ATIS-1000615.2014**(R2019)**

Digital Subscriber Signalling System No. 1 (DSS1) – Layer 3 Overview

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Is an American National Standard developed by the **Signaling, Architecture, and Control (SAC)** Subcommittee under the **ATIS Packet Technologies and Systems Committee (PTSC).**

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American National Standard for Telecommunications

Digital Subscriber Signalling System No. 1 (DSS1) – Layer 3 Overview

Alliance for Telecommunications Industry Solutions

Approved June 2014

American National Standards Institute, Inc.

Abstract

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The Digital Subscriber Signalling System No.1 (DSS1) is a suite of protocols that provides the means for users to invoke the full range of services and capabilities available from the Integrated Services Digital Network (ISDN). The structure of DSS1 is consistent with the seven-layer model described in ITU-T Recommendation I.320. The complete suite of Layer 3 DSS1 protocols encompasses a set of several standards, each one addressing its own aspect of the suite. This standard provides an overview of DSS1 Layer 3 functions and protocols. It also provides a list of the standards in which the individual aspects of the DSS1 Layer 3 suite are defined.

i

Foreword

The information contained in this Foreword is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

The Digital Subscriber Signalling System No. 1 (DSS1) is a suite of protocols that provides the means for users to invoke the full range of services and capabilities available from the Integrated Services Digital Network (ISDN). The structure of DSS1 is consistent with the seven-layer model described in ITU-T Recommendation I.320. The complete suite of Layer 3 DSS1 protocols encompasses a set of several standards, each one addressing its own aspect of the suite. This standard provides an overview of DSS1 Layer 3 functions and protocols. It also provides a list of the standards in which the individual aspects of the DSS1 Layer 3 suite are defined.

Users of the other standards in the DSS1 Layer 3 suite of standards will find this overview standard to be a useful introduction to them. Also, this standard will provide a useful bibliography of the other available standards.

The Alliance for Telecommunication Industry Solutions (ATIS) serves the public through improved understanding between providers, customers, and manufacturers. The Packet Technologies and Systems Committee (PTSC) develops and recommends standards and technical reports related to services, architectures, and signaling, in addition to related subjects under consideration in other North American and international standards bodies. PTSC coordinates and develops standards and technical reports relevant to telecommunications networks in the U.S., reviews and prepares contributions on such matters for submission to U.S. ITU-T and U.S. ITU-R Study Groups or other standards organizations, and reviews for acceptability or per contra the positions of other countries in related standards development and takes or recommends appropriate actions.

Many of PTSC's participants are also active participants in similar activities of the ITU-T. Therefore, this standard is consistent with ITU-T Recommendation Q.930 (1988).

ANSI guidelines specify two categories of requirements: mandatory and recommendation. The mandatory requirements are designated by the word *shall* and recommendations by the word *should*. Where both a mandatory requirement and a recommendation are specified for the same criterion, the recommendation represents a goal currently identifiable as having distinct compatibility or performance advantages.

Suggestions for improvement of this document are welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, PTSC, 1200 G Street NW, Suite 500, Washington, DC 20005.

At the time of consensus on this document, PTSC, which was responsible for its development, had the following leadership:

> M. Dolly, PTSC Chair (AT&T)
> V. Shaikh, PTSC Vice-Chair (ACS)
> M. Dolly, PTSC SAC Chair (AT&T)

The **SAC** Subcommittee was responsible for the development of this document.

Table of Contents

Table of Figures

ATIS Standard on –

Digital Subscriber Signalling System No.1 (DSS1) – Layer 3 Overview

1   Scope, Purpose, & Application

The Digital Subscriber Signalling System No.1 (DSS1) is a suite of protocols that provides the means for users to invoke the full range of services and capabilities available from an ISDN.

The structure of the interface between a user and an ISDN is described in ITU-T Recommendation I.412. That structure defines an interface which consists of a variable number of discrete channels. The channels are of various types. One type of channel (the D- Channel) is used to carry the DSS1 signalling messages between the user and the network.

The structure of the DSS1 protocol suite is based on the seven-layer model described in ITU-T Recommendation I.320. Layer 1 functions are described in *American National Standard for Telecommunications - Integrated services digital network – ISDN basic access interface for use on metallic loops for application at the network side of NT – Layer 1 specification*[1], ATIS-0600601, *American National Standard for telecommunications – Integrated services digital network – ISDN basic access interface for S and T reference points – Layer 1 specification*, ATIS-0600605; and *American National Standard for telecommunications – ISDN primary rate – Customer installation metallic interfaces – Layer 1 specification*, ANSI T1.408-1990. Layer 2 functions are described in *American National Standard for telecommunications – Integrated services digital network - ISDN signalling specification for application at the user-network interface – Layer 2 specification*, ATIS-1000602.

The Layer 3 protocols provide:

- the means to establish, maintain, and terminate network connections across an ISDN between communicating entities; and
- procedures that may be used to invoke and control supplementary services.

This standard describes the Layer 3 DSS1 functions and protocol in general terms. Details of the Layer 3 protocols are provided in the standards listed in clause 8. A glossary of Layer 3 terms is provided in clause 3.

2   Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI T1.408-1990, *Telecommunications - ISDN primary rate - Customer installation metallic interfaces - Layer 1 specification.*

ATIS-0600601.1999(R2009), *Integrated services digital network (ISDN) – basic access interface for use on metallic loops for application at the network side of NT, Layer 1 specification.*[1]

ATIS-1000602.1996(R2014), *Integrated services digital network (ISDN) – Data-Link Layer signaling specification for application at the user-network interface - Layer 2 specification.*[2]

ATIS-0600605.1991(R2009), *Telecommunications – Integrated services digital network (ISDN) – basic access interface for S and T reference points - Layer 1 specification.*[3]

ATIS-1000607.2000(R2009), *Telecommunications – Integrated services digital network (ISDN) – Layer-3 signaling specification for circuit- switched bearer service for digital subscriber signaling system no. 1 (DSS1).*[4]

ITU-T Recommendation 1.320, *ISDN protocol reference mode.*[5]

ITU-T Recommendation 1.412, *ISDN user- network interfaces – Interface structures and capabilities.*[7]

ITU-T Recommendation 0.920, *ISDN user- network interface data link layer - General aspects.*[7]

ITU-T Recommendation 0.921, *ISDN user- network interface - Data link layer specification.*[7]

3   Definitions

These terms are common among the standards in the suite of Layer 3 DSS1 standards.

3.1   access

3.1.1   access connection: A connection (using either the 8-Channel or a logical link on the D-Channel) established between the user equipment and a packet-mode handler function, over which packet-mode calls (incoming and outgoing) are established.

3.1.2   incoming access: The ability of a user to terminate data calls via an ISDN.

3.1.3   outgoing access: The ability of a user to originate data calls via an ISDN.

3.2   access unit: A conceptual unit of an ISDN which provides interworking functions between the circuit-switched data transmission services of an ISDN and the packet- switched data transmission services of a Packet Switched Public Data Network (PSPDN) for both incoming and outgoing calls.

3.3   channel: A channel represents a specified portion of the information-carrying capacity of an interface.

3.3.1   B-channel: A 64-kbit/s channel ac- companied by timing, intended to carry a wide variety of user information streams, such as voice encoded at 64 kbit/s, data information at bit rates less than or equal to

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[1] This document is available from the Alliance for Telecommunications Industry Solutions (ATIS), 1200 G Street N.W., Suite 500, Washington, DC 20005 < https://www.atis.org/docstore/product.aspx?id=25275>

[2] This document is available from the Alliance for Telecommunications Industry Solutions (ATIS), 1200 G Street N.W., Suite 500, Washington, DC 20005 < https://www.atis.org/docstore/product.aspx?id=24726>

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[4] This document is available from the Alliance for Telecommunications Industry Solutions (ATIS), 1200 G Street N.W., Suite 500, Washington, DC 20005 < https://www.atis.org/docstore/product.aspx?id=24729>

[5] This document is available from the International Telecommunications Union. < http://www.itu.int/ITU-T/ >

64 kbit/s, wide- band voice encoded at 64 kbit/s, and voice encoded at bit rates less than 64 kbit/s alone or combined with other digital information streams.

3.3.2 D·channel: A 16- or 64-kbit/s channel carrying control and signalling information and, optionally, packetized information and telemetry.

3.3.3 H-channel: A 384-, 1472-, or 1536-kbit/s channel (H0, H10, and H11 respectively) accompanied by timing, intended to carry a wide variety of user information streams, such as fast facsimile, video, high speed data, high quality audio, information streams each at rates less than the respective H-Channel bit rate that has been rate adapted or multiplexed together, and packet-switched information.

3.4 ITU-T (International Telecommunication Union – Telecommunication Standardization Sector): The ITU has been a specialized agency of the United Nations since 1948. As the oldest international treaty organization, it traces its formal beginnings to 1865. The ITU-T traces its formal beginnings to 1954, when its predecessor, the International Telegraph and Telephone Consultative Committee (CCITT) was founded for the purpose of promoting and ensuring the operation of international telecommunications systems.

3.5 Data unit

3.5.1 frame relaying service data unit (FSDU): This term refers to the data units exchanged at the functional boundary between the core functions of ITU-T Recommendation Q.921 (ATIS-1000602) and the end-to-end protocol implemented above the core functions of Q.921 (ATIS-1000602).

3.5.2 frame relaying protocol data unit (FSDU): This term refers to the data units exchanged at the user-network interface. Their format is based on that defined in ITU-T Recommendation Q.921 (ATIS-1000602).

3.6 digital subscriber line: The physical line connecting the network and the user which allows for transmission of digital signals according to American National Standards. The digital subscriber line may be used, for example, to provide the basic rate interface between the user and the network.

3.7 Frames

3.7.1 delivered duplicated frames: A frame D received by a particular destination user is defined to be a duplicated frame if both of the following conditions are true:

- D was not generated by the source user;
- D is exactly the same as a frame that was previously delivered to that destination.

3.7.2 delivered errored frame: A delivered frame is defined to be an errored frame when the value of one or more bits in the frame is in error, or when some, but not all, bits in the frame are lost bits or extra bits (i.e., bits that were not present in the original signal).

3.7.3 delivered out-of-sequence frame: Consider a sequence of frames F_1, F_2, F_3, …F_n. Assume that F_1 is transmitted first, F_2 second, etc. A delivered frame F_i is defined to be out of sequence if it arrives at the destination after any of the frames $F_{(i+1)}$, $F_{(i+2)}$, …F_n.

3.7.4 frame size: Frame size is the number of octets after the address field and before Frame Check Sequence (FCS) field in a frame. Octet count is done either before zero- bit insertion or after zero-bit extraction.

3.7.5 lost frame: A transmitted frame is declared to be a lost frame when the frame is not delivered to the destination user within an agreed-upon measurement period, and the net- work is responsible. The procedure used to reach agreement on the measurement period should allow for the possibility that more than one network may be involved in the connection.

3.7.6 misdelivered frame: A misdelivered frame is a frame transferred from a source user to a destination user other than the intended destination user. It is considered inconsequential whether the information is correct or incorrect in content.

3.7.7 frame handling (FH) function: A conceptual part of the ISDN that is used to interpret, process, and switch frame-mode data calls.

3.8 functional group: Sets of functions that may be needed in ISDN user access arrangements. In a particular access arrangement, specific functions in a functional group may or may not be present, and may be performed in one or more pieces of equipment.

3.8.1 network termination 1 (NT1): A functional group that includes functions broadly equivalent to Layer 1 (physical) of the OSI Reference Model. These functions are associated with the proper physical and electromagnetic termination of the network, and include line transmission termination, Layer 1 line maintenance functions and performance monitoring, timing, power transfer, Layer 1 multiplexing, and interface termination.

3.8.2 network termination 2 (NT2): An ISDN functional group that includes functions broadly equivalent to Layer 1 and higher layers of the ITU-T Recommendation X.200 Reference Model. PBXs, local area networks, and terminal controllers are examples of equipment or combinations of equipment that provide NT2 functions. These functions include Layer 2 and Layer 3 protocol handling, Layer 2 and Layer 3 multiplexing, switching, concentration, maintenance functions, and interface termination.

3.8.3 terminal equipment (TE): A functional group that includes functions broadly belonging to Layer 1 and higher layers of the ITU-T Recommendation X.200 Reference Model. Digital telephones, data terminal equipment, and integrated work stations are examples of equipment (or combinations of equipment) that provide these functions. These functions include protocol handling, maintenance functions, interface functions, and connection functions to other equipments. In some publications, Terminal Equipments are called Terminal Endpoints.

3.8.4 terminal equipment 1 (TE1): A functional group that includes functions belonging to the functional group TE, and with an interface that complies with the ITU-T ISDN user-network interface Recommendations. In some publications, *Terminal Equipments* are called *Terminal Endpoints.*

3.8.5 terminal equipment 2 (TE2): A functional group that includes functions belonging to the functional group TE, but with an inter- face that complies with national standards {e.g., EIA/TIA-232-E} or with interface Recommendations other than the ITU-T ISDN interface Recommendations (e.g., the X-Series interface Recommendations), or an interface not included in ITU-T Recommendations. In some publications, Terminal Equipments are called Terminal Endpoints.

3.8.6 terminal adapter (TA): A functional group that includes functions broadly be- longing to Layer 2 and higher layers of the Recommendation X.200 Reference Model that allow a TE2 terminal to be served by an ISDN user-network interface.

3.9 ISDN: An Integrated Services Digital Network (ISDN) is a network, in general evolving from an existing telephony network, that provides end-to-end digital connectivity to support a wide range of both voice and non-voice services. User access to an ISDN is via a limited set of standard multi-purpose interfaces.

3.10 information rate: The information rate for a frame relay logical connection is the average number of end user bits transferred per second, in one direction, across a user-net- work interface as measured over an interval of duration 't'. The measurement interval 't' is network dependent.

3.11 Interface

3.11.1 primary-rate interface: An ISDN user-network interface structure where the interface structure is composed of multiple B- Channels and one D-Channel. The bit rate of the D-Channel in this structure is 64 kbit/s. When a 1544-kbit/s primary-rate interface is provided, the interface structure is 23B+D.

3.11.2 basic-rate interface: An ISDN inter- face where the interface structure is com- posed of two B-Channels and one D-Channel, 2B+D. The bit rate of the D-Channel in this structure is 16 kbit/s.

3.12 network or network side: The system or equipment on one side of the ISDN user- network interface (basic rate or primary rate) that provides a port through which the user gains access to the telecommunications services offered by the ISDN.

3.13 packet handling (PH) function: A conceptual part of the ISDN that is used to interpret, process, and switch packet-mode data calls. In some implementations, the PH functions logically belonging to the ISDN may reside physically in a node of the PSPDN.

3.14 PSPDN: A Packet Switched Public Data Network (PSPDN) is a public data network where the data transmission services are packet-switched. The PSPDN may also carry services of other data services.

3.15 public data network: A Public Data Network (PDN) is a network established and operated for the purpose of providing data transmission services to the public.

3.16 reference points: A conceptual point dividing the functional groups in an ISDN user access arrangement. In a specific access arrangement, a reference point may correspond to a physical interface between pieces of equipment, or there may not be any physical interface corresponding to the reference point.

3.16.1 R reference point: The conceptual reference point dividing the TE2 and the TA in a particular ISDN access arrangement.

3.16.2 S reference point: The conceptual reference point dividing the TE1 and the NT2 in a particular ISDN access arrangement.

3.16.3 T reference point: The conceptual reference point dividing the NT2 and the NT1 in a particular ISDN access arrangement.

3.16.4 U reference point: The conceptual reference point at the network side of the NT1 in a particular ISDN access arrangement.

3.17 signalling: The exchange of information specifically concerned with the establishment and control of connections, and with management, in a network.

3.18 Symmetry

3.18.1 unidirectional: The condition where information flow is provided only in one direction.

3.18.2 bidirectional symmetric: The condition where the information flow characteristics provided by the service are the same between two (or more) reference points in the forward or backward directions.

3.18.3 bidirectional asymmetric: The condition where the information flow characteristics provided by the service are different in the two directions.

3.19 Traffic management

3.19.1 dynamic window control: A procedure to modify the transmitter's transmit window in response to the user's perception of congestion conditions in the network.

3.19.2 explicit congestion message: A message generated by the network and sent to the user terminal to indicate a congestion condition.

3.19.3 implicit congestion control: A scheme under which user terminals first detect a possible congestion condition by means other than explicit congestion messages, and then take appropriate action to reduce their throughput.

3.20 Delay

3.20.1 cumulative transit delay: The total transit delay applicable for a data call obtained by summing the individual transit delays of all component portions of the data connection.

3.20.2 transit delay: Transit delay is defined only between pairs of boundaries. Transit delay of an FPDU starts at the time t_1, at which the first bit of the FPDU crosses the first boundary, and ends at the time t_2 at which the last bit of the FPDU crosses the second boundary. Transit delay = t_2-t_1.

3.21 user or user side: The call control in the user equipment that communicates to the network across the basic- or primary-rate interface.

4   General Aspects of Layer 3

Signalling between a user and an ISDN requires a combination of the following:

- application of Layer 3 signalling protocols designed to control circuit switched, packet switched, or frame relay connections, or to control supplementary services; and
- application of an appropriate data-link (Layer 2) service which is, in turn, supported by an appropriate physical (Layer 1) service.

Layer 3 of DSS1 provides the user with the functions needed to signal for the establishment and operation of a network connection and for the control of supplementary services. Layer 3's use of underlying resources (such as data link connections) to transmit DSS1 signalling is invisible to the user.

4.1   Services Provided by the Data Link Layer

Layer 3 uses functions and services provided by the data link layer as defined in ANSI T1 .602. These services can be summarized as:

- establishment of data-link connections; error-protected transmission of data; and
- reestablishment of a data-link connection (indicating the loss of information).

4.2   Symmetry of the Layer 3 Protocol

As an option, the Layer 3 protocol for control of basic circuit-mode connections can be fully symmetrical at the user-network interface. This protocol is intended for user-network interfaces, but it may also be used to enable direct user-to-user communication (e.g., Private Automatic Branch Exchange (PABX)=to-PABX communication over a leased circuit). Extensions for symmetrical call operation are described in annex D of ATIS-1000607.

5   Structure of Layer 3

5.1   Categories of Functions

There are two categories of functions per- formed at Layer 3 and services provided by Layer 3 in signalling. The first category contains those functions that directly control connections and supplementary services.

The second category contains those functions relating to the transport of messages additional to the functions provided by the data-link layer. An example of the additional Layer 3 functions is the provision of re-routing of signalling messages on an alternate D-Channel (where provided) in the event of D-Channel failure. Other possible functions in this category may include multiplexing and message segmentation and blocking.

It is intended that the communications between these two categories will be aligned as far as possible, with the primitives used between the user parts and the message-transfer part in Signalling System No. 7.

Further study is required to determine the functions to be included in each category.

6 Functions of Layer 3

The Layer 3 protocol is designed to effect the establishment and control of circuit-switched and packet-switched connections. The functions support procedures for both basic call control and call control in conjunction with net- work-provided supplementary facilities. Furthermore, services involving the use of connections of different types, according to user's specification, may be effected through "multi-media" call control procedures.

Functions performed by Layer 3 include the following:

- processing of primitives for communicating with the data-link layer;
- generation and interpretation of Layer 3 messages for peer-level communication;
- administration of timers and logical entities (e.g., call-references) used in call control procedures;
- administration of access resources, including B-Channels, and packet-layer logical channels {e.g., ITU-T Recommendation X.25);
- checking to ensure that services provided are consistent with user requirements (e.g., as expressed by bearer capability, addresses, low layer and high layer compatibilities).

This list of Layer 3 functions is not exhaustive, and it is not intended to imply that all of these functions are provided on both the terminal and the network side of the user-network interface.

The following general functions may also be performed by Layer 3:

- routing and relaying;
- network connection control;
- conveying user-to-network and network- to-user information;
- network connection multiplexing; segmenting and reassembly;
- error detection;
- error recovery;
- sequencing;
- congestion control and user-data flow control; and
- restart.

6.1 Routing & Relaying

Network connections exist either between users or between users and ISDN exchanges. Network connections may involve intermediate systems that provide relays to other interconnecting subnetworks and that facilitate inter- working with other networks. Routing functions determine an appropriate route between Layer 3 addresses.

6.2 Network Connection Control

This function includes mechanisms for providing network connections making use of data connections provided by the data-link layer.

6.3 Conveying User Information

This function may be carried out with or with- out the establishment of a circuit-switched connection.

6.4 Network Connection Multiplexing

Layer 3 provides multiplexing of call control information for multiple calls onto a single data-link connection.

6.5 Segmenting & Reassembly

Layer 3 may segment and reassemble messages for the purpose of facilitating their transfer across the local user-network interface.

6.6 Error Detection

Error detection functions are used to check for procedural errors in the Layer 3 protocol. Error detection in Layer 3 uses, among other information, notification of loss of information from the data-link layer.

6.7 Error recovery

This function includes mechanisms for recovering from detected errors.

6.8 Sequencing

This function includes mechanisms for *provid*ing the service of sequenced delivery of Layer 3 information over a given network connection when requested. In normal conditions Layer 3 ensures the delivery of information in the sequence it is submitted by the user.

6.9 Congestion Control & User Data Flow Control

Layer 3 may indicate rejection or unsuccessful indication for connection establish requests to control congestion within the network.

6.10 Restart

This function is used to return channels and interfaces to an idle condition to recover from certain abnormal conditions.

7 Interface between Layer 3 & the Adjacent Layers

7.1 Overview of the Interfaces

ISDN user-network interface Layer 3 provides its services to the upper layer via Layer 3 service access point (SAP), and receives services from the data-link layer via data-link layer SAP, as shown in figure 1. A particular service is provided to the upper layer, or received from the data-link layer, by exchanging a corresponding sequence of primitives across the SAP.

7.2 Interface between Layer 3 & Data-Link Layer

Overview of the interface between ISDN user- network interface Layer 3 and the data-link layer from the viewpoint of the data-link layer is given in Section 2 of ITU-T Recommendation Q.920. Primitives and primitive procedures for this interface are specified in section 4 of ITU-T Recommendation Q.921. The texts of these two ITU-T Recommendations are printed with ATIS-1000602.

7.3 Interface between Layer 3 & Upper Layer

Primitives and primitive procedures for this interface are not defined in this standard.

8 Suite of Layer 3 Standards

The suite of American National Standards on Layer 3 DSS1 protocols is:

– ATIS-1000607, *Integrated services digital network (ISDN) – Layer 3 signaling specification for circuit-switched bearer ser- vice for digital subscriber signaling system number 1 (DSS1)*

– ATIS-1000608, *Telecommunications- Digital subscriber signaling system no. 1 (DSS1)- Layer 3 signaling specification for X.25 Packet switched bearer service*

– ATIS-1000610, *Telecommunications- Digital subscriber signaling system no. 1 (DSS1)- Generic procedures for the control of ISDN supplementary services*

– ATIS-1000615, *Telecommunications- Digital subscriber signalling system no. 1 (DSS1)- Layer 3 overview*
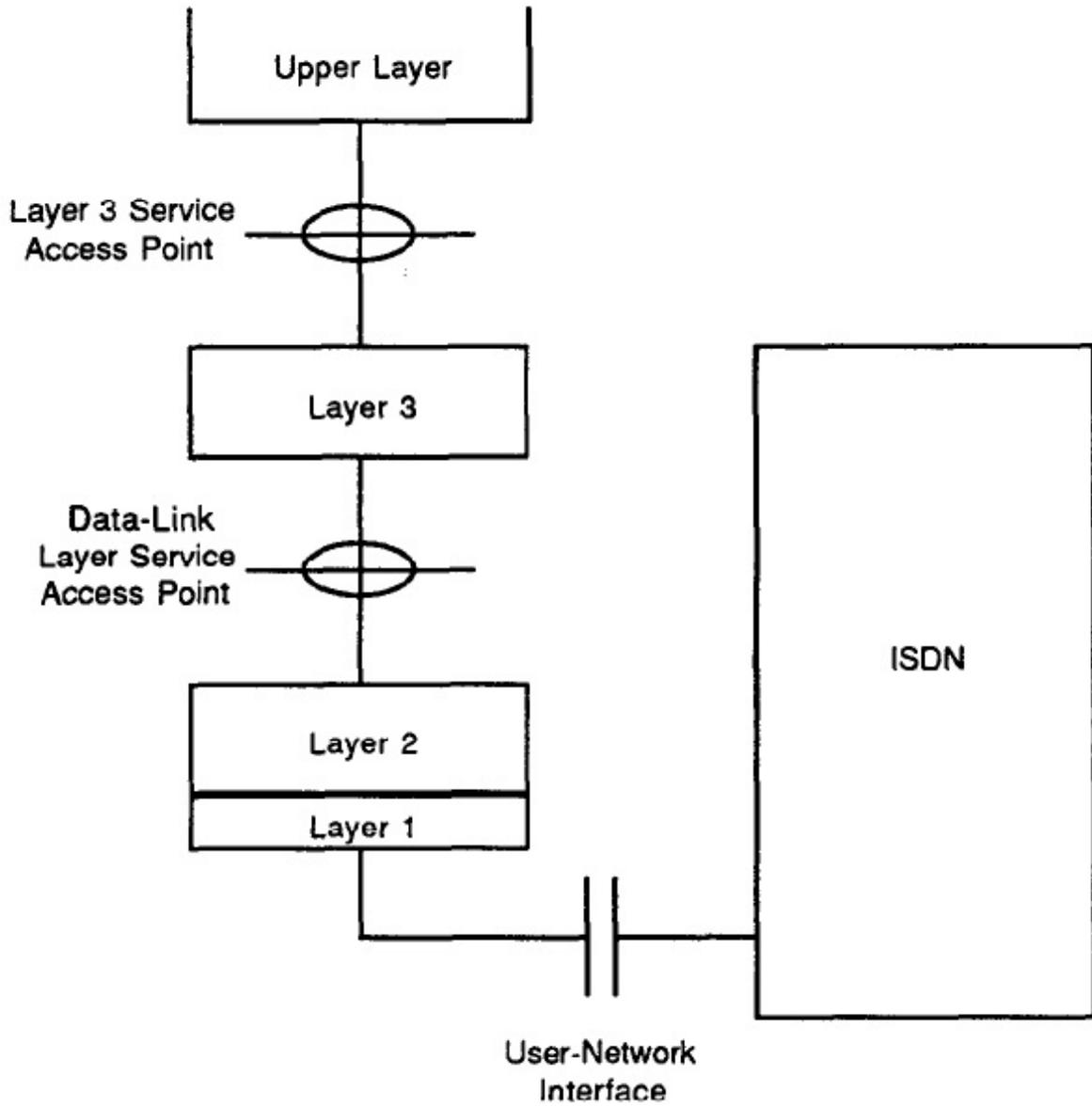
Figure 1: Overview of Interfaces between Layer 3 and Other Layers

Annex A: Bibliography (Informative)

ATIS-1000608.1991(R2012), *Integrated Services Digital Network (ISDN) - Signaling Specification for X.25 Packet-Switched Bearer Service for Digital Subscriber Signaling System Number 1 (DSS1).*

ATIS-1000610.1998(R2013), *Generic Procedures for the Control of ISDN Supplementary Services.*