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~~MOE®~~

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NOTICE

This document describes ~~Qwest®~~ CenturyLink Metro ~~Optical~~ Ethernet service ~~or MOE~~ as offered by ~~Qwest~~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).

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1. Introduction

1.1 General

This document describes ~~Qwest~~CenturyLink® Metro ~~Optical~~ Ethernet service f/k/a ~~or~~ MOE® as offered by ~~Qwest~~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).

1.2 Reason for Reissue

- ~~Remove the Qwest-provided Uninterruptible Power Supply (UPS) option with Protect Routing and QoS~~
- ~~Remove the Qwest-provided Category 5E, single and multimode Fiber Distribution Panels at the User-Network Interface~~
- ~~Change to P1 QoS~~
- Update company name from Qwest to CenturyLink
- Change service name from Metro Optical Ethernet (MOE) to Metro Ethernet
- Grandfather SP-TLS and SM-TLS and add enhanced SP-SM and SM-SM port combinations in an EVC, wherein:

  SP = Service Provider
  SM = Service Multiplexer
  TLS = Transparent LAN Service
- Partial service description update

1.3 Purpose

The purpose of this document is to describe ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet service. Sufficient 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 ~~Qwest~~CenturyLink ~~MOE~~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 ~~Qwest~~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.

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2. Service Description

2.1 General

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

2.2 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Service Points

~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Service Points are geographic locations, designated by ~~Qwest~~CenturyLink, where the ~~MOE~~ company's Metro Ethernet ~~network~~ Network (MEN) is accessible via Institute of Electrical and Electronics Engineers (IEEE) 802.3-2008 standard ~~metallic~~ twisted-pair, singlemode and/or multimode fiber ~~optic Ethernet~~ Local Area Network (LAN) interfaces. Service Points are those Serving Wire Centers (SWCs), which are defined as entry points into the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~. ~~Qwest~~CenturyLink Interoffice Facilities (IOF) will be utilized where required to provide access to the nearest ~~MOE~~Metro Ethernet core switch and transport customer traffic between Wire Centers within the same Local Access and Transport Area (LATA).

~~Network Access Links (NALs) are~~ Connection to the MEN is available at ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Service Points or to customer building locations served by ~~Qwest~~CenturyLink Network Disclosed Central Offices (COs) in selected metropolitan areas. ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service to buildings without sufficient facilities will be considered on a case-by-case basis~~n Individual Case Basis (ICB)~~.

2.2.1 Ethernet with Extended Transport

~~MOE~~Metro Ethernet may also be available to customer locations that are not within the ~~Qwest~~CenturyLink-designated service area via Ethernet with Extended Transport (EwET). With EwET, ~~Qwest~~CenturyLink provides interoffice transport facilities for extending ~~MOE~~Metro Ethernet from a core switch CO to an outlying SWC and delivery to the customer premises. The UNIs connected to EwET do not support~~s~~ the full set of ~~following MOE~~Metro Ethernet Service Attributes and are limited to the following physical User-Network Interfaces and EVC Bandwidth Profiles (described in Section 2.11.1):

- 10Base-T with 5 or 10 Mbps

- 100Base-TX with 10, 20, 30 or 40 Mbps

Note that some ~~optional MOE features~~ UNI and EVC Service Attributes ~~described in this document~~ are not available on EwET ~~links~~ including:

1. Service Multiplexer and Service Provider ports
2. Protect Routing
3. Quality of Service (QoS)

See the ~~MOE~~Metro Ethernet Network Disclosure for CO availability as well as the Tariff for additional information on EwET including applicable rates.

2.3 Overview

~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet ~~or MOE~~ is a Layer 2 data transport service that offers enterprise and Carrier customers the ability to interconnect standard 10/100/1000 Mbps Local Area Network (LAN) interfaces within a metropolitan area. The ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Network (MEN) designated service area consists of intelligent Ethernet core and edge switches as well as emerging Ethernet transport technologies such as Next Generation multiservice SONET, WDM (e.g. CWDM, DWDM), and SHDSL Ethernet over copper (EoCu), ~~where available~~ as determined by the company to connect two or more customer-designated ~~locations~~ UNIs using Institute of Electrical and Electronics Engineers, IEEE® 802®.1d Media Access Control (MAC) bridging.

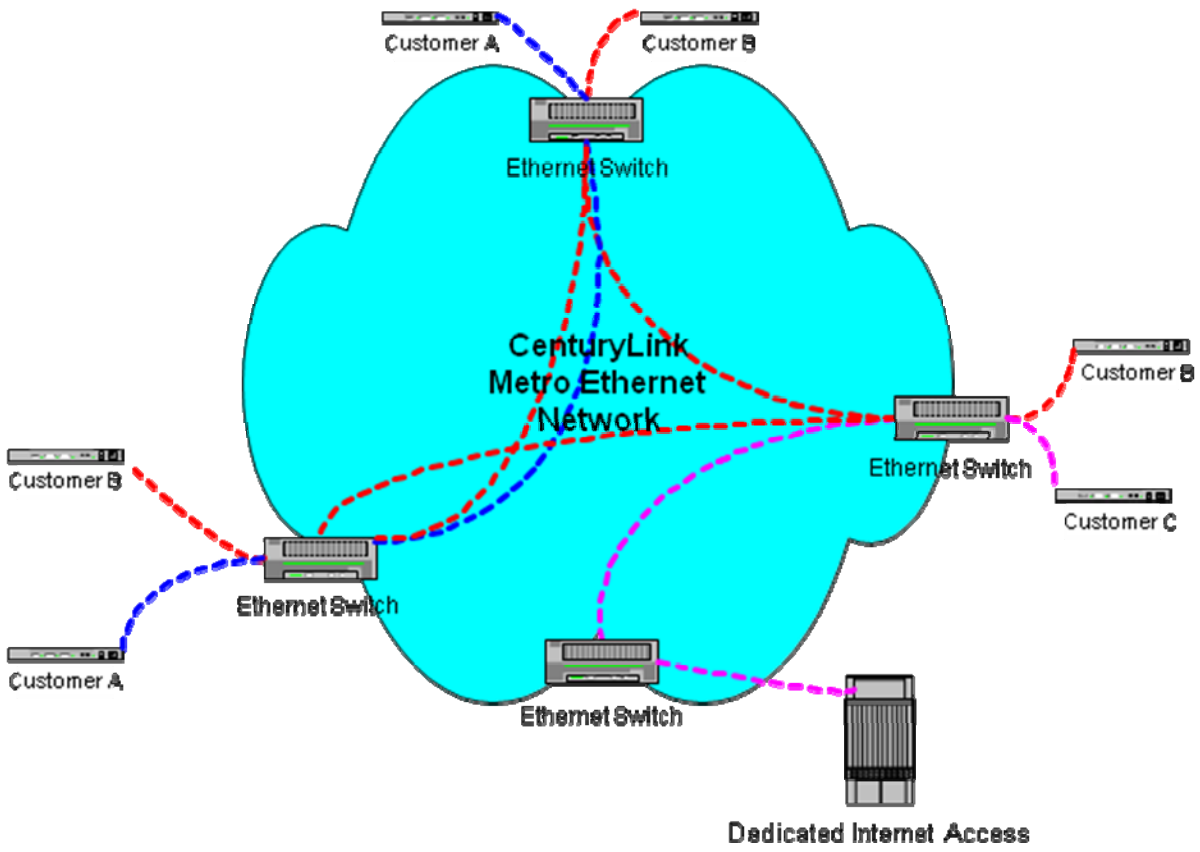
At ~~Qwest~~CenturyLink's discretion and based upon the customer's bandwidth requirements, various types of equipment may be placed at End-User premises to deliver electrical and optical Ethernet User-Network Interfaces (UNIs). The UNI is the physical demarcation point between the responsibility of ~~Qwest~~CenturyLink and the responsibility of the Subscriber. Equipment on the Subscriber side of the UNI is referred to as Customer Edge (CE).

The CE and ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~ will exchange Service Frames across the UNI. An ingress Service Frame is an Ethernet frame transmitted across the UNI toward ~~Qwest~~CenturyLink and an egress Service Frame is an Ethernet frame transmitted across the UNI toward the customer. The Service Frame consists of the first bit of the Destination MAC Address through the last bit of the Frame Check Sequence (FCS).

Ingress Service Frames will be ~~transported from each~~ rate-limited at the UNI, and forwarded to a ~~Qwest~~CenturyLink ~~Central Office (CO) core~~ switch/router ~~using a rate-limited Network Access Link (NAL)~~. UNIs~~NALs~~ are available in customer-specified bandwidth increments from 5 Mbps up to 1 Gbps. The physical UNI Service Attribute as well as the ~~NAL bandwidth~~ Bandwidth (Profile) attribute ~~can~~ may be different at each UNI in (that are members of) an EVC~~location~~.

~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet UNIs may be located at End-User premises, Interexchange Carrier (IC) or Internet Service Provider (ISP) Points-of-Presence (POPs), or within selected ~~Qwest~~CenturyLink Central Offices (COs). Connectivity between UNIs is specified by the Ethernet Virtual Connection (EVC). Each individual ~~MOE~~Metro Ethernet customer's ~~two or more~~ User-Network Interfaces~~/Network Access Links~~ will be connected via a Point-to-Point or Multipoint-to-Multipoint EVC. For customers A, B and C in Figure 2-1, a single EVC allows each of their locations to communicate with all of their other UNIs in an EVC ~~locations~~ on the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Network (MEN).

Figure 2-1 ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet Network Example



An Ethernet service that is based on a Point-to-Point EVC is designated as an Ethernet Line (E-Line) Service type (as with Customers A and C above), and an Ethernet service that is based upon a Multipoint-to-Multipoint EVC is designated as an Ethernet LAN (E-LAN) Service type (Customer B). Section 2.12.1, Ethernet Virtual Connections provides further information.

~~The MOE network bandwidth between customer locations is not dedicated to one user, but shared between multiple customers within a metro.~~ EVCs are used to separate individual customer's traffic, ensure security of communications and traffic confidentiality between different customers, and will conform to the IEEE 802.1Q, *Virtual Bridged Local Area Networks* standard. The sharing of the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~ is based on customer Bandwidth Profiles and ~~is subject to Qwest~~ will be engineered by CenturyLink ~~oversubscription policy in the core~~ to deliver each customer's Service Frames in accordance with the Performance Specifications as defined in Chapter 4.

Connectivity between customer-designated locations is accomplished by provisioning a customer's EVC through the ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet edge and core switches, SONET where applicable and fiber optic or copper transport facilities. ~~Qwest~~CenturyLink will manage the capacity of the ~~MOE~~MEN ~~network~~, provide traffic segregation and security, and enforce the ~~bandwidth~~ Bandwidth Profiles ~~or throughput~~ for each customer's UNI ~~Network Access Link (NAL)~~, based on the subscribed Committed Information Rate (CIR) ~~and/or Excess Information Rate (EIR)~~.

2.4 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Customer Access Ports

~~MOE~~Metro Ethernet has five different types of customer access ports listed in Table 2-1 and refers to the CE-VLAN ID/EVC mapping at the UNI and whether Layer 2 Control Protocols are discarded or tunneld. The port types are then classified according to the User-Network Interface (UNI) and EVC per UNI, and Ethernet Virtual Connection (EVC) service attributes further described in Sections 2.11 and 2.12.

Table 2-1 ~~MOE~~Metro Ethernet Customer Access Ports

Customer Access Port	Description
Non-TLS	Supports one EVC per UNI Untagged customer frames only Doesn't tunnel Layer 2 Control Protocols
TLS	Supports one EVC per UNI Untagged and VLAN tagged customer frames Transparent to customer VLAN tags Tunnels Layer 2 Control Protocols – STP, CDP and VTP
TLS Plus	Supports one EVC per UNI Untagged and VLAN tagged customer frames Transparent to customer VLAN tags Tunnels Layer 2 Control Protocols – STP, CDP, VTP and LACP Can only be placed in a Point-to-Point (E-Line) EVC
Service Multiplexer	Supports more than one EVC per UNI Untagged customer frames dropped Transparent to customer VLAN tags Doesn't tunnel Layer 2 Control Protocols
Service Provider	Supports more than one EVC per UNI Untagged customer frames dropped Transparent to customer VLAN tags Doesn't tunnel Layer 2 Control Protocols

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. LACP = Link Aggregation Control Protocol
7. See Section 2.11.12 for additional information on Layer 2 Control Protocol Processing with TLS and TLS Plus ports.

2.5 Rate-Limiting, Committed and Excess Information Rates

~~The Qwest MOE Network provides hardware-based rate-limiting to provide control of the traffic flows from multiple customers, which may share the same physical Gigabit Ethernet links.~~ Each customer's individual ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Network Access Links (NALs) will be rate-limited at the ~~switch port (~~UNI~~)~~ or EVC to a customer-specified ~~bandwidth~~Bandwidth Profile. ~~The Layer 2 edge and core switches will perform rate-limiting for all Ethernet traffic across all switch ports in the Qwest MOE Network.~~ At each UNI, the customer's traffic will be policed and bandwidth limited in both ingress (entry) and egress (exit) directions.

Non-TLS, TLS and TLS Plus customer access ports will be rate-limited at the UNI level while Service Multiplexer and Service Provider ports for example with any single switch port provisioned to support multiple of their Subscribers, who are ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet End-User customers, rate-limiting can be performed on the individual customer EVCs at the UNI. Per EVC ingress and egress policing enables the rate-limiting of individual EVCs or VLANs ~~on 802.1Q Gigabit Ethernet trunk ports~~. The ~~Qwest MOE intelligent Ethernet edge and core switches~~ UNI ~~are~~ is capable of performing rate-limiting via Committed Information Rate (CIR) ~~or Excess Information Rate (EIR)~~ functionality ~~depending upon service order. The Qwest MOE rate-liming of EIR for best effort traffic (with CIR=0)~~ and ~~CIR for QoS customers' traffic~~ is:

- Equal to the (fractional Ethernet) Bandwidth Profile ordered by the customer per UNI or EVC
- Available from 5 Mbps up to 1000 Mbps (the maximum physical port speed)

Currently, Ingress and egress rate-limiting will be equal at all switch ports, i.e. symmetrical at a given UNI.

2.6 VLANs

An Ethernet Virtual Circuit ~~LAN~~ (~~VLAN~~EVC) ~~is a switched network that~~ connects two or more customer locations or User-Network Interfaces (UNIs) and:

- Enables the transfer of Ethernet frames between locations that are connected by the same ~~VLAN~~EVC.
- Prevents data transfer between customer locations or UNIs that are not part of the same ~~VLAN~~EVC.

The function of an ~~VLAN~~ EVC is to isolate the Layer 2 Media Access Control (MAC) broadcast domains. In order to provide data privacy and security, each individual customer subnet will be separated from all other customers on a unique Ethernet Virtual Connection (EVC) at the edge site/switch and across the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~. ~~EVCs identified by IEEE 802.1Q VLANs ensure that data~~ Data packets ~~are~~ will be forwarded only to end stations within an ~~specific subnet~~EVC~~, thus reducing broadcast transmissions and allowing the Qwest MOE Network to be shared between multiple customers within a metro~~.

2.6.1 VLAN Stacking

Service Frames at the UNI may contain an IEEE 802.1Q Customer VLAN Tag. Such a Tag is referred to as a Customer Edge VLAN Tag (CE-VLAN Tag). VLAN stacking, standardized in IEEE 802.1ad-2005, *Provider Bridges*, is a technique whereby a second VLAN tag is inserted into the Ethernet frame header so that overlapping VLAN IDs can be supported across a switched network. ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service is capable of 'stacking' the CE VLAN Tag or Customer VLAN Tag (C-Tag in IEEE terminology) into the ~~Qwest~~CenturyLink-inserted Service VLAN Tag (S-Tag), thus enabling customers the capability of a Layer 2 VPN.

For End-User customers, VLAN stacking is done in which the customer or User Facing PE (U-PE) switch port typically operates in a transparent (802.1Q tunneling) mode and any traffic being sent by the customer, including the CE-VLAN ID and Class of Service (CoS)/802.1p packet priority bits are passed to an EVC and tunneled across the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~.

At the ingress UNI, an additional 802.1Q header with S-Tag is added to the Ethernet frame. The ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~ will make its forwarding decisions based on this additional header. Once the frame arrives at the egress UNI, the outer or ~~Qwest~~CenturyLink-inserted S-Tag is then discarded for handoff to the customer at the far end. Thus, an End-User customer may configure and extend their CE-VLANs across the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~ without the need to coordinate with ~~Qwest~~CenturyLink.

~~As stated in Section 2.7.5, Carrier Interconnection a standard set of VLAN IDs or S-Tags / C-Tags for example may be agreed upon between Qwest, ICs, ISPs and other co-providers.~~ Depending upon the ~~MOE~~Metro Ethernet Customer Access Ports or UNIs in an EVC, Service Provider ports may also be configured to provide CE-VLAN ID and CoS Preservation. Based on the CE-VLAN ID/EVC Map, one or multiple CE-VLANs can be mapped to each EVC.

To distinguish the Subscriber's VLAN tag from the Service Provider inserted VLAN tag (such as when using Q-in-Q), the Metro Ethernet Forum (MEF) has defined the term CE-VLAN ID (Customer Edge VLAN ID) to represent the Subscriber's VLAN ID. The CE-VLAN Tag also contains the 802.1p field, which the MEF has termed CE-VLAN CoS which refers to the Subscriber's 802.1p field. CE service attributes for ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service including CE-VLAN ID Preservation, CE-VLAN CoS Preservation and CE-VLAN ID/EVC Map requirements are described in Sections 2.11 and 2.12.

2.7 Architecture

The baseline ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet architecture is a distributed Layer 2 core and edge intelligent Ethernet switching topology with statistical multiplexing for shared data transport bandwidth over direct fiber or where available SONET facilities. The ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet physical network consists of point-to-point Gigabit Ethernet circuits or switch-to-switch internodal links, while the logical or virtual network supports controlled customer access bandwidth with multipoint-to-multipoint connectivity. **This document does not attempt to identify every internal architecture or provisioning option that might be used by CenturyLink to deliver Metro Ethernet service.**

2.7.1 Physical Network

The ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet physical network architecture adapts to a wide diversity of enhanced transport technologies that exist in ~~Qwest~~CenturyLink's Metropolitan Area Networks (MANs). Figure 2-2 depicts an example of ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet delivered across multiple topologies and transport platforms. The Network Access Links or edge site/switch to core switch connections as well as the core switch to core switch Interoffice Facility (IOF) interconnections may for example be provided over:

- Direct fiber
- SONET 1+1 Linear, UPSR or 2F BLSR configurations
- Wavelength Division Multiplexing (WDM) including Coarse (CWDM) and Dense (DWDM)

Additionally, Ethernet over copper Network Access Link architectures including repeaters may be used.

~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet traffic will typically be collected at the End-User premises by a ~~Qwest~~CenturyLink-provided Layer 2 (L2) edge switch, which interfaces to customer-provided Data Terminal Equipment (DTE). There could be multiple customers on a single edge switch. These switches are then connected via Gigabit Ethernet uplinks and transported directly over fiber or Next Generation multiservice SONET Add-Drop Multiplexers (ADMs), where available or possibly WDM to the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet core switching infrastructure.

The SONET ADM maps the Ethernet frames into a Synchronous Transport Signal (STS)-'24c', STS3c-7v or appropriate STS-Nc (or STSNc-Xv) Synchronous Payload Envelope (SPE) bandwidth capacity to provide for Layer 1 protected transport via the ~~Qwest~~CenturyLink SONET infrastructure. The Ethernet frames are then forwarded unmodified to the appropriate core switch. The encapsulation and transport do not affect information in the headers and IEEE 802.1Q VLANs are tunneled (see Sections 2.4 and 2.12 for ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet access ports and EVC configurations supporting customer VLAN tag transparency, or Customer Edge VLAN ID and CoS Preservation).

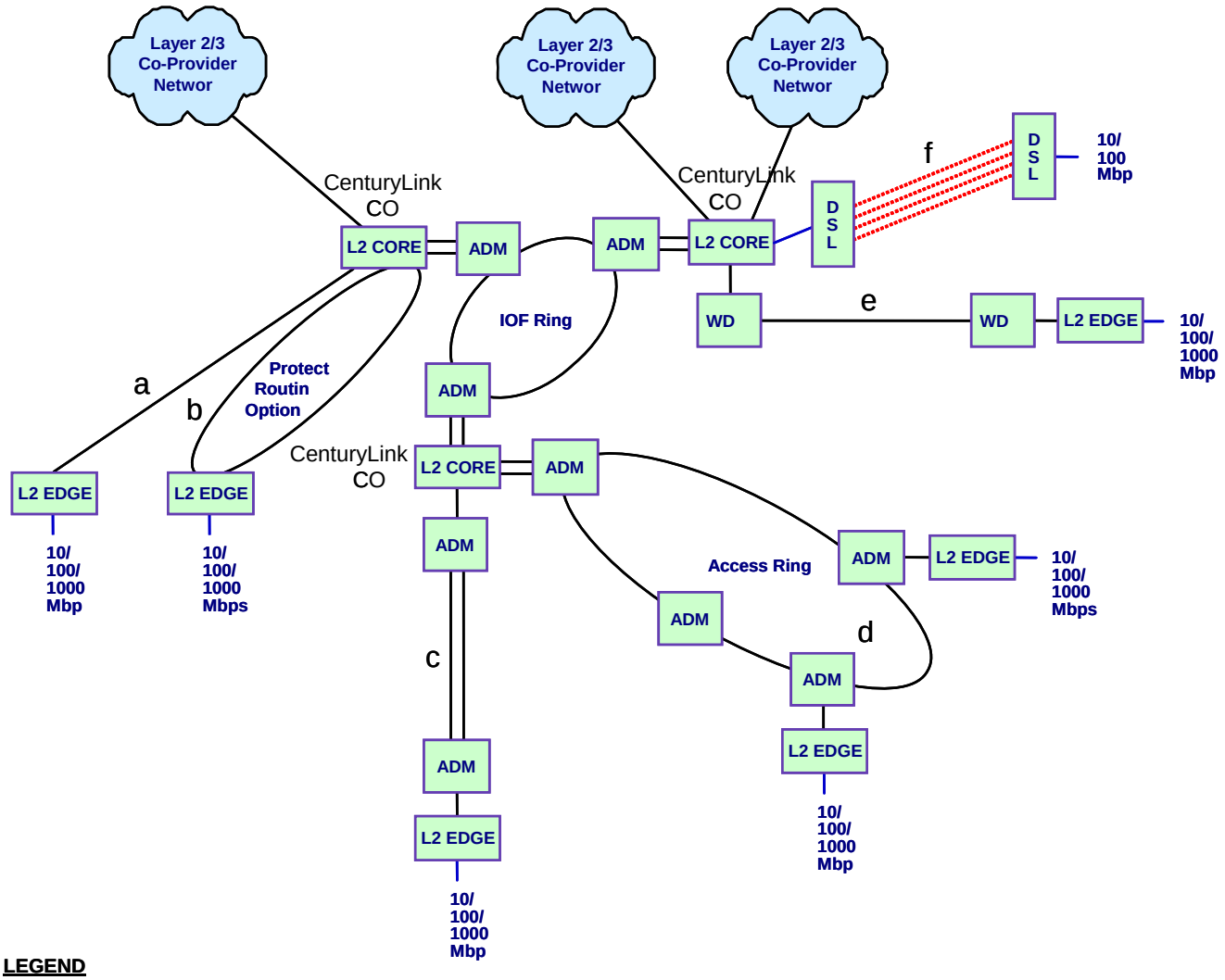
The ~~Qwest~~CenturyLink SONET network will be used where available to connect the Layer 2 paths to form a Layer 2 switching network over SONET. The multiservice SONET ADMs employ Next Generation Gigabit Ethernet port cards to encapsulate the customers' Ethernet traffic for transport between the edge and core switches as well as from ~~Qwest~~CenturyLink Central Office (CO) core switch to CO core switch in the interoffice. The Gigabit Ethernet core aggregation and edge intelligent Ethernet switches are sized to operate at wire speed while the standard logical Layer 2 network will be used to manage the shared ~~MOE~~Metro Ethernet transport bandwidth.

Typical direct fiber, Ethernet-over-SONET (EoS) or copper and WDM physical Network Access Link (NAL) architectures are shown in Figure 2-2. At the center of the diagram are the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Layer 2 (L2) core switches, which aggregate the ~~MOE~~Metro Ethernet traffic from all the End-User customer locations and interconnect to other Carriers or Layer 2/3 co-providers' networks via Gigabit Ethernet links. The core switches reside in ~~Qwest~~CenturyLink COs, which are ~~MOE~~Metro Ethernet Serving Wire Centers (SWCs) designated as entry or Service Points into the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~. Other COs listed by ~~Qwest~~CenturyLink as ~~MOE~~Metro Ethernet Service Points will backhaul customer traffic to the nearest core switch facility.

The Layer 2 edge switches may reside at End-User premises or be deployed within some ~~Qwest~~CenturyLink COs as an aggregation device or to provide ~~MOE~~Metro Ethernet User-Network Interfaces (UNIs) including at Interexchange Carrier (IC) or Internet Service Provider (ISP) defined Points of Presence (POPs). Both core and edge switches perform statistical multiplexing, traffic separations, policing and marking. At the ingress, the switch checks for errors on a received packet, determines the destination port, stores the packet in shared memory and then forwards the packet to the destination port.

As indicated in the diagram, depending upon the customer demand requirements and ~~Qwest~~CenturyLink Local Loop infrastructure, different architectures may be used to provide the Ethernet NALs or customer-designated edge sites to ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Layer 2 core switch connections.

Figure 2-2 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Physical Network



LEGEND

= Single-Mode Fiber pair
= Copper pair
= Cat-5E copper cabling or fiber pair
ADM = SONET Add-Drop Multiplexer
WDM = Wavelength Division Multiplexer
DSL = Digital Subscriber Line modem
Layer 2/3 Co-Provider Network = IC or ISP

2.7.2 Network Access Links

Network Access Links (NALs) are the ~~Qwest~~CenturyLink-provided connections to the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~ from the User-Network Interface (UNI) locations at End-User premises, IC or ISP POP to the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet core switching infrastructure as well as for delivering 1000Base-LX UNIs within selected ~~Qwest~~CenturyLink COs (see Section 2.7.3). As illustrated in Figure 2-2, the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet customer UNI can connect to the ~~Metro Optical Ethernet network~~ MEN via several types of NAL physical network architectures. The edge switches are connected back to a ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet core switch at the Service Point or local Serving Wire Center via 1 Gbps (2 Gbps bi-directional) full duplex, point-to-point Ethernet circuits over direct fiber or SONET, where available or possibly via Wavelength Division Multiplexing (WDM). 10Base-T UNIs with a 3, 5, 7 or 10 Mbps Bandwidth Profile/NAL as well as 100Base-TX UNIs with a 3, 5, 7, 10, 20 or 30 Mbps Bandwidth Profile/NAL may also be delivered to a customer premises via various standard IEEE 802.3ah Ethernet over bonded copper pair topologies using enhanced SHDSL modems.

~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet is an Individual Case Basis (ICB) designed service and as such will follow the standard Auto Quote Contract Billing, AQCB® System Design Center (SDC) process. ~~Qwest~~CenturyLink Engineering will determine the appropriate Network Access Link architecture to best meet each customer's service requirements based on the existing infrastructure facilities and Local Network policy. Although there are several Network Access Link architectures, all of the following designs represented in Figure 2-2 meet the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet requirements and may be used to provide the service.

- All edge switch to core switch connections are Gigabit Ethernet using one or more Single-Mode Fiber (SMF) pairs. Fiber redundancy with diversity is a customer-orderable Network Access Link option where available, i.e. where such facilities exist in the ~~Qwest~~CenturyLink Local Loop infrastructure. Customer sites served by copper facilities will be connected to the ~~MOE~~Metro Ethernet core network using 10/100Base-T interfaces and Category 5E cabling.

- Although not shown, the User-Network Interface (UNI) will be at an RJ-45 jack on a ~~Qwest~~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 ~~Qwest~~CenturyLink-provided SFP via a fiber jumper and adapter/coupler for optical Gigabit Ethernet interfaces. See Chapter 3, Network Interfaces for further information.

a) *Edge switch single homed to core switch over direct fiber (single pair)*

- The customer interfaces available via the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Layer 2 edge switches are 10Base-T, 100Base-TX and 1000Base-T electrical as well as 1000Base-LX (1300-1310 nm, SMF) and 1000Base-SX (850 nm, MMF) optical.
- Customers desiring a physical 10 or 100 Mbps optical LAN interface for example will need to use a media converter. Currently, media converters are not a ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service option and must be Customer Provided Equipment (CPE).

b) Optional Protect Routing: *Single edge switch dual homed to a single core switch over two fiber pairs using IEEE 802.3-2008 (Clause 43) Link Aggregation Control Protocol (LACP) for customer-requested enhanced service availability*

- Available with a single customer port (UNI) and offered on a where available basis only* with the following ~~MOE~~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 1000 Mbps (full data rate) only

  * Customers are advised to consult with ~~Qwest~~CenturyLink Engineering for specific details including availability
- Local loop redundancy is provided by provisioning two Gigabit Ethernet uplinks from the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet edge switch to the CO core switch.
- Diverse facilities are provided with a minimum of 25' separation from the first utility vault outside the ~~Qwest~~CenturyLink Central Office 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 Gigabit Ethernet trunk port on the ~~MOE~~Metro Ethernet edge or core switch, or connecting fiber facilities.
- This option is not intended to provide for any additional customer bandwidth or traffic load balancing on the dual uplinks or Link Aggregation failover across the User-Network Interface.
- See the ~~MOE~~Metro Ethernet Tariff for additional applicable rates per customer User-Network Interface/Network Access Link.

c & d) *Edge switch single homed to core switch over SONET ADMs*

- Point-to-point Ethernet circuit over a 1+1 Linear, UPSR or 2F BLSR configuration.
- Provides low latency transport of full line rate Gigabit Ethernet traffic.
- Each Gigabit Ethernet port maps to a contiguous concatenated Synchronous Transport Signal (STS) circuit.
- Ethernet frames are transparently mapped into the SONET Super Rate payload.
- The SONET network provides encapsulation and Layer 1 protected transport of Ethernet traffic only (no Layer 2 switching).

e) *Edge switch single homed to core switch over WDM*

- Shown is a two channel (1310/1550 nm) passive Wavelength Division Multiplexing (WDM) system.
- Provides ultra low latency protected transport of full line rate Gigabit Ethernet traffic.
- A point-to-point Coarse or Dense WDM (CWDM or DWDM) system may also be used for Layer 1 transport if available in the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~ infrastructure.

f) *Direct core switch connection using DSL modems over copper*

- 10Base-T or 100Base-TX Ethernet interfaces only.
- New Ethernet First Mile (EFM) PHY level standard IEEE 802.3ah-2004 (Amendment to IEEE Std 802.3-2008) bonding of up to 8 copper cable pairs using G.SHDSL.bis line code
- Supports Bandwidth Profiles or throughput up to a maximum of 30 Mbps symmetrical

- Deployment based on customer requirements, copper pair availability and loop distance
- 'Hitless' cut line protection

2.7.3 ~~MOE~~Metro Ethernet User-Network Interfaces at ~~Qwest~~CenturyLink Central Offices

~~MOE~~Metro Ethernet customer-orderable handoffs at ~~Qwest~~CenturyLink Central Offices (COs) are limited to 1000Base-LX (SMF) User-Network Interfaces (UNIs) with a 100, 600 or 1000 Mbps Bandwidth Profile and available at ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet core switch CO locations only for providing cross-connects to a:

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

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

2.7.4 Core Switch Connections

The Gigabit Ethernet (or 10 Gigabit Ethernet) connections between the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Layer 2 core switches may be provided over direct fiber, SONET or WDM. Where available SONET facilities may be used and depending upon the number of ~~Qwest~~CenturyLink COs, multiple direct fiber connections, SONET rings and/or CWDM/DWDM systems or Optical Add-Drop Multiplexer (OADM) rings may be required. The core switch Interoffice Facilities (IOF) architecture will be (in order of preference) full mesh, partial mesh, ring (mesh) or linear including hub and spoke.

In Figure 2-2, the three ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Layer 2 core switches are shown as an example connected together in a full mesh via a single SONET ring. Each ~~Qwest~~CenturyLink CO core switch connects directly to each of the other two core switches with a point-to-point Gigabit Ethernet circuit on the ring. Different scenarios are also possible for the ~~MOE~~Metro Ethernet core switch interconnections. For example, there could be more than three ~~Qwest~~CenturyLink CO sites in a metro region or more than one core switch per CO.

Regardless of the specific ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet core switch architecture, protection will be provided via Layer 1 transport redundancy and Ethernet Layer 2 Control Protocols on the Gigabit Ethernet IOF links. The primary requirement is that in case of a single link failure in the core switch network, no ~~Qwest~~CenturyLink CO site will be isolated. There will always be either another parallel Gigabit Ethernet connection or an alternate path to get from core switch to core switch.

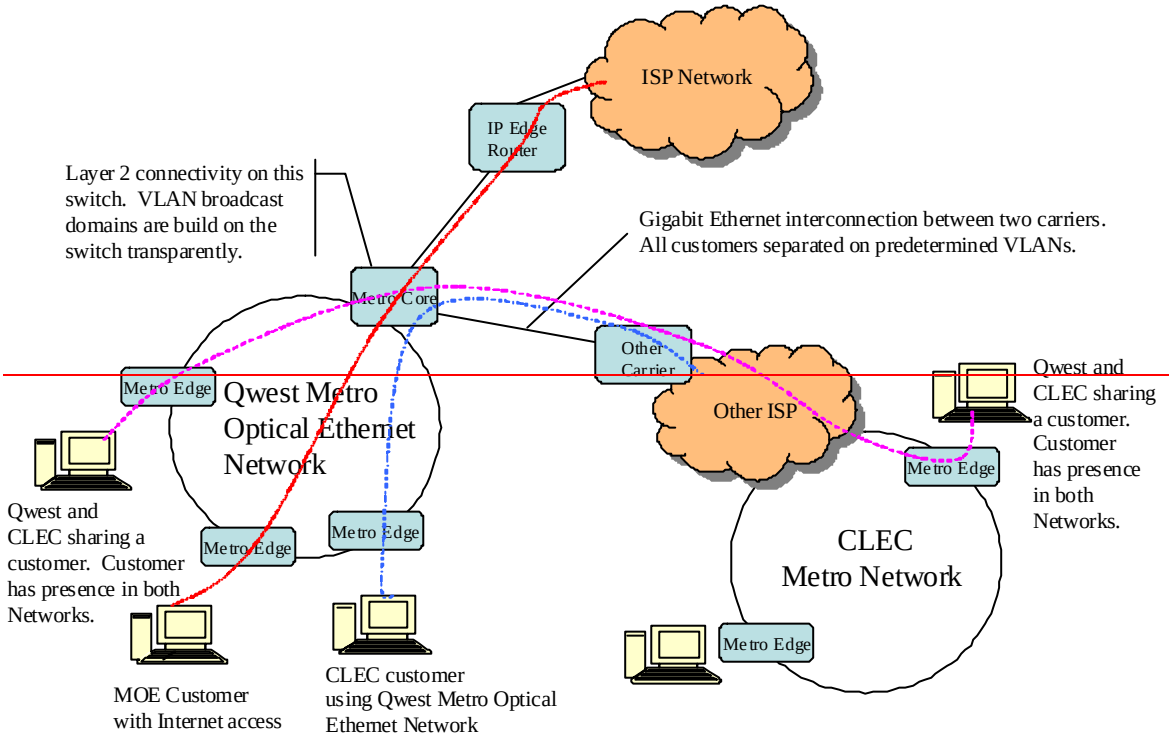
"Per-VLAN" Spanning Tree Protocol will be run on the redundant/alternate path Gigabit Ethernet connections in the core switch IOF network to provide for Layer 2 rerouting of customer traffic in case of a failure. This design ensures high availability of the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet core switch to core switch connections.

~~2.7.5 Carrier Interconnection~~

~~As shown in Figure 2-3, the MOE core switches may be designated connection points to Interexchange Carriers (ICs), Internet Service Providers (ISPs) or other co-provider's networks as determined by Qwest. MOE User-Network Interfaces delivered via an edge switch will be used to connect to other Carriers, ISPs and End-User customers in a metro. With Service Provider ports, a standard set of VLANs may be agreed upon between the Carriers for the purpose of exchanging Ethernet traffic, or where available transparent to the Qwest MOE Network. All VLANs or Ethernet Virtual Connections (EVCs) will be rate-limited both in the ingress (entry) and egress (exit) directions. For further information including available options for Service Provider ports see:~~

- ~~Section 2.11, UNI and EVC per UNI Service Attributes for MOE Customer Access Ports~~
- ~~Section 2.12, Ethernet Virtual Connection Service Attributes for MOE Customer Access Ports~~

~~**Figure 2-3** Carrier Interconnection~~



2.8 Resiliency

The following is in addition to the physical redundancy, and Layer 1 and Layer 2 protection protocols described in Section 2.7.2, Network Access Links and Section 2.7.4, Core Switch Connections.

2.8.1 Edge Switches

The ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet edge switches will be deployed with ~~the features below in order to maximize network uptime and prevent loss of customer traffic:~~

~~P~~per-port broadcast and multicast traffic controls to prevent faulty end stations or Denial of Service (DoS) attacks from disrupting the ~~MOE~~MEN ~~network~~ (see Section 2.12.2 for further information).

- ~~Switch port auto-recovery automatically attempts to re-enable a link that becomes disabled due to a network error.~~

2.8.2 Core Switches

To ensure high service availability for mission-critical applications, ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet core switches will be deployed with these features:

- Standby Switch Fabric Module (1+1).
- Redundant voltage termination modules.
- IEEE 802.3-2008 (Clause 43) Link Aggregation Control Protocol (LACP) enhances fault tolerance and offers higher-speed aggregated bandwidth and load balancing on multiple parallel Gigabit Ethernet core switch connections.

2.9 Customer MAC Address Limits

For customers who choose to connect to the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~ 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 switch port/UNI.

2.10 Introduction to ~~MOE~~Metro Ethernet Service Attributes

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

For a ~~MOE~~Metro Ethernet request, attributes will be specified for each UNI in the EVC as well as for the EVC(s) and captured on the ~~Qwest~~CenturyLink and/or Alliance for Telecommunications Industry Solutions (ATIS) Access Service Request (ASR) EVC Form(s) at the time of service order. ~~Qwest~~CenturyLink Metro ~~Optical~~ 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 ~~Qwest~~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.~~1~~2, *Ethernet Services Attributes - Phase 2*, ~~November~~ October ~~2006~~ 2009 document available at: http://www.metroethernetforum.org/ and has been reproduced with permission of the Metro Ethernet Forum.

2.11 UNI and EVC per UNI Service Attributes for ~~MOE~~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 a number of characteristics that will influence how the Customer Edge (CE) device sees a service. These are called UNI service attributes, and for ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet include:

- Physical Layer; User-Network Interface speed, mode, and physical medium
- MAC Layer
- UNI Maximum Transmission Unit 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 2-4 ~~on page 2-31~~ along with the parameter values for each ~~MOE~~Metro Ethernet customer access port.

2.11.1 Available User-Network Interfaces and Bandwidth Profiles

The customer will select both a physical User-Network Interface (UNI) speed (and electrical, Single-Mode Fiber or Multi-Mode Fiber type for Gigabit Ethernet) along with a Bandwidth Profile for each Network Access Link (NAL) location. ~~Qwest~~CenturyLink ~~MOE~~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 UNIs

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 UNIs 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 UNIs 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 UNIs at customer premises locations may be ordered as hard coded or provisioned with auto-negotiation (preferred).

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 (except with TLS Plus ports) and physical media may be mixed in the same EVC.

The customer will then select a Bandwidth Profile, which is a is a limit on the rate at which frames or bytes can traverse the UNI, from 5 Mbps to 1000 Mbps for each UNI/NAL. The ~~Qwest~~CenturyLink ~~MOE~~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 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 ~~Qwest~~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 ~~Qwest~~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

Additionally, ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet TLS Plus ports are restricted to a:

- 100 Mbps Bandwidth Profile on Fast Ethernet UNIs
- 1000 Mbps Bandwidth Profile on Gigabit Ethernet UNIs

Requirements for connecting to the ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet ~~network~~ Network (MEN) at the UNI are specified in Chapter 3, Network Interfaces.

2.11.2 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 of the following are true:

- The physical medium is capable of supporting 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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet customer 10/100/1000 Mbps Local Area Network (LAN) User-Network Interfaces (UNIs) as well as the internodal Gigabit Ethernet circuits will be provisioned for full duplex operation. Half duplex transmission mode is not a ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service option.

2.11.3 Ethernet Frame Formats

~~Qwest~~CenturyLink ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~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.

2.11.4 Maximum Transmission Unit

The Ethernet Maximum Transmission Unit (MTU) refers to the size (in bytes) of the largest customer packet that a standard MAC frame can transport in the Data field as the Layer 2 encapsulated payload or Protocol Data Unit (PDU). ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service supports Ethernet Version 2 and IEEE 802.3 frames with an MTU of 1500 bytes (which for 802.3 MAC frames includes 3 or 4 bytes for the LLC data). With the Layer 2 header and Frame Check Sequence (FCS), this equates to the IEEE 802.3/802.1Q maximum untagged/VLAN tagged frame size of 1518/1522 bytes.

Although jumbo frames of 2016 bytes on Ethernet and Fast Ethernet (10/100 Mbps) ports as well as 9018 bytes on Gigabit Ethernet ports can be supported in some instances on an Individual Case Basis (ICB), various ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet transport may limit the maximum deliverable frame size to 1704, 1632, 1536 (on EwET links) or even 1532 bytes. Customers are advised to consult with ~~Qwest~~CenturyLink Engineering for specific details including availability and may request UNI and EVC MTU sizes as listed in Table 2-4 UNI and EVC per UNI Service Attributes, and Table 2-7 EVC Service Attributes, whereas:

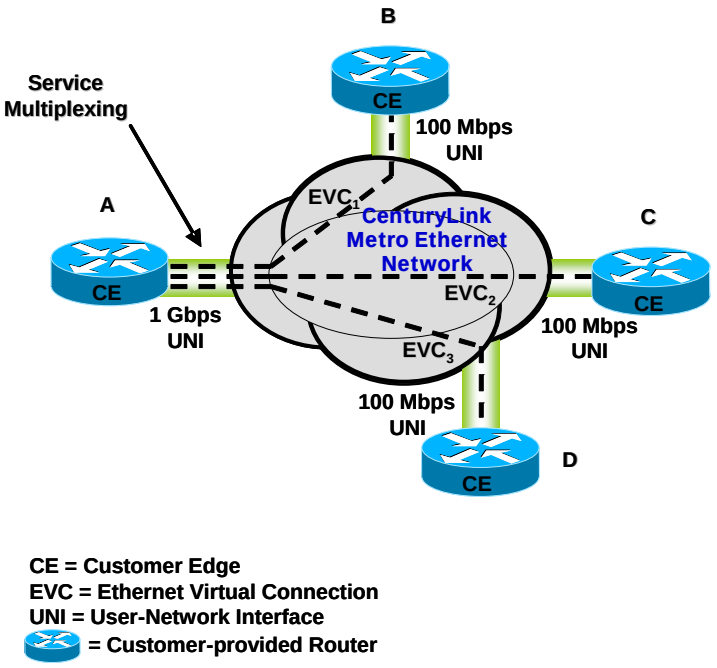
- The UNI Maximum Transmission Unit size service attribute specifies the maximum Service Frame size (in bytes) allowed at the UNI and is independent of the EVCs at the UNI.
- The EVC Maximum Transmission Unit size service attribute specifies the maximum Service Frame size (in bytes) allowed on the EVC.
- Every UNI in the EVC must be capable of supporting the EVC MTU Service Frame size.
- The EVC MTU size for each EVC at the UNI must be less than or equal to the UNI MTU size.
- An EVC may contain UNIs that don't have equal MTU sizes.

2.11.5 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 separate physical UNIs or ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet ports. This attribute is independent of the EVCs at the UNI.

Figure 2-4 Service Multiplexing Example



See Figure 2-11 ~~on page 2-38~~ for an example of Service Multiplexing using a Point-to-Point EVC and Multipoint-to-Multipoint EVC.

2.11.6 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 ~~1~~2 through 4095. 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 point to the same EVC as described in Section 2.11.8, Bundling.

The 4094~~5~~ CE-VLAN IDs always exist at each UNI and are independent of the EVCs at the UNI.

2.11.7 CE-VLAN ID/EVC Map

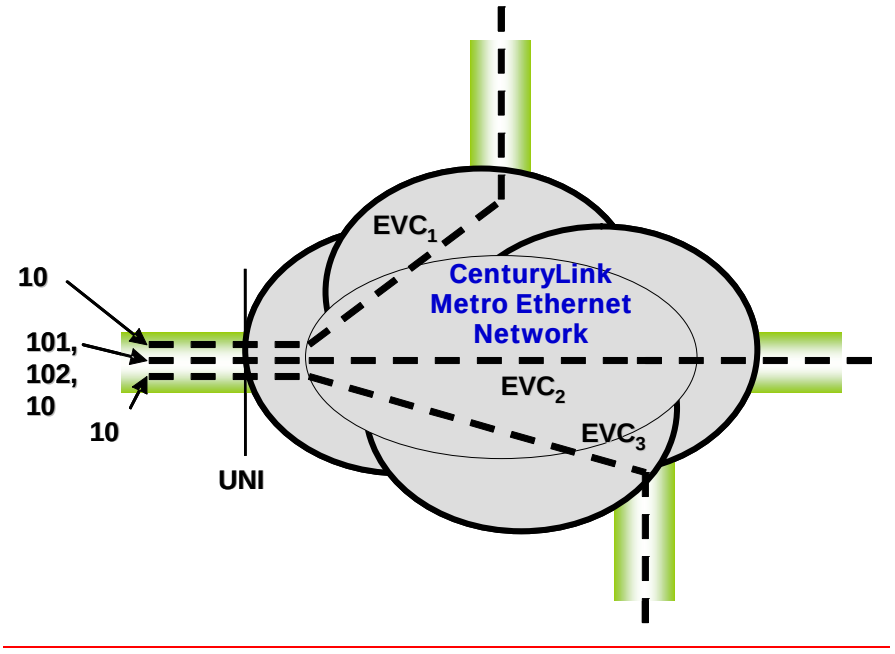
CE-VLAN IDs must be mapped when one UNI supports tagging and the other UNI does not support tagging. In these cases, the CE-VLAN ID used to identify an EVC is locally significant to each UNI. The CE-VLAN ID/EVC Map provides a mapping table between the CE-VLAN IDs at the UNI to the EVC which they belong.

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, ~~Qwest~~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, ~~Qwest~~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 ~~MOE~~Metro Ethernet UNI there will be a mapping of each CE-VLAN ID to at most one EVC. The collection of all of these mappings is the CE-VLAN ID/EVC Map. With no Bundling or All to One Bundling attributes (as described in Sections 2.11.8 and 2.11.9 following) at the UNI, exactly one CE-VLAN ID will be mapped to at most one EVC. Figure 2-5 shows an example of a CE-VLAN ID/EVC Map at a ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Service Multiplexer or Service Provider port with Service Multiplexing.

Figure 2-5 Example of a CE-VLAN ID/EVC Map

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



In Figure 2-5, 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 ~~MOE~~MEN ~~network~~. In Figure 2-5, untagged ingress Service Frames as well as CE-VLAN IDs outside of 100 to 104 aren't mapped to any ~~Qwest~~CenturyLink ~~MOE~~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 ~~Qwest~~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, ~~Qwest~~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 ~~Qwest~~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.

2.11.8 Bundling

When a UNI has the Bundling attribute, it is configured so that more than one CE-VLAN ID can map to a particular 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.

In 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.

Figure 2-6 Example of Bundling

UNI A

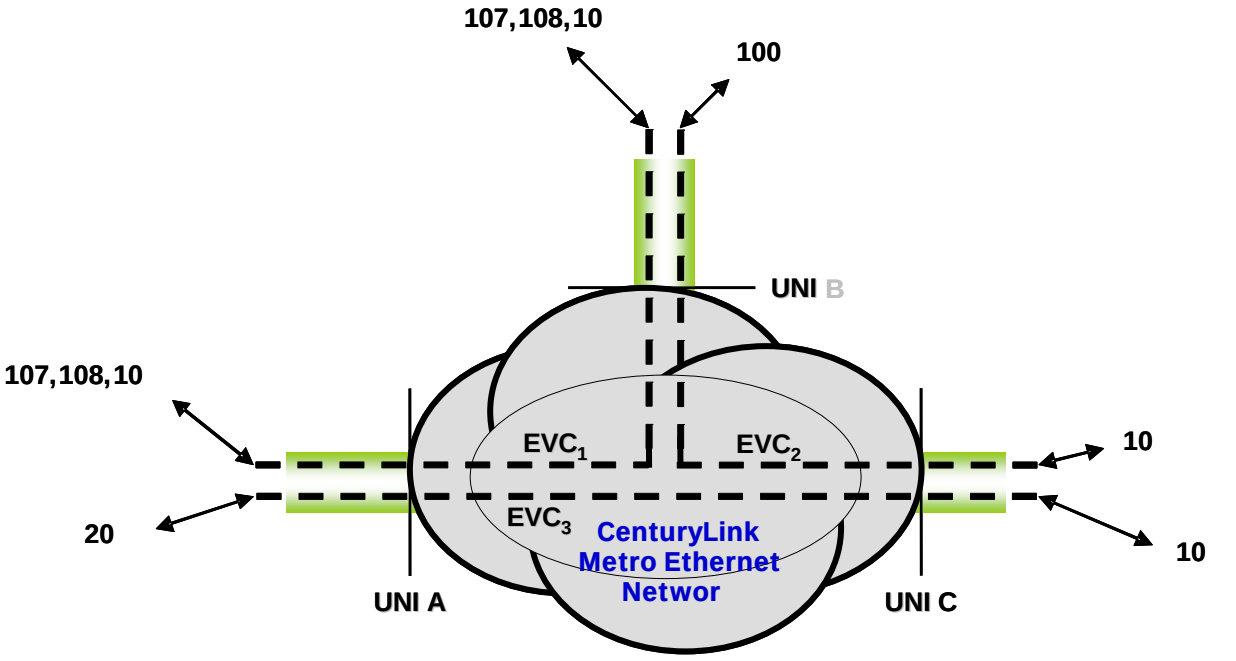
CE-VLAN ID	EVC
107, 108, 109	EVC_1
200	EVC_3

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



2.11.9 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 2-2 shows the possible Bundling and Service Multiplexing combinations for the various ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet port types. The All to One Bundling service attribute is independent of the EVCs at the UNI.

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

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

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

2.11.10 Ingress Bandwidth Profile

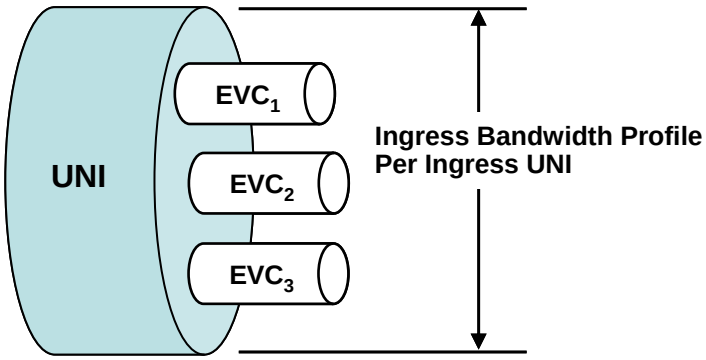
The Ingress Bandwidth Profile is used to regulate the amount of ingress traffic at a particular UNI. An Ingress Bandwidth Profile is defined for ingress Service Frames at the particular UNI.

2.11.10.1 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 ~~Qwest~~CenturyLink ~~MOE~~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



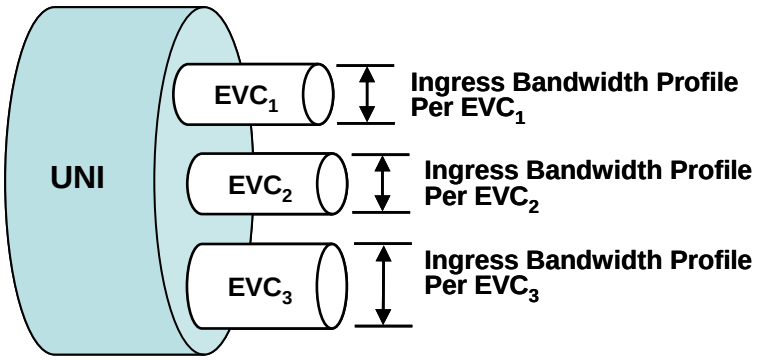
2.11.10.2 Ingress Bandwidth Profile per EVC

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 ~~Qwest~~CenturyLink ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~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 2.5, Rate-Limiting, Committed and Excess Information Rates for further information.

2.11.11 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 particular UNI and applies to all or a subset of all egress Service Frames at the UNI in question.

Currently with ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet, Egress Bandwidth Profiles will be provisioned symmetrical with the corresponding Ingress Bandwidth Profiles. In other words, at a particular UNI the Ingress and Egress Bandwidth Profiles must match and with Service Multiplexing on Service Multiplexer and Service Provider ports 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.

2.11.12 Layer 2 Control Protocol Processing

There are many Layer 2 Control Protocols that might be used in the customer's network and Table 2-3 below provides a partial list of standardized Ethernet protocols currently in use which may be processed* or discarded at the UNI, or passed to an EVC where they may be tunneled across the ~~Qwest~~CenturyLink ~~MOE~~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 2.11.6 and 2.11.7). The UNI Layer 2 Control Protocol Processing service attribute is independent of the EVCs at the UNI.

* This table is not intended to address Layer 2 (or 3) Control Protocol requirements for peering; or at a Network-to-Network Interface (NNI).

Table 2-3 Layer 2 Control Protocol Tunneling

Protocol	Destination MAC Address[1]	TLS Ports	TLS Plus Ports	All other ~~MOE~~Metro Ethernet port types
IEEE 802.1D Bridge Group Address for Spanning Tree Protocol (STP)[2]	01-80-C2-00-00-00	Tunnel	Tunnel	Discard
IEEE 802.3x Full Duplex MAC Flow Control (PAUSE) Frames	01-80-C2-00-00-01	Discard	Discard	Discard
IEEE 802.3-2008 (Clause 43) Link Aggregation Control Protocol (LACP)[3]	01-80-C2-00-00-02	Discard	Tunnel[4]	Discard
IEEE 802.1X Port Authentication	01-80-C2-00-00-03	Discard	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	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	Tunnel	Tunnel	Discard

Table 2-3 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. Cisco Discovery Protocol (CDP) and VLAN Trunking Protocol (VTP) as well as Link Aggregation Control Protocol are tunneled with TLS Plus ports on Point-to-Point EVCs only where the UNIs involved in the Link Aggregation Group are the same speed.
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 ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~ without being processed).
7. 'Discard' means that the ~~MOE~~MEN ~~Network~~ 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 ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~.

Table 2-4 UNI and EVC per UNI Service Attributes

Service Attribute	~~MOE~~Metro Ethernet Customer Access Port				
	Non-TLS	**TLS**	**TLS Plus**[1]	**Service Multiplexer**	**Service Provider**
Speed (Section 2.11.1)	10 Mbps, or 100 Mbps, or 1 Gbps	10 Mbps, or 100 Mbps, or 1 Gbps	100 Mbps, or 1 Gbps	10 Mbps, or 100 Mbps, or 1 Gbps	10 Mbps, or 100 Mbps, or 1 Gbps
Mode (Sections 2.11.1 and 2.11.2)	Full Duplex	Full Duplex	Full Duplex	Full Duplex	Full Duplex
Physical Medium (Section 2.11.1)	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	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	100Base-TX, or 1000Base-T Auto-Negotiation, or 1000Base-LX, or 1000Base-LX Auto-Negotiation, or 1000Base-SX, or 1000Base-SX Auto-Negotiation	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	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
MAC Layer (Section 2.11.3)	IEEE 802.3-2008, or Ethernet V2.0 (DIX)	IEEE 802.3-2008, or Ethernet V2.0 (DIX)	IEEE 802.3-2008, or Ethernet V2.0 (DIX)	IEEE 802.3-2008, or Ethernet V2.0 (DIX)	IEEE 802.3-2008, or Ethernet V2.0 (DIX)
UNI Maximum Transmission Unit size in bytes[2] (Section 2.11.4)	10/100 Mbps UNIs: 2016, or 1522 with earlier release software 1 Gbps UNIs: 9018, or 1996 with earlier release software	10/100 Mbps UNIs: 2016, or 1522 with earlier release software 1 Gbps UNIs: 9018, or 1996 with earlier release software	100 Mbps UNIs: 2016, or 1522 with earlier release software 1 Gbps UNIs: 9018, or 1996 with earlier release software	10/100 Mbps UNIs: 2016, or 1522 with earlier release software 1 Gbps UNIs: 9018, or 1996 with earlier release software	10/100 Mbps UNIs: 2016, or 1522 with earlier release software 1 Gbps UNIs: 9018, or 1996 with earlier release software
Service Multiplexing (Section 2.11.5)	No	No	No	Yes	Yes

Table 2-4 UNI and EVC per UNI Service Attributes (Continued)

Service Attribute	~~MOE~~Metro Ethernet Customer Access Port				
	Non-TLS	**TLS**	**TLS Plus**[1]	**Service Multiplexer**	**Service Provider**
CE-VLAN ID/EVC Map (Section 2.11.7)	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	All untagged and CE-VLAN Tagged frames are mapped to one Point-to-Point 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
Maximum Number of EVCs	1	1	1	10	100
				EVCs are a limited ~~Qwest~~CenturyLink resource and offered on a 'where available' basis within the ~~MOE~~Metro Ethernet ~~network~~Network (MEN).	
Bundling (Section 2.11.8)	No (N/A[3])	No	No	Yes[4], or No	Yes[4], or No
All to One Bundling (Section 2.11.9)	Yes[3]	Yes	Yes	No	No
Ingress Bandwidth Profile per Ingress UNI (Section 2.11.10.1)	Yes	Yes	Yes	Yes, or No if per EVC	Yes, or No if per EVC
Ingress Bandwidth Profile per EVC (Section 2.11.10.2)	No	No	No	Yes, or No if per UNI	Yes, or No if per UNI
Egress Bandwidth Profile per Egress UNI (Section 2.11.11)	Yes	Yes	Yes	Yes, or No if per EVC	Yes, or No if per EVC
Egress Bandwidth Profile per EVC (Section 2.11.11)	No	No	No	Yes, or No if per UNI	Yes, or No if per UNI

Table 2-4 UNI and EVC per UNI Service Attributes (Continued)

Service Attribute		~~MOE~~Metro Ethernet Customer Access Port				
		Non-TLS	**TLS**[5]	**TLS Plus**[1]	**Service Multiplexer**	**Service Provider**
Layer 2 Control Protocol Processing (Section 2.11.12)	STP	Discard	Pass to EVC (tunnel), or Discard (with 2 TLS ports in an E-Line configuration only)	Pass to EVC (tunnel)	Discard	Discard
	CDP	Discard	Pass to EVC (tunnel)	Pass to EVC (tunnel)	Discard	Discard
	VTP	Discard	Pass to EVC (tunnel)	Pass to EVC (tunnel)	Discard	Discard
	LACP[6]	Discard	Discard	Pass to EVC (tunnel)	Discard	Discard
	All-bridge multicast	Discard	Pass to EVC (tunnel), or Discard (with 2 TLS ports in an E-Line configuration only)	Pass to EVC (tunnel)	Discard	Discard
	GARP	Discard	Pass to EVC (tunnel), or Discard (with 2 TLS ports in an E-Line configuration only)	Pass to EVC (tunnel)	Discard	Discard
	PAUSE frames	Discard	Discard	Discard	Discard	Discard
	Port Authentication	Discard	Discard	Discard	Discard	Discard

Table 2-4 Notes:

1. TLS Plus is an option, where available in the ~~Qwest~~CenturyLink network and requires the customer to order multiple parallel, (full duplex) point-to-point links operating at the same data rate, and is only offered on ~~MOE~~Metro Ethernet with full line rate Fast Ethernet (100Base-TX) or Gigabit Ethernet (1000Base-T/LX/SX) ports. Consult with ~~Qwest~~CenturyLink Engineering for specific details including availability.
2. Maximum customer jumbo frame size including Layer 2 header, payload with any CE-VLAN Tag(s), and trailer (FCS)
3. CE-VLAN Tagged frames received at the UNI will be dropped with only untagged customer frames mapped to the EVC.
4. If Bundling is yes, then CE-VLAN ID Preservation (see Section 2.12.3) must be yes.
5. Layer 2 Control Protocol tunneling on TLS ports is offered on a "where available" basis only.
6. Load balancing is the responsibility of the customer with Link Aggregation failover times dependent upon their CPE configuration and protocol. See IEEE 802.3-2008, Clause 43 and applicable vendor documentation for further information.
7. CE = Customer Edge
8. TLS = Transparent LAN Service
9. N/A = Not Applicable
10. STP = Spanning Tree Protocol
11. CDP = Cisco Discovery Protocol
12. VTP = VLAN Trunking Protocol
13. LACP = Link Aggregation Control Protocol
14. GARP = Generic Attribute Registration Protocol

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

The EVC is a fundamental aspect of ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet ~~Service~~ 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 2.11.5.

An ingress Service Frame that is mapped to the EVC (see Section 2.11.7) 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 ~~Qwest~~CenturyLink ~~MOE~~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 Transmission Unit size

The EVC service attributes are described in the following sections and listed in Table 2-7 ~~on page 2-41~~ along with the parameter values for each ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~.

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~~ 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

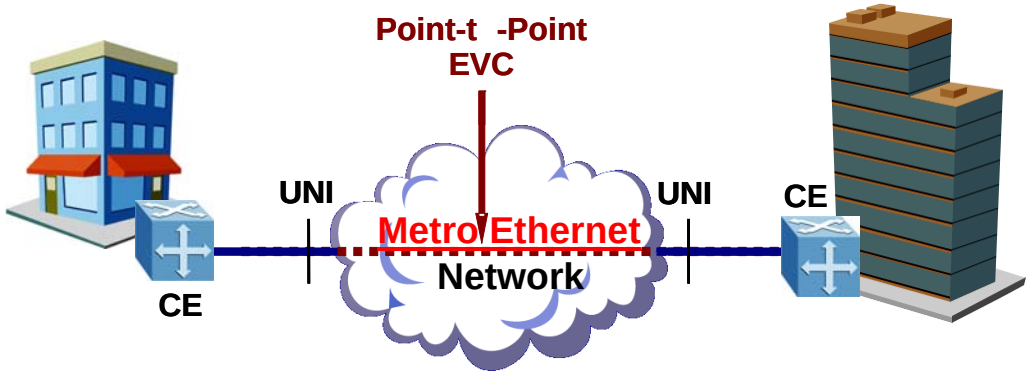
  Is associated with exactly two UNIs and an ingress Service Frame at one UNI can only be an egress frame at the other UNI.

- 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.

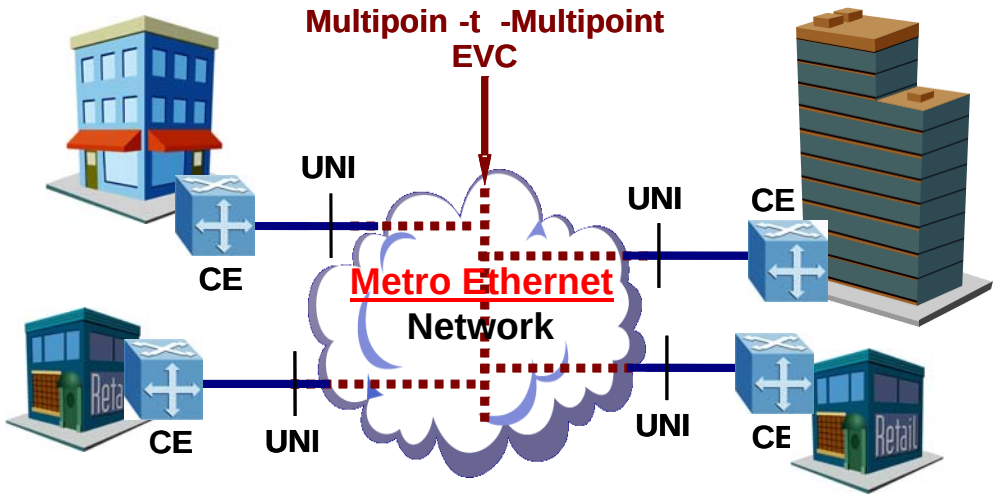
The Ethernet Line Service (E-Line Service) provides a Point-to-Point Ethernet Virtual Connection (EVC) between two User-Network Interfaces (UNIs) as illustrated in Figure 2-9. The E-Line Service is used for Ethernet point-to-point connectivity across the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~. Customer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

Figure 2-10 E-LAN Service



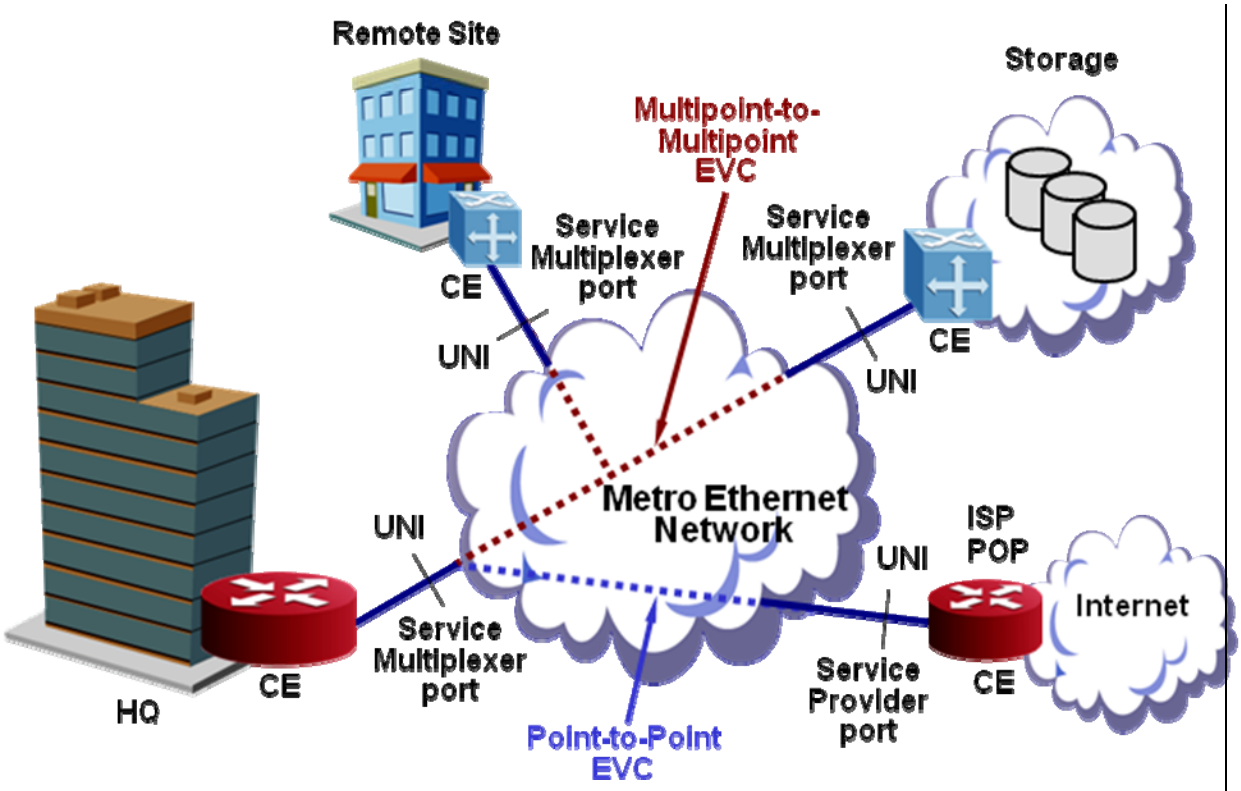
In a Point-to-Point EVC, exactly two UNIs are associated with one another. In a Multipoint-to-Multipoint EVC, two or more UNIs are associated with one another. ~~MOE~~Metro Ethernet Point-to-Point EVC requests will be provisioned using a Multipoint-to-Multipoint EVC with two UNIs where one or more additional UNIs can be added to the multipoint capable EVC at a later date.

~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service can support Service Multiplexing (see Section 2.11.5) 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.

In conjunction with the 10-15-2012 grandfathering of Service Multiplexer to TLS port configurations in an EVC, the three Service Multiplexer ports in the Multipoint-to-Multipoint EVC were customer-specified similar to TLS ports in that they may be provisioned by the company to support untagged frames and Layer 2 Control Protocol tunneling on a per EVC basis. If these additional service attributes can only be supported at the Remote and Storage Sites, then a separate Point-to-Point EVC would additionally be required between these two locations.

At the ISP POP, a service multiplexed UNI provides the ability to support multiple of their Subscribers on a single ~~Qwest~~CenturyLink ~~MOE~~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 ~~MOE~~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 ~~MOE~~MEN ~~network~~) 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, ~~Qwest~~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, ~~Qwest~~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
- 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 ~~MOE~~Metro Ethernet interfaces associated with multicast routers

2.12.3 CE-VLAN ID Preservation

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 2-5 is maintained.

Table 2-5 CE-VLAN ID Preservation

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

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 2-6 below.

Table 2-6 CE-VLAN ID Preservation Service Attribute for an EVC

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 ~~1~~2 – 4094

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 2.11.7 and 2.11.8), 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 the number of CE-VLAN IDs.

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.

Table 2-7 EVC Service Attributes

Service Attribute	~~MOE~~Metro Ethernet Customer Access Port				
	Non-TLS	**TLS**	**TLS Plus**	**Service Multiplexer**	**Service Provider**
EVC Type (Section 2.12.1)	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point	Point-to-Point, or Multipoint-to-Multipoint	Point-to-Point, or Multipoint-to-Multipoint
Maximum Number of UNIs (Section 2.12.1)	2 for E-Line Point-to-Point EVCs, or Unlimited (≥ 2) for E-LAN Multipoint-to-Multipoint EVCs	2 for E-Line Point-to-Point EVCs, or Unlimited (≥ 2) for E-LAN Multipoint-to-Multipoint EVCs	Must be 2	2 for E-Line Point-to-Point EVCs, or Unlimited (≥ 2) for E-LAN Multipoint-to-Multipoint EVCs	2 for E-Line Point-to-Point EVCs~~, and see Table 2-8 on page 2-43 for valid E-LAN Multipoint-to-Multipoint EVC configurations~~
	See Table 2-8 for valid as well as not supported EVC configurations.				
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	Yes, or No (See Table 2-8 ~~on page 2-43~~)	Yes, or No (See Table 2-8 ~~on page 2-43~~)
CE-VLAN CoS Preservation (Section 2.12.4)	No (N/A[2])	Yes	Yes	Yes	Yes
Class of Service Identifier based on EVC (Section 2.13)	No (per UNI)	No (per UNI)	No (per UNI)	Yes	Yes

Table 2-7 EVC Service Attributes (Continued)

Service Attribute	~~MOE~~Metro Ethernet Customer Access Port				
	Non-TLS	**TLS**	**TLS Plus**	**Service Multiplexer**	**Service Provider**
Class of Service Identifier based on Priority Code Point Field (Section 2.13)	No (N/A[2])	Yes	Yes	Yes	Yes
Class of Service Identifier based on DSCP (Section 2.13)	Yes	Yes	Yes	Yes	Yes
EVC Maximum Transmission Unit size in bytes[3] (Section 2.11.4)	1536 on EwET links, or 1632 (or 1532 with earlier release software) Ethernet over copper (EoCu) access links, or 1704 with other EoCu access links, or 2016, or 1522 with earlier release software for 10/100 Mbps frames over GigE or 10 GigE trunks[4], or 9018, or 1996 with earlier release software for 1 Gbps frames over GigE or 10 GigE trunks[4]				

Table 2-7 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. Maximum customer jumbo frame size including Layer 2 header, payload with any CE-VLAN Tag(s), and trailer (FCS)
4. Including possible Ethernet over SONET (EoS), Reconfigurable Optical Add-Drop Multiplexer (ROADM) / Dense Wavelength Division Multiplexing (DWDM), etc. ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet infrastructure transport platforms

Note that when an EVC contains more than one ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet customer access port type or different service attributes at each UNI, the end-to-end ~~MOE~~Metro Ethernet service parameters will be limited to those attributes supported across all UNIs (transversed for a given customer frame or traffic flow) in the EVC. Table 2-8 provides additional requirements for ~~MOE~~Metro Ethernet customer access ports in an EVC.

Table 2-8 Additional Service Attribute Requirements for ~~MOE~~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 10-15-2012 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 Multiplexer to TLS Plus	Not a valid combination
Service Provider to Service Provider	Only valid E-LAN combination is two Service Provider ports and one non-Service Provider port

Table 2-8 Additional Service Attribute Requirements for Metro Ethernet Customer Access Ports in an EVC (Continued)

Service Provider to TLS Effective 10-15-2012 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
Service Provider to TLS Plus	Not a valid combination
TLS to Non-TLS	Not a valid combination
TLS to TLS Plus	Not a valid combination
Non-TLS to TLS Plus	Not a valid combination

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

2.13 Quality of Service

2.13.1 Overview

~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Quality of Service (QoS) is an optional feature that allows customers to prioritize their Ethernet or IP traffic applications using four different Classes of Service (CoS) at a port or User-Network Interface (UNI). QoS enables ~~MOE~~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. For UNIs that support multiple Ethernet Virtual Connections (i.e., Service Multiplexer and Service Provider ports), Bandwidth Profiles for the different QoS traffic classes may be selected at the UNI or EVC level.

Though supported on all 10/100/1000 Mbps UNIs and ~~MOE~~Metro Ethernet customer access ports, QoS is dependant upon the switching equipment and transport facilities within the ~~Qwest~~CenturyLink network and is offered on a 'where available' basis.

Traffic will be classified upon entry at the ~~MOE~~MEN ~~network~~ edge based on examination of either 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

Configured traffic class and policy maps are then used to determine which of four queues each packet is assigned to per ~~MOE~~Metro Ethernet QoS customer port (UNI). 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 ~~Qwest~~CenturyLink ~~Metro Optical Ethernet network~~MEN. During periods of congestion, the Priority 1 queue will have guaranteed traffic delivery based on the customer's ordered P1 Bandwidth Profile. As indicated in chapter 4, a 0.001% dropped packets performance parameter also applies to this class within the ~~MOE~~Metro Ethernet core switch network.

- Priority 2 – 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 ~~MOE~~MEN ~~network~~.

2.13.2 Description

P1 traffic is offered in 5 Mbps increments (or where available, 3 Mbps increments with 3, 5 or 7 Mbps Bandwidth Profiles) up to 50 Mbps per UNI, though ~~Qwest~~CenturyLink will consider requests for greater amounts on an Individual Case Basis (ICB). At least 5 Mbps (or where available, 3 Mbps with 3, 5 or 7 Mbps Bandwidth Profiles) of the customer's QoS profile must be Priority 1 traffic where the Bandwidth Profile is applied per UNI; or customer-specified at the UNI or EVC level with Service Multiplexer and Service Provider ports. Customers will then determine how the remaining per service connection bandwidth will be allocated across the other traffic classes as a percentage of P2, P3 and P4 QoS levels in selecting from eight different templates such as described in Section 8.8 of the Rates and Services Schedule (RSS) No. 1 available from: http://tariffs.qwest.com:8000/idc/groups/public/documents/rss/htmltoc_qc_rss1.htm. Particularly with E-LAN service, Bandwidth Profiles and QoS templates may be selected independently at each UNI.

For each connection, the customer's traffic will be rate-limited to their Bandwidth Profile as specified in the template selected for each UNI or EVC within the customer's QoS profile. The P1 queue is the only individual queue that will be rate-limited, but each of the non-P1 queues will be guaranteed a minimum percentage of the remaining bandwidth. The sum of the traffic class percentages or ~~MOE~~Metro Ethernet Bandwidth Profile allocation among all four QoS levels at a given ~~MOE~~Metro Ethernet service connection, whether explicitly using all of the available queues or not, must equal no more than 100% and in some cases ~~Qwest~~CenturyLink will strip 1% off of the P4 queue.

Traffic policing algorithms implemented on the switch ports specify how much of the bandwidth to allocate to a specific traffic flow and will limit the bandwidth the P1 queue can consume to the amount assigned to P1 per the customer selected QoS template(s). This gives a low latency effect to the P1 queue by tail-dropping excess P1 traffic, thus limiting the latency and jitter of real-time applications. P1 traffic is always sent first, up to the assigned bandwidth while ~~Qwest~~CenturyLink traffic shaping, where available provides a more even packet flow over time and reduces the peaks and valleys of incoming bursty traffic.

While the P1 priority traffic bandwidth is reserved, any IP packets sent that exceed the customer's ordered average rate P1 bandwidth will be policed and dropped at ingress. Customers should shape their traffic to the subscribed bandwidth in order to ensure that their P1 Bandwidth Profile values are not exceeded otherwise excessive latency or packet loss may occur.

A template is not required for 100% non-prioritized traffic or standard ~~MOE~~Metro Ethernet service without QoS. If a customer doesn't need to prioritize one type of traffic over another and simply requires the Metro ~~Optical~~ Ethernet service connections to be provisioned as best effort, then they do not need to specify any QoS parameters. With no QoS, the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~Network~~ will provide a best effort service to each incoming customer IP packet or Ethernet frame. Non-QoS queuing will be First In, First Out (FIFO) in which the packets are sent in the order they are received.

2.13.3 QoS Traffic Classification

~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet QoS supports ingress traffic classification options based on:

For non-IP traffic -

- CoS value in the 802.1p user priority bits within the incoming IEEE 802.1Q customer VLAN tagged frames

For IP traffic -

- CoS value (if present) as carried within the incoming customer Layer 3 packets in 802.1Q tagged VLANs, or
- IP precedence value within the incoming customer packets

Customers will need to specify either CoS or IP precedence-based classification when ordering QoS. EVC NCI Codes (see Section 3.6.7) are used to determine the type of classification, which for ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service will be applied on a per port/UNI basis. Note that ~~MOE~~Metro Ethernet QoS traffic classification is not an EVC level option on Service Multiplexer or Service Provider ports configured to support Service Multiplexing.

The ~~MOE~~Metro Ethernet switches will identify the different customer prioritized traffic with QoS based on the value of either:

- The first three (most significant) bits within the 2-byte Tag Control Information (TCI) field in the Layer 2 802.1Q frame header

- The first three (most significant) bits within the 1-byte Type of Service (ToS) field in the Layer 3 IPv4 standard packet header for incoming tagged and untagged frames on the Ethernet link between the Customer Edge (CE) and ~~Qwest~~CenturyLink Provider Edge (PE)

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 precedence bits within their network equipment for transmission at the premises based on their ordered QoS service per connection. ~~Qwest~~CenturyLink's CoS and IP precedence values queue assignments for the four different ~~MOE~~Metro Ethernet QoS traffic classes are listed in Table 2-9 below.

Table 2-9 Customer CoS and IP Precedence Settings for each QoS Traffic Class

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

*** Note:** Some "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 precedence values will be acted upon accordingly at the ~~MOE~~Metro Ethernet UNI with traffic forwarding and queue scheduling determined by the incoming P1, P2, P3 or P4 priority in alignment with the customer-ordered QoS and selected service connection template(s).

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3. Network Interfaces

3.1 Applicability of Technical Specifications

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

3.2 Description of ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet User-Network Interfaces

~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet service ~~or MOE~~ will be provisioned using intelligent Ethernet switches. This technology allows ~~Qwest~~CenturyLink to deliver the standard 10/100/1000 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/.

~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Network Access Links are provided to both End-User and Carrier customers. The signal characteristics and supported MAC Layers at the User-Network Interface (UNI) 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 for all customers will be at an RJ-45 jack on a ~~Qwest~~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 ~~Qwest~~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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service and the customer-provided Data Terminal Equipment (DTE).

~~Qwest~~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 ~~Qwest~~CenturyLink telecommunications equipment placed on customer premises.

~~Qwest~~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) in order to allow the placement of ~~Qwest~~CenturyLink-owned equipment inside these cabinets for the provisioning of ~~MOE~~Metro Ethernet service to the customer.

Table 3-1 Available Interfaces

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 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, ~~Qwest~~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, ~~Qwest~~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 ~~Qwest~~CenturyLink ~~MOE~~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. Singlemode 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 fibre and cable*.
7. SC/UPC (with Ultra Physical Contact polish) is the ~~Qwest~~CenturyLink default optical connector for new ~~Qwest~~CenturyLink ~~MOE~~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. ~~Qwest~~CenturyLink will manually provision (or hard code) the speed and (full) duplex transmission mode on all 10/100 Mbps ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service option at the UNI. See Section 2.11.12, Layer 2 Control Protocol Processing for further information on tunneling of customer Bridge Protocol Data Units (BPDUs).
11. nm = nanometer

Table 3-1 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. ~~Qwest~~CenturyLink ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~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.

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

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

To connect to the ~~Qwest~~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 ~~Qwest~~CenturyLink Metro ~~Optical~~ 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.

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

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

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

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 3-5 Two Twisted-Pair Crossover Cable RJ-45 Connections for 10/100 Mbps Electrical UNIs

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

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

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

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.

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

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

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-

3.4 Distance Limitations

The maximum supported cable length from the ~~Qwest~~CenturyLink ~~MOE~~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 ~~MOE~~Metro Ethernet edge switch at a customer site, all User-Network Interfaces should be jointly engineered between ~~Qwest~~CenturyLink and the customer.

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

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)

Notes:

1. Including cable from ~~Qwest~~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 ~~Qwest~~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 ~~Qwest~~CenturyLink ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet switch port to (active) Customer Provided Equipment for 1000Base-LX (1300-1310 nm, SMF) and 1000Base-SX (850 nm, MMF) UNIs.

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

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

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

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.

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 also provide specific codes to aid in ordering the User-Network Interfaces and Network Access Links for ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service. The NC and NCI Codes are to be provided by the customer to the ~~Qwest~~CenturyLink Service Representative at the time a request for new or upgrades to an existing service are initiated.

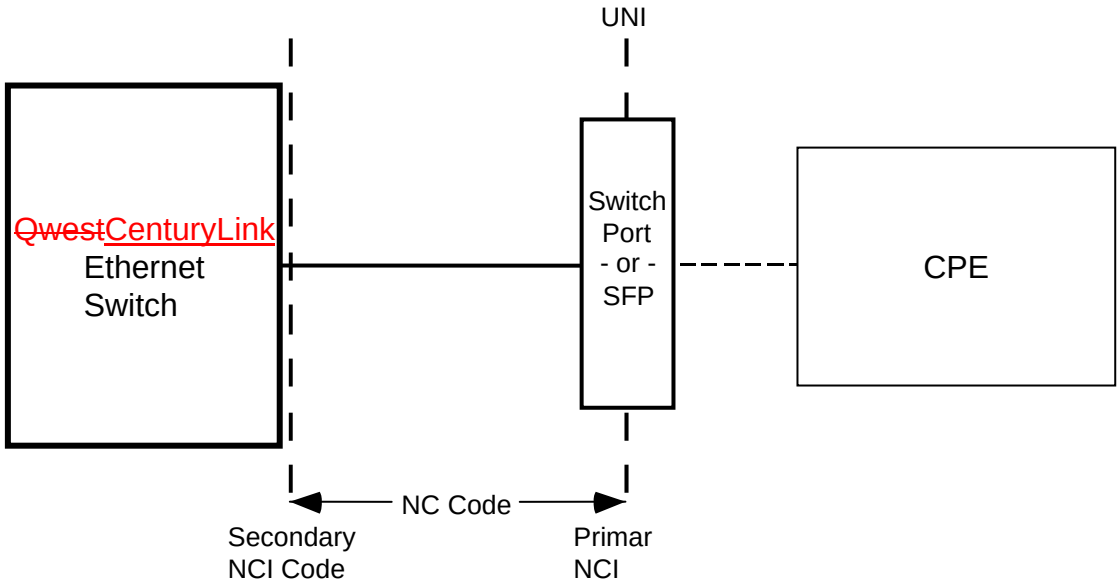
Additional information concerning NC/NCI Codes is available in ANSI T1.223-1997, *Information Interchange - Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for the North American Telecommunications System*.

In some instances ~~Qwest~~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 ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet service as defined in this publication.

~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service is 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 ~~Qwest~~CenturyLink infrastructure, the ~~MOE~~Metro Ethernet customer orders will only occur between the User-Network Interface (UNI) and ~~Qwest~~CenturyLink edge (or core) Ethernet switch. Figure 3-1 shows where the NC, and Primary and Secondary NCI Codes apply to ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service. As indicated in the figure, a Primary NCI Code/NC Code/Secondary NCI Code combination is required for each UNI or ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Network Access Link location.

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

Figure 3-1 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet NC and NCI Codes



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CPE = Customer Provided Equipment
SFP= Small-form Factor Pluggable transceiver module
NC = Network Channel
NCI = Network Channel Interface
UNI = User-Network Interface

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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet, the NC Code is specified by the customer to advise ~~Qwest~~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 ~~Qwest~~CenturyLink ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet, the third character defines full duplex transmission mode and the fourth character options indicate the Bandwidth Profile or throughput per NAL.

3.6.2 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet NC Codes

Tables 3-11 to 3-13 lists the Network Channel (NC) Codes for ordering ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet service.

Table 3-11 NC Codes for 10 Mbps 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 3-12 NC Codes for 100 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 3-13 NC Codes for 1000 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

Table 3-13 NC Codes for 1000 Mbps Service (Continued)

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)

Tables 3-11 to 3-13 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 2.11.5.
2. Point-to-point applies to the individual Gigabit Ethernet Network Access Links, however the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Layer 2 VPN service provides for multipoint-to-multipoint connectivity.

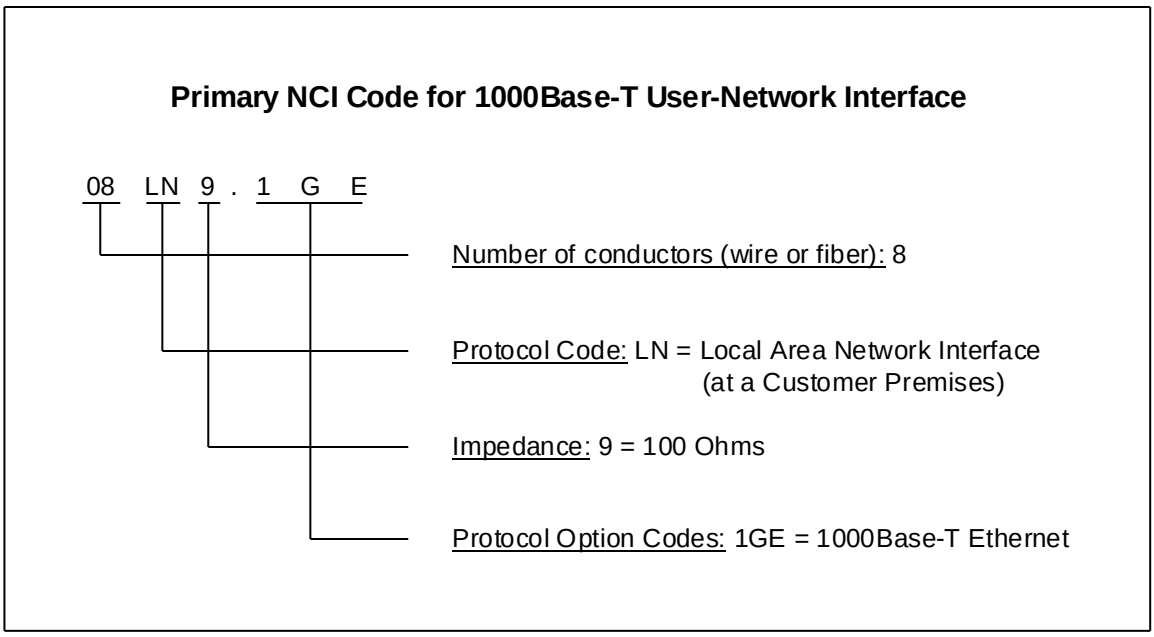
3.6.3 NCI Code Form and Components

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 ~~Qwest~~CenturyLink ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet NCI Code Example



3.6.4 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Primary NCI Codes

Tables 3-14 and 3-15 list the Primary Network Channel Interface (NCI) Codes for ordering ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet User-Network Interfaces (UNIs) at customer premises and Table 3-16 lists the Primary NCI Code for ordering 1000Base-LX UNIs at ~~Qwest~~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 ~~Qwest~~CenturyLink CO location would be indicated for a Central Office Cross-Connect (COCC) to another compatible finished service or to provide ~~MOE~~Metro Ethernet connectivity to a Competitive Local Exchange Carrier (CLEC) collocation cage in conjunction with ordering a 2 fiber Optical ITP. See Section 2.7.3, ~~MOE~~Metro Ethernet User-Network Interfaces at ~~Qwest~~CenturyLink Central Offices for further information.

Table 3-14 Primary NCI Codes for Electrical UNIs at a Customer Premises

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 3-15 Primary NCI Codes for 1000Base-LX and 1000Base-SX UNIs at a Customer Premises

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 3-16 Primary NCI Code for 1000Base-LX UNIs at a ~~Qwest~~CenturyLink Central Office

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

3.6.5 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Secondary NCI Codes

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

Tables 3-17 and 3-18 list the Secondary NCI Codes for ordering ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet service.

Table 3-17 Secondary NCI Codes for Electrical UNIs

NCI Code	Description
04CX9.10T	4 Conductors, Digital Termination On A Switch, 100 Ohms, 10Base-T Ethernet Switch Port
04CX9.1CT	4 Conductors, Digital Termination On A Switch, 100 Ohms, 100Base-T Ethernet Switch Port
08CX9.1GE	8 Conductors, Digital Termination On A Switch, 100 Ohms, Gigabit Ethernet Switch Port

Table 3-18 Secondary NCI Code for 1000Base-LX and 1000Base-SX UNIs

NCI Code	Description
02CXF.1GE	2 Conductors, Digital Termination On A Switch, Fiber, Gigabit Ethernet Switch Port

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

3.6.6 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet NC/NCI Code Combinations

Table 3-19 lists all the valid NC Code, Primary and Secondary NCI Code combinations for ordering ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet physical ports and Bandwidth Profiles, or User-Network Interface/Network Access Links (UNI/NALs).

Table 3-19 NC Code, Primary and Secondary NCI Code Combinations

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

Table 3-19 NC Code, Primary and Secondary NCI Code Combinations (Continued)

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 um MMF)	Customer Premises
KRFB	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	10	1000Base-SX (62.5 um 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 um MMF)	Customer Premises
KRFD	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	20	1000Base-SX (62.5 um 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 um MMF)	Customer Premises
KRFF	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	30	1000Base-SX (62.5 um MMF)	Customer Premises

Table 3-19 NC Code, Primary and Secondary NCI Code Combinations (Continued)

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 um MMF)	Customer Premises
KRFH	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	40	1000Base-SX (62.5 um 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 um MMF)	Customer Premises
KRFJ	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	50	1000Base-SX (62.5 um 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 um MMF)	Customer Premises
KRFL	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	60	1000Base-SX (62.5 um MMF)	Customer Premises

Table 3-19 NC Code, Primary and Secondary NCI Code Combinations (Continued)

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 um MMF)	Customer Premises
KRFN	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	70	1000Base-SX (62.5 um 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 um MMF)	Customer Premises
KRFP	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	80	1000Base-SX (62.5 um 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 um MMF)	Customer Premises
KRFR	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	90	1000Base-SX (62.5 um MMF)	Customer Premises

Table 3-19 NC Code, Primary and Secondary NCI Code Combinations (Continued)

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	1000	100	1000Base-T	Customer Premises
KRE1	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	100	1000Base-LX (SMF)	Customer Premises
KRE1	02QBF.K02	02CXF.1GE	1000	100	1000Base-LX (SMF)	Central Office[2]
KRE1	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	100	1000Base-SX (50 um MMF)	Customer Premises
KRE1	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	100	1000Base-SX (62.5 um MMF)	Customer Premises
KRE2	08LN9.1GE	08CX9.1GE	1000	200	1000Base-T	Customer Premises
KRE2	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	200	1000Base-LX (SMF)	Customer Premises
KRE2	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	200	1000Base-SX (50 um MMF)	Customer Premises
KRE2	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	200	1000Base-SX (62.5 um MMF)	Customer Premises
KRE3	08LN9.1GE	08CX9.1GE	1000	300	1000Base-T	Customer Premises
KRE3	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	300	1000Base-LX (SMF)	Customer Premises
KRE3	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	300	1000Base-SX (50 um MMF)	Customer Premises
KRE3	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	300	1000Base-SX (62.5 um MMF)	Customer Premises

Table 3-19 NC Code, Primary and Secondary NCI Code Combinations (Continued)

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	1000	400	1000Base-T	Customer Premises
KRE4	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	400	1000Base-LX (SMF)	Customer Premises
KRE4	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	400	1000Base-SX (50 um MMF)	Customer Premises
KRE4	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	400	1000Base-SX (62.5 um MMF)	Customer Premises
KRE5	08LN9.1GE	08CX9.1GE	1000	500	1000Base-T	Customer Premises
KRE5	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	500	1000Base-LX (SMF)	Customer Premises
KRE5	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	500	1000Base-SX (50 um MMF)	Customer Premises
KRE5	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	500	1000Base-SX (62.5 um MMF)	Customer Premises
KRE6	08LN9.1GE	08CX9.1GE	1000	600	1000Base-T	Customer Premises
KRE6	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	600	1000Base-LX (SMF)	Customer Premises
KRE6	02QBF.K02	02CXF.1GE	1000	600	1000Base-LX (SMF)	Central Office[2]
KRE6	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	600	1000Base-SX (50 um MMF)	Customer Premises
KRE6	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	600	1000Base-SX (62.5 um MMF)	Customer Premises

Table 3-19 NC Code, Primary and Secondary NCI Code Combinations (Continued)

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	1000	700	1000Base-T	Customer Premises
KRE7	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	700	1000Base-LX (SMF)	Customer Premises
KRE7	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	700	1000Base-SX (50 um MMF)	Customer Premises
KRE7	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	700	1000Base-SX (62.5 um MMF)	Customer Premises
KRE8	08LN9.1GE	08CX9.1GE	1000	800	1000Base-T	Customer Premises
KRE8	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	800	1000Base-LX (SMF)	Customer Premises
KRE8	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	800	1000Base-SX (50 um MMF)	Customer Premises
KRE8	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	800	1000Base-SX (62.5 um MMF)	Customer Premises
KRE9	08LN9.1GE	08CX9.1GE	1000	900	1000Base-T	Customer Premises
KRE9	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	900	1000Base-LX (SMF)	Customer Premises
KRE9	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	900	1000Base-SX (50 um MMF)	Customer Premises
KRE9	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	900	1000Base-SX (62.5 um MMF)	Customer Premises

Table 3-19 NC Code, Primary and Secondary NCI Code Combinations (Continued)

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	1000	1000	1000Base-T	Customer Premises
KRE0	02LNF.A02, or 02LNF.AA2	02CXF.1GE	1000	1000	1000Base-LX (SMF)	Customer Premises
KRE0	02QBF.K02	02CXF.1GE	1000	1000	1000Base-LX (SMF)	Central Office[2]
KRE0	02LNF.A04, or 02LNF.AA4	02CXF.1GE	1000	1000	1000Base-SX (50 um MMF)	Customer Premises
KRE0	02LNF.A07, or 02LNF.AA7	02CXF.1GE	1000	1000	1000Base-SX (62.5 um MMF)	Customer Premises

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 ~~Qwest~~CenturyLink to provide these Bandwidth Profiles.
2. 1000Base-LX User-Network Interfaces are only available at ~~Qwest~~CenturyLink Central Offices which have a ~~MOE~~Metro Ethernet core switch
3. SMF = Single-Mode Fiber
4. MMF = Multi-Mode Fiber
5. um = micron

3.6.7 EVC NC/NCI Codes

Tables 3-20 to 3-22 lists the Ethernet Virtual Connection (EVC) NC/NCI Codes used to specify the ~~MOE~~Metro Ethernet Layer 2 connectivity and corresponding service attributes for each UNI or customer access port type in the EVC. See Section 2.12.1, Ethernet Virtual Connections for additional information.

Table 3-20 EVC NC Codes

NC Code	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.~~1~~2), Point-to-Point Ethernet Virtual Connection (EVC). Defined in MEF 10.~~1~~2 as an association of exactly two UNIs.
VLM-	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.~~1~~2), Multipoint-to-Multipoint Capable Ethernet Virtual Connection (EVC). Defined in MEF 10.~~1~~2 as an association of two or more UNIs.

Table 3-21 EVC NCI Codes for ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Service

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 frames ingressing 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 ALSO 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 ALSO 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 ALSO supports multiple classes of service distinguished via Layer 3 DSCP/TOS)

Table 3-21 EVC NCI Codes for ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Service (Continued)

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 ALSO 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 ALSO 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.~~1~~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.~~1~~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.~~1~~2 for clarification. This EVC ALSO supports multiple classes of service distinguished via P-bits.)

Table 3-22 Valid EVC NC/NCI Code Combinations for ~~MOE~~Metro Ethernet Customer Access Ports

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 2.11 and 2.12) captured on EVC Form
		02VLN.VB	- Plus (many to one) Bundling (see Section 2.11.8)
		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 2.11.8) 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 2.11 and 2.12) captured on EVC Form
		02VLN.VB	- Plus (many to one) Bundling (see Section 2.11.8)
		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 2.11.8) 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)

Table 3-22 Valid EVC NC/NCI Code Combinations for ~~MOE~~Metro Ethernet Customer Access Ports (Continued)

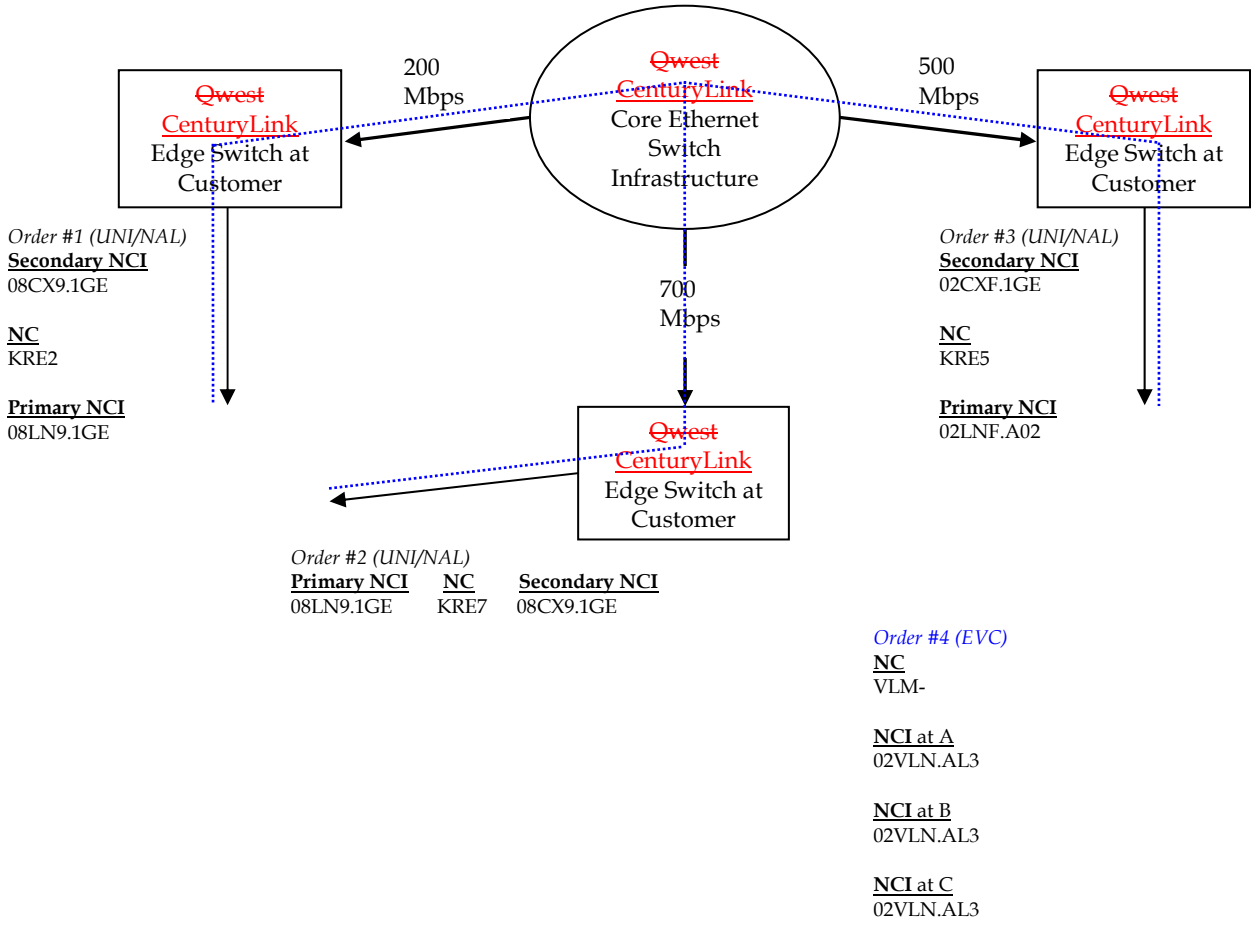
Access Port Type	EVC NC Code	EVC NCI Code	Comments
Non-TLS	VLP- or VLM-	02VLN.UNT	- Other UNI and EVC service attributes (see Sections 2.11 and 2.12) captured on EVC Form
		02VLN.UL3*	- Plus QoS per IP Precedence bits in the ToS field (see Section 2.13)
TLS	VLP- or VLM-	02VLN.A2	- Other UNI and EVC service attributes (see Sections 2.11 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)
TLS Plus	VLP-	02VLN.A2	- Other UNI and EVC service attributes (see Sections 2.11 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)

*** 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.

3.6.8 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet NC/NCI Code Example

Figure 3-3 shows a ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet NC/NCI Code example for a 3 point customer premises ~~MOE~~Metro Ethernet Transparent LAN Service (TLS ports) with Quality of Service (QoS) per IP Precedence bits in the ToS field. See Section 2.11, UNI and EVC per UNI Service Attributes for ~~MOE~~Metro Ethernet Customer Access Ports; Section 2.12, Ethernet Virtual Connection Service Attributes for ~~MOE~~Metro Ethernet Customer Access Ports and Section 2.13, Quality of Service for further information.

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



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4. Performance Specifications

4.1 General

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

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

These performance objectives apply to all ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Network Access Link (NAL) and core switch infrastructure architectures described in Section 2.7 and are based on congestion-free network conditions. For customers with standard best effort service with no QoS, the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet ~~network~~ 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 ~~MOE~~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 ~~MOE~~Metro Ethernet Bandwidth Profiles that are less than the physical UNI speed will be the sole responsibility of the customer. When ordering ~~MOE~~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 ~~Qwest~~CenturyLink; otherwise the ~~MOE~~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 ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~MEN equipment (randomly without QoS) discarding the incoming Ethernet frames due to, for example, customers with a Layer 2 switch continually transmitting bursty traffic at the full port rate

4.2 Bandwidth Change Requests

As indicated in Section 3.2, Description of ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Network Interfaces the ~~Qwest~~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 ~~MOE~~Metro Ethernet electrical interface the customer ordered as well as the particular edge device deployed by ~~Qwest~~CenturyLink to deliver the service.

~~Qwest~~CenturyLink ~~MOE~~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) UNIs and/or Network Access Link (NAL) Bandwidth Profiles. . The appropriate Layer 2 and Layer 1 transport (if applicable) bandwidth must be available in the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~network~~ infrastructure to meet the bandwidth change request, specifically without requiring the installation of any additional equipment.

4.3 Service Availability

Service availability is defined as the ability of a customer to exchange data packets with the ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet ~~network~~ Network (MEN) at the User-Network Interface via Customer Provided Equipment (CPE). Availability specifies the percentage of time the customer's ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet are listed in Table 4-1.

Table 4-1 Service Availability

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

Table 4-1 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 ~~Qwest~~CenturyLink entrance facility standards. For additional information see ~~Qwest~~CenturyLink Technical Publication 77344, *Diversity and Avoidance.*
2. Service availability includes all components of the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet ~~network~~ 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 ~~Qwest~~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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service availability objective assumes two hours every six months for the network maintenance window.

4.4 Throughput

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

For the case of EwET (see Section 2.2.1, Ethernet with Extended Transport) links ordered with a 100Base-TX UNI and 40 Mbps Bandwidth Profile, the throughput applies to at least 256 byte frames whereas smaller customer packets may experience lower throughput or be dropped. Although not expected in typical traffic flows, constant transmission of 64 or 128 byte frames, for example, would result in an approximate throughput of 36.3 and 39.5 Mbps respectively due to the EwET encapsulation overhead comprising a greater percentage of the available customer payload capacity.

Through CIR, bandwidth will be available in the increments ordered by the customer per NAL as listed in Section 2.5, Rate-Limiting, Committed and Excess Information Rates. CIR rates will be met by adequate rate-limiting of the ~~Qwest~~CenturyLink ~~MOE~~MEN Layer 2 edge and core switches, and SONET transport infrastructure where applicable.

4.5 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 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service with store-and-forward devices; and as based on Technical Specification MEF 10.~~1~~2, *Ethernet Services Attributes - Phase 2*, ~~November~~ October ~~2006~~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 ~~Qwest~~CenturyLink ~~MOE~~MEN ~~network~~ will be as indicated in Table 4-2.

Table 4-2 ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet Network Latency

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

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 ~~Qwest~~CenturyLink ~~MOE~~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 ~~Qwest~~CenturyLink ~~MOE~~MEN ~~network~~.

4.6 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 2.11.4 for further information)
- Corrupted frames with invalid Cyclic Redundancy Check (CRC), Frame Check Sequence (FCS) or alignment errors
- Broadcast frames dropped by ~~Qwest~~CenturyLink ~~MOE~~MEN traffic controls (see Section 2.12.2)
- Non-transparent customer Layer 2 Control Protocol Service Frames (see Section 2.11.12)

Packet loss is defined as the percentage of packets that are dropped within, or between switches that are a part of, the ~~MOE~~MEN ~~network~~. 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. ~~Qwest~~CenturyLink will engineer the ~~Metro Optical Ethernet network~~ MEN to minimize packet loss such that the performance objective will not exceed that listed in Table 4-3.

Table 4-3 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 ~~MOE~~Metro Ethernet core network

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

Thus, over any calendar month the ~~Qwest~~CenturyLink ~~MOE~~MEN ~~network~~ 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.

4.7 VLAN Leakage

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

4.8 Restoration/Fail-over Times

Where applicable, the following protocols will provide ~~Qwest~~CenturyLink ~~MOE~~MEN Layer 1 and Layer 2 protection with the restoration/fail-over time objectives indicated. See Sections 2.7, Architecture and 2.8, Resiliency for further information on the ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service restoration capabilities.

4.8.1 SONET

Automatic protection switching improves the availability and reliability performance of ~~Qwest~~CenturyLink ~~MOE~~Metro Ethernet service by substituting standby equipment or alternate channels when failure occurs.

The protection switch will operate and switch the failing channel to the protection system when the Bit Error Ratio (BER) on the SONET transport system exceeds 1 X 10-6 and operates at that BER for 10 consecutive seconds or longer. Once a decision is made to switch to a protection system, the additional time required to complete the switch will not exceed 50 milliseconds.

4.8.2 Spanning Tree Protocol

In case of a failure between ~~Qwest~~CenturyLink ~~MOE~~MEN Layer 2 core switches or any core and edge switches interconnected using standard Institute of Electrical and Electronics Engineers (IEEE) 802.1d Spanning Tree Protocol or "Per-VLAN" Spanning Tree Protocol, the following will apply. Automatic reconfiguration of the spanning tree and rerouting of customer traffic by activation of a redundant path will occur in less than 50 seconds. With this implementation, a failure within a single customer VLAN will be confined to that VLAN only.

4.8.3 Link Aggregation

If a ~~Qwest~~CenturyLink ~~MOE~~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 2.7.2, Network Access Links.

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5. Maintenance

5.1 ~~Qwest~~CenturyLink Responsibilities

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

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

Upon receipt of a trouble alarm or report, ~~Qwest~~CenturyLink will initiate action within twenty (20) minutes to clear the trouble and will commit to the following service restoral times for the ~~Qwest~~CenturyLink ~~MOE~~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

5.2 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 ~~Qwest~~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 ~~Qwest~~CenturyLink personnel may sometimes be necessary to isolate the trouble.

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6. Definitions

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

6.1 Acronyms

ADM	Add-Drop Multiplexer
ANSI	America National Standards Institute
AQCB	Auto Quote Contract Billing
BER	Bit Error Ratio
BPDU	Bridge Protocol Data Unit
Cat-5	Category 5 balanced cable
CE	Customer Edge
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
EoS	Ethernet-over-SONET
FC	Fiber Connector
EVC	Ethernet Virtual Connection
FD	Frame Delay
FDX	Full Duplex
FLR	Frame Loss Ratio
GBIC	Gigabit Interface Converter
Gbps	Gigabit per Second
HDX	Half Duplex
IC	Interexchange Carrier
~~ICB~~	~~Individual Case Basis~~
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
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
~~MOE~~	~~Metro Optical Ethernet~~
MTU	Maximum Transmission Unit
NAL	Network Access Link
NC	Network Channel
NCI	Network Channel Interface
nm	Nanometer
OADM	Optical Add-Drop Multiplexer
OWD	One-Way Delay
PDU	Protocol Data Unit
PHY	Physical Layer entity
POP	Point of Presence
QoS	Quality of Service
RSS	Rates and Services Schedule
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
µm	Micron
UNI	User-Network Interface
UPC	Ultra Physical Contact
UTP	Unshielded Twisted-Pair
VLAN	Virtual LAN
VPN	Virtual Private Network
WAN	Wide Area Network
WDM	Wavelength Division Multiplexing

6.2 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.

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, by definition.

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 particular 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.

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)

Equipment on the subscriber side of the UNI

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 ~~Qwest~~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)

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 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 Transmission Unit (MTU) Size

The maximum sized 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.

Facilities

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

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~~ Loss ~~ratio~~ Ratio is a measure of the number of lost frames between the ingress UNI and the egress UNI~~inside the metro Ethernet network~~. Frame ~~loss~~ Loss ~~ratio~~ 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.

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

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

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 Transmission Unit (MTU) Size

The maximum sized Service Frame 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 ~~Optical~~ Ethernet ~~(MOE)~~ Network

~~Qwest~~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.

Multicast

When applied to the ~~Qwest~~CenturyLink Metro ~~Optical~~ Ethernet service, the functionality which supports the transport of multiple duplicate frames from a single location to multiple End-User locations within the ~~Qwest~~CenturyLink ~~MOE~~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 Access Link (NAL)

A ~~MOE~~Metro Ethernet access channel used to connect customer facilities at the Network Interface with a corresponding Metro ~~Optical~~ Ethernet switch.

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.)

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.

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 the purpose of obtaining LATA access and to which ~~Qwest~~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 a 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 effected; the complete interaction of all possible series of messages across an interface. Protocols may govern portions of a network, types of service, or administrative procedures.

Protocol Code

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

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

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

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

Service Provider

The organization providing Ethernet service(s)

Serving Wire Center (SWC)

The term "Serving Wire Center" denotes a ~~Qwest~~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

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

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 ~~MOE~~Metro Ethernet Network Access Link. ~~MOE~~Metro Ethernet ports are the physical entry points in the ~~MOE~~MEN ~~network~~ 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 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 a tag header immediately following the Source MAC Address field of the frame or, if the frame contained a Routing Information field, immediately following the Routing Information field.

Throughput

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

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 Transmission Unit (MTU) Size

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 a tag header immediately following the Source MAC Address field of the frame or, if the frame contained a Routing Information field, immediately following the Routing Information field.

User-Network Interface (UNI)

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

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 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

VLAN Stacking

A technique that lets Carriers offer multiple Virtual LANs over a single circuit

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.

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7. References

7.1 American National Standards Institute Documents

ANSI INCITS 230-1994	*Information Technology - Fibre Channel Physical and Signaling Interface (FC-PH)*
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*
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ANSI/TIA/EIA-570-B-2010	*Residential Telecommunications Cabling Standard*
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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*

7.2 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*

7.3 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*

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

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

7.5 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 10.~~1~~2 *Ethernet Services Attributes - Phase 2*, ~~November~~ October ~~2006~~2009

7.6 Telcordia Documents

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

SR-307 *COMMON LANGUAGE NC/NCI Dictionary*

7.7 ~~Qwest~~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

7.8 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 ~~Qwest~~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/

- 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

- ~~Qwest~~CenturyLink Technical Publications from:

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

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