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PART IV

I.400-Series Recommendations

ISDN USER-NETWORK INTERFACES

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SECTION 1

ISDN USER-NETWORK INTERFACES

Recommendation I.410

GENERAL ASPECTS AND PRINCIPLES RELATING TO RECOMMENDATIONS ON ISDN USER-NETWORK INTERFACES

(Malaga-Torremolinos, 1984)

1 General

1.1 Recommendation I.120 gives the conceptual principles on which an ISDN should be based. The main feature of an ISDN is the support of a wide range of service capabilities, including voice and nonvoice applications, in the same network by offering end-to-end digital connectivity.

1.2 A key element of service integration for an ISDN is the provision of a limited set of standard multipurpose user-network interfaces. These interfaces represent a focal point both for the development of ISDN network components and configurations and for the development of ISDN terminal equipment and applications.

1.3 An ISDN is recognized by the service characteristics available through user-network interfaces, rather than by its internal architecture, configuration or technology. This concert plays a key role in permitting user and network technologies and configurations to evolve separately.

2 Interface applications

Figure 1/I.410 shows some examples of ISDN user-network interfaces. The following cases are identified, corresponding to:

1) access of a single ISDN terminal;

2) access of a multiple ISDN terminal installation;

3) access of multiservice PBXs, or local area networks, or, more generally, of private networks;

4) access of specialized storage and information processing centres.

In addition, depending on the particular national regulatory arrangements, either ISDN user-network interfaces or internetwork interfaces may be used for access of:

5) dedicated service networks;

6) other multiple services networks, including ISDNs.

3 Interface Recommendation objectives

User-network interface Recommendations should allow:

1) different types of terminals and applications to use the same interface;

2) portability of terminals from one location to another (office, home, public access points) within one country and from one country to another country;

3) separate evolution of both terminal and network equipment, technologies and configurations;

4) efficient connection with specialized storage and information processing centres and other networks.

Figure 1/I.410, p.

User-network interfaces should be designed to provide an appropriate balance between service capabilities and cost/tariffs, in order to meet service demand easily.

4 Interface characteristics

User-network interfaces are specified by a comprehensive set of characteristics, including:

1) physical and electromagnetic (including optical) characteristics;

2) channel structures and access capabilities;

3) user-network protocols;

4) maintenance and operation characteristics;

5) performance characteristics;

6) service characteristics.

A layered approach has been adopted for the definition of ISDN user-network interfaces according to the ISDN protocol reference model, Recommendation I.320.

5 Interface capabilities

In addition to the multiservice capability, an ISDN user-network interface may allow for capabilities such as the following:

1) multidrop and other multiple terminal arrangements;

2) choice of information bit rate, switching mode, coding method, etc., on a call-by-call or other (e.g. semi-permanent or subscription time option) basis, over the same interface according to the user's need;

3) capability for compatibility checking in order to check whether calling and called terminals can communicate with each other.

6 Other I-Series Recommendations

6.1 The reference configurations for ISDN user-network interfaces define the terminology for various reference points and the types of functions that can be provided between reference points. Recommendation I.411 contains the reference configurations and shows significant applications.

6.2 The number of different interfaces is kept to a minimum. Recommendation I.412 defines a limited set of interface structures, and possible access capabilities for the ISDN user-network interfaces. A distinction is necessary between the interface structure and the access capability supported by the particular network access arrangement.

6.3 The user-network interfaces, as defined in Recommendations I.420 and I.421, are applicable to a wide range of situations without modification (e.g. to both reference points S and T, as defined in Recommendation I.411).

Recommendation I.411

ISDN USER-NETWORK INTERFACES — REFERENCE CONFIGURATIONS

(Malaga-Torremolinos, 1984)

1 General

1.1 This Recommendation provides the reference configurations for ISDN user-network interfaces.

1.2 From the user's perspective, an ISDN is completely described by the attributes that can be observed at an ISDN user-network interface, including physical, electromagnetic, protocol, service, capability, maintenance, operation and performance characteristics. The key to defining, and even recognizing, an ISDN is the specification of these characteristics.

1.3 An objective of ISDN is that a small set of compatible user-network interfaces can economically support a wide range of user applications, equipment and configurations. The number of different user-network interfaces is minimized to maximize user flexibility through terminal compatibility (from one application to another, one location to another, and one service to another) and to reduce costs through economies in production of equipment and operation of both ISDN and user equipment. However, different interfaces are required for applications with widely different information rates, complexity, or other characteristics, as well as for applications in the evolutionary stages. In this way, simple applications need not to be burdened with the cost of accommodating features employed by complex applications.

1.4 Another objective is to have the same interfaces used even though there are different configurations (e.g. single terminal versus multiple terminal connections, connections to a PABX versus direct connections into the network, etc.) or different national regulations.

2 Definitions

2.1 **Reference configurations** are conceptual configurations useful in identifying various possible physical user access arrangements to an ISDN. Two concepts are used in defining reference configurations: reference points and functional groupings. Layout and application examples of reference configurations are given in § 3.

2.2 **Functional groups** are sets of functions which 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. Note that specific functions in a functional group may be performed in one or more pieces of equipment.

2.3 **Reference points** are the conceptual points dividing functional groups. 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. Physical interfaces that do not correspond to a reference point (e.g. transmission line interfaces) will not be the subject of ISDN user-network interface Recommendations.

3 Reference configuration

3.1 The reference configurations for ISDN user-network interfaces define reference points and types of functions that can be provided between reference points. Figure 1/I.411 shows the reference configurations, while Figures 2/I.411, 3/I.411 and 4/I.411 show examples of applications of such configurations.

3.2 The ISDN user-network interface Recommendations in the I-Series apply to physical interfaces at reference points S and T, using the recommended interface structures according to Recommendation I.412. At reference point R, physical interfaces in accordance with other Recommendations (e.g. the X-Series interface Recommendations) may be used.

Note 1 — Physical interfaces not included in CCITT Recommendations may appear at reference point R.

Note 2 — There is no reference point assigned to the transmission line, since an ISDN user-network interface is not envisaged at this location.

3.3 Figure 1a/I.411 defines the reference configuration with the functional groups NT1, NT2 and TE1. Figure 1b/I.411 illustrates that TE1 may be replaced by the combination of TE2 and TA.

Figure 1/I.411, p.

3.4 Lists of functions for each functional group are given below. Each particular function is not necessarily restricted to a single functional group. For example, ‘‘interface termination’’ functions are included in the function lists of NT1, NT2 and TE. The function lists for NT2, TE and TA are not exhaustive. For a particular access arrangement, specific functions in a functional group are either present or absent.

The functional groups are described in relation to the ISDN protocol reference model in Recommendation I.320.

3.4.1 *Network termination 1 (NT1)*

This functional group 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. NT1 functions are:

— line transmission termination;

— layer 1 line maintenance functions and performance monitoring;

— timing;

— power transfer;

— layer 1 multiplexing;

— interface termination, including multidrop termination employing layer 1 contention resolution.

3.4.2 *Network termination 2 (NT2)*

This functional group includes functions broadly equivalent to layer 1 and higher layers of the Recommendation X.200 reference model. PABXs, local area networks, and terminal controllers are examples of equipment or combinations of equipment that provide NT2 functions. NT2 functions include:

— layers 2 and 3 protocol handling;

— layers 2 and 3 multiplexing;

— switching;

— concentration;

— maintenance functions; and

— interface termination and other layer 1 functions.

For example, a simple PABX can provide NT2 functions at layers 1, 2 and 3. A simple terminal controller can provide NT2 functions at only layers 1 and 2. A simple time division multiplexer can provide NT2 functions at only layer 1. In a specific access arrangement, the NT2 functional group may consist of only physical connections.

3.4.3 *Terminal equipment (TE)*

This functional group includes functions broadly belonging to layer 1 and higher layers of the Recommendation X.200 reference model. Digital telephones, data terminal equipment, and integrated work stations are examples of equipment or combinations of equipment that provide the functions. The TE functions are:

— protocol handling;

— maintenance functions;

— interface functions;

— connection functions to other equipments.

3.4.3.1 *Terminal equipment type 1 (TE1)*

This functional group includes functions belonging to the functional group TE, and with an interface that complies with the ISDN user-network interface Recommendations.

3.4.3.2 *Terminal equipment type 2 (TE2)*

This functional group includes functions belonging to the functional group TE but with an interface that complies with interface Recommendations other than the ISDN interface Recommendation (e.g. the X-Series interface Recommendations) or interfaces not included in CCITT Recommendations.

3.4.4 *Terminal adaptor (TA)*

This functional group includes functions broadly belonging to layer 1 and higher layers of the Recommendation X.200 reference model that allow a TE2 terminal to be served by an ISDN user-network interface. Adaptors between physical interfaces at reference points R and S or R and T are examples of equipment or combinations of equipment that provide TA functions.

4 Physical realizations of reference configurations

4.1 Figure 2/I.411 gives examples of configurations illustrating combinations of physical interfaces at reference points R, S and T; Figures 2a/I.411 and 2b/I.411 show separate interfaces at S and T; Figures 2c/I.411 and 2d/I.411 show an interface at S but not T; Figures 2e/I.411 and 2f/I.411 show an interface at T but not S; Figures 2g/I.411 and 2h/I.411 show an interface at S and T where they coincide. Additionally, Figures 2b/I.411, 2d/I.411, 2f/I.411 and 2h/I.411 show an interface at reference point R.

4.2 Figures 3/I.411 and 4/I.411 show examples of physical implementations. The examples given in Figure 3/I.411 show physical realizations of functional groups TE, NT1 and NT2, based on physical interfaces occurring at reference points R, S and T. The examples given in Figure 4/I.411 show applications of the reference configurations to physical configurations when multiple physical interfaces occur at a reference point.

The examples given in Figure 4/I.411 are not intended to be either exhaustive or mandatory. Square blocks in Figures 3/I.411 and 4/I.411 represent equipment implementing functional groupings.

Note — TE1 or TE2 + TA may be used interchangeably in Figure 4/I.411.

4.2.1 Figures 4a/I.411 and 4b/I.411 show applications of the reference configurations in the cases where NT2 functions consist of only physical connections. Figure 4a/I.411 describes the direct physical connection of multiple TEs (TE1s or TE2s + TAs) to NT1 using a multidrop arrangement (i.e. a bus). Figure 4b/I.411 illustrates the separate connection of a number of TEs to NT1.

In these cases, all of the characteristics of the physical interfaces applied at reference points S and T must be identical.

4.2.2 Figure 4c/I.411 shows the provision of multiple connections between NT2 and TEs. NT2 may include various types of distribution arrangements, such as star, bus or ring configuration included within the equipment. Figure 4d/I.411 shows a case where a bus distribution is used between TEs and the NT2 equipment.

4.2.3 Figures 4e/I.411 and 4f/I.411 show arrangements where multiple connections are used between NT2 and NT1 equipment. In particular, Figure 4e/I.411 illustrates the case of multiple NT1 equipment, while Figure 4f/I.411 refers to the case where NT1 provides layer 1 upward multiplexing of the multiple connections.

4.2.4 Figure 4g/I.411 illustrates the case where NT1 and NT2 functions are merged in the same equipment; the corresponding merging of NT1 and NT2 functions for other configurations in Figure 4/I.411 may also occur.

4.2.5 Figure 4h/I.411 illustrates the case where TA and NT2 functions are merged in the same equipment; the corresponding merging of TA and NT2 functions for other configurations in Figure 4/I.411 may also occur.

4.2.6 In addition to the examples of physical implementation shown in Figures 3/I.411 and 4/I.411, a possible combination of NT1, NT2 and TA into one physical entity could be considered, in which both reference points S and T exist but are not realized as physical interfaces. Such an implementation is to be considered an interim means of providing connection to an ISDN and might be used to complement the recommended means of connecting terminals via physical interfaces at reference points S and T in the early stages of ISDN implementation. This should not be considered as a reference configuration because it poses significant problems in relation to the models of ISDN presently being studied.

4.2.7 These physical implementations are limited in their arrangements and combinations by the electrical and other characteristics of the interface specifications and equipment.

4.3 The reference-configurations given in Figure 1/I.411 apply for the specification of the interface structures and access arrangements given in Recommendation I.412.

Figure 2/I.411, p. 3

Figure 3/I.411, p. 4

Figure 4/I.411, p. 5

Recommendation I.412

ISDN USER-NETWORK INTERFACES

INTERFACE STRUCTURES AND ACCESS CAPABILITIES

(Malaga-Torremolinos, 1984; amended at Melbourne, 1988)

1 General

This Recommendation defines limited sets of both channel types and interface structures for ISDN user-network physical interfaces.

2 Definitions

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

2.2 Channels are classified by channel types, which have common characteristics. Channel types are specified in § 3.

2.3 The channels are combined into interface structures, specified in § 4. An interface structure defines the maximum digital information-carrying capacity across a physical interface.

2.4 In an actual access arrangement some of the channels available across an ISDN user-networks physical interface, as defined in the applicable interface structure, may not be supported by the network. Some ISDN services will not require the full capacity of a B-channel; in those cases in which users require only such services, the access capability might be further reduced. The capability provided by those channels that are actually available for communication purposes, is referred to as the access capability provided through the interface.

3 Channel types and their use

3.1 *B-channel*

3.1.1 The B-channel is a 64 kbit/s channel accompanied by timing.

Note — The method for providing this timing is a subject of the individual interface Recommendations.

A B-channel is intended to carry a wide variety of user information streams. A distinguishing characteristic is that a B-channel does not carry signalling information for circuit switching by the ISDN. Signalling information used for circuit switching by the ISDN is carried over other types of channels, e.g. a D-channel.

3.1.2 User information streams may be carried on a B-channel on a dedicated, alternate (within one call or as separate calls), or simultaneous basis, consistent with the B-channel bit rate. The following are samples of user information streams:

i) voice encoded at 64 kbit/s according to Recommendation G.711;

ii) data information corresponding to circuit or packet-switching user classes of service at bit rates less than or equal to 64 kbit/s, according to Recommendation X.1;

iii) wideband voice encoded at 64 kbit/s according to Recommendation G.722;

iv) voice encoded at bit rates lower than 64 kbit/s alone, or combined with other digital information streams.

It is recognized that a B-channel may also be used to carry user information streams not covered by CCITT Recommendations.

3.1.3 B-channels may be used to provide access to a variety of communication modes within the ISDN. Examples of these modes are:

i) circuit switching;

ii) packet switching, supporting packet mode terminals; and

iii) semi-permanent connections.

In case i), the ISDN can provide either a transparent end-to-end 64 kbit/s connection or a connection specifically suited to a particular service, such as telephony, in which case a transparent 64 kbit/s connection may not be provided.

In case ii), the B-channel will carry protocols at layers 2 and 3 according to Recommendation X.25 which have to be handled by the network. The application of D-channel protocols for this case is for further study.

In case iii), the semi-permanent connection can be provided, for example by using circuit or packet switching modes.

3.1.4 Single information streams at bit rates less than 64 kbit/s should be rate adapted to be carried on the B-channel as described in Recommendation I.460.

3.1.5 Multiple information streams from a given user may be multiplexed together in the same B-channel, but for circuit switching, an entire B-channel will be switched to a single user-network interface. This multiplexing should be in accordance with Recommendation I.460.

Note — Independent routing of subrate channels circuit switched to different destinations is for further study.

3.2 *D-channel*

3.2.1 The D-channel may have different bit rates as specified in § 4.

A D-channel is primarily intended to carry signalling information for circuit switching by the ISDN.

A D-channel uses a layered protocol according to Recommendations I.440, I.441, I.450 and I.451. In particular the link access procedure is frame oriented (Note).

Note — The use of Signalling System No. 7 at a user-network interface is for further study.

3.2.2 In addition to signalling information for circuit switching, a D-channel may also be used to carry teleaction information and packet-switched data.

In certain cases where such signalling is not being utilized, the D-channel may support only teleaction information or packet-switched data.

3.3 *H-channels*

3.3.1 H-channels have the following bit rates, accompanied by timing:

H_0 channel : 384 kbit/s

H_1 channels : 1536 (H_{11}) and 1920 (H_{12}) kbit/s.

Note — The method for providing this timing is a subject of the individual interface Recommendation.

Higher rate H-channels are for further study.

An H-channel is intended to carry a variety of user information streams. A distinguishing characteristic is that an H-channel does not carry signalling information for circuit switching by the ISDN.

3.3.2 User information streams may be carried on an H-channel on a dedicated, alternate (within one call or as separate calls), or simultaneous basis, consistent with the H-channel bit rates. The following are examples of user information streams:

i) fast facsimile;

ii) video: e.g. for teleconferencing;

iii) high speed data;

iv) high quality audio or sound programme material;

v) information streams, each at rates lower than the respective H-channel bit rate (e.g. voice at 64 kbit/s), which have been rate adapted or multiplexed together;

vi) packet-switched information.

3.4 *Other channels*

For further study.

4 Interface structures

ISDN user-network physical interfaces at ISDN reference points S and T shall comply with one of the interface structures defined below.

4.1 *B-channel interface structures*

4.1.1 *Basic interface structure*

4.1.1.1 The basic interface structure is composed of two B-channels and one D-channel, 2 B + D. The bit rate of the D-channel in this interface structure is 16 kbit/s.

4.1.1.2 The B-channels may be used independently; i.e. in different connections at the same time.

4.1.1.3 With the basic interface structure, two B-channels and one D-channel are always present at the ISDN user-network physical interface. One or both B-channels, however, may not be supported by the network. See Appendix I.

4.1.2 *Primary rate B-channel interface structures*

These structures correspond to the primary rates of 1544 kbit/s and 2048 kbit/s.

4.1.2.1 The primary rate B-channel interface structures are composed of B-channels and one D-channel. The bit rate of this D-channel is 64 kbit/s.

4.1.2.2 At the 1544 kbit/s primary rate the interface structure is 23 B + D.

4.1.2.3 At the 2048 kbit/s primary rate the interface structure is 30 B + D.

4.1.2.4 With the primary rate B-channel interface structures, the designated number of B-channels is always present at the ISDN user-network physical interface. One or more of the B-channels may not be supported by the network.

4.1.2.5 In the case of a user-network access arrangement containing multiple interfaces, it is possible for the D-channel in one structure to carry the signalling for B-channels in another primary rate structure without an activated D-channel. When a D-channel is not activated, the designated time slot may or may not be used to provide an additional B-channel, depending on the situation; e.g., 24 B for a 1544 kbit/s interface.

4.2 *H-channel interface structure*

4.2.1 *Primary rate interface H_0-channel structures*

4.2.1.1 The primary rate interface H_0-channel structures are composed of H_0-channels with or without a D-channel, as indicated below. When present in the same interface structure the bit rate of the D-channel is 64 kbit/s. Additional primary rate interface H_0-channel structures are for further study.

4.2.1.2 At the 1544 kbit/s primary rate interface the H_0-channel structures are 4 H_0 and 3 H_0 + D. The use of the additional capacity across the interface is for further study. When the D-channel is not provided, signalling for the H_0-channels is provided by the D-channel in another interface.

4.2.1.3 At the 2048 kbit/s primary rate interface the H_0-channel structure is 5 H_0 + D. In the case of a user-network access arrangement containing multiple interfaces, it is possible for the D-channel in one structure to carry the signalling for H_0-channels in another primary rate interface without a D-channel in use.

4.2.1.4 With the primary rate interface H_0-channel structures, the designated number of H_0-channels is always present at the user-network physical interface. One or more of the H_0-channels may not be supported by the network.

4.2.1.5 In the case of a user-network access arrangement containing multiple interfaces it is possible for the D-channel of one structure to carry the signalling for H_0-channels in another primary rate interface structure without an activated D-channel. When a D-channel is not required in a 1544 kbit/s interface, the 4 H_0-channel structure may be used.

4.2.2. *Primary rate interface H_1-channel structures*

4.2.2.1 *1536 kbit/s $H_{1\backslash d1}$-channel Structure*

The 1536 kbit/s $H_{1\backslash d1}$-channel structure is composed of one 1536 kbit/s $H_{1\backslash d1}$-channel. Signalling for the $H_{1\backslash d1}$-channel, if required, is carried in a D-channel on another interface structure within the same user-network access arrangement.

4.2.2.2 *1920 kbit/s $H_{1\backslash d2}$-channel Structure*

The 1920 kbit/s $H_{1\backslash d2}$-channel structure is composed of one 1920 kbit/s $H_{1\backslash d2}$-channel and a D-channel. The bit rate of the D-channel is 64 kbit/s. Signalling for the $H_{1\backslash d2}$-channel, if required, is carried in this D-channel or the D-channel of another interface structure within the same user-network access arrangement.

4.3 *Primary rate interface structures for mixtures of B- and H_0*annels

A primary rate interface may have a structure consisting of a single D-channel and any mixture of B- and H_0-channels. The bit rate of the D-channel is 64 kbit/s. In the case of a user-network access arrangement containing multiple interfaces, a D-channel in one interface structure may also carry signalling for channels in another interface structure. When a D-channel is not activated, its 64 kbit/s capacity may or may not be used for the mixture of B- and H_0-channels, depending on the situation, e.g. 3 H_0 + 6 B for a 1544 kbit/s interface.

4.4 *Other interface structure(s)*

For further study.

5 Examples of application of interface structures

5.1 *Access arrangement for PABX, terminal controller, local area network, etc.*

Figure 1/I.412 illustrates a typical PABX, or LAN access arrangement. For this particular configuration it is not necessary to apply the same interface structure at both S and T reference points. For example, basic interface structures may be used for interfaces located at reference point S. Either basic or primary rate or other interface structures may be used at interfaces located at reference point T.

Figure 1/I.412, p.

APPENDIX I
(to Recommendation I.412)

Access capabilities

I.1 As stated in § 2.4, not all of the channels present in an ISDN user-network physical interface are necessarily supported by the network. The resulting capability provided in an ISDN user-network access arrangement is defined as the access capability.

To assist in guiding the implementations of ISDN equipment and services around the world, several preferred access capabilities are identified here. While these preferred arrangements do not preclude the implementation of other access capabilities, they are intended to assist in the worldwide commonality which is a key objective of ISDN.

I.2 *Preferred access capabilities*

a) *Preferred basic access capabilities*

— 2 B + D

— B + D

— D

b) *Primary rate — B-channel access capabilities*

— *n* | B + D

n | 23 for 1544 kbit/s primary rate, unless signalling is provided in another physical interface (see § 4.1.2.5); then *n* = 24 may be allowed.

n 30 for 2048 kbit/s primary rate, unless signalling is provided in another physical interface (see § 4.1.2.5) then *n* = 31 may be allowed.

c) *Primary rate —* H_0*-channel access capabilities*

— *n* $|_0$+ D

n | 3 for 1544 kbit/s primary rate

n | 5 for 2048 kbit/s primary rate

— *n* $|_0$

n | 4 for 1544 kbit/s primary rate

d) *Other channel structure access capabilities*

For further study.

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SECTION 2

APPLICATION OF I-SERIES RECOMMENDATIONS TO

ISDN USER-NETWORK INTERFACES

Recommendation I.420

BASIC USER-NETWORK INTERFACE

(Malaga-Torremolinos, 1984)

The basic user-network interface structure is defined in Recommendation I.412. The detailed specifications are contained in Recommendations I.430 (layer 1), I.440 and I.441 (layer 2), I.450, I.451 and I.452 (layer 3).

Recommendation I.421

PRIMARY RATE USER-NETWORK INTERFACE

(Malaga-Torremolinos, 1984)

The primary rate user-network interface structures are defined in Recommendation I.412. The detailed specifications are contained in Recommendations I.431 (layer 1), I.440 and I.441 (layer 2), I.450, I.451 and I.452 (layer 3).

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SECTION 3

ISDN USER-NETWORK INTERFACES: LAYER 1 RECOMMENDATIONS

Recommendation I.430

BASIC USER-NETWORK INTERFACE — LAYER 1 SPECIFICATION

(Malaga-Torremolinos, 1984; amended at Melbourne, 1988)

1 General

This Recommendation defines the layer 1 characteristics of the user-network interface to be applied at the S or T reference points for the basic interface structure defined in Recommendation I.412. The reference configurations for the interface is defined in Recommendation I.411 and is reproduced in Figure 1/I.430.

Figure 1/I.430, p.

In this Recommendation, the term ''NT'' is used to indicate network terminating layer 1 aspects of NT1 and NT2 functional groups, and the term ''TE'' is used to indicate terminal terminating layer 1 aspects of TE1, TA and NT2 functional groups, unless otherwise indicated. However, in § 6.2 only, the terms ''NT'' and ''TE'' have the following meaning: the term ''NT'' is used to indicate the layer 1 network side of the basic access interface; the term ''TE'' is used to indicate the layer 1 terminal side of the basic access interface.

The terminology used in this Recommendation is very specific and not contained in the relevant terminology Recommendations. Therefore Annex E to this Recommendation provides terms and definitions used in this Recommendation.

2 Service characteristics

2.1 *Services required from the physical medium*

Layer 1 of this interface requires a balanced metallic transmission medium, for each direction of transmission, capable of supporting 192 kbit/s.

2.2 *Service provided to layer 2*

Layer 1 provides the following services to layer 2 and the management entity:

2.2.1 *Transmission capability*

Layer 1 provides the transmission capability, by means of appropriately encoded bit streams, for the B- and D-channels and the related timing and synchronization functions.

2.2.2 *Activation/deactivation*

Layer 1 provides the signalling capability and the necessary procedures to enable customer TEs and/or NTs to be deactivated when required and reactivated when required. The activation and deactivation procedures are defined in § 6.2.

2.2.3 *D-channel access*

Layer 1 provides the signalling capability and the necessary procedures to allow TEs to gain access to the common resource of the D-channel in an orderly fashion while meeting the performance requirement of the D-channel signalling system

2.2.4 *Maintenance*

Layer 1 provides the signalling capability, procedures and necessary functions at layer 1 to enable the maintenance functions to be performed.

2.2.5 *Status indication*

Layer 1 provides an indication to the higher layers of the status of layer 1.

2.3 *Primitives between layer 1 and the other entities*

Primitives represent, in an abstract way, the logical exchange of information and control between layer 1 and other entities. They neither specify nor constrain the implementation of entities or interfaces.

The primitives to be passed across the layer 1/2 boundary or to the management entity and parameter values associated with these primitives are defined and summarized in Table 1/I.430. For description of the syntax and use of the primitives, refer to Recommendation X.211 and relevant detailed descriptions in § 6.

3 Modes of operation

Both point-to-point and point-to-multipoint modes of operation, as described below, are intended to be accommodated by the layer 1 characteristics of the user-network interface. In this Recommendation, the modes of operation apply only to the layer 1 procedural characteristics of the interface and do not imply any constraints on modes of operation at higher layers.

3.1 *Point-to-point operation*

Point-to-point operation at layer 1 implies that only one source (transmitter) and one sink (receiver) are active at any one time in each direction of transmission at an S or T reference point. (Such operation is independent of the number of interfaces which may be provided on a particular wiring configuration — see § 4).

H.T. [T1.430]

TABLE 1/I.430

Primitives associated with layer 1

lw(228p) . lw(228p) . L1 | (<- | 2 _ lw(54p) | lw(30p) | lw(30p) | lw(30p) | lw(54p) .
lw(228p) . M | (<- | 1 _ lw(54p) | cw(30p) | cw(30p) | cw(30p) | cw(30p) | lw(54p) .
MPH-ERROR — X — X { Type of error or recovery from a previously reported error

} _ lw(54p) | cw(30p) | cw(30p) | cw(30p) | cw(30p) | lw(54p) . MPH-ACTIVATE — X — — _ lw(54p) | cw(30p) | cw(30p) | cw(30p) | cw(30p) | lw(54p) . MPH-DEACTIVATE X X — — _ lw(54p) | cw(30p) | cw(30p) | cw(30p) | cw(30p) | lw(54p) . MPH-INFORMATION — X — X Connected/disconnected

Note 1 — PH-DATA REQUEST implies underlying negotiation between layer 1 and layer 2 for the acceptance of the data.

Note 2 — Priority indication applies only to the request type.

Tableau 1/I.430 [T1.430], p. 8

3.2 *Point-to-multipoint operation*

Point-to-multipoint operation at layer 1 allows more than one TE (source and sink pair) to be simultaneously active at an S or T reference point. (The multipoint mode of operation may be accommodated, as discussed in § 4, with point-to-point or point-to-multipoint wiring configurations.)

4 Types of wiring configuration

The electrical characteristics of the user-network interface are determined on the basis of certain assumptions about the various wiring configurations which may exist in the user premises. These assumptions are identified in two major configuration descriptions, § 4.1 and § 4.2, together with additional material contained in Annex A. Figure 2/I.430 shows a general Reference Configuration for wiring in the user premises.

4.1 *Point-to-point configuration*

A point-to-point wiring configuration implies that only one source (transmitter) and one sink (receiver) are interconnected on an interchange circuit.

4.2 *Point-to-multipoint configuration*

A point-to-multipoint wiring configuration allows more than one source to be connected to the same sink or more than one sink to be connected to the same source on an interchange circuit. Such distribution systems are characterized by the fact that they contain no active logic elements performing functions (other than possibly amplification or regeneration of the signal).

4.3 *Wiring polarity integrity*

For a point-to-point wiring configuration , the two wires of the interchange circuit pair may be reversed. However, for a point-to-multipoint wiring configuration, the wiring polarity integrity of the interchange circuit (TE-to-NT direction) must be maintained between TEs (see the reference configuration in Figure 20/I.430).

In addition, the wires of the optional pairs, which may be provided for powering, may not be reversed in either configuration.

4.4 *Location of the interfaces*

The wiring in the user premises is considered to be one continuous cable run with jacks for the TEs and NT attached directly to the cable or using stubs less than 1 metre in length. The jacks are located at interface points I_A and I_B (see Figure 2/I.430). One interface point, I_A, is adjacent to each TE. The other interface point I_B, is adjacent to the NT. However, in some applications, the NT may be connected to the wiring without the use of a jack or with a jack which accommodates multiple interfaces (e.g., when the NT is a port on a PBX). The required electrical characteristics (described in § 8) for I_A and I_B are different in some aspects.

Figure 2/I.430, p.

4.5 *NT and TE associated wiring*

The wiring from the TE or the NT to its appropriate jack affects the interface electrical characteristics. A TE, or an NT that is not permanently connected to the interface wiring, may be equipped with either of the following for connection to the interface point (I_A and I_B, respectively):

— a hard wired connecting cord (of not more than 10 metres in the case of a TE, and not more than 3 metres in the case of an NT) and a suitable plug, or;

— a jack with a connecting cord (of not more than 10 metres in the case of a TE, and not more than 3 metres in the case of an NT) which has a suitable plug at each end.

Normally, the requirements of I.430 apply to the interface point (I_A and I_B, respectively), and the cord forms part of the associted TE or NT. However, as a national option, where the terminating resistors are connected internally to the NT, the connecting cord may be considered as an integral part of the interface wiring. In this case, the requirements of this Recommendation may be applied to the NT at the connection of the connecting cord to the NT. Note that the NT may attach directly to the interface wiring without a detachable cord. Also note that the connector, plug and jack used for the connection of the detachable cord to the NT is not subject to standardization.

Although a TE may be provided with a cord of less than 5 metres in length, it shall meet the requirements of this Recommendation with a cord having a minimum length of 5 metres. As specified above, the TE cord may be detachable. Such a cord may be provided as a part of the TE, or the TE may be designed to conform to the electrical characteristics specified in § 8 with a ‘‘standard ISDN basic access TE cord’’ conforming to the requirements specified in § 8.9 of this Recommendation and having the maximum permitted capacitance.

The use of an extension cord , of up to 25 metres in length, with a TE is permitted but only on point-to-point wiring configurations. (The total attenuation of the wiring and of the cord in this case should not exceed 6 dB.)

5 Functional characteristics

The following paragraphs show the functions for the interface.

5.1 *Interface functions*

5.1.1 *B-channel*

This function provides, for each direction of transmission, two independent 64 kbit/s channels for use as B-channels (as defined in Recommendation I.412).

5.1.2 *Bit timing*

This function provides bit (signal element) timing at 192 kbit/s to enable the TE and NT recover information from the aggregate bit stream

5.1.3 *Octet timing*

This function provides 8 kHz octet timing for the NT and TE.

5.1.4 *Frame alignment*

This function provides information to enable NT and TE to recover the time division multiplexed channels.

5.1.5 *D-channel*

This function provides, for each direction of transmission, one D-channel at a bit rate of 16 kbit/s, as defined in Recommendation I.412.

5.1.6 *D-channel access procedure*

This function is specified to enable TEs to gain access to the common resource of the D-channel in an orderly controlled fashion. The functions necessary for these procedures include an echoed D-channel at a bit rate of 16 kbit/s in the direction NT to TE. For the definition of the procedures relating to D-channel access see § 6.1.

5.1.7 *Power feeding*

This function provides for the capability to transfer power across the interface. The direction of power transfer depends on the application. In a typical application, it may be desirable to provide for power transfer from the NT towards the TEs in order to, for example, maintain a basic telephony service in the event of failure of the locally provided power. (In some applications unidirectional power feeding or no power feeding at all, across the interface, may apply.) The detailed specification of power feeding capability is contained in § 9.

5.1.8 *Deactivation*

This function is specified in order to permit the TE and NT to be placed in a low power consumption mode when no calls are in progress. For TEs that are power fed across the interface from power source 1 and for remotely power fed NTs, deactivation places the functions that are so powered into a low power consumption mode (see § 9). The procedures and precise conditions under which deactivation takes place are specified in § 6.2. (For some applications it will be appropriate for NTs to remain in the active state all the time.)

5.1.9 *Activation*

This function restores all the functions of a TE or an NT, which may have been placed into a low power consumption mode during deactivation, to an operating power mode (see § 9), whether under normal or restricted power conditions. The procedures and precise conditions under which activation takes place are defined in | (sc 6.2. (For some applications it will be appropriate for NTs to remain in the active state all the time.)

5.2 *Interchange circuits*

Two interchange circuits, one for each direction of transmission, shall be used to transfer digital signals across the interface. All of the functions described in § 5.1, except for power feeding, shall be carried by means of a digitally multiplexed signal structured as defined in § 5.4.

5.3 *Connected/disconnected indication*

The appearance/disapearance of power is the criterion used by a TE to determine whether it is connected/disconnected at the interface. This is necessary for TEI (Terminal Endpoint Identifier) assignments according to the procedures described in Recommendation I.441.

A TE which considers itself connected, when unplugged, can cause duplication of TEI values after reconnection. When duplication occurs, procedures described in Recommendation I.441 will permit recovery.

5.3.1 *TEs powered across the interface*

A TE which is powered from power source 1 or 2 across the interface shall use the detection of power source 1 or 2, respectively, to establish the connection status. (See § 9 and Figure 20/I.430 for a description of the power sources.)

5.3.2 *TEs not powered across the interface*

A TE which is not powered across the interface may use either:

a) the detection of power source 1 or power source 2, whichever may be provided, to establish the connection status; or

b) the presence/absence of local power to establish the connection status.

TEs which are not powered across the interface and are unable to detect the presence of power source 1 or 2 shall consider themselves connected/disconnected when local power is applied/removed.

Note — It is desirable to use the detection of power source 1 or source 2 to establish the connection status when automatic TEI selection procedures are used within the management entity.

5.3.3 *Indication of connection status*

TEs which use the detection of power source 1 or 2, whichever is used to determine connection/disconnection, to establish the connection status shall inform the management entity (for TEI purposes) using:

a) MPH-INFORMATION INDICATION (connected)

when operational power and the presence of power source 1 or 2, whichever is used to determine connection/disconnection, is detected; and

b) MPH-INFORMATION INDICATION (disconnected) when the disappearance of power source 1 or 2, whichever is used to determine connection/disconnection, is detected, or power in the TE is lost.

TEs which are unable to detect power source 1 or 2, whichever may be provided, and, therefore, use the presence/absence of local power to estabish the connection status [see § 5.3.2 b)], shall inform the management entity using:

a) MPH-INFORMATION INDICATION (disconnected)

when power (see Note) in the TE is lost;

b) MPH-INFORMATION INDICATION (connected)

when power (see Note) in the TE is applied.

Note — The term ‘‘power’’ could be the full operational power or backup power TEI values in memory and maintain the capability of receiving and transmiting layer 2 frames associated with the TEI procedures.

5.4 *Frame structure*

In both directions of transmission, the bits shall be grouped into frames of 48 bits each. The frame structure shall be identical for all configurations (point-to-point and point-to-multipoint).

5.4.1 *Bit rate*

The nominal transmitted bit rate at the interfaces shall be 192 kbit/s in both directions of transmission.

5.4.2 *Binary organization of the frame*

The frame structures are different for each direction of transmission. Both structures are illustrated diagrammatically in Figure 3/I.430.

Figure 3/I.430, p.

5.4.2.1 *TE to NT*

Each frame consists of the groups of bits shown in Table 2/I.430; each individual group is d.c.-balanced by its last bit (L bit).

5.4.2.2 *NT to TE*

Frames transmitted by the NT contain an echo channel (E bits) used to retransmit the D bits received from the TEs. The D-echo channel is used for D-channel access control. The last bit of the frame (L bit) is used for balancing each complete frame.

The bits are grouped as shown in Table 3/I.430.

H.T. [T2.430]

TABLE 2/I.430

Bit position	Group
1 and 2	{ Framing signal with balance bit }
3 - 11	{ B1-channel (first octet) with balance bit }
12 and 13	{ D-channel bit with balance bit }
14 and 15	{ F A auxiliary framing bit or Q bit with balance bit }
16 - 24	{ B2-channel (first octet) with balance bit }
25 and 26	{ D-channel bit with balance bit }
27 - 35	{ B1-channel (second octet) with balance bit }
36 and 37	{ D-channel bit with balance bit }
38 - 46	{ B2-channel (second octet) with balance bit }
47 and 48	{ D-channel bit with balance bit }

Tableau 2/I.430 [T2.430], p. 11

H.T. [T3.430]

TABLE 3/I.430

Bit position	Group
1 and 2 Framing signal with balance bit }	{
3 - 10	B1-channel (first octet)
11	E, D-echo-channel bit
12	D-channel bit
13	Bit A used for activation
14	F A auxiliary framing bit
15 N bit (coded as defined in § 6.3) }	{
16 - 23	B2-channel (first octet)
24	E, D-echo-channel bit
25	D-channel bit
26	M, multiframing bit
27 - 34	B1-channel (second octet)
35	E, D-echo-channel bit
36	D-channel bit
37 S, The use of this bit is for further study }	{
38 - 45	B2-channel (second octet)
46	E, D-echo-channel bit
47	D-channel bit
48 Frame balance bit }	{

Note — S is set to binary ZERO.

Tableau 3/I.430 [T3.430], p. 12

5.4.2.3 *Relative bit positions*

At the TEs, timing in the direction TE to NT shall be derived from the frames received from the NT.

The first bit of each frame transmitted from a TE towards the NT shall be delayed, nominally, by two bit periods with respect to the first bit of the frame received from the NT. Figure 3/I.430 illustrates the relative bit positions for both transmitted and received frames.

5.5 *Line code*

For both directions of transmission, pseudo-ternary coding is used with 100% pulse width as shown in Figure 4/I.430. Coding is performed in such a way that a binary ONE is represented by no line signal; whereas, a binary ZERO is represented by a positive or negative pulse. The first binary ZERO following the framing bit-balance bit is of the same polarity as the framing bit-balance bit. Subsequent binary ZEROs must alternate in polarity. A balance bit is a binary ZERO if the number of binary ZEROs following the previous balance bit is odd. A balance bit is a binary ONE if the number of binary ZEROs following the previous balance bit is even.

Figure 4/I.430, p.

5.6 *Timing considerations*

The NT shall derive its timing from the network clock from the NT and use this derived timing to synchronize its transmitted signal.

6 Interface procedures

6.1 *D-channel access procedure*

The following procedure allows for a number of TEs connected in a multipoint configuration to gain access to the D-channel in an orderly fashion. The procedure always ensures that, even in cases where two or more TEs attempt to access the D-channel simultaneously, one, but only one, of the TEs will be successful in completing transmission of its information. This procedure relies upon the use of layer 2 frames delimited by flags consisting of the binary pattern ‘‘01111110’’ and the use of zero bit insertion to prevent flag imitation (see Recommendation I.441).

The procedure also permits TEs to operate in a point-to-point manner.

6.1.1 *Interframe (layer 2) time fill*

When a TE has no layer 2 frames to transmit, it shall send binary ONEs on the D-channel, i.e., the interframe time fill in the TE-to-NT direction shall be binary ONEs.

When an NT has no layer 2 frames to transmit, it shall send binary ONEs or HDLC flags, i.e., the interframe time fill in the NT-to-TE direction shall be either all binary ONEs or repetitions of the octet ‘‘01111110’’. When the interframe time fill is HDLC flags , the flag which defines the end of a frame may define the start of the next frame.

6.1.2 *D-echo channel*

The NT, on receipt of a D-channel bit from TE or TEs, shall reflect the binary value in the next available D-echo channel bit position towards the TE. (It may be necessary to force the D-echo channel bits to all binary ZEROs during certain loopbacks — see Note 4 of Table I.1/I.430 and § 5 of Recommendation G.960).

6.1.3 *D-channel monitoring*

A TE, while in the active condition, shall monitor the D-echo channel, counting the number of consecutive binary ONEs. If a ZERO bit is detected, the TE shall restart counting the number of consecutive ONE bits. The current value of the count is called C.

Note — C need not be incremented after the value eleven has been reached.

6.1.4 *Priority mechanism*

Layer 2 frames are transmitted in such a way that signalling information is given priority (priority class 1) over all other types of information (priority class 2). Furthermore, to ensure that within each priority class all competing TEs are given a fair access to the D-channel, once a TE has successfully completed the transmission of a frame, it is given a lower level of priority within that class. The TE is given back its normal level within a priority class when all TEs have had an opportunity to transmit information at the normal level within that priority class.

The priority class of a particular layer 2 frame may be a characteristic of the TE which is preset at manufacture or at installation, or it may be passed down from layer 2 as a parameter of the PH-DATA REQUEST primitive.

The priority mechanism is based on the requirement that a TE may start layer 2 frame transmission only when C (see § 6.1.3) is equal to, or exceeds, the value X_1 for priority class 1 or is equal to, or exceeds, the value X_2 for priority class 2. The value of X_1 shall be eight for the normal level and nine for the lower level of priority. The value of X_2 shall be ten for the normal level and eleven for the lower level of priority.

In a priority class the value of the normal level of priority is changed into the value of the lower level of priority (i.e. higher value) when a TE has successfully transmitted a layer 2 frame of that priority class.

The value of the lower level of priority is changed back to the value of the normal level of priority when C (see § 6.1.3) equals the value of the lower level of priority, (i.e. higher value).

6.1.5 *Collision detection*

While transmitting information in the D-channel, the TE shall monitor the received D-echo channel and compare the last transmitted bit with the next available D-echo bit. If the transmitted bit is the same as the received echo, the TE shall continue its transmission. If, however, the received echo is different from the transmitted bit, the TE shall cease transmission immediately and return to the D-channel monitoring state

6.1.6 *Priority system*

Annex B describes an example of how the priority system may be implemented.

6.2 *Activation/deactivation*

6.2.1 *Definitions*

6.2.1.1 *TE states*

6.2.1.1.1 State F1 (inactive): In this inactive state the TE is not transmitting. In the case of locally powered TEs which cannot detect the appearance/disappearance of power source 1 or 2, this state is entered when local power is not present. For TEs which can detect power source 1 or power source 2, this state is entered whenever loss of power (required to support all TEI functions) is detected, or when the absence of power from source 1 or 2, whichever power source is used for determining the connection status, is detected.

6.2.1.1.2 State F2 (sensing): This state is entered after the TE has been powered on but has not determined the type of signal (if any) that the TE is receiving.

6.2.1.1.3 State F3 (deactivated): This is the deactivated state of the physical protocol. Neither the NT nor the TE is transmitting.

6.2.1.1.4 State F4 (awaiting signal): When the TE is requested to initiate activation by means of a PH-ACTIVATE REQUEST primitive, it transmits a signal (INFO 1) and waits for a response from the NT.

6.2.1.1.5 State F5 (identifying input): At the first receipt of any signal from the NT, the TE ceases to transmit INFO 1 and awaits identification of signal INFO 2 or INFO 4.

6.2.1.1.6 State F6 (synchronized): When the TE receives an activation signal (INFO 2) from the NT, it responds with a signal (INFO 3) and waits for normal frames (INFO 4) from the NT.

6.2.1.1.7 State F7 (activated): This is the normal active state with the protocol activated in both directions. Both the NT and the TE are transmitting normal frames.

6.2.1.1.8 State F8 (lost framing): This is the condition when the TE has lost frame synchronization and is awaiting re-synchronization by receipt of INFO 2 or INFO 4 or deactivation by receipt of INFO 0.

6.2.1.2 *NT states*

6.2.1.2.1 State G1 (deactive): In this deactivated state the NT is not transmitting.

6.2.1.2.2 State G2 (pending activation): In this partially active state the NT sends INFO 2 while waiting for INFO 3. This state will be entered on request by higher layers, by means of a PH-ACTIVATE REQUEST primitive, or on the receipt of INFO 0 or lost framing while in the active state (G3). Then the choice to eventually deactivate is up to higher layers within the NT.

6.2.1.2.3 State G3 (active): This is the normal active state where the NT and TE are active with INFO 4 and INFO 3, respectively. A deactivation may be initiated by the NT system management, by means of an MPH-DEACTIVE REQUEST primitive, or the NT may be in the active state all the time, under non-fault conditions.

6.2.1.2.4 State G4 (pending deactivation): When the NT wishes to deactivate, it may wait for a timer to expire before returning to the deactivated state.

6.2.1.3 *Activate primitives*

The following primitives should be used between layers 1 and 2 and between layer 1 and the management entity in the activation procedures. For use in state diagrams, etc., abbreviations of the primitive names are also given.

PH-ACTIVATE REQUEST (PH-AR)

PH-ACTIVATE INDICATION (PH-AI)

MPH-ACTIVATE INDICATION (MPH-AI)

6.2.1.4 *Deactivate primitives*

The following primitives should be used between layers 1 and 2 and between layer 1 and the management entity in the deactivation procedures. For use in state diagrams, etc., abbreviations of the primitive names are also given.

MPH-DEACTIVATE REQUEST (MPH-DR)

MPH-DEACTIVATE INDICATION (MPH-DI)

PH-DEACTIVATE INDICATION (PH-DI)

6.2.1.5 *Management primitives*

The following primitives should be used between layer 1 and the management entity. For use in state diagrams, etc., abbreviations of the primitive names are also given.

MPH-ERROR INDICATION (MPH-EI)

Message unit contains type of error or recovery from a previously reported error.

MPH-INFORMATION INDICATION (MPH-II)

Message unit contains information regarding the physical layer conditions. Two parameters are provisionally defined: connected and disconnected.

Note — Implementation of primitives in NTs and TEs is not for recommendation.

6.2.1.6 *Valid primitive sequences*

The primitives defined in § 6.2.1.3, § 6.2.1.4 and § 6.2.1.5 specify, conceptually, the service provided by layer 1 to layer 2 and the layer 1 management entity. The constraints on the sequence in which the primitives may occur are specified in Figure 5/I.430. These diagrams do not represent the states which must exist for the layer 1 entity. However, they do illustrate the condition that the layer 2 and management enities perceive layer 1 to be in at a result of the primitives transferred between entities. Furthermore, Figure 5/I.430 does not represent an interface and is used only for modelling purposes.

Figure 5/I.430, p.

6.2.2 *Signals*

The identifications of specific signals across the S/T reference point are given in Table 4/I.430. Also included is the coding for these signals.

H.T. [T4.430]
TABLE 4/I.430
Definition of INFO signals
(Note 1)

Signals from NT to TE	Signals from TE to NT		
INFO 0	No signal.	INFO 0	No signal.
		INFO 1 (Note 2)	{
A continuous signal with the following pattern: Positive ZERO, negative ZERO, six ONEs. **MONTAGE Figure CCITT 62731** Nominal bit rate = 192 kbit/s. }			
INFO 2 (Note 3)	{		
Frame with all bits of B, D, and D-echo channels set to binary ZERO. Bit A set to binary ZERO. N and L bits set according to the normal coding rules. }			
		INFO 3	{
Synchronized frames with operational data on B and D channels. }			
INFO 4 (Note 3)	{		
Frames with operational data on B, D, and D-echo channels. Bit A set to binary ONE. }			

Note 1 — For configurations where the wiring polarity may be reversed (see § 4.3) signals may be received with the polarity of the binary ZEROs inverted. All NT and TE receivers should be designed to tolerate wiring polarity reversals.

Note 2 — TEs which do not need the capability to initiate activation of a deactivated I.430 interface (e.g., TEs required to handle only incoming calls) need not have the capability to send INFO 1. In all other respects, these TEs shall be in accordance with § 6.2. It should be noted that in the point-to-multipoint configuration more than one TE transmitting simultaneously will produce a bit pattern, as received by the NT, different form that described above, e.g., two or more overlapping (asynchronous) instances of INFO 1.

Note 3 — During the transmission of INFO 2 or INFO 4, the F A bits and the M bits from the NT may provide the Q-bit pattern designation as described in § 6.3.3.

Table 4/I.430 [T4.430], p.

6.2.3 *Activation/deactivation procedure for TEs*

6.2.3.1 *General TE procedures*

All TEs conform to the following (these statements are an aid to understanding; the complete procedures are specified in § 6.2.3.2):

a) TEs, when first connected, when power is applied, or upon the loss of frame alignment (see § 6.3.1.1) shall transmit INFO 0. However, the TE that is disconnected but powered is a special situation and could be transmitting INFO 1 when connected.

b) TEs transmit INFO 3 when frame alignment is established (see § 6.3.1.2). However, the satisfactory transmission of operational data cannot be assured prior to the receipt of INFO 4.

c) TEs that are locally powered shall, when power is removed, initiate the transmission of INFO 0 before frame alignment is lost.

6.2.3.2 *Specification of the procedure*

The procedure for TEs which can detect power source 1 or 2 is shown in the form of a finite state matrix Table 5/I.430. An SDL representation of the procedure is outlined in Annex C. The finite state matrices for two other TE types are given in Annex C, Tables C-1/I.430 and C-2/I.430. The finite state matrix and SDL representations reflect the requirements necessary to assure proper interfacing of a TE with an NT conforming to the procedures described in Table 6/I.430. They also describe primitives at the layer 1/2 boundary and layer 1/management entity boundary.

6.2.4 *Activation/deactivation for NTs*

6.2.4.1 *Activating/deactivating NTs*

The procedure is shown in the form of a finite state matrix in Table 6/I.430. An SDL representation of the procedure is outlined in Annex C. The finite state matrix and SDL representations reflect the requirements necessary to assure proper interfacing of an activating/deactivating NT with a TE conforming to the procedures described in Table 5/I.430. They also describe primitives at the layer 1/2 boundary and layer 1/management entity boundary.

6.2.4.2 *Non-activating/non-deactivating NTs*

The behaviour of such NTs is the same as that of an activating/deactivating NT never receiving MPH-DEACTIVATE REQUEST from the management entity. States G1 (deactive), G4 (pending deactivation) and timers 1 and 2 may not exist from such NTs.

6.2.5 *Timer values*

The finite state matrix tables show timers on both the TE and the NT. The following values are defined for timers:

— TE: Timer 3, not to be specified (the value depends on the subscriber loop transmission technique. The worst case value is 30s).

— NT: Timer 1, not to be specified.

NT: Timer 2, 25 to 100 ms.

6.2.6 *Activation times*

6.2.6.1 *TE activation times*

A TE in the deactivated state (F3) shall, upon the receipt of INFO 2, establish frame synchronization and initiate the transmission of INFO 3 within 100 ms. A TE shall recognize the receipt of INFO 4 within two frames (in the absence of errors).

A TE in the ‘‘waiting for signal’’ state (F4) shall, upon the receipt of INFO 2, cease the transmission of INFO 1 and initiate the transmission of INFO 0 within 5 ms and then respond to INFO 2, within 100 ms, as above. (Note that in Table 5/I.430, the transition from F4 to F5 is indicated as the result of the receipt of ‘‘any signal’’ which is in recognition of the fact that a TE may not know that the signal being received is INFO 2 until after it has recognized the presence of a signal.)

6.2.6.2 *NT activation times*

An NT in the deactivate state (G1) shall, upon the receipt of INFO 1, initiate the transmission of INFO 2 (synchronized to the network) within 1 s under normal conditions. Delays, ‘‘Da’’, as long as 30 s are acceptable under abnormal (non-fault) conditions, e.g., as a result of a need for retrain for an associated loop transmission system.

An NT in the ‘‘pending activation’’ state (G2) shall, upon the receipt of INFO 3, initiate the transmission of INFO 4 within 500 ms under normal conditions. Delays, ‘‘Db’’, as long as 15 s are acceptable under abnormal (non-fault) conditions provided that the sum of the delays ‘‘Da’’ and ‘‘Db’’ are not greater than 30 s.

H.T. [1T5.430]

TABLE 5/I.430
{
Activation/deactivation layer 1 finite state matrix for TEs
TEs powered from power source 1 ou 2
}

State name State number Event	Inactive F1 INFO sent	Sensing F2 INFO 0	Deactivated F3 INFO 0	Awaiting signal F4 INFO 0	Identifying input F5 INFO 1	Synchronized F6 INFO 0	Activated F7 INFO 3	Lost framing F8 INFO 3
Power on and detection of Power S (Note 1 and Note 2)	F2	—	—	—	—	—	—	—
Loss of power (Note 1) MPH-II(d), MPH-DI, PH-DI; F1 MPH-II(d), MPH-DI, PH-DI; F1 MPH-II(d), MPH-DI, PH-DI; F1 MPH-II(d), MPH-DI, PH-DI; F1 MPH-II(d), MPH-DI, PH-DI; F1	—	F1	MPH-II(d); F1					

Disappearance of power S (Note 2) MPH-II(d), MPH-DI, PH-DI; F1 MPH-II(d), MPH-DI, PH-DI; F1 MPH-II(d), MPH-DI, PH-DI; F1 MPH-II(d), MPH-DI, PH-DI; F1 MPH-II(d), MPH-DI, PH-DI; F1	—	F1	MPH-II(d); F1					

} PH-ACTIVATE REQUEST Expiry T3 Receive INFO 0 MPH-DI, PH-DI, MPH-EI2; F3 }	 / / /	 | / MPH-II(c); F3	 ST. T3; F4 — —	 | MPH-DI, PH-DI; F3 —	 | MPH-DI, PH-DI; F3 —	 — MPH-DI, PH-DI; F3 MPH-DI, PH-DI; F3	 | — MPH-DI, PH-DI; F3	 — — {
Receive any signal (Note 3)	/	—	—	F5	—	/	/	—

Tableau 5/I.430 [1T5.430] (a l'italienne), p. 16

H.T. [2T5.430]

{
TABLE 5/I.430 *(cont.)*
}
{
Activation/deactivation layer 1 finite state matrix for TEs
TEs powered from power source 1 ou 2
}

| State name State number Event | | | | | |	| Inactive F1 INFO sent | | | | | |	| Sensing F2 INFO 0 | |	| Deactivated F3 INFO 0 | |	| Awaiting signal F4 INFO 0 | |	| Identifying input F5 INFO 1 | |	| Synchronized F6 INFO 0 | |	| Activated F7 INFO 3 | |	| Lost framing F8 INFO 3 | | |INFO 0 | |
Receive INFO 2	/	MPH-II(c); F6	F6	/	F6 (Note 4)	—	MPH-EI1; F6	MPH-EI2; F6
Receive INFO 4 MPH-II(c), PH-AI, MPH-AI; F7 } PH-AI, MPH-AI; F7 (Note 4) } PH-AI, MPH-AI, MPH-EI2; F7 } PH-AI, MPH-AI, MPH-EI2; F7 }	/ PH-AI, MPH-AI; F7 { —	{ / {	{					
Lost framing	/	/	/	/	/	MPH-EI1; F8	MPH-EI1; F8	—

{
—
No change, no action
|
Impossible by the definition of the layer 1 service
/
Impossible situation
a, b; Fn
Issue primitives ‘‘a’’ and ‘‘b’’ and then go to state ‘‘Fn’’
PH-AI
Primitive PH-ACTIVATE INDICATION
PH-DI
Primitive PH-DEACTIVATE INDICATION
MPH-AI
Primitive MPH-ACTIVATE INDICATION
} {
MPH-DI
Primitive MPH-DEACTIVATE INDICATION
MPH-EI1
Primitive MPH-ERROR INDICATION reporting error
MPH-EI2
Primitive MPH-ERROR INDICATION reporting recovery from error
MPH-II(c)
Primitive MPH-INFORMATION INDICATION (connected)
MPH-II(d)
Primitive MPH-INFORMATION INDICATION (disconnected)
ST. T3
Start timer T3
Power S
Power source 1 or power source 2.
}
{

Primitives are signals in a conceptual queue and will be cleared on recognition, while the INFO signals are continuous signals which are available all the time. }

Note 1 — The term ''power'' could be the full operational power or backup power. Backup power is defined such that it is enough to hold the TEI value in memory and maintain the capability of receiving and transmitting layer 2 frames associated with the TEI procedures.

Note 2 — The procedures described in Table 5/I.430 require the provision of power source 1 or power source 2 to enable their complete operation. A TE which determines that it is connected to an NT not providing power source 1 or 2 should default to the procedures described in Table C-1/I.430.

Note 3 — This event reflects the case where a signal is received and the TE has not (yet) determined whether it is INFO 2 or INFO 4.

Note 4 — If INFO 2 or INFO 4 is not recognized within 5 ms after the appearance of a signal, TEs must go to F5.

Tableau 5/I.430 [2T5.430] (a l'italienne), p. 17

H.T. [1T6.430]

TABLE 6/I.430

Activation/deactivation layer 1 finite state matrix for NTs

lw(72p) | lw(42p) | lw(36p) | lw(42p) | lw(36p) . lw(72p) | cw(42p) | cw(36p) | cw(42p) | cw(36p) . PH-ACTIVATE REQUEST Start timer T1 G2 | | Start timer T1 G2 _ lw(72p) | cw(42p) | cw(36p) | cw(42p) | cw(36p) . MPH-DEACTIVATE REQUEST | Start timer T2 PH-DI; G4 Start timer T2 PH-DI; G4 | lw(72p) | cw(42p) | cw(36p) | cw(42p) | cw(36p) . Expiry T1 (Note 1) — Start timer T2 PH-DI; G4 / — _ lw(72p) | cw(42p) | cw(36p) | cw(42p) | cw(36p) . Expiry T2 (Note 2) — — — G1 lw(72p) | cw(42p) | cw(36p) | cw(42p) | cw(36p) . Receiving INFO 0 — — { MPH-DI, MPH-EI; G2 (Note 3)

} G1 _ lw(72p) | cw(42p) | cw(36p) | cw(42p) | cw(36p) . Receiving INFO 1 Start timer T1 G2 — / — _ lw(72p) | cw(42p) | cw(36p) | cw(42p) | cw(36p) . Receiving INFO 3 / { Stop timer T1 PH-AI, MPH-AI; G3 (Note 4)

} — — _ lw(72p) | cw(42p) | cw(36p) | cw(42p) | cw(36p) . Lost framing / / { MPH-DI, MPH-EI; G2 (Note 3)

} — _ lw(72p) | cw(42p) | cw(36p) | cw(42p) | cw(36p) .

{ — No state change / Impossible by the definition of peer-to-peer physical layer procedures or system internal reasons | Impossible by the definition of the physical layer service a, b; Gn Issue primitives ''a'' and ''b'' then go to state ''Gn'' PH-AI Primitive PH-ACTIVATE INDICATION PH-DI Primitive PH-DEACTIVATE INDICATION MPH-AI Primitive MPH-ACTIVATE INDICATION MPH-DI Primitive MPH-DEACTIVATE INDICATION MPH-EI Primitive MPH-ERROR INDICATION Primitives are signals in a conceptual queue and will be cleared on recognition, while the INFO signals are continuous signals which are available all the time.

}

Tableau 6/I.430 [1T6.430], p. 18

DU TABLEAU SUR NOUVELLE PAGE
H.T. [T1.430]
TABLE 1/I.430
Primitives associated with layer 1

L1 | (<- | 2
M | (<- | 1

MPH-ERROR Type of error or recovery from a previously reported error }	—	X	—	X	{
MPH-ACTIVATE	—	X	—	—	
MPH-DEACTIVATE	X	X	—	—	
MPH-INFORMATION Connected/disconnected }	—	X	—	X	{

Note 1 — PH-DATA REQUEST implies underlying negotiation between layer 1 and layer 2 for the acceptance of the data.

Note 2 — Priority indication applies only to the request type.

Tableau 6/I.430 [2T6.430], p. 19

6.2.7 *Deactivation times*

A TE shall respond to the receipt of INFO 0 by initiating the transmission of INFO 0 within 25 ms.

An NT shall respond to the receipt of INFO 0 or the loss of frame synchronization by initiating the transmission of INFO 2 within 25 ms; however, the layer 1 entity does not deactivate in response to INFO 0 from a TE.

6.3 *Frame alignment procedures*

The first bit of each frame is the framing bit, F; it is a binary ZERO.

The frame alignement procedure makes use of the fact that the framing bit is represented by a pulse having the same polarity as the preceding pulse (line code violation). This allows rapid reframing.

According to the coding rule, both the framing bit and the first binary ZERO bit following the framing bit-balance bit (in position 2 in the same frame) produce a line code violation. To guarantee secure framing, the auxiliary framing bit pair F_A and N in the direction NT to TE or the auxiliary framing bit F_A with the associated balancing bit L in the direction TE to NT are introduced. This ensures that there is a line code violation at 14 bits or less from the framing bit F, due to F_A or N being a binary ZERO bit (NT to TE) or to F_A being a binary ZERO bit (TE to NT) if the F_A bit position is not used as a Q bit. The framing procedures do not depend on the polarity of the framing bit F, and thus are not sensitive to wiring polarity.

The coding rule for the auxiliary framing bit pair F_A and N, in the direction NT to TE, is such that N is the binary opposite of F_A ($N = F_A$). The F_A and L bits in the direction TE to NT are always coded such that the binary values of F_A and L are equal.

6.3.1 *Frame alignment procedure in the direction NT to TE*

Frame alignment, on initial activation of the TE, shall comply with the procedures defined in § 6.2.

6.3.1.1 *Loss of frame alignment*

Loss of frame alignment may be assumed when a time period equivalent to two 48-bit frames has elapsed without having detected valid pairs of line code violations obeying the 14 bit criterion as described above. The TE shall cease transmission immediately.

6.3.1.2 *Frame alignments*

Frame alignment may be assumed to occur when three consecutive pairs of line code violations obeying the 14 bit criterion have been detected.

6.3.2 *Frame alignment in the direction TE to NT*

The criterion of a line code violation at 13 bits or less from the framing bit (F) shall apply except if the Q-channel (see § 6.3.3) is provided, in which case the 13 bit criterion applies in four out of five frames.

6.3.2.1 *Loss of frame alignment*

The NT may assume loss of frame alignment if a time period equivalent to at least two 48-bit frames has elapsed since detecting consecutive violations according to the 13 bit criterion, if all F_A bits have been set to binary ZERO. Otherwise, a time period equivalent to at least three 48-bit frames shall be allowed before assuming loss of frame alignment. On detection of loss of frame alignment the NT shall continue transmitting towards the TE.

6.3.2.2 *Frame alignment*

The NT may assume that frame alignment has been regained when three consecutive pairs of line code violations obeying the 13 bit criterion have been detected.

6.3.3 *Multi-framing*

A multi-frame described in the following paragraphs is intended to provide extra layer 1 capacity in the TE-to-NT direction through the use of an extra channel between the TE and NT (Q-channel). This extra layer 1 capacity exists only between the TE and NT, i.e., there is no requirement for the transmission of signals between NT and ET to carry the information conveyed by this extra layer 1 capacity. The use of the Q-channel is for further study. However, TEs shall provide for identification of the bit positions which provide this extra capacity, designated Q bits. TEs not using this capability shall provide for setting each Q bit to a binary ONE. The provision of this capability in NTS is optional.

The use of the Q bits shall be the same in point-to-point as in point-to-multipoint configurations. Future standardization for the use of Q bits is for further study. (There is no inherent collision detection mechanism provided, and any collision detection mechanism that is required for any application of the Q bits will be outside the scope of this Recommendation.)

6.3.3.1 *General mechanism*

a) Q bit identification : The Q bits (TE-to-NT) are defined to be the bits in the F_A bit position of every fifth frame. The Q-bit positions in the TE-to-NT direction are identified by binary inversions of the F_A/N bit pair (F_A = binary ONE, N = binary ZERO) in the NT-to-TE direction. The provision of the capability in NTs is optional. The provision for identification of the Q-bit positions in the NT-to-TE direction permits all TEs to synchronize transmission in Q-bit positions — thereby avoiding interference of F_A-bits from one TE with the Q-bits of a second TE in passive bus configurations.

b) Multi-frame identification : A multi-frame, which provides for structuring the Q bits in groups of four (Q1 — Q4), is established by setting the M bit, in position 26 of the NT-to-TE frame, to binary ONE in every twentieth frame. This structure provides for 4-bit characters in a single channel, TE-to-NT. The provision of the capability in NTs is optional.

6.3.3.2 *Q-bit position identification algorithm*

The Q-bit position identification algorithm is illustrated in Table 7/I.430. Two examples of how such an identification algorithm can be realized are as follows. The TE Q-bit identification algorithm may be simply the transmission of a Q bit in each frame in which a binary ONE is received in the F_A-bit position of the NT-to-TE frame (i.e., echoing of the received F_A bits). Alternatively, to minimize the Q-bit transmission errors that could result from errors in the F_A bits of NT-to-TE frames, a TE may synchronize a frame counter to the Q-bit rate and transmit Q bits in every fifth frame, i.e., in frames in which F_A bits should be equal to binary ONE. The F_A bit is present in every frame. Q bits would be transmitted only after counter synchronization to the frame binary ONEs in the F_A bit positions of the NT-to-TE frames is achieved (and only if such bits are received). When the counter is not synchronized (not achieved or lost), a TE which uses such algorithm shall transmit binary ZEROs in Q-bit positions. The algorithm used by a TE to determine when synchronization is defined to be achieved or the algorithm used to determine when it is defined to be lost is not described in this Recommendation, but it should be noted that the transmission of multi-framing from an NT is not mandatory.

No special Q-bit identification is required in the NT because the maximum round trip delay of NT-to-TE-to-NT is a small fraction of a frame and, therefore, Q-bit identification is inherent in the NT.

H.T. [T7.430]
TABLE 7/I.430
Q-bit position identification and multi-frame structure

Frame Number NT-to-TE F A bit position } TE-to-NT F A bit position (Notes 1 and 2) }	{ { NT-to-TE M Bit		
1 2 3 4 5	ONE ZERO ZERO ZERO ZERO	Q1 ZERO ZERO ZERO ZERO	ONE ZERO ZERO ZERO ZERO
6 7 8 9 10	ONE ZERO ZERO ZERO ZERO	Q2 ZERO ZERO ZERO ZERO	ZERO ZERO ZERO ZERO ZERO
11 12 13 14 15	ONE ZERO ZERO ZERO ZERO	Q3 ZERO ZERO ZERO ZERO	ZERO ZERO ZERO ZERO ZERO
16 17 18 19 20	ONE ZERO ZERO ZERO ZERO	Q4 ZERO ZERO ZERO ZERO	ZERO ZERO ZERO ZERO ZERO
1 2 etc.	ONE ZERO	Q1 ZERO	ONE ZERO

Note 1 — If the Q-bits are not used by a TE, the Q-bits shall be set to binary ONE.

Note 2 — Where multi-frame identification is not provided with a binary ONE in an appropriate M bit, but where Q-bit positions are identified, Q-bits 1 through 4 are not distinguished.

Table 7/I.430 [T7.430], p.

6.3.3.3 *TE Multi-frame identification*

The first frame of the multi-frame is identified by the M bit equal to a binary ONE. TEs that are not intended to use, nor to provide for the use of, the Q-channel are not required to identify the multi-frame. TEs that are intended to use, or to provide for the use of, the Q-channel shall use the M bit equal to a binary ONE to identify the start of the multi-frame.

The algorithm used by a TE to determine when synchronization or loss of synchronization of the multi-frame is achieved is not described in this Recommendation, however, it should be noted that the transmission of multi-framing from an NT is not mandatory.

6.3.4 *S-bit channel structuring algorithm*

The algorithm for structuring the S-bits (NT-to-TE frame bit position 37) into an S-channel will use a combination of the F_A-bit inversions and the M bit used to structure the Q-bit channel as described in § 6.3.3. The use of the S-channel and its structure are for further study.

6.4 *Idle channel code on the B-channels*

A TE shall send binary ONEs in any B-channel which is not assigned to it.

7 Layer 1 maintenance

The test loopbacks defined for the basic user-network interface are specified in Appendix I.

MONTAGE : § 8 SUR LE RESTE DE CETTE PAGE