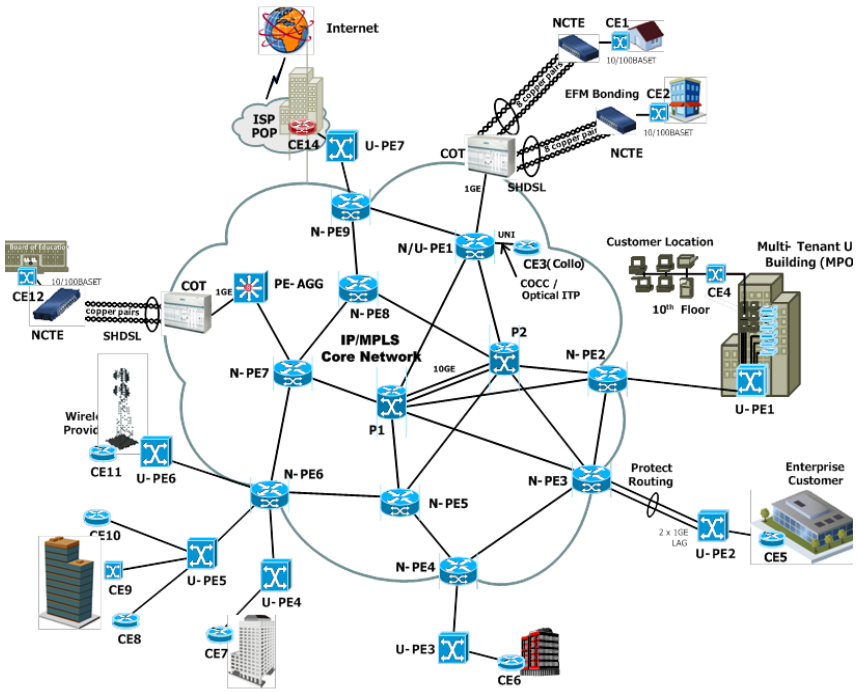

Figure 2-2 CenturyLink Metro Ethernet Network

2.5.3 Edge

As shown in Figure 2-2, customers may connect to the CenturyLink MEN via a company-provided Multi-Tenant Unit switch (MTU-s) placed at the premises or a Carrier Point of Presence (POP); and functions as a U-PE in a H-VPLS architecture in accordance with IETF RFC 4762, *Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling*. An MTU-s is a bridging capable device whereas CenturyLink Metro Ethernet service will typically use an Ethernet Edge access network based on IEEE 802.1ad, Provider Bridges with Service VLAN Tag (S-Tag) extensions to aggregate Layer 2 Customer Edge (CE) traffic between an MTU-s and one (or more in the case of multi-homing) routing and bridging capable devices (PE-rs). A PE-rs is usually located at a Central Office (CO); and functions as an N-PE device. Other variations such as deploying routing but non-bridging capable devices (PE-r), or MPLS (spokes) to the Edge of the network are also possible.

The MTU-s U-PE has customer access ports and a Q-in-Q tunnel (virtual) port that connects directly or through a switched Ethernet network to a Serving N-PE router, which is attached to a core MPLS Packet Switched Network (PSN) infrastructure with 10 Gbps IP trunks to the Provider (P) core routers or Serving N-PE peers (depending upon the size and design of each metro). A Serving N-PE will support multiple U-PEs within a local loop in a typical hub and spoke topology, though the Ethernet access devices and physical topology will vary. An S-Tag serves as a local service delimiter in the Metro Ethernet access network that is mapped to an emulated Virtual Circuit (RFC 4448, *Encapsulation Methods for Transport of Ethernet over MPLS Networks*, Ethernet/802.3 PDU encapsulated pseudo-wire) in a VPLS instance at the ingress Serving N-PE router. From a conceptual view, the U-PEs facing customer equipment combined with N-PEs attached to the core network represent a logical PE constructed architecture from which multiple VPN services are provided.

Customer Edge (CE) Connections

CE devices will typically connect to a U-PE that can attach to CEs of multiple customers, especially if, for example, there are multiple Metro Ethernet customers occupying the same building such as illustrated in Figure 2-2 with U-PE1. An N-PE device might also be equipped to support U-PE functions as with N/U-PE1 enabling a UNI in the CO for CLEC collocation or cross-connect to another CenturyLink compatible finished service as discussed in Section 2.5.

In Figure 2-2 several customer premises are served via an Ethernet over Copper (EoCu) access link architecture. In general, the EoCu application is used for Metro Ethernet service locations that don't have fiber facilities. Ethernet in the First Mile over Copper (EFMCu) using multi-pair bonding allows fast deployment of symmetrical Ethernet Access/Backhaul links over existing voice-grade copper infrastructure. The IEEE 802.3-2008 EFM Physical Layer specifications are based on ITU-T G.991.2, *Single-Pair High-Speed Digital Subscriber Line (SHDSL) transceivers*. EFMCu using standard G.SHDSL.bis technology over a single copper pair supports an optional aggregation or bonding of multiple copper pairs, providing higher bandwidth, longer reach and improved resiliency.

EoCu platforms for both repeater and non-repeater solutions, depending upon the EFMCu equipment some features including Service Multiplexer and Servicer Provider ports as well as Quality of Service (QoS) options may or may not be available (Protect Routing isn't supported). CenturyLink Engineering will determine the appropriate MEN access architecture to best meet each customer's service requirements based on the Local Network infrastructure facilities and corporate policy. The company will work with the customer to identify what limitations, if any, may exist within the network.

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2.5.4 Core

All of the core N-PE routers that participate in a particular VPLS VPN service are connected together by a full mesh of (e.g., RSVP-TE signaled) MPLS Label Switched Path (LSP) tunnels, over which RFC 3985, *Pseudo Wire Emulation Edge-to-Edge (PWE3) Architecture*, pseudo-wires are established as part of the MEN infrastructure as a standard L2VPN architecture (RFC 4665, *Service Requirements for Layer 2 Provider-Provisioned Virtual Private Networks*). Two primary unidirectional tunnels will be configured between N-PE peers, along with two Fast Re-Route (FRR) protected backup tunnels (in IP/MPLS core networks with P routers). Each of the two TE Tunnels between Serving N-PEs may take a unique path.

Signaling specified in RFC 4447, *Pseudo-wire Setup and Maintenance Using the Label Distribution Protocol (LDP)*, is used to negotiate a set of ingress and egress Pseudo Wire (PW) labels on a per service order basis. Virtual Circuit (VC) LSPs are signaled via Targeted LDP (RFC 4762) sessions inside MPLS tunnels through the exchange of LDP Label Mapping messages to configure a full mesh of bidirectional (Tx & Rx) VCs between each of the Serving N-PEs ("VPLS Forwarder" modules) along with implementing Layer 2 split horizon. The PW labels are used by the egress N-PE routers for demultiplexing traffic arriving from different customer services over the same set of LSP tunnels. Once all tunnel and VC LSPs are established, CE-VLAN tagged or untagged frames (depending upon the end-to-end ordered service configuration) are transported through the MPLS core network using a dual label stack.

2.5.5 Logical

Within the PE-rs, a Virtual Forwarding Instance (VFI) terminates PWs for interconnection with other VFIs in the core network; whereas a Virtual Switching Instance (VSI) on the PE-rs "bridge" module will terminate the (Q-in-Q) Attachment Circuits (RFC 3985) for accommodating CE devices. A VSI/VFI includes the Forwarding Information Base (FIB) for an L2VPN that in RFC 4664, *Framework for Layer 2 Virtual Private Networks (L2VPNs)*, defines the broadcast domain membership and may be populated dynamically (such as by Source MAC Address learning on a frame-by-frame basis) for E-LAN or statically (e.g., by cross-connect configuration) for E-Line. At a Serving N-PE, each EVC identified by a Service VLAN ID (S-VLAN ID) is mapped (or cross-connected) to a VSI/VFI. Whereas, the VC label is bound with the Source MAC Address for future FIB lookup on a packet received via an Attachment Circuit. With the ingress N-PE FIB then having learned the Destination MAC Address, it will forward the packet on the PW connecting to the appropriate egress Serving N-PE device(s). Separate VLAN MAC address tables are built in each Serving NPE that is part of a customer's Metro Ethernet service.

The MTU-s and the PE-rs treat each spoke connection like an Attachment Circuit (AC) of the VPLS service. CenturyLink Metro Ethernet AC's are either physical or logical (VLAN-tagged) Ethernet ports that connect to a Customer Edge device and are associated with an S-Tag on the Ethernet trunk (uplink). Packets to unknown destinations are replicated to all ports in the service including the spoke. Once the MAC address is learned, hairpin traffic between CE8, CE9 and CE10 in Figure 2-2 for example, will be locally switched by the MTU-s (U-PE5) without sending to the N-PE. Traffic between CE8, CE9 or CE10 and any remote destination is switched directly onto the spoke and sent to the PE-rs (N-PE6) over the point-to-point Q-in-Q tunnel. Intra-N-PE or hairpin configured traffic destined for CE7 or CE11 will be switched by N-PE6 once it has learned the MAC addresses. The PE-rs N-PE maps an S-Tag to a VPLS instance with associated PWs, and vice versa; switching traffic between the spoke, PWs, and ACs.

The overall bridging architecture is based on two logically separated layers, where a core N-PE router will forward packets to PWs that connect to other N-PE routers only if they arrive on Q-in-Q tunnels that connect to U-PEs. From an end-to-end Ethernet service perspective, the PE devices provide a logical interconnect such that CE Ethernet access ports or VLANs belonging to a specific EVC / VPLS VPN service all appear to be connected by a single Carrier Ethernet LAN that functions as a standard logical learning bridge.

Note: VPN constructs such as IGP routing protocols along with auto-discovery, signaling, OAM, etc. mechanisms may vary in the MEN and will be determined by CenturyLink as necessary to properly support the Metro Ethernet finished service offering. A complete description of the protocols used to maintain loop-free connectivity along with enabling redundancy and dual-homing with provisioning of active/standby PWs or path / links in the IP/MPLS core and edge of the MEN is outside the intended scope of this document.

2.6 Protect Routing

Protect Routing is an optional customer feature of CenturyLink Metro Ethernet that provides for enhanced service availability in the local loop by provisioning redundant, dual-homed uplinks running IEEE 802.1AX-2008, *Link Aggregation*, between the company-owned (single) U-PE at the customer-designated premises and the (single) ingress N-PE in a CenturyLink Central Office.

See the CenturyLink Metro Ethernet Rates and Services Schedule (RSS) for the Protect Routing charges per UNI along with applicable service guarantee.

Protect Routing is available with a single customer port (UNI) and offered on a where available basis only* with the following Metro Ethernet UNIs and Bandwidth Profiles:

- 10Base-T with 5 or 10 Mbps
- 100Base-TX with 10, 20, 30, 40, 50, 60, 70, 80, 90 or 100 Mbps
- 1000Base-T/LX/SX with 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000 Mbps

* Customers are advised to consult with CenturyLink Engineering for specific details including availability.

Diverse facilities are provided with a minimum of 25' separation from the first utility vault outside the CenturyLink CO to the last utility vault at the customer premises. Any exceptions should be documented in a Separation Waiver. The operation of Link Aggregation provides for Layer 2 rerouting of customer traffic following the failure of either trunk port on the U-PE or N-PE, or interconnecting fiber facilities.

2.7 Metro Ethernet User-Network Interfaces at CenturyLink Central Offices

Metro Ethernet customer-orderable handoffs at CenturyLink Central Offices (COs) are limited to 1000Base-LX (SMF) and 10-GBased-LR (SMF), 10-GBased-ER (SMF), 100GBase-RL4, ER4 (SMF) on an Individual Case Basis (ICB). User-Network Interfaces UNIs) with a 100, 600 or 1000 Mbps Bandwidth Profile and available at CenturyLink Metro Ethernet core switch CO locations only for providing cross-connects to a:

- Compatible finished service (e.g. Ethernet ports on SST, SHNS, GeoMax or OWS)
- Competitive Local Exchange Carrier (CLEC) collocation cage via a 2 fiber Optical Interconnect Tie Pair (ITP)

For further information regarding Metro Ethernet with collocation see the Tariff and CenturyLink Technical Publication 77386, *Interconnection and Collocation for Transport and Switched Unbundled Network Elements and Finished Services*.

2.8 Customer MAC Address Limits

For customers who choose to connect to the CenturyLink MEN via an Ethernet switch or IEEE 802.1D Media Access Control (MAC) Bridges, the maximum number of MAC addresses that can be supported is currently limited to 600 per 10bt, 100bt UNIs, and 600 for1000bt, 1000lx and 1000sx UNI or ENNI. For 10G UNI and ENNI or 100G UNI consult with CenturyLink when more than 600 MAC addresses are needed.

2.9 Introduction to Metro Ethernet Service Attributes

With Metro Ethernet there are two types of service attributes, those that apply to a physical port or User-Network Interface (UNI), described in Section 2.10 and 2.11, and those that apply to an Ethernet Virtual Connection (EVC), described in Section 2.12.

For a Metro Ethernet request, attributes will be specified for each UNI in the EVC as well as for the EVC(s) and captured on the CenturyLink and/or Alliance for Telecommunications Industry Solutions (ATIS) Access Service Request (ASR) EVC Form(s) at the time of service order. CenturyLink Metro Ethernet is modeled from the point of view of the Subscriber's equipment referred to as the Customer Edge (CE) that is used to access the service. The valid combinations of CenturyLink UNI and EVC attributes will define the customer's service in terms of what is seen by each CE.

Much of the information in the following sections is based on work of the Metro Ethernet Forum such as described in the Technical Specification MEF 10.2, *Ethernet Services Attributes - Phase 2*, October 2009 document available at: http://www.metroethernetforum.org/ and has been reproduced with permission of the Metro Ethernet Forum.

2.10 UNI and EVC per UNI Service Attributes for Metro Ethernet Customer Access Ports

This section describes attributes at each UNI. These attributes fall into two types:

- Attributes independent of the EVCs at the UNI
- Attributes associated with an EVC at the UNI.

When each attribute is described, its type is noted.

A UNI can have various characteristics that will influence how the Customer Edge (CE) device sees a service. These are called UNI service attributes, and for CenturyLink Metro Ethernet include:

- Physical Layer; User-Network Interface speed, mode, and physical medium
- MAC Layer
- UNI Maximum Frame Size
- Service Multiplexing
- CE-VLAN ID/EVC Map
- Maximum number of EVCs
- Bundling

- All to One Bundling
- Ingress/Egress Bandwidth Profile per UNI
- Ingress/Egress Bandwidth Profile per EVC
- Layer 2 Control Protocol Processing

The UNI and EVC per UNI service attributes are described in the following subsections and listed in Table 2-8 along with the parameter values for each Metro Ethernet customer access port.

2.10.1 Available Network Interfaces and Bandwidth Profiles

When ordering the UNI/ENNI the customer will select both a physical User-Network Interface (UNI/ENNI) speed and media (electrical, Single-Mode Fiber or Multi-Mode Fiber type for Gigabit Ethernet) along with a Billed Bandwidth for each UNI/ENNI. CenturyLink Metro Ethernet service offers the following IEEE 802.3-2008, *Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications* standard UNIs. This standard includes speed, mode and physical medium specifications for Ethernet (802.3), Fast Ethernet (802.3u) and Gigabit Ethernet (802.3z).

Ethernet UNIs

10Base-T

- 10 Mbps full duplex Local Area Network interface over two pairs of twisted-pair telephone or Category 3, 4 or 5 (recommended) copper wire with an RJ-45 connector
- In general, 10Base-T UNIs will be hard coded.

Fast Ethernet UNIs

100Base-TX

- 100 Mbps full duplex Local Area Network interface over two pairs of Category 5 Unshielded Twisted-Pair (UTP) or Shielded Twisted-Pair (STP) copper wire with an RJ-45 connector
- In general, 100Base-TX UNIs will be hard coded.

Gigabit Ethernet UNI/ENNIs

1000Base-T

- 1000 Mbps full duplex Local Area Network interface using four pairs of Category 5 balanced copper cabling with an RJ-45 connector
- Per IEEE 802.3-2008, 1000Base-T UNI/ENNIs will be provisioned with auto-negotiation.

1000Base-LX

- 1000 Mbps full duplex Local Area Network interface using long wavelength (1300-1310 nm) lasers over one pair of Single-Mode Fiber (SMF) with an SC, FC or LC (at premises locations) UPC duplex connector
- 1000Base-LX UNI/ENNIs at customer premises locations may be ordered as hard coded or provisioned with auto-negotiation (preferred).
- 1000Base-SX
- 1000 Mbps full duplex Local Area Network interface using short wavelength (850 nm) lasers over one pair of Multi-Mode Fiber (MMF) with an SC, FC or LC (at premises locations) UPC duplex connector
- 1000Base-SX UNI/ENNIs at customer premises locations may be ordered as hard coded or provisioned with auto-negotiation (preferred).

10 Gigabit Ethernet UNI/ENNIs

10GBase-LR

- 10Gbps Base-LR, 1310 nm, Single-mode Fiber, 10Km

10G Base-ER

- 10Gbps Base-ER Fiber, 1550nm, Single-mode Fiber, 40Km

100 Gigabit Ethernet UNI

100GBASE-ER4

- 100 Gbps PHY using 100GBASE-R encoding over four WDM lanes via two 1310 nm single-mode fibers, with reach up to at least 40 km per IEEE 802.3ba-2010

100GBASE-LR4

- 100 Gbps PHY using 100GBASE-R encoding over four WDM lanes via two 1310 nm single-mode fibers, with reach up to at least 10 km per IEEE 802.3ba-2010

The physical Layer User-Network Interface attributes of speed, mode and physical medium are independent of the EVCs at the UNI, and UNIs with different speeds or data rates and physical media may be mixed in the same EVC.

The customer will then select a Billed Bandwidth Profile, which is a is a limit on the rate at which frames can traverse the interface from 5 Mbps to 1000 Mbps for each UNI/ENNI. The CenturyLink Metro Ethernet customer facing switch port will be rate-limited down to this speed. The rate-limited bandwidth or throughput that is specified by the customer for each UNI/ENNI (Network Access Link) is available in the following increments:

10 Mbps Ethernet ports

- 3*, 5, 7* and 10 Mbps

  * Offered on a where available basis only with equipment that has been operationalized by CenturyLink to provide these Bandwidth Profiles

100 Mbps Ethernet ports

- 3*, 5*, 7*, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 Mbps

  * Offered on a where available basis only with equipment that has been operationalized by CenturyLink to provide these Bandwidth Profiles

1000 Mbps or Gigabit Ethernet ports

- 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, 900 and 1000 Mbps

10 Gbps Ethernet ports

- 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 Gbps

Offered on a where available basis only

100 Gbps Ethernet ports

- 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 Gbps

Offered on a where available basis only

Requirements for connecting to the CenturyLink Metro Ethernet Network (MEN) at the UNI/ENNI are specified in Chapter 3, Network Interfaces.

2.10.2 Full Duplex Operation

Full duplex operation allows simultaneous communication between a pair of Data Terminal Equipment (DTE) or end stations using point-to-point media (dedicated channel). Full duplex operation does not require that transmitters defer, nor do they monitor or react to receive activity, as there is no contention for a shared medium in this mode. Full duplex mode can only be used when all the following are true:

- The physical medium supports simultaneous transmission and reception without interference.
- There are exactly two stations connected with a full duplex point-to-point link. Since there is no contention for use of a shared medium, the multiple access, i.e. Carrier Sense Multiple Access with Collision Detection (CSMA/CD) algorithms are unnecessary.
- Both stations on the LAN are capable of, and have been configured to use, full duplex operation.

All CenturyLink Metro Ethernet customer 10/100/1000 Mbps Local Area Network (LAN) User-Network Interfaces (UNIs) and ENNIs as well as the internodal Gigabit Ethernet circuits will be provisioned for full duplex operation. Half duplex transmission mode is not a CenturyLink Metro Ethernet service option.

2.10.3 Ethernet Frame Formats

CenturyLink Metro Ethernet service supports customer traffic with the following standard Ethernet frame formats:

- IEEE 802.3-2008 including the Logical Link Control (LLC) header as described in ISO/IEC 8802-2: 1998, Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical Link Control
- Ethernet Version 2 as released by the DIX (Digital Equipment Corporation/ Intel/Xerox) consortium

The following Ethernet frame formats are not supported and should be considered incompatible with CenturyLink Metro Ethernet service:

- 802.3 SNAP (w/Sub-Network Access Protocol header)
- Novell (NetWare) proprietary or "802.3 raw"

The MAC Layer attribute is independent of the EVCs at the UNI.

2.10.4 Ethernet Maximum Frame Size (MFS)

The Customer (UNI) or operator (ENNI) will order an interface speed (Primary and Secondary NCI codes) from CenturyLink. For each UNI/ENNI ordered by a customer CenturyLink Metro Ethernet will support a Maximum Frame Size value as listed in Table 2-3. The value listed is the minimum MFS value supported for each orderable interface speed, the actual configured MFS value may typically be greater than the minimum value. If a customer requires an MFS that is greater than the minimum value implemented by CenturyLink for an interface speed they are advised to consult with CenturyLink for specific details including availability for larger MFS values for their UNI or ENNI.

Maximum Frame Size		
Interface Speed	Interface Type	MFS (bytes)
10 Base-T	UNI	1996
100 Base-T	UNI	1996
1000 Base-T	UNI/ENNI	9018
1000 Base LX/SX	UNI/ENNI	9018
10G	UNI/ENNI	9018
100G	UNI	9018

Table 2-3 Maximum Frame Size

The Ethernet Maximum Frame size (MFS) for a UNI or an ENNI refers to the size (in bytes) of the largest Layer 2 Ethernet Frame supported by the interface. The Ethernet Frame at the UNI or ENNI interface is defined as beginning at the first bit of the Destination MAC Address and ending at the last bit of the Frame Check Sequence. The payload within the Ethernet frame available for customer MAC Client Data will be at least 18 to 26 bytes less than the Ethernet Maximum Frame size depending on any additional VLAN Tags used by the customer at the UNI or the operator at the ENNI. The MFS attribute is used to describe the maximum size of the Ethernet frame for MOE product rather than using the more generic MTU (maximum transmission unit) term. This is to help clarify the product layer 2 frame size support in contrast to the “payload” within the layer 2 frame available to

support the MTU of customer application (IP, TCP, etc.). The MFS attribute is also preferred in place of the generic term "Jumbo Frame" (an Ethernet frame with a payload greater than the standard MTU of 1500 bytes). MFS defines a specific size of "Jumbo Frame" supported by the MOE product. Figure 2-3 shows MFS for frames at the UNI or the ENNI.

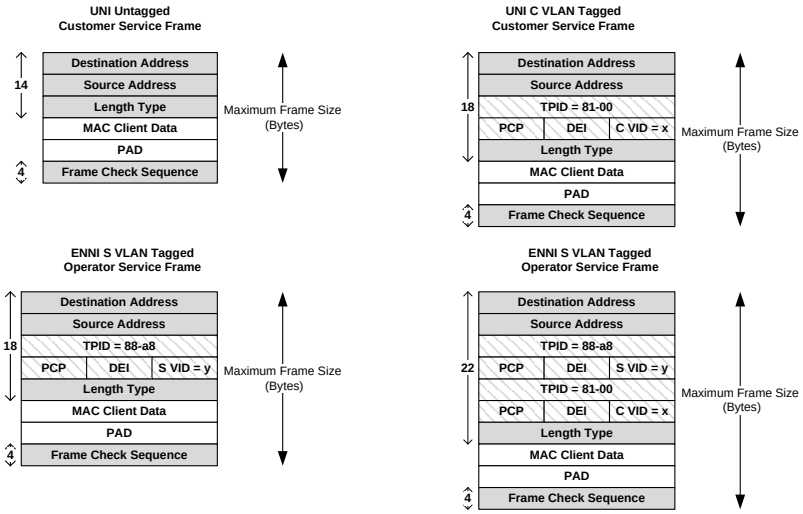

Figure 2-3 Maximum Frame Size

- The UNI Maximum Frame Size service attribute specifies the maximum Service Frame size (in bytes) allowed at the UNI and is independent of the EVCs/OVCs at the UNI.
- The ENNI Maximum Frame Size service attribute specifies the maximum ENNI Frame size (in bytes) allowed at the ENNI and is independent of the OVCs at the ENNI.
- The EVC Maximum Frame Size service attribute specifies the maximum Service Frame size (in bytes) allowed on the EVC.
- The EVC Maximum Frame size value must be less than or equal to the smallest of the UNI maximum frame size values.
- The OVC Maximum Frame Size service attribute specifies the maximum Service Frame size (in bytes) allowed on the OVC.
- The OVC Maximum Frame size value must be less than or equal to the value of the smallest ENNI maximum frame size.
- The OVC Maximum Frame size value must be less than or equal to the value of the smallest UNI maximum frame size + 4 bytes. The implication of this

statement is that if a UNI and an ENNI have the same MFS, at a UNI an OVC will support 4 less bytes of customer payload than EVCs that may exist at that UNI.

- Fundamentally the MFS of an EVC or OVC is derived from the MFS of the smallest interface associated by the EVC/OVC and describes the largest frame that can be forwarded from ingress interface to egress interface.

The Customer (UNI) or operator (ENNI) will order an interface speed (Primary and

2.10.5 Service Multiplexing

A Service Multiplexer or Service Provider port (UNI) with the Service Multiplexing attribute will be configured to support multiple Ethernet Virtual Connections (EVCs) at the UNI. Point-to-Point and Multipoint-to-Multipoint EVCs may be multiplexed in various combinations at a Service Multiplexer or Service Provider port (UNI), thus reducing the number of UNIs that need to be purchased and managed by the customer. Point-to-point EVCs will be provisioned using a multipoint capable EVC but with only two UNIs.

Figure 2-4 shows an example of Service Multiplexing. Using Service Multiplexing, instances of Point-to-Point EVCs to each of sites B, C and D can be implemented at site A without requiring the customer to order three physical UNIs or CenturyLink Metro Ethernet ports. This attribute is independent of the EVCs at the UNI.

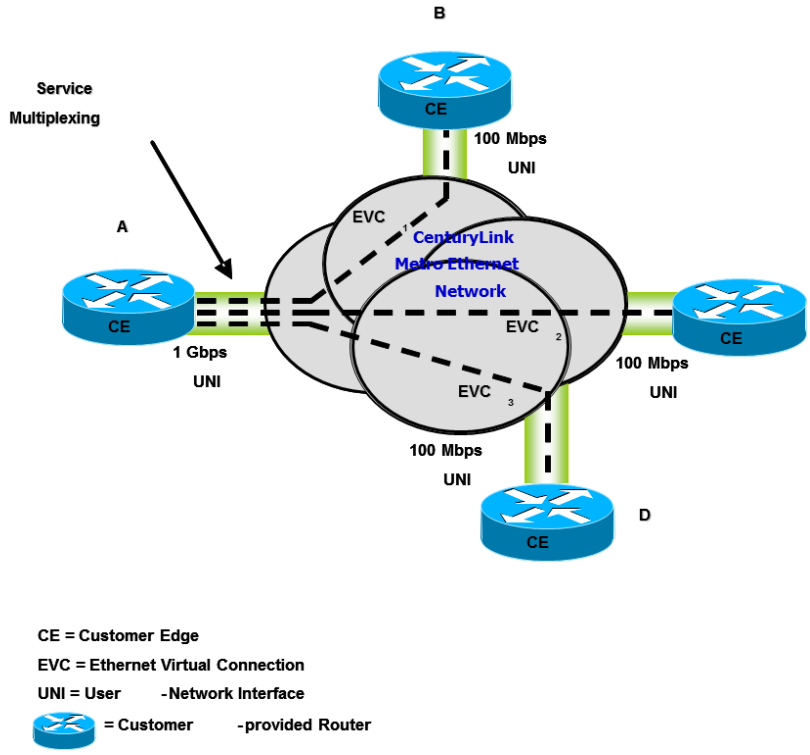

Figure 2-4 Service Multiplexing Example

See Figure 2-10 for an example of Service Multiplexing using a Point-to-Point EVC and Multipoint-to-Multipoint EVC.

2.10.6 Customer Edge VLAN ID

At a given UNI, the EVC for a Service Frame is identified by the Customer Edge VLAN ID (CE-VLAN ID), numbered 2 through 4094. The CE-VLAN ID is derived from the content of the incoming customer Service Frame.

For an Ethernet frame with an IEEE 802.1Q tag for which the 12-bit VLAN ID isn't zero, the CE-VLAN ID is equal to the VLAN ID in the tag. More than one CE-VLAN ID may map to the same EVC as described in Section 2.10.8, Bundling.

The 4094 CE-VLAN IDs always exist at each UNI and are independent of the EVCs at the UNI.

2.10.7 CE-VLAN ID/EVC Map

CE-VLAN IDs must be mapped when one UNI supports tagging and the other UNI does not support tagging. In these cases, the CE-VLAN ID used to identify an EVC is locally significant to each UNI. The CE-VLAN ID/EVC Map provides a mapping table between the CE-VLAN IDs at the UNI to the EVC which they belong.

When a UNI does not support VLAN tags, any Ethernet Service Frames delivered at the UNI will be delivered without VLAN tags. If the originating UNI supports VLAN tags and the Service Frame was sent to the UNI with a CE-VLAN Tag, CenturyLink will remove the CE-VLAN Tag before delivering the Service Frames to the UNI that does not support VLAN tagging. For Service Frames sent from a UNI supporting untagged Service Frames to a UNI supporting tagged Service Frames, CenturyLink will insert the proper CE-VLAN Tag before delivery to the UNI supporting tagged Service Frames as defined by the CE-VLAN ID/EVC Map service attribute.

At each Metro Ethernet UNI there will be a mapping of each CE-VLAN ID to at most one EVC. The collection of these mappings is the CE-VLAN ID/EVC Map. With no Bundling or All to One Bundling attributes (as described in Sections 2.10.8 and 2.10.9 following) at the UNI, exactly one CE-VLAN ID will be mapped to at most one EVC. Table 2-4 and Figure 2-5 both show an example of a CE-VLAN ID/EVC Map at a CenturyLink Metro Ethernet Service Multiplexer or Service Provider port with Service Multiplexing.

CE-VLAN ID	EVC
Untagged	Drop
100	EVC_1
101, 102, 103	EVC_2
104	EVC_3
Not 100 – 104	Drop

Table 2-4 Example of CE-VLAN ID / EVC MAP

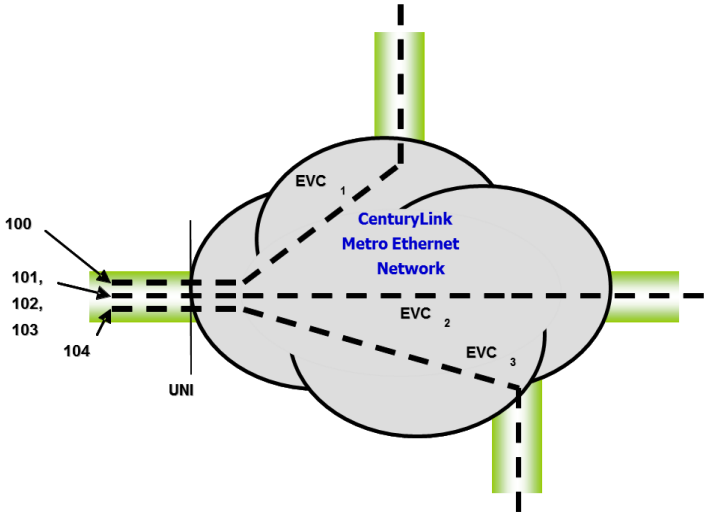

Figure 2-5 Example of CE-VLAN ID / EVC MAP

In Figure 2-5 Example of CE-VLAN ID / EVC MAP, an ingress Service Frame with CE-VLAN ID 100 is transported according to the properties and attributes of EVC_1. An ingress Service Frame with CE-VLAN ID 101, 102 or 103 is transported according to the properties and attributes of EVC_2. An egress Service Frame coming from EVC_3 is given CE-VLAN ID 104.

When an instance of the CE-VLAN ID/EVC Map does not contain an entry for a given CE-VLAN ID, any ingress Service Frame at the UNI with this CE-VLAN ID will be discarded by the MEN. In Figure 2-5 Example of CE-VLAN ID / EVC MAP, untagged ingress Service Frames as well as CE-VLAN IDs outside of 100 to 104 aren't mapped to any CenturyLink Metro Ethernet EVC and if transmitted by the CE will be dropped at the UNI.

For Service Multiplexer or Service Provider ports in an EVC with CE-VLAN ID Preservation as described in Section 2.12.3, the customer will provide the CE-VLAN ID mapping requirements at the time of service order. In some scenarios, it may be necessary for the customer and CenturyLink to agree upon the CE-VLAN ID/EVC Map at the UNI. While every effort will be made to accommodate a specific customer CE-VLAN ID/EVC Map request, CenturyLink reserves the right to dictate the mapping.

Note that for a given UNI, the CE-VLAN ID/EVC Map may be constrained by the range of CE-VLAN ID values that can be supported by the CE and the range of CE-VLAN ID values that can be supported by CenturyLink.

The CE-VLAN ID/EVC mapping for a given EVC at a UNI may be different from the mapping at another UNI in the EVC only when the CE-VLAN ID Preservation attribute doesn't apply to the EVC. In this case, CE-VLAN IDs may be translated whereas the CE-VLAN ID of an egress service frame is not identical in value to the CE-VLAN ID of the corresponding ingress service frame.

The mapping of one or more CE-VLAN IDs to an EVC is an attribute associated with the EVC at the UNI.

CE VLAN relationships are global to a service, the customer is responsible to order and assign the CE VLAN ID values as needed.

2.10.8 Bundling

When a UNI has the Bundling attribute, it is configured so that more than one CE-VLAN ID can map to an EVC at the UNI. An EVC with more than one CE-VLAN ID mapping will have the CE-VLAN ID Preservation service attribute (see Section 2.12.3) and the list of CE-VLAN IDs mapped to the EVC will be the same at each UNI in the EVC.

Service Provider and Service Multiplexer UNI are configured by default to support bundling. A list of one CE VLAN or more than one CE VLANs can be ordered at a Service Provider or Service Multiplexer UNI. It is recommended that when a customer requires to have more than one CE VLAN bundled into an EVC at a UNI that the list of VLANs be limited to 50 or less.

In Table 2-5 and Figure 2-6, UNI A and UNI B have the Bundling attribute as seen from the mapping for EVC_1. (EVC_1 has the CE-VLAN ID Preservation attribute). Bundling is compatible with Service Multiplexing whereas UNI A and UNI B for example, have Service Multiplexing and Bundling on the same UNI. The Bundling service attribute is independent of the EVCs at the UNI.

Note in this example:

- EVC_1 must have CE-VLAN ID Preservation.
- EVC_2 has CE-VLAN ID Preservation.
- EVC_3 does not have CE-VLAN ID Preservation.

UNI A	
CE-VLAN ID	**EVC**
107, 108, 109	EVC_1
200	EVC_3

UNI B	
CE-VLAN ID	**EVC**
107, 108, 109	EVC_1
100	EVC_2

UNI C	
CE-VLAN ID	**EVC**
100	EVC_2
107	EVC_3

Table 2-5 Example of Bundling

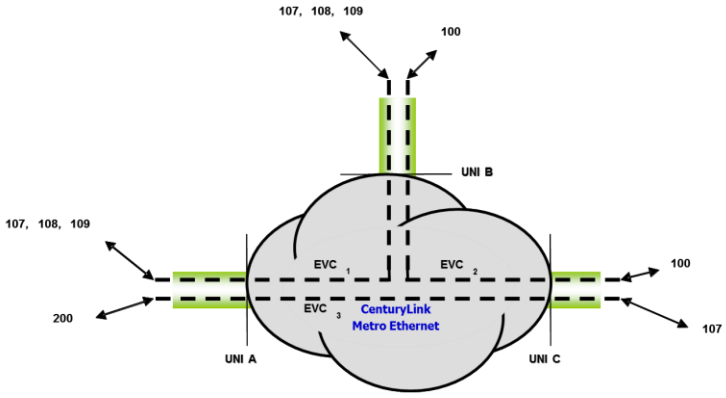

Figure 2-6 Example of Bundling

2.10.9 All to One Bundling

When a UNI has the All to One Bundling attribute, which is a special case of Bundling, all CE-VLAN IDs will map to a single EVC at the UNI (i.e., no Service Multiplexing). The EVC at the UNI will have the CE-VLAN ID Preservation service attribute as described in Section 2.12.3, and the list of CE-VLAN IDs mapped to the EVC will include all CE-VLAN IDs and be the same at each UNI in the EVC. Thus, all UNIs in the EVC must have the All to One Bundling service attribute. Table 2-6 shows the possible Bundling and Service Multiplexing combinations for the various CenturyLink Metro Ethernet port types. The All to One Bundling service attribute is independent of the EVCs at the UNI.

Service Attributes	Non-TLS	Service Multiplexer, or Service Provider*	Service Multiplexer, or Service Provider	TLS
Service Multiplexing	☐	☑	☑	☐
Bundling	☐	☐	☑	☐
All to One Bundling	☐	☐	☐	☑

Table 2-6 Valid Combinations of Service Multiplexing, Bundling and All to One Bundling

*** Note:** Each CE-VLAN ID is mapped to no more than one EVC in a one-to-one mapping arrangement.

2.11 Ingress Bandwidth Profile

The Ingress Bandwidth Profile is used to regulate the amount of ingress traffic at a particular UNI. An Ingress Bandwidth Profile is defined for ingress Service Frames at the particular UNI.

2.11.1 Ingress Bandwidth Profile per Ingress UNI

With this application of policing, a single Bandwidth Profile is applied to all ingress Service Frames at the UNI. The Ingress Bandwidth Profile per Ingress UNI manages bandwidth non-discriminately for all EVCs at the UNI, i.e. some EVCs may get more bandwidth while others may get less.

Figure 2-7 shows an example of a CenturyLink Metro Ethernet Service Multiplexer or Service Provider port with ingress policing and a Bandwidth Profile at the UNI where all ingress Service Frames for the three EVCs would all be subject to a single Bandwidth Profile. If there is a per UNI Ingress Bandwidth Profile, then there cannot be any other Ingress Bandwidth Profiles at that UNI. The Ingress Bandwidth Profile per Ingress UNI service attribute is independent of the EVCs at the UNI.

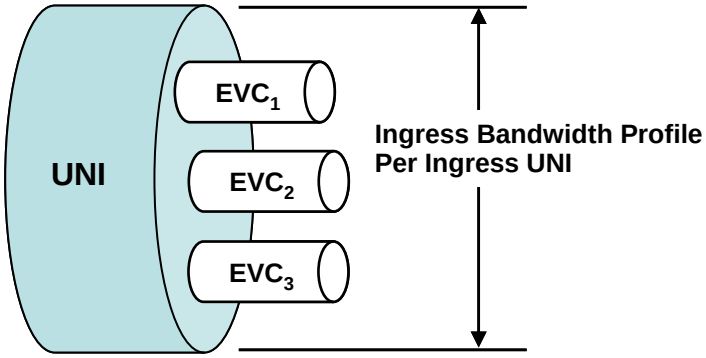

Figure 2-7 Ingress Bandwidth Profile per Ingress UNI

2.11.2 Ingress Bandwidth Profile per EVC

With this application of policing, a single Bandwidth Profile is applied to all ingress Service Frames for an instance of an EVC at the UNI (i.e., per Ethernet Virtual Connection). Thus, if a UNI has three Ethernet Virtual Connections, there could be three ingress Bandwidth Profiles, one for each EVC.

For example, in Figure 2-8 with a Fast Ethernet (100Base-TX) UNI on a CenturyLink Metro Ethernet Service Multiplexer or Service Provider port, EVC_1 could have a Bandwidth Profile or CIR of 20 Mbps, EVC_2 could have 10 Mbps and EVC_3 could have 50 Mbps. As implied in the figure, the sum of the individual EVC Ingress Bandwidth Profiles at a UNI must be less than or equal to the UNI speed. Furthermore, the Bandwidth Profile charge in the CenturyLink Metro Ethernet Rates and Services Schedule (RSS) No. 1 is assessed on a per port (UNI) basis and must be equal to or greater than the sum of the individual EVC Bandwidth Profiles.

The Ingress Bandwidth Profile per EVC service attribute is associated with each EVC at the UNI.

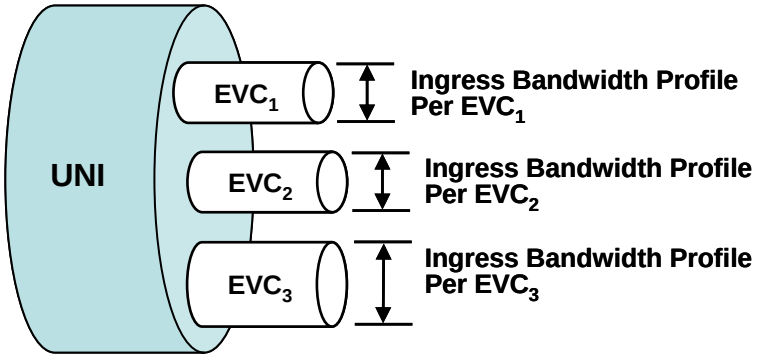

Figure 2-8 Ingress Bandwidth Profile per EVC

See Section 2.4, Rate-Limiting, Committed and Excess Information Rates for further information.

2.11.3 Egress Bandwidth Profile

An Egress Bandwidth Profile is used to regulate the amount of egress traffic at a particular UNI. An Egress Bandwidth Profile is defined for a UNI and applies to all or a subset of all egress Service Frames at the UNI in question.

Currently with CenturyLink Metro Ethernet, the corresponding Ingress Bandwidth Profiles and Egress Bandwidth Profiles will be provisioned symmetrical. In other words, at a UNI the Ingress and Egress Bandwidth Profiles must match and for a UNI supporting Service Multiplexing (Service Multiplexer UNI and Service Provider UNI) be similarly applied (i.e., per UNI or per EVC at a UNI).

Note for E-Line services with an Ingress Bandwidth Profile applied at the ingress UNI, traffic on the EVC is already controlled, therefore an Egress Bandwidth Profile per EVC at the egress UNI may not be mandated.

2.11.4 Layer 2 Control Protocol Processing

There are many Layer 2 Control Protocols that might be used in the customer's network Table 2-7 below provides a partial list of standardized Ethernet protocols

currently in use which may be discarded at the UNI or passed to an EVC where they may be tunneled (forwarded without be processed) across the CenturyLink Metro Ethernet service. The associated EVC is determined by the CE-VLAN ID of the Service Frame carrying the Layer 2 Control Protocol and CE-VLAN ID/EVC Map (see Sections 2.10.6 and 2.10.7). The UNI Layer 2 Control Protocol Processing service attribute is independent of the EVCs at the UNI.

* Table 2-7 is not intended to address any additional Layer 2 (or 3) Control Protocol requirements for peering.

Protocol	Destination MAC Address[1]	TLS Ports	All other Metro Ethernet port types
IEEE 802.1D Bridge Group Address for Spanning Tree Protocol (STP)[2]	01-80-C2-00-00-00	Tunnel	Discard
IEEE 802.3x Full Duplex MAC Flow Control (PAUSE) Frames	01-80-C2-00-00-01	Discard	Discard
IEEE 802.3-2008 (Clause 43) Link Aggregation Control Protocol (LACP)[3]	01-80-C2-00-00-02	Discard	Discard
IEEE 802.1X Port Authentication	01-80-C2-00-00-03	Discard	Discard
A protocol to be multicast to IEEE 802.1D all LANs Bridge Management Group Address[5]	01-80-C2-00-00-10	Tunnel	Discard
IEEE 802.1D / 802.1Q Generic Attribute Registration Protocol (GARP)	01-80-C2-00-00-20 through 01-80-C2-00-00-2F	Discard	Discard

Table 2-7 Layer 2 Control Protocol Tunneling

Table 2-7 Notes:

1. Hexadecimal canonical format

2. Customer Bridge Protocol Data Units (BPDUs) for 802.1D, 802.1w Rapid and 802.1s Multiple Spanning Tree Protocols (STP, RSTP and MSTP)
3. May include the Marker protocol, which is an option specified as part of Link Aggregation and provides an indication that all frames transmitted on a given link have been received by the MAC client
4
5. The All LANs Bridge Management Group Address (01-80-C2-00-00-10) has been officially deprecated in 802.1Q-2005, which states that address should not be used for Bridge management or for any other purpose. The recommended protocol for remote Bridge management is SNMP, which typically uses IP as a Network Layer protocol.
6. 'Tunnel' means that an ingress Layer 2 Control Protocol (L2CP) frame at a given UNI gets delivered unchanged to each of the destination UNIs. The requirement is that all UNIs in the EVC must tunnel the same protocols. In 802.1 terms, the L2CP is forwarded through the bridge relay (passed through the switches in the CenturyLink MEN without being processed).
7. 'Discard' means that the MEN will ignore the L2CP frame, i.e., it will not participate in (or source) the protocol and it will not forward the frame.
8. For cases in which more than one protocol uses the same Destination MAC Address such as LACP and Link OAM, then the required action related to tunneling is the same.

Additionally, any Layer 3 protocol that can be encapsulated and transported over Ethernet, such as IP or IPX can be transported over the CenturyLink MEN.

Service Attribute	Metro Ethernet Customer/Network Access Port				
	Non-TLS	TLS	Service Multiplexer	Service Provider	ENNI
Speed (Section 2.10.1)	10 Mbps, or 100 Mbps, or 1 Gbps, 10G, 100G	10 Mbps, or 100 Mbps, or 1 Gbps, 10G, 100G	10 Mbps, or 100 Mbps, or 1 Gbps, 10G, 100G	10 Mbps, or 100 Mbps, or 1 Gbps, 10G, 100G	1 Gbps 10Gbps
Mode (Sections 2.10.1 and 2.10.2)	Full Duplex	Full Duplex	Full Duplex	Full Duplex	Full Duplex
Physical Medium (Section 2.10.1)	10Base-T, or 100Base-TX, or 1000Base-T Auto-Negotiation, or 1000Base-LX, or 1000Base-LX Auto-Negotiation, or 1000Base-SX, or 1000Base-SX Auto-Negotiation 10G 100G	10Base-T, or 100Base-TX, or 1000Base-T Auto-Negotiation, or 1000Base-LX, or 1000Base-LX Auto-Negotiation, or 1000Base-SX, or 1000Base-SX Auto-Negotiation 10G 100G	10Base-T, or 100Base-TX, or 1000Base-T Auto-Negotiation, or 1000Base-LX, or 1000Base-LX Auto-Negotiation, or 1000Base-SX, or 1000Base-SX Auto-Negotiation 10G 100G	10Base-T, or 100Base-TX, or 1000Base-T Auto-Negotiation, or 1000Base-LX, or 1000Base-LX Auto-Negotiation, or 1000Base-SX, or 1000Base-SX Auto-Negotiation 10G 100G	1000Base-T Auto-Negotiation, or 1000Base-LX, or 1000Base-LX Auto-Negotiation, or 1000Base-SX, or 1000Base-SX Auto-Negotiation 10G
UNI Maximum Frame size in bytes (Section 2.10.4)	10/100 Mbps UNIs: 2016 1 Gbps 10G 100G UNIs: 9018	10/100 Mbps UNIs: 2016, 1 Gbps 10G 100G UNIs: 9018	10/100 Mbps UNIs: 2016 1 Gbps 10G 100G UNIs: 9018	10/100 Mbps UNIs: 2016, 1 Gbps 10G 100G UNIs: 9018	1 Gbps or 10G ENNI: 9018, o
Service Multiplexing (Section 2.10.5)	No	No	Yes	Yes	Yes

Service Peers @	Customer / User	Customer / User	Customer / User	Customer / User	Operator / Network

Service Attribute	Metro Ethernet Customer Access Port				
	Non-TLS	**TLS**	**Service Multiplexer**	**Service Provider**	**ENNI**
CE-VLAN ID/EVC Map[1] (Section 2.10.7)	All untagged CE frames received at the UNI are mapped to one EVC, and all CE-VLAN Tagged frames received at the UNI will be dropped	All untagged and CE-VLAN Tagged frames are mapped to one EVC	One or multiple CE-VLANs can be mapped to each EVC, and all untagged frames received at the UNI will be dropped	One or multiple CE-VLANs can be mapped to each EVC, and all untagged frames received at the UNI will be dropped	n/a
Maximum Number of EVCs	1	1	10	1G =100 10G = 500	n/a
S-VLAN ID/OVC Map (Section 2.10.7)	n/a	n/a	n/a	n/a	One S-VLAN ID value mapped to each OVC at ENNI
Maximum Number of OVCs	1	1	10	n/a	1G = 100 10G = 500
Bundling (Section 2.10.8)	No (N/A[3])	No		Yes[4], or No	No
All to One Bundling (Section 2.10.9)	Yes[3]	Yes	No	No	No
Ingress Bandwidth Profile per Ingress UNI (Section 2.11.1)	Yes	Yes	Yes, or No if per EVC	Yes, or No if per EVC	No
Ingress Bandwidth Profile per EVC (Section 2.11.2)	No	No	Yes, or No if per UNI	Yes, or No if per UNI	n/a
Ingress Bandwidth Profile per OVC (Section 2.11.2)	No	No	Yes, or No if per UNI	Yes, or No if per UNI	Yes

Egress Bandwidth Profile per Egress UNI (Section 2.11.3)	Yes	Yes		Yes, or No if per EVC	Yes, or No if per EVC
Egress Bandwidth Profile per EVC (Section 2.11.3)	No	No	Yes, or No if per UNI	Yes, or No if per UNI	Yes, or No if per UNI
Egress Bandwidth Profile per OVC (Section 2.11.13)	No	No	Yes, or No if per UNI	Yes, or No if per UNI	Yes

Service Attribute		Metro Ethernet Customer Access Port				
		Non-TLS	TLS[5]	Service Multiplexer	Service Provider	ENNI
Layer 2 Control Protocol Processing (Section 2.11.4)	STP	Discard	Pass to EVC (tunnel), or Discard (with 2 TLS ports in an E-Line configuration only)	Discard	Discard	Untagged Discard S-Tagged Pass
	CDP	Discard	Pass to EVC (tunnel)	Discard	Discard	Untagged Discard S-Tagged Pass
	VTP	Discard	Pass to EVC (tunnel)	Discard	Discard	Untagged Discard S-Tagged Pass
	LACP[6]	Discard	Discard	Discard	Discard	Discard
	All-bridge multicast	Discard	Pass to EVC (tunnel), or Discard (with 2 TLS ports in an E-Line configuration only)	Discard	Discard	Untagged Discard S-Tagged Pass
	GARP	Discard	Pass to EVC (tunnel), or Discard (with 2 TLS ports in an E-Line configuration only)	Discard	Discard	Discard
	PAUSE frames	Discard	Discard	Discard	Discard	Discard
	Port Authentication	Discard	Discard	Discard	Discard	Discard

Table 2-8 UNI/ENNI and EVC/OVC per UNI/ENNI Service Attributes

Table 2-8 Notes:

1. CE-VLAN Tagged frames received at the UNI will be dropped with only untagged customer frames mapped to the EVC.
2. If Bundling is yes, then CE-VLAN ID Preservation (see Section 2.12.3) must be yes.
3. Layer 2 Control Protocol tunneling on TLS ports is offered on a "where available" basis only
4. CE = Customer Edge
5. TLS = Transparent LAN Service
6. N/A = Not Applicable
7. STP = Spanning Tree Protocol
8. CDP = Cisco Discovery Protocol
9. VTP = VLAN Trunking Protocol
10. LACP = Link Aggregation Control Protocol
11. GARP = Generic Attribute Registration Protocol

2.12 Ethernet Virtual Connection Service Attributes for Metro Ethernet Customer Access Ports

The EVC is a fundamental aspect of CenturyLink Metro Ethernet service and defined as an association of two or more UNIs that limits the exchange of Service Frames to UNIs in the EVC. A given UNI can support more than one EVC via the Service Multiplexing attribute as described in Section 2.10.5.

An ingress Service Frame that is mapped to the EVC (see Section 2.10.7) can be delivered to one or more of the UNIs in the EVC. It will not be delivered back to the ingress UNI or to a UNI not in the EVC. An EVC is always bi-directional in the sense that ingress Service Frames can originate at any UNI in an EVC.

EVC service attributes provide the ability to describe the characteristics of the EVC(s) at each UNI reference point, and for CenturyLink Metro Ethernet include:

- EVC type
- Maximum number of UNIs
- Unicast, Multicast and Broadcast Service Frame Delivery
- CE-VLAN ID Preservation
- CE-VLAN CoS Preservation
- Class of Service Identifier based on EVC, Priority Code Point Field or DSCP
- EVC Maximum Frame size

The EVC service attributes are described in the following sections and listed in Table 2-11 along with the parameter values for each Metro Ethernet customer access port.

2.12.1 Ethernet Virtual Connections

An Ethernet Virtual Connection (EVC) is an association of two or more UNIs that limits the exchange of Service Frames to UNIs within the EVC, where the UNI is a standard Ethernet interface that is the point of demarcation between the Customer Edge and the CenturyLink MEN.

An EVC performs two functions:

- Connects two or more Subscriber sites (UNIs) enabling the transfer of Ethernet Service Frames between them
- Prevents data transfer between Subscriber sites that are not part of the same EVC

Two basic rules govern delivery of Ethernet frames over an EVC:

- A Service Frame is never delivered back to the UNI from which it originated.
- Service Frames are delivered with the Ethernet MAC addresses and frame contents unchanged, i.e., the Ethernet frame headers and payload remain intact from source to destination(s).

Based on these characteristics, an EVC can be used to construct a Layer 2 Virtual Private Network (VPN).

There are two types of customer-orderable EVCs with NC Codes listed in Section 3.6.7:

- Point-to-Point

  Is associated with exactly two UNIs and an ingress Service Frame at one UNI can only be an egress frame at the other UNI.

- Multipoint-to-Multipoint

  Is associated with two or more UNIs and an ingress Service Frame at one of the UNIs can be an egress frame at one or more of the other UNIs.

The Ethernet Line Service (E-Line Service) provides a Point-to-Point Ethernet Virtual Connection (EVC) between two User-Network Interfaces (UNIs) as illustrated in Figure 2-9. The E-Line Service is used for Ethernet point-to-point connectivity across the CenturyLink MEN. Customer Edge (CE) equipment (customer-provided) attaches to the MEN at the UNI using a standard 10 Mbps, 100 Mbps or 1 Gbps Ethernet interface.

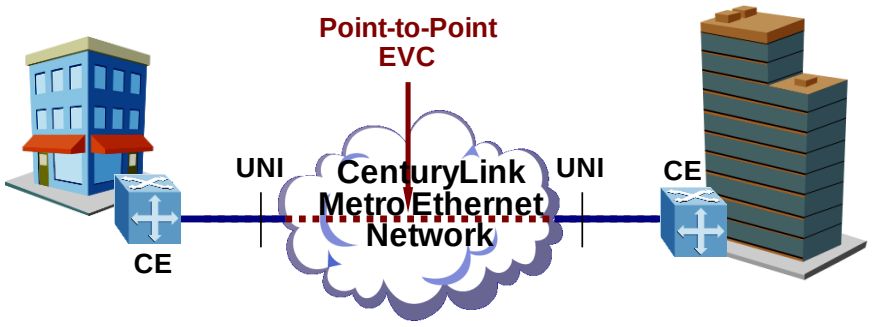

Figure 2-9 E-Line Service

The Ethernet LAN Service (E-LAN Service) provides multipoint connectivity, i.e., it may connect two or more UNIs as illustrated in Figure 2-10. Customer data sent from one UNI can be received at one or more of the other UNIs. Each site (UNI) is connected to a multipoint EVC. As new sites (UNIs) are added, they are connected to the same multipoint EVC thus simplifying provisioning and service activation. From a customer perspective, an E-LAN Service makes the CenturyLink MEN look like a LAN.

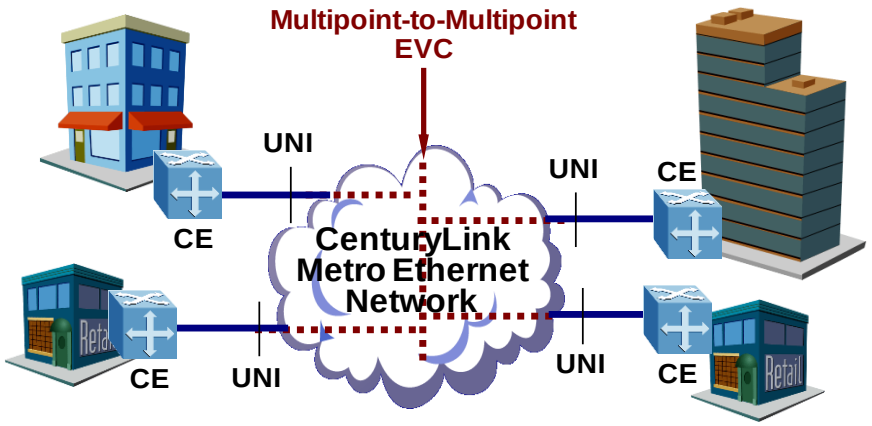

Figure 2-10 E-LAN Service

In a Point-to-Point EVC, exactly two UNIs are associated with one another. In a Multipoint-to-Multipoint EVC, two or more UNIs are associated with one another. Metro Ethernet Point-to-Point EVC requests will be provisioned using a Multipoint-to-Multipoint EVC with two UNIs. This supports the ability for the customer to add additional UNIs to the EVC later.

CenturyLink Metro Ethernet service can support Service Multiplexing (see Section 2.10.5) of EVCs at none, one or more UNIs depending upon the configuration. For example, an E-LAN Service (Multipoint-to-Multipoint EVC) and an E-Line Service (Point-to-Point EVC) may be provided at the same UNI. In Figure 2-11, the E-LAN Service is used to interconnect the End User customer's Headquarters, Remote Site and Storage while the E-Line Service is used to connect to the Internet with both services offered via EVC Service Multiplexing on a Service Multiplexer port or UNI at the Headquarters location.

At the ISP POP, a service multiplexed UNI provides the ability to support multiple of their Subscribers on a single CenturyLink Metro Ethernet Service Provider port. This configuration ensures that the internal End User customer's data won't be sent to the Internet or unnecessarily consume ISP bandwidth resources.

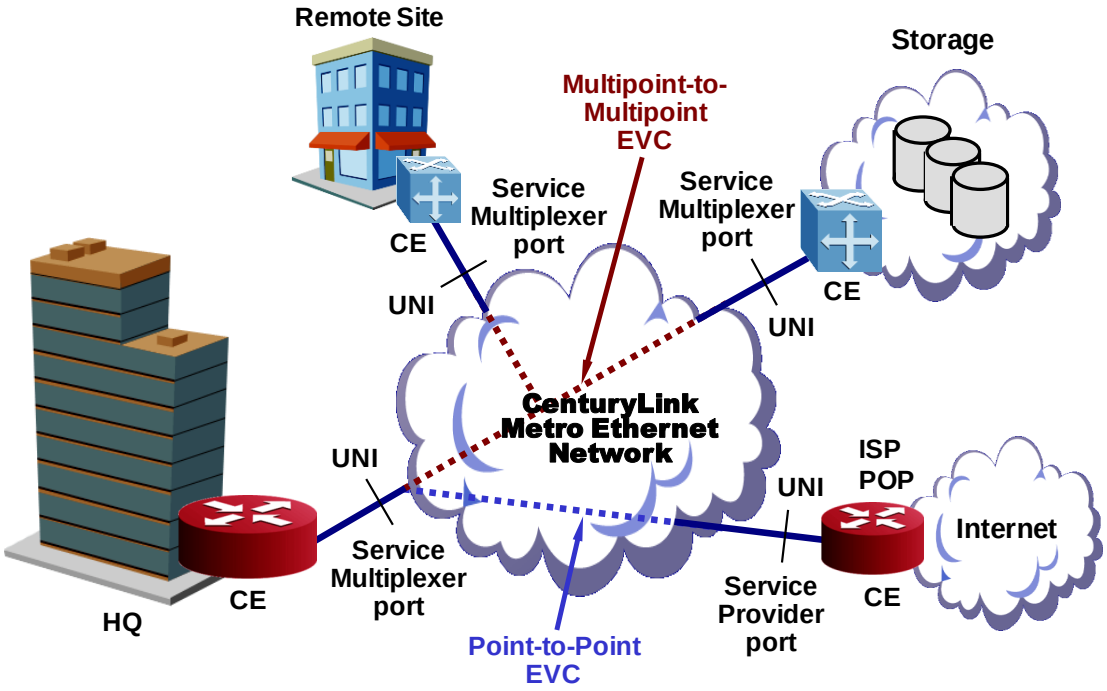

Figure 2-11 Metro Ethernet Example using E-Line and E-LAN with Service Multiplexing

2.12.2 Unicast, Multicast and Broadcast Service Frame Delivery

An Ethernet Virtual Connection (EVC) allows Ethernet Service Frames to be exchanged between UNIs that are connected via the same EVC. Some frames are Subscriber data Service Frames while others are Ethernet control Service Frames as determined from the Destination MAC Address.

A unicast Service Frame may already be known (learned by the MEN) or unknown. An E-LAN Service will support address learning whereas Ethernet frames with an unknown unicast, multicast or broadcast address will be flooded to all UNIs associated with the Ethernet Virtual Connection (EVC), while frames with a known unicast address will be delivered only to the UNI where that MAC address has been learned.

While Ethernet frames will be forwarded to the appropriate end stations in each customer's EVC, CenturyLink recommends that customers enable controls for multicast, broadcast and unknown unicast traffic within their own network. To constrain flooding and prevent excessive traffic from degrading overall network performance, CenturyLink:

- Will limit the percentage of total available bandwidth that can be used by broadcast traffic (Ethernet frames having the broadcast Destination MAC Address) to approximately 1% per customer facing switch port
- Upon request use Internet Group Management Protocol (IGMPv3) snooping to suppress IP multicast traffic to non-interested ports so that customer traffic is forwarded only to those Metro Ethernet interfaces associated with multicast routers

2.12.3 CE-VLAN ID Preservation

An EVC will preserve customer CE VLAN ID values when the customer orders the same VLANs at each UNI member of and EVC. An EVC that contains only TLS UNI will preserve customer CE VLAN ID values. In an EVC with CE-VLAN ID Preservation (or transparency):

1. The CE-VLAN ID/EVC Map for the EVC is identical at all UNIs in the EVC.
2. The relationship between the ingress Service Frame and its corresponding egress Service Frame(s) described in Table 2-9 is maintained.

Ingress Service Frame	Egress Service Frame(s)
No IEEE 802.1Q Tag	No IEEE 802.1Q Tag
Contains IEEE 802.1Q Tag	Contains IEEE 802.1Q Tag with VLAN ID equal to the VLAN ID of the Tag on the ingress Service Frame

Table 2-9 CE VLAN ID Preservation

An EVC with the CE-VLAN ID Preservation service attribute will preserve (not modify) the CE-VLAN ID for Service Frames as indicated in Table 2-10below.

CE-VLAN ID/EVC Map Characteristic	Service Frames with CE-VLAN ID Preserved
All to One Bundling at all UNIs	All Data Service Frames
All other cases	All tagged Data Service Frames with VLAN ID in the range 2 – 4094

Table 2-10 CE VLAN ID Preservation Attribute for an EVC

When an EVC includes a UNI with Bundling at which more than one CE-VLAN ID is mapped to the EVC by the CE-VLAN ID/EVC Map (see Sections 2.10.7 and 2.10.8), the EVC will have the CE-VLAN ID Preservation service attribute. With CE-VLAN ID Preservation there is no constraint on the Subscriber choice of VLAN ID or but a maximin of 50 CE VLAN ID values can be bundled.

2.12.4 CE-VLAN CoS Preservation

In an EVC with CE-VLAN CoS Preservation, an egress Service Frame resulting from an ingress Service Frame that contains a CE-VLAN CoS will have the identical CE-VLAN CoS. The customer priority values will be passed unchanged by the EVC from ingress to egress except for an EVC that does not have the same VLAN at the ingress UNI and all egress UNIs, for such an EVC customer IP priority values are preserved but customer PCP values are not

Service Attribute	Metro Ethernet Customer Access Port				
	Non-TLS	**TLS**	**Service Multiplexer**	**Service Provider**	**ENNI**
EVC Type (Section 2.12.1)	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point, or Multipoint-to-Multipoint	n/a
OVC Type	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point, or Multipoint-to-Multipoint
Maximum Number of UNIs per EVC (Section 2.12.1)	2 for E-Line Point-to-Point EVCs, or n ≥ 2 and <51for E-LAN Multipoint-to-Multipoint EVCs. > 50 ICB	2 for E-Line Point-to-Point EVCs, or n ≥ 2 and <51for E-LAN Multipoint-to-Multipoint EVCs. > 50 ICB	2 for E-Line Point-to-Point EVCs or n ≥ 2 and <51for E-LAN Multipoint-to-Multipoint EVCs. > 50 ICB	2 for E-Line Point-to-Point EVCs. 3 for Multipoint-to-Multipoint EVCs. 2 SP and one other.	n/a
Maximum Number of UNIs per OVC (Section 2.12.1)	2 for E-Line Point-to-Point EVCs, or n ≥ 2 and <51for E-LAN Multipoint-to-Multipoint OVCs. > 50 ICB	2 for E-Line Point-to-Point EVCs, or n ≥ 2 and <51for E-LAN Multipoint-to-Multipoint OVCs. > 50 ICB	2 for E-Line Point-to-Point EVCs, or n ≥ 2 and <51for E-LAN Multipoint-to-Multipoint OVCs. > 50 ICB	1 for E-Line Point-to-Point OVCs, or ICB for E-LAN Multipoint-to-Multipoint OVCs	2 for E-Line Point-to-Point EVCs, or 1for E-LAN Multipoint-to-Multipoint OVCs. > 1 ICB
Maximum Number of ENNI	n/a	n/a	n/a	n/a	1 for Point to Point OVC with

					UNI, 2 for Point to Point OVC with ENNI, 1 for Multipoint to Multipoint OVC, > 1 ICB
Unicast Service Frame Delivery (Section 2.12.2)	Deliver Unconditionally[1]	Deliver Unconditionally[1]	Deliver Unconditionally[1]	Deliver Unconditionally[1]	Deliver Unconditionally[1]
Multicast Service Frame Delivery (Section 2.12.2)	Deliver Unconditionally[1]	Deliver Unconditionally[1]	Deliver Unconditionally[1]	Deliver Unconditionally[1]	Deliver Unconditionally[1]
Broadcast Service Frame Delivery (Section 2.12.2)	Deliver Conditionally	Deliver Conditionally	Deliver Conditionally	Deliver Conditionally	Deliver Conditionally
CE-VLAN ID Preservation (Section 2.12.3)	No (N/A[2])	Yes	Yes, or No (See Table 2-10Table 2-9)	Yes, or No (See Table 2-10)	Yes,
CE-VLAN CoS Preservation (Section 2.12.4)	No (N/A[2])	Yes	Yes, or No (See Table 2-12Table 2-10)	Yes, or No (See Table 2-12)	Yes
Class of Service Identifier based on EVC/OVC (Section 2.13)	No (per UNI)	No (per UNI)	Yes	Yes	Yes
Class of Service Identifier based on Priority Code	No (N/A[2])	Yes	Yes	Yes	n/a

Point Field of C VLAN (Section 2.13)					
Class of Service Identifier based on DSCP (Section 2.13)	Yes	Yes	Yes	Yes	n/a
Class of Service Identifier based on Priority Code Point Field of S-VLAN	n/a	n/a	n/a	n/a	Yes

Table 2-11 EVC/OVC Service Attributes

Table 2-11 Notes:

1. Deliver Unconditionally if the traffic conforms to the service policy
2. N/A = Not Applicable as CE-VLAN Tagged frames received at the UNI will be dropped with only untagged customer frames mapped to the EVC
3. Including possible Ethernet over SONET (EoS), Reconfigurable Optical Add-Drop Multiplexer (ROADM) / Dense Wavelength Division Multiplexing (DWDM), etc. CenturyLink Metro Ethernet infrastructure transport platforms.

Note that when an EVC contains more than one CenturyLink Metro Ethernet customer access port type or different service attributes at each UNI, the end-to-end Metro Ethernet service parameters will be limited to those attributes supported across all UNIs in the EVC. Table 2-12 provides additional requirements for Metro Ethernet customer access ports in an EVC.

Service Multiplexer to Service Provider	May be configured with CE-VLAN ID Preservation CE-VLAN CoS Preservation Only valid E-LAN combination is one Service Multiplexer and two Service Provider ports
Service Multiplexer to TLS **Effective 11-17-2012 this configuration is no longer available**; and limited to existing Metro Ethernet (or MOE) contract customers if/where supported by company equipment only. Customers are advised to order: Service Multiplexer to Service Multiplexer port configurations in an EVC and work with CenturyLink Engineering to specify the necessary end-to-end service attributes for all Ethernet traffic flows.	Untagged frames dropped CE-VLAN ID Preservation CE-VLAN CoS Preservation No Layer 2 Control Protocol tunneling May be configured to support untagged frames on a per EVC basis CE-VLAN ID Preservation CE-VLAN CoS Preservation May be configured to support Layer 2 Control Protocol tunneling on a per EVC basis
Service Multiplexer to Non-TLS	No CE-VLAN ID Preservation No CE-VLAN CoS Preservation No Layer 2 Control Protocol tunneling
Service Provider to Service Provider	Only valid E-LAN combination is two Service Provider ports and one non-Service Provider port

Service Provider to TLS **Effective 11-17-2012 this configuration is no longer available**; and limited to existing Metro Ethernet (or MOE) contract customers if/where supported by company equipment only. Customers are advised to order: Service Multiplexer to Service Provider port configurations (see above) in an EVC with similar end-to-end service attributes.	Untagged frames dropped CE-VLAN ID Preservation CE-VLAN CoS Preservation No Layer 2 Control Protocol tunneling Only valid E-LAN combination is one TLS and two Service Provider ports
Service Provider to Non-TLS	No CE-VLAN ID Preservation No CE-VLAN CoS Preservation No Layer 2 Control Protocol tunneling Only valid E-LAN combination is one Non-TLS and two Service Provider ports
TLS to Non-TLS	Not a valid combination
SP to ENNI	Not Supported

Table 2-12 Additional Service Attributes for Metro Ethernet Access Ports in an EVC

Table 2-12 Note: E-LAN is an Ethernet service type distinguished by its use of a Multipoint-to-Multipoint EVC such as for CenturyLink Metro Ethernet when there are more than two UNIs in the EVC.

2.13 Quality of Service and Class of Service

2.13.1 Overview

CenturyLink Metro Ethernet supports two optional methods that will allow a customer to prioritize their Ethernet applications within the CenturyLink network, Quality of Service (QoS) and Class of Service (CoS). QoS and CoS will enable CenturyLink Metro Ethernet to differentiate between the customer's traffic flows during periods of network congestion to ensure delivery of real-time or mission-critical traffic ahead of lower priority. QoS is a method that supports either mapping all customer traffic into one class of service, the best effort class of service or having CenturyLink classify and then map customer traffic into four different classes of service. The CoS option is a method that supports three different classes of service. The Cos option also supports having the choice of mapping all customer traffic into the lowest class of service, but additionally the CoS option also supports the options of mapping all customer traffic into the medium class of service or the highest class of service as well as having CenturyLink classify customer traffic and then mapping the traffic into the three Classes of Service.

When multiple classes of service are supported at a UNI (Non-TLS or TLS) or for an EVC at a UNI (Service Multiplex, Service Provider) the customer must select whether CenturyLink will classify and map customer traffic into the correct Class of Service based on the QoS customer's incoming:

- Layer 2 Class of Service (CoS) 802.1p user priority bits
- Layer 3 Differentiated Services Code Point (DSCP)/Type of Service (ToS) IP precedence bits

When a UNI or an EVC is configured to support multiple classes of services, once customer traffic has been classified and mapped to the correct class of service a bandwidth amount will be applied to each class of service. The feature of the bandwidth applied to each class of service is support for the sharing of unused higher class of service bandwidth to lower classes of service. This bandwidth sharing is useful to efficiently use bandwidth between the classes and not strand unused higher class of service bandwidth.

Though supported on all UNIs and Metro Ethernet customer access ports, QoS and Cos are dependent upon the switching equipment and transport facilities within the CenturyLink network and are offered on a 'where available' basis.

2.13.2 Quality of Service

When QOS option is used by a customer the configured traffic class and policy maps are used to determine which of four queues each customer frame is assigned to per Metro Ethernet QoS customer UNI (TLS and Non-TLS UNIs) or EVC at the UNI (SM or SP UNIs). Predefined queuing methods will prioritize each QoS customer's traffic separately with four different Classes (or Levels) of Service:

- Priority 1 – This QoS level is designed to carry premium customer traffic such as Voice over Internet Protocol (VoIP) and other real-time applications. This class will be configured for strict priority queuing allowing latency-sensitive applications, such as voice and video traffic to be sent first. P1 traffic will be marked for expedite handling within the CenturyLink MEN. During periods of congestion, the Priority 1 queue will have guaranteed traffic delivery based on the customer's ordered P1 Bandwidth
- Profile.Priority2 – This QoS level supports interactive video and critical business traffic such as financial transactions or storage applications.
- Priority 3 – This QoS level is intended for business data traffic or commercial applications.
- Priority 4 – This QoS level is the standard default traffic class for all other applications not defined in the above P1, P2 or P3 queues and is suitable for standard business applications such as file or batch transfers, email and web browsing. P4 will have the lowest forwarding priority of any QoS traffic on the MEN.

Customers will need to specify either CoS or IP based classification when ordering QoS. EVC NCI Codes (see Section 3.6.7) are used to determine the type of classification, for the EVC. The Metro Ethernet Service will identify the different customer prioritized traffic with QoS based on the value of either:

- Layer 2 Class of Service (CoS) 802.1p user priority bits
- Layer 3 Differentiated Services Code Point (DSCP)/Type of Service (ToS) IP precedence bits

QoS classification for IPv6 packets (or other Layer 3 traffic types such as IPX, AppleTalk, SNA, etc.) is currently not supported. The customer is responsible for appropriately setting the 802.1p, or IP priority bits within their network equipment for transmission at the premises based on their ordered QoS service per connection. CenturyLink's assignments for customer CoS and IP precedence values to the four different Metro Ethernet QoS traffic classes are listed in Table 2-13 below.

QoS Traffic Class	Layer 2 CoS	802.1p Bits	Layer 3 IP Precedence (and Equivalent DSCP Values)	IP Precedence Bits
Priority 1 (P1)	5	101	5 (40-47)	101
Priority 2 (P2)	4 6 7*	100 110 111	4 (32-39) 6 (48-55) 7* (56-63)	100 110 111
Priority 3 (P3)	2 3	010 011	2 (16-23) 3 (24-31)	010 011
Priority 4 (P4)	0 1	000 001	0 (0-7) 1 (8-15)	000 001

Table 2-13 Customer CoS and IP Priority value for Each QOS Traffic Class

*** Note:** Some customer "network control" traffic may also use the Priority 2 queue, e.g. Layer 2 keepalives will share this queue if they are running on the CE-PE link.

The customer marked CoS or IP priority values will be acted upon accordingly at the Metro Ethernet UNI or EVC with traffic forwarding and queue scheduling determined by the incoming P1, P2, P3 or P4 priority in alignment with the customer-ordered QoS and associated bandwidth values and template selected. The customer priority values will be passed unchanged by the EVC from ingress to egress except for an EVC that does not have the same VLAN at the ingress UNI and all egress UNIs, for such an EVC customer IP priority values are preserved but customer PCP values are not.

Note: For a Non-TLS UNI prioritization of customer traffic can only be based on IP priority since the UNI only supports untagged customer traffic.

2.13.3 Bandwidth for QOS

When QOS is enabled for a UNI or the EVCs at the UNI the customer traffic will be classified into the four QOS Class of Service values P1, P2, P3 and P4. The customer must

determine the bandwidth values that CenturyLink will apply to each Class of Service. The customer will provide CenturyLink with a UNI or EVC value, a P1 value and a template value. The template value will be used to configure the bandwidth for P2, P3 and P4 Class of Service. The UNI or EVC bandwidth is the sum of all bandwidth used by the four Class of Services. The P1 bandwidth is a subset of the UNI or EVC bandwidth. The template is specified as percentages for P2, P3 and P4 bandwidths and configures how the P2, P3 and P4 Class of Services share the UNI or EVC bandwidth not used by P1. To ensure that bandwidth is available for the P2, P3 and P4 Class of Services the P1 bandwidth amount must be a value greater than 0 and less than the UNI or EVC bandwidth amount. Stated another way for the QOS option you cannot dedicate 100% of the UNI or EVC bandwidth to P1, there must be bandwidth available for traffic classified into P2, P3 and P4. In general, the best practice for bandwidth with QOS enabled is to have the P1 bandwidth amount a smaller percentage (< 30%) of the total bandwidth at the UNI or EVC.

When Quality of Service is ordered eight different options or templates will be available. Each template specifies how the remaining Bandwidth Profile will be distributed to Priorities 2, 3 and 4 as set forth in the eight templates, below:

Priority 2 Priority 3 Priority 4

- Template 1 20% 40% 40%
- Template 2 25% 35% 40%
- Template 3 30% 30% 40%
- Template 4 35% 25% 40%
- Template 5 40% 20% 40%
- Template 6 45% 15% 40%
- Template 7 50% 10% 40%
- Template 8 55% 5% 40%

The 8 different templates are described in Section 8.8 of the Rates and Services Schedule (RSS) No. 1 available from:

http://www.centurylink.com/tariffs/fcc_cloc_acc_isg_no_11.pdf

Quality of Service comes with a service guarantee for every 3 or 5 megabit increments of Priority 1 traffic. The SLA credit will be based on a specific calendar month's performance set forth in Section 2.4.4.B.3, preceding.

When a customer uses a Point to Point Line Services both the Bandwidth Profiles and QOS options should match at each end. When an E-LAN service is

implemented, Bandwidth Profiles and QoS templates may be selected independently at each UNI.

The QOS method supports an EVC with a mix of UNI members where QOS enabled and disabled.

2.13.4 Class of Service

When the CoS option is used by a customer the configured traffic class and policy maps are used to determine which of three queues each customer frame is assigned to per Metro Ethernet CoS customer UNI (TLS and Non-TLS UNIs) or EVC at the UNI (SM or SP UNIs). Predefined queuing methods will prioritize each QoS customer's traffic separately with three different Classes (or Levels) of Service:

- Real Time (RT) – This QoS level is designed to carry premium customer traffic such as Voice over Internet Protocol (VoIP) and other real-time applications. This class will be configured for strict priority queuing allowing latency-sensitive applications, such as voice and video traffic to be sent first. P1 traffic will be marked for expedite handling within the CenturyLink MEN. During periods of congestion, the Priority 1 queue will have guaranteed traffic delivery based on the customer's ordered P1 Bandwidth
- Guaranteed Data (GD) – This QoS level supports interactive video and critical business traffic such as financial transactions or storage applications. This QoS level is intended for business data traffic or commercial applications.
- Business Class (BC) – This QoS level is the standard default traffic class for all other applications not defined in the above RT and GD queues and is suitable for standard business applications such as file or batch transfers, email and web browsing. BC will have the lowest forwarding priority of any QoS traffic on the MEN.

Customers will need to specify either CoS or IP based classification when ordering CoS. EVC NCI Codes (see Section 3.6.7) are used to determine the type of classification, for the EVC. The Metro Ethernet Service will identify the different customer prioritized traffic with CoS based on the value of either:

- Layer 2 Class of Service (CoS) 802.1p user priority bits
- Layer 3 Differentiated Services Code Point (DSCP)/Type of Service (ToS) IP precedence bits

QoS classification for IPv6 packets (or other Layer 3 traffic types such as IPX, AppleTalk, SNA, etc.) is currently not supported. The customer is responsible for appropriately setting the 802.1p, or IP priority bits within their network equipment for transmission at the premises based on their ordered CoS service per connection. CenturyLink's assignments for customer CoS and IP precedence values to the three different Metro Ethernet CoS traffic classes are listed in Table 2-14 below.

QoS Traffic Class	Layer 2 CoS	802.1p Bits	Layer 3 IP Precedence (and Equivalent DSCP Values)	IP Precedence Bits
Priority RT	5	101	5 (40-47)	101
Priority GD	2 3 4 6 7	010 011 100 110 111	2 (16-23) 3 (24-31) 4 (32-39) 6 (48-55) 7 (56-63)	010 011 100 110 111
Priority BC	0 1	000 001	0 (0-7) 1 (8-15)	000 001

Table 2-14 Customer CoS and IP Precedence Settings for CoS Traffic Class

The customer marked CoS or IP priority values will be acted upon accordingly at the Metro Ethernet UNI or EVC with traffic forwarding and queue scheduling determined by the incoming RT, GD, BC priority in alignment with the customer-ordered CoS and associated bandwidth values. The customer priority values will be passed unchanged by the EVC from ingress to egress except for an EVC that does not have the same VLAN at the ingress UNI and all egress UNIs, for such an EVC customer IP priority values are preserved but customer PCP values are not.

Note: For a Non-TLS UNI prioritization of customer traffic can only be based on IP priority since the UNI only supports untagged customer traffic.

2.13.5 Bandwidth for CoS

When an EVC is configured to support CoS options to support the additional functionality available in CoS all UNI members of a CoS EVC must be configured in the same manner.
When an EVC supports a single Class of service of either RT or GD or BC only a single bandwidth amount is needed for the EVC at each UNI.

When an EVC is configured to support the multiple Class of Services RT and GD and BC at the UNI or the EVC the customer traffic will be classified into the three CoS Class of Service values RT, GD and BC. The customer must determine the bandwidth values that CenturyLink will apply to each Class of Service. To ensure that bandwidth is available for the Class of Services the bandwidth value for each Class of Service must be greater than 0. The sum of the Class of Service Bandwidth values is the EVC bandwidth. In general, the best practice for bandwidth with multiple CoS enabled is to have the RT bandwidth amount a smaller percentage (< 30%) of the total bandwidth at the UNI or EVC. It is also recommended that CoS and EVC bandwidth values should align where possible with the rate increment values in Section 3.6.2. For example, a 100mb EVC could be divided as RT 10mb, GD 20mb, and BC 80mb. For a 100mb EVC at a UNI where a customer may only need 1mb of GD for their applications, although CoS could be purchased in 1mb increments we do not recommend a 100mb EVC at the UNI with values of RT 10mb, GD 1mb, and BC 89mb. Since bandwidth sharing is enabled for the EVC, values of RT 10mb, GD 10mb and BC of 80 would meet the needs at the site, the unused GD is available for the BC class of service.

When a customer uses a Point to Point Line Service the one of more Bandwidth Profiles should match at each end, with an E-LAN service, Bandwidth Profiles may be selected independently at each UNI for the EVC to meet the needs of the site.

When an EVC is configured to provide the additional functionality available in the CoS option all UNI members of a CoS EVC must be configured in the same manner.

2.13.6 Class of Service for ENNI

When a customer uses an ENNI to host one or more OVCs, the OVC will be configured to use the CoS option. Both the OVC end at the ENNI and the OVC endpoint at the UNI must use the CoS option. QoS is not available for a UNI hosting an OVC or an ENNI.

For an OVC endpoint at a UNI the CoS option will work the same as for an EVC at a UNI. For an OVC endpoint at an ENNI the CoS option will support the same class of service choices of RT or GD or BC as well as the multi-CoS choice or RT and GD and BC. However, for a multi-CoS OVC at an ENNI classification for customer traffic is accomplished using the PCP values in the S-VLAN tag applied at the ENNI (stacked onto the customer VLAN tag. At the ENNI classification using layer 3 DSCP values is not supported. Bandwidth at the ENNI for each Class of service in the OVC will all work the same as at a UNI. For an OVC with a single Class of Service only a single bandwidth is required.

QoS Traffic Class	Layer 2 CoS S-VLAN	802.1p Bits S-VLAN	Layer 3 IP Precedence (and Equivalent DSCP Values)	IP Precedence Bits
Priority RT	5	101	Not supported	Not supported
Priority GD	2 3 4 6 7	010 011 100 110 111		
Priority BC	0 1	000 001		

Table 2-15 Operator CoS Setting for CoS Traffic Class at ENNI

3 Network Interfaces

3.1 Applicability of Technical Specifications

Technical specifications presented in this chapter are applicable to CenturyLink Metro Ethernet service only. This document does not attempt to describe the equipment used to provide this service.

3.2 Description of CenturyLink Metro Ethernet User-Network Interfaces

CenturyLink Metro Ethernet service will be provisioned using intelligent Ethernet switches. This technology allows CenturyLink to deliver the standard 10,100, or1000 Mbps Local Area Network (LAN) interfaces shown in Table 3-1. A detailed description of these Ethernet protocols can be found in documents available from the Institute of Electrical and Electronics Engineers' (IEEE's) web site at: http://standards.ieee.org/.

CenturyLink Metro Ethernet Network Access Links are provided to both End-User (UNI) and Carrier customers (UNI or ENNI). The signal characteristics and supported MAC Layers at the User-Network Interface (UNI) or ENNI will be as specified in the IEEE 802.3-2008, *Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications* standard. The physical UNI or ENNI for all customers will be at an RJ-45 jack on a CenturyLink-provided switch port or integrated demarcation panel, or possibly Gigabit Ethernet Small Form-factor Pluggable (SFP) transceiver module for electrical; and an SC, FC or LC UPC duplex connector on a CenturyLink-provided SFP via a fiber jumper and adapter/coupler for optical Gigabit Ethernet interfaces at customer premises locations. While other indoor/outdoor arrangements may be supported, a company-provided Category 5E Patch Panel or Fiber Distribution Panel (FDP) isn't required. The User-Network Interface (UNI) is the point of demarcation between CenturyLink Metro Ethernet service and the customer-provided Data Terminal Equipment (DTE).

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 QWEST EQUIPMENT IN CUSTOMER-OWNED OUTDOOR CABINETS*, describes the environmental (including electromagnetic compatibility), power, and grounding requirements for customer-owned outdoor cabinets (if provided) to allow the

placement of CenturyLink-owned equipment inside these cabinets for the provisioning of Metro Ethernet service to the customer.

Interface	Bit Rate	Bandwidth Profile or Data Rate	Mode	Impedance or Central Wavelength	Cable or Fiber Type	Connector
10Base-T	10 Mbps	3[1], 5, 7[1], 10	Full duplex	100 ohms	Two pairs[2] of twisted-pair telephone or Category 3, 4 or 5 (recommended[3]) copper wire	RJ-45
100Base-TX	100 Mbps	3[1], 5[1], 7[1], 10, 20, 30, 40, 50, 60, 70, 80, 90, 100	Full duplex	100 ohms	Two pairs[2] of Category 5 Unshielded Twisted-Pair (UTP) or Shielded Twisted-Pair (STP) copper wire	RJ-45
1000Base-T	1000 Mbps	10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000	Full duplex	100 ohms	Four pairs of Category 5 balanced copper cabling	RJ-45
1000Base-LX	1000 Mbps[5]	10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000	Full duplex	1300-1310 nm	One pair of Single-Mode Fiber[6]	Duplex SC, FC or LC UPC[7]

1000Base-SX	1000 Mbps[5]	10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000	Full duplex	850 nm	One pair of Multi-Mode Fiber[8]	Duplex SC, FC or LC UPC[7]

Table 3-1 Available Interfaces

Table 3-1 Notes:

1. 3 & 7 Mbps Bandwidth Profiles on 10Base-T UNIs and 3, 5 & 7 Mbps Bandwidth Profiles on 100Base-TX UNIs have limited availability.
2. While 10Base-T and 100Base-TX compatible devices can use a two twisted-pair cable, CenturyLink will wire all 10/100/1000 Mbps electrical switch ports to the User-Network Interface (UNI) with a four twisted-pair cable and terminate on standard RJ-45 connectors. Only the pinouts will be different for 10/100 Mbps ports since just 4 of the 8 wires or RJ-45 connector pins are used.
3. Although the customer may use Category 3, 4 or 5 copper wire when connecting to 10Base-T ports, CenturyLink will use Category 5E (Enhanced performance) balanced copper cabling for all electrical interfaces.
4. Given the above, remote upgrades from 10Base-T to 100Base-TX (and 1000Base-T in some cases) on existing electrical interfaces may be possible for CenturyLink Metro Ethernet customers. See Section 4.2, Bandwidth Change Requests for further information.
5. The actual signaling rate for 1000Base-LX/SX User-Network Interfaces with 8B/10B line encoding is 1250 Mbps.
6. Single mode fiber is 9-10/125 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 fiber and cable*.
7. SC/UPC (with Ultra Physical Contact polish) is the CenturyLink default optical connector for new CenturyLink Metro Ethernet 1000Base-LX/SX UNIs 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.
8. 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*; see Table 3-9 for distance limitations.
9. CenturyLink will manually provision (or hard code) the speed and (full) duplex transmission mode on all 10/100 Mbps Metro Ethernet customer facing electrical ports. However, auto-negotiation must be enabled at the UNI for 1000Base-T ports and 1000Base-LX/SX UNIs at customer premises locations may be ordered via NCI Code as hard coded or provisioned with auto-negotiation.
10. Multiple interfaces using IEEE 802.3-2008 (Clause 43) Link Aggregation or, 802.1D, 802.1w Rapid or 802.1Q Multiple Spanning Tree Protocol (STP) for increased bandwidth and/or link redundancy/load balancing is currently not a CenturyLink Metro Ethernet service option at the UNI. See Section 2.11.4, Layer 2 Control Protocol Processing for further information on tunneling of customer Bridge Protocol Data Units (BPDUs).
11. nm = nanometer

Table 3-9 Notes (Continued):

12. SC (Subscriber Connector) is a push-pull type of fiber optic connector with a square barrel; standardized in ANSI/TIA/EIA-604-3-B, *FOCIS (Fiber Optic Connector Intermateability Standard) 3, Type SC and SC-APC* and equivalent IEC 61754-4, *Fibre Optic Connector Interfaces - Part 4: Type SC Connector Family*.
13. FC (Fiber Connector) is a keyed, locking type of fiber optic connector with a round barrel and threaded retaining ring; standardized in ANSI/TIA/EIA-604-4-B, *FOCIS (Fiber Optic Connector Intermateability Standard) 4, Type FC and FC-APC* and equivalent IEC 61754-13, *Fibre Optic Connector Interfaces - Part 13: Type FC-PC Connector*.
14. LC (Lucent or Local Connector) is a small form-factor fiber optic connector with a cylindrical ferrule and split sleeve coupler; standardized in ANSI/TIA/EIA-604-10-A, *FOCIS (Fiber Optic Connector Intermateability Standard) 10, Type LC* and equivalent IEC 61754-20, *Fibre Optic Connector Interfaces - Part 20: Type LC Connector Family*.
15. CenturyLink Metro Ethernet User-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*.

3.3 Connecting to 10Base-T, 100Base-TX and 1000Base-T User-Network Interfaces

The CenturyLink Metro Ethernet 10/100/1000 Mbps electrical interfaces use standard RJ-45 connectors at the User-Network Interface (UNI). Table 3-2 shows the pinouts.

Pin	Label
1	TP0+
2	TP0-
3	TP1+
4	TP2+
5	TP2-
6	TP1-
7	TP3+
8	TP3-

Table 3-2 10 / 100 / 1000 Mbps Electrical Port RJ-45 Pinouts

To connect to the CenturyLink-provided switch port or integrated demarcation panel, or possibly Gigabit Ethernet SFP transceiver module for electrical UNIs, the customer will use either a straight-through or crossover cable depending upon their equipment. For connecting to servers, workstations and routers a straight-through cable is required, and for switch connections a crossover cable is required. The UNI associated with CenturyLink Metro Ethernet 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 can use a two or four twisted-pair cable. Table 3-3 shows the two twisted-pair, straight-through cable and Table 3-4 shows the four twisted-pair, straight-through cable RJ-45 connections at the UNI. Table 3-5 shows the two twisted-pair, crossover cable and Table 3-6 shows the four twisted-pair, crossover cable RJ-45 connections at the UNI.

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

Table 3-3 Two Twisted Pair Straight-Through Cable RJ-45 Connections for 10 / 100 / 1000 Mbps Electrical Ports

RJ-45	RJ-45
1 RD+	1 TD+
2 RD-	2 TD-
3 TD+	3 RD+
6 TD-	6 RD-
4 NC	4 NC
5 NC	5 NC
7 NC	7 NC
8 NC	8 NC

Table 3-4 Four Twisted Pair Straight Through Cable RJ-45 Connections for 10 / 100 / 1000 Mbps Electrical Ports

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

Table 3-5 Two Twisted Pair Crossover Cable RJ-45 Connection for 10 / 100 /1000 Mbps Electrical Ports

RJ-45	RJ-45
1 RD+	3 TD+
2 RD-	6 TD-
3 TD+	1 RD+
6 TD-	2 RD-
4 NC	4 NC
5 NC	5 NC
7 NC	7 NC
8 NC	8 NC

Table 3-6 Four Twisted Pair Crossover Cable RJ-45 Connections for 10 / 100 / 1000 Mbps Electrical Ports

When connecting to 1000Base-T compatible devices, the customer must use a four twisted-pair Category 5 (or better) cable. Table 3-7 shows the straight-through cable and Table 3-8 shows the crossover cable RJ-45 connections at the UNI.

RJ-45	RJ-45
1 TP0+	1 TP1+
2 TP0-	2 TP1-
3 TP1+	3 TP0+
6 TP1-	6 TP0-
4 TP2+	4 TP3+
5 TP2-	5 TP3-
7 TP3+	7 TP2+
8 TP3-	8 TP2-

Table 3-7 Four Twisted-Pair Straight-Through Cable RJ-45 Connections for 10/100/1000 Mbps Electrical Ports

RJ-45	RJ-45
1 TP0+	3 TP1+
2 TP0-	6 TP1-
3 TP1+	1 TP0+
6 TP1-	2 TP0-
4 TP2+	7 TP3+
5 TP2-	8 TP3-
7 TP3+	4 TP2+
8 TP3-	5 TP2-

Table 3-8 Four Twisted-Pair Crossover Cable RJ-45 Connections for 10/100/1000 Mbps Electrical Ports

3.4 3.4 Distance Limitations

The maximum supported cable length from the CenturyLink Metro Ethernet switch port to (active) Customer Provided Equipment shall be as listed in Table 3-9. Although it's assumed that in most cases the subtended equipment will be co-located with the Metro Ethernet edge switch at a customer site, all User-Network Interfaces should be jointly engineered between CenturyLink and the customer.

Interface	Impedance or Central Wavelength	Cable or Fiber Type	Modal bandwidth (MHz/km)	Maximum Distance
10Base-T	100 ohms	Two pairs of twisted-pair telephone or Category 3, 4 or 5 (recommended) copper wire	N/A	100 meters (328 feet[2])
100Base-TX	100 ohms	Two pairs of Category 5 Unshielded Twisted-Pair (UTP) or Shielded Twisted-Pair (STP) copper wire	N/A	100 meters (328 feet[2])
1000Base-T	100 ohms	Four pairs of Category 5 balanced copper cabling	N/A	100 meters (328 feet[2])
1000Base-LX	1300-1310 nm	One pair of Single-Mode Fiber	N/A	10 kilometers (6.2 miles)
1000Base-SX	850 nm	One pair of 50 micron Multi-Mode Fiber	400	500 meters (1,640 feet)
			500	550 meters (1,804 feet)
		One pair of 62.5 micron Multi-Mode Fiber	160	220 meters (722 feet)
			200	275 meters (902 feet)

Table 3-9 Maximum Distance from the User-Network Interface[1]

Notes:

1. Including cable from CenturyLink switch port to UNI
2. Distances beyond 328 feet will require a pair of customer-provided Media Converters
3. N/A = Not Applicable
4. nm = nanometer
5. Single-Mode Fiber is 9 or 10/125 micron

Copper cables, Single-Mode Fiber (SMF) or Multi-Mode Fiber (MMF) jumpers to connect the Customer Provided Equipment (CPE) to the UNI at the CenturyLink switch port or integrated demarcation panel, or SFP transceiver module via a fiber jumper and adapter/coupler must be provided by the customer. These cables should be at least 3 meters long to facilitate attachment within the edge switch enclosure, access module or equipment frame.

3.5 1000Base-LX and 1000Base-SX Interface Power Levels

The CenturyLink Metro Ethernet 1000Base-LX User-Network Interface fully complies with the IEEE 802.3-2008 (802.3z) 1000Base-LX standard. However, it has a higher optical quality which allows it to reach 10 kilometers (6.2 miles) over 1310 nm Single-Mode Fiber, compared with the 5 km (3.1 miles) specified in the IEEE standard. Table 3-10 lists the fiber loss budget from the CenturyLink Metro Ethernet switch port to (active) Customer Provided Equipment for 1000Base-LX (1300-1310 nm, SMF) and 1000Base-SX (850 nm, MMF) UNIs. It's the transmitting party's responsibility to achieve the minimum interface power.

The optical power level at the User-Network Interface (FDP) shall meet the minimum transmit power listed in Table 3-10. Also, it's the responsibility of the customer to attenuate the optical signal level if required.

Interface	Transmit (dBm)		Receive (dBm)	
	Max	Min	Max	Min
1000Base-LX	– 3	– 9.5	– 3	– 19
1000Base-SX	– 4	– 9.5	0	– 17

Table 3-10 Fiber Loss Budget for 1000Base-LX and 1000Base-SX UNIs

Note: Based on any valid 8-bit/10-bit code pattern at the User-Network Interface

3.6 Network Channel (NC) and Network Channel Interface (NCI) Codes

NC and NCI Codes convey service and technical parameters. The following sections explain the codes in a general manner and will also provide specific codes to aid in ordering the User-Network Interfaces and Network Access Links for CenturyLink Metro Ethernet service. The NC and NCI Codes are to be provided by the customer to the CenturyLink Service Representative at the time a request for new or upgrades to an existing service are initiated.

Additional information concerning NC/NCI Codes is available in ANSI T1.223-1997, *Information Interchange - Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for the North American Telecommunications System*.

In some instances, CenturyLink service offerings differ from those described by Telcordia Technologies in their published Industry Support Interface: ISI-SR-STS 000307, *NC/NCI Code Dictionary*. Furthermore, definitions of NC and NCI Codes can change over time, therefore it's important to request CenturyLink Metro Ethernet service as defined in this publication.

CenturyLink Metro Ethernet interfaces (UNI and ENNI) are ordered and provisioned on a per port, per location basis and will be identified using standard NC/NCI Codes. Since the edge switches and Gigabit Ethernet uplinks between the edge site/switch and core switches as well as the core switch network interconnections are CenturyLink infrastructure, the Metro Ethernet customer orders will only occur between the User-Network Interface (UNI) and CenturyLink edge (or core) Ethernet switch. Figure 3-1 shows where the NC, and Primary and Secondary NCI Codes apply to CenturyLink Metro Ethernet service. As indicated in Figure 3-1, a Primary NCI Code/NC Code/Secondary NCI Code combination is required for each UNI or CenturyLink Metro Ethernet Network Access Link location.

For Dedicated Internet Access (DIA), the Internet Service Provider (ISP) will order the Ethernet circuits or NALs from CenturyLink to connect to their subscribers, who are CenturyLink Metro Ethernet End-User customers.

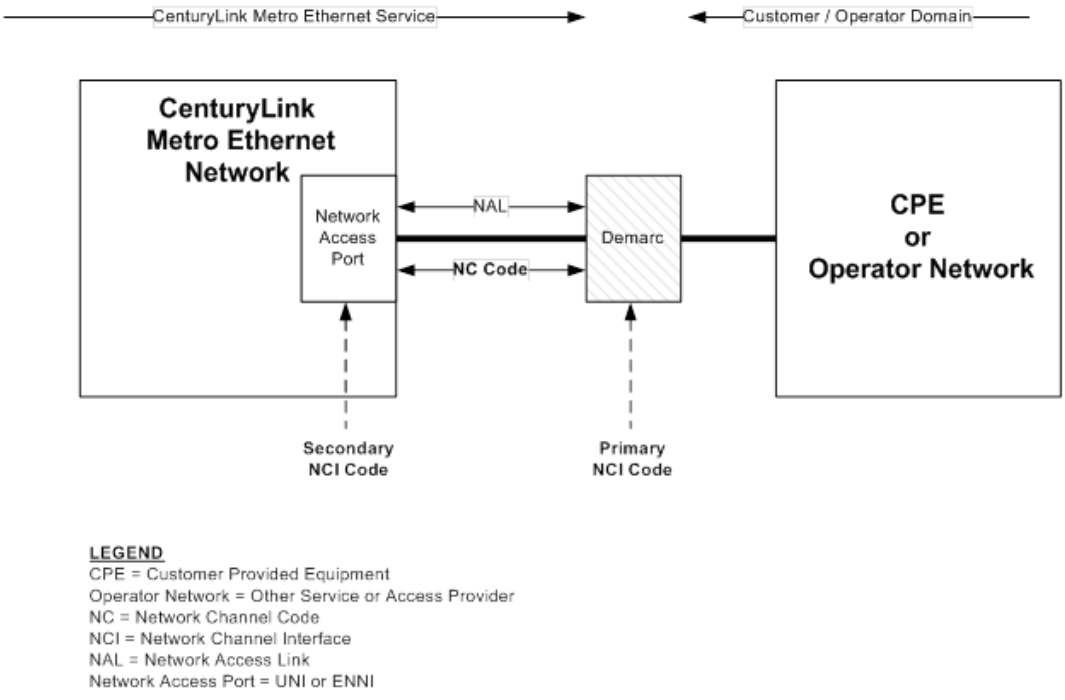

Figure 3-1 CenturyLink Metro Ethernet NC and NCI Codes

3.6.1 NC Code Function and Format

Primarily, service considerations are encoded into Network Channel (NC) Codes. Included in this code set are customer orderable options associated with the individual Ethernet channels or Network Access Links (NALs). When ordering CenturyLink Metro Ethernet, the NC Code is specified by the customer to advise CenturyLink of the required service configuration of the NAL and EVC (see Section 3.6.7).

An NC Code consists of four alpha/numeric characters, which may include a dash (–). There are neither spaces nor delimiters between the characters. An NC Code has two data elements:

- The first two characters are the Channel Code, which for CenturyLink Metro Ethernet identify the Ethernet service for each Network Access Link as 10, 100 or 1000 Mbps at the UNI.
- The last two characters are the Optional Feature Codes, which represent specific options available for each channel. Varying combinations of the third and fourth characters allow for further description of the type of service. For CenturyLink Metro Ethernet, the third character defines full duplex transmission mode and the fourth character options indicate the Bandwidth Profile or throughput per interface.

3.6.2 CenturyLink Metro Ethernet NC Codes

Table 3-11, Table 3-12, Table 3-14 and Table 3-15 lists the Network Channel (NC) Codes for ordering CenturyLink Metro Ethernet service.

NC Code	Description
KPE2	Rate-Adjustable 10 Mbps Ethernet, Full Duplex Facility supporting EVC Service Multiplexing[1], 3 Mbps
KPE5	Rate-Adjustable 10 Mbps Ethernet, Full Duplex Facility supporting EVC Service Multiplexing, 5 Mbps
KPE3	Rate-Adjustable 10 Mbps Ethernet, Full Duplex Facility supporting EVC Service Multiplexing, 7 Mbps
KPE-	Rate-Adjustable 10 Mbps Ethernet, Full Duplex Facility supporting EVC Service Multiplexing, 10 Mbps

Table 3-11 NC Codes for 10 Mbps Service

NC Code	Description
KQEN	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing[1], 3 Mbps
KQEJ	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 5 Mbps
KQEO	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 7 Mbps
KQE1	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 10 Mbps
KQE2	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 20 Mbps
KQE3	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 30 Mbps
KQE4	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 40 Mbps
KQE5	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 50 Mbps
KQE6	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 60 Mbps
KQE7	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 70 Mbps
KQE8	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 80 Mbps
KQE9	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 90 Mbps
KQE-	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 100 Mbps

Table 3-12 NC Codes for 100 Mbps Service

NC Code	Description
KRFB	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing[1], 10 Mbps
KRFD	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 20 Mbps
KRFF	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 30 Mbps
KRFH	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 40 Mbps

KRFJ	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 50 Mbps
KRFL	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 60 Mbps
KRFN	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 70 Mbps
KRFP	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 80 Mbps
KRFR	Rate-Adjustable 1 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 90 Mbps
KRE1	Rate-Adjustable Gigabit Ethernet (Point to Point[2] and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing[1], 100 Mbps
KRE2	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 200 Mbps
KRE3	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 300 Mbps
KRE4	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 400 Mbps
KRE5	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 500 Mbps
KRE6	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 600 Mbps

NC Code	Description
KRE7	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 700 Mbps
KRE8	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 800 Mbps
KRE9	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 900 Mbps

KRE0	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 1000 Mbps (full rate)

Table 3-13 NC Codes for 1000 Mbps Service

NC Code	Description
KSE1	Rate-Adjustable 10 Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 2 Gbps
KSE2	Rate-Adjustable 10 Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 2 Gbps
KSE3	Rate-Adjustable 10 Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 3 Gbps
KSE4	Rate-Adjustable 10 Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 4 Gbps
KSE5	Rate-Adjustable 10 Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 5 Gbps
KSE6	Rate-Adjustable 10 Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 6 Gbps
KSE7	Rate-Adjustable 10 Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 7 Gbps
KSE8	Rate-Adjustable 10 Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 8 Gbps
KSE9	Rate-Adjustable 10 Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC Service Multiplexing, 9 Gbps
KSE-	Rate-Adjustable 10 Gigabit Ethernet (Full Duplex), 10 Gbps (full rate)

Table 3-14 NC Codes for 10G bps Service

NC Code	Description
KUE-	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), 100G bps
KUEB	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 10 Gbps
KUED	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 20 Gbps
KUEF	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 30 Gbps
KUEH	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 40 Gbps
KUEK	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 50 Gbps
KUEM	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 60 Gbps
KUEP	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 70 Gbps
KUER	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 80 Gbps
KUET	Rate-Adjustable 100 Gbps Ethernet (Full Duplex), Rate based on Ethernet Switch, Facility supporting EVC Service Multiplexing, 90 Gbps

Table 3-15 NC Codes for 100G bps Service

Table 3-11, Table 3-12, Table 3-13, Table 3-14, Table 3-15 Notes:

1. While these KP, KQ and KR NC Codes can be used with any of the different customer access port types, EVC (Ethernet Virtual Connection) Service Multiplexing is only provided on Service Multiplexer and Service Provider ports as described in Section 2.10.5.
2. Point-to-point applies to the individual Gigabit Ethernet Network Access Links; however, the CenturyLink Metro Ethernet Layer 2 VPN service provides for multipoint-to-multipoint connectivity.

Customers need to consult with CenturyLink concerning the availability and NC Codes for 10G service channels.

3.6.3 NCI Code Form and Components

The Network Channel Interface (NCI) Code provides the means to define the physical characteristics at the User-Network Interface (UNI) for the service order, design and circuit provisioning processes.

An NCI Code has the form 08LN9.1GE. The period between the characters is a delimiter, which is used for improved clarity and causes the subsequent Protocol Option Codes to stand out. An NCI Code has no dashes (–).

The CenturyLink Metro Ethernet NCI Codes define the physical 10, 100 and 1000 Mbps electrical and optical customer interface, and EVC (see Section 3.6.7) options available with the service. Figure 3-2 illustrates the components of the Network Channel Interface Code with the subsequent definitions for a 1000Base-T UNI.

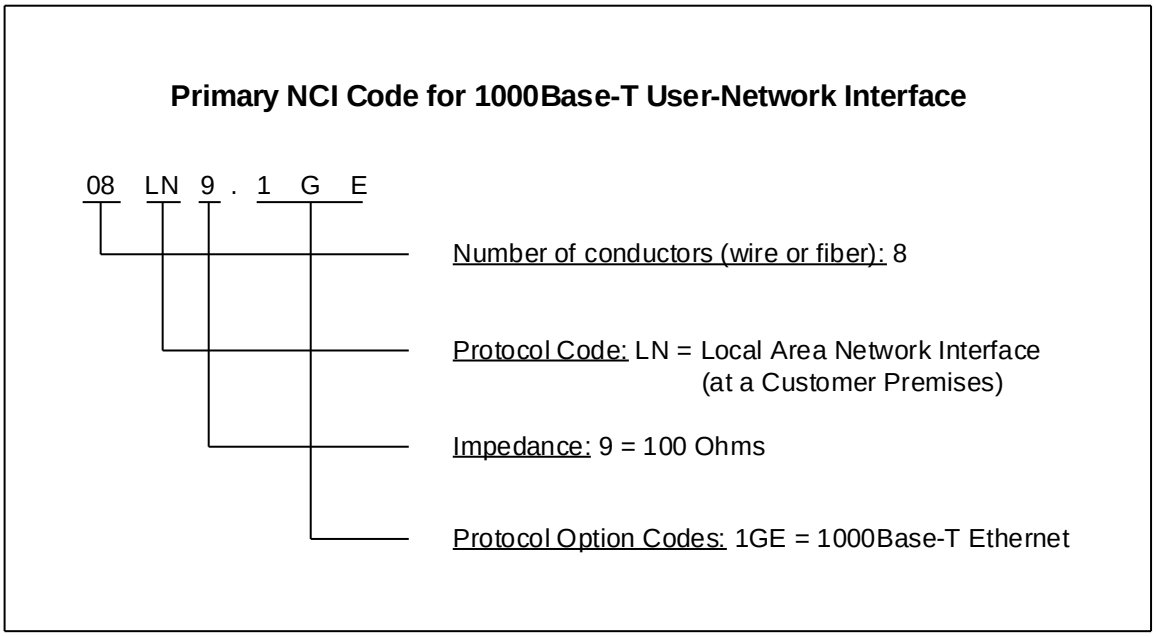

Figure 3-2 CenturyLink Metro Ethernet NCI Code Example

3.6.4 CenturyLink Metro Ethernet Primary NCI Codes

Table 3-16 , Table 3-17, Table 3-19 and Table 3-21 list the Primary Network Channel Interface (NCI) Codes for ordering CenturyLink Metro Ethernet User-Network Interfaces (UNIs) at customer premises Table 3-18 and list Table 3-20 the Primary NCI Code for ordering 1000Base-LX UNIs at CenturyLink Central Office (CO) locations. A customer premises may be at an End-User or Access Carrier, e.g. Interexchange Carrier (IC) or Internet Service Provider (ISP) Point-of-Presence (POP), while a CenturyLink CO location would be indicated for a Central Office Cross-Connect (COCC) to another compatible finished service or to provide Metro Ethernet connectivity to a Competitive Local Exchange Carrier (CLEC) collocation cage in conjunction with ordering a 2 fiber Optical ITP. See Section 2.7, Metro Ethernet User-Network Interfaces at CenturyLink Central Offices for further information.

NCI Code	Description
04LN9.10T	4 Conductors, Local Area Network Interface, 100 Ohms, 10Base-T Ethernet
04LN9.1CT	4 Conductors, Local Area Network Interface, 100 Ohms, 100Base-T Ethernet
08LN9.1GE	8 Conductors, Local Area Network Interface, 100 Ohms, 1000Base-T Ethernet

Table 3-16 Primary NCI Codes for an Electrical UNI or ENNI at a Customer Premise

NCI Code	Description
02LNF.A02	2 Conductors, Local Area Network Interface, Fiber, 1310 nm, Single-mode Fiber
02LNF.AA2	2 Conductors, Local Area Network Interface, Fiber, 1310 nm, Single-mode Fiber with Auto-negotiation
02LNF.A04	2 Conductors, Local Area Network Interface, Fiber, 850 nm, 50-micron Multi-mode Fiber
02LNF.AA4	2 Conductors, Local Area Network Interface, Fiber, 850 nm, 50 micron Multi-mode Fiber with Auto-negotiation
02LNF.A07	2 Conductors, Local Area Network Interface, Fiber, 850 nm, 62.5 micron Multi-mode Fiber
02LNF.AA7	2 Conductors, Local Area Network Interface, Fiber, 850 nm, 62.5 micron Multi-mode Fiber with Auto-negotiation

Table 3-17 Primary NCI Codes for a 1000Base-LX or1000Base-SX UNI or ENNI at a Customer Premise

NCI Code	Description
02QBF.K02	2 Conductors, Central Office Manual Cross Connect Termination with No Sub-Rating Capability for Non-Multiplexed Facilities Only, Fiber, Ethernet, 1310 nm, Single-mode Fiber

Table 3-18 Primary NCI Code for a 1000Base-LX UNI or ENNI at a CenturyLink Central Office

NCI Code	Description
02LNF.A02	2 Conductors, Local Area Network Interface, Fiber, 1310 nm, Single-mode Fiber, 10Km, 10G Base-LR
02LNF.A03	2 Conductors, Local Area Network Interface, Fiber, 1550nm, Single-mode Fiber, 40Km, 10G Base-ER
02.LNF.A0A	2 Conductors, Local Area Network Interface, Fiber, 1550nm, Single-mode Fiber, 80Km, 10G Base-ZR

Table 3-19 Primary NCI Code for a 10G Base UNI or ENNI at a Customer Premise

NCI Code	Description
02QBF.K02	2 Conductors, Local Area Network Interface, Fiber, 1310nm, Single-mode Fiber, 10Km, 10G Base-LR
02QBF.K03	2 Conductors, Local Area Network Interface, Fiber, 1550nm, Single-mode Fiber, 40Km, 10G Base-ER
02QBF.K03	2 Conductors, Local Area Network Interface, Fiber, 1550nm, Single-mode Fiber, 80Km, 10G Base-ZR

Table 3-20 Primary NCI Code for 10G Base UNI or ENNI at a CenturyLink Central Office

NCI Code	Description
02LNF.CE4	2 Conductors, Local and Wide Area Network Interface, 100GBASE-ER4, 100 Gbps PHY using 100GBASE-R encoding over four WDM lanes via two 1310 nm single-mode fibers, with reach up to at least 40 km per IEEE 802.3ba-2010
02LNF.CL4	2 conductors, Local and Wide Area Network Interface, 100GBASE-LR4, 100 Gbps PHY using 100GBASE-R encoding over four WDM lanes via two 1310 nm single-mode fibers, with reach up to at least 10 km per IEEE 802.3ba-2010

Table 3-21 Primary NCI Code for a 100G Base UNI at a Customer Premise

NCI Code	Description
02QBF.CE4	2 conductors, Local and Wide Area Network Interface, 100GBASE-ER4, 100 Gbps PHY using 100GBASE-R encoding over four WDM lanes via two 1310 nm single-mode fibers, with reach up to at least 40 km per IEEE 802.3ba-2010

02QBF.CL4	2 conductors, Local and Wide Area Network Interface, 100GBASE-LR4, 100 Gbps PHY using 100GBASE-R encoding over four WDM lanes via two 1310 nm single-mode fibers, with reach up to at least 10 km per IEEE 802.3ba-2010

Table 3-22 Primary NCI Code for 100G Base UNI at a CenturyLink Central Office

Customers need to consult with CenturyLink concerning the availability and primary NCI Codes for 100G UNI and ENNIs.

3.6.5 CenturyLink Metro Ethernet Secondary NCI Codes

As shown in Figure 3-1 and Figure 3-3, a Secondary Network Channel Interface (NCI) Code applies at each CenturyLink Metro Ethernet switch port used to deliver a customer's interface. The CenturyLink Metro Ethernet switch port is at the other, i.e. CenturyLink end of the Network Channel (NC) or interface, whereas a Primary NCI Code applies at the UNI.

Table 3-23, Table 3-24, Table 3-25 and Table 3-26 list the Secondary NCI Codes for ordering CenturyLink Metro Ethernet service.

NCI Code	Description
04CX9.10T	4 Conductors, Digital Termination On A Switch/Router, 100 Ohms, 10Base-T Ethernet Switch Port
04CX9.1CT	4 Conductors, Digital Termination On A Switch/Router, 100 Ohms, 100Base-T Ethernet Switch Port
08CX9.1GE	8 Conductors, Digital Termination On A Switch/Router, 100 Ohms, Gigabit Ethernet Switch Port
08CX9.N1B	8 Conductors, Digital Termination On A Switch/Router, 100 Ohms, 1000Base-T 1 Gbps Ethernet ENNI termination per MEF 26, COS Enabled. (Supports multiple classes of service via the subsequently ordered OVCs)

Table 3-23 Secondary NCI Codes for Electrical UNIs and ENNIs

NCI Code	Description
02CXF.1GE	2 Conductors, Digital Termination On A Switch/Router, Fiber, Gigabit Ethernet Switch Port
02CXF.N1C	2 Conductors, Digital Termination On A Switch/Router, Fiber, 1 Gbps Ethernet ENNI termination per MEF 26, COS Enabled. (Supports multiple classes of service via the subsequently ordered OVCs)

Table 3-24 Secondary NCI Code for 1000Base-LX and 1000Base-SX UNIs and ENNIs

Note: This NCI Code is the same regardless of whether the 1000Base-LX UNI is at a customer premises or Central Office location.

NCI Code	Description
02CXF.10G	2 Conductors, Digital Termination On A Switch/Router, Fiber, 10 Gigabit Ethernet Switch Port
02CXF.NXC	2 Conductors, Digital Termination On A Switch/Router, Fiber, 10 Gbps Ethernet ENNI termination per MEF 26, COS Enabled. (Supports multiple classes of service via the subsequently ordered OVCs)

Table 3-25 Secondary NCI Code for 10G Base-LR/ER/ZX UNIs and ENNI

NCI Code	Description
02CXF.1HG	2 conductors, Local and Wide Area Network Interface, 100 Gbps Ethernet User to Network Interface (UNI)

Table 3-26 Secondary NCI Code for 100G UNIs

Customers need to consult with CenturyLink concerning the availability and Secondary NCI Codes for 100G UNI and ENNIs.

3.6.6 CenturyLink Metro Ethernet NC/NCI Code Combinations

Table 3-27 lists all the valid NC Code, Primary and Secondary NCI Code combinations for ordering CenturyLink Metro Ethernet physical ports and Bandwidth Profiles, or User-Network Interface (UNI).

NC Code	Primary NCI Code	Secondary NCI Code	Physical Interface (Mbps)	Bandwidth Profile (Mbps)	User-Network Interface	User-Network Interface Location
KPE2	04LN9.10T	04CX9.10T	10	3	10Base-T	Customer Premises[1]
KPE5	04LN9.10T	04CX9.10T	10	5	10Base-T	Customer Premises
KPE3	04LN9.10T	04CX9.10T	10	7	10Base-T	Customer Premises[1]
KPE-	04LN9.10T	04CX9.10T	10	10	10Base-T	Customer Premises
KQEN	04LN9.1CT	04CX9.1CT	100	3	100Base-TX	Customer Premises[1]
KQEJ	04LN9.1CT	04CX9.1CT	100	5	100Base-TX	Customer Premises[1]
KQEO	04LN9.1CT	04CX9.1CT	100	7	100Base-TX	Customer Premises[1]
KQE1	04LN9.1CT	04CX9.1CT	100	10	100Base-TX	Customer Premises
KQE2	04LN9.1CT	04CX9.1CT	100	20	100Base-TX	Customer Premises
KQE3	04LN9.1CT	04CX9.1CT	100	30	100Base-TX	Customer Premises
KQE4	04LN9.1CT	04CX9.1CT	100	40	100Base-TX	Customer Premises
KQE5	04LN9.1CT	04CX9.1CT	100	50	100Base-TX	Customer Premises
KQE6	04LN9.1CT	04CX9.1CT	100	60	100Base-TX	Customer Premises
KQE7	04LN9.1CT	04CX9.1CT	100	70	100Base-TX	Customer Premises
KQE8	04LN9.1CT	04CX9.1CT	100	80	100Base-TX	Customer Premises
KQE9	04LN9.1CT	04CX9.1CT	100	90	100Base-TX	Customer Premises
KQE-	04LN9.1CT	04CX9.1CT	100	100	100Base-TX	Customer Premises

NC Code	Primary NCI Code	Secondary NCI Code	Physical Interface (Mbps)	Bandwidth Profile (Mbps)	User-Network Interface	User-Network Interface Location
KRFB	08LN9.1GE	08CX9.1GE	1000	10	1000Base-T	Customer Premises
KRFB	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	10	1000Base-LX (SMF)	Customer Premises
KRFB	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	10	1000Base-SX (50 µm MMF)	Customer Premises
KRFB	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	10	1000Base-SX (62.5 µm MMF)	Customer Premises
KRFD	08LN9.1GE	08CX9.1GE	1000	20	1000Base-T	Customer Premises
KRFD	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	20	1000Base-LX (SMF)	Customer Premises
KRFD	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	20	1000Base-SX (50 µm MMF)	Customer Premises
KRFD	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	20	1000Base-SX (62.5 µm MMF)	Customer Premises
KRFF	08LN9.1GE	08CX9.1GE	1000	30	1000Base-T	Customer Premises
KRFF	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	30	1000Base-LX (SMF)	Customer Premises
KRFF	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	30	1000Base-SX (50 µm MMF)	Customer Premises
KRFF	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	30	1000Base-SX (62.5 µm MMF)	Customer Premises

NC Code	Primary NCI Code	Secondary NCI Code	Physical Interface (Mbps)	Bandwidth Profile (Mbps)	User-Network Interface	User-Network Interface Location
KRFH	08LN9.1GE	08CX9.1GE	1000	40	1000Base-T	Customer Premises
KRFH	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	40	1000Base-LX (SMF)	Customer Premises
KRFH	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	40	1000Base-SX (50 µm MMF)	Customer Premises
KRFH	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	40	1000Base-SX (62.5 µm MMF)	Customer Premises
KRFJ	08LN9.1GE	08CX9.1GE	1000	50	1000Base-T	Customer Premises
KRFJ	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	50	1000Base-LX (SMF)	Customer Premises
KRFJ	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	50	1000Base-SX (50 µm MMF)	Customer Premises
KRFJ	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	50	1000Base-SX (62.5 µm MMF)	Customer Premises
KRFL	08LN9.1GE	08CX9.1GE	1000	60	1000Base-T	Customer Premises
KRFL	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	60	1000Base-LX (SMF)	Customer Premises
KRFL	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	60	1000Base-SX (50 µm MMF)	Customer Premises
KRFL	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	60	1000Base-SX (62.5 µm MMF)	Customer Premises

NC Code	Primary NCI Code	Secondary NCI Code	Physical Interface (Mbps)	Bandwidth Profile (Mbps)	User-Network Interface	User-Network Interface Location
KRFN	08LN9.1GE	08CX9.1GE	1000	70	1000Base-T	Customer Premises
KRFN	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	70	1000Base-LX (SMF)	Customer Premises
KRFN	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	70	1000Base-SX (50 µm MMF)	Customer Premises
KRFN	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	70	1000Base-SX (62.5 µm MMF)	Customer Premises
KRFP	08LN9.1GE	08CX9.1GE	1000	80	1000Base-T	Customer Premises
KRFP	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	80	1000Base-LX (SMF)	Customer Premises
KRFP	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	80	1000Base-SX (50 µm MMF)	Customer Premises
KRFP	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	80	1000Base-SX (62.5 µm MMF)	Customer Premises
KRFR	08LN9.1GE	08CX9.1GE	1000	90	1000Base-T	Customer Premises
KRFR	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	90	1000Base-LX (SMF)	Customer Premises
KRFR	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	90	1000Base-SX (50 µm MMF)	Customer Premises
KRFR	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	90	1000Base-SX (62.5 µm MMF)	Customer Premises

NC Code	Primary NCI Code	Secondary NCI Code	Physical Interface (Mbps)	Bandwidth Profile (Mbps)	User-Network Interface	User-Network Interface Location
KRE1	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	100	1000Base-T	Customer Premises
KRE1	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	100	1000Base-LX (SMF)	Customer Premises
KRE1	02QBF.K02	02CXF.1GE, or 02CXF.N1C	1000	100	1000Base-LX (SMF)	Central Office[2]
KRE1	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	100	1000Base-SX (50 µm MMF)	Customer Premises
KRE1	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	100	1000Base-SX (62.5 µm MMF)	Customer Premises
KRE2	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	200	1000Base-T	Customer Premises
KRE2	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	200	1000Base-LX (SMF)	Customer Premises
KRE2	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	200	1000Base-SX (50 µm MMF)	Customer Premises
KRE2	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	200	1000Base-SX (62.5 µm MMF)	Customer Premises
KRE3	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	300	1000Base-T	Customer Premises
KRE3	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	300	1000Base-LX (SMF)	Customer Premises
KRE3	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	300	1000Base-SX (50 µm MMF)	Customer Premises
KRE3	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	300	1000Base-SX (62.5 µm MMF)	Customer Premises

NC Code	Primary NCI Code	Secondary NCI Code	Physical Interface (Mbps)	Bandwidth Profile (Mbps)	User-Network Interface	User-Network Interface Location
KRE4	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	400	1000Base-T	Customer Premises
KRE4	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	400	1000Base-LX (SMF)	Customer Premises
KRE4	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	400	1000Base-SX (50 µm MMF)	Customer Premises
KRE4	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	400	1000Base-SX (62.5 µm MMF)	Customer Premises
KRE5	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	500	1000Base-T	Customer Premises
KRE5	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	500	1000Base-LX (SMF)	Customer Premises
KRE5	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	500	1000Base-SX (50 µm MMF)	Customer Premises
KRE5	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	500	1000Base-SX (62.5 µm MMF)	Customer Premises
KRE6	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	600	1000Base-T	Customer Premises
KRE6	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	600	1000Base-LX (SMF)	Customer Premises
KRE6	02QBF.K02	02CXF.1GE, or 02CXF.N1C	1000	600	1000Base-LX (SMF)	Central Office[2]
KRE6	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	600	1000Base-SX (50 µm MMF)	Customer Premises
KRE6	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	600	1000Base-SX (62.5 µm MMF)	Customer Premises

NC Code	Primary NCI Code	Secondary NCI Code	Physical Interface (Mbps)	Bandwidth Profile (Mbps)	User-Network Interface	User-Network Interface Location
KRE7	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	700	1000Base-T	Customer Premises
KRE7	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	700	1000Base-LX (SMF)	Customer Premises
KRE7	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	700	1000Base-SX (50 µm MMF)	Customer Premises
KRE7	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	700	1000Base-SX (62.5 µm MMF)	Customer Premises
KRE8	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	800	1000Base-T	Customer Premises
KRE8	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	800	1000Base-LX (SMF)	Customer Premises
KRE8	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	800	1000Base-SX (50 µm MMF)	Customer Premises
KRE8	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	800	1000Base-SX (62.5 µm MMF)	Customer Premises
KRE9	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	900	1000Base-T	Customer Premises
KRE9	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	900	1000Base-LX (SMF)	Customer Premises
KRE9	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	900	1000Base-SX (50 µm MMF)	Customer Premises
KRE9	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	900	1000Base-SX (62.5 µm MMF)	Customer Premises

NC Code	Primary NCI Code	Secondary NCI Code	Physical Interface (Mbps)	Bandwidth Profile (Mbps)	User-Network Interface	User-Network Interface Location
KRE0	08LN9.1GE	08CX9.1GE, or 08CX9.N1B	1000	1000	1000Base-T	Customer Premises
KRE0	02LNF.A02, or 02LNF.AA2	02CXF.1GE, or 02CXF.N1C	1000	1000	1000Base-LX (SMF)	Customer Premises
KRE0	02QBF.K02	02CXF.1GE, or 02CXF.N1C	1000	1000	1000Base-LX (SMF)	Central Office[2]
KRE0	02LNF.A04, or 02LNF.AA4	02CXF.1GE, or 02CXF.N1C	1000	1000	1000Base-SX (50 µm MMF)	Customer Premises
KRE0	02LNF.A07, or 02LNF.AA7	02CXF.1GE, or 02CXF.N1C	1000	1000	1000Base-SX (62.5 µm MMF)	Customer Premises
KSE	02LNF.A02, 02LNF.A03	02CXF.NXC	10G	10G	10G Base-LR/ER (1310/1550 nm, SFM)	Customer Premises
KSE	02QBF.K02, 02QBF.K03	02CXF.NXC	10G	10G	10G Base-LR/ER/ZR (1310/1550/1550 nm, SFM)	Central Office
KUE-	02LNF.CE4, 02LNF.CL4	02CXF.1HG	100G	100G	100G Base-ER4/LR4(1310nm)	Customer Premises
KUE-	02QBF.CE4, 02QBF.CL4	02CXF.1HG,	100G	100G	100G Base-ER4/LR4(1310nm)	Central Office
KUEB	02LNF.CE4, 02LNF.CL4	02CXF.1HG,	100G	10G	100G Base-ER4/LR4(1310nm)	Customer Premises
KUEB	02QBF.CE4, 02QBF.CL4	02CXF.1HG	100G	10G	100G Base-ER4/LR4(1310nm)	Central Office
KUED	02LNF.CE4, 02LNF.CL4	02CXF.1HG,	100G	20G	100G Base-ER4/LR4(1310nm)	Customer Premises
KUED	02QBF.CE4, 02QBF.CL4	02CXF.1HG	100G	20G	100G Base-ER4/LR4(1310nm)	Central Office
KUEF	02LNF.CE4, 02LNF.CL4	02CXF.1HG,	100G	30G	100G Base-ER4/LR4(1310nm)	Customer Premises

KUEF	02QBF.CE4, 02QBF.CL4	02CXF.1HG	100G	30G	100G Base-ER4/LR4(1310nm)	Central Office
KUEH	02LNF.CE4, 02LNF.CL4	02CXF.1HG,	100G	40G	100G Base-ER4/LR4(1310nm)	Customer Premises
KUEH	02QBF.CE4, 02QBF.CL4	02CXF.1HG	100G	40G	100G Base-ER4/LR4(1310nm)	Central Office
KUEK	02LNF.CE4, 02LNF.CL4	02CXF.1HG,	100G	50G	100G Base-ER4/LR4(1310nm)	Customer Premises
KUEK	02QBF.CE4, 02QBF.CL4	02CXF.1HG	100G	50G	100G Base-ER4/LR4(1310nm)	Central Office
KUEM	02LNF.CE4, 02LNF.CL4	02CXF.1HG,	100G	60G	100G Base-ER4/LR4(1310nm)	Customer Premises
KUEM	02QBF.CE4, 02QBF.CL4	02CXF.1HG	100G	60G	100G Base-ER4/LR4(1310nm)	Central Office
KUEP	02LNF.CE4, 02LNF.CL4	02CXF.1HG,	100G	70G	100G Base-ER4/LR4(1310nm)	Customer Premises
KUEP	02QBF.CE4, 02QBF.CL4	02CXF.1HG	100G	70G	100G Base-ER4/LR4(1310nm)	Central Office
KUER	02LNF.CE4, 02LNF.CL4	02CXF.1HG,	100G	80G	100G Base-ER4/LR4(1310nm)	Customer Premises
KUER	02QBF.CE4, 02QBF.CL4	02CXF.1HG	100G	80G	100G Base-ER4/LR4(1310nm)	Central Office
KUET	02LNF.CE4, 02LNF.CL4	02CXF.1HG,	100G	90G	100G Base-ER4/LR4(1310nm)	Customer Premises
KUET	02QBF.CE4, 02QBF.CL4	02CXF.1HG	100G	90G	100G Base-ER4/LR4(1310nm)	Central Office

Table 3-27 NC Code, Primary and Secondary NCI Code Combinations

Notes:

1. 3 & 7 Mbps on 10Base-T UNIs and 3, 5 & 7 Mbps on 100Base-TX UNIs are offered on a where available basis only with equipment that has been operationalized by CenturyLink to provide these Bandwidth Profiles.
2. 1000Base-LX User-Network Interfaces are only available at CenturyLink Central Offices which have a Metro Ethernet core switch
3. SMF = Single-Mode Fiber

4. MMF = Multi-Mode Fiber
5. µm = micron

3.6.7 EVC NC/NCI Codes

Table 3-28 and Table 3-29 list the Ethernet Virtual Connection (EVC) and Operator Virtual Connection NC Codes used to specify the Metro Ethernet Layer 2 connectivity between associated UNIs or ENNI. As described in Section 2.12.1 the corresponding service attributes for each UNI customer access port type in the EVC or OVC are specified using the EVC NCI codes in Table 3-30. The OVC NCI codes for an OVC at an ENNI are specified using the EVC NCI codes in Table 3-31.

NC Code	EVC Type Description
VLP-	Ethernet Virtual Connection (An association of two or more UNIs that limits the exchange of Service Frames to UNIs in the Ethernet Virtual Connection per MEF 10.2), Point-to-Point Ethernet Virtual Connection (EVC). Defined in MEF 10.2 as an association of exactly two UNIs.
VLM-	**Multi-to-Multi** EVC or OVC (An association of two or more UNIs or ENNIs that limits the exchange of Service Frames to ENNIs in the Operator Virtual Connection per MEF 26), Multipoint-to-Multipoint Capable EVC or OVC (EVC per MEF 10.2 or OVC per MEF 26) as an association of two or more UNIs or ENNIs. NOTE: to be a multipoint OVC at least one member must be an ENNI port.

Table 3-28 EVC NC Codes

NC Code	OVC Type Description
VLC	**Point-to-Point** Operator Virtual Connection (OVC) An association of one UNI and one ENNI or two ENNIs that limits the exchange of Service Frames to the UNI and ENNI designated in the Virtual Connection.
VLM-	**Multi-to-Multi** EVC or OVC (An association of two or more UNIs or ENNIs that limits the exchange of Service Frames to ENNIs in the Operator Virtual Connection per MEF 26), Multipoint-to-Multipoint Capable EVC or OVC (EVC per MEF 10.2 or OVC per MEF 26) as an association of two or more UNIs or ENNIs. NOTE: to be a multipoint OVC at least one member must be an ENNI port.

Table 3-29 OVC NC Codes

NCI Code	Description
02VLN.A2	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT MAP WITH ALL TO ONE BUNDLE (This EVC accepts ALL ingress frames at the UNI, No Service Multiplexing)

02VLN.AL3	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT WITH ALL TO ONE BUNDLE + DSCP/TOS MAP (This EVC accepts ALL frames ingressing the UNI, and supports multiple classes of service distinguished via Layer 3 DSCP/TOS)
02VLN.A2P	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT WITH ALL TO ONE BUNDLE + PBIT MAP (This EVC accepts ALL frames ingressing the UNI, and supports multiple classes of service distinguished via P-bits)
02VLN.UNT	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT + UNTAGGED FRAMES MAP (This EVC maps to all untagged frames on a UNI)
02VLN.UL3	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT + UNTAGGED FRAMES + DSCP/TOS MAP (This EVC accepts only untagged frames ingressing the UNI, and supports multiple classes of service distinguished via Layer 3 DSCP/TOS)

NCI Code	Description
02VLN.V	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT + VLAN MAP (This EVC accepts only tagged frames with a specific CEVLAN ID)
02VLN.VL3	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT + VLAN + DSCP/TOS MAP (This EVC accepts only tagged frames with a specific CEVLAN ID and supports multiple classes of service distinguished via Layer 3 DSCP/TOS)
02VLN.VP	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT + VLAN + PBIT MAP (This EVC accepts only tagged frames with a specific CEVLAN ID and supports multiple classes of service distinguished via P-bits)
02VLN.VB	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT + Bundled VLAN MAP (This EVC accepts only tagged frames with two or more specific CE-VLAN IDs. It should not be confused with All-to-one bundling which is a different attribute. See MEF 10.2 for clarification.)
02VLN.VB3	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT + Bundled VLAN + DSCP/TOS MAP (This EVC accepts only tagged frames with two or more specific CE-VLAN IDs. It should not be confused with All-to-one bundling which is a different attribute. See MEF 10.2 for clarification. This EVC ALSO supports multiple classes of service distinguished via Layer 3 DSCP/TOS.)
02VLN.VBP	2 Conductors, Ethernet Virtual Connection (EVC) Termination (EVC/UNI Map Type), PORT + Bundled VLAN + PBIT MAP (This EVC accepts only tagged frames with two or more specific CE-VLAN IDs. It should not be confused with All-to-one bundling which is a different attribute. See MEF 10.2 for clarification. This EVC ALSO supports multiple classes of service distinguished via P-bits.)

Table 3-30 EVC NCI Codes for CenturyLink Metro Ethernet Service

NCI Code	Description
02VLN.VBT	Operator Virtual Connection (OVC) with bundling. For Point to Point and multipoint **(ENNI)**
02VLN.VST	Operator Virtual Connection (OVC). For Point to Point and multipoint **(ENNI)**

Table 3-31 OVC NCI Codes for CenturyLink Metro Ethernet Service

Table 3-32 shows the EVC NCI codes used to specify either QOS or CoS at a UNI for the EVC. For an ENNI CoS is always specified by the S-VLAN PCP.

Access Port Type	EVC NC Code	EVC NCI Code	Comments
Service Multiplexer	VLP- or VLM-	02VLN.V	- Other UNI and EVC service attributes (see Sections 2.10 and 2.12) captured on EVC Form
		02VLN.VB	- Plus (many to one) Bundling (see Section 2.10.8)
		02VLN.VL3*	- Plus QoS per IP Precedence bits in the ToS field (see Section 2.13)
		02VLN.VB3*	- Plus (many to one) Bundling (see Section 2.10.8) and QoS per IP Precedence bits in the ToS field (see Section 2.13)
		02VLN.VP*	- Plus QoS per 802.1Q P-bits (see Section 2.13)
		02VLN.VBP*	- Plus (many to one) Bundling (see Section 2.11.8) and QoS per 802.1Q P-bits (see Section 2.13)
Service Provider	VLP- or VLM-	02VLN.V	- Other UNI and EVC service attributes (see Sections 2.10 and 2.12) captured on EVC Form
		02VLN.VB	- Plus (many to one) Bundling (see Section 2.10.8)
		02VLN.VL3*	- Plus QoS per IP Precedence bits in the ToS field (see Section 2.13)
		02VLN.VB3*	- Plus (many to one) Bundling (See Section 2.10.8) and QoS per IP Precedence bits in the ToS field (see Section 2.13)
		02VLN.VP*	- Plus QoS per 802.1Q P-bits (see Section 2.13)
		02VLN.VBP*	- Plus (many to one) Bundling (see Section 2.10.8) and QoS per 802.1Q P-bits (see Section 2.13)

Access Port Type	EVC NC Code	EVC NCI Code	Comments
Non-TLS	VLP- or VLM-	02VLN.UNT	- Other UNI and EVC service attributes (see Sections 2.10 and 2.12) captured on EVC Form
		02VLN.UL3*	- Plus QoS per IP Precedence bits in the ToS field (see Section 2.13)
TLS	VLP- or VLM-	02VLN.A2	- Other UNI and EVC service attributes (see Sections 2.10 and 2.12) such as Layer 2 Control Protocol Tunneling captured on EVC Form
		02VLN.AL3*	- Plus QoS per IP Precedence bits in the ToS field (see Section 2.13)
		02VLN.A2P*	- Plus QoS per 802.1Q P-bits (see Section 2.13)

Table 3-32 EVC NCI Codes for QoS or CoS

*** Note:** QoS per IP Precedence and 802.1Q P-bits EVC NCI Codes cannot be mixed or both applied at a port (UNI) or across UNIs in the EVC. See Section 2.13.3, QoS Traffic Classification for further information.

CenturyLink Metro Ethernet NC/NCI Code Example

Figure 3-3 shows a CenturyLink Metro Ethernet NC/NCI Code example for a 3-point customer premises Metro Ethernet Transparent LAN Service (TLS ports) with Quality of Service (QoS) per IP Precedence bits in the ToS field. See Section 2.10, UNI and EVC per UNI Service Attributes for Metro Ethernet Customer Access Ports; Section 2.12, Ethernet Virtual Connection Service Attributes for Metro Ethernet Customer Access Ports and Section 2.13, Quality of Service for further information.

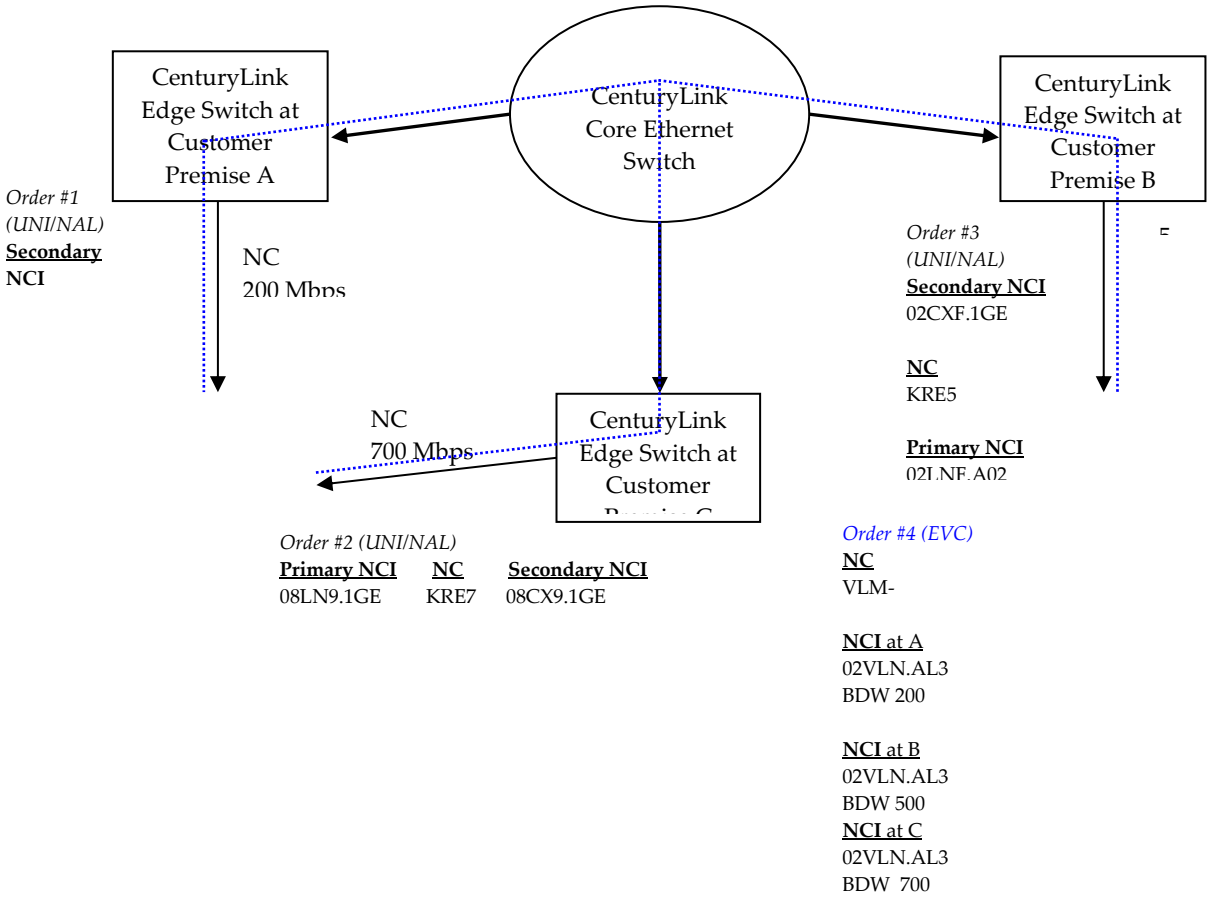

Figure 3-3 CenturyLink Metro Ethernet NC/NCI Code Service Order Example

Performance Specifications

3.7 General

This chapter describes the performance objectives for CenturyLink Metro Ethernet service. The performance specifications affect the service quality experienced by the customer and consist of the following objectives for CenturyLink Metro Ethernet:

- Bandwidth Change Requests
- Service Availability
- Throughput
- Latency
- Packet Loss
- VLAN Leakage
- Restoration/Fail-over Times

These performance objectives apply to the CenturyLink Metro Ethernet interface and core switch infrastructure architectures described in Section 2.5 and are based on congestion-free network conditions. For customers with standard best effort service with no QoS, the CenturyLink Metro Ethernet Network (MEN) will randomly discard packets when congestion occurs. All policing algorithms as well as counters for gathering billing and measurement statistics are built into the MEN hardware and therefore will not impact the performance of the customer's service.

Any service degradation such as decreased throughput or dropped packets resulting from a customer's oversubscription of any of their Metro Ethernet Bandwidth Profiles that are less than the physical UNI speed will be the sole responsibility of the customer. When ordering Metro Ethernet service with Bandwidth Profiles less than the standard 10/100/1000 Mbps data rate, customers must shape their traffic to the desired/subscribed rate before transmission to CenturyLink; otherwise the MEN policers will enforce the rate and may result in:

- Reduced customer throughput with applications using protocols with acknowledgement functions such as TCP, which may throttle back due to traffic exceeding the Metro Ethernet Bandwidth Profile being dropped by the policer
- Increased latency with customer traffic stored in ingress buffers until the frames are either forwarded, or dropped and retransmitted if required by a higher layer protocol within the Customer-Provided Equipment (CPE)

- The CenturyLink MEN equipment (randomly without QoS) discarding the incoming Ethernet frames due to, for example, customers with a Layer 2 switch continually transmitting bursts traffic at the full port rate

3.8 Bandwidth Change Requests

As indicated in Section 3.2, Description of CenturyLink Metro Ethernet Network Interfaces the CenturyLink cabling from the customer facing switch port to a co-located User-Network Interface (UNI) will be the same for all electrical interfaces. Then only the RJ-45 pinouts at the UNI may be different depending upon the Metro Ethernet electrical interface the customer ordered as well as the edge device deployed by CenturyLink to deliver the service.

CenturyLink Metro Ethernet customers may initiate a bandwidth change request for the access port speed on any in-service 10Base-T or 100Base-TX (and 1000Base-T in some cases) UNI Bandwidth Profiles. The appropriate Layer 2 and Layer 1 transport (if applicable) bandwidth must be available in the CenturyLink MEN infrastructure to meet the bandwidth change request, specifically without requiring the installation of any additional equipment.

3.9 Service Availability

Service availability is defined as the ability of a customer to exchange data packets with the CenturyLink Metro Ethernet Network (MEN) at the User-Network Interface via Customer Provided Equipment (CPE). Availability specifies the percentage of time the customer's Metro Ethernet service meets (or exceeds) the throughput, latency and packet loss performance objectives over any calendar month and may be expressed as:

$$\% \text{ Availability} = \frac{(\text{Total Time} - \text{Outage Time}) \times 100}{\text{Total Time}}$$

The service availability objectives for CenturyLink Metro Ethernet are listed in Table 3-33 Service Availability.

All User-Network Interfaces	Availability (Monthly)
With Single Cable Entrance	99.9%
With Dual Cable Entrances[1]	99.95%

Table 3-33 Service Availability

Table 3-33 Notes:

1. Equipment located on the customer's premises will have a single cable entrance unless the building owner elects to provide two physically separated cable entrances into the building. 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 CenturyLink Technical Publication 77344, *Diversity and Avoidance.*
2. Service availability includes all components of the CenturyLink Metro Ethernet Network (MEN) from edge site/switch to edge site/switch within a metro region for customers with two or more locations or from edge site/switch to core switch for customers with one location in a metro.
3. Service interruptions caused by CenturyLink planned network maintenance activities, maintenance at the customer premises or loss of customer traffic due to malfunction of Customer Provided Equipment are excluded from the availability calculation. The CenturyLink Metro Ethernet service availability objective assumes two hours every six months for the network maintenance window.

3.10 Throughput

The CenturyLink Metro Ethernet Bandwidth Profile is a limit on the rate at which Ethernet frames can traverse the User-Network Interface (UNI). CenturyLink Metro Ethernet service offers bandwidth or throughput for each customer interface. Specifically, the CenturyLink Metro Ethernet Committed Information Rate (CIR) is the minimum bandwidth or throughput that the CenturyLink MEN will deliver in both ingress and egress directions.

Through CIR, bandwidth will be available in the increments ordered by the customer per interface as listed in Section 2.4, Rate-Limiting, Committed and Excess Information Rates. CIR rates will be met by adequate rate-limiting of the CenturyLink MEN Layer 2 edge and core switches.

3.11 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 CenturyLink Metro Ethernet service with store-and-forward devices; and as based on Technical Specification MEF 10.2, *Ethernet Services Attributes - Phase 2*, October 2009, the one-way delay is the time measured between when the first bit of an Ethernet frame enters the ingress User-Network Interface to when the last bit of the same frame leaves the egress User-Network Interface. Specifically, from edge site/switch to edge site/switch within a metro region for customers with two or more locations or from edge site/switch to core switch for customers with one location in a metro. The latency performance objective across a single CenturyLink MEN will be as indicated in Table 3-34.

Latency (One-Way)	Objective (Monthly Average)
Maximum	Less than 25 milliseconds
Typical	Less than 15 milliseconds

Table 3-34 CenturyLink Metro Ethernet Network Latency

Thus, over any calendar month, 100% of the successfully delivered egress frames (discarded or lost frames are not counted) will have an average one-way delay of less than 25 milliseconds. This CenturyLink Metro Ethernet performance parameter applies to all supported Ethernet line/data rates (at the UNI), i.e. access ports and Bandwidth Profiles, frame sizes, alternate fiber routes where applicable and represents the total delay attributable to the CenturyLink MEN.

3.12 Packet Loss

The packet loss performance parameter identifies the percentage of in-profile Ethernet frames ("green" frames that are within CIR) not reliably delivered between User-Network Interfaces (UNIs) over a given measurement interval. Any frames that are out-of-profile ("yellow" or "red" frames, i.e. exceeding the CIR) are not counted towards the number of lost frames.

Customer frames that may additionally be blocked or discarded at the User-Network Interface and not counted towards the packet loss objective include the following:

- Runts or frame sizes less than 64 bytes
- Jumbo frames with a Maximum Transmission Unit (MTU) greater than 1500 bytes; or the IEEE 802.3/802.1Q maximum untagged/VLAN tagged frame size of 1518/1522 bytes (see Section 2.10.4 Maximum Frame Size for further information)
- Corrupted frames with invalid Cyclic Redundancy Check (CRC), Frame Check Sequence (FCS) or alignment errors
- Broadcast frames dropped by CenturyLink MEN traffic controls (see Section 2.12.2)
- Non-transparent customer Layer 2 Control Protocol Service Frames (see Section 2.10.12)

Packet loss is defined as the percentage of packets that are dropped within, or between switches that are a part of, the MEN. Specifically, from edge site/switch to edge site/switch within a metro region for customers with two or more locations or from edge site/switch to core switch for customers with one location in a metro. CenturyLink will engineer the MEN to minimize packet loss such that the performance objective will not exceed that listed in Table 3-35 Packet Loss.

Performance Parameter	Dropped Packets (Monthly Average)
Packet Loss Ratio	No more than 0.1%
	No more than 0.001% for P1 packets in the Metro Ethernet core network

Note: The Metro Ethernet core network is defined as from the first (CenturyLink-provided) core switch to the last core switch in a metro for a EVC traffic flow.

Table 3-35 Packet Loss

Thus, over any calendar month the CenturyLink MEN will successfully deliver at least 99.9% of a customer's packets from UNI to UNI or 99.999% for P1 traffic in the core.

3.13 VLAN Leakage

There will be zero (0) VLAN or MAC address leakage across the CenturyLink MEN. CenturyLink Metro Ethernet service does not currently support the routing or communication of traffic between VLANs or Ethernet Virtual Connections (EVCs).

3.14 Restoration/Fail-over Times

Where applicable, the following protocols will provide CenturyLink MEN Layer 1 and Layer 2 protection with the restoration/fail-over time objectives indicated. See Sections 2.5, Architecture and 2.6, Resiliency for further information on the CenturyLink Metro Ethernet service restoration capabilities.

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3.14.1 Link Aggregation

If a CenturyLink Metro Ethernet link within an IEEE 802.3-2008 (Clause 43) Link Aggregation Group fails, the traffic from the failed link will be redistributed across the remaining link(s) in less than 200 milliseconds. This will apply to the customer-requested optional Protected Routing for dual uplinks with diversity as indicated in Section 2.6, Network Access Links.

4 Maintenance

4.1 CenturyLink Responsibilities

CenturyLink is responsible for maintaining all equipment and cable on the CenturyLink Metro Ethernet network side of the User-Network Interface (UNI) at customer locations, and the transmission facility between UNIs.

CenturyLink will furnish the customer with a trouble reporting telephone number.

Upon receipt of a trouble alarm or report, CenturyLink will initiate action within twenty (20) minutes to clear the trouble and will commit to the following service restoral times for the CenturyLink Metro Ethernet Network (MEN):

- Four (4) hours maximum in the event of a service interruption due to an electronic component failure
- Eight (8) hours maximum if the trouble is caused by a cable failure

4.2 Customer Responsibilities

The customer is responsible for maintaining all equipment and cable on the customer side of the User-Network Interface at their locations.

In the case of service trouble, the customer or their responsible agent must sectionalize the fault or trouble and verify that the trouble is not in the customer-owned equipment or cable before calling the CenturyLink Customer Service Center. If the fault or trouble is isolated to the customer-owned equipment or cable, the customer is responsible for clearing the trouble and restoring the service to normal operation.

Joint testing between the customer or their agent and CenturyLink personnel may sometimes be necessary to isolate the trouble.

5 Definitions

Note: Definitions obtained from the MEF have been reproduced with permission of the Metro Ethernet Forum.

5.1 Acronyms

AC	Attachment Circuit
ADM	Add-Drop Multiplexer
ANSI	America National Standards Institute
BER	Bit Error Ratio
BPDU	Bridge Protocol Data Unit
C-Tag	Subscriber VLAN Tag
Cat-5	Category 5 balanced cable
CE	Customer Edge device
CE-VLAN CoS	Customer Edge VLAN CoS
CE-VLAN ID	Customer Edge VLAN ID
CE-VLAN Tag	Customer Edge VLAN Tag
CIR	Committed Information Rate
CLEC	Competitive Local Exchange Carrier
CO	Central Office
CoS	Class of Service
	Customer Edge Ethernet (L2 or L3) Switch
	Customer Edge Router
CPE	Customer Provided Equipment
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
dBm	Decibel reference to one milliwatt
DIA	Dedicated Internet Access
DSCP	Differentiated Services Code Point

DTE	Data Terminal Equipment
DWDM	Dense Wavelength Division Multiplexing
EFM	Ethernet in the First Mile
EIR	Excess Information Rate
E-LAN Service	Ethernet LAN Service
E-Line Service	Ethernet Line Service
ENNI	External Network-to-Network Interface
EoS	Ethernet-over-SONET
FC	Fiber Connector
EVC	Ethernet Virtual Connection
FD	Frame Delay
FDX	Full Duplex
FEC	Forwarding Equivalence Class
FIB	Forwarding Information Base
FLR	Frame Loss Ratio
GBIC	Gigabit Interface Converter
Gbps	Gigabit per Second
H-VPLS	Hierarchical VPLS
HDX	Half Duplex
IC	Interexchange Carrier
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers
IOF	Interoffice Facilities
IP	Internet Protocol
IPX	Internetwork Packet Exchange
ISO/IEC	International Organization for Standardization/International Electrotechnical Commission
ISP	Internet Service Provider

ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
L2	Layer 2
L3	Layer 3
LACP	Link Aggregation Control Protocol
LAN	Local Area Network
LATA	Local Access and Transport Area
LC	Lucent or Local Connector
LDP	Label Distribution Protocol
LSP	Label Switched Path
LSR	Label Switching Router
MAC	Media Access Control
MAN	Metropolitan Area Network
Mbps	Megabit per Second
MEF	Metro Ethernet Forum
MEN	Metro Ethernet Network
MMF	Multi-Mode Fiber
MNE	Maximum Number of EVCs
MNU	Maximum Number of UNIs
MPLS	MultiProtocol Label Switching
MTU	Maximum Transmission Unit
MTU-s	Multi-Tenant Unit switch
N-PE	Network-facing Provider Edge
NC	Network Channel
NCI	Network Channel Interface
nm	Nanometer
OADM	Optical Add-Drop Multiplexer

OVC	Operator Virtual Connection
OWD	One-Way Delay
P	Provider Router
PDU	Protocol Data Unit
PE	Provider Edge
PE-AGG	Provider Edge Aggregation device
PE-r	Provider Edge router
PE-rs	Provider Edge router/switch
PHY	Physical Layer entity
POP	Point of Presence
PSN	Packet Switched Network
PW	Pseudo Wire
PWE3	Pseudo Wire Emulation Edge-to-Edge
Q-in-Q	802.1Q-in-802.1Q (VLAN Stacking)
QoS	Quality of Service
RSS	Rates and Services Schedule
S-Tag	Service VLAN Tag
SC	Subscriber Connector
SDC	System Design Center
SFP	Small Form-factor Pluggable
SLA	Service Level Agreement
SLS	Service Level Specification
SMF	Single-Mode Fiber
SONET	Synchronous Optical Network
SPE	Synchronous Payload Envelope
STP	Shielded Twisted-Pair
STS	Synchronous Transport Signal
SWC	Serving Wire Center

TCP	Transmission Control Protocol
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
TLS	Transparent LAN Service
ToS	Type of Service
U-PE	User-facing Provider Edge
μm	Micron
UNI	User-Network Interface
UPC	Ultra Physical Contact
UTP	Unshielded Twisted-Pair
VC	Virtual Circuit
VFI	Virtual Forwarding Instance
VLAN	Virtual LAN
VPLS	Virtual Private LAN Service
VPN	Virtual Private Network
VSI	Virtual Switching Instance
WAN	Wide Area Network
WDM	Wavelength Division Multiplexing

5.2 Glossary

Access Customers

Any of the companies that provide telecommunications service between LATAs and/or order from the Access Tariffs, includes Interexchange Carriers.

All to One Bundling

A UNI attribute in which all CE-VLAN IDs are associated with a single EVC

Alternate Route

Places part of a customer's services over one route and the remainder of the services over a second route.

Attachment Circuit (AC)

The physical or virtual circuit attaching a CE to a PE

Auto-Negotiation

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

Automatic Protection Switch

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

Availability

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

Balanced Cable

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

Bandwidth

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

Bandwidth Profile

A characterization of ingress service frame arrival times and lengths at a reference point and a specification of the disposition of each service frame based on its level of compliance with the Bandwidth Profile

Bandwidth Profile per EVC

A bandwidth profile applied on a per-EVC basis.

Bandwidth Profile per UNI

A bandwidth profile applied on a per-UNI basis.

Bit

A binary unit of information 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.

Bit Error Ratio (BER)

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

Bit Rate

The total number of bits per second transferred to or from the Media Access Control (MAC).

Bridged Local Area Network

A concatenation of individual IEEE 802 LANs interconnected by MAC Bridges

Bridging

Denotes the process of connecting three or more customer locations

Broadcast Service Frame

A service frame that has a broadcast destination MAC address

Bundling

A UNI attribute in which more than one CE-VLAN ID can be associated with an EVC

Byte

A consecutive number of bits usually constituting a complete character or symbol. If the length of the byte is not specified, it is conventionally assumed to have a length of 8-bits. In the Digital Data System, a byte refers to an arbitrary group of 8 consecutive bits; it does not correspond to a byte of customer data.

Carrier

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

Carrier Sense Multiple Access with Collision Detection (CSMA/CD)

Carrier Sense Multiple Access with Collision Detection is a method of controlling access to a shared transmission path, particularly in Local Area Networks (LANs).

Category 5 Balanced Cabling

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

CE-VLAN CoS Preservation

An EVC attribute in which the CE-VLAN CoS of an egress Service Frame is identical in value to the CE-VLAN CoS of the corresponding ingress Service Frame

CE-VLAN ID Preservation

An EVC attribute in which the CE-VLAN ID of an egress service frame is identical in value to the CE-VLAN ID of the corresponding ingress service frame

CE-VLAN ID/EVC Map

An association of CE-VLAN IDs with EVCs at a UNI

Central Office (CO)

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

Central Wavelength

The average of two optical wavelengths at which the spectral radiant intensity is 50% of the maximum value

Channel

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

Class of Service (CoS)

A set of service frames that have a commitment from the Service Provider to receive a level of performance

Class of Service Identifier

Information derivable from a) the EVC to which the Service Frame is mapped, b) the combination of the EVC to which the Service Frame is mapped and a set of one or more CE-VLAN CoS values, c) the combination of the EVC to which the Service Frame is mapped and a set of one or more DSCP values, or d) the combination of the EVC to which the Service Frame is mapped and a set of one or more tunneled Layer 2 Control Protocols.

Color Forwarding

An OVC attribute defining the relationship between the Color of an egress ENNI Frame and the Color of the corresponding ingress ENNI Frame or Service Frame

Committed Information Rate (CIR)

CIR is a Bandwidth Profile parameter. It defines the average rate in bits per second of ingress service frames up to which the network delivers service frames and meets the performance objectives defined by the CoS service attribute.

Competitive Local Exchange Carrier (CLEC)

A Local Exchange Carrier certified to do business in a state.

Customer Edge (CE) device

Equipment on the subscriber side of the UNI, which may be a router or a switch in the customer's network interfacing with the Service Provider's network

Customer Edge (CE) VLAN CoS

The Priority Code Point bits in the IEEE 802.1Q Customer VLAN Tag in a Service Frame that is either tagged or priority tagged.

Customer Edge (CE) VLAN ID

The identifier derivable from the content of a service frame that allows the service frame to be associated with an EVC at the UNI

Customer Edge (CE) VLAN Tag

The IEEE 802.1Q tag in a tagged service frame

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) Network Interface.

Customers

Denotes any individual, partnership or corporation who subscribes to the services provided by CenturyLink 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.

Data Service Frame

A Service Frame that is Unicast, Multicast, or Broadcast.

Data Terminal Equipment (DTE)

A generic term for customer terminal equipment that connects to the network through a modem or through digital Network Channel Terminating Equipment (NCTE), e.g., a computer or a Private Branch Exchange (PBX)

Distributed VPLS

For scaling reasons, it is desired to distribute the functions in the PE across more than one device. For example, is it feasible to allocate MAC address learning on a comparatively small and inexpensive device close to the customer site, while participation in the PSN signaling and setup of PE to PE tunnels are done by routers closer to the network core. Also see Hierarchical VPLS (H-VPLS).

Diversity

Routing of customer circuits or access lines over physically separated facilities

Egress

The direction from the Service Provider network to the Customer Edge (CE)

Egress Bandwidth Profile

A service attribute that specifies the length and arrival time characteristics of egress Service Frames at the egress UNI

Egress Service Frame

A service frame sent from the Service Provider network to the Customer Edge (CE).

End Point Map

A mapping of specified S-Tag VLAN ID values to specified OVC End Point Identifiers

End Station

A system attached to a LAN that is an initial source or a final destination of MAC frames transmitted across that LAN. A Network Layer router is, from the perspective of the LAN, an end station; a MAC Bridge, in its role of forwarding MAC frames from one LAN to another, is not an end station.

End-User

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.).

Ethernet

A packet switched local network design (by Xerox Corp.) employing Carrier Sense Multiple Access with Collision Detection (CSMA/CD) as access control mechanism. Throughout this document, the term "Ethernet" is used interchangeably with the IEEE 802.3-2008 standard.

Ethernet LAN (E-LAN) Service

An Ethernet service type distinguished by its use of a multipoint-to-multipoint EVC

Ethernet Line (E-Line) Service

An Ethernet service type distinguished by its use of a point-to-point EVC

Ethernet Virtual Connection (EVC)

An association of two or more UNIs that limits the exchange of service frames to UNIs in the Ethernet Virtual Connection.

EVC Maximum Frame Size (MFS)

The maximum Service Frame allowed for an EVC.

Excess Information Rate (EIR)

EIR is a Bandwidth Profile parameter. It defines the average rate in bits/s of Service Frames up to which the network may deliver Service Frames but without any performance objectives.

External Network-to-Network Interface (ENNI)

A reference point representing the boundary between two Operator MENs that are operated as separate administrative domains

Facilities

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

First Mile

Also called the last mile, the subscriber access network or the local loop, the first mile is the communications infrastructure of the business park or the neighborhood.

Flooding

Flooding is a function related to Layer 2 services; when a PE receives a frame with an unknown destination MAC address, that frame is send out over (flooded) every other interface.

Forwarding Equivalence Class (FEC)

A group of packets which are forwarded in the same manner (e.g., over the same path, with the same forwarding treatment)

Forwarding Information Base (FIB)

A data structure that keeps track of the mapping of customer Ethernet frame addressing and the appropriate PW to use

Frame

A Layer 2 unit of data transmission on an IEEE 802 LAN MAC that conveys a Protocol Data Unit (PDU) between MAC Service users

Frame Delay

The time required to transmit a service frame from ingress UNI to egress UNI.

Frame Loss Ratio Performance

Frame Loss Ratio is a measure of the number of lost frames between the ingress UNI and the egress UNI. Frame Loss Ratio is expressed as a percentage.

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 (Gbps)

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

Half Duplex

Transmission in either direction between two points, but not simultaneously.

Hierarchical VPLS (H-VPLS)

A Layer 2 VPN architecture in which core PWs between core (hub) N-PE routers are augmented with access PWs or Q-in-Q tunnels (spokes to U-PE devices) to form a two-tier hierarchy that provides the benefits of less signaling in the MPLS core network and less packet replication on the N-PE routers. The U-PE routers have an aggregation role, do some packet replication and MAC address learning. Also see Distributed VPLS.

Impedance

The total opposition offered by an electric circuit to the flow of an alternating current of a single frequency. It is a combination of resistance and reactance and is measured in ohms.

Individual Case Basis (ICB)

Denotes a condition in which rates and charges for an offering are developed based on the circumstances in each case.

Ingress

The direction from the Customer Edge (CE) into the Service Provider network

Ingress Bandwidth Profile

A characterization of ingress Service Frame arrival times and lengths at the ingress UNI and a specification of disposition of each Service Frame based on its level of compliance with the characterization.

Ingress Service Frame

A service frame sent from the Customer Edge (CE) into the Service Provider network.

Interexchange Carrier (IC)

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.

Internetwork Packet Exchange (IPX)

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

Label Distribution Protocol (LDP)

A set of procedures by which one LSR informs another of the label/FEC bindings it has made.

Label Stack

An ordered set of labels (LSP label, VC label) such as for MPLS

Label Switched Path (LSP)

The path through one or more LSRs at one level of the hierarchy followed by a packet in a particular FEC

Label Switching Router (LSR)

A router which supports MPLS

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.

Layer 2

Data Link Layer. Provides the transfer of software between directly connected systems and detects any errors in the transfer. Establishes, maintains and releases software data links; handles error and flow control.

Layer 2 Control Protocol Service Frame

A service frame that is used for Layer 2 control, e.g., Spanning Tree Protocol

Layer 2 Control Protocol Tunneling

The process by which a Layer 2 Control Protocol service frame is passed through the Service Provider network without being processed and is delivered unchanged to the proper UNI(s)

Layer 3

Network Layer. Provides routing and relaying through intermediate systems. Also handles segmenting, blocking, error recovery, and flow control.

Link

The transmission path between any two interfaces of generic cabling

Link Aggregation Group

A group of links that appear to a MAC Client as if they were a single link. All links in a Link Aggregation Group connect between the same pair of Aggregation Systems. One or more conversations may be associated with each link that is part of a Link Aggregation Group

Local Access and Transport Area (LATA)

A geographic area for the provision and administration of communications service. It encompasses designated exchanges that are grouped to serve common social, economic and other purposes.

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 Loop

The physical, cable (copper or fiber) facilities that connect the Serving Wire Center to the customer's location

MAC Address Learning

MAC address learning is a function related to Layer 2 services; when PE receives a frame with an unknown source MAC address, the relationship between that MAC address and interface is learned for future forwarding purposes.

Maximum Number of EVCs (MNE)

The maximum number of EVCs that may be on a UNI

Maximum Number of UNIs (MNU)

The maximum number of UNIs that may be in an EVC

Maximum Frame Size (MFS)

The maximum packet size (excluding data link header) allowed for an Ethernet service.

Media Access Control (MAC)

The data link sublayer that is responsible for transferring data to and from the Physical Layer.

Megabits per Second (Mbps)

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

Metro Ethernet Network (MEN)

A Metro Ethernet Network comprising a single administrative domain, e.g. CenturyLink's network providing Ethernet services

Metropolitan Area Network (MAN)

A Metropolitan Area Network (MAN) is a data communications system which allows a number of independent data devices to communicate with each other.

Micron (µm)

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

MultiProtocol Label Switching (MPLS)

An IETF standard that provides support for multiple protocols over Layer 3 using labels to avoid the processing overhead associated with examining the packet header and performing complex routing operations

Multi-Tenant Unit switch (MTU-s)

A bridging capable access device that supports Layer 2 switching functionality and does all the normal bridging functions of learning and replication on all its ports, including the spoke, which is treated as a virtual port

Multicast

When applied to the CenturyLink Metro Ethernet service, the functionality which supports the transport of multiple duplicate frames from a single location to multiple End-User locations within the CenturyLink Metro Ethernet Serving Area.

Multicast Service Frame

A service frame that has a multicast destination MAC address

Multiplexer

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.

Multipoint-to-Multipoint EVC

An EVC with two or more UNIs. A multipoint-to-multipoint EVC with two UNIs is different from a point-to-point EVC because one or more additional UNIs can be added to it.

Nanometer (nm)

One billionth of one meter

Network

The interconnected telecommunications equipment and facilities.

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 interface elements located at a Point of Termination (POT) at a Central Office or at the Network Interface at a customer location. The NCI 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-facing Provider Edge (N-PE)

The N-PE is the device to which the signaling and control functions are allocated when a VPLS PE is distributed across more than one device. Also see Provider Edge router/switch (PE-rs).

Network Operator

The Administrative Entity of a MEN

Operator Virtual Connection

An association of OVC End Points

OVC End Point

An association of an OVC with a specific External Interface i.e., UNI, ENNI

OVC End Point Role

A property of an OVC End Point that determines the forwarding behavior between it and other OVC End Points that are associated with the OVC End Point by an OVC

Packet

A Layer 3 unit of data, consisting of binary digits including data and call-control signals, that is switched and transmitted as a composite whole.

Packet Switched Network (PSN)

Within PWE3, a network using IP or MPLS as the packet forwarding mechanism

Path

The sequence of segments and repeaters providing the connectivity between two DTEs in a single collision domain. In CSMA/CD networks there is one and only one path between any two DTEs.

Physical Layer entity (PHY)

Within IEEE 802.3, the portion of the Physical Layer that contains the functions that transmit, receive, and manage the encoded signals that are impressed on and recovered from the physical medium.

Point of Presence (POP)

A physical location within a LATA at which an Interexchange Carrier (IC) establishes itself for obtaining LATA access and to which CenturyLink provides access service

Point-to-Point

A circuit connecting two (and only two) points

Point-to-Point EVC

An EVC with exactly 2 UNIs.

Port

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

Power Budget

The minimum optical power an available to overcome the sum of attenuation plus power penalties of the optical path between the transmitter and receiver calculated as the difference between the transmitter launch power (min) and the receive power (min).

Premises

Denotes a building or portion(s) of a building occupied by a single customer or End-User either as a place of business or residence

Protocol

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

Protocol Code

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

Protocol Data Unit (PDU)

The unit of data output to, or received from, the network by a protocol layer.

Provider Edge (PE)

A PE is the name of the device or set of devices at the edge of the provider network.

Provider Edge Aggregation (PE-AGG)

A PE-AGG device is typically a Layer 2 switch that is service unaware and is used only to aggregate traffic to more function rich points in the network.

Provider Edge router (PE-r)

A non-bridging capable PE that supports routing but does not support any bridging functions

Provider Edge router/switch (PE-rs)

A routing and bridging capable device that supports all the bridging, routing and MPLS encapsulation functions for VPLS.

Provider Router (P)

A router in the Service Provider's core network that does not have interfaces directly toward a customer and used to interconnect the PE routers. P routers in an MPLS core network forward data packets based on the tunnel header.

Pseudo Wire (PW)

A mechanism that carries the essential elements of an emulated service from one PE to one or more other PEs over a PSN

Pseudo Wire Emulation Edge-to-Edge (PWE3)

A mechanism that emulates the essential attributes of a service over a PSN.

Pseudo Wire (PW) Label

The label at the bottom of a packet's label stack that may take the form specified in a number of IETF protocols; e.g., an MPLS label, which provides for the PW demultiplexing field and determines the disposition of the packet in the (MPLS) network

Redundant Route

Places the same customer services over two separate routes.

Repeater

Within IEEE 802.3, a device that is used to extend the length, topology, or interconnectivity of the physical medium beyond that imposed by a single segment, up to the maximum allowable end-to-end transmission line length. Repeaters perform the basic actions of restoring signal amplitude, waveform, and timing applied to the normal data and collision signals. Repeaters are only for use in half duplex mode networks.

Route

The physical path established through a network for a particular circuit.

Router

A Layer 3 interconnection device that appears as a Media Access Control (MAC) to a CSMA/CD collision domain

S-VLAN ID

The 12-bit VLAN ID field in the S-Tag of an ENNI Frame

Service Delimiter

Information used to identify a specific customer service instance.

Scheduled Downtime

A time interval agreed upon by both the Subscriber and Service Provider during which a service may be disabled by the Service Provider.

Service Frame

An Ethernet frame transmitted across the UNI toward the Service Provider or an Ethernet frame transmitted across the UNI toward the subscriber.

Service Level Agreement (SLA)

The contract between the Subscriber and Service Provider specifying the agreed to service level commitments and related business agreements.

Service Level Specification (SLS)

The technical specification of the service level being offered by the Service Provider to the subscriber

Service Multiplexing

A UNI service attribute in which the UNI can be in more than one EVC instance

Service Point

CenturyLink Metro Ethernet Service Points are geographic locations designated by the company where the Metro Ethernet Network (MEN) can be accessed.

Service Provider

The organization providing Ethernet service(s) UNI to UNI

Serving Wire Center (SWC)

The term "Serving Wire Center" denotes a CenturyLink Central Office (CO) 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

Signaling is the process by which the PEs that have VPNs behind them exchange information to set up PWs, PSN tunnels, and tunnel multiplexers. This process might be automated through a protocol or done by manual configuration. Different protocols may be used to establish the PSN tunnels and exchange the tunnel multiplexers.

Small Form-factor Pluggable (SFP)

A hot-swappable input/output device that plugs into a Gigabit Ethernet port or slot, linking the port with the network

Subscriber

The organization purchasing and/or using Ethernet services

Switch

A Layer 2 interconnection device that conforms to the ISO/IEC 15802-3: 1998 [ANSI/IEEE Std 802.1D, 2004 Edition] international standard.

Switch Port

A termination point on the Ethernet switch for the Metro Ethernet Network Access Link. Metro Ethernet ports are the physical entry points in the MEN for Network Access Links and are the originating and terminating points for Virtual Local Area Network connections.

Synchronous Optical Network (SONET)

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

Tag

An optional field in a frame header. It is the 4-byte field that, when present in an Ethernet frame, appears immediately after the Source Address, or another tag in an Ethernet frame header and which consists of the 2-byte Tag Protocol Identification Field (TPID) which indicates S-Tag or C-Tag, and the 2-byte Tag Control Information field (TCI) which contains the 3-bit Priority Code Point, and the 12-bit VLAN ID field

Tag Header

A tag header allows user priority information, and optionally, VLAN identification information, to be associated with a frame.

Tagged Frame

A tagged frame is a frame that contains an 802.1Q VLAN Identifier 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.

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

Transmission Control Protocol/Internet Protocol (TCP/IP)

Internetworking software suite originated on the Department of Defense's Arpanet network. IP corresponds to Open Systems Interconnection (OSI) Network Layer 3, TCP to OSI Layers 4 and 5.

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

Trunk

A communications path connecting two switching systems in a network, used in the establishment of an end-to-end connection whereas an Ethernet trunk carries multiple VLANs via a single network link

Tunnel

A method of providing transparent connectivity across a PSN, inside which one or more PWs can be established to transport packets from one PE to another

Tunnel Multiplexor

A tunnel multiplexor is an entity that is sent with the packets traversing the tunnel to make it possible to decide which instance of a service a packet belongs to and from which sender it was received.

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

UNI Maximum Frame Size (MFS)

The maximum sized Service Frame allowed at the UNI.

Unicast Service Frame

A service frame that has a unicast destination MAC address

Unscheduled Downtime

A time interval not agreed upon by both the Subscriber and Service Provider during which the Service Provider determines that the service is not usable.

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 an 802.1Q VLAN Identifier 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.

User-facing Provider Edge (U-PE)

The U-PE is the device to which the functions needed to take forwarding or switching decisions at the ingress of the provider network. Also see Multi-Tenant Unit switch (MTU-s).

User-Network Interface (UNI)

The physical demarcation point between the responsibility of the Service Provider and the responsibility of the subscriber

Virtual Circuit (VC)

A circuit used by a connection-oriented Layer 2 technology, requiring the maintenance of state information in Layer 2 switches, and is transported within a tunnel and identified by its tunnel multiplexer.

Virtual Circuit (VC) Label

In an MPLS-enabled IP network, a VC label is an MPLS label used to identify traffic within a tunnel that belongs to a VPN; i.e., the VC label is the tunnel multiplexer.

Virtual Forwarding Instance (VFI)

VFI is a logical entity that resides in a PE that includes the Router Information Base and Forwarding Information Base for a VPN instance. A VFI has similar functionality to a bridge but performs bridging operations on pseudowires.

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 Private LAN Service (VPLS)

A VPLS is a provider service that emulates the full functionality of a traditional Local Area Network (LAN). A VPLS makes it possible to interconnect several LAN segments over a Packet Switched Network (PSN) and makes the remote LAN segments behave as one single LAN. In a VPLS, the provider network emulates a learning bridge, and forwarding decisions are taken based on MAC addresses or MAC addresses and VLAN tag.

Virtual Private Network (VPN)

A private data network that makes use of the public telecommunication infrastructure, maintaining privacy through the use of a tunneling protocol and security procedures

Virtual Switching Instance (VSI)

In a Layer 2 context, a VSI performs standard LAN (i.e., Ethernet) bridging functions. Forwarding done by a VSI is based on MAC addresses and VLAN tags, and possibly other relevant information on a per VPLS instance basis.

VLAN Stacking

An 802.1Q tag inside another 802.1Q tag technique that lets Carriers offer multiple Virtual LANs over a single circuit using 802.1ad Provider Bridge extensions

VLAN Tagged Frame

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

VLAN Trunking Protocol (VTP)

A Layer 2 messaging protocol that manages the addition, deletion, and renaming of VLANs on a network-wide basis.

VPLS Instance (Domain)

A Layer 2 VPN that defines a community of interest for MAC addresses and VLANs.

6 References

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ANSI T1.223-1997	*Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for the North American Telecommunications System*
ANSI/TIA-492AAAA-B-2009	*Detail Specification for 62.5-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers*
ANSI/TIA-492AAAB-A-2009	*Detail Specification for 50-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers*
ANSI/TIA-526-7-2008	*OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant*
ANSI/TIA-526-14-2010	*OFSTP-14 Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant*
ANSI/TIA/EIA-570-B-2010	*Residential Telecommunications Cabling Standard*
ANSI/TIA/EIA-604-3-B-2004	*FOCIS (Fiber Optic Connector Intermateability Standard) 3, Type SC and SC-APC*
ANSI/TIA/EIA-604-4-B-2004	*FOCIS (Fiber Optic Connector Intermateability Standard) 4, Type FC and FC-APC*
ANSI/TIA/EIA-604-10-A-2002	*FOCIS (Fiber Optic Connector Intermateability Standard) 10, Type LC*
ANSI/TIA/EIA-758-A-2004	*Customer-Owned Outside Plant Telecommunications Cabling Standard*
ANSI/TIA/EIA-TSB95	*Additional Transmission Performance Guidelines for 100 Ohm 4-Pair Category 5*

6.2 International Organization for Standardization/International Electrotechnical Commission Publications

ISO/IEC 10742: 1994	*Information technology – Telecommunications and information exchange between systems – Elements of management information related to OSI Data Link Layer standards*
ISO/IEC 11801: 2002+A1:2008	*Information technology – Generic cabling for customer premises*
ISO/IEC 8802-2: 1998	*Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical Link Control*

6.3 Institute of Electrical and Electronics Engineers Documents

IEEE 802.1ad-2005	*Virtual Bridged Local Area Networks – Amendment 4: Provider Bridges*
IEEE 802.1ah-2008	*IEEE Standard for Local and metropolitan Area Networks – Virtual Bridged Local Area Networks Amendment 7: Provider Backbone Bridges*
IEEE 802.1D-2004	*IEEE Standards for Local and metropolitan area networks – Part 3: Media Access Control (MAC) Bridges*
IEEE 802.1Q-2005	*IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks*
IEEE 802.3-2008	*IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

IEEE 802.3ac-1998 *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Supplement to Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications: Frame Extensions for Virtual Bridged Local Area Network (VLAN) tagging on 802.3 Networks*

IEEE 802.3ah–2004 *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications - Amendment: Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for Subscriber Access Networks*

6.4 International Telecommunication Union - Telecommunication Standardization Sector (ITU-T) Recommendations

G.652 *Characteristics of a single-mode optical fibre and cable*

I.430 *Basic user-network interface – Layer 1 specification*

6.5 Metro Ethernet Forum Documents

Metro Ethernet Services – A Technical Overview, v2.7

Bandwidth Profiles for Ethernet Services, v1.4

MEF 6.1 *Ethernet Services Definitions - Phase 2*, April 2008

MEF 9 *Abstract Test Suite for Ethernet Services at the UNI*, October 2004

MEF 10.2 *Ethernet Services Attributes - Phase 2*, October 2009

MEF 12.1 *Carrier Ethernet Network Architecture Framework Part 2: Ethernet Services Layer - Base Elements*, April 15, 2010

MEF 14 *Abstract Test Suite for Traffic Management Phase 1*, November 2005

MEF 26.1 *Ethernet Network Interface (ENNI) – Phase 2*, January 2012

6.6 Internet Engineering Task Force (IETF) Request for Comments

RFC 3031 *Multiprotocol Label Switching Architecture*

RFC 3916 *Requirements for Pseudo-Wire Emulation Edge-to-Edge (PWE3)*

RFC 3985 *Pseudo Wire Emulation Edge-to-Edge (PWE3) Architecture*

RFC 4026 *Provider Provisioned Virtual Private Network (VPN) Terminology*

RFC 4447 *Pseudowire Setup and Maintenance Using the Label Distribution Protocol (LDP)*

RFC 4448 *Encapsulation Methods for Transport of Ethernet over MPLS Networks*

RFC 4664 *Framework for Layer 2 Virtual Private Networks (L2VPNs)*

RFC 4665 *Service Requirements for Layer 2 Provider-Provisioned Virtual Private Networks*

RFC 4762 *Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling*

6.7 Telcordia Documents

GR-20-CORE *Generic Requirements for Optical Fiber and Fiber Optical Cable*

SR-307 *COMMON LANGUAGE NC/NCI Dictionary*

6.8 CenturyLink Technical Publications

PUB 77344 *DIVERSITY AND AVOIDANCE*, Issue B, September 2001

PUB 77368 *CUSTOMER PREMISES ENVIRONMENTAL SPECIFICATIONS AND INSTALLATION GUIDE*, Issue F, July 2009

PUB 77386 *Interconnection and Collocation for Transport and Switched Unbundled Network Elements and Finished Services*, Issue N, February 2011

PUB 77419 *SPECIFICATIONS FOR THE PLACEMENT OF QWEST EQUIPMENT IN CUSTOMER-OWNED OUTDOOR CABINETS*, Issue B, June 2011

6.9 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 obtain;

- 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 which describes their publications.

- IEEE documents from:

  Institute of Electrical and Electronics Engineers
  445 Hoes Lane
  P.O. Box 1331
  Piscataway, NJ 08855
  Web: http://www.ieee.org/portal/site

- ITU-T Recommendations from:

  International Telecommunications Union
  General Secretariat
  Place des Nations, CH-1211
  Geneva 20, Switzerland
  Web: http://www.itu.int/home/

- Metro Ethernet Forum documents from:

  Web: http://www.metroethernetforum.org/

- Internet Engineering Task Force documents from:

  Web: http://www.ietf.org/rfc.html

- 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:

  Web: http://www.qwest.com/techpub/

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