



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.995.1

(02/2001)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Access networks

Overview of digital subscriber line (DSL) Recommendations

ITU-T Recommendation G.995.1

(Formerly CCITT Recommendation)



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For further details, please refer to the list of ITU-T Recommendations.

Overview of digital subscriber line (DSL) Recommendations

Summary

This Recommendation provides the necessary guidance and an overview of the DSL family of Recommendations and is therefore informative. It also describes how the various Recommendations in this family are related. It also contains a definition of a generic system reference configuration and how it relates to the system reference models of the DSL Recommendations. Additionally, the definition of a generic protocol reference architecture for DSL Recommendations and derivations of the appropriate user or management plane protocol reference architectures for the DSL Recommendations is included. Illustrations of the data service presentation options using the DSL Recommendations are also provided. A glossary of the terms used in the DSL Recommendations is also included.

Source

ITU-T Recommendation G.995.1 was revised by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 9 February 2001.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation G.995.1

Overview of digital subscriber line (DSL) Recommendations

1 Scope

This Recommendation provides an overview of the family of DSL Recommendations. It describes how the various DSL Recommendations are related. This Recommendation also defines a generic system reference and a protocol reference configuration for DSL Recommendations and relates it to the system reference models of the DSL Recommendations. This Recommendation is of informative nature and does not imply any specific requirements.

2 Revision History

This revision of ITU-T G.995.1 adds more clauses and text with regard to ITU-T G.991.2 and Annex H/G.992.2. Specifically, it adds:

- Text in clause 5.1 that introduces Annex H/G.992.1.
- Clause 5.4 that introduces ITU-T G.991.2.
- Text in clause 5.8 that describes relationship of ITU-T G.991.2 and Annex H/G.992.1 with the existing DSL Recommendations.
- Clause 6.1.1.4, that discusses the alignment of the G.991.2 system reference model with the G.995.1 reference configuration.
- Text in clause 6.2 that describes the user plane protocol reference architecture for ITU-T G.991.2.

3 Definitions

This Recommendation defines the following terms:

3.1 DSL Recommendations: The family of ITU-T Recommendations G.991.1, G.992.1, G.992.2, G.994.1, G.995.1, G.996.1 and G.997.1.

3.2 XDSL: Any of the various types of digital subscriber lines.

4 Abbreviations

This Recommendation uses the following abbreviations:

2B1Q	2 Binary 1 Quaternary
ADSL	Asymmetric Digital Subscriber Line
ATM	Asynchronous Transfer Mode
ATU	ADSL Transceiver Unit
ATU-C	ADSL Transceiver Unit-Central Office End
ATU-R	ADSL Transceiver Unit-Remote Terminal End
C	Common circuitry
CAP	Carrier-less Amplitude and Phase
CO	Central Office

CPE	Customer Premises Equipment
DLL	Digital Local Line
DSL	Digital Subscriber Line
GII	Global Information Infrastructure
H	HDSL transceiver
HDSL	High Bit Rate Digital Subscriber Line
h-p	high-pass
HSS-TC	Handshake Specific-Transmission Convergence
HSTU	Handshake Transceiver Unit
HSTU-C	Handshake Transceiver Unit-Central office end
HSTU-R	Handshake Transceiver Unit-Remote terminal end
I	Interface
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
l-p	Low-pass
LTU	Line Termination Unit
M	Mapping
MPS-TC	Management Protocol Specific-Transmission Convergence
NT1	Network Termination 1
NT2	Network Termination 2
NTU	Network Termination Unit
PHY	Physical Layer
PMD	Physical Media Dependant
PMS-TC	Physical Media Specific-Transmission Convergence
POTS	Plain Old Telephony Service
REG	Regenerator
SM	Service Module
SNI	Service Node Interface
STM	Synchronous Transfer Mode
TA	Terminal Adapter
TC	Transmission Convergence
TCM	Time Compressed Multiplex
TPS-TC	Transport Protocol Specific-Transmission Convergence
XNI	Access Network Interface
XTU	xDSL Transceiver Unit
XTU-C	xDSL Transceiver Unit-Central Office End
XTU-R	xDSL Transceiver Unit-Remote Terminal End



5 Overview of the Family of DSL Recommendations

The family of DSL Recommendations includes the following: ITU-T G.992.1, G.992.2, G.991.1, G.991.2, G.996.1, G.994.1, G.997.1 and G.995.1. ITU-T G.991.1, G.991.2, G.992.1 and G.992.2 have developed techniques for transmitting a range of bit rates over the existing copper local network from relatively short distances at high bit rates, and to long distances at relatively lower bit rates. ITU-T G.994.1, G.996.1, and G.997.1 support ITU-T G.992.1 and G.992.2 by providing common handshake, management and testing procedures. These Recommendations include mandatory requirements, recommendations and options; these are designated by the words "shall", "should" and "may", respectively. The word "will" is used only to designate events that take place under some defined set of circumstances.

In clauses 5.1-5.7, the DSL Recommendations have been introduced. In clause 5.8, the relationship of these Recommendations with each other is described.

5.1 ITU-T G.992.1: Asymmetric Digital Subscriber Line (ADSL) Transceivers

ITU-T G.992.1 specifies the physical layer characteristics of the Asymmetric Digital Subscriber Line (ADSL) interface to metallic loops. ITU-T G.992.1 has been written to help ensure the proper interfacing and interworking of ADSL transmission units at the customer end (ATU-R) and at the network operator end (ATU-C) and also to define the transport capability of the units. Proper operation is to be ensured when these two units are manufactured and provided independently.

A single twisted pair of telephone wires is used to connect the ATU-C to the ATU-R. The ADSL transmission units must deal with a variety of wire pair characteristics and typical impairments (e.g. crosstalk and noise). The transmission system is designed to operate on two-wire twisted metallic cable pairs with mixed gauges. ITU-T G.992.1 is based on the use of cables without loading coils, but bridged taps are acceptable in all but a few unusual situations.

An ADSL transmission unit can simultaneously convey all of the following: downstream simplex bearers, duplex bearers, a baseband analogue duplex channel, and ADSL line overhead for framing, error control, operations, and maintenance. ITU-T G.992.1 supports a minimum of 6.144 Mbit/s downstream and 640 kbit/s upstream net data rate.

Two categories of performance are specified. Category I performance is required for compliance with ITU-T G.992.1; performance enhancement options are not required for category I equipment. Category II is a higher level of performance. Category II performance and characteristics are not required for compliance with ITU-T G.992.1.

ADSL provides a variety of bearer channels in conjunction with other services:

- ADSL transmission on the same pair with voiceband transmission (including POTS and voiceband data services).
- ADSL transmission on the same pair with ISDN, as defined in Appendices I and II/G.961. The ADSL occupies a frequency band above the ISDN, and is separated from it by filtering.
- ADSL transmission on the same pair with voiceband transmission (including POTS and voiceband data services), and with ISDN in an adjacent pair as defined in Appendix III/G.961.
- In the direction from the network operator to the customer premises (i.e. downstream) the bearer channels may consist of full duplex low-speed bearer channels and simplex high-speed bearer channels; in the other direction (i.e. upstream) only low-speed bearer channels are provided.

Specifically, ITU-T G.992.1:

- defines the combined options and ranges of the simplex and full-duplex bearer channels provided;
- defines the line code and the spectral composition of the signals transmitted by both ATU-C and ATU-R;
- specifies the transmit signals at both the ATU-C and ATU-R;
- describes the electrical and mechanical specifications of the network interface;
- describes the organization of transmitted and received data into frames;
- defines the functions of the operations channel;
- defines the ATU-R to service module(s) interface functions;
- defines the Transmission Convergence Sub-layer for ATM transport.

In separate annexes it also:

- describes the transmission technique used to support the simultaneous transport on a single twisted-pair of voiceband services and both simplex and duplex bearer channels;
- describes the transmission technique used to support the simultaneous transport on a single twisted-pair of ISDN services as defined in Appendices I and II/G.961, and both simplex and duplex bearer channels;
- describes the transmission technique used to support the simultaneous transport on a single twisted-pair of voiceband services and both simplex and duplex bearer channels when they are subject to cross-talk from ISDN as defined in Appendix III/G.961;
- describes those specifications that are unique to Synchronized Symmetric Digital Subscriber Line (SSDSL) transceivers for use in the same cable binder as TCM-ISDN defined in ITU-T Appendix III/G.961. This SSDSL transmission method allows symmetric data rates in the range of 192 kbit/s to 1.6 Mbit/s with 32 kbit/s granularity using a scheme synchronized with TCM-ISDN. The 1.544 Mbit/s STM data transport capability is optionally supported.

ITU-T G.992.1 defines several optional capabilities and features:

- echo cancellation;
- trellis coded modulation;
- loop timing at either the ATU-C or the ATU-R;
- dual latency;
- transport of a network timing reference;
- transport of STM and/or ATM;
- reduced overhead framing modes.

By negotiation during initialization, G.992.1 in combination with G.994.1 provides for U-interface compatibility and interoperability between transceivers complying with ITU-T G.992.1 and between those transceivers that include different combinations of options.

5.2 ITU-T G.992.2: Splitterless asymmetrical digital subscriber line (ADSL) transceivers

ITU-T G.992.2 describes a transmission system that interfaces the telecommunications network and the customer installation in terms of their interaction and electrical characteristics. The requirements of ITU-T G.992.2 apply only to a single asymmetric digital subscriber line. ITU-T G.992.2 allows the provision of simultaneous voiceband transmission, including POTS and V-series data transmission, and a number of digital channels.

A single twisted pair of telephone wires is used to connect the ATU-C to the ATU-R. The ADSL transmission units must deal with a variety of wire pair characteristics and typical impairments.

(e.g. crosstalk and noise). The transmission system is designed to operate on two-wire twisted metallic cable pairs with mixed gauges and over the customer premises wiring. ITU-T G.992.2 is based on the use of cables without loading coils, but bridged taps are acceptable in all but a few unusual situations.

G.992.2 transmission unit can simultaneously convey a downstream and upstream simplex bearer, a baseband analogue duplex channel, and ADSL line overhead for framing, error control, operations, and maintenance. ITU-T G.992.2 supports a maximum of 1.536 Mbit/s downstream and 512 kbit/s upstream net data rates.

Specifically, ITU-T G.992.2:

- defines the line code and the spectral composition of the signals transmitted by both ATU-C and ATU-R;
- specifies the transmit signals at both the ATU-C and ATU-R;
- describes the electrical specifications of the network interface;
- describes the organization of transmitted and received data into frames;
- defines the functions of the operations channel;
- defines the ATU-R to service module(s) interface functions;
- defines the Transmission Convergence Sub-layer for ATM transport;
- defines the fast retrain procedure for use in the presence of non-linear off-hook phones in a splitterless environment;
- defines the power saving procedures for CPE and CO equipment;
- loop timing at the ATU-R.

In its separate annexes it also:

- describes the transmission technique used to support the simultaneous transport on a single twisted-pair of voiceband services and both simplex upstream and downstream bearer channels;
- describes the transmission technique used to support the simultaneous transport on a single twisted-pair of voiceband services and both simplex upstream and downstream bearer channels when they are subject to cross-talk from TCM-ISDN as defined in Appendix III/G.961;
- description of the transmission technique to support the simultaneous transport on a single twisted-pair of ISDN services as defined in Appendices I and II/G.961, and both simplex upstream and downstream bearer channels has been left for future study.

ITU-T G.992.2 defines several optional capabilities and features:

- transport of a network timing reference.

By negotiation during initialization, ITU-T G.992.2 provides for U-interface compatibility and interoperability between transceivers complying with ITU-T G.992.2 and between those transceivers that include different combinations of options.

5.3 ITU-T G.991.1: High bit rate digital subscriber line (HDSL) transceivers

ITU-T G.991.1 describes a transmission technique called High Bit Rate Digital Subscriber Line (HDSL), as a means for the transportation of several types of applications. The Recommendation defines the requirements for the individual HDSL transmission system, the transmission performance, the HDSL maintenance requirements and procedures.

An individual HDSL transceiver system is a two-wire bidirectional transceiver for metallic wires using the echo cancellation method. Three systems may be utilized, one transporting a bit rate of