Qwest Communications International Inc. Technical Publication

GeoMax

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NOTICE

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

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1. Introduction

1.1 General

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

1.2 Reason for Reissue

This publication is being reissued in order to add the following:

- OADM rings
- FICON™, SONET, Ethernet, FDDI, Fibre Channel and D1 Video interfaces

1.3 Scope

This document describes GeoMax service as offered by Qwest to its customers. It covers distinguishing interface features, technical specifications, and defines valid interfaces.

1.4 Organization of Document

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

Chapter 2 Service Description: Describes the features, functions and interface options of GeoMax service.

Chapter 3 Network Interfaces: Details the physical interfaces offered by this service. Also briefly addresses the form and function of Network Channel Codes and Network Channel Interface Codes as they pertain to this service. Presents the interface configurations available with this service.

Chapter 4 Performance Specifications: Furnishes expectations for service availability, throughput and protection switching.

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

Chapter 6 Customer Power Requirements: Identifies the unique power responsibilities of the customer for GeoMax.

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

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

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2. Service Description

2.1 General

GeoMax is a high capacity, multiprotocol, fiber optic data transport service that provides full duplex connectivity between multiple customer designated premises and/or Qwest Wire Centers. This service uses Optical Add-Drop Multiplexer (OADM)/Dense Wavelength Division Multiplexing (DWDM) equipment and dedicated fiber optic facilities to transport the following optical interfaces:

IBM™ Mainframe Protocols

- External Timing Reference (ETR)/Control Link Oscillator (CLO), or Sysplex Timer™ links – 16 Mbit/s signals for distributing the Time-Of-Day (TOD) information to all Central Processing Units (CPUs) in the sysplex and to keep the Sysplex Timer™ Units synchronized with each other
- Enterprise Systems Connection (ESCON™) channel – a 200 Mbit/s signal for sending user data and control information between:
  1. S/390™ CPUs
  2. A CPU and a Control Unit or Direct Access Storage Device (DASD)
  3. DASDs as a Peer-to-Peer Remote Copy (PPRC) ESCON™ channel
- InterSystem Channel (ISC), or Coupling Facility link – a 1.06 Gbit/s signal that provides data caching, locking, and queuing services between a Coupling Facility and a CPU
- Fiber Connection (FICON™) channel – a new 1.06 Gbit/s signal which provides for connectivity similar to ESCON™ while enabling full duplex data transfer and multiple concurrent Input/Output (I/O) operations on a single channel

See IBM™ publications, such as *S/390 I/O Connectivity Handbook*, SG24-5444 for further information. See Chapter 8 for ordering information.

SONET

- OC-3 at 155.52 Mbit/s
- OC-12 at 622.08 Mbit/s
- OC-48 at 2.488 Gbit/s

Concatenated SONET signals are fully supported.

Ethernet

- Fast Ethernet at 125 Mbit/s
- Gigabit Ethernet at 1.25 Gbit/s

Fiber Distributed Data Interface

- FDDI at 125 Mbit/s

Fibre Channel

- FC-12 at 133 Mbit/s
- FC-25 at 266 Mbit/s
- FC-50 at 531 Mbit/s
- FC-100 at 1.062 Gbit/s

Video

- D1 Video at 270 Mbit/s

These interfaces will be delivered from Qwest owned OADM/DWDM equipment, may be 2 or 4 fiber and will conform to the following standards for rate and format specifications:

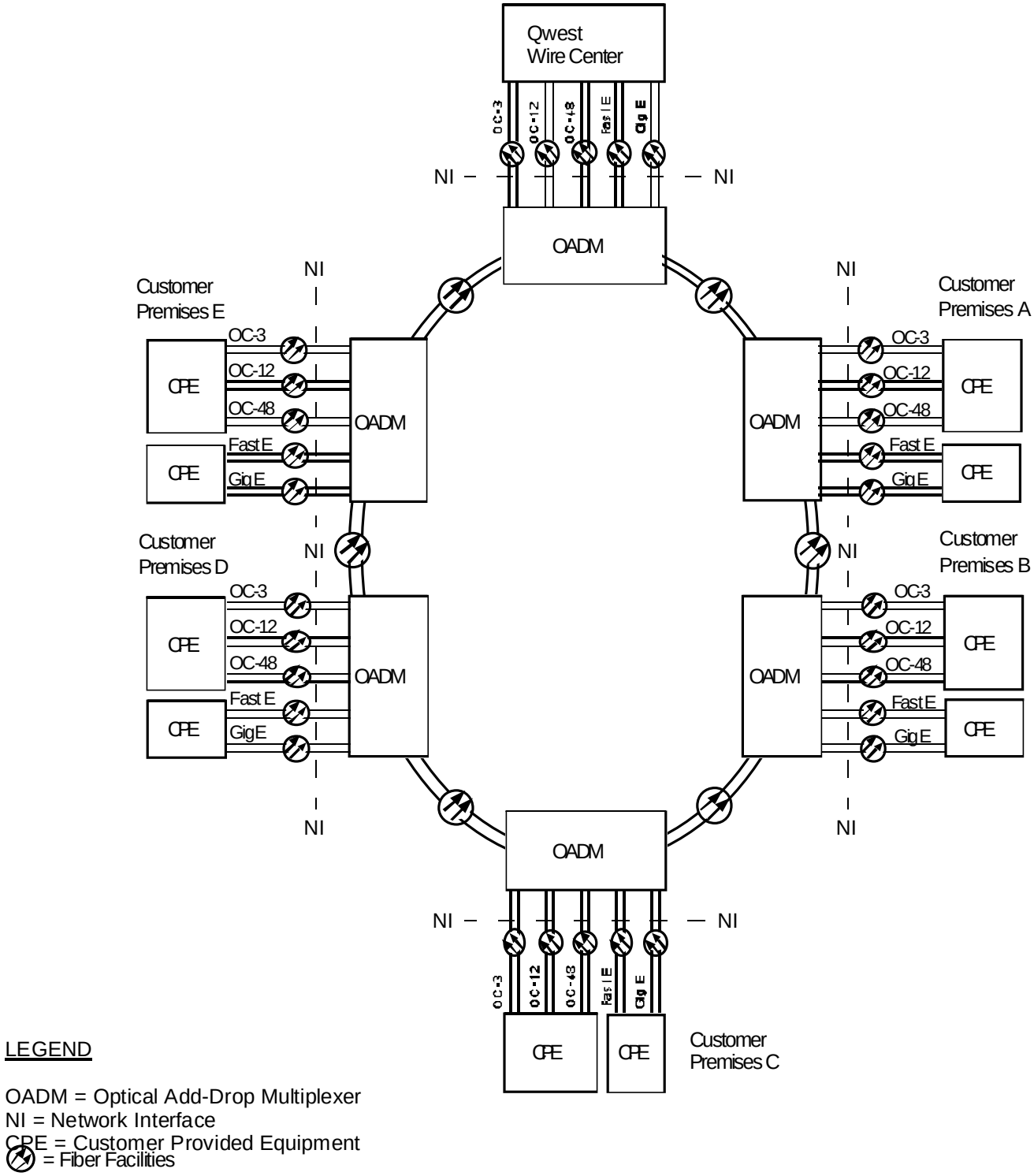
- IBM™ – ETR/CLO, ESCON™, ISC and FICON™
- American National Standards Institute (ANSI) – SONET, FDDI and Fibre Channel
- Institute of Electrical and Electronic Engineers (IEEE) – Ethernet
- Society of Motion Picture and Television Engineers (SMPTE) and Comite' Consultatif International des Radiocommunications (CCIR) – D1 Video

The GeoMax network connects two or more customer specified add-drop traffic locations, referred to as nodes, and may be configured in a closed ring (see Figure 2-1) or point-to-point (see Figure 2-2) architecture. Depending upon the design of the system, local loop and/or interoffice facilities may be used. A Qwest Wire Center node is not required.

The GeoMax design provides for native protocol connectivity and complete data security as the OADM/DWDM equipment does not view or process the data being transported. In addition, the network continually monitors signal quality such that service will be automatically rerouted around a point of failure using redundant equipment components and/or an alternate fiber path (optional).

GeoMax is a fully finished service with 24 X 7 monitoring provided by the !nterprise Prototype Network Operations Center (PNOC). GeoMax is managed by Qwest, with support from IBM™ (when IBM™ mainframe interfaces are involved).

Figure 2-1 GeoMax Network Example



2.2 Applications

GeoMax can provide Metropolitan Area Network (MAN) data transport solutions for applications such as:

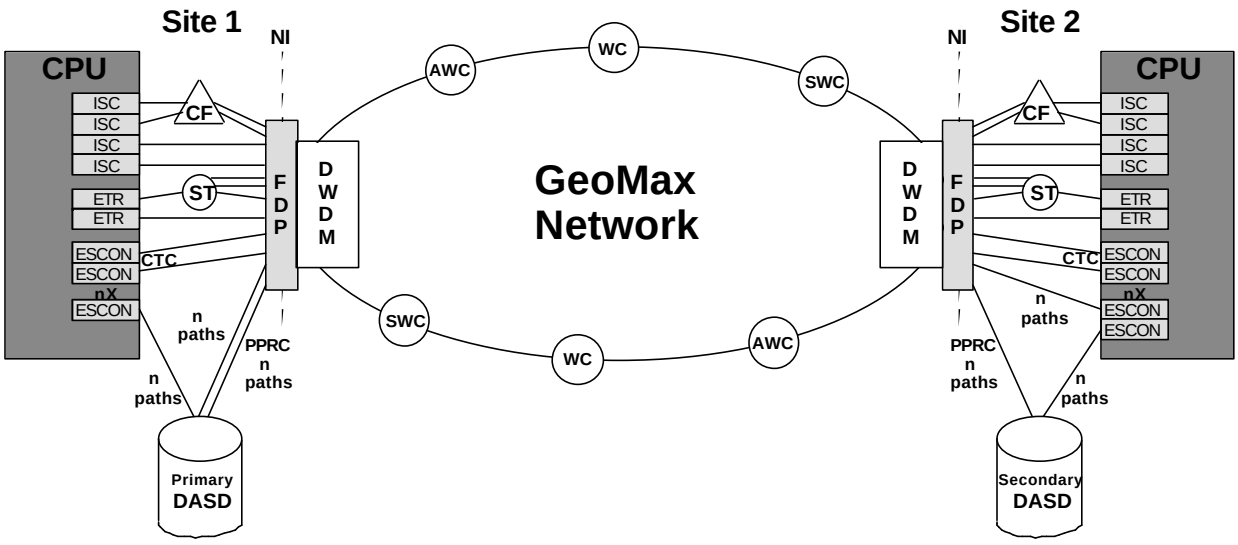
- High speed connectivity
- STS-3c, STS-12c and STS-48c broadband delivery
- LAN transmission
- Mainframe and peripheral linkages
- Video

IBM™ System 390™ applications include:

- Channel extension
- Direct Access Storage Device (DASD), or disk mirroring: Peer-to-Peer Remote Copy (PPRC)
- Tape archiving
- Geographically Dispersed Parallel Sysplex™ (GDPS)
- Data center backup and disaster recovery

GeoMax offers transport of ETR/CLO, ESCON™, ISC and FICON™ optical interfaces thus providing connections to any CPU or Input/Output (I/O) device that supports these protocols. This service enables the use of a GDPS for remote data backup for business continuity/disaster avoidance and real-time recovery. GeoMax supports FICON™ Bridge (FCV mode) and the future IBM™ implementation of native FICON™ Direct Attachment (FC mode). Figure 2-2 shows a possible GeoMax GDPS application. All equipment and connections on the side of the NI away from the GeoMax Network are the responsibility of the customer. GeoMax is an IBM™ supported solution for the transport of these mainframe protocols.

Figure 2-2 GDPS Application



Note: Each connection line represents a fiber pair.

LEGEND

AWC = Alternate Wire Center
CF = Coupling Facility
CPU = Central Processing Unit
CTC = Channel-to-Channel
DASD = Direct Access Storage Device
DWDM = Dense Wavelength Division Multiplex
ESCON™ = Enterprise Systems Connection
ETR = External Timing Reference
FDP = Fiber Distribution Panel
ISC = InterSystem Channel
NI = Network Interface
PPRC = Peer-to-Peer Remote Copy
ST = Sysplex Timer™
SWC = Serving Wire Center
WC = Wire Center

2.3 Distance Limitations

Currently, the maximum IBM™ supported end-to-end fiber route distance (including customer cables) is 40 km (24.8 mi.) for ETR/CLO links and 50 km (31.0 mi.) for ESCON™, ISC and FICON™ channels. ESCON™ and FICON™ channel distances may be further limited by specific characteristics of the Control Units and I/O devices. In a GDPS implementation the ETR/CLO links will limit the distance to 40 km maximum between the data centers. These distance limitations also apply to the protect fiber path for protected channels.

Optical Fiber Amplifiers (OFAs) are used as necessary to meet customer requirements. In general, designs with channel distances greater than 50 km or more than 9 nodes will require the use of OFAs in the GeoMax network. Regeneration also allows SONET, Ethernet, FDDI, Fibre Channel and D1 Video channel distances in excess of 100 km (62.1 mi.) by compensating for dispersion.

2.4 Protection

The GeoMax network ensures data survivability regardless of the protocol of the traffic being carried. Automatic Equipment and Path Protection Switching, coupled with protect path diversity provides end-to-end signal protection against equipment failures and fiber path cuts and improves the reliability of GeoMax service.

2.4.1 Equipment

In the GeoMax network, high availability of the equipment is accomplished by having backup equipment to which traffic is sent if an equipment failure occurs. Equipment switching protects OADM/DWDM equipment that is not protected by path switching and ensures that a failure in one circuit card does not cause a traffic outage in the network.

Equipment protection will be provided with a redundancy of components and 1:1 protection of service affecting plug-in units. A 1:1 protection scheme is an architecture in which a working unit can be bridged to a dedicated protect unit.

2.4.2 Fiber Path

GeoMax provides options for fiber path protection on a per customer channel interface basis as listed in Table 2-1.

Path switching protects the signal carried between the customer channel interface cards on the GeoMax network. This redundant path protection is provided on a 1+1, non-revertive basis. The 1+1 protection is defined as: An architecture in which the head-end signal is permanently bridged to the working and protection channels (dedicated equipment and fiber facilities) to enable the same payload to be redundantly transmitted to the tail-end. At the tail or receive end, the working and protect optical signals are monitored independently and identically for failures. The receiving equipment selects either the working or the protect signal as the one that carries the traffic, based on the quality of the two signals received. When a protection switch is initiated, it's performed only on the affected direction of traffic (i.e., unidirectional switching) and is non-revertive, or does not switch back to the original traffic carrying channel after the failure has been repaired.

GeoMax fiber path switching is not an option for ETR links as unidirectional path switching can cause the Sysplex Timer™ to incorrectly compensate for fiber propagation delay resulting in out of sync conditions with subsequent data integrity concerns. Furthermore, a multi-site Parallel Sysplex™ or Geographically Dispersed Parallel Sysplex™ (GDPS) could be forced into a split sysplex condition after a GeoMax path switch requiring customer intervention to resolve. Fault tolerance against single points of failure is best achieved by configuring multiple ETR and CLO links over physically separate fiber paths through the GeoMax network (using multiple non-protected channels in Table 2-1). See Sysplex Timer™ planning materials, such as *IBM Redbook OS/390 MVS Parallel Sysplex Configuration*, SG24-2076 or the *9037 Model 2 Sysplex Timer Planning Guide*, SA22-7233 for further information. See Chapter 8 for ordering information.

Protect path diversity is provided with GeoMax service. Protect path diversity provides for routing the alternate or protect fiber path between nodes over local loop and interoffice facilities physically separated from the working path by a minimum of 25 feet, from the first terminal/utility vault outside the customer premises/Qwest Wire Center to the last terminal/utility vault before the customer premises/Qwest Wire Center. The protect path is normally routed through Qwest designated Alternate Wire Centers (AWCs).

If special construction charges are required to build an alternate facility route, Qwest will present the customer with the option of having GeoMax service without diversity.

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.

2.5 Protection Options

Table 2-1 lists the channel protection options available with Qwest GeoMax service:

Table 2-1: GeoMax Protection Options

Channel Option	Description	NI[1]	Protection[2]		Single Point of Failure	Supported Protocols
			Equipment	Fiber Path		
Non-protected						
Option 1	Minimum protection	2F	√		Yes in some equipment cards, and there is no redundant fiber path	All
Option 2	This option accepts two sources, or channel paths for the same signal from the customer. The two signals are then sent over separate fiber routes.[3] This option can be seen as "non-protected" from the individual signal, or channel path basis. End-to-end protection is provided by the Customer Provided Equipment (CPE)/protocol[4].	4F	√	√[5]	No, if a failure occurs on the working path within the GeoMax network, the CPE will use the protect path	All
Protected	This option accepts only a single source, or channel path from the customer but duplicates the signal and sends it over separate fiber routes.	2F	√	√	Only at the customer Optical Channel Interface card level	All except ETR[6]

Notes:

1. Network Interface: 2 or 4 fiber.
2. As defined in Section 2.4.
3. Wherever possible, these signals are also routed via different OADM/DWDM equipment shelves.
4. For example, by S/390™ multiple channel path support in the OS/390™ channel path group, or SONET Automatic Protection Switching.
5. Path protection for this option is limited to protect path diversity.
6. Sysplex Timer™ or ETR link connections are supported as non-protected only.
7. Protected channels are recommended for device subsystems where high performance, throughput and availability are critical.

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3. Network Interfaces

3.1 Applicability of Technical Specifications

Technical specifications presented in this document are applicable to Qwest GeoMax service only. This document does not attempt to describe the equipment used to provide this interface.

3.2 Available Interfaces

GeoMax will be provisioned on Optical Add-Drop Multiplexer (OADM)/Dense Wavelength Division Multiplexing (DWDM) based fiber optic systems. This technology allows Qwest to transport and deliver the optical interfaces shown in Table 3-1. Details of the IBM™ data service protocols – ETR/CLO, ESCON™, ISC and FICON™ can be found on IBM's Redbook web site at http://www.redbooks.ibm.com.

Table 3-1 lists the available interfaces on Qwest GeoMax service. These interfaces may be 2 or 4 fiber and will be delivered to the Network Interface (NI), which will be at a Qwest provided Fiber Distribution Panel. Interfaces shall be equipped to terminate the types of connectors as listed in Table 3-1.

Table 3-1 Available Interfaces

Channel Type	Fiber	Connector	Bit Rate
ETR/CLO (Sysplex Timer™)	Multimode	ESCON™ duplex	16 Mbit/s
ESCON™	Singlemode	SC duplex	200 Mbit/s
	Multimode	ESCON™ duplex	
ISC (Coupling Link)	Singlemode	SC duplex	1.06 Gbit/s
FICON™	Singlemode	SC duplex	1.06 Gbit/s
OC-3	Singlemode	SC duplex	155.52 Mbit/s
OC-12	Singlemode	SC duplex	622.08 Mbit/s
OC-48	Singlemode	SC duplex	2.488 Gbit/s
Fast Ethernet	Singlemode	SC duplex	125 Mbit/s
	Multimode		
Gigabit Ethernet	Singlemode	SC duplex	1.25 Gbit/s
	Multimode		
FDDI	Singlemode	SC duplex	125 Mbit/s
	Multimode		
Fibre Channel	Multimode	SC duplex	133 Mbit/s
	Singlemode	SC duplex	266 Mbit/s
	Multimode		
	Singlemode	SC duplex	531 Mbit/s
	Singlemode	SC duplex	1.062 Gbit/s
D1 Video	Singlemode	SC duplex	270 Mbit/s

Notes:

1. SC = Subscriber Connector, a push-pull type of fiber optic connector with a square barrel that conforms to ANSI X3.230-1994: *Information Technology - Fibre Channel - Physical and Signaling Interface (FC-PH)*
2. ESCON™ duplex cable information can be found in the *IBM Input/Output Equipment Installation Manual-Physical Planning*, GC22-7064. See Chapter 8 for ordering information.
3. Bit rates listed may not correspond to effective channel data rate in a given application due to protocol overheads and other factors.
4. All interfaces will be delivered from Qwest owned OADM/DWDM equipment and have a central wavelength of 1310 nm.
5. Singlemode fiber is 9/125 micron.
6. Multimode fiber is either 62.5/125 or 50/125 micron.
7. GeoMax does not support the older ISC 850 nm multimode interface. Customers will need to upgrade to the 1310 nm singlemode interface.
8. The Open Fiber Control (OFC) safety feature of the ISC protocol is fully supported. Details of the timing and specifications for OFC are given in ANSI X3.230-1994.

3.3 Distance Limitations

Fiber optic patchcords or duplex jumper cables to connect the Customer Provided Equipment (CPE) to the GeoMax Fiber Distribution Panel must be provided by the customer. These cables should be at least 3 meters long to facilitate attachment within the OADM/DWDM equipment frame.

The maximum supported cable distance from the GeoMax Network Interface to the customer's equipment shall be as listed in Table 3-2. Transmit (Tx) and Receive (Rx) optical attenuators are used where required by Qwest to properly adjust Network Channel Interface signal power levels. It's assumed that in most cases the subtended equipment will be co-located with the GeoMax OADM/DWDM shelves at a customer site.

Each individual ETR and CLO 2 fiber interface link must have end-to-end Tx and Rx fiber paths whose lengths are within 10 meters (6.2 feet) maximum of each other for accurate processor Time-Of-Day (TOD) clock synchronization. Since this includes the GeoMax network, these customer fiber cables should be the same length.

Table 3-2 Maximum Distance from Network Interface

Channel Type	Fiber	Maximum Distance/dB Loss
ETR/CLO (Sysplex Timer™)	Multimode	500 meters (1,640 feet)/1.0 dB
ESCON™	Singlemode	500 meters (1,640 feet)/1.0 dB
	Multimode	
ISC (Coupling Link)	Singlemode	500 meters (1,640 feet)/1.0 dB
FICON™	Singlemode	500 meters (1,640 feet)/1.0 dB
OC-3	Singlemode	15 km (9.32 mi.)/11 dB
OC-12	Singlemode	15 km (9.32 mi.)/11 dB
OC-48	Singlemode	15 km (9.32 mi.)/14 dB
Fast Ethernet	Singlemode	15 km (9.32 mi.)/6 dB
	Multimode	550 meters (1,804 feet)/2 dB
Gigabit Ethernet	Singlemode	3 km (1.86 mi.)/6.5 dB
	Multimode	550 meters (1,804 feet)/8.5 dB
FDDI	Singlemode	15 km (9.32 mi.)/6 dB
	Multimode	550 meters (1,804 feet)/2 dB
Fibre Channel	Singlemode	3 km (1.86 mi.)/8.5 dB at 266 Mbit/s
		10 km (6.21 mi.)/10 dB at 531 Mbit/s
		10 km (6.21 mi.)/10 dB at 1.062 Gbit/s
	Multimode	550 meters (1,804 feet)/1 dB at 133 Mbit/s
		550 meters (1,804 feet)/2 dB at 266 Mbit/s
D1 Video	Singlemode	NA/5 dB

Notes:

1. Maximum distance is limited by fiber effects such as dispersion
2. Maximum link loss is at 1310 nm

3.4 Interface Power Levels

It’s the transmitting party's responsibility to achieve the minimum interface power. The optical power level at the Network Interface shall meet the minimum fixed power point levels listed in Table 3-3.

Table 3-3 Minimum Fixed Optical Power Point*

Interface	Rate	Minimum Fixed Power Point
Very Short Reach – Single Longitudinal Mode		
ESCON™	200 Mbit/s	-9.0 dBm
ISC	1.06 Gbit/s	-12 dBm
FICON™	1.06 Gbit/s	-9.0 dBm
Very Short Reach – Multi Longitudinal Mode		
ETR	16 Mbit/s	7.0 dBm
ESCON™	200 Mbit/s	- 21.5 dBm
Short Reach – Single Longitudinal Mode		
OC-3	155.52 Mbit/s	- 28 dBm
OC-12	622.08 Mbit/s	- 28 dBm
OC-48	2.488 Gbit/s	- 19 dBm
D1 Video	270 Mbit/s	- 28 dBm
Intermediate Reach – Single Longitudinal Mode		
OC-3	155.52 Mbit/s	- 28 dBm
OC-12	622.08 Mbit/s	- 28 dBm
OC-48	2.488 Gbit/s	- 19 dBm
Gigabit Ethernet	1.25 Gbit/s	- 20 dBm
Fibre Channel	266 Mbit/s	- 20 dBm
	1.062 Gbit/s	- 20 dBm
Intermediate Reach – Multi Longitudinal Mode		
Fast Ethernet	125 Mbit/s	- 20 dBm
Gigabit Ethernet	1.25 Gbit/s	- 20 dBm
FDDI	125 Mbit/s	- 20 dBm
Fibre Channel	133 Mbit/s	- 20 dBm
	266 Mbit/s	- 20 dBm

Table 3-3 Minimum Fixed Optical Power Point* (Continued)

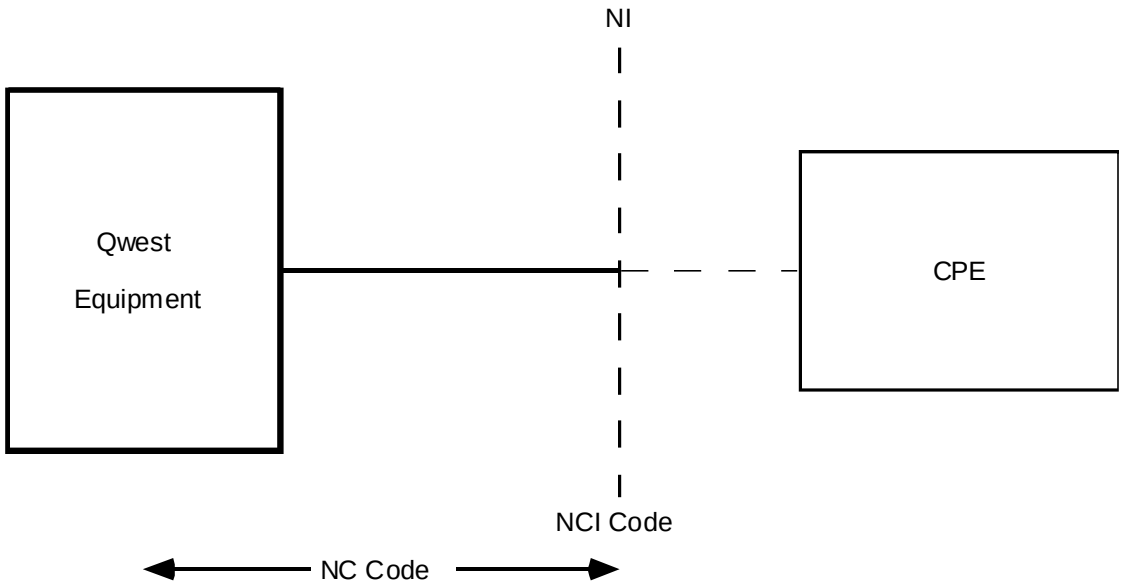
Interface	Rate	Minimum Fixed Power Point
Long Reach – Single Longitudinal Mode		
Fast Ethernet	125 Mbit/s	- 28 dBm
FDDI	125 Mbit/s	- 28 dBm
Fibre Channel	531 Mbit/s	- 28 dBm
	1.062 Gbit/s	- 19.5 dBm

***** Based on any valid 8-bit/10-bit code pattern

3.5 NC and NCI Codes

Network Channel (NC) and Network Channel Interface (NCI) Codes convey service and technical parameters. The following sections explain the codes in a general manner and also provide specific codes to aid in ordering the Qwest Network Interface (NI) for GeoMax service. The NC and NCI Codes are provided by the customer to the Qwest Service Representative at the time a request for service is initiated. Figure 3-1 shows where the codes apply.

Figure 3-1 NC and NCI Codes



LEGEND

CPE = Customer Provided Equipment
NC = Network Channel
NCI = Network Channel Interface
NI = Network Interface

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 North American Telecommunications System.* See Chapter 8 for ordering information.

In some instances Qwest 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 NCIs evolve. Therefore, it's important to request Qwest GeoMax service as defined in this Publication.

3.6 NC Code Function and Format

Primarily, service considerations are encoded into Network Channel (NC) Codes. Included in this code set are customer options associated with the individual channel services. The NC Code is specified by the customer to advise Qwest of the required service connection of the channel.

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

- The first two characters are the Channel Code which describes the channel service in an abbreviated form.
- The last two characters are the Optional Feature Code which represents the option codes available for each Channel Code. Varying combinations of this code allow for further identification of the type of service.

The customer must specify NC Codes for the desired service when ordering GeoMax.

3.7 GeoMax Network Channel Codes

Table 3-4 lists the Network Channel (NC) Codes available with Qwest GeoMax service.

Table 3-4 GeoMax NC Codes

NC Code	Description
OPA-	Optical Data Transport, Point-to-Point, ETR
OPB-	Optical Data Transport, Point-to-Point, ESCON™
OPC-	Optical Data Transport, Point-to-Point, ISC
OPD-	Optical Data Transport, Point-to-Point, FICON™
OB--	OC-3 SONET Point-to-Point
OD--	OC-12 SONET Point-to-Point
OF--	OC-48 SONET Point-to-Point
HM--	Data Link Connectivity – Fast Ethernet
	Data Link Connectivity – Gigabit Ethernet
OPE-	Optical Data Transport, Point-to-Point, FDDI
OPF-	Optical Data Transport, Point-to-Point, Fibre Channel
OPG-	Optical Data Transport, Point-to-Point, D1 Video

Notes:

1. ETR = External Timing Reference,
   also supports Control Link Oscillator (CLO) links
2. ESCON™ = Enterprise Systems Connection
3. ISC = InterSystem Channel
4. FICON™ = Fiber Connection
5. FDDI = Fiber Distributed Data Interface
6. Channel protection options listed in Table 2-1 are not differentiated by NC Codes and must be specified for each channel ordered at the time the request for service is initiated.
7. Each GeoMax NC Code requires a valid NCI Code from Table 3-5 at both ends of the channel, or service.

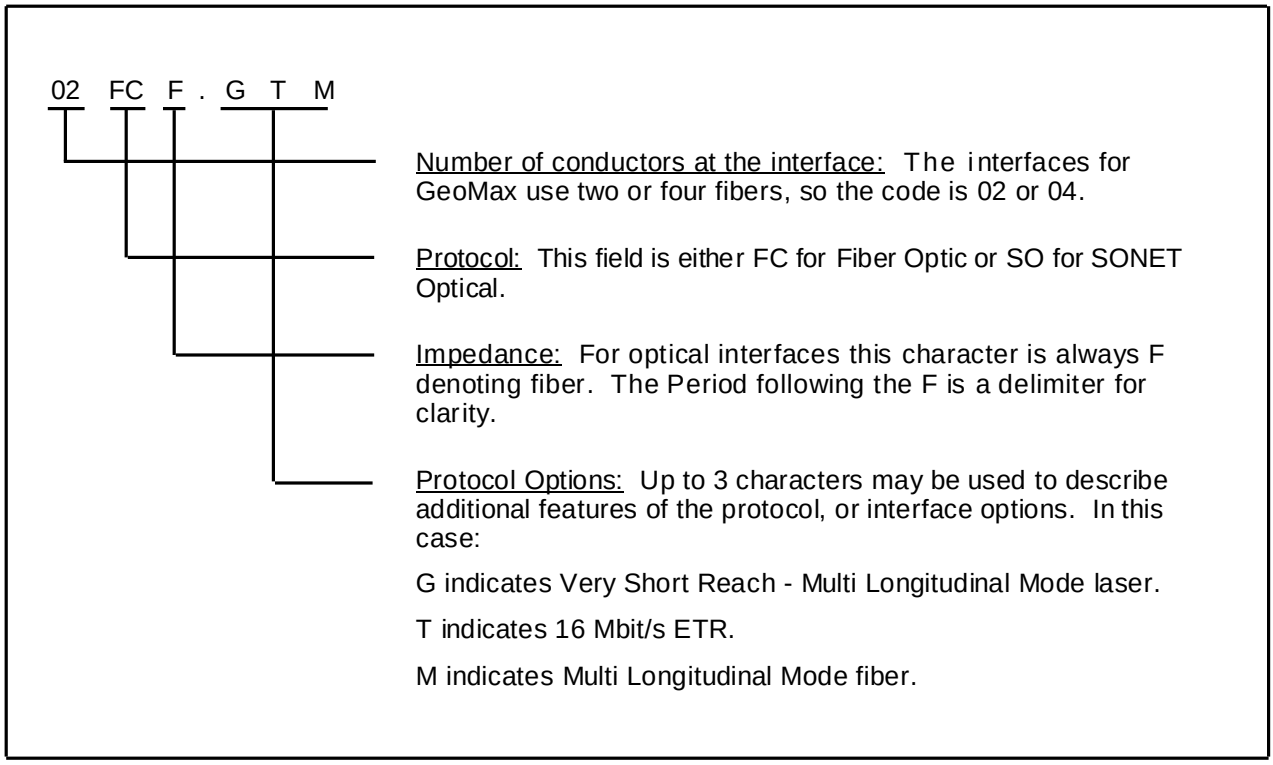
3.8 NCI Code Form and Components

The Network Channel Interface (NCI) Code provides the means to define the Network Interface physical and optical characteristics for the service order, design and circuit provisioning processes. The full NCI Code format has fields not used for optical services. Only those fields relevant to GeoMax interfaces are discussed here.

An NCI Code has the form 02FCF.GTM. The period between the characters is a delimiter, which is used for improved clarity. It causes the subsequent Protocol Option Codes to stand out. An NCI Code has no dashes (-).

Figure 3-2 illustrates the components of the GeoMax Network Channel Interface Codes.

Figure 3-2 GeoMax NCI Code Example



3.9 GeoMax Network Channel Interface Codes

Table 3-5 lists the optical NCI Codes available with Qwest GeoMax service.

Table 3-5: GeoMax NCI Codes

NCI Code	Nominal Bit Rate	Central Wavelength	Reach	Laser Type	Fiber Type	Interface (DC Balanced)
02FCF.GTM	16 Mbit/s	1310 nm	Very Short	MLM	MLM	ETR-NRZ
04FCF.GTM						
02FCF.GCS	200 Mbit/s	1310 nm	Very Short	SLM	SLM	ESCON™-NRZ
04FCF.GCS						
02FCF.GCM	200 Mbit/s	1310 nm	Very Short	MLM	MLM	ESCON™-NRZ
04FCF.GCM						
02FCF.GIS	1.06 Gbit/s	1310 nm	Very Short	SLM	SLM	ISC-NRZ
04FCF.GIS						
02FCF.GFS	1.06 Gbit/s	1310 nm	Very Short	MLM	SLM	FICON™-NRZ
04FCF.GFS						
02SOF.F	155.52 Mbit/s	1310 nm	Short	SLM	SLM	OC-3-NRZ
04SOF.F						
02SOF.D	155.52 Mbit/s	1310 nm	Intermediate	SLM	SLM	OC-3-NRZ
04SOF.D						
02SOF.F	622.08 Mbit/s	1310 nm	Short	SLM	SLM	OC-12-NRZ
04SOF.F						
02SOF.D	622.08 Mbit/s	1310 nm	Intermediate	SLM	SLM	OC-12-NRZ
04SOF.D						
02SOF.F	2.488 Gbit/s	1310 nm	Short	SLM	SLM	OC-48-NRZ
04SOF.F						
02SOF.D	2.488 Gbit/s	1310 nm	Intermediate	SLM	SLM	OC-48-NRZ
04SOF.D						
02FCF.10C	125 Mbit/s	1310 nm	Long	SLM	SLM	Fast E-NRZ
04FCF.10C						
02FCF.10D	125 Mbit/s	1310 nm	Intermediate	MLM	MLM	Fast E-NRZ
04FCF.10D						
02FCF.1GA	1.25 Gbit/s	1310 nm	Intermediate	MLM	SLM	Gig E-NRZ
04FCF.1GA						
02FCF.1GB	1.25 Gbit/s	1310 nm	Intermediate	MLM	MLM	Gig E-NRZ
04FCF.1GB						

Table 3-5 GeoMax NCI Codes (Continued)

NCI Code	Nominal Bit Rate	Central Wavelength	Reach	Laser Type	Fiber Type	Interface (DC Balanced)
02FCF.12S	125 Mbit/s	1310 nm	Long	SLM	SLM	FDDI-NRZ
04FCF.12S						
02FCF.12M	125 Mbit/s	1310 nm	Intermediate	MLM	MLM	FDDI-NRZ
04FCF.12M						
02FCF.F1M	133 Mbit/s	1310 nm	Intermediate	MLM	MLM	Fibre Channel-NRZ
04FCF.F1M						
02FCF.F2S	266 Mbit/s	1310 nm	Intermediate	MLM	SLM	Fibre Channel-NRZ
04FCF.F2S						
02FCF.F2N	266 Mbit/s	1310 nm	Intermediate	MLM	MLM	Fibre Channel-NRZ
04FCF.F2N						
02FCF.F5A	531 Mbit/s	1310 nm	Long	SLM	SLM	Fibre Channel-NRZ
04FCF.F5A						
02FCF.FGS	1.062 Gbit/s	1310 nm	Intermediate	MLM	SLM	Fibre Channel-NRZ
04FCF.FGS						
02FCF.FGA	1.062 Gbit/s	1310 nm	Long	SLM	SLM	Fibre Channel-NRZ
04FCF.FGA						
02FCF.27V	270 Mbit/s	1310 nm	Short	SLM	SLM	D1 Video-NRZ
04FCF.27V						

Notes:

1. ETR, ESCON™, ISC and FICON™ interfaces present a symmetric, fiber optic signal at a nominal rate using an IBM™ open, optical interface. Full details of these IBM™ protocols and physical requirements are available from IBM™ in their Redbook series. IBM's Redbook web site is at http://www.redbooks.ibm.com/.
2. SONET Optical Carrier rates are specified by the corresponding NC Code from Table 3-4.
3. See Protection Options in Section 2.5 for a further description of the 02 and 04 Fiber Network Channel Interface possibilities.
4. Very Short Reach = the distance specification for optical systems that operate effectively up to 500 meters (1,640 feet)
5. Short Reach = the distance specification for optical systems that operate effectively up to 3 km (1.86 mi.)
6. Intermediate Reach = the distance specification for optical systems that operate effectively from 3 to 20 km (1.86 to 12.4 mi.)
7. Long Reach = the distance specification for optical systems that operate effectively from 20 to 100 km (12.4 to 62.1 mi.)
8. MLM = Multi Longitudinal Mode
9. SLM = Single Longitudinal Mode

Table 3-5 Notes (Continued):

10. A DC balanced signals intent is the elimination of long strings of ones and zeros resulting in an equal number of each. It improves clock recovery effectiveness.
11. ETR = External Timing Reference, also supports Control Link Oscillator (CLO) links
12. ESCON™ = Enterprise Systems Connection
13. ISC = InterSystem Channel
14. FICON™ = Fiber Connection
15. Fast E = Fast Ethernet
16. Gig E = Gigabit Ethernet
17. FDDI = Fiber Distributed Data Interface
18. NRZ = Non-Return-to-Zero

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Tables

4. Performance Specifications

4.1 General

The GeoMax network does not cause any performance impact itself. It's completely transparent to the subsystems that are using it, acting as a single fiber optic channel.

Objectives given in this section are for all one-way system options, designed consistent with standard Optical Transport Network architectures.

These performance objectives apply in a normal operating environment and only for the GeoMax provided portion of a service. For services where GeoMax provides only a segment of the entire path, performance of the service is dictated by the segment with the lowest objectives.

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

4.2 Service Availability

The service is available when it's in a state where it's fully useable. A service is assumed to be in the available state unless a transition to the unavailable state is observed without a subsequent transition to the available state.

Transitions between the available and unavailable states are:

- Transition to the Unavailable state occurs at the beginning of 10 consecutive signal degradation or Loss Of Signal (LOS) seconds.
- Transition to the Available state occurs at the beginning of 10 consecutive seconds none of which consists of a signal degradation or a LOS condition.

Signal degradation and LOS conditions will be as determined by the !nterprise Prototype Network Operations Center (PNOC) monitoring of the GeoMax network, including the evaluation of all alarms, Threshold Crossing Alerts (TCAs), and events generated and logged by the Qwest OADM/DWDM equipment.

Each direction of the service is assumed to be in the available state unless a transition to the unavailable state is observed without a subsequent transition to the available state.

Availability objectives are stated in terms of the channel protection option ordered as shown in Table 4-1. GeoMax protection configurations and channel protection options are detailed in Chapter 2.

Table 4-1 Availability Objectives*

All channels/ bit rates	% Service Availability (Annual)
Non-protected	99.9
Protected	99.999

* Excludes planned outages/maintenance windows, malfunction of Customer Provided Equipment and power at the customer premises. See Chapter 6 for customer power requirements.

4.3 Bit Error Ratio (BER)

BER is defined as the ratio of the number of bit errors to the total number of bits transmitted in a given time interval.

The BER for GeoMax will be 10^{-12} or better for all channels on the service.

4.4 Throughput

Throughput is defined as the total capability of equipment to process or transmit data during a specified time period. The GeoMax network and each network component are designed and sized to deliver the full throughput that the native protocol can achieve. However, performance may be affected by the inherent delay caused by signals traveling over long distances , which is a characteristic of the protocol architecture, rather than a GeoMax side effect.

4.5 Delay (Latency)

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. The end-to-end one-way propagation delay across the GeoMax network, measured from Network Interface to Network Interface will be no more than 380 microseconds for channels with a fiber path length of up to 50 km and no more than 760 microseconds for channels with a fiber path length of up to 100 km. These distances also apply to the protect fiber path for protected channels.

4.6 Reflectance

Reflectance is defined as the ratio in decibels (dB) of reflected power to incident power. If not controlled, reflections can degrade system performance. In general, reflection-induced degradation increases with system bit-rate, optical source coherence, and fiber dispersion. By enforcing reflectance requirements on individual components placed in the fiber optic transmission span, and by requiring system performance to have a tolerance to specified reflectance values from these components, the effects of fiber optic system reflection noise can be minimized.

Individual channel reflectance objectives are stated in terms of the two parameters listed in Table 4-2. Optical Return Loss (ORL) is defined as the ratio of the optical power arriving downstream at a system interface to the optical power reflected back upstream to the same interface. Receiver reflectance criteria is enforced in order to prevent multi-path interference between two or more reflections.

Table 4-2 Reflectance Objectives

Parameter	All channels
ORL (minimum)*	24 dB
Receiver Reflectance (maximum)	–27 dB

* Includes patchcords, attenuators, connectors, splices, fiber, Fiber Distribution Panels and OADM/DWDM equipment components

4.7 Jitter Performance

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

Optical interface jitter performance will follow the standards as stated in GR-499-CORE, *Transport Systems Generic Requirements (TSGR): Common Requirements*.

4.8 Protection Switching

Automatic Protection Switching improves the availability and reliability performance of Qwest GeoMax service by substituting backup equipment or an alternate fiber path (optional) when failure occurs.

The protection switch function will operate and switch the signal to the protection system when a Loss Of Signal (LOS) or circuit card failure is detected on the working channel.

Once a decision is made to switch to the protection system, the additional time required to complete the switch will not exceed 50 milliseconds.

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5. Maintenance

5.1 Qwest Responsibilities

Qwest is responsible for all equipment and cable on their side of the Network Interface at the customer locations and for maintaining the transmission facility between customer locations**.**

Qwest will notify the customer within 20 minutes of a service affecting trouble alarm received via the Qwest !nterprise Prototype Network Operations Center (PNOC).

Qwest will also furnish the customer a trouble reporting telephone number. The Customer Service Center will be available 24 hours a day, 7 days a week.

Upon receipt of a trouble alarm or customer report, Qwest will initiate action within 20 minutes to clear the trouble and will commit to a 2 1/2 hour maximum service restorable time in the event of a service interruption due to an electronic component failure. If the trouble is caused by a cable failure, the maximum service restorable time will be 8 hours.

The !nterprise PNOC will update the customer as needed during the repair phase of trouble isolation and upon resolution.

5.2 Customer Responsibilities

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

The customer is responsible for power feeds at their locations.

The customer or their agent must sectionalize the trouble and verify that the trouble is not in the customer owned equipment or cable before calling the Qwest Customer Service Center.

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

Joint testing between the customer locations may sometimes be necessary to isolate the trouble.

Model numbers and technical specifications of the Customer Provided Equipment (CPE) attached to the GeoMax network may be helpful in resolving the problem.

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6. Customer Power Requirements

The following is intended to supplement Qwest Technical Publication 77368: *CUSTOMER PREMISES ENVIRONMENTAL SPECIFICATIONS AND INSTALLATION GUIDE,* Issue A, March 1998.

6.1 Essential AC

The GeoMax OADM/DWDM equipment requires a minimum of two customer power feeds per equipment frame. Each frame is equipped with fully redundant power supplies to allow the GeoMax equipment to survive the loss of customer power from either source. The power load is shared equally between the feeds under normal operating conditions. If power is interrupted to one of the power feeds, the other source will pick up the entire load and the service will continue to operate. To take full advantage of the redundancy/reliability that is built into the GeoMax equipment, it's recommended that the customer provide power from two separate distribution panels.

This AC power should be backed up by a standby power source such as an engine-alternator or Uninterruptible Power Supply (UPS) that is fully capable of supporting
Qwest electronic equipment located on the customer premises for up to 8 hours during the event of a commercial AC power failure.

GeoMax equipment frame power requirements are listed in Table 6-1.

Table 6-1 Essential AC Power Requirements[1]

Description	Plug	Receptacle	Connector
Two redundant feeds: 208 – 240 VAC nominal 20 Amp 50/60 Hz single phase	Hubbel 320 P6W	Hubbel 320 R6W	Hubbel 320 C6W

Notes:

1. Per frame, or 2 shelves. The number of frames required at each customer location is dependent upon the number of channels and protection options ordered.
2. The power plug must be connected to a properly wired and grounded receptacle or connector wiring. The customer is responsible for receptacle or connector wiring.
3. The GeoMax equipment will accept any International Electrotechnical Commission (IEC) 309 compatible receptacle and connector.
4. The customer should provide the outlets under a raised floor. The equipment power cords are 14 feet long.

6.2 Circuit Breakers

The maximum permissible Circuit Breaker (CB) rating is 20 Amps.

It's recommended that a 20 Amp time-delayed CB be used for both power feeds. This doesn't imply "Motor Start Characteristics". Should a fault occur within the GeoMax equipment, the equipment CB, which has a very fast trip curve, will open. The customer CB, which can be anything slower than the equipment CB, such as a thermal trip circuit breaker, will not open. This will improve problem determination in the event of a malfunction.

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7. Definitions

7.1 Acronyms

AC	Alternating Current
ANSI	American National Standards Institute
AWC	Alternate Wire Center
BER	Bit Error Ratio
CB	Circuit Breaker
CLO	Control Link Oscillator
CPE	Customer Provided Equipment
CPU	Central Processing Unit
DASD	Direct Access Storage Device
dB	Decibel
dBm	Decibel reference to one milliwatt
DC	Direct Current
DWDM	Dense Wave Division Multiplexing
ESCON	Enterprise Systems Connection
ETR	External Timing Reference
FDDI	Fiber Distributed Data Interface
Gbit/s	Gigabits per second
GDPS	Geographically Dispersed Parallel Sysplex
Hz	Hertz
I/O	Input/Output
IBM	International Business Machines
IEEE	Institute of Electrical and Electronic Engineers
ISC	InterSystem Channel
km	Kilometer
LAN	Local Area Network
LOS	Loss Of Signal
Mbit/s	Megabits per second
MLM	Multi Longitudinal Mode
NC	Network Channel
NCI	Network Channel Interface

NI	Network Interface
nm	Nanometer
NRZ	Non-Return-to-Zero
OADM	Optical Add-Drop Multiplexer
ORL	Optical Return Loss
PNOC	Prototype Network Operations Center
PPRC	Peer-to-Peer Remote Copy
Rx	Receive
S/390	System 390
SC	Subscriber Connector
SLM	Single Longitudinal Mode
SONET	Synchronous Optical Network
TOD	Time-Of-Day
Tx	Transmit
VAC	Volts Alternating Current

7.2 Glossary

American National Standards Institute (ANSI)

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

Attenuator

A device inserted into the electrical or optical path to lessen or weaken the signal.

Channel

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

Connector

A mechanical device used to align and join two optical fibers. The connector provides a means for coupling and decoupling fiber to a transmitter, receiver, or another fiber.

Data Rate

The maximum number of bits of information that can be transmitted per second, as in a data transmission link.

Decibel (dB)

A unit measurement of transmission loss, gain, or relative level. It's the logarithmic unit of signal power ratio most commonly used in telephony. It's used to express the relationship between two signal powers, usually between two acoustical, electrical, or optical signals; it's equal to ten times the common logarithm of the ratio of the two signal powers.

Dispersion

The broadening of input pulses as they travel the length of an optical fiber. There are three major types of dispersion, as follows:

- Modal dispersion, which is caused by the many optical path lengths in a multimode fiber
- Chromatic dispersion, which is caused by the differential delay at various wavelengths in the optical fiber
- Waveguide dispersion, which is caused by light traveling through both the core and cladding materials in singlemode fibers

Duplex

Pertaining to communication in which data can be sent and received at the same time.

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.

Fiber

A thin filament of glass that consists of a core and a cladding that is capable of carrying information in the form of light.

Full Duplex

Simultaneous transmission in both directions between two points.

Input/Output (I/O)

I/O describes any operation, program, or device that transfers data to or from a computer.

Jumper

An optical fiber cable with connectors on both ends.

Link

The physical connection and transmission medium used between a transmitter and a receiver.

Local Loop

The facility which connects the Serving Wire Center to the customer's location.

Loopback

An out-of-service test procedure applied to a full duplex channel that causes a received signal to be returned to the source.

Loss Of Signal (LOS)

A physical layer alarm sent by the receiver to indicate a cessation in signal transmission. For example, LOS is declared if a fiber optic cable is cut and the receiving end no longer detects any signal transmissions.

Maximum Link Loss

The maximum amount of link attenuation (loss), expressed in decibels, that can exist without causing a possible failure condition.

Micron

One millionth of a meter. Commonly used to express the geometric dimensions of optical fiber.

Microsecond

One millionth of a second.

Millisecond

One thousandth of a second.

Mode

An independent light path through an optical fiber.

Multimode Fiber

A fiber optic medium in which light travels in multiple modes. Typical core/cladding sizes (measured in microns) include 62.5/125 and 50/125.

Nanometer (nm)

One billionth of a meter. A unit of measure commonly used to express the wavelengths of light.

Network

The interconnected telecommunications equipment and facilities.

Network Channel (NC) Code

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

Network Channel Interface (NCI) Code

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

Network Interface (NI)

The point of demarcation on the customer's premises at which Qwest's responsibility for the provisioning and maintenance of service ends.

Point-To-Point

A link connecting two (and only two) points.

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.

Reflection

The abrupt change in direction of a light beam at an interface between two dissimilar media so the light beam returns into the media from which it originated.

Route

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

Serving Wire Center (SWC)

The Wire Center which normally provides service to a customer.

Singlemode Fiber

An optical fiber that supports only one mode of light propagation above the cutoff wavelength. Core diameters are usually between 5 and 10 microns and claddings are usually ten times the core diameter.

Terminal

In the loop, predetermined points of access designed to facilitate connection of the Customer Entrance Cable to the Outside Plant Facility.

Wavelength

The distance an electromagnetic wave travels in the time it takes to oscillate through a complete cycle. Wavelengths of light are measured in nanometers or microns.

Wavelength Division Multiplexing (WDM)

A technology that allows two or more optical signals with different wavelengths to be simultaneously transmitted in the same direction over one fiber, and then separated by wavelength at the distant end.

Wire Center (WC)

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

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8. References

8.1 American National Standards Institute Documents

ANSI T1.223-1997 *Information Interchange - Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for North American Telecommunications System.*

ANSI X3.230-1994 *Information Technology - Fibre Channel - Physical and Signaling Interface (FC-PH)*

8.2 Telcordia Documents

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

ISI-SR-STS 000307 *NC/NCI Code Dictionary*

8.3 Qwest Documents

PUB 77368 *CUSTOMER PREMISES ENVIRONMENTAL SPECIFICATIONS AND INSTALLATION GUIDE*, Issue A, March 1998

8.4 IBM Documents

GC22-7064 *IBM Input/Output Equipment Installation Manual-Physical Planning*

SA22-7233 *9037 Model 2 Sysplex Timer Planning Guide*

SG24-2076 *IBM Redbook OS/390 MVS Parallel Sysplex Configuration*

8.5 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 order;

- American National Standards Institute (ANSI) documents 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://web.ansi.org/public/search.asp

  ANSI has a catalog available which describes their publications.

- Telcordia documents from:

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  Phone: (908) 699-5800 (Others)
  Web: http://www.telcordia.com

- Qwest Technical Publications from:

  http://www.qwest.com/techpub

- International Business Machines (IBM) documents may be obtained from:

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S/390	Trademark of International Business Machines Corporation
Sysplex Timer	Trademark of International Business Machines Corporation
System 390	Trademark of International Business Machines Corporation