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(MOE)

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This document describes Qwest® Metro Optical Ethernet~~® (MOE)~~ service, MOE®, offered by Qwest 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® Metro Optical Ethernet® (MOE) service offered by Qwest 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

To add:

- Customer premises LC connector option for optical Gigabit Ethernet UNIs
- Customer-orderable subrate Bandwidth Profile options for 10/100 Mbps UNIs with Protected Routing
- New MTU (maximum supported customer frame size) Section
- New Multicast and Broadcast Traffic Section
- New Layer 2 Control Protocol Transparency Table
- An increase to the number of EVCs supported on Service Multiplexer and Service Provider ports to a maximum of 10 and 100 respectively
- P1 traffic limits for QoS customers
- Auto-negotiation requirement for 1000Base-T UNIs
- Changes to Qwest and customer traffic shaping requirements
- Clarification on throughput for smaller frame sizes
- Deletion of some Cisco-specific protocols language
- ~~802.1p user priority bits classification option for QoS customers~~
- ~~Bundled VLAN map EVC NCI Codes~~
- ~~Miscellaneous updates~~

1.3 Purpose

The purpose of this document is to describe Qwest 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.

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2. Service Description

2.1 General

This chapter provides a comprehensive description of Qwest® Metro Optical Ethernet® (MOE) service, and is intended to help customers understand the various types and characteristics of Qwest MOE, and to clearly communicate the service capabilities. While this document describes Metro Optical Ethernet as provided by Qwest to its customers, other non-standard designs may be considered on an Individual Case Basis.

2.2 Qwest MOE Service Points

Qwest MOE Service Points are geographic locations, designated by Qwest, where the MOE network is accessible via standard metallic and/or fiber optic Ethernet interfaces. Service Points are those Serving Wire Centers (SWCs), which are entry points into the Qwest MOE network. Qwest Interoffice Facilities (IOF) will be utilized where required to provide access to the nearest MOE core switch and transport customer traffic between Wire Centers within the same Local Access and Transport Area (LATA).

Network Access Links (NALs) are available at Qwest MOE Service Points or to customer building locations served by Qwest Network Disclosed Central Offices (COs) in selected metropolitan areas. Qwest MOE service to buildings without sufficient facilities will be considered on an Individual Case Basis (ICB).

2.2.1 Ethernet with Extended Transport

MOE may also be available to customer locations that are not within the Qwest-designated service area via Ethernet with Extended Transport (EwET). With EwET, Qwest provides interoffice transport facilities for extending MOE from a core switch CO to an outlying SWC and delivery to the customer premises. EwET supports the following MOE User-Network Interfaces and Bandwidth Profiles (described in Section 2.4):

- 10Base-T with 5 or 10 Mbps
- 100Base-TX with 10, 20, 30 or 40 Mbps

Note that some optional MOE features described in this document are not available on EwET links including:

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

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

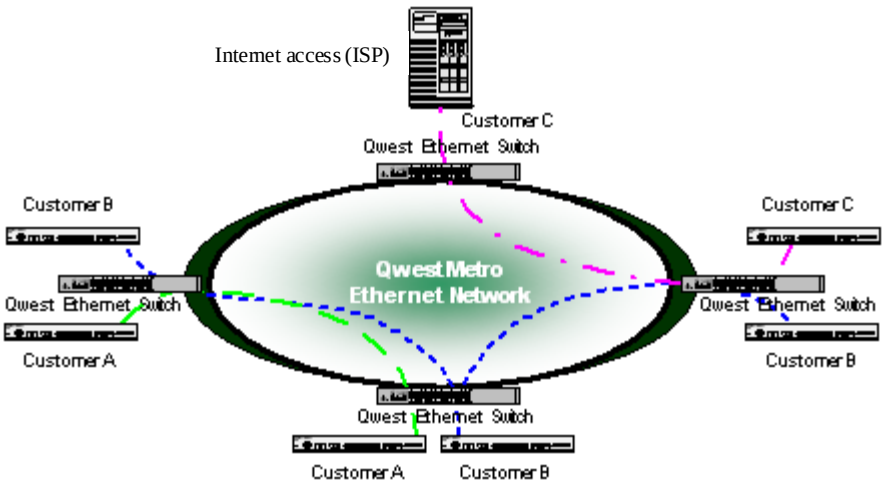
2.3 Overview

Qwest Metro Optical Ethernet (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 MOE network 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 G.SHDSL over copper, where available to connect two or more customer-designated locations using Institute of Electrical and Electronics Engineers, ~~(~~IEEE®~~)~~ 802®.1d Media Access Control (MAC) bridging.

At Qwest'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). Customer traffic will be transported from each UNI to a Qwest Central Office (CO) core switch using a rate-limited Network Access Link (NAL). NALs are available in customer-specified bandwidth increments from 5 Mbps up to 1 Gbps. The physical UNI as well as NAL bandwidth can be different at each location.

Qwest MOE UNIs may be located at End-User premises, Interexchange Carrier (IC) or Internet Service Provider (ISP) Points-of-Presence (POPs), or within selected Qwest Central Offices (COs). Each individual MOE customer's two or more User-Network Interfaces/Network Access Links will be connected via a multipoint-to-multipoint Virtual LAN (VLAN) or Ethernet Virtual Connection (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 locations on the Qwest MOE network.

Figure 2-1 Qwest Metro Optical Ethernet Example



The MOE network bandwidth between customer locations is not dedicated to one user, but shared between multiple customers within a metro. VLANs (or 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 MOE network is based on committed customer Bandwidth Profiles and is subject to Qwest oversubscription policy.

Connectivity between customer-designated locations is accomplished by provisioning a customer's EVC through the Qwest Metro Optical Ethernet edge and core switches, SONET where applicable and fiber optic or copper transport facilities. Qwest will manage the capacity of the MOE network, provide traffic segregation and security, and enforce the bandwidth or throughput for each customer Network Access Link (NAL), i.e. Committed Information Rates (CIRs).

The MOE Layer 2 core switches deployed in the Qwest COs provide IEEE 802.1Q VLAN aggregation as well as connectivity to co-providers' networks in each metro. This includes access to IC Internet Protocol (IP) Wide Area Network (WAN) backbones, ISPs and other service provider's Layer 2/3 metro infrastructures. The core switches send each customer's EVC traffic to the other core and edge switches as required for a point-to-point or multipoint Ethernet Layer 2 Virtual Private Network (VPN), or high speed Dedicated Internet Access (DIA) service across the shared Qwest MOE network infrastructure. For DIA, Qwest MOE service will connect a customer-designated location to an ISP's local Point-of-Presence (POP). The Qwest MOE network is a flat Layer 2 infrastructure with IP addressing and routing performed on IC or ISP Layer 3 devices.

2.4 Customer Access Ports and Bandwidth Profiles

The customer will select both a physical access port speed (and electrical, single or Multi-Mode Fiber type for Gigabit Ethernet) or User-Network Interface (UNI) along with a Bandwidth Profile or Network Access Link (NAL) for each location. Qwest MOE service offers the following IEEE 802.3-2005, *Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications* standard UNIs. This standard includes specifications for Ethernet (802.3), Fast Ethernet (802.3u) and Gigabit Ethernet (802.3z).

10Base-T ports

- 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

100Base-TX ports

- 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

1000Base-T ports

- 1000 Mbps full duplex Local Area Network interface using four pairs of Category 5 balanced copper cabling with an RJ-45 connector

1000Base LX ports

- 1000 Mbps full duplex Local Area Network interface using Long Wavelength (1300-1310 nm) lasers over one pair of Single-Mode Fiber (SMF) with a duplex FC-PC, ~~or~~ SC or LC connector

1000Base SX ports

- 1000 Mbps full duplex Local Area Network interface using Short Wavelength (850 nm) lasers over one pair of Multi-Mode Fiber (MMF) with a duplex FC-PC~~, or~~ SC or LC connector

The customer will then select a Bandwidth Profile from 5 Mbps to 1000 Mbps for each access port. The Qwest MOE 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 port, rate-limited in 5 Mbps increments

- 5 and 10 Mbps

100 Mbps Ethernet port, rate-limited in 10 Mbps increments

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

1000 Mbps or Gigabit Ethernet port, rate-limited in 100 Mbps increments

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

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

Additionally, MOE has five different types of customer access ports listed in Table 2-1 and classified according to the UNI and Ethernet Virtual Connection (EVC) service attributes in Section 2.~~12~~15.

Table 2-1 MOE Customer Access Ports

Customer Access Port	Description
Service Multiplexer	Supports more than one EVC per UNI, does not support Layer 2 Control Protocol tunneling
Service Provider	Supports more than one EVC per UNI, does not support Layer 2 Control Protocol tunneling
Non-TLS	Supports one EVC per UNI, untagged customer frames only
TLS	Supports one EVC per UNI, untagged and VLAN tagged customer frames, tunnels Layer 2 Control Protocols – STP, CDP and VTP
TLS Plus	Supports one EVC per UNI, untagged and VLAN Tagged customer frames, tunnels Layer 2 Control Protocols – STP, CDP, VTP and LACP, can only be placed in point to point EVCs

Note: See Section 2.~~11~~14 for additional information on Layer 2 Control Protocol tunneling with TLS (Transparent LAN Service) and TLS Plus ports.

2.5 Rate-Limiting and Committed Information Rate

The Qwest MOE network provides hardware-based rate-limiting ~~and traffic shaping~~ to provide control of the traffic flows from multiple customers, which may share the same physical Gigabit Ethernet links. Each customer's individual Qwest MOE Network Access Links (NALs) will be rate-limited at the switch port (UNI) or EVC to a customer-specified bandwidth. The Layer 2 edge and core switches will perform rate-limiting for all Ethernet traffic across all switch ports in the Qwest MOE network 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 MOE End-User customers, rate-limiting can be performed on the individual customer EVCs. 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 are capable of performing rate-limiting via Committed Information Rate (CIR) functionality. The Qwest MOE CIR 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)

Ingress and egress CIRs will be equal at all switch ports, i.e. symmetrical. Also, the sum of all CIRs may be greater than the physical Gigabit Ethernet link speed due to oversubscription of the network.

2.6 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 MOE 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 MOE service option.

2.7 Architecture

The baseline Qwest Metro Optical Ethernet (MOE) 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 MOE 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 Qwest to deliver MOE service.

2.7.1 Physical Network

The Qwest MOE physical network architecture adapts to a wide diversity of enhanced transport technologies that exist in Qwest's Metropolitan Area Networks (MANs). Figure 2-2 depicts an example of Qwest 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 MOE traffic will typically be collected at the End-User premises by a Qwest-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 MOE 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 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 Section 2.~~12~~ 15 for MOE access ports with Customer Edge VLAN ID preservation).

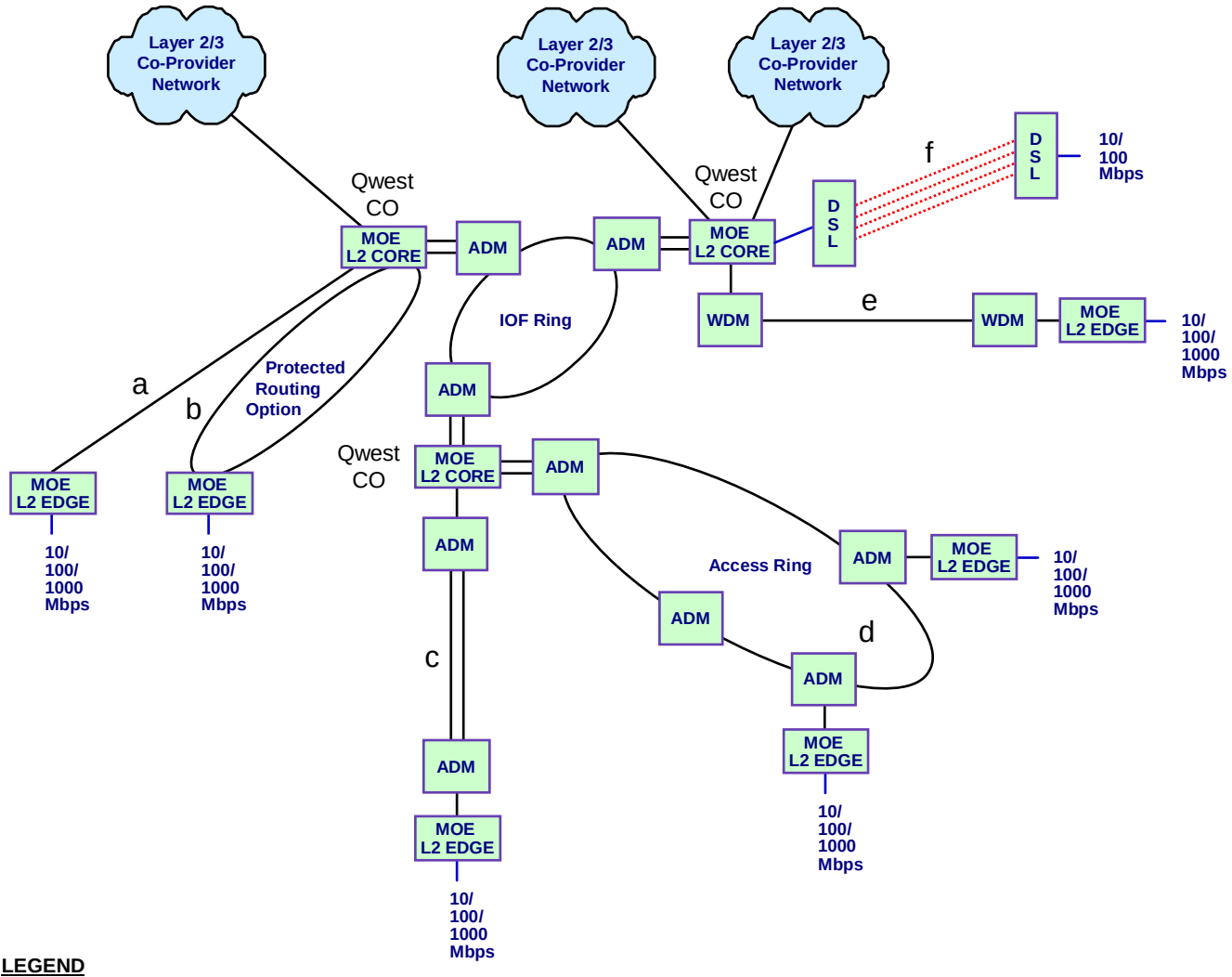
The Qwest SONET network will be used where available to connect the Layer 2 paths to form a Layer 2 switching network over SONET. The multiservice SONET ADMs employ Next Generation Gigabit Ethernet port cards to encapsulate the customers' Ethernet traffic for transport between the edge and core switches as well as from Qwest 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 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 MOE Layer 2 (L2) core switches, which aggregate the MOE 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 COs, which are MOE Serving Wire Centers (SWCs) designated as entry or Service Points into the Qwest MOE network. Other COs listed by Qwest as MOE 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 COs as an aggregation device or to provide MOE 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 Local Loop infrastructure, different architectures may be used to provide the Ethernet NALs or customer-designated edge sites to Qwest MOE Layer 2 core switch connections.

Figure 2-2 Qwest MOE 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-provided connections to the Qwest MOE network from the User-Network Interface (UNI) locations at End-User premises, IC or ISP POP to the Qwest MOE core switching infrastructure as well as for delivering 1000Base-LX UNIs within selected Qwest COs (see Section 2.7.3). As illustrated in Figure 2-2, the Qwest MOE customer UNI can connect to the Metro Optical Ethernet network via several types of NAL physical network architectures. The edge switches are connected back to a Qwest MOE 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 5 or 10 Mbps Bandwidth Profile/NAL as well as 100Base-TX UNIs with a 10, 20 or 30 Mbps Bandwidth Profile/NAL may also be delivered to a customer premises via standard IEEE 802.3ah Ethernet over bonded copper pairs using enhanced G.SHDSL modems. Network Access Link architectures are currently not a customer-specified option.

Qwest MOE 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 to determine the architecture that will best meet each customer's requirements based on the existing Qwest MOE infrastructure. Although there are several Network Access Link architectures, all of the following designs represented in Figure 2-2 meet the Qwest MOE 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 Local Loop infrastructure. Customer sites served by copper facilities will be connected to the MOE 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-provided Category 5E Patch Panel for electrical, and a duplex FC-PC, ~~or~~ SC or LC connector on a Qwest-provided Fiber Distribution Panel (FDP) 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 MOE 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 MOE service option and must be Customer Provided Equipment (CPE).

b) Optional Protected Routing: *Single edge switch dual homed to a single core switch over two fiber pairs using ~~(Cisco) EtherChannel or standard~~ IEEE 802.3-2005 (Clause ~~43802.3ad~~) Link Aggregation Control Protocol (LACP) for customer-requested enhanced service availability*

- Available with a single customer port (UNI) and offered on ~~full line rate 10, 100 Mbps and/or 1 Gbps User-Network Interfaces only, and on~~ a 'where available' basis with the following MOE 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
- Local loop redundancy is provided by provisioning two Gigabit Ethernet uplinks from the Qwest MOE edge switch to the CO core switch.
- Diverse facilities are provided with a minimum of 25' separation, wherever possible from the first utility vault outside the local Serving Wire Center to the last utility vault at the customer premises.
- The operation of ~~EtherChannel or~~ Link Aggregation provides for Layer 2 rerouting of customer traffic following the failure of either Gigabit Ethernet trunk port on the MOE edge or core switch, or connecting fiber facilities.
- This option does not 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 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 MOE 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 802.3-2005) 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 User-Network Interfaces at Qwest Central Offices

MOE customer-orderable handoffs at Qwest 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 MOE 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 with collocation see the Tariff and Qwest 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 MOE 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 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 MOE Layer 2 core switches are shown as an example connected together in a full mesh via a single SONET ring. Each Qwest 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 core switch interconnections. For example, there could be more than three Qwest CO sites in a metro region or more than one core switch per CO.

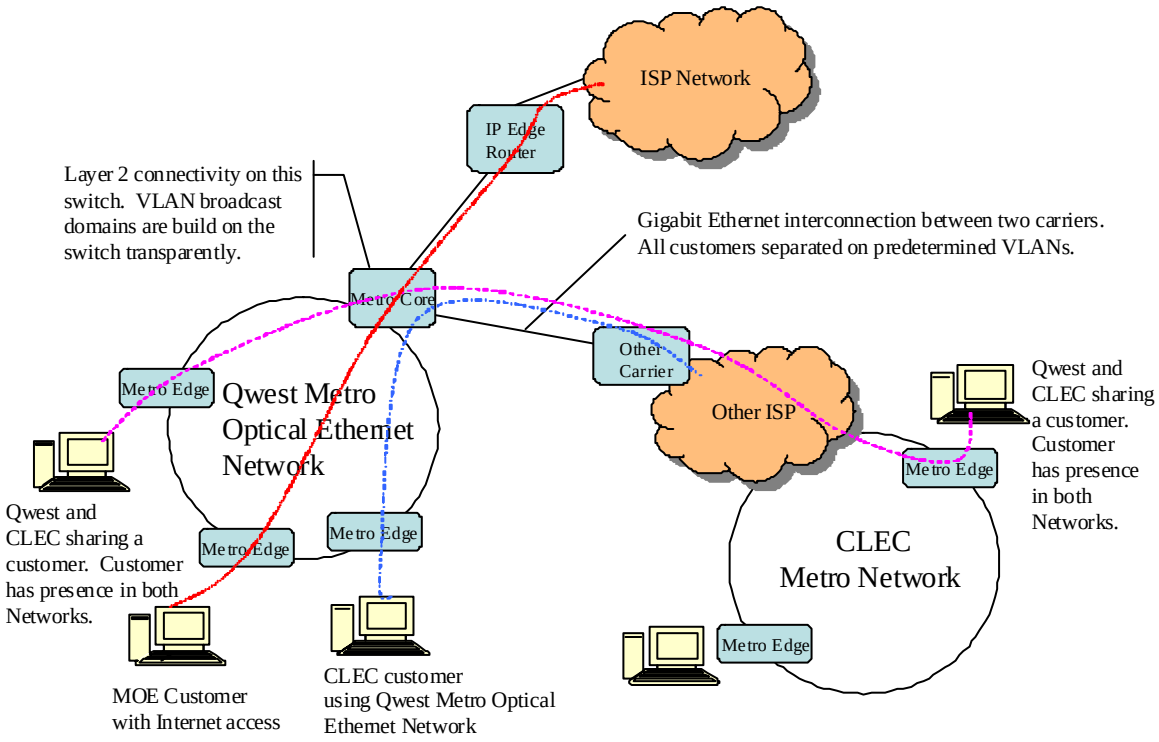
Regardless of the specific Qwest MOE core switch architecture, protection will be provided via Layer 1 transport redundancy and Ethernet Layer 2 Control Protocols on the Gigabit Ethernet IOF links. The primary requirement is that in case of a single link failure in the core switch network, no Qwest CO 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 ~~(PVST)~~ 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 MOE 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 see Section 2.~~12~~15, UNI and EVC Service Attributes for MOE Customer Access Ports including available options for Service Provider 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 Sections 2.7.2, Network Access Links and 2.7.4, Core Switch Connections.

2.8.1 Edge Switches

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

- Per-port broadcast~~,~~ and multicast~~, and unicast storm~~ traffic controls to prevent faulty end stations or Denial of Service (DoS) attacks from disrupting ~~degrading overall Qwest~~ the MOE network ~~performance~~(see Section 2.12 for further information).
- Switch port auto-recovery automatically attempts to re-enable a link that becomes disabled due to a network error.

- An Uninterruptible Power Supply (UPS) with approximately 4 hours battery backup and 2 to 4 milliseconds switch time to safeguard against power outages ~~may~~ will also be ~~provided~~provided ~~except in cases such as when~~ though may be waived by the customer at any of their premise locations if so desired.

2.8.2 Core Switches

To ensure high service availability for mission-critical applications, all Qwest MOE core switches will be deployed with the following features:

- Fully redundant (1+1) DC input, load-sharing power supplies.
- Standby Switch Fabric Module (1+1).
- Redundant clock modules.
- Redundant voltage termination modules.
- All modules and fan assemblies are hot-swappable, and can be added, replaced, or removed without interrupting the system power or causing other software or interfaces to shut down.
- ~~Cisco EtherChannel or standard~~ IEEE 802.3-2005 (Clause 43~~802.3ad~~) 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.

Furthermore, the core switches may be configured with:

- Redundant, hot-swappable supervisor engines with 1 to 3 second stateful failover enabling near-hitless software upgrades.
- Redundant supervisor engine in standby mode.

2.9 VLANs

A Virtual LAN (VLAN) 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.
- Prevents data transfer between customer locations or UNIs that are not part of the same VLAN.

The function of a VLAN 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 VLAN at the edge site/switch and across the Qwest MOE network. VLANs ensure that data packets are forwarded only to end stations within a specific subnet, thus reducing broadcast transmissions and allowing the Qwest MOE network to be shared between multiple customers within a metro.

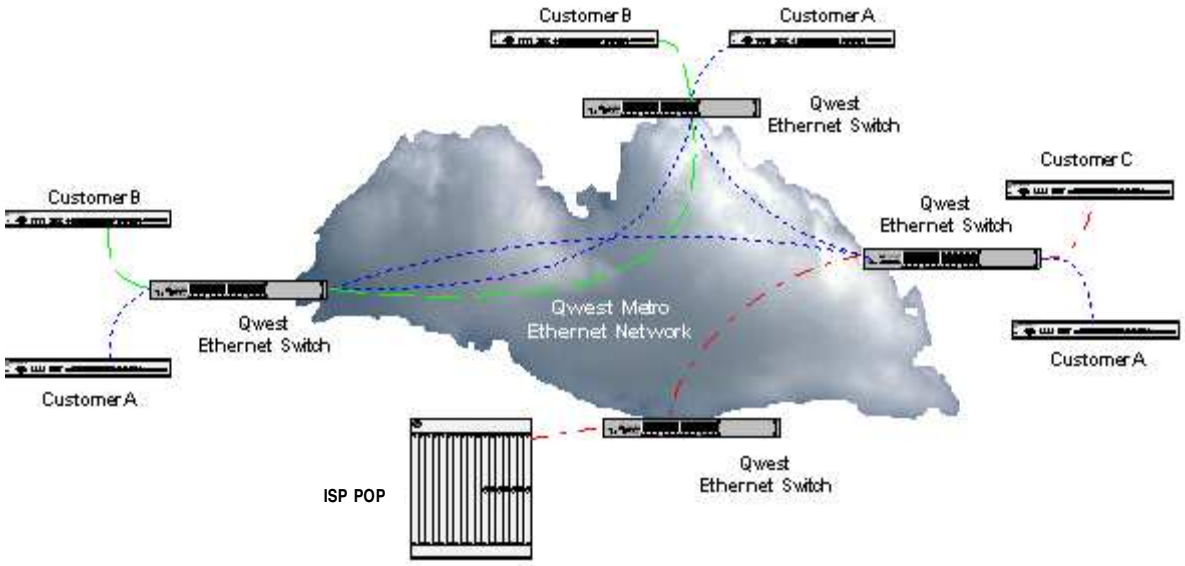
2.9.1 VLAN Tags and Ethernet Virtual Connections

In order to carry the traffic of more than one subnet down a single cable, IEEE 802.1Q, *Virtual Bridged Local Area Networks* defines an additional 4 bytes added to the standard 802.3 Ethernet frame. These additional bytes contain a VLAN Identifier (ID) or tag (and the 802.1p packet priority bits) for identifying standard Ethernet frames that belong to a particular VLAN.

VLAN tags will be used to separate and control Qwest MOE customer connectivity within a metro region. At the ingress Qwest Ethernet switch or entry point into the MOE network, each customer's Ethernet frames or packets will have a single Qwest-inserted VLAN tag to identify their rate-limited bandwidth provisioned within the physical Gigabit Ethernet trunk links. The Qwest MOE UNIs or Network Access Links at the End-User premises~~,~~ or ISP POP for example will be assigned to and associated with the customer's VLAN in order to provide a point-to-point or multipoint Ethernet Layer 2 Virtual Private Network (VPN), or high speed Dedicated Internet Access (DIA) service.

As shown in Figure 2-4, within the MOE service customer connectivity is provided by Qwest Ethernet Virtual Connections (EVCs), which are provisioned using IEEE 802.1Q VLANs. Specifically, the VLAN ID identifies the customer's frames as belonging to a particular EVC at a MOE port or UNI.

Figure 2-4 Qwest MOE EVCs



The Layer 2 core switches aggregate all the tagged Ethernet traffic coming from the Qwest MOE Layer 2 edge switches across a metro region and build separate broadcast domains for each customer's service based on their individual VLAN tags. All Carrier traffic will be VLAN tagged and passed on 802.1Q trunked Gigabit Ethernet interfaces to IC's and ISP's routers, or Layer 2/3 co-providers' VPN devices.

There are two types of customer-orderable EVCs with NC Codes listed in Section 3.6.7. 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 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. Shown in Figure 2-4, Customer A has a multipoint-to-multipoint EVC, while Customers B and C have 'point-to-point' EVCs. Section 2.~~12~~ 15 lists the available UNI and EVC Service Attributes for MOE Customer Access Ports.

2.9.2 VLAN Stacking

VLAN stacking, also referred to as Q-in-Q (802.1Q in 802.1Q), 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 network. Qwest MOE service is capable of 'stacking' a customer's VLAN tag or IEEE 802.1Q fields into the Qwest-inserted VLAN tag, thus enabling customers the capability of a Layer 2 VPN.

For End-User customers, VLAN stacking is done in which the customer facing switch port typically operates in a transparent mode and any traffic being sent by the customer, including VLAN tags and the Class of Service (CoS)/802.1p packet priority bits will be tunneled across the Qwest MOE network.

At the ingress UNI, an additional 802.1Q header with tag is added to the Ethernet frame. The Qwest MOE network will make its forwarding decisions based on this additional header. Once the frame arrives at the egress UNI, the outer or Qwest-inserted VLAN header is then discarded for handoff to the customer at the far end. Thus, an End-User customer can configure and extend their VLANs across the Qwest MOE network without the need to coordinate with Qwest. As stated in Section 2.7.5, Carrier Interconnection a standard set of VLAN IDs or tags will be agreed upon between Qwest, ICs, ISPs and other co-providers. Though as indicated in Section 2.~~12~~15, UNI and EVC Service Attributes for MOE Customer Access Ports, where available a new Qwest provisioning option allows for Customer Edge (CE) VLAN ID Preservation on Service Provider ports.

2.10 Ethernet Frame Formats

Qwest MOE service supports customer traffic with the following standard Ethernet frame formats:

- IEEE 802.3 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 ~~II~~ 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 MOE service:

- 802.3 SNAP (w/Sub-Network Access Protocol Header)
- Novell (NetWare) Proprietary or "802.3 Raw"

2.11 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 MOE 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 ~~standard Ethernet frame sizes up~~ to the IEEE 802.3/802.1Q maximum untagged/VLAN tagged frame size of 1518/1522 bytes.

Although larger MTUs of 1998 bytes on Ethernet and Fast Ethernet (10/100 Mbps) ports as well as 9000 bytes on Gigabit Ethernet ports can be supported in some instances on an Individual Case Basis (ICB), various Qwest MOE transport may limit the maximum deliverable frame size to 1632, 1536 (on EwET links) or even 1532 bytes. Customers are advised to consult with Qwest Engineering for specific details including availability. ~~See Section 4.6, Packet Loss for further customer Ethernet frame requirements.~~

With Qwest Metro Optical Ethernet service, the customers' Ethernet frames will be delivered with the Ethernet MAC addresses and frame contents unchanged, i.e. the frames will remain intact from source to destination(s) across the Qwest MOE network.

2.12 Multicast and Broadcast Traffic

While ~~Customers' unicast, multicast and broadcast~~ Ethernet frames will be forwarded ~~only~~ to the appropriate end stations ~~with~~in each customer's ~~VLAN or~~ EVC~~,~~. Qwest 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 will:

- Limit ~~while~~ 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 interfaces associated with multicast routers

2.13 Customer MAC Address Limitations

For customers who choose to connect to the Qwest MOE network via an Ethernet switch or IEEE 802.1D Media Access Control (MAC) Bridges, the maximum number of MAC addresses that can be supported ~~on MOE per customer Layer 2 device, i.e. Ethernet CPE~~ is currently limited to 600 per switch port/UNI.

2.~~11~~14 Layer 2~~/3~~ Control Protocol Tunneling

The Layer 2 Control Protocol service attribute may be applied at the UNI or per EVC. There are many Layer 2 Control Protocols that might be used in the customer's network and Table 2-2 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 discarded or tunneled across the Qwest MOE 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 Section 2.15.3).

* 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 2-2 Layer 2 Control Protocol Transparency

Protocol	Destination MAC Address	TLS Ports	TLS Plus Ports	All other MOE port types
Bridge Group Address for Spanning Tree Protocol (STP)[1]	01-80-C2-00-00-00	Tunnel	Tunnel	Discard
IEEE 802.3x Full Duplex MAC Control (PAUSE) Frames	01-80-C2-00-00-01	Discard	Discard	Discard
IEEE 802.3-2005 (Clause 43) Link Aggregation Control Protocol (LACP)[2]	01-80-C2-00-00-02	Discard	Tunnel[3]	Discard
IEEE 802.1X Port Authentication	01-80-C2-00-00-03	Discard	Discard	Discard
A protocol to be multicast to all bridges in a bridged LAN	01-80-C2-00-00-10	Tunnel	Tunnel	Discard
Generic Attribute Registration Protocol (GARP)	01-80-C2-00-00-20 through 01-80-C2-00-00-2F	Discard	Discard	Discard

Notes:

1. ~~TLS (Transparent LAN Service) ports are configured to provide Layer 2 Control Protocol tunneling of customer~~ Customer Bridge Protocol Data Units (BPDUs) for ~~(~~802.~~1d~~1D, 802.1w Rapid or 802.~~1s~~ 1Q Multiple~~)~~ Spanning Tree Protocol (STP, RSTP or MSTP)~~,~~
2. 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
3. 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~~.~~

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

2.~~12~~15 UNI and EVC Service Attributes for MOE Customer Access Ports

With MOE there are two types of service attributes, those that apply to a physical port or User-Network Interface (UNI), described in Chapter 3 and those that apply to an Ethernet Virtual Connection (EVC), described in Section 2.9.1. The UNI and EVC attributes are listed in Table 2-~~2~~ 3 along with the service parameters for each MOE customer access port. For a MOE request, attributes will be specified for each UNI in the EVC as well as for the EVC and captured on the Qwest and/or Alliance for Telecommunications Industry Solutions (ATIS) Access Service Request (ASR) EVC Form(s) at the time of service order.

Much of the information in this and the following subsections is based on work of the Metro Ethernet Forum such as described in their Technical Specification MEF 10.1, *Ethernet Services Attributes - Phase 2*, November 2006 document available at: http://www.metroethernetforum.org/ and has been reproduced with permission of the Metro Ethernet Forum.

Table 2-~~2~~ 3 UNI and EVC Service Attributes

UNI and EVC Attributes	MOE Customer Access Port Service Parameters
Physical medium (Table 3.1)	- 10Base-T - 100Base-TX - 1000Base-LX - 1000Base-SX Standard Ethernet PHY types per IEEE 802.3-2005
Speed (Table 3.1)	- 10 Mbps - 100 Mbps - 1 Gbps
Mode (Section 2.6)	Full duplex
MAC Layer (Section 2.10)	IEEE 802.3-2005, Ethernet Version ~~II~~ 2 (DIX)
Service Multiplexing (Section 2.~~12~~15.1)	- Yes for Service Multiplexer ports - Yes for Service Provider ports - No for Non-TLS ports - No for TLS ports - No for TLS Plus ports
CE-VLAN ID (Section 2.~~12~~15.2)	A number in 1, 2, …, 4094

Table 2-~~2~~ 3 UNI and EVC Service Attributes (Continued)

UNI and EVC Attributes	MOE Customer Access Port Service Parameters
CE-VLAN ID/EVC Map (Section 2.~~12~~15.3)	- Service Multiplexer ports: One or multiple CE-VLANs can be mapped to each EVC, and untagged frames received at the UNI may be dropped
	- Service Provider ports: One or multiple CE-VLANs can be mapped to each EVC[1], and all untagged frames received at the UNI will be dropped
	- Non TLS ports: 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
	- TLS ports: All untagged and CE-VLAN tagged frames are mapped to one EVC
	- TLS Plus ports: All untagged and CE-VLAN tagged frames are mapped to one point-to-point EVC
Maximum Number of EVCs (Per UNI)	- ~~5~~ 10 for Service Multiplexer ports - ~~50~~ 100 for Service Provider ports EVCs are a limited Qwest resource and offered on a `where available' basis within the MOE network. - 1 for Non-TLS ports - 1 for TLS ports - 1 for TLS Plus ports
Bundling (Section 2.~~12~~15.4)	- Yes or No for Service Multiplexer ports - Yes or No for Service Provider ports - No for Non-TLS ports - No for TLS ports - No for TLS Plus ports
All to One Bundling (Section 2.~~12~~15.5)	- No for Service Multiplexer ports - No for Service Provider ports - Yes for Non-TLS ports - Yes for TLS ports - Yes for TLS Plus ports

Table 2-~~2~~ 3 UNI and EVC Service Attributes (Continued)

UNI and EVC Attributes	MOE Customer Access Port Service Parameters
Bandwidth Profile and QoS (Section 2.~~13~~16) Per Ingress UNI (Section 2.~~12~~15.6)	- Yes or No for Service Multiplexer ports - Yes or No for Service Provider ports - Yes for Non-TLS ports - Yes for TLS ports - Yes for TLS Plus ports Yes = No Bandwidth Profile or QoS Per EVC option
Bandwidth Profile and QoS (Section 2.~~13~~16) Per EVC (Section 2.~~12~~15.7)	- Yes or No for Service Multiplexer ports - Yes or No for Service Provider ports - N/A for Non-TLS ports - N/A for TLS ports - N/A for TLS Plus ports Yes = No Bandwidth Profile or QoS Per Ingress UNI
Layer 2 Control Protocol (L2CP) Tunneling (Section 2.~~11~~14)	- No for Service Multiplexer ports - No for Service Provider ports - No for Non-TLS ports - Yes for STP, CDP and VTP and No for other L2CPs on TLS ports - Yes for STP, CDP, VTP and LACP[2] (point-to-point EVCs only) and No for other L2CPs on TLS Plus ports[3] Yes = Pass to EVC, No = Discard at ingress
EVC Type (Section 2.9.1)	- Point-to-point (E-LINE) or multipoint-to-multipoint (E-LAN) - TLS Plus ports can only be placed in point-to-point EVCs
CE-VLAN ID Preservation (Section 2.~~12~~15.8)	- Yes for Service Multiplexer ports - Yes or No for Service Provider ports[1] - N/A for Non-TLS ports - Yes for TLS ports - Yes for TLS Plus ports

Table 2-~~2~~ 3 Notes:

1. With the initial MOE offering the Service Provider VLAN IDs had to match Qwest VLAN IDs/tags, and where available a new Qwest provisioning option allows for customer or CE-VLAN ID Preservation.
2. Load balancing is the responsibility of the customer with Link Aggregation failover times dependent upon their CPE configuration and protocol. See IEEE 802.3-2005, clause 43 and applicable vendor, e.g. Cisco documentation for further information.
3. TLS Plus is an option, where available in the Qwest 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 with full line rate Fast Ethernet (100Base-TX) or Gigabit Ethernet (1000Base-T/LX/SX) ports. Consult with Qwest Engineering for specific details including availability.
4. CE = Customer Edge
5. TLS = Transparent LAN Service
6. N/A = Not Applicable

Note that when an EVC contains more than one customer access port type, the end-to-end MOE 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-~~3~~ 4 provides additional requirements for MOE customer access ports in an EVC.

Table 2-~~3~~ 4 Additional Requirements for MOE Customer Access Ports in an EVC

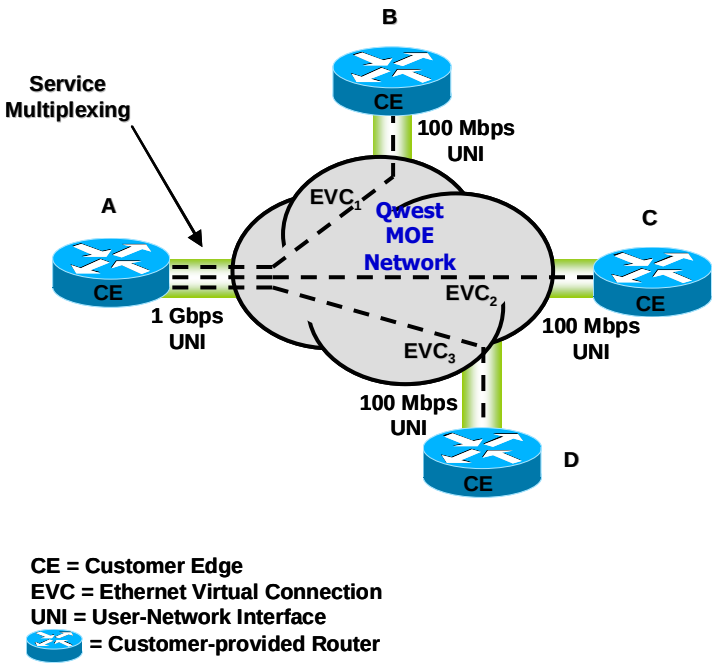
Service Multiplexer to Service Provider	Only valid E-LAN combination is one Service Multiplexer and two Service Provider ports
Service Multiplexer to Non-TLS	No CE-VLAN ID Preservation
Service Multiplexer to TLS	Untagged frames may be passed or dropped
Service Provider to Service Provider	Can only add one non-Service Provider port to this combination
Service Provider to Non-TLS	No CE-VLAN ID Preservation, only valid E-LAN combination is one Non-TLS and two Service Provider ports
Service Provider to TLS	Only valid E-LAN combination is one TLS and two Service Provider ports

Note: E-LAN is an Ethernet service type distinguished by its use of a multipoint-to-multipoint EVC and specifically for Qwest MOE when there are more than two UNIs in the EVC.

2.~~12~~15.1 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). Point-to-point EVCs and multipoint-to-multipoint EVCs may be multiplexed in various combinations at a Service Multiplexer or Service Provider port (UNI) as indicated in Section 2-12. Point-to-point EVCs will be provisioned using a multipoint EVC but with only two UNIs. Figure 2-5 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 ports.

Figure 2-5 Service Multiplexing Example



2.~~12~~15.2 Customer Edge VLAN ID

The EVC for a service frame is identified by the Customer Edge VLAN ID (CE-VLAN ID), numbered 1 through 4095. The CE-VLAN ID for a service frame with an IEEE 802.1Q tag is the value of the VLAN ID in the tag. More than one CE-VLAN ID may point to the same EVC as described in Section 2.~~12~~15.4, Bundling.

2.~~12~~15.3 CE-VLAN ID/EVC Map

At each MOE 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.~~12~~15.4 and 2.~~12~~15.5) at the UNI, exactly one CE-VLAN ID will be mapped to at most one EVC.

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 network.

For Service Multiplexer and Service Provider ports in an EVC with CE-VLAN ID Preservation as described in Section 2.~~12~~15.8, 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 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 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.

The CE-VLAN ID/EVC mapping for a given UNI in an EVC may be different from the mapping at another UNI in the EVC only when the CE-VLAN ID Preservation attribute does not apply to an EVC.

2.~~12~~15.4 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~~15.8) and the list of CE-VLAN IDs mapped to the EVC will be the same at each UNI in the EVC. Bundling may be described as shown in Figure 2-6.

Figure 2-6 Bundling CE-VLAN ID/EVC Map Example

Description

CE-VLAN ID	EVC
2000	EVC_1
2001	EVC_2
All others	EVC_3

Actual Map

CE-VLAN ID	EVC
2000	EVC_1
2001	EVC_2
1, …, 1999, 2002, …, 4095	EVC_3

2.~~12~~15.5 All to One Bundling

When a UNI has the All to One Bundling attribute, all CE-VLAN IDs will map to a single EVC at the UNI. The EVC at the UNI will have the CE-VLAN ID Preservation service attribute as described in Section 2.~~12~~15.8, 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.

2.~~12~~15.6 Bandwidth Profile and QoS Per Ingress UNI

With this application of policing, a single Bandwidth Profile is applied to all ingress service frames at the UNI. The Bandwidth Profile per Ingress UNI manages bandwidth non-discriminately for all EVCs at the UNI.

2.~~12~~15.7 Bandwidth Profile and QoS 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. Thus, if a UNI has three Ethernet Virtual Connections, there could be three ingress Bandwidth Profiles, one for each EVC. See Section 2.5, Rate-Limiting and Committed Information Rate for further information.

2.~~12~~15.8 CE-VLAN ID Preservation

In an EVC with CE-VLAN ID Preservation (or transparency), the relationship between the ingress service frame and its corresponding egress service frame(s) described in Table 2-~~4~~ 5 is maintained.

Table 2-~~4~~ 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

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.~~12~~15.4 and 2.~~12~~15.5), the EVC will have the CE-VLAN ID Preservation service attribute.

2.~~13~~16 Quality of Service

2.~~13~~16.1 Overview

Qwest MOE 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 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 customer access ports, QoS is dependant upon the switching equipment and transport facilities within the Qwest network and is offered on a 'where available' basis.

Traffic will be classified upon entry at the MOE 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 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 Metro Optical Ethernet network. 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 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 network.

2.~~13~~16.2 Description

P1 traffic is offered in 5 Mbps increments~~, where available~~ up to ~~100% of the total applicable customer-orderable Bandwidth Profile~~50 Mbps per UNI, though Qwest will consider requests for greater amounts on an Individual Case Basis (ICB). At least 5 Mbps 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 FCC Tariff No. 1 available from: http://tariffs.qwest.com:8000/Q_Tariffs/QT_Tariff_State_Page/index.htm.

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 Bandwidth Profile allocation among all four QoS levels at a given MOE service connection, whether explicitly using all of the available queues or not, must equal no more than 100% and in some cases Qwest 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 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 and if underutilized may be used by the other lower priority Classes of Service, 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 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 MOE 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~~16.3 QoS Traffic Classification

Qwest MOE 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 MOE service will be applied on a per port basis. Note that MOE QoS traffic classification:

1. Is not an EVC level option on Service Multiplexer or Service Provider ports configured to support Service Multiplexing
2. Must be the same for all UNIs in an EVC, using CoS and IP precedence values at different ends of the service is not supported

The MOE 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 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's CoS and IP precedence values queue assignments for the four different MOE QoS traffic classes are listed in Table 2-~~5~~ 6 below.

Table 2-~~5~~ 6 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 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® Metro Optical Ethernet® (MOE) service only. This document does not attempt to describe the equipment used to provide this service.

3.2 Description of Qwest MOE Network Interfaces

Qwest Metro Optical Ethernet (MOE) service will be provisioned using intelligent Ethernet switches. This technology allows Qwest 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 MOE Network Access Links are provided to both End-User and Carrier customers. The signal characteristics and supported MAC Layers at the Network Interface (NI) will be as specified in the IEEE 802®.3-2005, *Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications* standard. The physical NI for all customers will be at an RJ-45 jack on a Qwest-provided Category 5E Patch Panel for electrical, and a duplex FC-PC, ~~or~~ SC or LC connector on a Qwest-provided Fiber Distribution Panel (FDP) for optical Gigabit Ethernet interfaces. SC and LC connectors are an option, where available at customer premises locations only. The NI or User-Network Interface (UNI) is the point of demarcation between Qwest MOE service and the customer-provided Data Terminal Equipment (DTE).

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	5, 10	Full duplex	100 ohms	Two pairs[1] of twisted-pair telephone or Category 3, 4 or 5 (recommended[2]) copper wire	RJ-45
100Base-TX	100 Mbps[4]	10, 20, 30, 40, 50, 60, 70, 80, 90, 100	Full duplex	100 ohms	Two pairs[1] of Category 5 Unshielded Twisted-Pair (UTP) or Shielded Twisted-Pair (STP) copper wire	RJ-45
1000Base-T	1000 Mbps[4]	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[4]	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	Duplex FC-PC, ~~or~~ SC, or LC
1000Base-SX	1000 Mbps[4]	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	Duplex FC-PC, ~~or~~ SC, or LC

Table 3-1 Notes:

1. While 10Base-T and 100Base-TX compatible devices can use a two twisted-pair cable, Qwest 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.
2. Although the customer may use Category 3, 4 or 5 copper wire when connecting to 10Base-T ports, Qwest will use Category 5E (Enhanced performance) balanced copper cabling from the Qwest MOE switch port to the Category 5E Patch Panel UNI for all electrical interfaces.
3. 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 MOE customers. See Section 4.2, Bandwidth Change Requests for further information.
4. The actual signaling rate for 100Base-TX and 1000Base-T/LX/SX Network Interfaces is 125 Mbps and 1250 Mbps respectively.
5. ~~In general,~~ Qwest will manually provision (or hardcode) the speed and (full) duplex transmission mode on all 10/100~~/1000~~ Mbps MOE customer facing electrical ~~switch~~ ports. However, ~~Auto~~auto-negotiation ~~will only~~ must be enabled at the UNI for ~~optical~~ all Gigabit Ethernet (1000Base-T/LX/SX) ports.
6. Multiple interfaces using IEEE 802.~~3ad~~ 3-2005 (Clause 43) Link Aggregation or, 802.~~1d~~1D, 802.1w Rapid or 802.~~1s~~ 1Q Multiple Spanning Tree Protocol for increased bandwidth and/or link redundancy/load balancing ~~are~~is currently not a Qwest MOE service option~~s~~ at the UNI. See Section 2.~~11~~14, Layer 2~~/3~~ Control Protocol Tunneling for further information on customer applications of Spanning Tree Protocol.
7. nm = nanometer
8. Single-Mode Fiber is 9 or 10/125 micron.
9. Multi-Mode Fiber is 50 or 62.5/125 micron; see Table 3-9 for distance limitations.
10. FC-PC (Fiber Connector - Physical Contact) is a keyed, locking type of fiber optic connector with a round barrel and threaded retaining ring.
11. SC (Subscriber Connector) is a push-pull type of fiber optic connector with a square barrel that conforms to ISO/IEC 11801: 2002, *Information technology - Generic cabling for customer premises*.
12. 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.*
13. FC-PC is the Qwest MOE default connector type for 1000Base-LX/SX UNIs whereas SC and LC are customer-specified options, where available at premises locations. As there are no (e.g., NCI) codes for ordering, the customer would make the request to their Sales or Account Team, or the connector type should be determined during the field visit and captured on the site survey form.

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

The Qwest MOE 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-

Qwest will always use a straight-through cable to connect to the Category 5E Patch Panel for electrical UNIs and the customer will use either a straight-through or crossover cable depending upon the equipment they are connecting to the UNI. 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 Metro Optical Ethernet for LAN interconnection will not provide the repeater functionality as described in IEEE 802.3-2005.

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 MOE 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 edge switch at a customer site, all Network Interfaces should be jointly engineered between Qwest 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)
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)
1000Base-T	100 ohms	Four pairs of Category 5 balanced copper cabling	N/A	100 meters (328 feet)
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 switch port to UNI
2. N/A = Not Applicable
3. nm = nanometer
4. 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 on the Qwest Category 5E Patch Panel or Fiber Distribution Panel must be provided by the customer. These cables should be at least 2 meters long to facilitate attachment within the edge switch equipment frame. 2 meters is also the minimum supported cable distance from the Qwest Small Form-factor Pluggable (SFP) or Gigabit Interface Converter (GBIC) customer facing switch port used to deliver 1000Base-LX UNIs.

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

The Qwest MOE 1000Base-LX User-Network Interface fully complies with the IEEE 802.3-2005 (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 MOE 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 receiving party 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 MOE service. The NC and NCI Codes are to be provided by the customer to the Qwest Service Representative at the time a request for new or upgrades to an existing service are initiated.

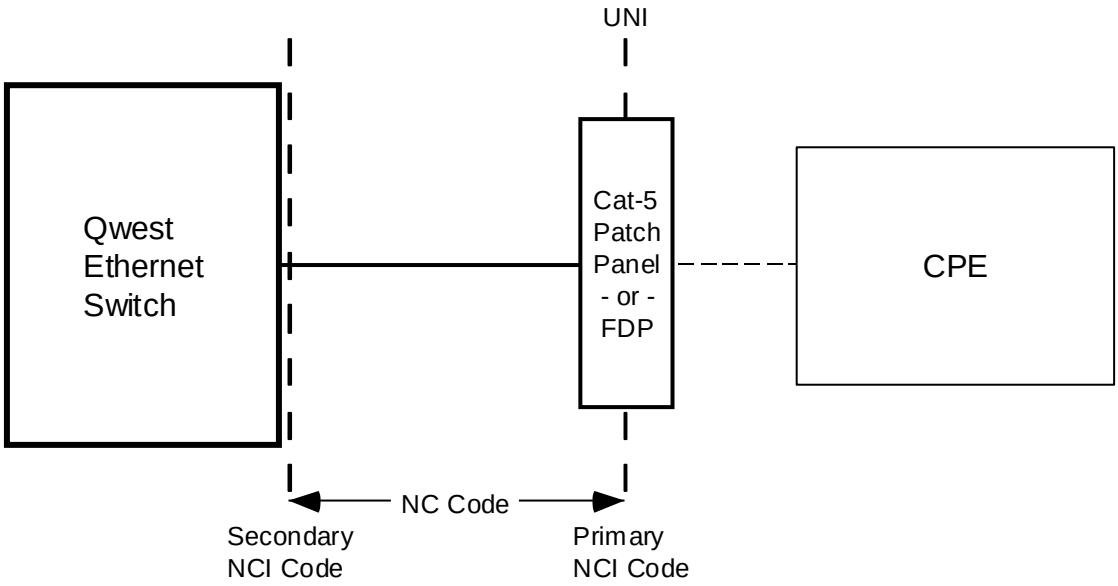
Additional information concerning NC/NCI Codes is available in ANSI T1.223-1997, *Information Interchange - Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for the North American Telecommunications System*.

In some instances Qwest 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 Metro Optical Ethernet (MOE) service as defined in this publication.

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

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

Figure 3-1 Qwest MOE NC and NCI Codes



LEGEND

CPE = Customer Provided Equipment
FDP = Fiber Distribution Panel
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 MOE, the NC Code is specified by the customer to advise Qwest 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 MOE 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 MOE, 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 MOE NC Codes

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

Table 3-11 NC Codes for 10 Mbps Service

NC Code	Description
KPE5	Rate-Adjustable 10 Mbps Ethernet, Full Duplex Facility supporting EVC service multiplexing[1], 5 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
KQE1	Fractional 100 Mbps Ethernet, Full Duplex – Rate based on Ethernet switch, Facility supporting EVC service multiplexing[1], 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, 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
KRE7	Rate-Adjustable Gigabit Ethernet (Point to Point and full duplex), Rate based on Ethernet switch, Facility supporting EVC service multiplexing, 700 Mbps

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

NC Code	Description
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)

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.~~12~~15.
2. Point-to-point applies to the individual Gigabit Ethernet Network Access Links, however the Qwest MOE Layer 2 VPN service provides for multipoint-to-multipoint connectivity.

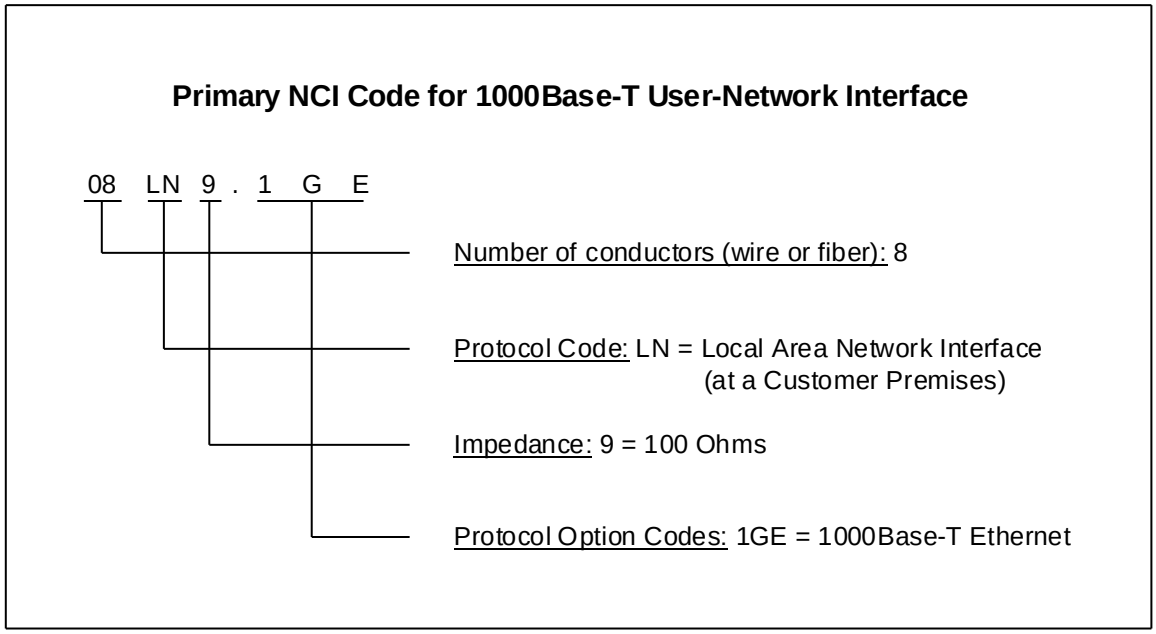
3.6.3 NCI Code Form and Components

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 MOE 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 MOE NCI Code Example



3.6.4 Qwest MOE Primary NCI Codes

Tables 3-14 and 3-15 list the Primary Network Channel Interface (NCI) Codes for ordering Qwest 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 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 CO location would be indicated for a Central Office Cross-Connect (COCC) to another compatible finished service or to provide MOE 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 User-Network Interfaces at Qwest 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.A04	2 Conductors, Local Area Network Interface, Fiber, 850 nm, 50 micron Multi-mode Fiber
02LNF.A07	2 Conductors, Local Area Network Interface, Fiber, 850 nm, 62.5 micron Multi-mode Fiber

Table 3-16 Primary NCI Code for 1000Base-LX UNIs at a Qwest 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 MOE Secondary NCI Codes

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

Table 3-19 lists all the valid NC Code, Primary and Secondary NCI Code combinations for ordering Qwest MOE 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
KPE5	04LN9.10T	04CX9.10T	10	5	10Base-T	Customer Premises
KPE-	04LN9.10T	04CX9.10T	10	10	10Base-T	Customer Premises
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
KRFB	08LN9.1GE	08CX9.1GE	1000	10	1000Base-T	Customer Premises
KRFB	02LNF.A02	02CXF.1GE	1000	10	1000Base-LX (SMF)	Customer Premises
KRFB	02LNF.A04	02CXF.1GE	1000	10	1000Base-SX (50 um MMF)	Customer Premises
KRFB	02LNF.A07	02CXF.1GE	1000	10	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
KRFD	08LN9.1GE	08CX9.1GE	1000	20	1000Base-T	Customer Premises
KRFD	02LNF.A02	02CXF.1GE	1000	20	1000Base-LX (SMF)	Customer Premises
KRFD	02LNF.A04	02CXF.1GE	1000	20	1000Base-SX (50 um MMF)	Customer Premises
KRFD	02LNF.A07	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	02CXF.1GE	1000	30	1000Base-LX (SMF)	Customer Premises
KRFF	02LNF.A04	02CXF.1GE	1000	30	1000Base-SX (50 um MMF)	Customer Premises
KRFF	02LNF.A07	02CXF.1GE	1000	30	1000Base-SX (62.5 um MMF)	Customer Premises
KRFH	08LN9.1GE	08CX9.1GE	1000	40	1000Base-T	Customer Premises
KRFH	02LNF.A02	02CXF.1GE	1000	40	1000Base-LX (SMF)	Customer Premises
KRFH	02LNF.A04	02CXF.1GE	1000	40	1000Base-SX (50 um MMF)	Customer Premises
KRFH	02LNF.A07	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	02CXF.1GE	1000	50	1000Base-LX (SMF)	Customer Premises
KRFJ	02LNF.A04	02CXF.1GE	1000	50	1000Base-SX (50 um MMF)	Customer Premises
KRFJ	02LNF.A07	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	02CXF.1GE	1000	60	1000Base-LX (SMF)	Customer Premises
KRFL	02LNF.A04	02CXF.1GE	1000	60	1000Base-SX (50 um MMF)	Customer Premises
KRFL	02LNF.A07	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	02CXF.1GE	1000	70	1000Base-LX (SMF)	Customer Premises
KRFN	02LNF.A04	02CXF.1GE	1000	70	1000Base-SX (50 um MMF)	Customer Premises
KRFN	02LNF.A07	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	02CXF.1GE	1000	80	1000Base-LX (SMF)	Customer Premises
KRFP	02LNF.A04	02CXF.1GE	1000	80	1000Base-SX (50 um MMF)	Customer Premises
KRFP	02LNF.A07	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	02CXF.1GE	1000	90	1000Base-LX (SMF)	Customer Premises
KRFR	02LNF.A04	02CXF.1GE	1000	90	1000Base-SX (50 um MMF)	Customer Premises
KRFR	02LNF.A07	02CXF.1GE	1000	90	1000Base-SX (62.5 um MMF)	Customer Premises
KRE1	08LN9.1GE	08CX9.1GE	1000	100	1000Base-T	Customer Premises
KRE1	02LNF.A02	02CXF.1GE	1000	100	1000Base-LX (SMF)	Customer Premises
KRE1	02QBF.K02	02CXF.1GE	1000	100	1000Base-LX (SMF)	Central Office[1]
KRE1	02LNF.A04	02CXF.1GE	1000	100	1000Base-SX (50 um MMF)	Customer Premises
KRE1	02LNF.A07	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	02CXF.1GE	1000	200	1000Base-LX (SMF)	Customer Premises
KRE2	02LNF.A04	02CXF.1GE	1000	200	1000Base-SX (50 um MMF)	Customer Premises
KRE2	02LNF.A07	02CXF.1GE	1000	200	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
KRE3	08LN9.1GE	08CX9.1GE	1000	300	1000Base-T	Customer Premises
KRE3	02LNF.A02	02CXF.1GE	1000	300	1000Base-LX (SMF)	Customer Premises
KRE3	02LNF.A04	02CXF.1GE	1000	300	1000Base-SX (50 um MMF)	Customer Premises
KRE3	02LNF.A07	02CXF.1GE	1000	300	1000Base-SX (62.5 um MMF)	Customer Premises
KRE4	08LN9.1GE	08CX9.1GE	1000	400	1000Base-T	Customer Premises
KRE4	02LNF.A02	02CXF.1GE	1000	400	1000Base-LX (SMF)	Customer Premises
KRE4	02LNF.A04	02CXF.1GE	1000	400	1000Base-SX (50 um MMF)	Customer Premises
KRE4	02LNF.A07	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	02CXF.1GE	1000	500	1000Base-LX (SMF)	Customer Premises
KRE5	02LNF.A04	02CXF.1GE	1000	500	1000Base-SX (50 um MMF)	Customer Premises
KRE5	02LNF.A07	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	02CXF.1GE	1000	600	1000Base-LX (SMF)	Customer Premises
KRE6	02QBF.K02	02CXF.1GE	1000	600	1000Base-LX (SMF)	Central Office[1]
KRE6	02LNF.A04	02CXF.1GE	1000	600	1000Base-SX (50 um MMF)	Customer Premises
KRE6	02LNF.A07	02CXF.1GE	1000	600	1000Base-SX (62.5 um MMF)	Customer Premises
KRE7	08LN9.1GE	08CX9.1GE	1000	700	1000Base-T	Customer Premises
KRE7	02LNF.A02	02CXF.1GE	1000	700	1000Base-LX (SMF)	Customer Premises
KRE7	02LNF.A04	02CXF.1GE	1000	700	1000Base-SX (50 um MMF)	Customer Premises
KRE7	02LNF.A07	02CXF.1GE	1000	700	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
KRE8	08LN9.1GE	08CX9.1GE	1000	800	1000Base-T	Customer Premises
KRE8	02LNF.A02	02CXF.1GE	1000	800	1000Base-LX (SMF)	Customer Premises
KRE8	02LNF.A04	02CXF.1GE	1000	800	1000Base-SX (50 um MMF)	Customer Premises
KRE8	02LNF.A07	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	02CXF.1GE	1000	900	1000Base-LX (SMF)	Customer Premises
KRE9	02LNF.A04	02CXF.1GE	1000	900	1000Base-SX (50 um MMF)	Customer Premises
KRE9	02LNF.A07	02CXF.1GE	1000	900	1000Base-SX (62.5 um MMF)	Customer Premises
KRE0	08LN9.1GE	08CX9.1GE	1000	1000	1000Base-T	Customer Premises
KRE0	02LNF.A02	02CXF.1GE	1000	1000	1000Base-LX (SMF)	Customer Premises
KRE0	02QBF.K02	02CXF.1GE	1000	1000	1000Base-LX (SMF)	Central Office[1]
KRE0	02LNF.A04	02CXF.1GE	1000	1000	1000Base-SX (50 um MMF)	Customer Premises
KRE0	02LNF.A07	02CXF.1GE	1000	1000	1000Base-SX (62.5 um MMF)	Customer Premises

Notes:

1. 1000Base-LX User-Network Interfaces are only available at Qwest Central Offices which have a MOE core switch
2. SMF = Single-Mode Fiber
3. MMF = Multi-Mode Fiber
4. 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 Layer 2 connectivity and corresponding service attributes for each UNI or customer access port type in the EVC. See Section 2.9.1, VLAN Tags and 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), Point-to-Point Ethernet Virtual Connection (EVC). Defined in MEF 10.1 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), Multipoint-to-Multipoint Capable Ethernet Virtual Connection (EVC). Defined in MEF 10.1 as an association of two or more UNIs.

Table 3-21 EVC NCI Codes for Qwest MOE 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 MOE 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 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 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 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 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 Section 2.15) captured on EVC Form
		02VLN.VB	- Plus (many to one) Bundling (see Section 2.15.4)
		02VLN.VL3*	- Plus QoS per IP Precedence bits in the ToS field (see Section 2.~~13~~16)
		02VLN.VB3*	- Plus (many to one) Bundling (see Section 2.~~12~~15.4) and QoS per IP Precedence bits in the ToS field (see Section 2.~~13~~16)
		02VLN.VP*	- Plus QoS per 802.1Q P-bits (see Section 2.~~13~~16)
		02VLN.VBP*	- Plus (many to one) Bundling (see Section 2.15.4) and QoS per 802.1Q P-bits (see Section 2.16)
Service Provider	VLP- or VLM-	02VLN.V	- Other UNI and EVC service attributes (see Section 2.15) captured on EVC Form
		02VLN.VB	- Plus (many to one) Bundling (see Section 2.15.4)
		02VLN.VL3*	- Plus QoS per IP Precedence bits in the ToS field (see Section 2.~~13~~16)
		02VLN.VB3*	- Plus (many to one) Bundling (See Section 2.~~12~~15.4) and QoS per IP Precedence bits in the ToS field (see Section 2.~~13~~16)
		02VLN.VP*	- Plus QoS per 802.1Q P-bits (see Section 2.~~13~~16)
		02VLN.VBP*	- Plus (many to one) Bundling (see Section 2.15.4) and QoS per 802.1Q P-bits (see Section 2.16)

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

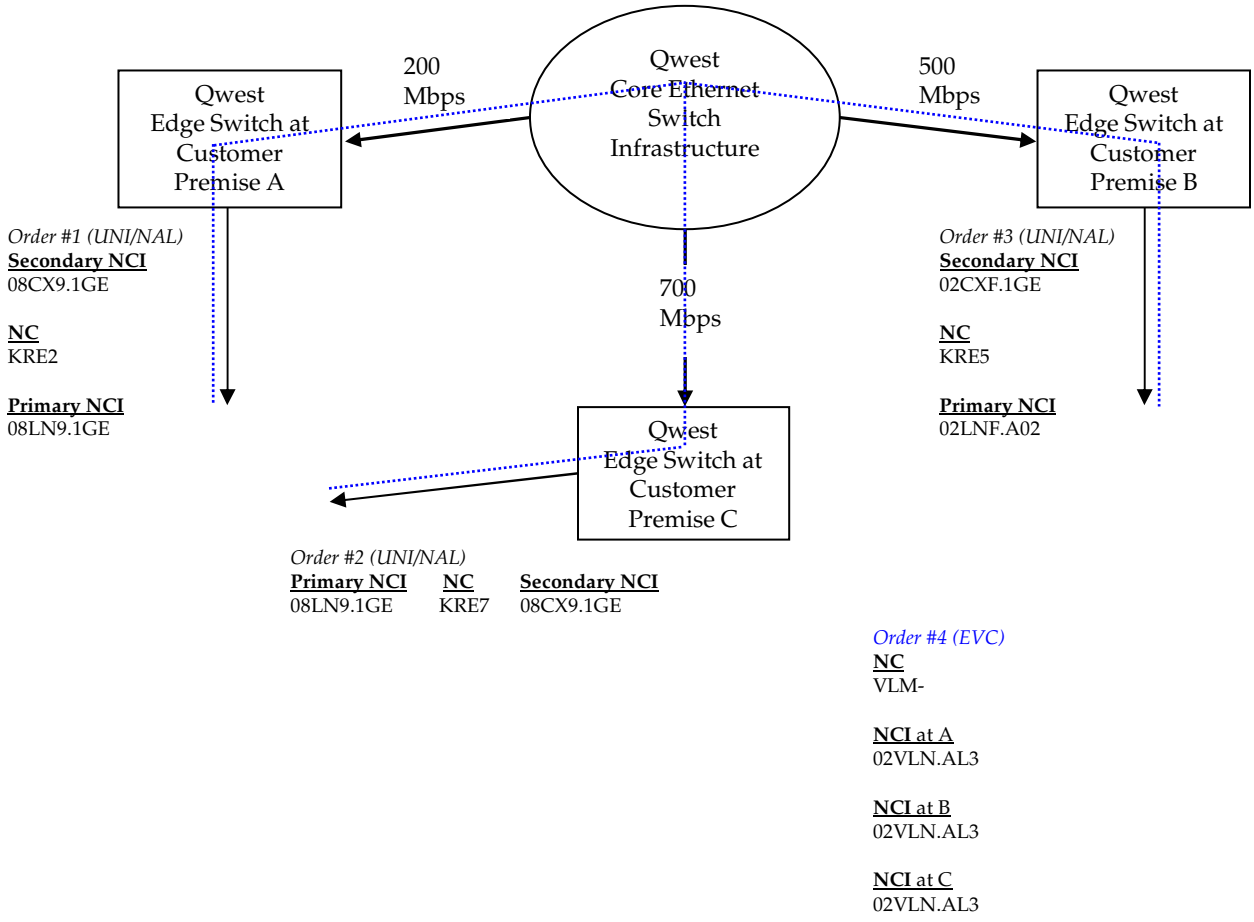
Access Port Type	EVC NC Code	EVC NCI Code	Comments
Non-TLS	VLP- or VLM-	02VLN.UNT	- Other UNI and EVC service attributes (see Section 2.~~12~~15) captured on EVC Form
		02VLN.UL3*	- Plus QoS per IP Precedence bits in the ToS field (see Section 2.~~13~~16)
TLS	VLP- or VLM-	02VLN.A2	- Other UNI and EVC service attributes (see Section 2.~~12~~15) 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~~16)
		02VLN.A2P*	- Plus QoS per 802.1Q P-bits (see Section 2.~~13~~16)
TLS Plus	VLP-	02VLN.A2	- Other UNI and EVC service attributes (see Section 2.~~12~~15) 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~~16)
		02VLN.A2P*	- Plus QoS per 802.1Q P-bits (see Section 2.~~13~~16)

* **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~~16.3, QoS Traffic Classification for further information.

3.6.8 Qwest MOE NC/NCI Code Example

Figure 3-3 shows a Qwest MOE NC/NCI Code example for a 3 point customer premises MOE Transparent LAN Service (TLS ports) with Quality of Service (QoS) per IP Precedence bits in the ToS field. See Section 2.~~12~~15, UNI and EVC Service Attributes for MOE Customer Access Ports and Section 2.~~13~~16, Quality of Service for further information.

Figure 3-3 Qwest MOE NC/NCI Code Service Order Example



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Tables

4. Performance Specifications

4.1 General

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

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

These performance objectives apply to all Qwest MOE 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 MOE network will randomly discard packets when congestion occurs. All ~~shaping and~~ policing algorithms as well as counters for gathering billing and measurement statistics are built into the MOE 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 Bandwidth Profiles will be the sole responsibility of the customer. ~~It is recommended that~~ When ordering MOE 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; otherwise MOE policers will enforce the rate~~.~~ and ~~This~~ may result in:

- ~~reduced~~ Reduced customer throughput with applications using protocols with acknowledgement functions such as TCP, which may throttle back due to traffic exceeding the MOE 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 MOE 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 MOE Network Interfaces the Qwest 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 electrical interface the customer ordered as well as the particular edge device deployed by Qwest to deliver the service.

Qwest MOE 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 Physical Layer transport (if applicable) bandwidth must be available in the Qwest MOE 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 Metro Optical Ethernet network at the User-Network Interface via Customer Provided Equipment (CPE). Availability specifies the percentage of time the customer's MOE 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 MOE 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 entrance facility standards. For additional information see Qwest Technical Publication 77344, *Diversity and Avoidance.*
2. Service availability includes all components of the Qwest MOE network 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 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 MOE service availability objective assumes two hours every six months for the network maintenance window.

4.4 Throughput

The Qwest MOE Bandwidth Profile is a limit on the rate at which Ethernet frames can traverse the User-Network Interface (UNI). Qwest MOE service offers a better than best effort bandwidth or throughput for each customer Network Access Link (NAL). Specifically, the Qwest MOE Committed Information Rate (CIR) is the minimum bandwidth or throughput that the Qwest MOE network will deliver ~~for at least 256 byte frames~~ in both ingress and egress directions ~~under normal operating conditions. For smaller frame sizes customer packets may be dropped~~.

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 2.4, Customer Access Ports and Bandwidth Profiles. CIR rates will be met by adequate rate-limiting of the Qwest MOE 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 MOE service with store-and-forward devices; and as based on Technical Specification MEF 10.1, *Ethernet Services Attributes - Phase 2*, November 2006, 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 MOE network will be as indicated in Table 4-2.

Table 4-2 Qwest MOE 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 MOE 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 MOE 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 for further information)
- Corrupted frames with Cyclic Redundancy Check (CRC), Frame Check Sequence (FCS) or alignment errors
- Broadcast frames dropped by Qwest MOE traffic controls (see Section 2.12)
- Non-transparent customer Layer 2 Control Protocol service frames (see Section 2.14)

Packet loss is defined as the percentage of packets that are dropped within, or between switches that are a part of, the MOE 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 will engineer the Metro Optical Ethernet network 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 core network

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

Thus, over any calendar month the Qwest MOE 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 MOE network. Qwest 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 MOE 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 MOE service restoration capabilities.

4.8.1 SONET

Automatic protection switching improves the availability and reliability performance of Qwest MOE 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 MOE 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 ~~(PVST)~~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 ~~the~~ this implementation ~~of PVST~~, a failure within a single customer VLAN will be confined to that VLAN only.

4.8.3 Link Aggregation

If a Qwest MOE link within an ~~Cisco EtherChannel or~~ IEEE 802.3-2005 (~~802.3ad~~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 Responsibilities

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

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

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

- 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 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 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 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

CPE Customer Provided Equipment

CSMA/CD Carrier Sense Multiple Access with Collision Detection

dBm Decibel reference to one milliwatt

DIA Dedicated Internet Access

DTE Data Terminal Equipment

DWDM Dense Wavelength Division Multiplexing

E-LAN Ethernet~~®~~ LAN

E-Line Ethernet Line

EoS Ethernet-over-SONET

EVC Ethernet Virtual Connection

FDP Fiber Distribution Panel

GBIC Gigabit Interface Converter

Gbps Gigabit per Second

IC Interexchange Carrier

ICB Individual Case Basis

ID Identifier

IEEE® Institute for 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 Telecommunications Union - Telecommunications Standardization Sector

L2 Layer 2

L3 Layer 3

LACP Link Aggregation Control Protocol

LAN Local Area Network

LATA Local Access and Transport Area

MAC Media Access Control

MAN Metropolitan Area Network

Mbps Megabit per Second

MMF Multi-Mode Fiber

MOE Metro Optical Ethernet

MTU Maximum Transmission Unit

NAL Network Access Link

NC Network Channel

NCI Network Channel Interface

NI Network Interface

nm Nanometer

OADM Optical Add-Drop Multiplexer

OWD One-Way Delay

POP Point of Presence

~~PVST Per-VLAN Spanning Tree~~

QoS Quality of Service

SDC System Design Center

SFP Small Form-factor Pluggable

SLS Service Level Specification

SMF Single-Mode Fiber

SONET Synchronous Optical Network

SPE Synchronous Payload Envelope

STP Shielded Twisted-Pair

STS Synchronous Transport Signal

STS-24c Synchronous Transport Signal level 24, concatenated

SWC Serving Wire Center

TCP Transmission Control Protocol

TIA/EIA Telecommunications Industry Association/Electronic Industries Association

TLS Transparent LAN Service

UNI User-Network Interface

UPS Uninterruptable Power Supply

UTP Unshielded Twisted-Pair

VLAN Virtual Local Area Network

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.

American National Standards Institute (ANSI)

An organization supported by the telecommunications industry to establish performance and interface standards.

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

Bit (Binary Digit)

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

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 (Multipoint Service)

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 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

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 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~~®~~ 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 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).

dBm

A decibel in which the reference power is one milliwatt. Decibel reference to one milliwatt.

Diversity

Routing of customer circuits or access lines over physically separated facilities

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 802.3-2005 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.

Facilities

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

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 source to destination across the metro Ethernet network.

Frame Loss Ratio Performance

Frame loss ratio is a measure of the number of lost frames inside the metro Ethernet network. Frame loss ratio is expressed as a percentage.

Full Duplex

Simultaneous transmission in both directions between two points.

Gigabit Interface Converter (GBIC)

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

Gigabits per Second (Gbps)

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

Half Duplex

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

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 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.

International Telecommunications Union (ITU)

An international standards group formerly know as the Consultative Committee on International Telephone and Telegraph (CCITT).

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.

Layer 4

Transport Layer. Provides the transparent transfer of software between end systems. Handles end-to-end control, multiplexing, and mapping.

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.

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

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.

Multicast

When applied to the Qwest 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 MOE 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 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.)

Network Interface (NI)

The demarcation point at the customer's premise where Qwest's responsibility for the provisioning of service ends.

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.

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 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

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 Specification

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 MOE Service Points are geographic locations designated by the company where the MOE network can be accessed.

Service Provider

The organization providing Ethernet service(s)

Serving Wire Center (SWC)

The term "Serving Wire Center" denotes a Qwest 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 Network Access Link. MOE ports are the physical entry points in the MOE 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.

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

Unicast Service Frame

A service frame that has a unicast destination MAC address

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 (ANSI) Documents

ANSI/TIA/EIA-10-A-2002	*FOCIS (Fiber Optic Connector Intermateability Standard) 10, Type LC*
ANSI/TIA/EIA-568-B	*Commercial Building Telecommunications Cabling Standard*
ANSI/TIA/EIA TSB95	*Additional Transmission Performance Guidelines for 100 Ohm 4-Pair Category 5*
ANSI/TIA/EIA 526-7-1998	*Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant*
ANSI/INCITS ~~X3.~~230-1994	*Information Technology - Fibre Channel Physical and Signaling Interface (FC-PH)*
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*

7.2 International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) Publications

ISO/IEC 15802-3: 1998 [ANSI/IEEE Std 802.1D, 2004 Edition]	*Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Common specifications – Part 3: Media Access Control (MAC) Bridges*
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*
ISO/IEC 15802-1: 1995	*Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Common specifications – Part 1: Medium Access Control (MAC) service definition*

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	*Information technology – Generic cabling for customer premises*

7.3 Institute of Electrical and Electronics Engineers (IEEE) Documents

IEEE Std 802.3-2005	*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 Std 802.1Q-2003	*IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks*
IEEE Std 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*

7.4 International Telecommunications Union - Telecommunications Sector (ITU-T) Publications

ITU-T Recommendation I.430 (1995)	*Basic user-network interface – Layer 1 specification*

7.5 Metro Ethernet Forum (MEF) Documents

Metro Ethernet Services – A Technical Overview, v2.6, 2003

Bandwidth Profiles for Ethernet Services, v1.2, 2004

MEF 6.1	*Ethernet Services Definitions - Phase 2*, April 2008
MEF 10.1	*Ethernet Services Attributes - Phase 2*, November 2006

7.6 Telcordia Documents

~~ISI~~ SR- ~~STS 000~~307	*COMMON LANGUAGE NC/NCI ~~Code~~ Dictionary*

7.7 Qwest Technical Publications

PUB 77344	*DIVERSITY AND AVOIDANCE*, Issue B, September 2001
PUB 77368	*CUSTOMER PREMISES ENVIRONMENTAL SPECIFICATIONS AND INSTALLATION GUIDE*, Issue E, March 2006
PUB 77386	*Interconnection and Collocation for Transport and Switched Unbundled Network Elements and Finished Services*, Issue ~~L~~M, ~~February~~ October 2007

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 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 publications 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 Technical Publications from:

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

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