UCR 2008, Change 2, Modification #2 provides Digital Subscriber Line (DSL) requirements. Section 5.3.1 was modified to reflect this change.

Corrections to UCR 2008, Change 2, made by Modification # 2

SECTION	NEW Requirements	EFFECTIVE DATE
5.3.1.9	Digital Subscriber Line Requirements	Immediate

5.3.1.9 Digital Subscriber Line (DSL) Requirements

5.3.1.9.1 Introduction

This section includes requirements for using DSL access technologies to link buildings within DoD Bases at UC locations worldwide. This section also describes how newer Ethernet, in the First Mile over Copper (EFMCu) access technologies, could be used to link buildings within Bases at these UC locations.

5.3.1.9.2 Primary Application Support

DSL is primarily used at military facilities to provide Local Area Network (LAN) interconnection. As such, the primary DSL functions that support this application are:

- Symmetrical bandwidth (available with some DSL access technologies)
- Use of DSL repeaters to provide an extended range of operation
- Point-to-Point configurations
- Point-to-Multi-Point configurations

5.3.1.9.3 DSL Overview

DSL uses existing twisted-pair telephone lines to transport high-bandwidth data, such as multimedia and video, between endpoints. The term xDSL covers a number of DSL technologies. Those that are standards-based are shown in Table 5.3.1-15.

Many of these DSL technologies support both analog voice services and high-bandwidth digital data services (which may include UC VoIP and Video over IP services). In this case, different frequency bands are used on each twisted-pair copper telephone line for the analog voice service and the digital data service.

Table 5.3.1-15. ITU DSL Standards Overview

Version	Standard	Common Name	Downstream Rate↑	Upstream Rate↓	Initially Approved in
Hight Bit Rate DSL (HDSL)	ITU G.991.1	HDSL/2/4 (multi pair)	1.5-2.0 Mbps	1.5-2.0 Mbps	1998
ADSL	ITU G.992.1	ADSL (G.DMT)	6.144 Mbps	640 Kbps	1999
ADSL	ITU G.992.2	ADSL Lite (G.Lite)	1.5 Mbps	0.5 Mbps	1999
ADSL	ITU G.992.1 Annex A	ADSL over POTS	6.144 Mbps	640 Kbps	1999
Very High Speed DSL (VDSL)	ITU G.993.1	VDSL	52 Mbps	16 Mbps	2001
ADSL2	ITU G.992.3 Annex J	ADSL2	8 Mbps	800 Kbps	2002
ADSL2	ITU G.992.3	ADSL2	8 Mbps	800 Kbps	2002
ADSL2	ITU G.992.4	Splitterless ADSL2	1.5 Mbps	0.5 Mbps	2002
Single Pair High-Speed DSL (SHDSL)	ITU G.991.2	G.SHDSL (single pair)	2.3 Mbps	2.3 Mbps	2003
ADSL2+	ITU G.992.5	ADSL2+	24 Mbps	1.3 Mbps	2003
ADSL	ITU G.992.1 Annex B	ADSL over ISDN	12 Mbps	1.8 Mbps	2005
ADSL2	ITU G.992.3 Annex L	RE-ADSL2	5 Mbps	0.8 Mbps	2005
VDSL2	ITU G.993.2	VDSL2	100 Mbps[1]	100 Mbps[1]	2006
ADSL2+	ITU G.992.5 Annex M	ADSL2+M	24 Mbps	3.3 Mbps	2008

Notes :

1. VDSL2 supports transmission at a bidirectional net data rate (the sum of upstream and downstream rates) up to 200 Mbps.

5.3.1.9.3.1 DSL Bonding

Wire bonding solutions provide a method for combining multiple copper DSL connections (with the same or different bit rates) together into a single, aggregate connection. This technology is extremely valuable when support for high-speed services must be provided. Bonding can allow delivery of high-bandwidth services even when the bandwidth of individual DSL connections is relatively low.

Three DSL bonding standards are defined in Table 5.3.1-16.

Table 5.3.1-16. DSL Bonding Standards

ITU-T Standard	Description
G.998.1	**ATM-based multi-pair bonding:** A method for bonding of multiple DSL lines to transport an ATM payload beyond the rate/reach capability of a single DSL loop. This protocol allows the bonding of 2 to 32 pairs and supports dynamic removal and restoration of pairs without human intervention.
G.998.2	**Ethernet-based multi-pair bonding:** Provides a method for bonding of multiple DSL lines for Ethernet transport. This recommendation builds on IEEE 802.3ah-2004 Ethernet in the First Mile (EFM) methods, and extends Ethernet transport over multiple xDSL technologies, including ADSL.
G.998.3	**Multi-pair bonding using time-division inverse multiplexing:** Details a method for bonding DSL lines using Time-Division Inverse Multiplexing (TDIM). This recommendation uses IEEE 802.3ah handshakes for pair discovery, parameter negotiation, and setup. It also allows the hitless addition and removal of pairs (i.e. without any service disruption) and the fast removal of a pair upon pair failure.

Each of these bonding methods is designed to be efficient in a DSL environment and independent of the particular physical layer being used. A primary goal of each method is to provide the capability to bond lines that are running at different data rates in order to maximize the bit rate available over the bonded connection.

Bonding of multiple logical links, which is done independent of physical layer technology, can also be provided using the Multilink Point-to-Point Protocol (MLPPP), as specified in IETF Request for Comment (RFC) 1990, *The PPP Multilink Protocol (MP)*. This type of bonding can be used with any xDSL technology. MLPPP defines a method for splitting, recombining and sequencing datagrams across multiple logical data links. MLPPP is currently used in some ADSL products to provide link bonding.

5.3.1.9.4 Ethernet in the First Mile over Copper (EFMCu)

Ethernet in the first mile (EFM) is known as IEEE 802.3ah and defines Ethernet in the access network, i.e., first or last mile. EFMCu defines interfaces over voice-grade copper with optional multi-pair aggregation or bonding transmission.

EFMCu allows for deployment of resilient symmetrical Ethernet Access links over existing voice-grade copper infrastructure, providing an economical alternative to fiber and a solution where only voice-grade copper infrastructure exists.

There are two standardized EFMCu technologies:

- Long reach 2BASE-TL, delivering a minimum of 2 Mbps and a maximum of 5.69 Mbps over distances of at least 2700 m, using standard G.SHDSL.bis technology over a single copper pair.

- Short reach 10PASS-TS, delivering a minimum of 10 Mbps over distances of at least 750 m, using standard VDSL technology over a single copper pair.

5.3.1.9.5 DSL-Based ASLAN Interconnection Architectures

DSL or EFMCu connections are used to provide ASLAN interconnection in the Network Edge Segment. Either can be utilized in cases where voice-grade wiring is the only choice for linking ASLANs in different buildings within a military base. DSL or EFMCu utilization within a base is described in the following sections.

5.3.1.9.5.1 Point-to-Point Interconnection of ASLANs

The simplest scenario for DSL use on a military base is for basic point-to-point LAN interconnection. This can be used for connectivity within an ASLAN, or for connectivity between ASLANs on the same base. It makes use of Unshielded Twisted Pair (UTP) copper phone cables for connectivity.

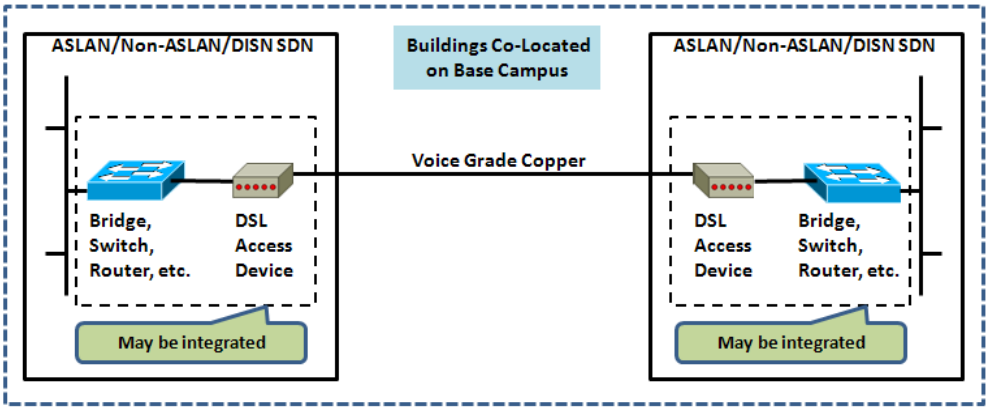

Figure 5.3.1-19. Point-to-Point LAN Interconnection

At each location is a DSL access device which contains a DSL line interface (on the voice-grade copper side) and typically an Ethernet physical interface (on the LAN side). At a minimum the DSL access device supports data bridging between its two sides, but it may have additional functionality built in, such as LAN switching and IP routing.

5.3.1.9.5.2 Point-to-Multipoint Interconnection of ASLANs

A more complicated scenario for DSL use on a military base is for point-to-multipoint LAN interconnection. This can be used for aggregating connectivity of ASLANs to a single or multiple core locations within the same base. It also makes use of UTP copper phone cables for connectivity.

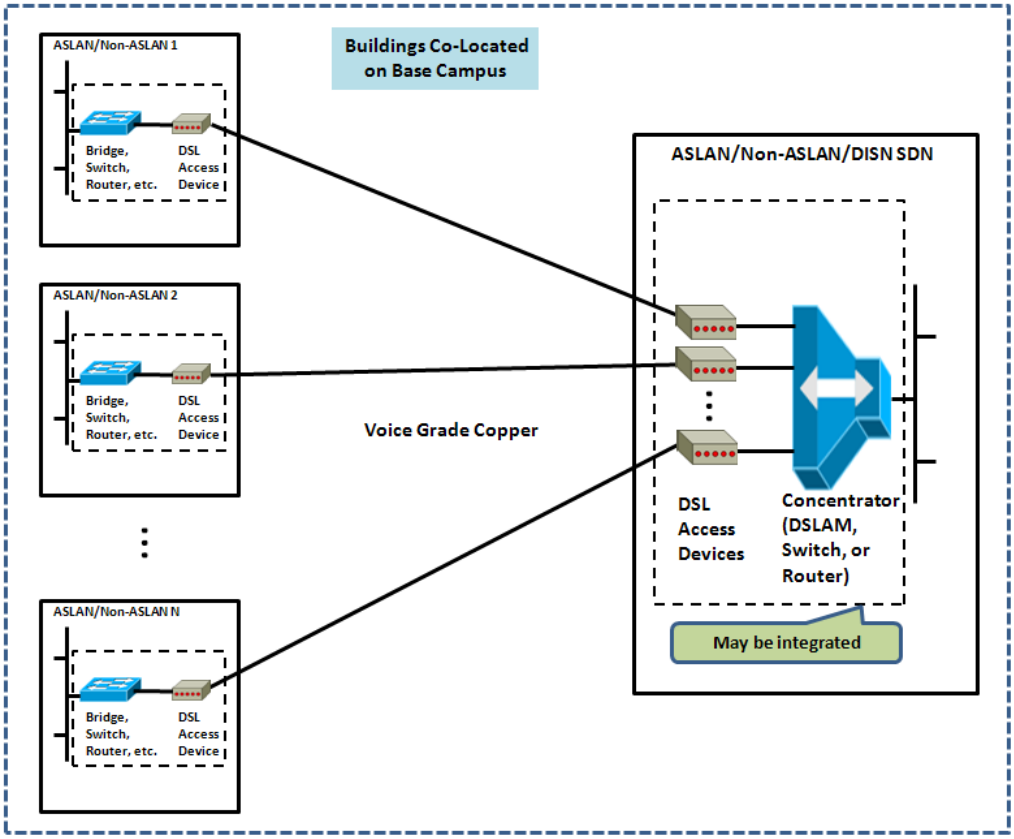

Figure 5.3.1-10. Point-to-Multipoint Interconnection Concentration

In this scenario a Concentrator handles connectivity for multiple ASLAN locations and then aggregates traffic that is destined for remote destinations. Typically the Concentrator is a DSL Access Manager (DSLAM), a Bridge, or a Router, all of which have advanced functionality to support switching or routing of IP packets between local ASLANs, and forwarding/routing of IP backets between local DSLAMs and remote destinations.

DSLAMs can support a very large amount of interfaces (e.g., multiple 19 inch / 23 inch racks of equipment that support hundreds of access interfaces), or they can be very small, mini-DSLAMs that support less than one hundred access interfaces.

5.3.1.9.5.3 DSL Repeaters

There may be situations where the distance between two ASLANs is too long to support a single DSL connection. In this scenario, a solution could be to use multiple DSL wire hops to bridge the link. While the total distance may be too great for a single DSL transmitter/receiver pair, cascading two separate DSL links may provide the solution. In this case a DSL repeater could be used to amplify the DSL signal at a midpoint in the total link to provide enough amplification to drive the signal over the total link length.

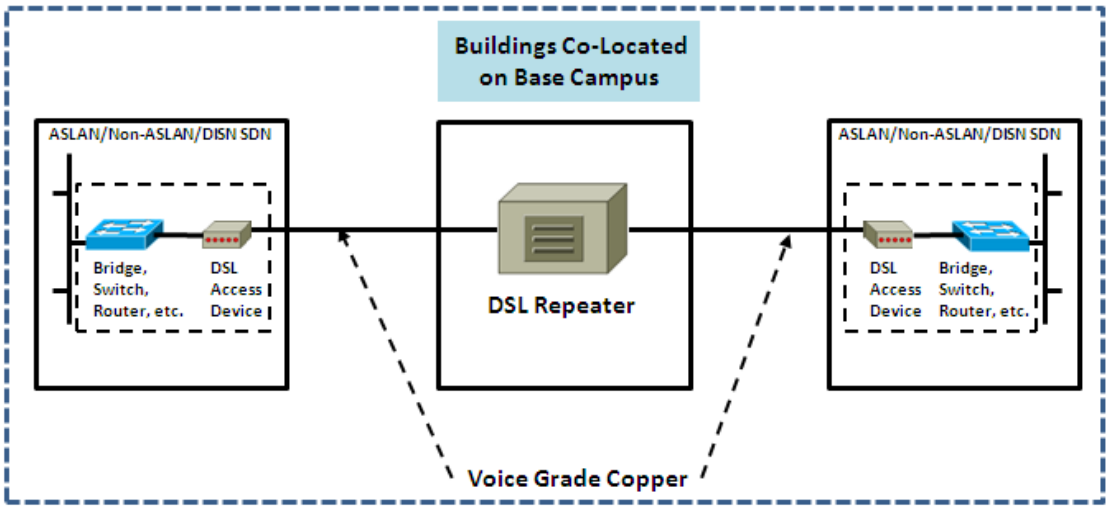

Figure 5.3.1-21. DSL Repeater Provides Extended Distance

Use of a DSL repeater provides extended distance/speed between DSL endpoints.

5.3.1.9.5.4 DSL Support for Analog Voice and Voice over IP (VoIP)

DSL Access Device, Concentrator, and Repeater products can also be used to carry both Analog Voice and VoIP services over existing voice-grade copper links. In this case, the Analog Voice is carried over the link using the pre-existing Analog Voice frequency band, and the VoIP is carried over the link using the separate frequency bands that the DSL products use for IP data service. A Base configuration supporting Analog Voice, IP Data, Voice over IP, and Video over IP with DSL Modems, a DSLAM, and a UC LSC, is shown in Figure 5.3.1-22.

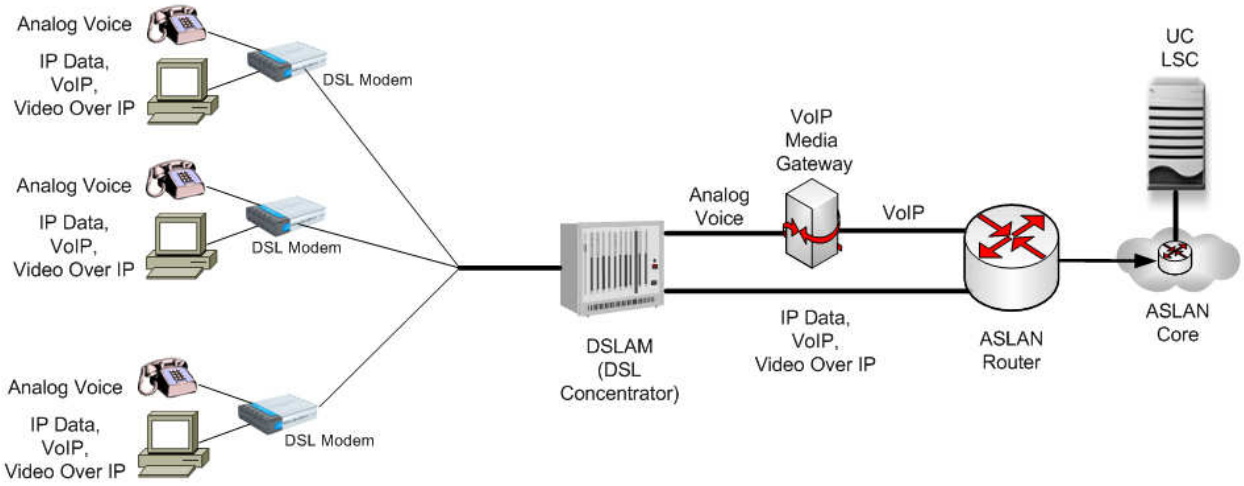

Figure 5.3.1-22. Base Configuration Supporting Analog Voice and VoIP using DSL Modems and a DSLAM

In the above configuration, the Analog Voice, VoIP, and Video over IP Services are all provided by a UC LSC and its associated VoIP Media Gateway on the Base. The Media Gateway provides conversion between Analog Voice service and UC VoIP service in this case. For VoIP and Video Over IP services, the DSLAM also needs to be interoperable with the ASLAN Router and the UC LSC, based on the ASLAN Router requirements in Section 5.3.1 and the LSC requirements in Section 5.3.2.

On Bases that are not equipped with an LSC and a Media Gateway, the Analog Voice service can be provided by an End Office or PBX on the Base. When a UC LSC and VoIP Media Gateway are located at the Base, the DSLAM and the MG can be interconnected using either individual analog lines (e.g., Unshielded Twisted Pairs) or by a ISDN PRI that multiplexes the analog lines onto one or more T1 facilities. In this case, the DSLAM also needs to be interoperable with the MG ISDN PRI requirements in Section 5.3.2.

It is also possible for the DSLAM and the VoIP Media Gateway to be integrated into a single product. In this case, the DSLAM side of the product needs to meet the Concentrator requirements in this Section, and the MG side of the product needs to meet the MG requirements in Section 5.3.2. Support for integrated DSLAM/MG products is not required.

5.3.1.9.6 DSL Requirements

The following requirements are specified for the DSL products that implement the DSL architectures utilized by DISA. The DSL products are categorized into the following types:

- Access Devices
- Concentrators
- Repeaters

5.3.1.9.6.1 Physical Layer

[Required: Access Devices, Concentrators, Repeaters] DSL products shall provide at least one of the following DSL interface types:

- ADSL ITU G.992.1 (G.DMT)
- ADSL ITU G.992.2 (G.Lite)
- ADSL2 ITU G.992.3
- ADSL2+ ITU G.992.5

[Conditional: Access Devices, Concentrators, Repeaters] Access Devices, Concentrators, and Repeaters shall provide the following DSL interface types:

- SHDSL ITU G.991.2
- VDSL ITU G.993.1
- HDSL ITU G.991.1
- VDSL2 ITU G.993.2
- Long reach 2BASE-TL IEEE Std 802.3ah
- Short reach 10PASS-TS IEEE Std 802.3ah

[Required: Access Devices, Concentrators] DSL products shall provide at least one of the following Ethernet interface types (other types may be provided as conditional interfaces):

- 10 Mbps IEEE Std 802.3i (10-BaseT Ethernet)
- 100 Mbps IEEE Std 802.3u (100-BaseT Fast Ethernet)

[Conditional: Access Devices, Concentrators] DSL products shall also provide at least one of the following Ethernet interface types:

- 1000 Mbps IEEE Std 802.3z (1000-Base X Gigabit Ethernet over Fiber-Optic)
- 1000 Mbps IEEE Std 802.3ab (1000-Base T Gigabit Ethernet over Twisted Pair)

5.3.1.9.6.2 Data Link Layer

[Conditional: Access Devices, Concentrators] DSL products shall meet at least one of the following DSL bonding capabilities:

- ATM-based multi-pair bonding — ITU G.998.1
- Ethernet-based multi-pair bonding — ITU G.998.2
- Multi-pair bonding using time-division inverse multiplexing — ITU G.998.3
- Multilink Point-to-Point Protocol bonding — RFC 1990

[Required: Access Devices, Concentrators] DSL products shall meet the Ethernet Media Access Control (MAC) capabilities defined in IEEE Std 802.3-2002.

[Required: Access Devices, Concentrators] DSL products shall meet the Ethernet Media Access Control (MAC) bridging capabilities defined in IEEE Std 802.1D-2004.

[Required: Access Devices, Concentrators] DSL products shall meet the Ethernet Virtual Local Area Network (VLAN) capabilities defined in IEEE Std. 802.1Q.

[Conditional: Access Devices, Concentrators] DSL products shall meet the Ethernet in the First Mile bonding requirements specified in IEEE Std 802.3ah.

[Conditional: Access Devices, Concentrators] DSL products shall meet the Asynchronous Transfer Mode (ATM) capabilities defined in ITU I.361.

[Conditional: Access Devices, Concentrators] DSL products shall meet the ATM Adaptation Layer 5 (AAL5) capabilities defined in ITU I.363.5.

5.3.1.9.6.3 Network Layer

[Required: Access Devices, Concentrators] DSL products shall meet all of the IPV4 protocol requirements for UC Access products as listed in Table 5.3.1.3.5-1, IPv4 Protocol Requirements, of Section 5.3.1, Assured Services Local Area Network Infrastructure.

[Required: Access Devices] DSL products shall meet all of the IPV6 protocol requirements for LAN Switch products as listed in Table 5.3.5-3, UC Host, of Section 5.3.5, IPv6 Requirements.

[Required: Concentrators] DSL products shall meet all of the IPV6 protocol requirements for LAN Switch products as listed in Table 5.3.5-6, LAN Switch, of Section 5.3.5, IPv6 Requirements.

5.3.1.9.6.4 Information Assurance

[Required: Access Devices, Concentrators, Repeaters] The Information Assurance requirements are contained in Section 5.4, Information Assurance Requirements.

5.3.1.9.6.5 DSL Support for Analog Voice Services

The following Access Device and Concentrator requirements are based on the Base Configuration Supporting Analog Voice and VoIP using DSL Modems and a DSLAM shown in Figure 5.3.1-22. These requirements apply to Analog Voice services, and do not apply to VoIP or Video over IP Services.

[Conditional: Concentrators] If the Concentrator (DSLAM) routes analog voice traffic (or analog voice traffic multiplexed onto a T1) to/from a VoIP Media Gateway and UC LSC for voice call completion, the Concentrator's interface to the VoIP Media Gateway shall match the Media Gateway interface requirements in Section 5.3.2.12, Media Gateway Requirements.

When the Concentrator is a DSLAM that supports analog voice traffic, analog phones can also be supported at the DSL Access Devices (the DSL Modems). In this scenario, the analog voice signal is transmitted together with the digital DSL signal over the DSL copper lines.

[Conditional: Concentrators] If the Concentrator (DSLAM) supports analog voice traffic, the side of the DSLAM that terminates the Voice Grade Copper lines shall use a splitter to separate the analog phone traffic from the digital DSL traffic at each of the lines. In this case, the DSLAM shall also route the analog phone traffic to the point of analog voice distribution (the local VoIP Media Gateway, End Office, or PBX) and route the digital DSL traffic to the DSL components within the DSLAM. This DSLAM-based splitter shall also act as a filter to prevent interference between the analog phone service and the DSL IP data service (including VoIP and Video over IP services when they are used).

[Conditional: Access Devices] If the Access Device (DSL Modem) supports an analog phone connection, then the Access Device shall contain a low pass filter that is located between the analog phone line (DSL modem user side) and the DSL line (DSL modem network side). This low pass filter shall prevent interference between the analog phone service and the DSL IP data service (including VoIP and Video over IP services when they are used).

5.3.1.9.6.6 Device Management

[Required: Access Devices, Concentrators, Repeaters] DSL products shall meet the device management requirements for Management Options, Fault Management, Loopback Capability, and Operational Configuration Restoral, as specified in Section 5.9.2.4, Device Management.

[Required: Access Devices, Concentrators, Repeaters] DSL products shall meet the device management requirements that allow network managers to monitor, configure, and control all

aspects of the network and observe changes in network status, as specified in Section 5.3.1.6, LAN Network Management Requirements.

[Required: Access Devices, Concentrators, Repeaters] DSL products shall support the following device management functions that secure access to these devices:

- Password-protected user accounts that are either defined for each individual device, or centrally controlled for multiple devices using a Radius server
- SSH (Secure Shell) interfaces that provide encryption, authentication and data integrity
- Graphical User Interface (GUI) applications that can be used for local and remote management of all DSL elements served by the management function

[Required: Access Devices, Concentrators, Repeaters] DSL products shall support the Simple Network Management Protocol (SNMP) Version 3 network management protocol and have the ability to send SNMP traps to up to four defined trap destinations. The DSL products shall allow the SNMP agent parameters and trap destinations to be defined on an individual element basis (per Access Device, Concentator, and Repeater) and on a group-of-elements basis.

5.3.1.9.7 References

The following References were used in the DSL Requirements Section:

G.991.1	ITU-T Recommendation G.991.1, “High bit rate digital subscriber line (HDSL) transceivers,” 1998.
G.991.2	ITU-T Recommendation G.991.2, “Single-pair high-speed digital subscriber line (SHDSL) transceivers,” 1998.
G.992.1	ITU-T Recommendation G.992.1, “Asymmetric digital subscriber line (ADSL) transceivers,” 1999.
G.992.2	ITU-T Recommendation G.992.2, “Splitterless asymmetric digital subscriber line (ADSL) transceivers,” 1999.
G.992.3	ITU-T Recommendation G.992.3, “Asymmetric digital subscriber line transceivers 2 (ADSL2),” 2009.
G.992.4	ITU-T Recommendation G.992.4, “Splitterless asymmetric digital subscriber line transceivers 2 (splitterless ADSL2),” 2002.
G.992.5	ITU-T Recommendation G.992.5, “Asymmetric digital subscriber line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus),” 2009.

G.993.1	ITU-T Recommendation G.993.1, “Very high speed digital subscriber line transceivers (VDSL),” 2004.
G.993.2	ITU-T Recommendation G.993.2, “Very high speed digital subscriber line transceivers 2 (VDSL2),” 2006.
G.998.1	ITU-T Recommendation G.998.1, “ATM-based multi-pair bonding,” 2005.
G.998.2	ITU-T Recommendation G.998.2, “Ethernet-based multi-pair bonding,” 2005.
G.998.3	ITU-T Recommendation G.998.3, “Multi-pair bonding using time-division inverse multiplexing,” 2005.
I.361	ITU-T Recommendation I.361, “B-ISDN ATM layer specification,” 1999.
I.363.5	ITU-T Recommendation I.363.5, “B-ISDN ATM Adaptation Layer specification : Type 5 AAL,” 1999.
RFC 1990	K. Sklower, B. Lloyd, et al, “The PPP Multilink Protocol (MP),” August 1996.
802.1D	IEEE Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges, June 2004.
802.1Q	IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks, 2003.
802.3	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, 26 December 2008.
802.3ab	IEEE Standard for information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications: 1000BASE-T Gbit/s Ethernet over twisted pair at 1 Gbit/s (125 MB/s), 1999.
802.3ah	IEEE Standard for information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment: Media Access Control Parameters, Physical Layers, and Management Parameters for Subscriber Access Networks, 2004.

802.3i	IEEE Standard for information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications: 10BASE-T 10 Mbps (1.25 MB/s) over twisted pair, 1990.
802.3u	IEEE Standard for information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications: 100BASE-TX, 100BASE-T4, 100BASE-FX Fast Ethernet at 100 Mbps (12.5 MB/s) w/autonegotiation, 1995.
802.3z	IEEE Standard for information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications: 1000BASE-X Gbit/s Ethernet over Fiber-Optic at 1 Gbit/s (125 MB/s), 1998.