INTERNATIONAL TELECOMMUNICATION UNION

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THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

BLUE BOOK

VOLUME III – FASCICLE III.9

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)
INTERNETWORK INTERFACES AND MAINTENANCE PRINCIPLES

RECOMMENDATIONS I.500-I.605

IXTH PLENARY ASSEMBLY
MELBOURNE, 14-25 NOVEMBER 1988

Geneva 1989

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PRELIMINARY NOTE

In this Volume, the expression "Administration" is used for shortness to indicate both a telecommunication Administration and a recognized private operating agency.

PART V

I.500-Series Recommendations

INTERNETWORK INTERFACES

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Recommendation I.500

GENERAL STRUCTURE OF THE ISDN INTERWORKING RECOMMENDATIONS

(Melbourne, 1988)

1 Introduction

An ISDN is a network, in general evolving from a telephony Integrated Digital Network, that provides end-to-end digital connectivity to support a wide range of services, including voice and non-voice services, to which users have access by a limited set of standard multi-purpose user network interfaces. In contrast, existing dedicated networks have always been developed for specific (types of) services. Therefore, especially in the initial phase, the ISDN may support many services which in principle are still existent in dedicated networks. Thus, it is necessary to provide interworking between ISDN and dedicated networks to allow communication between terminals belonging to equivalent services offered through different networks.

There will be a need for interworking functions (IWF) between ISDN and dedicated networks to cope with the different environments given by the various networks. The structure of these IWFs showing the functions necessary for the mapping should be uniform to permit, if possible, a common use of functional parts in several IWFs. Detailed description of these IWFs, which (as far as is possible), should permit conveyance of ISDN features through existing networks, is given in the I.500-Series of Recommendations.

The I.500-Series of Recommendations deal with network aspects of interworking.

2 Organization of ISDN interworking Recommendations

Figure 1/I.500 shows the organization of the ISDN interworking Recommendations contained in the I.500-Series Recommendations, and the relationship with other Recommendations. The Recommendations in Figure 1/I.500 have been grouped by level of detail into:

- general level;
- scenario level;
- functional level;
- protocol level.

2.1 *General level*

Recommendations I.500 and I.510 form the general level, i.e., the basis for Recommendations in the scenario and functional levels.

Recommendation I.500 describes the organization of the (ISDN interworking) Recommendations and the structure of the I.500-Series of Recommendations, whilst I.510 sets out the ISDN interworking principles.

2.2 *Scenario level*

The scenario level of Recommendations describes the general arrangements for interworking between ISDN and ISDN, and between ISDN and dedicated networks. Recommendation I.515 specifying the parameter exchange which may be necessary for interworking situations, is also located at the scenario level.

2.3 *Functional level*

The detailed level is formed by those Recommendations that are specifying the interworking functional requirements of the interworking scenarios shown in the scenario level Recommendations.

2.4 *Protocol level*

In the protocol level, the protocols listed are those that appear at the reference points K_x and N_x.

Note – ISDN interworking related subjects that correspond to the above four levels are also dealt with in the Recommendations I.310, I.324, I.340, X.300 and X.301. Recommendation I.310 defines the interworking reference points and an outline description of IWF.

Recommendation I.340 defines ISDN Connection Types.

Recommendations X.300 and X.301 give the guiding principles and functions for interworking between networks offering data services described in Recommendations X.1 and X.10.

2.5 Recommendations which relate to interworking are shown in Figure 1/I.500 and are assigned to the levels listed in § 2. As the contents of some Recommendations cover more than one level, these Recommendations appear at each level to which they relate.

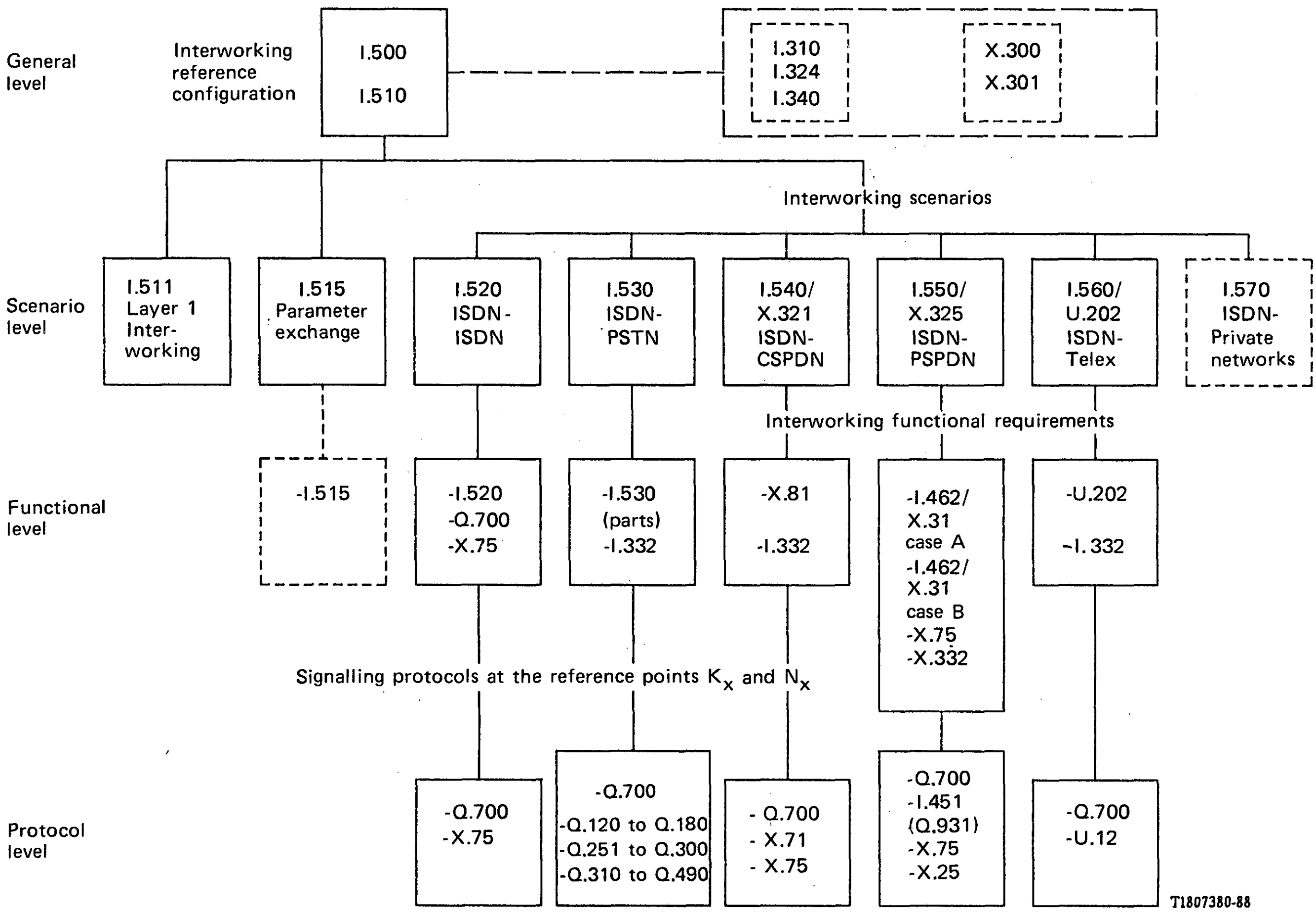


FIGURE 1/I.500

Organization of ISDN interworking Recommendations

3 References

The references are general to all I.500 Recommendations and are to be read in conjunction with Figure 1/I.500, where the organization of ISDN interworking Recommendations is shown.

3.1 *Interworking*

X.300-Series	Interworking between public networks, and between public networks and other networks for the provision of data transmission services
I.324	ISDN architecture functional model
I.340	Connection types/elements for ISDN-ISDN interworking
X.31	Support of packet-mode terminal equipment by an ISDN
X.81	Interworking between an ISDN circuit switched and a circuit switched public data network (CSPDN)

3.2 *Services and network capabilities*

X.1	International user classes of service in public data networks and integrated services digital networks (ISDNs)
X.2	International data transmission services and optional user facilities in public data networks and ISDNs
X.10	Categories of access for data terminal equipment (DTE) to public data transmission services
I.122	Framework for providing additional packet-mode bearer services
I.200-Series	Service aspects supported by an ISDN
I.310	ISDN – Network functional principles
I.320	ISDN protocol reference model
I.325	Reference configurations for ISDN connection types
I.411	ISDN user-network interfaces – reference configurations
I.412	ISDN user-network interfaces – Interface structures and access capabilities
I.420	Basic rate user-network interface
I.421	Primary rate user-network interface
I.441 (Q.921)	ISDN user-network interface data link layer specification
I.451 (Q.931)	ISDN user-network interface layer 3 specification

3.3 *Signalling*

Q.700	Network protocols (MTP, ISUP, etc.)
Q.120-Q.180	Specification of Signalling Systems No. 4 and No. 5
Q.251-Q.300	Specification of Signalling System No. 6
Q.310-Q.490	Specification of Signalling Systems R1 and R2
X.25	Interface between data terminal equipment (DTE) and data circuit equipment (DCE) for terminals operating in the packet-mode and connected to public data networks by dedicated circuits
X.71	Decentralized terminal and transit control signalling system on international circuits between synchronous data networks
X.75	Packet switched signalling system between public networks providing data transmission services
U.12	Terminal and transit control signalling system for telex and similar services on international circuits (type D signalling)

3.4 *Rate adaptation*

I.460	Multiplexing, rate adaptation and support of existing interfaces
I.461 (X.30)	Support of X.21, X.21 *bis* and X.20 *bis* based DTEs by an ISDN
I.462 (X.31)	Support of packet-mode terminal equipment by an ISDN
I.463 (V.110)	Support of DTEs with V-Series type interfaces by an ISDN
I.464	Multiplexing, rate adaptation and support of existing interfaces for restricted 64 kbit/s transfer capability
I.465 (V.120)	Support by ISDN of DTEs with V-Series type interfaces with provision for statistical multiplexing

3.5 *Numbering*

X.121	International numbering plan for public data networks
X.122	Numbering plan interworking between a Packet Switched Public Data Network (PSPDN) and an Integrated Services Digital Network (ISDN) or Public Switched Telephone Network (PSTN) in the short-term
I.331 (E.164)	Numbering plan for the ISDN era
E.166	Numbering plan interworking in the ISDN era
I.330	ISDN numbering and addressing principles
I.332	Numbering principles for interworking between ISDNs and dedicated networks with different numbering plans
F.69	Plan for telex destination codes

Recommendation I.510

DEFINITIONS AND GENERAL PRINCIPLES FOR ISDN INTERWORKING

(Melbourne, 1988)

1 Introduction

This Recommendation sets forth the general principles for interworking between ISDNs, between ISDNs and other networks, and internal to an ISDN. The need for interworking stems from the coexistence of existing dedicated networks with ISDNs and from the use of different, yet compatible, bearer services or teleservices for the provision of an end-to-end telecommunication service. When ISDNs are introduced, it is to be expected that most users will need to interwork with the users of other networks, especially public switched telephone networks (PSTNs), public land mobile networks (PLMNs) and dedicated data networks.

Normally, each instance of communication within an ISDN will take place between the users of services with identical attribute values. However, communication may also take place between users of services with non-identical attribute values. In these cases interworking functions (IWFs) will be required. In general, when an ISDN user communicates with the user of another network, if the service perceived by the user of that other network were to be defined by the attribute method, the values would not be identical to those of the ISDN user.

The purpose of interworking is to enable the users of "different" services on an ISDN to establish a useful communication or for an ISDN user to establish a useful communication with a user of another network and vice-versa. The term "service" in this Recommendation implies a telecommunication service as defined in Recommendation I.210.

To permit interworking, interworking capabilities, making use of IWFs, may be required in one or more of the following:

– the ISDN,

– any other network involved,

– customer equipment.

2 Scope

This Recommendation contains the definitions and general principles to be applied in instances of ISDN interworking, which include interworking between ISDNs, between ISDNs and other networks, and internal to an ISDN.

The ISDN interworking configurations to be considered within the scope of this Recommendation include the interconnection of two networks where at least one network is an ISDN, the concatenation of more than two networks where an ISDN interconnects other networks (as a transit network), or the interconnection of two ISDNs by one or more other networks.

ISDN interworking, as defined in this Recommendation, is considered to take place whenever end-to-end communication has to be provided:

a) between different networks where at least one network is an ISDN, or

b) between telecommunication services with different lower or higher layer attributes or both, where at least one of the interworking telecommunication service is supported by the ISDN, or

c) between different networks and between telecommunication services with different lower or higher layer service attributes, or both.

ISDN interworking, as defined in this Recommendation, is intended to cover both voice and non-voice applications.

Note – Interworking at layers above layer 3 of the OSI model is not generally specified within this Recommendation and is for further study.

3 Abbreviations

CCSN	Common channel signalling network (SS No.7)
CE	Connection element
CS	Circuit switched
CSPDN	Circuit switched public data network
DTE	Data terminal equipment
ISDN	Integrated Services Digital Network
IWF	Interworking function
OSI	Open Systems Interconnection
PDN	Public data network
PH	Packet handler
PLMN	Public land mobile network
PS	Packet switched
PSPDN	Packet switched public data network
PSTN	Public switched telephone network
SS No.7	Signalling System No. 7
TA	Terminal adaptor
TE	Terminal equipment

4 Definitions

4.1 *Definitions related to services and network capabilities*

The definitions which follow are related to services and to network capabilities. In those instances where terms already are defined in other Recommendations, appropriate references are made to such Recommendations.

The following definitions apply to ISDN interworking:

Telecommunication service, as defined in Recommendation I.210.

Bearer service in the ISDN, as defined in Recommendation I.210 and in the I.230-Series.

Teleservice, as defined in Recommendation I.210 and in the I.240-Series, provides the full capacity for communication through terminal and network lower and higher layer functions.

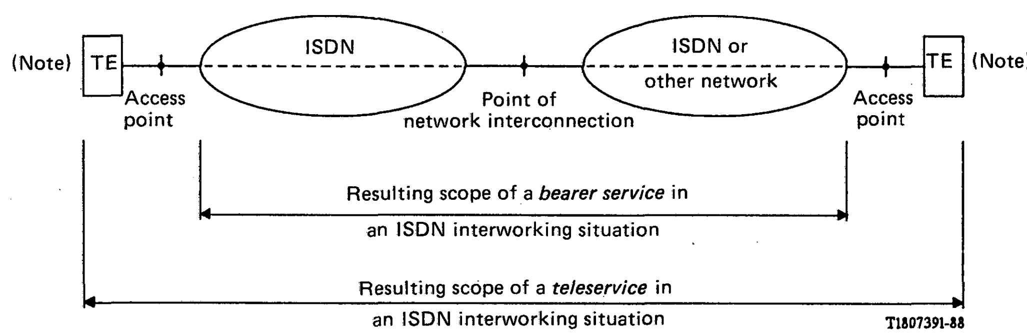
Bearer service in dedicated networks: The term *bearer service* in dedicated networks is characterized by a set of lower layer attributes (e.g. data transmission services, as defined in Recommendation X.1, for use in public data networks) and corresponds to the term *bearer service* in an ISDN. Examples of *bearer services* in dedicated networks are data transmission over a data network and data transmission over the telephone network.

Supplementary service, as defined in Recommendation I.210 and in the I.250 Series.

Bearer capability, as defined in Recommendation I.210, specifies the technical features of a *bearer service* in an ISDN as these appear to a user at the access point (S/T reference point). The term *bearer capability* also may be used with respect to dedicated networks. A *bearer capability* does not include any terminal functions.

4.2 *Definitions related to general ISDN interworking configurations*

This section provides concepts and definitions of terms relevant to the general ISDN interworking configuration. Figure 1/I.510 depicts the scope of application of several key terms.



Note – The TE is used to refer to either a TE1 or a TE2 plus a terminal adaptor when the network to which it is connected is an ISDN.

FIGURE 1/I.510

In accordance with Figure 1/I.510, the following terms are defined:

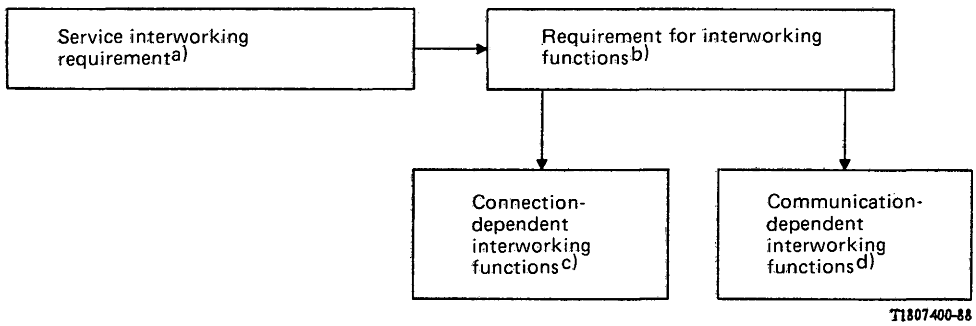
interworking

Within the scope of the I.500-Series of Recommendations, the term *interworking* is used to express interactions between networks, between end systems, or between parts thereof, with the aim of providing a functional entity capable of supporting an end-to-end communication. The interactions required to provide a functional entity rely on functions and on the means to select these functions.

interworking functions (IWFs)

The functions referred to in the Interworking definition above, which include the conversion of physical and electrical states and the mapping of protocols. An IWF may be implemented in the ISDN, in the other network(s), at the user's premises, through a third-party service provider, or in some combination of these.

The IWFs needed as a result of a service requirement for interworking are categorized as connection-dependent IWFs or communication-dependent IWFs. The relationships among these terms and definitions for connection-dependent IWFs and for communication-dependent IWFs are contained in Figure 2/I.510.



a) Service interworking requirements arise from the service definitions specified in the I.200-Series Recommendations.

b) IWFs are needed as a result of any service requirement for interworking.

c) Connection-dependent IWFs are those functions needed in order to interconnect ISDNs or ISDN and other networks.

d) Communication-dependent IWFs are those functions in addition to connection-dependent IWFs needed in order to establish a specific end-to-end communication and which may differ from application to application.

FIGURE 2/I.510

Telecommunication services to be supported by ISDN interworking configurations

5 Telecommunication services to be supported by ISDN interworking configurations

This section contains a list of telecommunication services that are supported by interconnections between ISDNs and between ISDNs and other networks and defines the types of interworking functions required. The concept of § 5 take into account:

a) the definitions as outlined in § 4;

b) existing networks to be interconnected with ISDN (ISDNs, PSTNs, CSPDNs, PSPDNs, others);

c) services to be offered with the ISDN and through interworking with ISDN.

End-to-end communication may require:

i) interworking at lower layers;

ii) interworking at higher layers;

iii) interworking at both lower and higher layers.

Table 1/I.510 displays the networks that support telecommunication services which are also supported by an ISDN and which are candidates, therefore, for interworking with an ISDN in the provision of one of those telecommunication services. Furthermore, Table 1/I.510 depicts the type of interworking functions that may be required for each interworking configuration. Note that the table does not indicate the possibility for interworking between different telecommunication services (e.g. telex-to-Teletex).

TABLE 1/I.510

Network support of telecommunication services

Telecommunication services supported by the ISDN	ISDN interconnected with					
	ISDN	PSTN	CSPDN	PSPDN	Telex	Other dedicated networks
Telephony	0	N	–	–	–	N
Data transmission (see Note 2)	(L)	N, L	N, (L)	N, (L)	–	N, (L)
Telex	0	–	–	–	N, L	N, L
Teletex	0	N, L	N, L	N, L	–	N, L, H
Fascimile	0	N, L	N, L	N, L	–	N, L

0 No interworking functions foreseen

N Connection-dependent interworking needed

L Lower layer communication-dependent interworking needed

H Higher layer communication-dependent interworking needed

( ) N/L/H may be needed

Note 1 – The list of services in Table 1/I.510 is not exhaustive and is therefore for further study. In particular, bearer services must be included.

Note 2 – See Recommendation X.1 for a description of data transmission services.

Note 3 – It is assumed for Table 1/I.510 that, for the cases of ISDN-to-ISDN interworking, the telecommunication services listed above are supported in both ISDNs by the same bearer, no interworking functions are therefore required. ISDN-to-ISDN interworking situations that involve different bearers, as an extension of Table 1/I.510, are for further study.

6 ISDN interworking configurations

This section contains the general interworking reference configurations that form the basis of all possible ISDN interworking configurations covered by the I.500-Series of Recommendations.

The configurations are entirely functional and do not serve any aspect of the interworking function(s) needed in any specific instance of interworking. The complexities of specific cases are considered in the Recommendations that deal at a scenario level of detail with the individual types of networks with which an ISDN may be interconnected, i.e. Recommendations I.520, I.530, etc.

The network interworking reference point is the K_x or N_x reference point when the network directly interconnected to the ISDN is a non-ISDN or an ISDN, respectively.

6.1 *Reference points for network interconnections*

The protocol reference model for ISDN interworking is outlined in § 5 of Recommendation I.320.

The reference points K_x and N_x for network interconnections are defined in Recommendation I.324, § 4.2.4.

According to Note 1 to Figure 8/I.324 the value x = 1 signifies that interworking functions exist in the ISDN. The value x = 2 signifies that no interworking functions are required in the ISDN. No assumption is made regarding interworking functions outside the ISDN. Regardless of the value of x, the possibility of interworking functions in the other networks, between the networks, or of some combination of these situations, is kept open. The case of N_1 covers the situation when interworking functions are split between the two ISDNs involved.

6.1.1 *Interworking using one-stage selection (one-stage interworking)*

Interworking using one-stage selection is possible when the interconnection of networks takes place by interconnecting trunk lines. It is also possible when the networks are physically inseparable [for example, see b) of Figure 6/I.510, and associated text]. In this type of interworking, each of the terminals involved in a communication has assigned to it a directory number from the numbering plan of the network to which it is connected. For call establishment, one-stage selection is assumed. An example of this type of interworking is the interconnection of a CSPDN using X.71 interexchange signalling and an ISDN using SS No. 7 interexchange signalling.

For interworking by one-stage selection, the interconnection of networks takes place at reference points K_x or N_x (see Figure 3/I.510).

The application of existing interfaces and the specification of new interfaces at the K_x and N_x reference points for interworking by one-stage selection needs further study.

Note – In Recommendation X.300 this category of interworking is defined as "interworking by call control mapping" (see § 6.2.1 of Recommendation X.300).

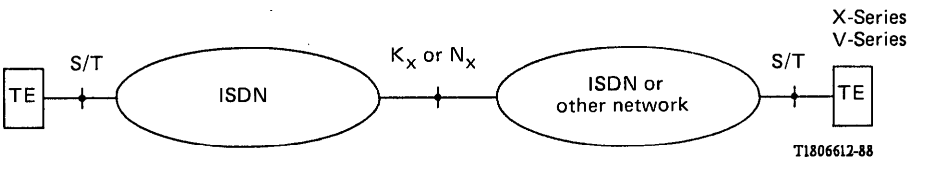


FIGURE 3/I.510

Interworking by one-stage selection at reference points K_x or N_x

6.1.2 *Interworking using two-stage selection (two-stage interworking)*

Interworking using two-stage selection is sometimes required, e.g. access to a PSPDN through an ISDN according to case A of Recommendation X.31. In this example, each of the terminals involved in a communication has assigned to it a directory number from the numbering plan of the PSPDN. For call establishment, two-stage selection is assumed: first, a connection is established through the ISDN to the appropriate PSPDN port; second, a connection is established through the PSPDN to the called terminal.

The logical appearance of interworking by two-stage selection at reference point K_2 (see Note 1) may be that of a customer access (see Figure 4/I.510).

The application of existing interfaces and the specification of new interfaces at the K_2 reference point for interworking by two-stage selection is for further study.

Note 1 – Since, in the case of interworking using two-stage selection depicted in Figure 4/I.510, no IWFs are required in the ISDN, only reference point K_2 is relevant.

Note 2 – In Recommendation X.300, examples of this category of interworking are defined as "interworking by port access" (see § 6.2.2 of Recommendation X.300).

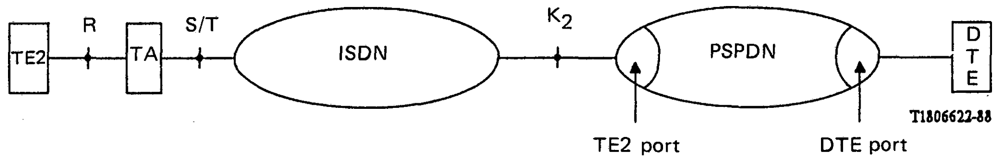


FIGURE 4/I.510

Interworking by two-stage selection at reference point K_2

6.2 *ISDN-to-ISDN interconnection*

6.2.1 *Reference configuration*

With regard to ISDN-to-ISDN interworking in the context of the I.500-Series of Recommendations, the functionality required for bearer service interworking is contained in ISDN-to-ISDN internetwork interfaces.

Figure 5/I.510 shows a reference configuration for ISDN-to-ISDN interworking. The services offered at the endpoints may be different.

ISDN-to-ISDN interworking may involve the functionality required for interworking to take place between ISDNs operated by, for instance, different Administrations.

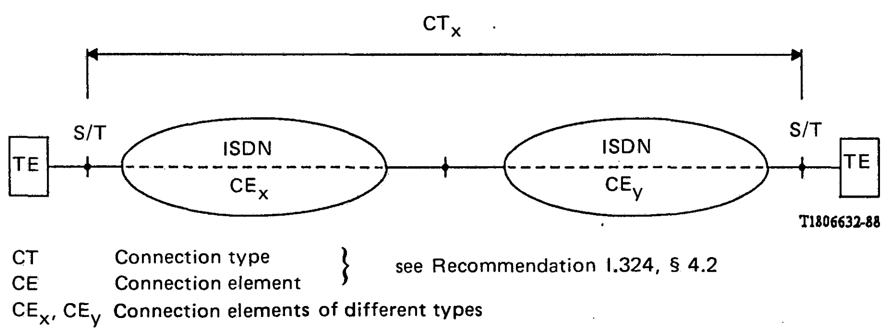


FIGURE 5/I.510

Reference configuration where ISDN-to-ISDN interworking is required

6.2.2 *Connection types*

Applicable Recommendation: I.520.

a) ISDN circuit mode - ISDN circuit mode (both ISDNs supporting a circuit-switched bearer service);

b) ISDN packet mode - ISDN packet mode (both ISDNs supporting the ISDN virtual circuit bearer service defined in Recommendation X.31 under case b);

c) ISDN packet mode - ISDN circuit mode (interworking where a packet switched bearer is requested by one ISDN and a circuit switched bearer by the other ISDN);

d) ISDN packet mode - ISDN circuit mode (interworking, where a circuit switched bearer is requested in one ISDN to obtain access to the packet handler of another ISDN for communication over an ISDN virtual circuit bearer service).

6.3 *Interworking between ISDNs and other networks*

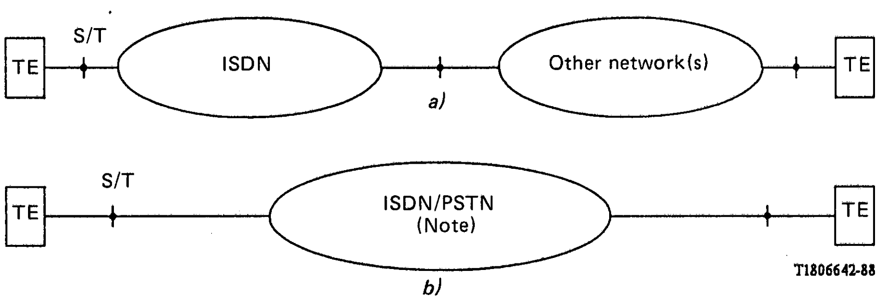
6.3.1 *Reference configurations*

Network interworking is required whenever an ISDN and a non-ISDN are interconnected to provide an end-to-end connection.

Network interworking functions typically would contain the functionality needed for conversion of physical and electrical interface characteristics and for mapping of layer 2 and layer 3 network protocols. Examples of such network interworking functions are: signalling conversions, information transfer, protocol conversions, analogue-to-digital (and *vice versa*) conversions, and interworking between different numbering and charging plans.

Two reference configurations for network interworking are shown in Figure 6/I.510. The services offered at the endpoints may be different.

The separation between an ISDN and a non-ISDN may not always be obvious. A local exchange may, for example, support both traditional telephony service and ISDN services. The physical network components supporting these services may be inseparable. From a functional perspective, such a case might be covered by a) of Figure 6/I.510, while b) of Figure 6/I.510 might be more appropriate from an implementation point of view.



Note – Case b) illustrates the situation when no clear division exists between physical components supporting ISDN and physical components supporting PSTN.

FIGURE 6/I.510

Some examples of reference configurations where network interworking is required

6.3.2 *Connection types*

6.3.2.1 *ISDN-PSTN*

Applicable Recommendation: I.530.

a) ISDN circuit mode-PSTN
   - speech
   - 3.1 kHz
   - 64 kbit/s unrestricted

b) ISDN packet mode, X.31 case b)-PSTN.

6.3.2.2 *ISDN-CSPDN*

Applicable Recommendation: I.540.

a) ISDN circuit mode-CSPDN;

b) ISDN packet mode, X.31 case b)-CSPDN

6.3.2.3 *ISDN-PSPDN*

Applicable Recommendation: I.550.

a) ISDN circuit mode-PSPDN;

b) ISDN circuit mode, to provide interworking port access to a PSPDN, X.31, case a);

c) ISDN packet mode, X.31 case b)-PSPDN.

6.3.2.4 *ISDN-Telex*

Applicable Recommendation: I.560.

a) ISDN circuit mode-Telex

b) ISDN packet mode-Telex

6.3.2.5 *ISDN-Private networks*

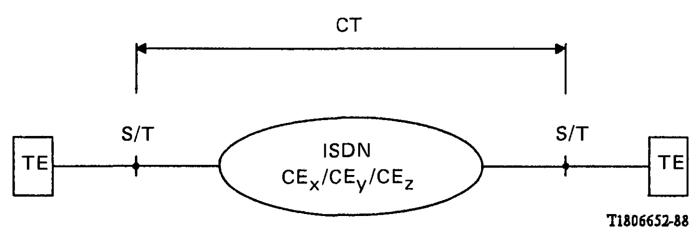
Interworking between ISDNs and private networks may occur at reference points S/T; other reference points, if required, need to be specified.

6.4 *ISDN internal interworking*

Internal ISDN interworking involves the capabilities required for interworking between different connection elements within an ISDN, as well as the capabilities required to support other interworking requirements within an ISDN.

A reference configuration is given in Figure 7/I.510. The services offered at the endpoints may be different.

Not all aspects of internal ISDN interworking may be subject to standardization. The existence and functionality of such interworking, however, may have an impact on the required functionality of network interworking or ISDN-to-ISDN interworking.



CT Connection type
CE Connection element
CE_x, CE_y, CE_z Connection elements of differents types

FIGURE 7/I.510

Reference configuration where internal ISDN interworking is required

6.5 *Network concatenation configurations*

Note 1 – The impact of network concatenation configurations (i.e. cascaded networks) on ISDN and existing networks and on the mechanisms and functionalities for the realization of these networks is for further study.

Note 2 – In the case of cascaded (concatenated) networks, other than ISDN networks, a requirement may exist for interworking functions between pairs of such networks.

6.5.1 *Reference configurations*

See Figure 8/I.510.

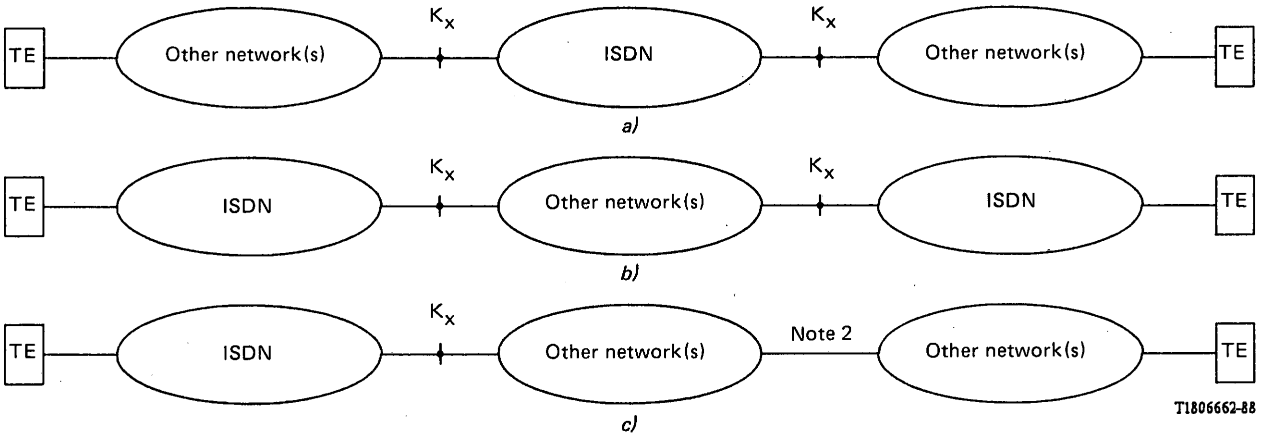


FIGURE 8/I.510

Network concatenation reference configurations

6.5.2 *Connection types*

6.5.2.1 *ISDN-PSTN-ISDN*

Applicable alternatives at reference points K_x are described in § 6.3.2.1 and in Recommendation I.520.

6.5.2.2 *ISDN-PSPDN-ISDN*

Applicable alternatives at reference points K_x are described in § 6.3.2.3 and in Recommendation I.520.

6.5.2.3 *ISDN-CSPDN-ISDN*

Applicable alternatives at reference points K_x are described in § 6.3.2.2 and in Recommendation I.520.

6.5.2.4 *ISDN-PSPDN-PSTN*

Applicable alternatives at reference points K_x are described in § 6.3.2.3.

6.5.2.5 *ISDN-PSPDN-CSPDN*

Applicable alternatives at reference points K_x are described in § 6.3.2.3.

6.5.2.6 *ISDN-PSPDN-Telex*

Applicable alternatives at reference points K_x are described in § 6.3.2.3.

6.5.2.7 *ISDN-CSPDN-PSPDN*

Applicable alternatives at reference points K_x are described in § 6.3.2.2.

7 Interworking functional requirements – General aspects

7.1 *Categories of interworking functions*

The following network-related characteristics and protocols depend on the network type (ISDN circuit-switched, ISDN packet-switched, PSTN, CSPDN, PSPDN, etc.) and may be identified at the point of network interworking for conversion or mapping:

a) network characteristics related to the connection type, such as interface characteristics, switching mode, bit rate, transfer mode, etc., and non-protocol conversion-related characteristics such as numbering plan and special routing;

b) network-to-network protocols used for call establishment interexchange signalling, such as SS No. 7, X.71, X.75, etc. (e.g. SS No. 7 ISUP to another User Part of SS No. 7, SS No.7 to non-ISDN signalling system, D-channel signalling to non-ISDN user access signalling systems based on national standards);

c) protocols used for the support of those supplementary services and service signals which have network-to-network relevance, as in the case, for example, of the closed user group facility;

d) signals due to network operation and maintenance;

e) inband protocol conversion IWFs such as rate adaption, modem pools, and generation of inband tones and announcements.

The definition of the conversion or mapping functions is the subject of specific interworking Recommendations which address ISDN interworking at a functional level of detail (see Recommendation I.500).

Interworking functional must take into account the mapping of protocols (protocol elements) dedicated to the support of OSI network layer service characteristics. These requirements should be formulated with the recognition that the networks involved in ISDN interworking may support the OSI network layer service as defined in Recommendation X.213 in different ways and to different extents (see Recommendation X.300, § 6).

7.2 *Mapping principles*

Interworking implies the transfer of information between two different entities across an interface. This transfer may imply the need to map different protocols with respect to coding, sequencing, and timing. Ideally, no information content should be lost in mapping. This objective may not be achievable in all circumstances. Three different cases are identified:

a) one-to-one mapping, where the information is transferred across the interface without any loss;

b) mapping with degraded information transfer, where parts of information are lost when crossing the interface;

c) no meaningful mapping possible, due to the fact that crucial parts of one protocol cannot be represented in the other protocol.

In these cases, appropriate actions have to be taken at the interworking point with respect to one or both of the communicating entities.

7.3 *Guidelines on the description of mapping functions*

For further study.

7.4 *Functional requirements for lower layer service interworking*

(For example, mapping of layer 2 and layer 3 protocols by end systems in support of end-to-end communication).

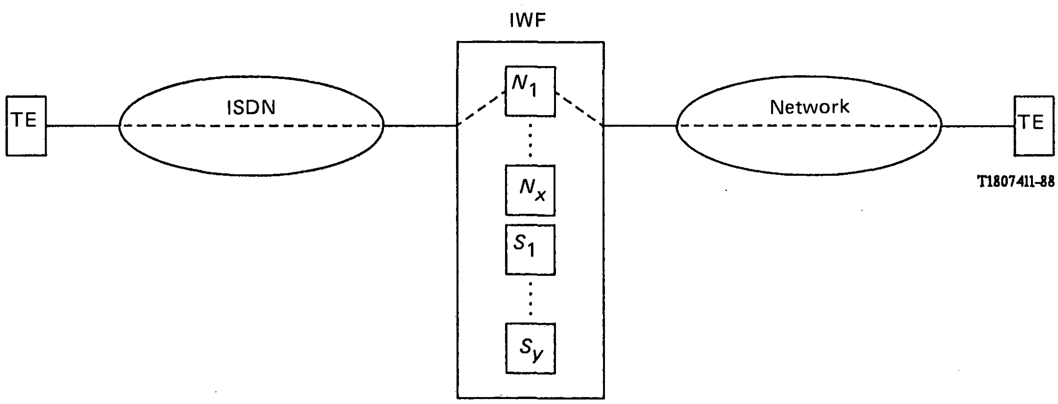
For further study.

7.5 *Functional requirements for higher layer service interworking*

For further study.

8 General aspects of selection mechanisms for interworking functions

ISDN interworking will involve sets of different functional elements dedicated to the various cases of network interworking. For each call where interworking is required, specific interworking functions have to be selected (see Figure 9/I.510).



IWF Interworking functions

$N_1 \ldots N_x$ Connection-dependent interworking functions

$S_1 \ldots S_y$ Communication-dependent interworking functions

FIGURE 9/I.510

Selection of interworking functions, where an ISDN is interconnected with another network (communication-dependent interworking functions may or may not be required)

When the IWF is not an addressed entity, the following concept for the selection of interworking functions is therefore defined:

a) Connection-dependent interworking functions are selected by evaluation of user-network and network-network signalling information. Relevant information includes:
   - bearer capability,
   - low layer compatibility,
   - service indication,
   - routing information (address information, transit network information),
   - information on supplementary services (facilities), if applicable;

b) Network-provided communication-dependent interworking functions are selected by evaluation of user-network and network-network signalling information. Relevant information includes:
   - service indication,
   - lower and higher layer compatibility information,
   - information on supplementary services (facilities), if applicable;

c) End-system-provided communication-dependent interworking functions, if available, are activated by one of the following approaches:
   - by evaluation of user-network signalling information during the call establishment phase (service indication and lower/higher compatibility information),
   - by evaluation of user-to-user compatibility information during the parameter exchange phase.

Note – Examination of these information elements requires further study.

ISDN-TO-ISDN LAYER 1 INTERNETWORK INTERFACE

(Melbourne, 1988)

1 General

The objective of this Recommendation is to define the layer 1 aspects of the ISDN interworking, including reference configuration and interworking functions.

Note – For the international interworking between networks based on different digital hierarchies and speech encoding laws, see Recommendation G.802.

2 Reference configuration

General reference configuration and logically defined reference points for ISDN interworking with other networks or other ISDNs are given in Figure 4/I.310, where K, M and N are defined as logical reference points for interworking. However, from the viewpoint of physical interworking, the digital sections and digital links defined in Rec. G.701 are shared among the logically different networks of the same network provider. Therefore, the commonly designated reference point for layer 1 interworking should be established so that it can be used as the common layer 1 specification for the logically different reference points K, M and N.

2.1 *Layer 1 reference configuration*

Figure 1/I.511 shows the layer 1 reference configuration and layer 1 reference point Q.

Figure 1/I.511 reflects the interworking between different network providers each of which has logically different networks or special facilities. The number of logically different networks which a network provider has is one or more; however, at least one network provider should contain an ISDN.

The internetwork termination (IT) is a functional grouping associated with the proper physical and electromagnetic termination of the network as well as section, link and/or circuit termination of the network. Note that specific functions of IT may be performed with one or more pieces of equipment.

Reference point Q should be one of the equipment interfaces listed in Recs. G.702 and G.707. The specification of Q can be used as the common description of the layer 1 specification for the different logical interfaces K, M and N.

The digital link of each network should be terminated at Q.

2.2 *Physical realizations of reference configuration*

Figure 2/I.511 gives examples of configurations made up of combinations of physical interfaces at reference point Q; Figure 2a/I.511 shows an interface without transmission section (line or radio); and Figures 2b/I.511 and 2c/I.511 show interfaces with transmission sections.

In every case, reference point Q should appear as the equipment interface.

The mandatory functions of IT described in § 3 are the same in each application, while the optional functions may be different according to the following cases, if interworking:

- with or without transmission sections,
- with or without master-slave relation, such as master-slave synchronization and remote maintenance between two network providers.

3 Layer 1 interworking functions

Layer 1 interworking functions at Q, which may be performed by the IT, should be classified into mandatory and optional functions.

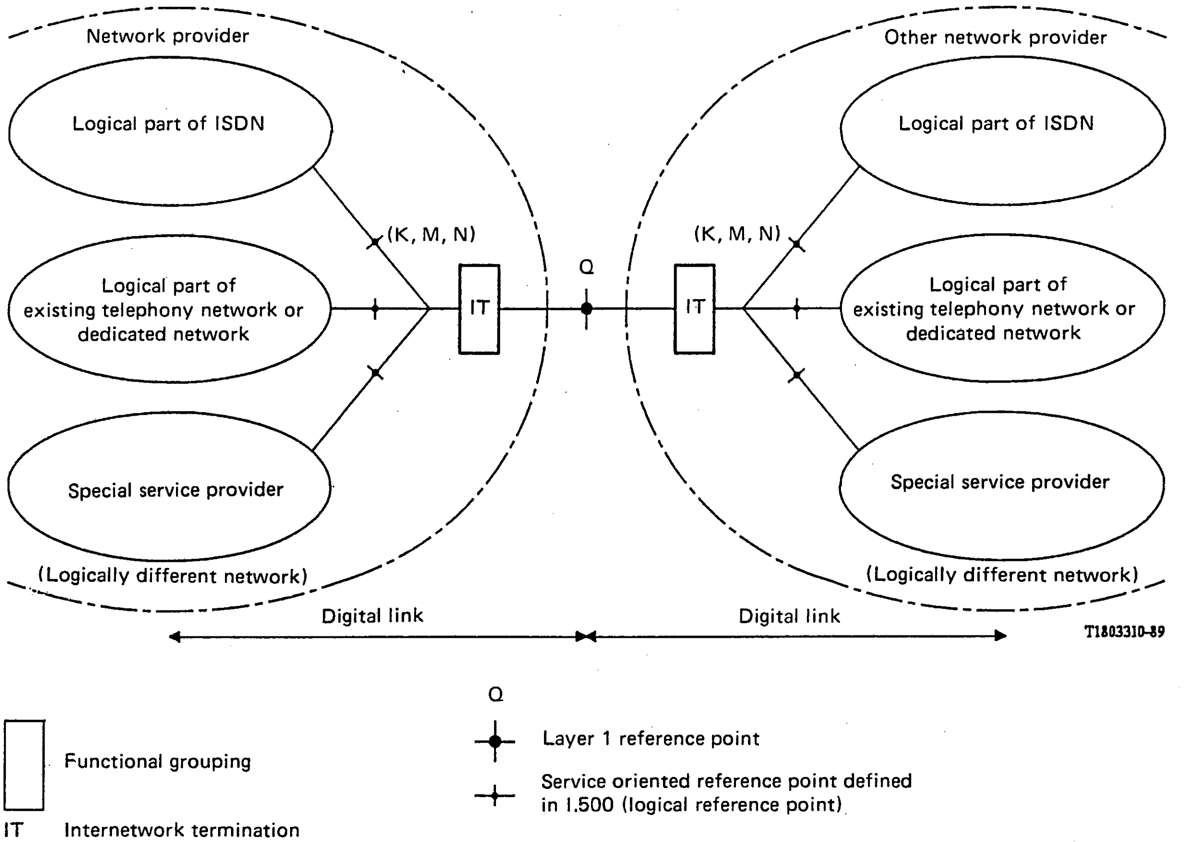
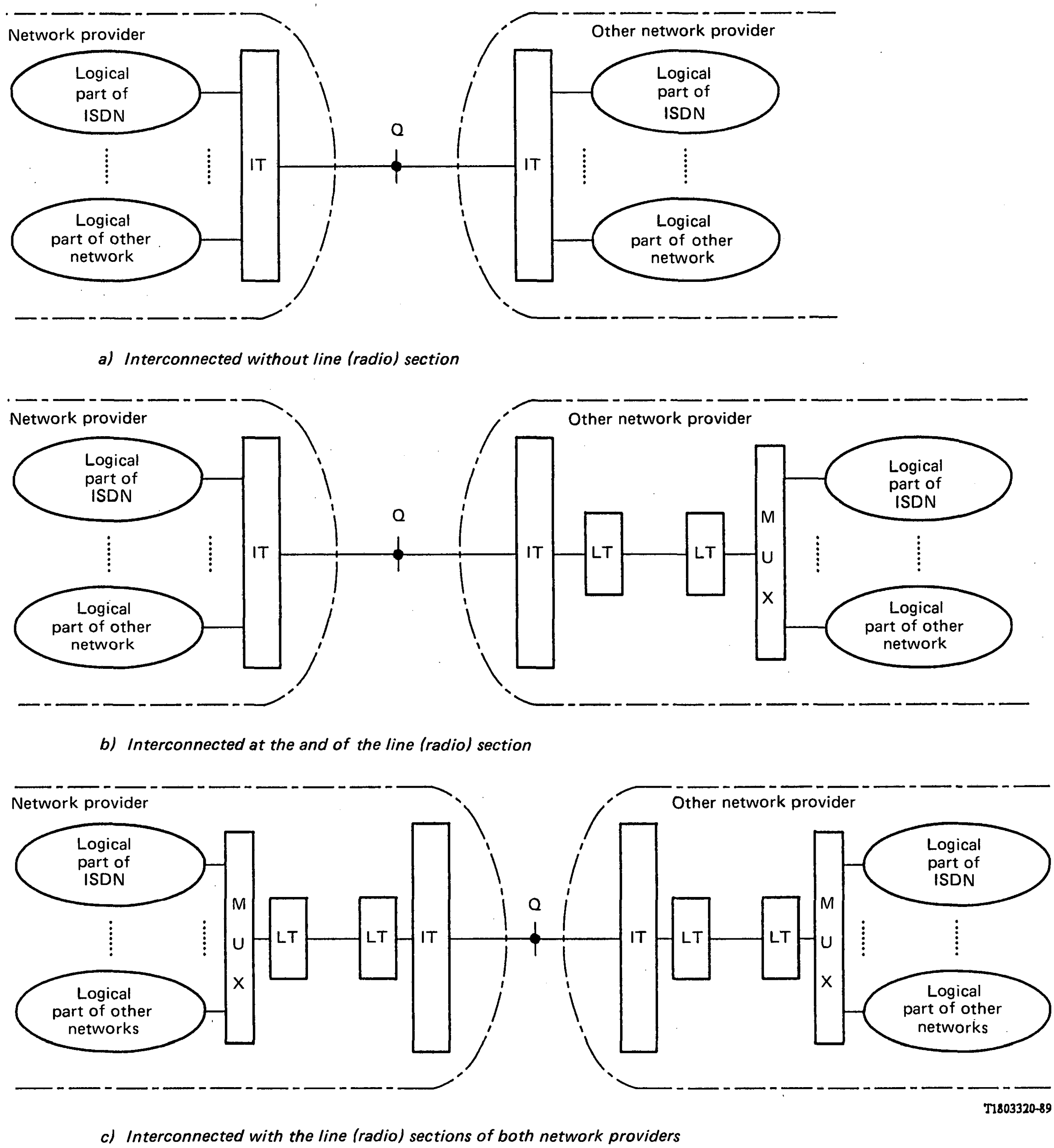


FIGURE 1/I.511

Reference configuration for the ISDN-related internetwork interface at layer 1



IT Internetwork termination
LT Line termination

FIGURE 2/I.511

Examples of physical configurations

3.1 *Mandatory functions*

Every item related to mandatory functions should always be carried out in order be classified into mandatory and optional functions.

3.1.1 *Providing standardized equipment interfaces*

Reference point Q should be applied to one of the equipment interfaces standardized in the G.700-G.900 Series Recommendations for digital networks, transmission systems and multiplexing equipment.

Items to be standardized are as follows:

1) *Interface bit rate*

   Interface bit rate at Q should be selected from among the hierarchical bit rates defined in Recs. G.702 and G.707.

   It should be noted that the interworking hierarchy be applied to the international interworking as defined in Rec. G.802 when interconnection based on an asynchronous hierarchy is adopted.

2) *Physical/electrical characteristics*

   Physical/electrical characteristics at Q should conform to the relevant part of G.700-G.900 Series Recommendations.

3) *Functional characteristics*

   Functional characteristics at Q should conform to the relevant part of G.700-G.900 Series Recommendations.

4) *Time slot assignment*

   There are two methods for assigning time slots in the frame structure to various channels: the fixed format method and the variable format method. A set of examples of both methods is described in Figure 3/I.511.

   Fixed format – Time slots for interworking information channels are pre-assigned in a fixed manner in the interworking frame structure by bilateral negotiation.

   Variable format – A flexible time slot is allocated to any information channel on a demand assignment basis.

5) *Time slot sequence integrity*

   Time slot sequence integrity should be performed. Furthermore, it is preferable to perform time slot sequence integrity with 8 kHz integrity.

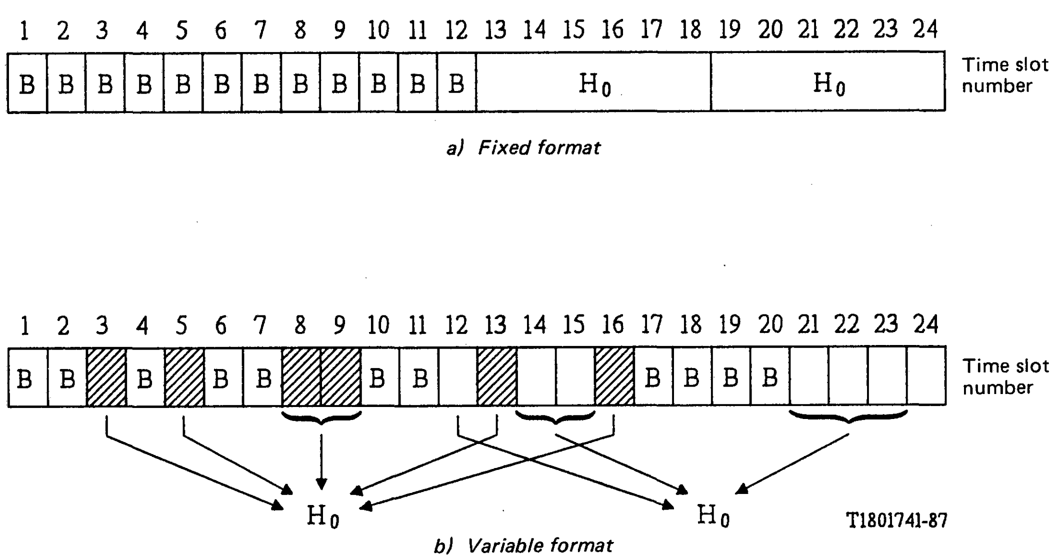


FIGURE 3/I.511

Examples of fixed format and variable format time slot assignment

3.1.2 *Providing layer 1 maintenance capability*

Reference point Q should meet the maintenance requirements defined in the relevant part of the M-Series and N-Series Recommendations.

Items to be standardized are as follows:

1) *Termination of the digital link*

   Termination of the digital link should conform to the relevant part of the M-Series Recommendations.

2) *Termination of the digital circuit*

   Termination of the digital circuit should conform to the relevant part of the M-Series Recommendations and is deferred for further study.

3.2 *Optional functions*

Not all of the items of the optional functions can be achieved at reference point Q. Only some of them are selected according to the features of each connection type or differences in the relationship between network providers.

3.2.1 *Providing interworking between different connection types in layer 1*

In some applications, connection types which are different in layer 1 items can be successfully interconnected over reference point Q by using the optional capabilities listed below.

Items to be standardized are as follows:

1) *Coding rule conversion*

   i) μ-A law coding rule conversion should be performed according to Rec. G.802 in the case of speech and 3.1 kHz audio services;

   ii) Unrestricted 64 kbit/s digital service shall not be subject to network provided conversion.

2) *Interconnection among connection types with different layer 1 attributes*

   Rate adaption should be performed according to Recs. I.460, I.461, I.462, I.463 and I.464.

3.2.2 *Providing network synchronization clock*

If network synchronization is performed over reference point Q by other methods than the plesiochronous method, the clock should meet the requirement defined in Rec. G.812.

Recommendation I.515

PARAMETER EXCHANGE FOR ISDN INTERWORKING

(Melbourne, 1988)

1 General

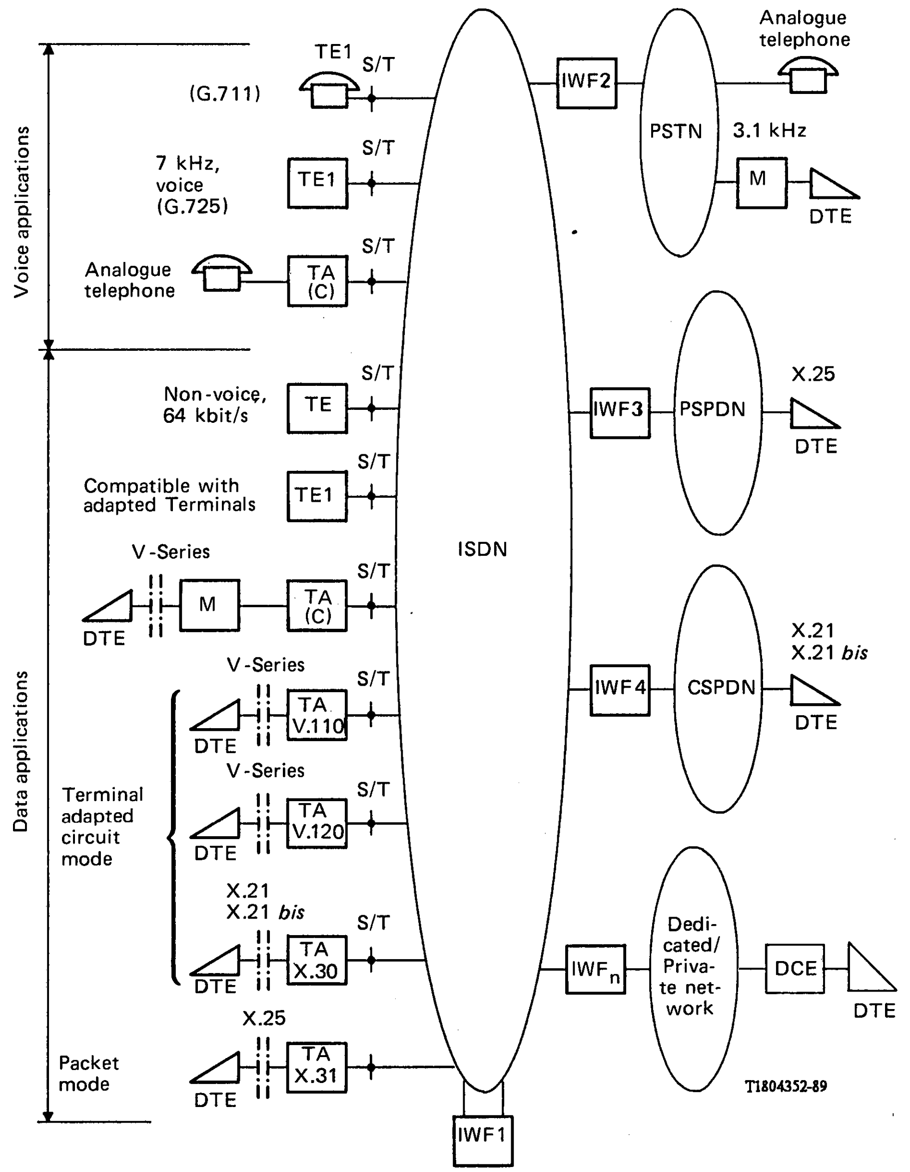
1.1 *Scope*

The objective of this Recommendation is to provide overall parameter exchange principles and functional descriptions for ISDN interworking. This Recommendation describes the principles for parameter exchange mechanisms. It is recognized that depending on the available (end-to-end) signalling capability, the exchange of parameters may use either out- or in-band procedures.

Parameter exchange may be necessary to establish compatible interworking functions for a variety of applications. Typical examples where parameter exchange takes place include, terminal adaption compatibility establishment, modem type selection and voice encoding compatibility establishment. This does not imply, however, any requirement for an ISDN to support network based modem interworking.

Figure 1/I.515 illustrates several voice and data applications, supported by different networks and mechanisms. Parameter exchange may be necessary where interworking between different terminals or networks (as per other Recommendations) is required.

Note – Where interworking procedures exist, the appropriate references are made herein.



IWF Interworking function (may include: physical Requirements, signalling requirements, terminal adaptation modulation, etc.)

M Modem

TA(C) Terminal adaptator with codec

Note 1 – IWFs may be located:

a) within the network(s),

b) separate to the network(s),

c) within the customer's premises.

Note 2 – The requirement for interworking between terminals may not be inferred from this figure.

Note 3 – This figure is not exhaustive.

FIGURE 1/I.515

1.2 *Definitions and abbreviations*

Use is made of the following terms within this Recommendation. These terms do not necessarily refer to any existing protocol structure, rather they define information requirements in the context of this Recommendation.

– **bearer capability information**

  Specific information defining the lower layer characteristics of the network.

– **low layer compatibility information**

  Information defining the lower layer characteristics of a TE or TA.

– **high layer compatibility information**

  Information defining the higher layer characteristics of a terminal.

– **protocol identifier**

  Information defining the specific protocols used by a terminal to support data transfer.

– **progress indicator**

  Information supplied to indicate to the ISDN terminal that interworking has occurred.

– **out-band parameter exchange**

  Information exchanged via signalling channels which are not within the channel used for user information transfer.

– **in-band parameter exchange**

  Information exchanged using the same information channel as that used for the user information transfer.

2 Principles

2.1 *Types of parameter exchanges*

Three types of parameter exchange need to be considered:

i) end-to-end, out-band as shown in Figure 2/I.515. Parameter exchange is accomplished via the D-channel and Signalling Systems No. 7;

ii) end-to-end, in-band as shown in Figure 3/I.515.

iii) Parameter exchange to select IWFs as shown in Figure 4/I.515.

The in-band parameter exchange occurs after the establishment of an end-to-end connection and may provide for establishment of compatibility between the endpoints, based on characteristics such as protocol, rate adaption scheme and modem type.

2.2 *Relationship of parameter exchange to call establishment*

Parameter exchange may occur:

i) prior to call establishment (call negotiation). In this case parameter exchange will occur using out-band techniques;

ii) after call establishment, prior to information transfer. In this case parameter exchange may occur using either in-band or out-band techniques;

iii) during the information transfer phase of the call. In this case parameter exchange will occur using either in-band or out-band techniques.

2.2.1 *Parameter exchange prior to call establishment (call negotiation)*

Call negotiation may be used to satisfy a number of basic call requirements in ISDN. In addition, call negotiation may be necessary for interworking as described in I.510 (between terminals, services and networks) for:

a) terminal section (see Recs. I.333, Q.931, Q.932);

b) selection of interworking requirements when interworking between ISDN and other dedicated networks is identified (e.g. modem type);

c) the appropriate selection of network (ISDN or other network) functions to support the service required (e.g. use of call progress indicator);

d) the selection of network functions when interworking between incompatible terminals is identified or when interworking of different services is required.

Each of the requirements a) through d) above are necessary during the call establishment phase. Therefore, call or service negotiation mechanisms should be included within basic call establishment procedures. Further study is required.

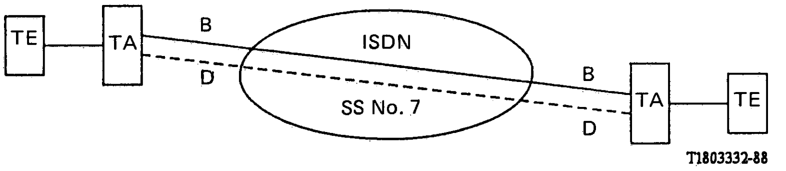
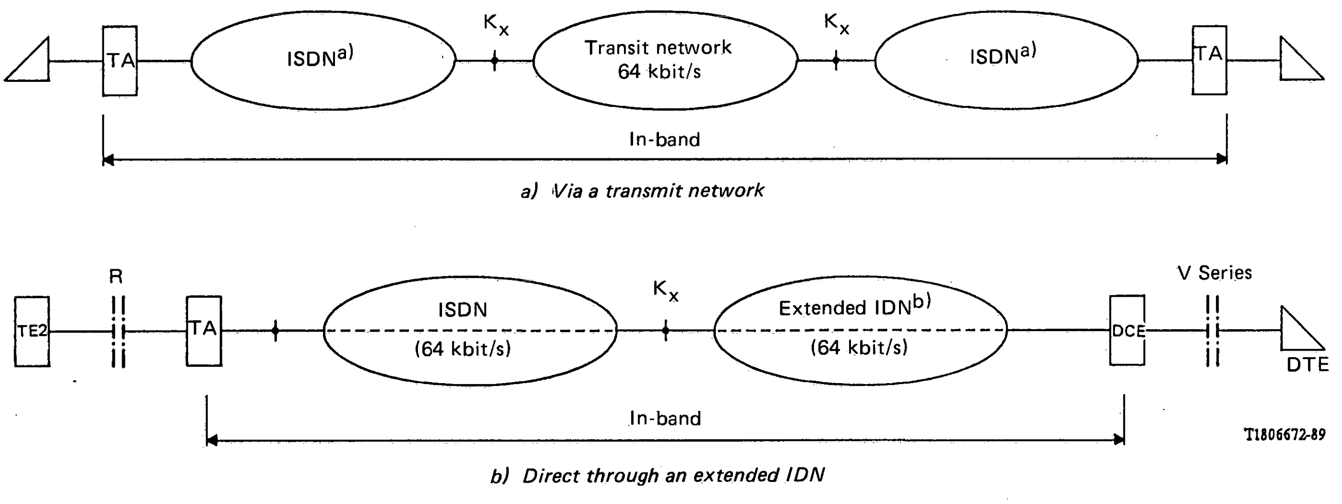


FIGURE 2/I.515

Out-band parameter exchange via D-channel



a) 64 kbit/s connection type is assumed for ISDN.

b) The extended IDN shown has a 64 kbit/s transmission channel (see Recommendation I.231), however its signalling system is not compatible with that of the ISDN.

FIGURE 3/I.515

In-band parameter exchange

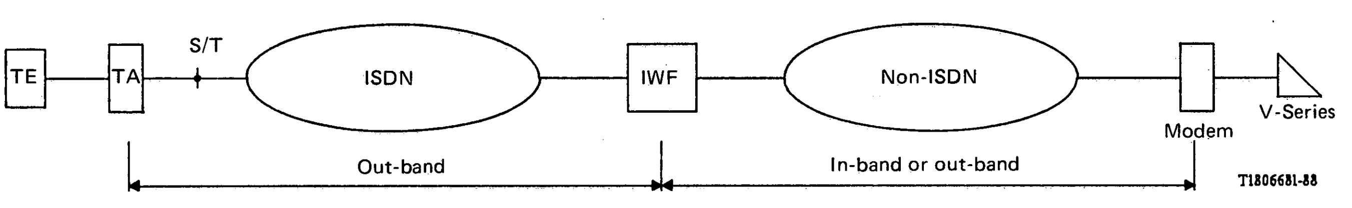


FIGURE 4/I.515

Parameter exchange to select IWFs

2.2.1.1 *Call negotiation types*

Three types of call negotiation are currently envisaged:

- user to network,
- network to user,
- user to user.

The relationship between user-to-user call negotiation and network-to-user call negotiation required further study.

Call negotiation in each of the above cases may involve the forwarding of parameters to the destination, may involve forwarding of parameters on request, or may involve forward and backward negotiation to establish compatible terminal and network parameters.

2.2.1.2 *Information elements available for call negotiation*

Three information elements are currently associated with call negotiation (see note):

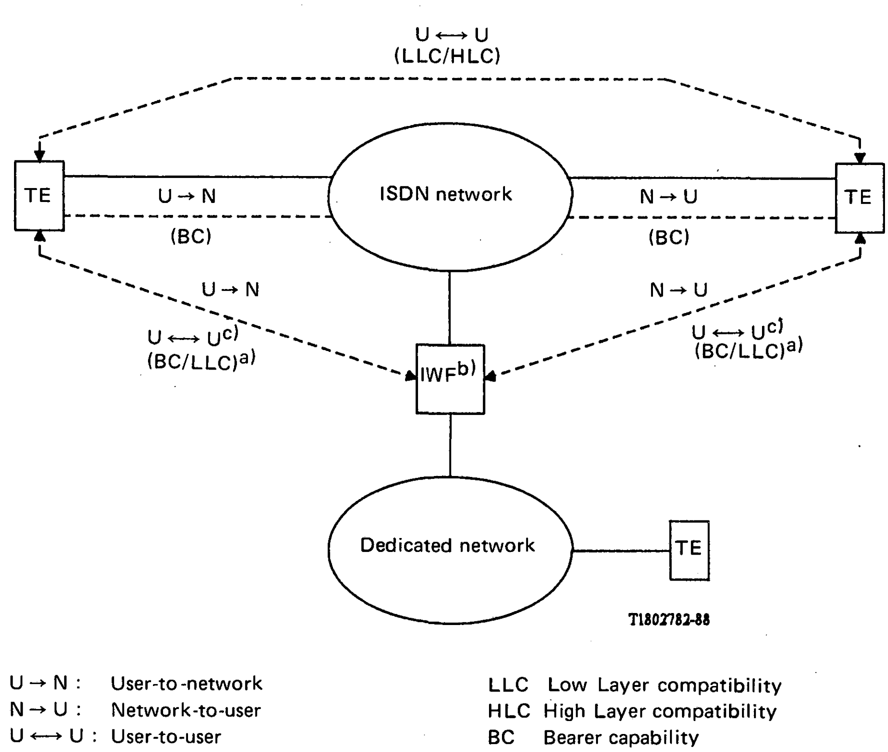
- bearer capability (BC);
- low layer compatibility (LLC);
- high layer compatibility (HLC).

The relationship of these information elements to parameter exchange functions is for further study.

Note – BC, LLC, HLC are information elements defined in Recommendation Q.931.

2.2.1.3 *Transfer of information*

The transfer of information associated with call negotiation is illustrated in figure 5/I.515.



a) The examination of LLC by the network when the IWF is not an addressed entity, is for further study.

b) The IWF can be distributed (see Recommendation I.510 for definition of IWF).

c) When the IWF is on the customer premises, examination of additional information elements to satisfy basic call requirements may be appropriate (e.g. sub-address called party ID).

FIGURE 5/I.515

Transfer of information associated with call negotiation

2.2.2 *Parameter exchange after call establishment and prior to information transfer phase*

This parameter exchange may be necessary when signalling to allow adequate compatibility checking during the call set-up phase is not available, or when additional capability checking is required due to characteristics of the terminals which are not defined in call establishment procedures.

When out-band parameter exchange is used refer to § 3.1.2.

When in-band paramaeter exchange is used refer to § 3.2.1.

2.2.3 *Parameter exchange during information transfer phase*

This parameter exchange may be necessary when configurations change during the information transfer phase (e.g. maintenance, sub-channel information). Detailed aspects are for further study.

3 Parameter exchange procedures

3.1 *Out-band parameter exchange*

3.1.1 *Prior to call establishment*

Refer to Recs. Q.931 and Q. 764. Other protocols are for further study.

3.1.2 *After call establishment and prior to information transfer phase*

Refer to Recs. Q.931 and Q.764.

3.1.3 *During information transfer phase*

Refer to Recs. Q.931 and Q.764.

3.2 *In-band parameter exchange*

3.2.1 *After call establishment and prior to information transfer*

The following parameter exchange sequence identifies one method of establishment compatibility during interworking between an ISDN and existing networks and between ISDNs:

- call establishment phase (e.g. refer to Recs. Q.931 and Q.764);
- originating terminal changes from idle condition to busy condition;
- connection enters paramters exchange phase;
- connection enters information transfer phase.

3.2.1.1 *Voice services*

Refers to Recommendation G.725.

3.2.1.2 *Parameter exchange mechanism for terminal adaption protocol identification*

Some In-band Parameter Exchange (IPE) procedures are in existence, e.g. Appendix I of Recommendation V.110. Two circuit mode terminal adaption procedures are emerging within CCITT (i.e. I.463/V.110 and I.465/V.120). In many countries, the Terminal Adaptor (TA) desing may not be controlled by the administration/RPOAs so that special forms of terminal adaption may be deployed. To support multiple forms of terminal adaption in a mixed ISDN/non-ISDN network, terminal adaption implementations which support multiple terminal adaption protocols will be required. For use with such implementations, a method is needed for some applications to identify the specific terminal adaption protocol to be used by the multifunctional adaptor (MTA) devices. This will allow the terminal equipment (or appropriate network component), to release the call where compatibility cannot be achieved, or to request the network to provide an appropriate interworking function.

It should be noted that it is good practice to design data terminals, for circuit-mode applications, which can automatically answer or originate calls, automatically establish compatibility if possible and, if necessary, to disconnect when connected to an incompatible terminal.

Though it is recognized that out-band procedures are preferable where applicable (i.e., intra-ISDN situations), for interworking with dedicated networks, in-band parameter exchange procedures may be required.

Alternative methods exist for distinguishing between terminal adapttion protocols. One satisfactory method is the use of self identification by examining the incoming bit stream. The method would be sed on the need to provide, in any TA or TE1, the ability to determine when it is connected to an incompatible TE1 or TA/TE2 or, through an IWF, with an incompatible terminal or another network. Appendix II describes one such procedure.

An alternative satisfactory method is to use protocol identification (PID) procedure. Appendix I presents an in-band parameter exchange procedure for establishing a common terminal adaption (TA) protocol between communicating TA devices.

3.2.2 *During the information transfer phase*

For further study.

4 Parameter exchange functions

Parameters exchanged to support interworking may be divided into the following three categories. These parameters may be exchanged end-to-end or between an endpoint and an IWF. The list of parameters presented here are examples; for any given instances of communication, different parameters may be required.

4.1 *Numbering parameters*

- subscriber number;
- sub-address;
- terminal selection (see Recommendation I.333).

4.2 *Protocol control parameters*

Protocol control parameters can be used to identify the protocol supported. An example is the terminal adaption protocol supported, such as V.110, V.120.

4.3 *DTE/DCE configuration parameters*

DTE/DCE configuration parameters are used to identify specific transmission or communication capabilities of the called DTE. The following is a list of such configuration parameters:

- modem type (e.g., V-Series number)
- data rate (e.g., 9.6 kbit/s, 56 kbit/s)
- synchronization (e.g., synchronous or asynchronous)
- parity (odd, even or no parity)
- transmission mode (e.g., half or full duplex)
- number of start/stop bits (e.g., 1 or 2)
- terminal clock source (e.g., network provided, network independent)
- terminal interface signals (e.g., 106, 108)
- sub-channel information.

4.4 *Operations and maintenance parameters*

Operations and maintenance parameters are used to convey/monitor the status of the DTE/DCE at the terminating points. Status monitored may include:

- terminal power (ON or OFF)
- terminal presence (connected or disconnected)
- terminal interface signals status (e.g., 106, 108)
- terminal clock source (e.g., network provided, network independent)
- loopback status (e.g., ON or OFF)

5 Parameter exchange for selection of IWF

When an IWF is involved in a connection, parameters can be exchanged to establish compatibility.

There are a variety of techniques that can be used to provide compatibility of functions in an interworking environment. These can be categorized into two types. A single stage approach in which the network automatically inserts the IWF, and a two-stage approach in which the user must provide additional information to complete the interworking connection.

Note – For examples of interworking configurations, refer to the appropriate I.500-Series Recommendations. Appendix III details examples of parameter exchange for the selection of IWFs in the case of ISDN-PSTN interworking for data.

5.1 *Single stage*

In a single stage approach, the interworking function is handled automatically by the network. In order to ensure compatibility of the parameters the following techniques may be used:

i) parameter registration (service profile) – the DTE/DCE parameters are registered with the ISDN;

ii) parameter negotiation – parameter negotiation may be possible between networks and end-users or between networks or between users to determine parameter compatibility where suitable signalling exists. The signalling capabilities and parameters required may vary and are for further study. For example, see Appendix I of V.110;

iii) default parameter identification – the network provides an interworking function with common parameters. Any DCE must conform to the IWF common parameters;

iv) parameter adaption – the interworking function recognizes and adapts to the end-user's parameters. For example, for ISDN-PSTN the interworking function may adapt to the modulation standard of the modem (see Appendix III).

5.2 *Two stages*

In the two-stage approach, during the first stage the user accesses the IWF and establishes the required parameters. In the second stage of the call the IWF uses the parameters to complete the end-to-end connection.

6 Reference

See Recommendation I.500.

APPENDIX I

(to Recommendation I.515)

Protocol for identification of terminal adaption protocols

I.1 As shown in Figure I-1/I.515 the total in-band parameter exchange consists of two distinct phases. These are:

a) Phase 1 – the protocol identification (PID) phase, which occurs at the bearer rate (64 kbit/s);

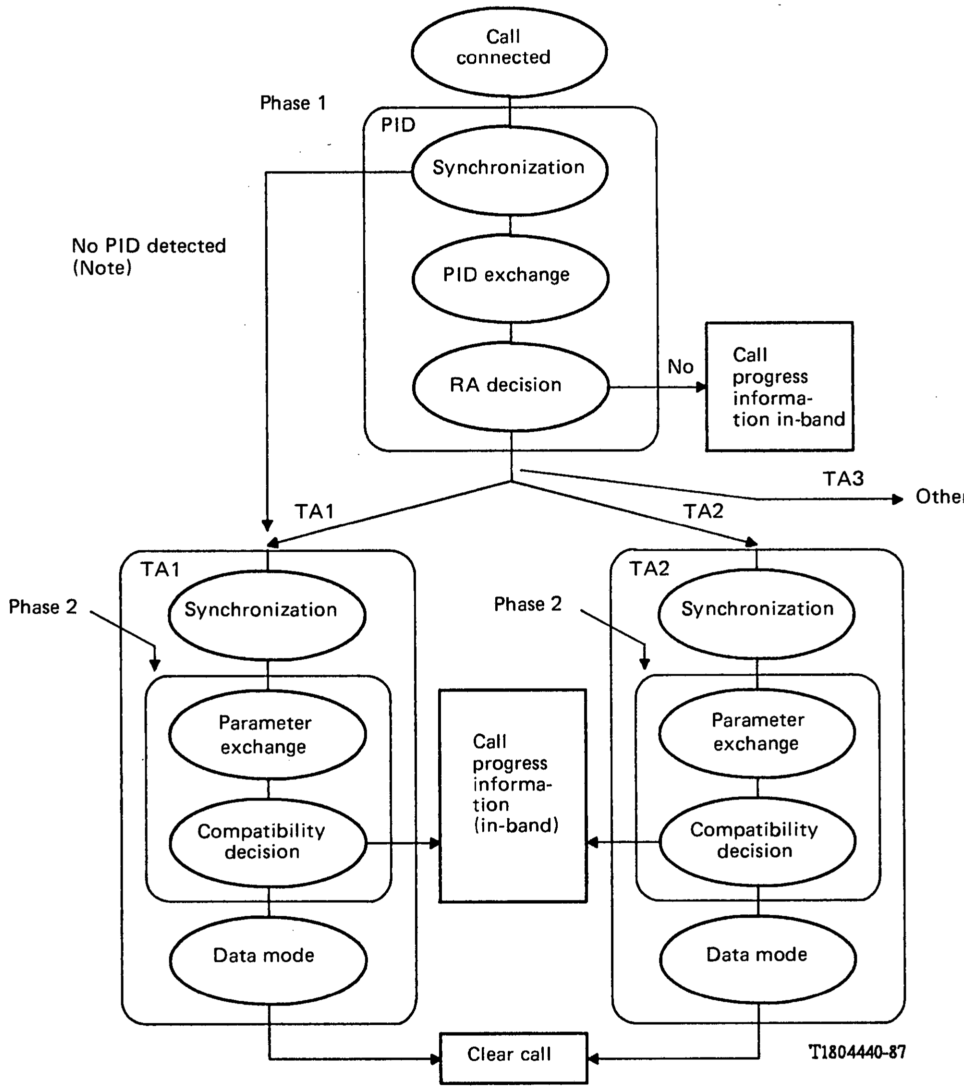
b) Phase 2 – the in-band parameter exchange (IPE) which is part of the rate adaption (RA) protocol used during the call.

Both these phases are optional and may or may not be implemented depending on the particular situation.

1) Phase 1 – PID: after call establishment PID phase begins.

2) Phase 2 – IPE: the IPE is imbedded within the TA protocol. It is the responsibility of the RA protocol designers to create an IPE that is applicable to the services and requirements of a particular TA protocol. An example is Appendix I to Rec. V.110 in which a complete IPE is specified for V.110.

   - The IPE allows parameters to be exchanged between TA devices to ensure end-to-end compatibility before entering the data (information) phase.
   - In the case of a successful IPE the protocol enters the data (information) phase.
   - In the case of unresolvable differences between the TA devices, the IPE will provide a call progress message that can be used to take further action or clear the call.



Note – If no PID is detected, the TA defaults to a user selected TA protocol.

FIGURE I-1/I.515

IPE flow diagram

I.2 *Identification procedure*

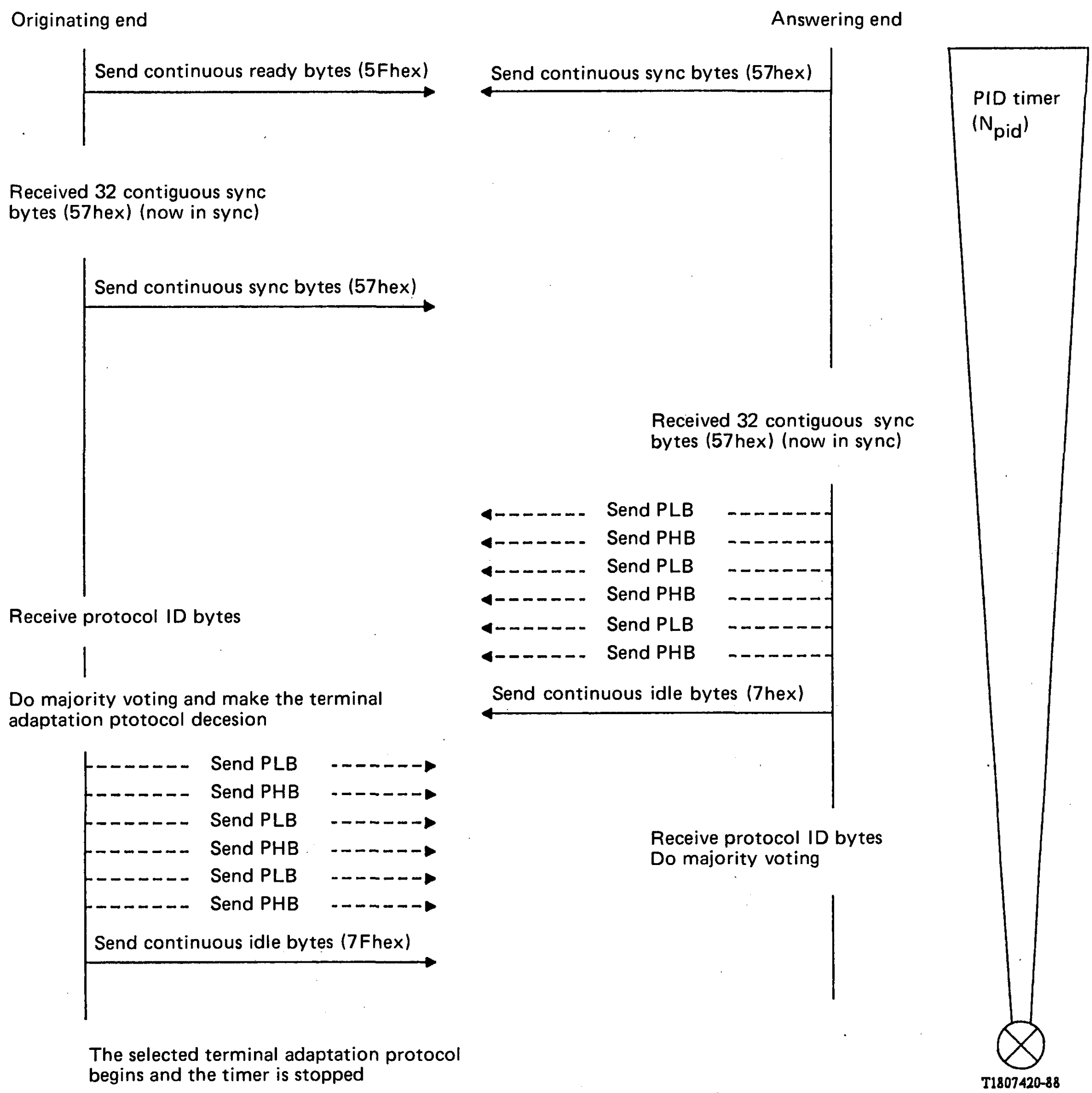
All TA devices that follow this procedure shall start with the simple protocol identification technique described here before entering the TA protocol phase. The method is designed especially for digital networks.

The protocol identification is performed during the following three steps after the call is placed by using the normal call establishment procedures:

1) end-to-end synchronization;
2) passing the Protocol Identifier (PI);
3) making a decision regarding the type of TA to use for the call.

For the case of a device with a PID and one without a PID which interwork, a timer value (N_{pid}) should be set in the PID for defaulting to the preferred terminal adaption protocol. N_{pid} must be long enough to allow for initial line settling and short enough to prevent the PID from causing the terminal adaption protocol to time out and clear its call. The value of timer N_{pid} should be set to allow for long delay connections (e.g. satellites).

Refer to Figure I-2/I.515 for the timer sequence diagram of a successful protocol identification procedure. The sequence and acronyms in Figure I-2/I.515 are described in §§ I.3 to I.5.



Note – If the PID phase fails for whatever reason (e.g. no PID, error in PID) and the timer expires, the TA device can default to a preferred TA protocol as shown in the flow diagram of Figure I-1/I.515.

FIGURE I-2/I.515

Time sequence diagram of a successful protocol identification procedure

I.3 *End-to-end synchronization*

After the physical call has been established, the originating end sends continuous ready bytes (5Fhex) waiting to detect the answering end. The answering end sends continuous sync bytes (57hex). (See Figure I-3/I.515).

When the originating end sees at least 32 contiguous sync bytes (57hex) it is in sync and starts sending continuous sync bytes (57hex).

When the answering end sees 32 contiguous sync bytes it is in sync.

The receivers at each end wait for at least 32 contiguous occurrences (4 ms) of the sync byte to be received without corruption before initiating the protocol. The sequence can then proceed to the next step.

The synchronization method described in this section allows for:

1) settling of the physical circuit;
2) notice in the network;
3) positive identification of the fact that TA devices are present at both ends;
4) transmission on restricted 64 kbit/s links and through networks that use bit 8 for signalling; and
5) simple implementation.

	Initialization bytes								
	B1	B2	B3	B4	B5	B6	B7	B8	
Originating end	0	1	0	1	1	1	1	1	(5F in hexadecimal)
Answering end	0	1	0	1	0	1	1	1	(57 in hexadecimal)

Note 1 – B1 is transmitted and received first.

Note 2 – B8 is set to 1 for transmission and ignored on reception.

FIGURE I-3/I.515

I.4 *Passing the protocol identifier (PI)*

This is the critical information that is to be passed and therefore a special technique is used to provide robustness in the face of noise, and yet maintain simplicity.

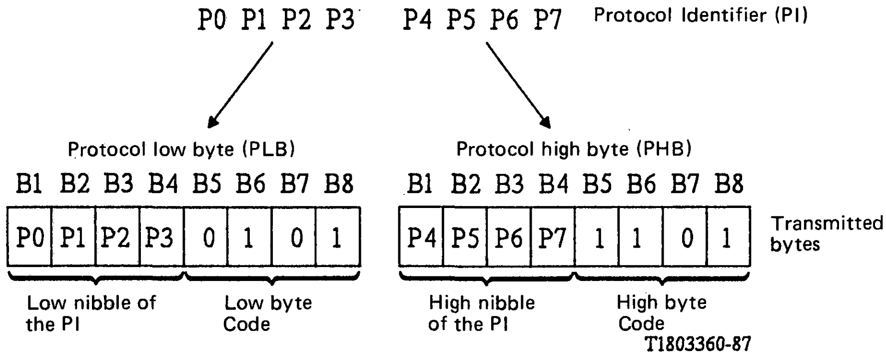
The PI is split into two bytes and three identical pairs are sent (refer to Figure I-4/I.515).

The PI passing technique described in this section:

1) provides positive identification of the protocol bytes (low and high byte codes);
2) provides redundant pairs of byte codes which allows for a technique to determine the protocol identification in the presence of noise (i.e. repeated three times);
3) allows all eight bits of the PI to be used even on networks that use bit 8 for signalling; and
4) allows for operation on restricted 64 kbit/s networks and networks that use bit 8 for signalling (i.e. guarantees one's density, bit 8 set to 1).

I.5 *TA decision*

After the answering end has received 32 contiguous sync-bytes (§ I.3), it then sends its PI. The protocols supported by the answering end are coded in the PI byte (see Figure I-5/I.515) and transmitted to the originating end. The originating end will check the PI and decide which (if any) TA protocol it wishes to support.



Note 1 – P0 and P4 are the first bits transmitted and received in their respective bytes.

Note 2 – Bit 8 of all bytes is set to 1 for transmission and ignored on reception.

Note 3 – The transmission sequence, PLB PHB PLB PHB PLB PHB, facilitates detection of the protocol identifier code by the originating end's receiver.

FIGURE I-4/I.515

Protocol Identifier

P7	P6	P5	P4	P3	P2	P1	P0
V.110	V.120	X.30	X.31	res.	res.	res.	res. [a]

Example: 11000000 supports V.110 and V.120 protocols.

Note – Bits marked "res." are set to 0, pending future allocation.

[a] Use of P0 as an extension bit is for further study.

FIGURE I-5/I.515

PI interpretation

After the answering end has sent its PI, it sends a distinct "idle byte" (see Figure I-6/I.515) continuous and waits for the matching PI from the originating end.

B1	B2	B3	B4	B5	B6	B7	B8	
0	1	1	1	1	1	1	1	(7F in hexadecimal)

Note 1 – B1 is transmitted and received first.

Note 2 – B8 is set to 1 for transmission and ignored on reception.

FIGURE I-6/I.515

Idle byte

The originating end then sends back its PI with only the bit that corresponds to the desired TA protocol set to 1.

If the originating end cannot support any of the answering end's TA protocols, it sends back a null PI byte (Figure I-7/I.515), and then terminates the call using normal call disconnection procedures.

P0	P1	P2	P3	P4	P5	P6	P7	
0	0	0	0	0	0	0	0	(00 in hexadecimal)

FIGURE I-7/I.515

Null PI byte

The method described in this section:

a) supports various CCITT recognized forms of TA schemes;

b) allows for future TA schemes;

c) limits the proliferation of TA schemes;

d) allows the originating end to control the selection of the common TA protocol; and

e) provides a positive indication of a failed call.

APPENDIX II

(to Recommendation I.515)

TA protocol self identification

This appendix discusses guidelines for self-identification procedures that may be used by multi-protocol terminal adaptor (MTA) implementations in selecting the protocol to be used on an individual connection. It is assumed that the multi-protocol terminal adaptor supports the procedures of Recs. I.463 (V.110) and I.465 (V.120). Where out-band signalling is available, multi-protocol terminal adaptors should function in accordance with the protocol negotiated during call set-up. Self-identification procedures are only applicable where such signalling capabilities are not available.

II.1 *MTAs intended to interwork with uni-protocol TAs*

The MTA may initiate transmission as if it were a uni-protocol TA conforming to any of the capabilities provided. The received signals would be examined by the MTA and the MTA should revert to transmission in accordance with the procedures of the protocol of the uni-protocol TA as indicated by the received signals. If compatibility is not achieved it would provide a disconnect.

It is noted that there is a range of capabilities that may be implemented in TAs conforming to either Rec. I.463 (V.110) or Rec. I.465 (V.120). For distinguishing the capabilities of the different TA protocols, an MTA should follow the procedures specified in the individual Recommendations.

II.2 *MTAs intended to interwork with other MTAs*

The MTA should initiate transmission, following the connect indication, in accordance with Rec. I.465 (V.120).

Note – Self identification can be extended to accommodate multiple protocols. It is only necessry to define the priority for the use of each protocol and a retry procedure. The general rule would be that an MTA would always initiate transmission assuming the protocol of the highest priority suported that has not been tried. The MTA would always delay disconnect, when the received signal is not recognized, for a period long enough for the necessary number of retries [this is protocol and implementation dependent – see, for example, Recs. I.463 (V.110) and I.465 (V.120)].

APPENDIX III

(to Recommendation I.515)

Parameter exchange for selection of IWFs in the case of ISDN-PSTN data interworking

III.1 *Mechanisms for modem selection – General options*

The IWF would have to cooperate with the user to establish the appropriate modem selection. The interworking function may also be required to convert the signalling format, and negotiate the required data signalling rate (modem rate).

There are two general categories of modem selection techniques:

a) mechanisms which do not require the ISDN user to have prior knowledge of the modem characteristics of the PSTN user;

b) mechanisms which may require the ISDN user to have prior knowledge of the modem characteristics of the PSTN user.

Note – The preferred methods for modem selection for ISDN-PSTN calls are for further study.

III.1.1 *Mechanisms which do not require the ISDN user to have prior knowledge of the modem characteristics of the PSTN user*

III.1.1.1 *Use of a multi-standard modem at the IWF*

The modem in the IWF recognizes and adapts to the end-user modulation standard. The number of, and choices of, modulation standards that would be supported in the IWF is for further study and would normally be a service provider option. For examples of possible implementation see Recs. V.100 and V.32.

III.1.1.2 *Negotiation*

Negotiation between end-user and network or between networks or between users to determine compatible modem characteristics may be possible where suitable signalling methods exist. The signalling capabilities and parameters required are for further study, and would normally be a service provider option.

III.1.1.3 *Registration*

The DTE/DCE characteristics of the PSTN user are registered with the ISDN.

III.1.2 *Mechanisms which may require the ISDN user to have prior knowledge of modem characteristics of the PSTN user*

III.1.2.1 *Default identification*

Any DTE uses the same default modem characteristics.

III.1.2.2 *Selection by ISDN user of the modem dynamically*

Using available parameter exchange mechanisms (i.e. SN, LLC/BC, IPE) the user selects specific TA/modem characteristics at the IWF.

III.2 *ISDN bearer capabilities for interworking*

III.2.1 *3.1 kHz ISDN bearer capability*

See Figure III-1/I.515.

In the scenario the following cases are considered:

– terminal is connected to ISDN access via a modem and uses a 3.1 kHz audio bearer through TA;

– terminal selection in ISDN is made by means of multiple subscribers numbers.

The PSTN user uses only the number corresponding to the appropriate terminal in ISDN for a call to that terminal. ISDN user does the same for calls to other terminals in ISDN or PSTN.

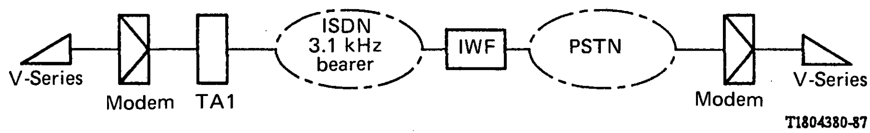


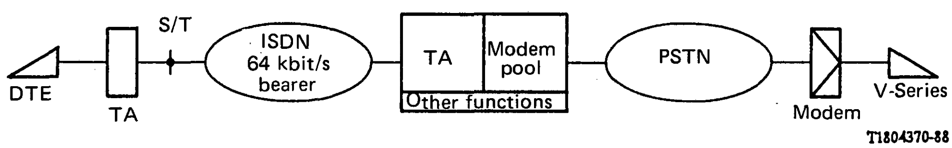
FIGURE III-1/I.515

IWF as defined for PSTN/3.1 kHz audio interworking

III.2.2 *64 kbit/s ISDN bearer capability*

The following modem selection procedures apply to ISDN-PSTN interworking (see Figure III-2/I.515) since the ISDN and PSTN will share network transmission and switching facilities. These modem selection procedures assume that the modem interworking point will be the originating (for ISDN to PSTN calls) or terminating (for PSTN to ISDN calls) ISDN exchange, i.e. modem pools are available at each ISDN exchange.

The modems in the modem pool at each ISDN exchange can be grouped by their speeds; suitable codes and/or full Subscriber Numbers (SNs) can be assigned to each group of modems.



Note – IWF is distributed. The representation in the figure is not a physical representation.

FIGURE III-2/I.515

ISDN-PSTN interworking for circuit switched calls

III.3 *Options for modem selection*

The modem selection procedures outlined in this section are provided as potential options, which Administrations may choose, with modifications as required, to suit their own operating environment and applications.

III.3.1 *ISDN-PSTN calls (bidirectional)*

III.3.1.1 *Option 1 (example of the method detailed in § III.1.1.1)*

This is a single stage modem selection procedure which relies upon the following system requirements:

– data terminals on the ISDN have separate SNs;

– the ISDN exchange can distinguish whether any incoming call is from the PSTN and can distinguish that an outgoing call is destined for the PSTN.

For a voice-band data call originated by a PSTN terminal, and intended for a data terminal on the ISDN, the terminating ISDN exchange will intercept the call and direct the call to an IWF. At the IWF, a modem will be inserted into the path, and the modem will recognize and adapt to the modulation standard used by the PSTN user. The IWF may pass parameters (e.g. LLC) to the called user when establishing the ISDN portion of the call.

For a data call originated in the ISDN intended for a data terminal on the PSTN, the ISDN exchange will intercept the call and direct the call to the IWF. The IWF will use the requested service (BC/LLC) on the ISDN portion of the call. At the IWF, a modem will be inserted into the path, and the modem will recognize and adapt to the modulation standard used by the PSTN user.

III.3.1.2 *Option 2 (example of the method detailed in III.1.1.3)*

This is a single stage modem selection procedure which relies on the following system requirements:

- circuit data terminals on ISDN loops have separate SNs;
- a call progress indicator that PSTN to ISDN, or ISDN to PSTN interworking has occurred; and
- service profiles of destination terminals are available at the ISDN exchange (data *vs* speech terminals, pre-subscribed modem type).

III.3.1.2.1 *PSTN-to-ISDN call*

The terminating ISDN exchange recognizes that:

- the call is from the PSTN (from the call progress indicator);
- the call is for a data terminal (from service profile); and
- the modem type subscribed to (from service profile).

The terminating exchange will insert the pre-subscribed modem type from the pool.

III.3.1.2.2 *ISDN-to-PSTN call*

The ISDN terminal will initiate the callas a 64 kbit/s, rate adapted digital data call for all calls to both ISDN and PSTN destinations. On the receipt of the progress indicator (ISDN/PSTN interworking), the local exchange will insert the pre-subscribed modem type in the path.

If the calling ISDN terminal knows *a priori* that the called terminal in on a PSTN analogue loop, it may indicate in the *set-up* message the pre-subscribed modem type to be inserted.

III.3.2 *ISDN-to-PSTN calls*

III.3.2.1 *Option 3 (example of the method detailed in III.1.2.2)*

For a data call originated by a data terminal on the ISDN, the modem selection is done by using some appropriate information elements in the Q.931 *set-up* message. Modem selection by the calling party is dependent upon the calling party's prior knowledge of the modulation standard used by the called party on the PSTN or upon the user of a multi-standard modem at the IWF. The appropriate modem is inserted in the end-to-end path.

III.3.3 *PSTN-to-ISDN calls*

III.3.3.1 *Option 4 (example of the method detailed in III.1.2.2 using subscriber number.)*

This is a two-stage method in which the modem pools at each exchange are grouped according to modulation standard and/or speed and each group is assigned a full subscriber number (SN). The first stage selects an appropriate modem and the second stage completes the connection to the desired terminal through the selected modem. Separate SNs for the data terminals on the ISDN digital loop are not needed because it is the responsibility of the PSTN subscriber to request a modem from the pool when he needs a data connection; the IWF will generate the appropriate bearer capability. However, the PSTN terminal equipment should have the capability to input a second set of digits, i.e. the called number (e.g. using V.25 *bis* protocol).

Therefore for a PSTN-to-ISDN data call, the PSTN user first dials the address of the appropriate group of modems at the terminating exchange. Once this connection is established the PSTN user dials the address of the called ISDN subscriber. This set of digits is used by the signalling conversion functionality (part of the IWF at the terminating exchange) to set up the connection from the modem to the called ISDN terminal. The exchange of call progress tones for this case needs further study.

III.3.3.2 *Option 5 (example of the method detailed in III.1.1.2)*

This is a single-stage modem selection procedure which relies upon the following system requirements:

- circuit data terminals on ISDN loops have separate SNs;
- PSTN terminals have suitable signalling capabilities to indicate the modem speed/type in response to a request from the terminating exchange;
- the ISDN exchange can distinguish whether an incoming call is from the PSTN or the ISDN (using call progress indicator); and
- the ISDN exchange maintains a data base on service profiles of terminals served by the exchange (analog *vs* digital, and speech *vs* data in case of digital subscribers).

The user must be aware of any special operational requirements.

For a voice-band data call originated by a PSTN terminal, and intended for a digital data terminal on the ISDN, the terminating ISDN exchange will recognize that:

- the call is coming from the PSTN; and
- the call is intended for a digital data terminal on the ISDN.

The terminating ISDN exchange will intercept the call and send a suitable tone/signal back to the originating PSTN subscriber. Using some suitable signalling capability, the PSTN subscriber will indicate the code for modem selection, which will be used by the terminating exchange to attach a suitable modem and complete the path to the digital data terminal.

Recommendation I.520

GENERAL ARRANGEMENTS FOR NETWORK INTERWORKING BETWEEN ISDNs

(Melbourne, 1988)

1 Introduction

The number of ISDNs existing in the world is increasing and more than one ISDN may exist even within a single country. Therefore, ISDN-ISDN network interfaces should be standardized to facilitate the interworking between ISDNs and to extend connectivity world-wide.

2 Scope

The purposes of this Recommendation are:

1) to identify the general arrangements for ISDN-ISDN interworking, and
2) to define the functions and other requirements for the ISDN-ISDN interface.

Recommendation I.324 defines the reference point between two interconnected ISDNs to be the N_x reference point. This Recommendation (I.520) identifies other Recommendations which should be applied to the N_x reference point and clarifies the functions and requirements for interworking at the N_x reference point.

3 Required information and information handling

Figure 1/I.520 illustrates the general configuration for interworking between two ISDNs. The information given in Tables 1/I.520, 2/I.520 and 3/I.520, when required, has to be carried by Signalling System No. 7 (SS No. 7) ISUP and X.75, and is handled at the IWF in one of the following ways:

i) information is terminated at the IWF and is not transferred to other ISDNs;

ii) information is interpreted at the IWF and is transferred to other ISDNs;

iii) information is transferred through the IWF transparently;

iv) information is newly generated at the IWF.

Tables 1/I.520, 2/I.520 and 3/I.520 also show the classification of information into the above four categories for circuit mode bearer services, circuit mode supplementary services and packet mode bearer services respectively.

Additional information required specifically for OAM (Operational, Administrative and Maintenance) functions is for further study.

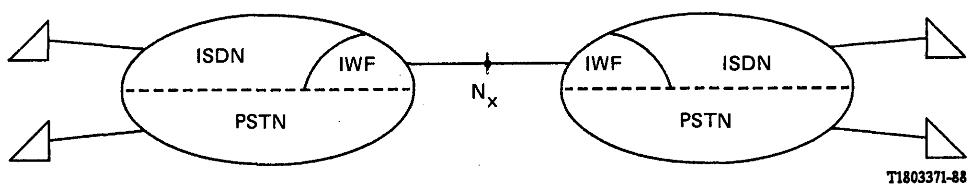


FIGURE 1/I.520

General configuration for interworking between two ISDNs

TABLE 1/I.520

Information required for IWF between ISDNs for circuit mode bearer services

Category	Required information	Q.931 information element	Q.763 parameter name
i	First transit network subsequent to IWF	Transit network selection	Transit network selection
ii	Called party number (Note 1)	Called party number/Key pad	Called party number/Subsequent number
	Calling party's category (Note 2)	(Unnecessary)	Calling party's category
	Bearer capability	Bearer capability	Transmission medium requirements User service information
	Call indicators (Note 3)	(Unnecessary)	Forward call indicators Backward call indicators
	Use of satellite (Note 4)	(Unnecessary)	Nature of connection indicators
iii (Note 8)	Calling party number	Calling party number	Calling party number
	Subaddress	Subaddress	Access transport
	Calling party's category	(Unnecessary)	Calling party's category
	Terminal compatibility (Note 5)	Low layer compatibility High layer compatibility	Access transport
	User-to-user signalling	User-to-user information element	User-to-user information
	Cause	Cause	Cause indicator
	Charge	(Unnecessary)	Charge information
iv	Cause for interworking	Cause	Cause indicator
	Charging information (Note 6)	(Unnecessary)	Charge information
	Change of services (Note 7)	(Should be defined)	(Should be defined)

Note 1 – For charging use.

Note 2 – For discrimination of priority call/ordinary call.

Note 3 – These indicators are used to identify:

1) international incoming call,

2) available end-to-end signalling system,

3) charged call/noncharged call.

Note 4 – When a satellite circuit is employed for an interworking call at the interworking point, this information is processed at the IWF. If a satellite circuit is not employed for a call, this information is transferred through the IWF transparently.

Note 5 – There may be cases where the terminal compatibility information is processed (see § 5.4).

Note 6 – This information is used only when access charging is necessary.

Note 7 – All ISDNs do not necessarily provide identical services (or connection types). When a change of services occurs at the IWF, the network should send the indication for change of services and may solicit acceptance of change of services to a calling user in certain cases (see § 5.3.1 of this Recommendation).

Note 8 – The information in this category is transferred through the IWF transparently.

TABLE 2/I.520

Information required for IWF between ISDNs for circuit mode supplementary services

Category	Required information	Q.931 information element	Q.763 parameter name
ii	Supplementary service request	Network specific facility Key pad facility Feature activation Feature indication	(Should be defined)
iii	Progress indicator Suspend/Resume indicator	Progress indicator Notification indicator	Access transport Suspend/Resume indicator

TABLE 3/I.520

Information required for IWF between ISDNs for packet mode bearer services (in-band signalling)

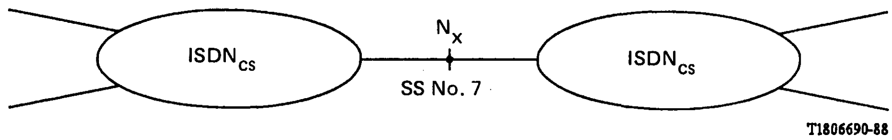
Category	Required information	Rec. X.25 information	Rec. X.75 information
i	Transit network identification	RPOA selection	Transit network identification
ii	Packet type Logical channel number Called party number Throughput class Window size Packet size Call identifier Transit delay selection User-to-user information	Packet type identifier Logical channel number Called DTE address Throughput class negotiation Flow control parameter negotiation Flow control parameter negotiation (Unnecessary) Transit delay indication/selection Fast select identifier	Packet type identifier Logical channel number Called DTE address Throughput class indication Window size indication Packet size indication Call identifier Transit delay indication Fast select indication
iii	Calling party number Terminal compatibility Subaddress Cause	Calling DTE address (Call user data) Calling address extension Called address extension Diagnostic code	Calling DTE address (Should be defined) Calling address extension Called address extension Diagnostic code
iv	Cause for interworking Charging	(Should be defined) Charging information	(Should be defined) (Should be defined)

Note – The relationship between X.25 facilities and ISDN supplementary services is for further study.

4 Description of ISDN-ISDN interworking configurations

4.1 *ISDN-ISDN interface where circuit mode bearer services are provided by both ISDNs*

See Figure 2/I.520.



cs circuit switched

FIGURE 2/I.520

$ISDN_{cs}$ interworking with $ISDN_{cs}$

4.1.1 *Bearer services*

Individual bearer service categories are defined in the I.230-Series of Recommendations.

Layer 1 interworking specifications are recommended in Recommendation I.511. Layers 2 and 3 in the U-plane are passed transparently.

4.1.2 *Supplementary services*

4.1.2.1 *Other than user-to-user signalling*

For supplementary services other than user-to-user signalling, call control information is transferred via Signalling System No. 7 across the N_x reference point. The interface for user information transfer is not different from that of basic bearer services.

4.1.2.2 *User-to-user signalling services*

There are two methods of transferring user-to-user signalling. One is transfer of user-to-user signalling within Q.931 call control messages which have been mapped into Signalling System No. 7 messages and then are conveyed via the Signalling System No. 7 network. The other is transfer of user-to-user signalling within stand alone USER INFO messages (which have been mapped into Signalling System No. 7 messages and then are conveyed via the Signalling System No. 7 network), or optionally may be transferred via packet handlers (PHs) in some ISDNs. In the case where user-to-user signalling is transferred between packet handlers (PHs) in both ISDNs, the X.75 protocol may be applied to the internetwork interface to transfer user-to-user signalling. In the case where user-to-user signalling is transferred via Signalling System No. 7 networks in both ISDNs or at least in one ISDN, the Signalling System No. 7 protocol should be applied to the internetwork interface for user-to-user signalling.

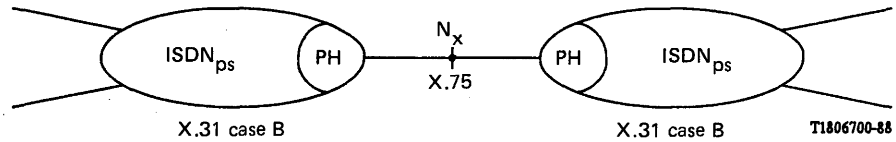
4.1.3 *Signalling System No. 7 for the control of circuit mode services at the N_x reference point*

For the control of circuit mode services in the long term, Signalling System No. 7 with ISUP will be used at the N_x reference point.

4.2 *ISDN-ISDN Interface where both ISDNs provide X.31 case B based packet mode bearer services*

See Figure 3/I.520.

The X.75 protocol is used to transfer X.31 based packet mode services at the N_x reference point. Layers 1, 2, and 3 for this interface are specified in X.75.



ps packet switched

FIGURE 3/I.520

ISDN$_{ps}$ interworking with ISDN$_{ps}$

4.3 *ISDN-ISDN interface where a circuit mode bearer service is provided by one ISDN to access either a PSPDN, or a PH and an X.31 case B packet mode bearer service provided by another ISDN*

With this type of interworking, two different configurations are considered, I and II. In configuration I, interworking between the two ISDNs utilizes X.75 interexchange signalling. See Figure 4/I.520.

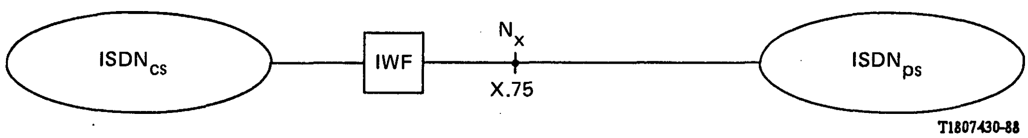
In configuration II, a circuit switched access to the PH in the ISDN$_{(ps)}$ is provided, and the interworking between the two ISDNs utilizes a Signalling System No. 7 protocol.

This interworking arrangement applies for data transmission services. General arrangements are covered in § 6.3 of X.320. There are two possibilities:

i) X.31 case A interworking with X.31 case B. Case A refers to the situation where a transparent circuit switched access to PSPDN is provided by ISDN. Case B refers to the situation where a packet mode bearer service is provided by an ISDN PH.

ii) ISDN circuit switched access to an ISDN PH (this case may exist if the originating ISDN does not have PH functionality).

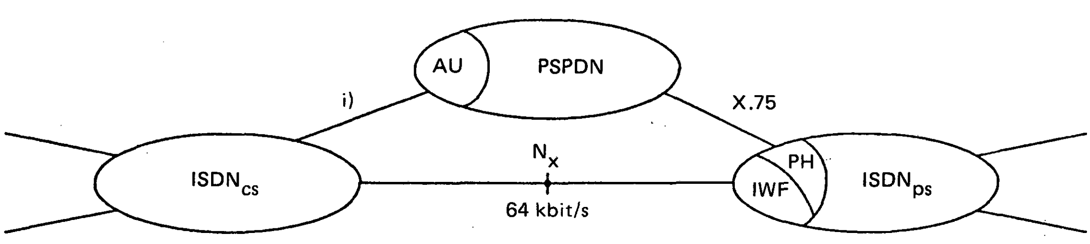
Several aspects of interworking for data transmission services as well as their application to other transmission services are for further study.



Note – The IWF is logically part of the ISDN$_{cs}$. For further details, see Recommendation X.320.

FIGURE 4a/I.520

Configuration I: ISDN$_{cs}$ interworking with ISDN$_{ps}$



Note – For accessing the PH, the IWF must include access unit (AU) functionality as defined in Recommendation X.31 for the PSPDN.

FIGURE 4b/I.520

Configuration II: ISDN$_{cs}$ interworking with ISDN$_{ps}$

4.4 *ISDN-ISDN interworking via a transit network*

ISDN-ISDN interworking via a transit network (see Figure 5/I.520) may be a useful configuration in the short term for extending specific ISDN services on an end-to-end basis. Special transmission, switching and signalling capabilities may have to be deployed in the transit network to ensure that the specific ISDN service is available end-to-end.

The detailed interworking functions and interfaces for this configuration are for further study.

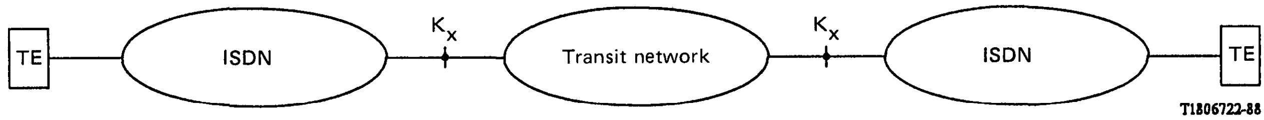


FIGURE 5/I.520

Interworking of two ISDNs via a transit network

4.5 *ISDN-ISDN interface for additional packet mode bearer services*

For packet mode services that are currently under study, out-band call control signalling is used. The same out-band call control is used for circuit mode services. Two alternatives can be considered for this out-band call control: enhancement of Signalling System No. 7 and enhancement of the D-channel protocol. The choice between the two alternatives is for further study.

4.6 *ISDN-ISDN interface where an X.31 case B based packet mode bearer service is provided on one ISDN and an additional packet mode bearer service is requested on another ISDN*

Two alternatives can be considered: the first is based on in-band signalling (X.75), and the second is based on out-band signalling (Signalling System No. 7 or D-channel protocol). The choice between the two alternatives is for further study.

4.7 *ISDN-ISDN interface for circuit mode to additional packet mode service*

This section is for further study.

5 **Interworking functions**

Interworking functions commonly employed for various types of interworking are described in Recommendation I.510. The interworking functions specific to ISDN-ISDN interworking are described here.

5.1 *Echo control processing and speech processing*

Table 4/I.520 shows the permitted relationship between circuit mode bearer services and various forms of speech processing functionality. These speech processing functions include digital speech interpolation (DSI), low rate encoding (LRE) and digital circuit multiplication (DCM). Depending upon the particular relationship to the circuit mode bearer services, these processing functions are specified as essential, optional, prohibited or functionally disabled.

For a speech, 3.1 kHz audio, or 64 kbit/s unrestricted call within an ISDN, appropriate network control is required to ensure that the relationship shown within Table 4/I.520 is realized. An example of this control might be routing (to exclude or include a function) or out-band signalling (to disable a function). Further, it is to be noted that a disabling tone (see Recommendations V.25 and I.530) may be used to functionally remove echo control devices on a 3.1 kHz audio bearer service connection.

TABLE 4/I.520

Relationship between speech processing and bearer services within an ISDN and for ISDN-ISDN interworking

Speech processing functions	Bearer service				
	1	2	3	4	
	Speech	3.1 kHz audio [a]	64 kbit/s Unrestricted	Alternate speech/64 kbit/s Unrestricted [b]	
				Speech	64 kbit/s
Echo control [c]	E [d) e)]	E [d) e)]	FD	[e)]	FD
A-μ law conversion [f]	E	E	FD	E	FD
DSI	O	O [g]	FD	O	FD
LRE	O	O [g]	FD	O	FD
DCM	O	O [g]	FD [h]	O [i]	FD [i]
Analog facilities	O	O [g]	P	P	P

E Essential

O Optional

P Prohibited

FD Functionally disabled

DSI Digital speech interpolation

LRE Low rate encoding (e.g. Rec. G.721).

DCM Digital circuit multiplication employing LRE and DSI and having controllable flexibility in modes of operation.

Note – The bearer services in columns 1, 2 and 3 of the table permit control of speech processing devices only at call set-up as required for the particular bearer service requested. The bearer service in column 4 requires additional post set-up user-to-network signalling (out-band by D-channel messages) in order to perform the required in-call service modifications between the relevant alternative services.

a) For the 3.1 kHz audio bearer service, echo control is included in the connection at the time of call set-up. It is disabled for the transmission of voice-band data by use of the disabling tone (see Recs. V.25 and I. 530).

b) The exchange may set up a 64 kbit/s unrestricted bearer path with echo control devices and A-μ law converters (if necessary) enabled for speech. In any case, the set up of parallel paths for speech and 64 kbit/s unrestricted must be avoided.

c) Echo control needs to be disabled when continuity check is performed.

d) Although echo control may not be required in ISDN-ISDN interworking for digital telephones (for further study), its inclusion for possible internetworking reasons for the speech bearer service is essential (see also Rec. I.530).

e) The necessity for network or terminal provided echo control in 4-wire end-to-end speech connections is for further study.

f) The IWF converting A-μ laws should also make the necessary bit translation in the bearer capability information element to indicate the law used.

g) The network may include signal processing techniques provided they are appropriately modified or functionally removed prior to information transfer.

h) The 64 kbit/s transparent capability will be invoked, subject to the available transmission capacity, by the adjoining exchange over a dedicated out-band signalling system.

i) The provision of this bearer service using DCM is subject to the ability of the out-band signalling system and the DCM equipment to execute in-call modifications initiated by the adjoining exchange.

For a call which involves communication through different ISDNs, the network information regarding control of these functions needs to be extended across the ISDN-ISDN internetwork interfaces. This information transfer is realized between the exchanges in interworking ISDNs by means of:

1) the Signalling System No. 7 ISUP bearer capability information element, and

2) the use of a disabling tone (see Recommendations V.25 and I.530) by terminals, in the case of a 3.1 kHz audio bearer service.

The control of speech processing functions (DCM, A-μ law conversion, echo control, etc.) by exchanges is:

a) not needed when a disabling tone (see Recommendations V.25 and I.530) is used, in conjunction with the 3.1 kHz audio bearer service by a terminal(s), and

b) to be implemented using out-band call processes (currently under study) when needed.

The procedures in the case of alternate speech/64 kbit/s unrestricted bearer services, are for further study.

5.2 *Generation of in-band tones and announcements for speech and 3.1 kHz audio bearer services*

(*Note* – This function is also necessary for a call within one ISDN, which does not involve network interworking nor internal ISDN interworking.)

5.2.1 *Unsuccessful call delivery*

The point of call failure (i.e. the point at which the connection cannot proceed further) should generate the appropriate out-band clearing message toward the calling exchange. In response to this message, the calling exchange should send the appropriate out-band message to the calling user. However, for speech and 3.1 kHz audio bearer services, the network must be capable of generating the appropriate in-band tones or announcements. In this case, the clearing message should not be sent prior to the completion of the announcements.

5.2.2 *Successful call delivery*

For speech and 3.1 kHz audio bearer services, the terminating exchange should generate in-band ring back tone towards the calling user upon successful delivery of the call.

5.3 *Call negotiation between ISDNs*

There are two aspects of call negotiation between ISDNs: service agreement and connection agreement.

5.3.1 *Service agreement between ISDNs*

Service agreement between ISDNs is defined as established compatibility between the two networks on a requested service. The service agreement does not necessarily occur on a call-by-call basis, but in a pre-determined way which has been agreed by bilateral negotiation between the two ISDNs. If the service agreement is established, connection agreement then begins between the two ISDNs.

If the service agreement is not established, procedures are for further study, including the following four alternatives. Additionally, the impact of these alternatives on user-to-network protocols or internetwork protocols is for further study.

1) The call may be established without the service compatibility (e.g. in the case of a supplementary service request).

2) The call may be cleared.

3) Either of the ISDNs may negotiate with the originating user to change or abandon the user's service request.

4) Another alternative may be selected from the originating user's service profile.

5.3.2 *Connection agreement between ISDNs*

Connection agreement between ISDNs is defined as negotiation on the connection element between the two networks. Connection agreement is required when the connection elements employed in each ISDN are different, even if service agreement exists. (For example, see Appendix I.) The use of call progress indicators for this purpose is for further study.

In a speech bearer service, the objects for connection agreement might be the use of one of the following: UDI (unrestricted digital information)/RDI (restricted digital information), satellite circuits, DSI circuits, the difference of PCM coding rules, circuit selection between digital networks having different hierarchical structures, etc. Parameter exchange, if required, are executed by the two networks.

The connection agreement does not necessarily occur on a call-by-call basis, but in a pre-determined way which has been established by other Recommendations (e.g. Recommendation G.802 for interworking between hierarchies and Recommendation G.711 for A-μ law conversion) or agreed between two ISDNs.

5.4 *Compatibility checking between end users of different ISDNs*

When the connection path between two terminals on different ISDNs is established, low level compatibility (LLC), high layer compatibility (HLC) or user defined compatibility may be examined on an end-to-end basis.

Compatibility checking items between end users are as follows:

1) *Low layer compatibility*

   LLC information would normally be used for user-to-user call negotiation and would be passed transparently through the networks. The IWF may, where required, examine and act on LLC information (see Recommendation I.515, § 2.2.1.3) in the cases where the LLC checking lists (see Recommendation Q.931) employed by the relevant ISDNs are different.

2) *High layer compatibility*

   The HLC is to be conveyed transparently and the networks need not operate on it. The examination and action on HLC information by the IWF is for further study, in the case where the HLC checking lists employed by the relevant ISDNs are different.

3) *User defined compatibility checking*

   User defined compatibility checking is the user responsibility. The network does not participate in this compatibility checking.

6 Functional interworking requirements for data transmission services

See Recommendation X.320 on general arrangements for interworking between ISDNs for the provision of data transmission services.

Network interworking requirements for the case where an X.31 based packet mode bearer service is requested on one ISDN and a new packet mode bearer service is requested on another ISDN will be provided when new packet mode bearer services are defined.

7 References

See Recommendation I.500.

APPENDIX I

(to Recommendation I.520)

ISDN connections involving restricted 64 kbit/s transfer capability

I.1 *General*

During an interim period the existence of networks or parts of networks only capable of transferring 64 kbit/s in a restricted manner (i.e. 64 kbit/s octet structured transfer capability with the all-zero not permitted) will have to be taken into account for international intercommunication purposes.

For those networks, or parts thereof, the rules described hereafter have to be followed in order to allow communication with networks, or parts thereof, that already provide unrestricted 64 kbit/s transfer capability. The necessary interworking functions (e.g. interworking units, rate adaptors) have to be provided by the network with restricted 64 kbit/s transfer capability. Signalling provisions should be incorporated in Recommendation I.451 (Q.930). The network with 64 kbit/s transfer capability will not be affected by this interworking, other than transporting the appropriate signalling across this network to and from the terminal connected to the 64 kbit/s network.

I.2 *Interworking with ISDNs providing restricted 64 kbit/s* (see Figure I-1/I.520)

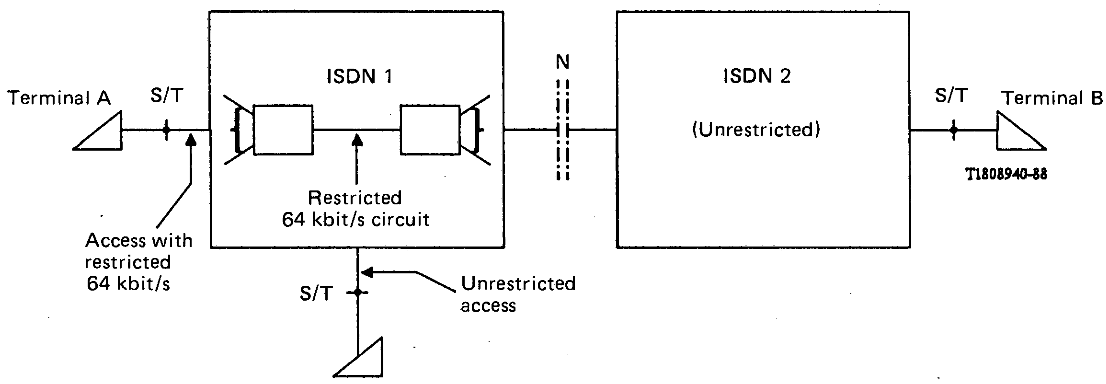


FIGURE I-1/I.520

Interworking with ISDNs providing restricted 64 kbit/s

ISDN 1 may have some arrangements having only restricted 64 kbit/s transfer capability. ISDN 2 is unrestricted. In both cases, at the reference points S/T, the I.412 user-network interfaces are provided. However, where restricted 64 kbit/s arrangements are involved, only information streams not having the all-zero octet are possible.

Four possible cases of interworking for circuit switched connections between terminals A and B are considered (UDI means unrestricted digital information and RDI means restricted digital information). (See Table I-1/I.520.)

I.3 *Considerations for terminal designed to operate with restricted 64 kbit/s transfer capability* (Figure I-2/I.520)

Existing terminals at rates less than 64 kbit/s will require rate adaption to operate with restricted 64 kbit/s transfer capability (see Recommendation I.464).

TABLE I-1/I.520

	Terminal A	S/T	ISDN 1 (restricted)	N	ISDN 2 (unrestricted)	S/T	Terminal B
1	UDI – Request	→	barred				
2	RDI – Request (Note 2)	→	Carried as RDI	Transferred as RDI	Carried as UDI	→	Offered as RDI
3			Barred (Note 1) ←	Transferred as UDI	Carried as UDI		UDI – Request
4	Offered as RDI	←	Carried as RDI ←	Transferred as RDI	Carried as UDI		RDI – Request (Note 2)

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UDI Unrestricted digital information
RDI Restricted digital information

Note 1 – Dependent upon national implementation, a UDI-request may also be barred at some place in ISDN 2, provided that it has a record of the restricted destinations/circuits.

Note 2 – The first and fourth columns of the table contain the signalling messages as generated or received by the terminals. The second and third columns are the transport capabilities of ISDN 1 and ISDN 2. The signalling messages would be transferred without change through the network signalling systems.

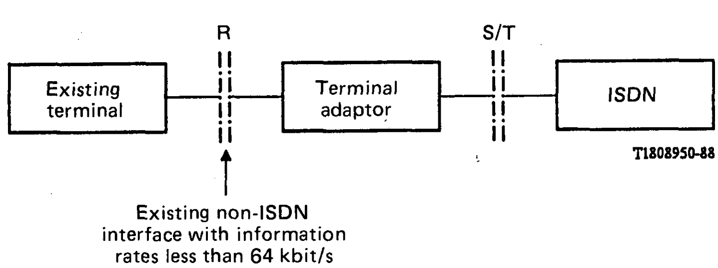


FIGURE I-2/I.520

Considerations for terminals with restricted 64 kbit/s transfer capability

Recommendation I.530

NETWORK INTERWORKING BETWEEN AN ISDN AND A PUBLIC SWITCHED TELEPHONE NETWORK (PSTN)

(Melbourne, 1988)

1 General

In many countries, digitization of the existing PSTN has been ongoing over a number of years through the implementation of digital switching and transmission facilities. Furthermore, common channel signalling systems (e.g. Signalling System No. 6, Signalling System No. 7) have been introduced or will soon be introduced in these networks.

The digitization of the user network access is one of the steps by which an IDN becomes an ISDN. However, it is foreseen that this will be a long transition period for some networks.

Thus, the purpose of this Recommendation is to identify the interworking functions and requirements to support interworking between an ISDN and a PSTN.

2 Scope

The purpose of this Recommendation is to describe the general arrangements for interworking between ISDN and PSTN. Both the provision of ISDN voice transmission and data transmission services are within the scope of this Recommendation.

3 Abbreviations

DP	Dial Pulse
DTE	Data Terminal Equipment
DTMF	Dual-tone Multiple Frequency
IDN	Integrated Digital Network
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
LE	Local Exchange
NT	Network Termination
PABX	Private Automatic Branch Exchange
PSTN	Public Switched Telephone Network
SS No. 7	Signalling System No. 7
TE	Terminal Equipment
TA	Terminal Adaptor
TUP	Telephone User Part.

4 Interworking configuration and network characteristics

4.1 *Interworking configurations*

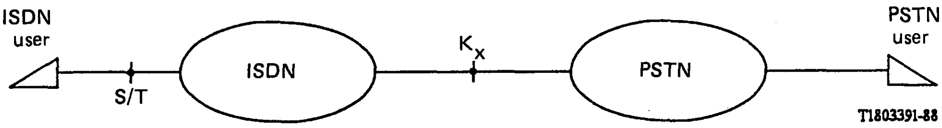
See Figure 1/I.530.

4.2 *Key ISDN and PSTN characteristics and related interworking functions*

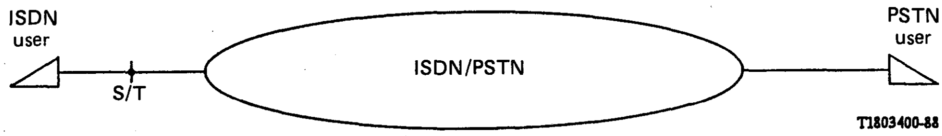
Table 1/I.530 identifies the key characteristics of an ISDN and a PSTN, indicating possible interworking functions to accommodate dissimilar characteristics.

4.2.1 *Location of interworking functions*

Given that the transition period from a PSTN to an ISDN may occur over a long period of time, there will be an ongoing requirement for ISDN-PSTN interworking. In such a situation, it is likely that interworking functions will be required at not just one but several locations. As the transition to ISDN continues, interworking points will come into existence and later may not be required.



a) Interexchange scenario



b) Intra-exchange scenario

Note 1 – In part *a)* refer to Rec. I.324 for the definition of K_x reference point.

Note 2 – Part *b)* illustrates the case where no clear division exists between ISDN and PSTN network components.

FIGURE 1/I.530

Points where interworking may exist are:

– within the local exchange;
– at transit exchange;
– at international gateway offices.

Note – The optimum location of each interworking function may be specific per interworking function and dependent on the usage of the service, network topology, etc.

5 ISDN bearer services suitable for ISDN-PSTN interworking

This section considers the subject of ISDN services suitable for ISDN-PSTN interworking. The discussions dealing with the ISDN to/from PSTN direction are addressed in individual subsections, as is the subject of circuit mode and packet mode.

5.1 *ISDN bearer services suitable for ISDN to PSTN interworking (circuit)*

Currently, there are three identified bearer services that could be used within the ISDN to PSTN interworking. These are (refer to Recommendation I.211):

i) circuit mode 64 kbit/s, 8 kHz structured bearer services, usable for speech information transfer (Note 1);
ii) circuit-mode 64 kbit/s, 8 kHz structured bearer services, usable for 3.1 kHz audio information transfer (Note 2);
iii) circuit-mode 64 kbit/s unrestricted, 8 kHz structured bearer service (Note 3).

It is recognized that the communication characteristics obtained for each of these three bearer services on an ISDN to PSTN basis may not be the same as that obtained for ISDN to ISDN configurations.

Note 1 – This bearer service is used for the ISDN to PSTN-interworking for the purpose of speech information transfer.

Note 2 – This bearer service is used for the ISDN to PSTN interworking for the purpose of 3.1 kHz audio information transfer. For PSTN to ISDN interworking, this bearer service will be selected at the boundary of the PSTN to the ISDN for the purpose of speech information transfer *and* for 3.1 kHz audio information transfer.

Note 3 – This bearer service may be required for ISDN-PSTN interworking. Refer to Recommendation I.231 for the 64 kbit/s interworking service definition.

Remarks – ISDN-PSTN interworking means interworking both ways between ISDN and PSTN, while ISDN to PSTN refers to a call initiated in the ISDN and terminated in the PSTN, and PSTN to ISDN refers to a call initiated in the PSTN and terminated in ISDN.

TABLE 1/I.530

Key ISDN and PSTN characteristics

	ISDN	PSTN	Interworking functions
Subscriber interface	Digital	Analog	a
User network signalling	Out-band (I.441/I.451)	Mainly in-band (e.g. DTMF)	b, e
User terminal equipment supported	Digital TE (ISDN NT, TE1 or TE2 + TA)	Analog TE (e.g. dial pulse telephones, PABXs, modem-equipped DTEs)	c
Interexchange signalling	SS No. 7 ISDN user part (ISUP)	In-band (e.g. R1, R2, No. 4, No. 5) or out-band (e.g. SS No. 6, SS No. 7 TUP)	d, e
Transmission facilities	Digital	Analog/digital	a
Information transfer mode	Circuit/paquet	Circuit	f
Information transfer capability	Speech, digital unrestricted, 3.1 kHz audio, video, etc.	3.1 kHz audio (voice/voice-band data)	f

Interworking functions:

a – Analogue-to-digital and digital-to-analogue conversion on transmission facilities.

b – Mapping between PSTN signals in the subscriber access and I.451 messages for intra-exchange calls.

c – Support of communication between modem-equipped PSTN DTEs and ISDN terminals;

d – Conversion between the PSTN signalling system and Signalling System No. 7 ISDN user part.

e – Mapping between signals in the ISDN subscriber (I.441, I.451) access and PSTN in-band interexchange signalling (e.g. R1).

f – Further study required.

5.2 *ISDN bearer services suitable for PSTN to ISDN interworking (circuit)*

Currently, there is no internationally recognized method of service differentiation between voice and non-voice calls originating in the PSTN. However, the "circuit-mode 64 kbit/s, 8 kHz structured bearer service for 3.1 kHz audio information transfer" provides for the capability equivalent to PSTN. (Reference Recommendation I.231.) Therefore, PSTN calls may interwork to this service in ISDN.

The call progress indicator within ISUP will identify when interworking between ISDN and PSTN occurs. This indicator will enable the ISDN to select a connection that would support 3.1 kHz audio. A V-Series terminal connected to the ISDN via a terminal adaptor and using the 64 kbit/s unrestricted bearer service requires the use of an IWF (including a modem) for calls from PSTN users. To effect the connection, a 64 kbit/s connection to the IWF would need to be used.

5.3 *ISDN bearer services suitable for ISDN to PSTN interworking (packet)*

Currently, there are two identified bearer services that could be used within the ISDN, for ISDN (packet mode calls) to PSTN interworking:

i) B-channel: packet-mode, unrestricted digital information, service data unit integrity, X.25 link level, X.25 packet level bearer service;

ii) D-channel: packet mode, unrestricted digital information, service data unit integrity, I.441 link level, X.25 packet level bearer service.

Note – Detailed mechanisms are for further study.

5.4 *ISDN bearer services suitable for PSTN to ISDN interworking (packet)*

(For further study.)

6 Connection type suitable for ISDN-PSTN interworking

This section identifies the mapping of ISDN bearer services and possible connection types for ISDN-PSTN interworking. Depending on the specific ISDN bearer service being considered, more than one ISDN connection type may be applicable. However, in some cases the connection type may not be fully compatible with the requested bearer service, thereby leading to downgrading of service.

The ISDN bearer services and possible connection types that may be used are summarized in Table 2/I.530, under the four possible interworking cases. Refer to Recommendation I.335 for more details regarding the mapping between ISDN bearer services and ISDN connection types.

7 Functional requirements for ISDN-PSTN interworking

7.1 *Interworking between signalling systems*

Interworking between signalling systems, specifically for interexchange calls between the PSTN signalling system (which may be in-band) and Signalling System No. 7 (ISDN UP) on an ISDN, may be required. The interworking procedures are specified in Recommendation Q.699.

For intra-exchange calls between the ISDN and PSTN subscriber, interworking between I.451 messages and signals in the PSTN subscriber access may also be required.

7.2 *Provision of interworking indications*

An interworking indication is required for the ISDN local exchange (LE) to know that ISDN-PSTN interworking has occurred. ISUP Q.761-Q.764 and I.451/Q.931 protocols have the ability to identify this interworking situation to the ISDN LE and the ISDN terminal (call progress indicator).

The ISDN terminal would be informed in every case that ISDN-PSTN interworking has occurred. This information is required to satisfy as a minimum the requirement to:

– tell the terminal to connect the B-channel so that in-band tones and announcements can be received when ISDN-to-PSTN calls are originated;

– tell the ISDN terminal that some or all of service selection information and address may be unavailable – the terminal may then be required to accept the call without out-band compatibility checking;

– tell data terminal equipment to anticipate in-band handshaking signals for ISDN-PSTN calls.

TABLE 2/I.530

ISDN bearer services and connection types suitable for ISDN-PSTN interworking

Interworking	ISDN bearer services categories	ISDN connection types			
		64 kbit/s unrestricted	Speech	3.1 kHz audio	Packet
ISDN to PSTN (circuit)	64 kbit/s unrestricted	Y	N	N	N
	Speech	R	Y	Y	N
	3.1 kHz audio	R	FS	Y	N
PSTN to ISDN (circuit)	64 kbit/s unrestricted	Y	N	N	N
	3.1 kHz audio	R	N	Y	N
ISDN to PSTN (packet)	Virtual call and permanent virtual circuit	For further study			
PSTN to ISDN (packet)	Virtual call and permanent virtual circuit	For further study			

Y YES – Can be used (Some interworking scenarios may require further study.)

N NO – Cannot be used

FS – For further study

R – Can be used except when A/μ law conversion and echo control are limiting

Note 1 – It is recognized that existing PSTN services must be supported by ISDN using currently defined ISDN bearer services.

Note 2 – It is possible that the service obtained on each of the bearer services for ISDN to PSTN interworking may not be the same as that obtained for ISDN to ISDN configurations.

Note 3 – Refer to Rec. I.231 for the service definition for 64 kbit/s interworking. Various mechanisms for ISDN-PSTN interworking supporting V-Series terminals connected to the ISDN using the 64 kbit/s unrestricted bearer service are contained in Rec. I.515. Procedures require further study.

Note 4 – Other ISDN bearer services and connection types that may be applicable for ISDN-PSTN interworking are for further study.

The following interworking scenarios have been recognized:

a) an ISDN-PSTN call which uses a Signalling System No. 7 ISUP connection between the originating and terminating local exchanges;

b) an ISDN-PSTN call which uses a non-Signalling System No. 7 ISUP connection (e.g. R1, Signalling System No. 7 TUP) between the originating and terminating local exchanges;

c) an ISDN-PSTN call which involves a combination of Signalling System No. 7 ISUP and non-Signalling System No. 7 ISUP interexchange signalling connections between the originating and terminating local exchanges;

d) an ISDN-PSTN call within the same local exchange (i.e. no interexchange signalling).

7.2.1 *Network indication of modification of communication characteristics*

The network will always provide an indication to the user of modification of communication characteristics. The modification of communication characteristics may be due to the following reasons:

- interworking with another network;
- resource constraints in the network.

In addition to providing an indication, the network may solicit user acceptance of the modification of communication characteristics in certain cases. Examples are:

- downgrading of service;
- upgrading of service.

For most interworking cases, user acceptance is not applicable.

There may be a requirement for the resolution of information transfer capability requests other than speech and 3.1 kHz audio on ISDN-to-PSTN calls. The choices of rejection (with a suitable cause indication) or negotiation (involving parameter exchange) are possible (Recommendation I.515).

There may also be a requirement for the rejection of supplementary service requests available on an ISDN, but not supported on the PSTN. However, negotiation for supplementary services may be possible as well.

The principles for call negotiation in an ISDN-PSTN interworking situation are for further study.

7.2.2 *Failure indication*

Failure indication, when carried by the I.451 and ISUP signalling messages, should be meaningful and give a clear indication of the reason.

The network failure indication should be able to identify the network where congestion occurred. This may be of use in networks allowing RPOA selection.

7.3 *Generation of in-band tones and announcements*

In-band tones and announcements are provided for all speech and 3.1 kHz audio bearer service calls between an ISDN and a PSTN (reference Recommendation E.180). Within ISDN, in-band tones and announcements, with the exception of ring-back tone, should be provided at a point as close as possible to the calling user (i.e. network, PABX, or terminal). Whenever possible, out-band messages should also be used within the ISDN and the local access.

The network (ISDN or PSTN) must be capable of generating in-band tones and announcements. However, for ISDN-to-PSTN interworking cases, the ISDN terminals will receive the in-band tones and announcements whenever the tones are generated within the PSTN, i.e. beyond the interworking point. Nevertheless, this does not preclude the terminal from providing its own tones and announcements.

In-band ring-back tone should be generated by the terminating exchange (or terminating PABX).

Furthermore, two call scenarios exist:

a) the call is unsuccessful (user busy, network congestion, etc.);

b) the call is delivered successfully.

Regardless of the call type, the same in-band tones and announcements (depending on the call scenario) should be provided to the callling user.

7.3.1 *Call type 1: PSTN-to-ISDN*

7.3.1.1 *Unsuccessful call delivery*

When the point of call failure (i.e. the point at which the call cannot proceed further) is within the PSTN or at the PSTN user, normal PSTN procedures apply.

When the point of call failure is within the ISDN or at the ISDN user, the ISDN should send the appropriate out-band clearing message as far back towards the gateway exchange as possible.

- If the out-band message can be sent all the way through to the gateway exchange, then the gateway exchange should pass the information to the PSTN using the PSTN's normal procedures (i.e. out-band if the PSTN supports the out-band message, otherwise in-band).
- If the message cannot be sent out-band all the way to the gateway exchange, then the appropriate in-band tone or announcement should be provided by the ISDN at the point where out-band signalling is no longer capable of handling the message.

For the above cases, the clearing message should not be sent prior to the completion of the announcement.

7.3.1.2 *Successful call delivery*

If the call is delivered successfully to the ISDN user, then the terminating ISDN exchange should generate in-band ring-back tone towards the PSTN user.

7.3.2 *Call type 2: ISDN-to-PSTM*

7.3.2.1 *Unsuccessful call delivery*

When the point of call failure is within the ISDN, the call should be handled as an ISDN-to-ISDN call (see Recommendation I.520).

When the point of call failure is within the PSTN, the PSTN's procedures apply. For instance, if the PSTN supports out-band signalling to the gateway exchange, then the gateway exchange should map the message to the appropriate out-band ISDN clearing message (i.e. the gateway exchange handles the call as an ISDN-to-ISDN call). If the PSTN does not support out-band signalling, then it will generate the appropriate in-band tone or announcement.

The ISDN terminal should be alerted to the fact that interworking has occurred so that the user can be prepared to receive the appropriate in-band tone or announcement. The intermediate interworking point will provide the interworking message which will suppress, when necessary, tone generation in the ISDN terminal, and pass through any in-band tones.

For the above cases, the clearing message should not be sent prior to the completion of the announcement.

7.3.2.2 *Successful call delivery*

If the call is delivered successfully to the PSTN user, then the terminating PSTN exchange will provide in-band ring-back tone. The ISDN terminal should be alerted to the fact that interworking has occurred so the user can be prepared to receive the in-band ring-back tone.

7.4 *Handling of non-voice calls between ISDN and PSTN subscribers*

There may be an interworking requirement for the capability to interconnect modem-equipped terminals on the PSTN and compatible terminals on an ISDN access. This may in the future include a means for compatibility checking and the provision of a modem pool to perform A/D conversion and rate adaption (Recommendation I.515).

There are in principle two alternative approaches to provide data communication between an ISDN customer and a PSTN customer:

i) The data terminal of the ISDN customer is connected to a modem which in turn is connected to an A/D converter (PCM). A call will be handled as for telephony. Further study is required to determine what interworking functions are required in this case.

ii) The data terminal of the ISDN customer is connected to a terminal adaptor according to, e.g. Recommendation I.463, i.e. the data flow is rate adapted to 64 kbit/s. At a suitable interworking point, the original data flow (e.g. 1.2 kbit/s) is extracted and converted to "analogue" form by a modem for further transfer to the remote data terminal (i.e. the usage of modem pools). Mechanisms for modem interworking are contained in Recommendation I.515.

To handle non-voice calls in an ISDN-PSTN interworking situation, the following interworking functions may be required.

a) capability to distinguish a data call and its relevant parameters when the call is coming from a PSTN;

b) capability to distinguish a data call and its relevant parameters when the call is going to a PSTN;

c) special routing algorithms for inclusion of proper IWFs as detected in a) and b);

d) IWFs for protocol conversion as detected in a) and b).

For interworking between ISDN and PSTN, the need for in-band parameter exchange is recognized as necessary, with the understanding that out-band parameter exchange should be used whenever possible (refer to Recommendation I.515).

Note – When ISDN-PSTN interworking, using a modem pool in conjunction with the 64 kbit/s unrestricted bearer service, it may not be possible to extend PSTN supervisory tones to the ISDN user. The interworking implications of this in the ISDN are for further study.

7.5 *Control of speech processing and echo control devices*

Connections provided for ISDN/PSTN interworking may use speech processing techniques as long as these do not restrict the required information transfer. Restrictive devices should be functionally modified or removed using, for example, the 2.1 kHz in-band [ECD (echo control device) disabling] tone.

Digital circuit multiplication equipment (DCME) for example is designed to be compatible with the 3.1 kHz audio transfer capability. Echo control devices and their use in the PSTN are recommended in Recommendation G.131.

Similar Recommendations should apply to the ISDN/PSTN interworking case. In particular, both echo suppressors and echo cancellers must be located within a range limitation of the four-wire/two-wire interface. These limits are mentioned in Recommendations G.131, § 2.2, G.164, § 1.1.3 and G.165, § 3.2. If echo control devices are included in the ISDN connection, they will need to be disabled using the 2.1 kHz echo control disabling tone generated by the modem as is current practice in the PSTN. While echo suppressors should respond to a 2100 Hz tone (Recommendation G.164), echo cancellers should only respond if the tone includes phase reversals as specified in Recommendation G.165. It is recommended that the 2.1 kHz tone should not be converted into an ISDN signalling message and vice-versa.

7.6 *A/μ law encoding*

The treatment of A/μ law encoding and translation in ISDN/PSTN interworking can be based on the continuation of existing procedures whereby appropriate A/μ law translation is performed by the μ-law network when crossing international boundaries. Terminals would encode speech and 3.1 kHz audio using the G.711 law appropriate to the resident network. Unrestricted 64 kbit/s services bit streams would not be manipulated in any way by the ISDN: terminals would be free to use any encoding (including G.711 or G.721) as deemed appropriate between themselves when unrestricted 64 kbit/s capability is requested.

8 References

See Recommendation I.500.

Recommendation I.540

GENERAL ARRANGEMENTS FOR INTERWORKING BETWEEN CIRCUIT SWITCHED PUBLIC DATA NETWORKS (CSPDNs) AND INTEGRATED SERVICES DIGITAL NETWORKS (ISDNs) FOR THE PROVISION OF DATA TRANSMISSION

(Melbourne, 1988)

See Recommendation X.321, Volume VIII, Fascicle VIII.6.

Recommendation I.550

GENERAL ARRANGEMENTS FOR INTERWORKING BETWEEN PACKET SWITCHED PUBLIC DATA NETWORKS (PSPDNs) AND INTEGRATED SERVICES DIGITAL NETWORKS (ISDNs) FOR THE PROVISION OF DATA TRANSMISSION

(Melbourne, 1988)

See Recommendation X.325, Volume VIII, Fascicle VIII.6.

Recommendation I.560

REQUIREMENTS TO BE MET IN PROVIDING THE TELEX SERVICE WITHIN THE ISDN

(Melbourne, 1988)

See Recommendation U.202, Volume VII, Fascicle VII.2.

PART VI

I.600-Series Recommendations

MAINTENANCE PRINCIPLES

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GENERAL MAINTENANCE PRINCIPLES OF ISDN SUBSCRIBER ACCESS AND SUBSCRIBER INSTALLATION

(Melbourne, 1988)

1 Scope of application

1.1 This Recommendation outlines the general aspects and principles relating to the reference configurations and general architecture for each kind of subscriber access (basic, primary, multiplexed, higher rate) and associated subscriber installations. This is given in terms of the function groupings and the interconnecting communication parties.

Loopback definitions and their locations used in this Recommendation are also given.

1.2 Recommendation I.602 is concerned with the maintenance of the ISDN subscriber installation. The maintenance principles are given in a general way for functions which are dependent on the design of NT2 and TE and more precisely where it impacts directly on the S or T interface (i.e. in relation to Recommendations I.430, I.431). These functions are supervised and/or controlled by the subscriber installation.

The ISDN management protocols which provide this activity are contained in Recommendation Q.940 on ISDN user-network management and maintenance protocols.

1.3 Recommendation I.603 describes maintenance for the network portion of the ISDN basic access (144 kbit/s). A common format with other similar Recommendations, in conformance with Recommendation M.20, is used.

The functions performed by the digital transmission section and the exchange termination (ET) are identified. These functions are supervised and/or controlled by the network or Administration (see § 3.3 of Recommendation I.601).

1.4 Recommendation I.604 describes maintenance of the network portion of the ISDN primary access (2048 and 1544 kbit/s) following the same principles as given in Recommendation I.603.

The functions provided by the digital transmission section and the exchange termination (ET) are identified. The functions are supervised and/or controlled by the network or Administration.

1.5 Recommendation I.605 describes the maintenance of a multiplexed basic rate system. Reference is made to Recommendations I.603 and I.604 when common mechanisms are applied.

The functions performed by the digital section of the ISDN basic rate access, the basic access multiplexer, the digital link, and the exchange termination (ET) are identified. These functions are supervised and/or controlled by the network or Administration.

2 Objectives

In order to try and meet overall objectives, a number of points have been identified for Administrations and maintenance service providers (see § 3.2.2.3):

i) to detect fault conditions, identify the failed maintenance entity, take system protection actions, inform the maintenance staff of Administrations;

ii) to incorporate facilities to enable the failure to be located by the maintenance staff, so that failure correction is achievable by a single attendance to the failed location;

iii) to provide an appropriate maintenance organization and levels of staffing, so as to achieve goals for out-of-service repair times;

iv) to incorporate facilities to allow clear differentiation of failures between the subscriber installation and the network;

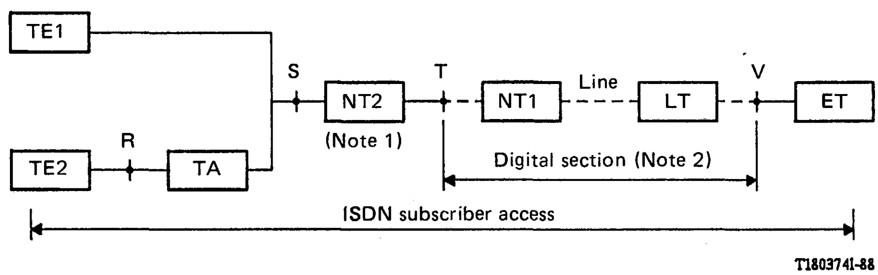
v) to incorporate facilities to allow clear differentiation between failures and normal subscriber activities.

3 Network reference model

3.1 *ISDN subscriber access and installation configuration*

Figure 1/I.601 shows the simplified ISDN subscriber access and installation configuration (based on Recommendations I.411 and Q.512).

The definitions contained in this figure are the ones used in the I.600-Series Recommendations.



Note 1 – The NT2 functional grouping may be null. In this case the S and T reference points are coincident.

Note 2 – The ISDN subscriber access contains a digital section which can use a variety of transmission techniques and may also include a regenerator. The digital section could be a basic rate section, a primary rate section, or a multiplexed basic rate section.

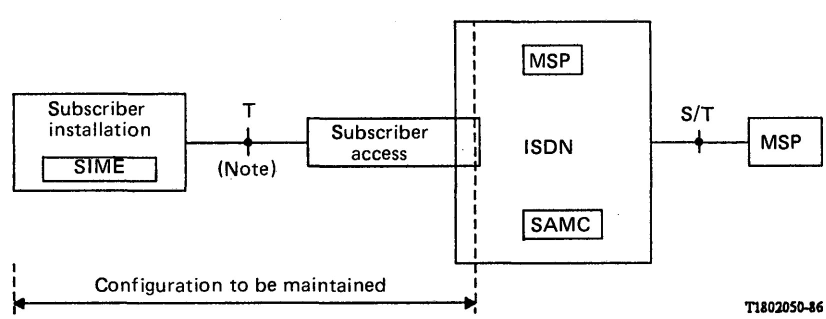
FIGURE 1/I.601

Simplified ISDN subscriber access and installation configuration (based on Recommendations I.411 and Q.512)

3.2 *Network configuration and definition for maintenance activities*

3.2.1 *Network configuration*

Figure 2/I.601 is the basis for the general maintenance principles of the ISDN access and subscriber installation.



SAMC Subscriber access maintenance centre
SIME Subscriber installation maintenance entity
MSP Maintenance service provider

Note – In the case where the subscriber installation does not contain a NT2, the S and T reference points are coincident.

FIGURE 2/I.601

Reference configuration for maintenance activities

3.2.2 *Definitions*

3.2.2.1 Subscriber Access Maintenance Centre (SAMC)

A SAMC represents a group of functions, network equipment elements and staff controlled by the Administration, which together have the responsibility and capability for maintenance functions and maintenance actions within the subscriber access, such as defined in Figure 2/I.601.

The equipment and functions may be centralized or distributed in the network, local exchange and subscriber access. The architecture of the SAMC and its internal interface(s) between SAMC staff equipment(s) is presented in § 3.4. Conceptually, the SAMC is considered to be a single functional entity within an ISDN, as seen by the subscriber.

3.2.2.2 Subscriber Installation Maintenance Entity (SIME)

An SIME represents a group of dedicated functions contained within the functional groups (as specified in Recommendation I.411) of the subscriber installation which have the following purposes, e.g.:

- interaction with the (human) user;
- handling of the maintenance protocol from the subscriber installation and/or maintenance service provider;
- control of internal testing and maintenance mechanisms.

It is considered that the functions of the SIME may be distributed throughout layers 1-3 and management/ maintenance entities, including NT1 functions in some applications. However, the precise architecture and protocol of the SIME is not a subject of this Recommendation.

3.2.2.3 Maintenance Service Provider (MSP)

The MSP represents a group of functions, equipment and maintenance staff, which together have the responsibility for maintaining a subscriber installation or a part of the subscriber installation. A MSP cannot control the maintenance functions of the subscriber access. If authorized, it can request an SAMC to perform these functions.

Agreement and responsibility for maintenance between the subscriber and the MSP for each part or parts of the subscriber installation should be made at the time of subscription to the maintenance service (this may take the form of a commercial contract). In any case, provision to allow a customer to change the maintenance service provider(s) is recommended. The subscriber may choose not to make such an agreement with the MSP.

Maintenance service providers can be:

- private providers;
- the Administration.

Note – A subscriber can act as his own MSP.

A private maintenance service provider external to ISDN is connected to the ISDN via a recommended T reference point. An Administration's maintenance service provider may be connected to the ISDN via a recommended T reference point or via an interface which is internal (outside the scope of this Recommendation) to the ISDN. More than one MSP may have the responsibility to maintain one subscriber installation. The responsibility for maintaining each equipment shall be unique. Other interfaces are for further study.

If authorized, the MSP can invoke maintenance function in the SIME. It is the sole responsibility of a subscriber installation and not of the network to ensure that an unauthorized MSP cannot get access to maintenance functions in the subscriber installation.

3.3 *Communication configurations*

3.3.1 *General*

The presentation of the relationships between the functional blocks SAMC, SIME and MSP and the configurations to be maintained have been completed by figures showing the various communication paths.

The communication paths are shown by bold lines within the Figures 3/I.601 to 7/I.601.

3.3.2 *Communication configuration for maintenance of a subscriber access by the SAMC*

Figure 3/I.601 shows the communication configuration between the subscriber access and the SAMC.

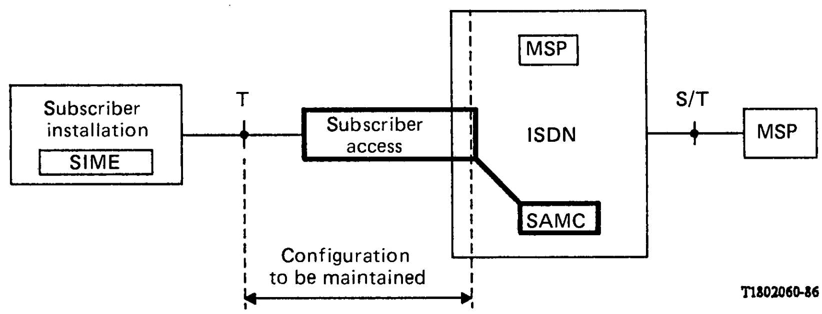
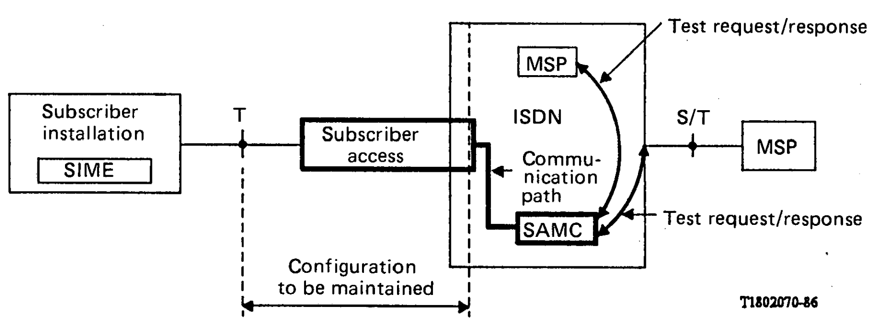


FIGURE 3/I.601

Communication configuration for the maintenance of a subscriber access by the SAMC

3.3.3 *Communication configuration for maintenance of a subscriber access by a SAMC requested by an MSP*

Figure 4/I.601 shows the communication configuration between an MSP and a SAMC that allows the MSP to request maintenance information and actions related to the subscriber access.



Note 1 – Test request and/or response are made by normal calls or automatic procedures after authorization. Protocols for the automatic procedure are to be defined. The MSP has no direct control over subscriber access maintenance.

The SAMC tests the subscriber access according to other sections of this Recommendation.

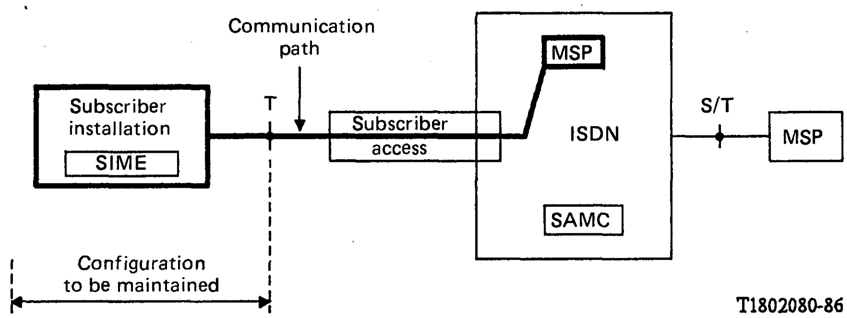
Note 2 – A subscriber may act as his own MSP, requesting the SAMC to perform tests on his own subscriber access.

FIGURE 4/I.601

Communication configuration for maintenance of a subscriber access by an SAMC requested by an MSP

3.3.4 *Communication configuration for maintenance of a subscriber installation by an MSP within the ISDN*

Figure 5/I.601 shows the communication configuration between an MSP within the ISDN and the subscriber installation.



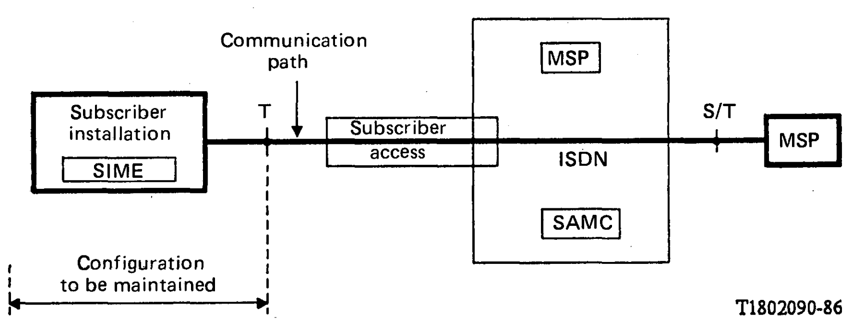
Note — In some countries the subscriber installation is allowed to control certain maintenance functions in the subscriber access without authorization of an SAMC.

FIGURE 5/I.601

Communication configuration for maintenance of a subscriber installation by an MSP with the ISDN

3.3.5 *Communication configuration for maintenance of a subscriber installation by an MSP connected to the ISDN via an S or T reference point*

Figure 6/I.601 shows the communication configuration between an MSD at reference point S or T and the subscriber installation.



Note — In some countries the subscriber installation is allowed to control certain maintenance functions in the subscriber access without authorization of an SAMC.

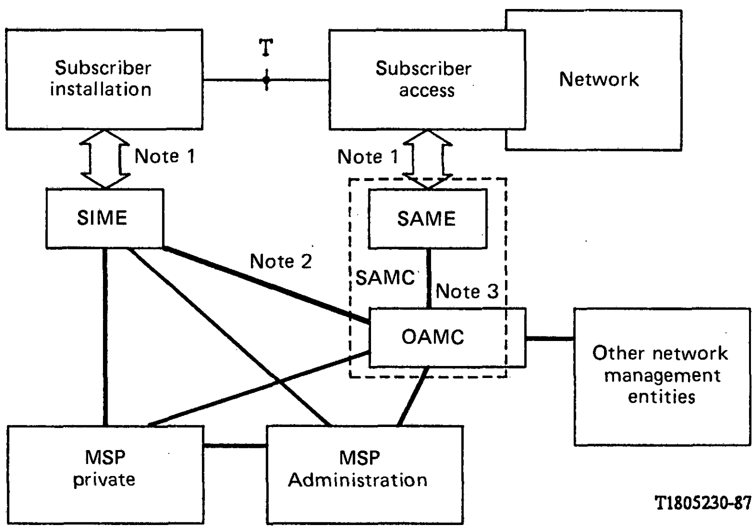
FIGURE 6/I.601

Communication configuration for maintenance of a subscriber installation by an MSP connected to the ISDN via an S or T reference point

3.4 *Management configurations*

3.4.1 *Relationships*

In Figure 7/I.601 the communication relationships between the management entities required to support the functions in this series of Recommendations are given. It does not imply any physical model of the network.



Note 1 – As shown here, only the relationships are indicated since the interface is outside the scope of this Recommendation.

Note 2 – In this case the subscriber is acting as his own MSP.

Note 3 – The OAMC acts as the communication agent for the SAME.

FIGURE 7/I.601

Communication relationships

The connections shown in Figure 7/I.601 represent the allowed communication paths that use the protocol architecture defined in Recommendation Q.940. These communications are subject to security procedures implemented by the receiver of the message.

The subscriber access maintenance entity (SAME) controls the subscriber access maintenance functions and provides communications for such activities. The SAMC functions might be distributed.

The operations administration and maintenance centre (OAMC) consists of a group of functions and staff. In the context of this Recommendation the OAMC is responsible for the communication with, and the controlling of, the subscriber access maintenance functions as provided by the SAME.

The OAMC may also be responsible for the communication with, and the controlling of, other maintenance functions as provided by other management entities. Such functions are outside the scope of this Recommendation. Therefore, the SAMC can be considered as the grouping of the SAME, communication path and part of the OAMC.

3.4.2 *Security provisions*

To facilitate maintenance procedures and failure localization, management entities responsible for different control domains may communicate. However, since management and maintenance information is of critical importance to system integrity, access to management functions and information is subject to prior authorization and security restrictions.

The security restrictions are enforced by the recipient of the maintenance request and may include requirements for user authentication (identification), the use of passwords and/or limited access based on the originating call.

The use of adequate security mechanisms is especially important in the case of the OAMC since maintenance functions for many users may be affected by unauthorized access.

3.5 *Maintenance conditions for an ISDN subscriber access*

In general, a subscriber access can be considered to be in one of the following conditions for the purpose of explanation of the relationship between maintenance and trafficability in this Recommendation.

3.5.1 *In service*

3.5.1.1 *Correct functioning*

An access which is fully equipped has been allocated an ISDN number(s) and is correctly functioning (meeting all the network performance and operational requirements) is considered to be "in service". The access can be either busy or free in this condition.

3.5.1.2 *Degraded transmission*

An access is said to be in the "degraded transmission" condition when the transmission of the digital section has degraded sufficiently to cause the initiation of further maintenance activity. The amount of degradation at which the maintenance activity is initiated is service dependent.

In this condition call offering is not changed (i.e. the same as for the "in service" condition). The levels at which an access enters the degraded transmission condition may be dependent on the quality of service provided to the customer. These levels are found in other Recommendations.

3.5.2 *Out of service*

3.5.2.1 *Out of service due to failure (unavailability state)*

When a failure exists and has been detected such that the network performance is below an acceptable limit the access is considered to be "out of service due to failure". In such a condition call offering may be rejected or attempted as normal. In the latter case, the call offering may not be successful and normal clearing with cause may not be possible.

Examples of failure conditions are:

- unacceptable transmission performance;
- access in a failure condition;
- failure of subscriber installation;
- failure of the digital transmission section;
- failure within individual exchange subscriber equipment;
- local exchange failure.

3.5.2.2 *Out of service due to operational reasons*

This condition is included for information but is not considered further in this Recommendation.

An Administration may wish to mark an access "out of service due to operational reasons" due to, for example, payment deficiencies by the customer.

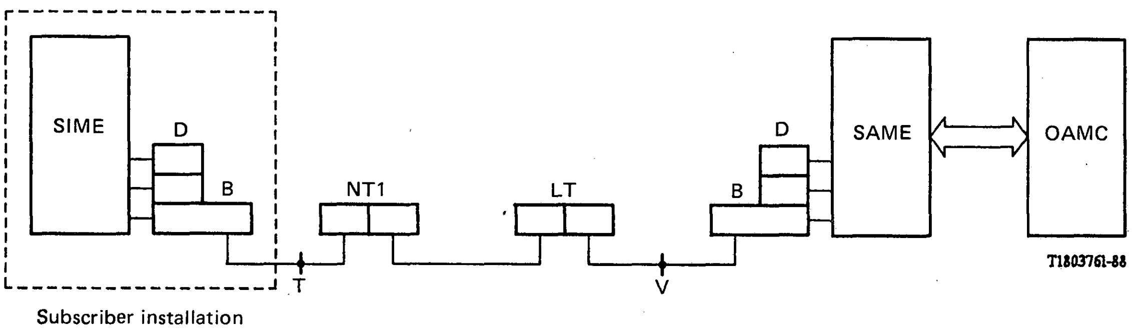
Call offering (either originating and/or terminating) may be rejected.

Note – In any of the conditions, testing (and/or measurements) may be in progress. The availability of the access call offering will be dependent on the specific test in progress. Whether the test or the call attempt is rejected (in the case of a collision) is dependent on the specific test and/or the Administration. Further study is required.

4 Control domain on the ISDN subscriber basic access

4.1 *General*

In Figure 8/I.601 the layered communication configuration is shown for the ISDN subscriber access showing also the SIME, SAMC and the OAMC.



Note 1 — The SAME will communicate with the OAMC. However, this is outside the scope of this Recommendation.

Note 2 — Some functions of the SAME and OAMC may be distributed.

FIGURE 8/I.601

Layered communication configuration

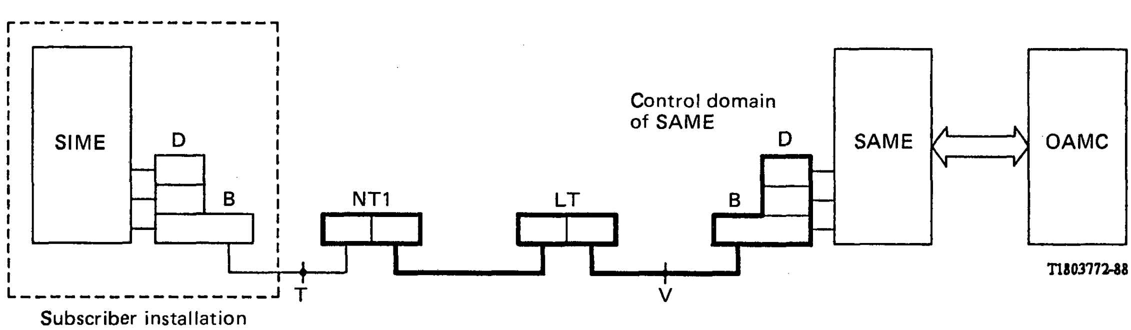
4.2 *Control domains*

The control domain is defined as the grouping of those protocol layer entities which are under the supervision and control of a management entity (e.g. SAME or SIME).

4.2.1 *The control domain of the SAME*

The control domain of the SAME is shown in Figure 9/I.601.

Since the SAME supervises the correct functioning of the peer-to-peer communication between protocol layer entities, failures outside its control domain will be recognized by the layer 2 and 3 processes in the ET and reported by it to the SAME (i.e. layers 2 and 3 failures in the B-channel entities of the subscriber installation, and layer 1 failures at the T reference point). Automatic additional failure localization may be necessary to have clear differentiation between failures in the subscriber installation and the subscriber access.



Note — In some countries certain NT1 functions are within the control domain of the SIME.

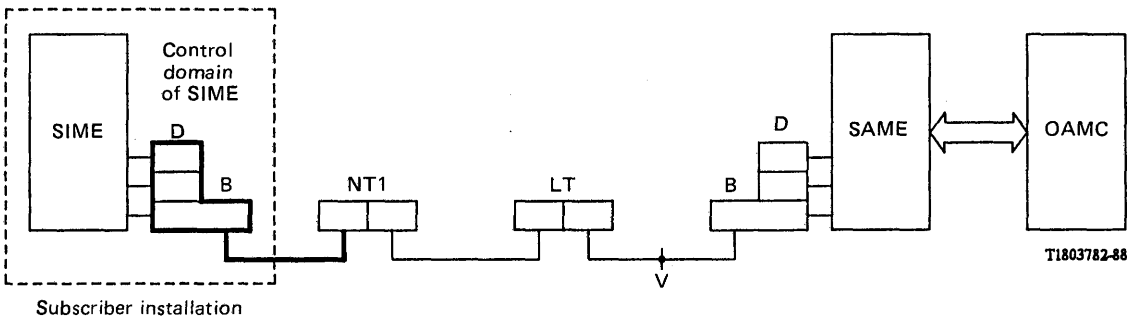
FIGURE 9/I.601

Control domain of the SAME

4.2.2 *The control domain of the SIME*

The control domain of the SIME is given in Figure 10/I.601.

Since the SIME supervises the correct functioning of the peer-to-peer communication between protocol layer entities, failures outside its control domain will be recognized by the layer 2 and 3 processes on the subscriber equipment and reported by them to the SIME [i.e. layers 2 and 3 failures in the D-channel entities of the exchange (ET), and layer 1 failures beyond the T reference point, as seen by the subscriber]. Automatic additional failure localization may be necessary to have clear differentiation between failures in the subscriber installation and the subscriber access.



Note – In some countries certain NT1 functions are within the control domain of the SIME.

FIGURE 10/I.601

Control domain of the SIME

5 Loopbacks

5.1 *Use of loopbacks*

In general loopbacks are used for failure localization and verification as defined in Recommendation M.20.

The use of loopbacks should not result in unnecessary activity in the terminal layer 2 functions, which could cause possible error reporting by the terminal management function to the user or his MSP.

5.2 *Digital loopback mechanism definitions*

A **digital loopback** is a mechanism incorporated into a piece of equipment whereby a bidirectional communication path may be connected back upon itself so that some or all of the information contained in the bit stream sent on the transmit path is returned on the receive path.

The *loopback point* is the location of the loopback.

The *loopback control point* is the point which has the ability to directly control loopbacks and should be located as close as possible to the loopback point.

The loopback control point may receive requests for loopback operation from several loopback requesting points.

The *loopback requesting point* is the point which requests the loopback control point to operate loopbacks.

Note 1 – The generation of the test pattern used over the loopback may or may not take place at the control point.

Note 2 – Loopback requests should be subject to identification and authorization.

Note 3 – Possible locations of loopback requesting points are: the network, or a telecommunications management network (TMN), or a maintenance service providers (MSP).

The following three types of loopback mechanisms are defined:

a) *Complete loopback* – a complete loopback is a physical layer [1] mechanism which operates on the full bit stream. At the loopback point, the received bit stream shall be transmitted back towards the transmitting station without modification.

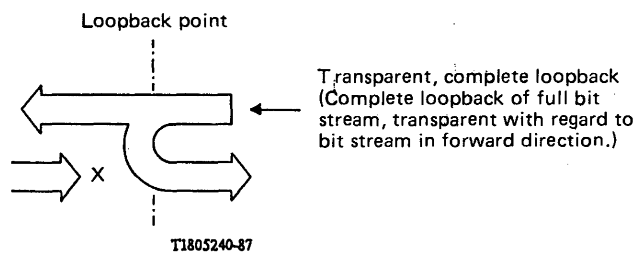
   Note – The use of the term "complete loopback" is not related to implementation since such a loopback may be provided by means of active logic elements or controlled unbalance of hybrid transformers, etc. At the control point only the information channels may be available.

b) *Partial loopback* – partial loopback is a physical layer [1] mechanism which operates on one or more specified channels multiplexed within the full bit stream. At the loopback point, the received bit stream associated with the specified channel(s) shall be transmitted back towards the transmitting station without modification.

c) *Logical loopback* – a logical loopback acts selectively on certain information within a specified channel or channels and may result in some specified modification of the looped information. Logical at any layer 2 loopbacks may be defined to apply at any layer [Ref. 1], depending on the detailed maintenance procedures specified.

For each of the above three types of loopback mechanisms, the loopback may be further categorized as either transparent or non-transparent. (See Figures 11/I.601 and 12/I.601.)

i) A transparent loopback is one in which the signal transmitted beyond the loopback point (the forward signal) when the loopback is activated, is the same as the received signal at the loopback point.

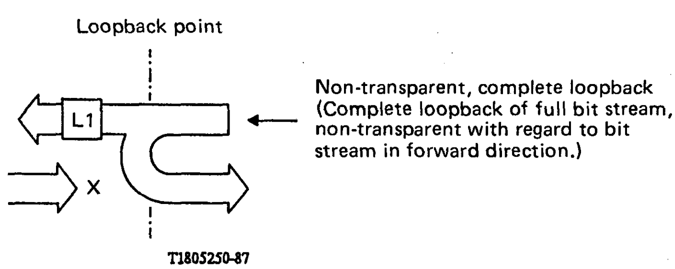


X = Signal inhibited in order to avoid interference with looped signal

FIGURE 11/I.601

Transparent loopback

ii) A non-transparent loopback is one in which the signal transmitted beyond the loopback point (the forward signal) when the loopback is activated, is not the same as the received signal at the loopback point. The forward signal may be a defined signal or unspecified.



X = Signal inhibited in order to avoid interference with looped signal
L1 = Device which changes or inhibits the transferred signal

FIGURE 12/I.601

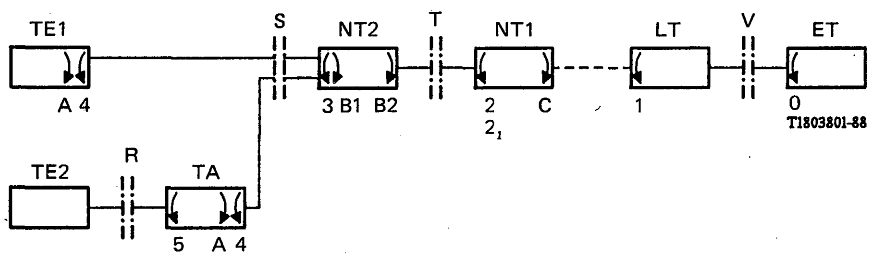
Non-transparent loopback

Note – Whether or not a transparent loopback is used, the loopback should not be affected by facilities connected beyond the point at which the loop is provided, e.g. by the presence of short circuits, open circuits or foreign voltages.

5.3 *Loopback locations in the subscriber access and subscriber installation*

Figure 13/I.601 shows the numbering and location of loopbacks described in the I-Series of Recommendations.

The characteristics and implementation status of these loopbacks are given in the appropriate I.600-Series Recommendation.



Note – The digital system used between the LT and NT1 may contain regenerators, which may also contain a loopback.

FIGURE 13/I.601

Location of loopbacks

Reference

[1] CCITT Recommendation *Reference model of open system interconnection for CCITT applications*, Vol. VIII, Rec. X.200.

Recommendation I.602

APPLICATION OF MAINTENANCE PRINCIPLES TO ISDN SUBSCRIBER INSTALLATIONS

(Melbourne, 1988)

1 Scope of application

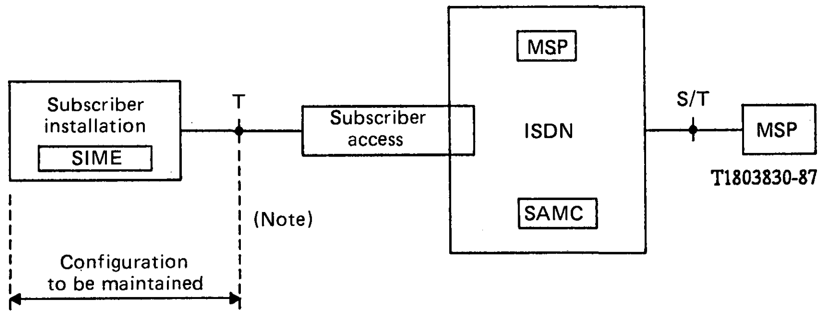
This Recommendation presents the possible elementary functions for the maintenance of the subscriber installation. The functions are to be considered as optional, except when needed to meet specific network interface requirements found in Recommendations I.430 and I.431.

These functions can be controlled by the local side (e.g. from the subscriber premises) and by a remote side [i.e. from an MSP (maintenance service provider), as described in Recommendation I.601].

It is the responsibility of the subscriber installation to ensure that only authorized MSPs are given access to the following functions.

2 Network configuration for maintenance activities

Figure 1/I.602 is the basis for the general maintenance principles of the ISDN subscriber installation.



SAMC Subscriber access maintenance centre
SIME Subscriber installation maintenance entities
MSP Maintenance service provider

Note – In some countries the subscriber installation is allowed to control certain maintenance functions in the subscriber access without authorization of an SAMC.

FIGURE 1/I.602

Configuration for the maintenance of the subscriber installation

3 Automatic supervision

3.1 *Continuous automatic supervision on layer 1*

3.1.1 *General*

This supervision may be realized by permanent automatic mechanisms located in the pieces of equipment of the subscriber installation (see definition in Figure 1/I.602). These automatic mechanisms are operational during the active period of the subscriber basic access. They are designed to detect malfunctioning of particular items, e.g. power supply, quality level of transmission, incoming signal, frame alignment.

3.1.2 *Subscriber installation functions*

The following functions may be supervised:

- monitoring of operation functions within the subscriber installation (e.g. power supply);
- supervision of information related to or received from the digital transmission section.

3.2 *Automatic supervision on layer 2 and layer 3 of the D-channel protocol*

This activity covers supervision of activities on layers 2 and 3 of the D-channel protocol. Automatic supervision on layers 2 and 3 may be made by self-acting mechanisms implemented in the subscriber installation.

There are three categories of automatic supervision which may be performed by layer 2 and layer 3 of the D-channel protocol:

- service provision incapability detection (e.g. detection of incapability of layer 2 to establish a data link connection);
- protocol misoperation detection;
- error monitoring (e.g. layer 2 CRC check procedure can detect the occurrence of an errored frame).

These events (defined in Recommendations I.440 and I.450) should be recorded.

4 Internal tests

4.1 *Internal test of the TE1 and TA*

Some of the TEs/TAs may manage internal tests for all or parts of their functionalities. The internal tests may be activated either automatically by the TE and TAs or by a local command in the TE and TAs or by a remote request.

Some of these tests are dependent on the terminal type. Such tests shall not affect the user-network interface, i.e. no test signals shall be transmitted across the interface when a test is in operation.

The terminal equipment may have the ability to abort an internal test sequence, for example, in case of an incoming call attempt. If this test has been requested by an MSP, the subscriber installation should report the discontinuance of the test to the requesting MSP.

The result of an internal test procedure execution should be either *passed* or *failed*, and in the latter case an additional diagnostic information may be given.

4.2 *Internal test of the NT2*

The subscriber should have facilities which can help to verify that the subscriber installation is not affected by a failure. Definitions of these procedures and functions require further study. The functionalities may be similar to the ones presented for the TE and TA in § 4.1.

The following internal tests of the NT2 have been identified:

4.2.1 *Continuity test*

The objective is to verify that the internal S interfaces of the NT2 can be activated. The mechanism which is implemented in the NT2 could be based on a normal activation of the layer 1 of the interfaces.

The principle for such a test is the same as the one defined for the local exchange function (see Recommendation I.603, § 3.3).

4.2.2 *S interface check using loopback 3*

The loopbacks are shown in § 7. The results could be used for failure localization, particularly in the case where the NT2 functions are distributed.

4.2.3 *Test call to the terminal equipment from the NT2*

An NT2 may address one particular terminal equipment of the installation. Thus, it easily controls a test call. This procedure would allow the NT2 to verify the connection of the TE or TA to the installation and also to check layers 1, 2 and 3 operating conditions (e.g. response time supervision).

The test call could be initiated by the SIME.

The test call could be a normal call made for maintenance purposes.

5 Test call from the MSP

Further study is required, especially concerning charging and authorization aspects.

6 Call to a test responder from the subscriber installation

The MSP may provide test responders that are accessed via normal call procedures. There may be test responders for various teleservices and bearer services.

The selection of the service involved with the test call is made using the lower layer and higher layer compatibility information elements as defined for the normal call control procedures.

7 Loopbacks

7.1 *Locations of loopbacks associated with the subscriber installation*

Loopback locations for failure localization and verification are shown in Figure 2/I.602.

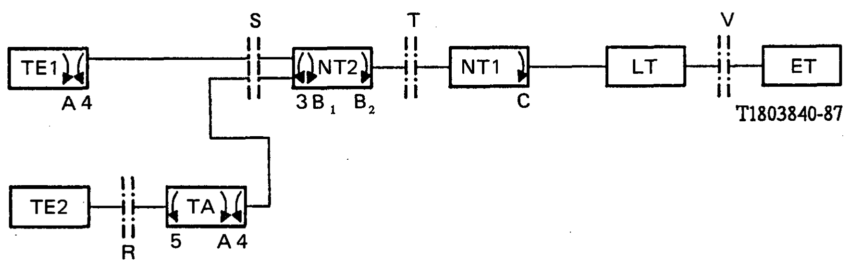


FIGURE 2/I.602

Loopback locations associated with the subscriber installation

7.2 *Loopback characteristics for basic rate subscriber installations*

Characteristics of loopbacks are given in Table 1/I.602.

7.3 *Loopback characteristics for primary rate subscriber installations*

Characteristics of loopbacks are given in Table 2/I.602.

8 Status request

A piece of equipment, i.e. NT2, TE, TA may have different states regarding its operation and/or maintenance conditions, e.g. in service, out of service, under tests, etc. These states may be defined in the future.

An MSP may request a SIME in the subscriber installation to indicate the current status of a particular terminal and/or of the connected terminal equipment.

9 Failure report to MSP

A subscriber installation which has detected that a TE is in a failed condition (e.g. when it is detected that a threshold has been exceeded) may have the ability to inform (via the ISDN), immediately, the MSP responsible for the concerned TE.

After reception of such an information, the MSP may initiate a more precise failure localization.

10 Interrogation of parameter values and counters

A MSP may have the ability to access basic information, such as instantaneous value of a parameter or counter.

TABLE 1/I.602

Characteristics of loopback mechanisms for basic rate subscriber installations

Loop-back	Location	Channel(s) looped back	Loopback type	Control point	Control mechanism	Application	Implementation
3	See Appendix I of Recommendation I.430						
4	See Appendix I of Recommendation I.430						
5	Inside the TA, as near as possible to the R interface	B_1, B_2	Partial, partial transparent or non-transparent	NT2, remote maintenance server or remote user	Message from an MSP (Note 1)	Failure localization	Optional
A	See Appendix I of Recommendation I.430						
B_1	See Appendix I of Recommendation I.430						
B_2	See Appendix I of Recommendation I.430						
C	See Appendix I of Recommendation I.430						

Note 1 – This loop might also be controlled by signalling in the B-channel as specified in the X- and V-Series Recommendations.

Note 2 – Activation/deactivation of loopback 3 may be initiated by request from an MSP (by management messages carried via layer 3 in the D-channel). However, the generalization of the test pattern over the loopback would be by the NT2.

Note 3 – From a technical viewpoint it is desirable that loopback 3 can always be implemented (although not mandatory) and, therefore, the design of protocols for loopback control should include the operation of loopback 3.

Note 4 – Whether the loopback is transparent or non-transparent is an implementor's decision. Whether or not a transparent loopback is used, the loopback should not be affected by configurations and conditions beyond the point at which the loopback is provided, e.g. by the presence of short circuits, open circuits or foreign voltages.

TABLE 2/I.602

Characteristics of optional loopbacks for primary rate access

Loop-back	Location	Channel(s) looped	Loopback type	Control point	Control mechanism	Implementation
C	Inside the NT1	23 B + D or 24 B channels (Note 5) 30 B + D or 31 B channels (Note 6)	Complete, non-transparent (Note 4)	TE, NT2	Layer 1 (Note 1)	Optional
B_1	Inside the NT2, at subscriber side (Note 2)	B, H_0, H_1 (Note 3)	Partial, transparent or non-transparent	TE, NT2	Layer 1 or Layer 3	Optional
B_2	Inside the NT2, at the network side	These loopbacks are optional in the TE/NT2. When used, e.g., as part of an internal test, the TE/NT2 should transmit normal signal to the network.				
A	Inside the TE					
3	In NT2, as near as possible to reference point S, towards the ET	23 B + D or 24 B channels (Note 5) 30 B + D or 31 B channels (Note 6)	Complete, transparent or non-transparent (see Note to I.601)	NT2	Local maintenance	Optional (Note 8)
				NT2	Layer 3 messages in D-channel or in-band signalling in B-channel (Note 7)	
4	Inside the TA or TE	B, H_0, H_1 (Note 3)	Partial, transparent or non-transparent	NT2, local exchange, remote maintenance server or remote user	Layer 3	Optional

Note 1 – Transfer of layer 3 service messages may take place between TE (or NT2) and the exchange prior to the use of the layer 1 control mechanism. However, there are situations where the TE (or NT2) may not receive a reply:

a) the message may not be transmitted when the interface is in a failure situation;

b) a network that does not support layer 3 signalling option need not respond.

Definition of layer 1 control signals from TE (or NT2) towards NT1 remains for further study.

Note 2 – Loopback B is applicable to each individual interface as reference point S.

Note 3 – The different B, H_0 and H_1 channel loopbacks are controlled by separate control signals. However, several per channel loopbacks may be applied at the same time.

Note 4 – The signal toward ET from the NT1 needs further study.

Note 5 – For 1544 kbit/s interface.

Note 6 – For 2048 kbit/s interface.

Note 7 – Activation/deactivation of loopback 3 may be requested from a maintenance service provider (MSP).

Note 8 – From a technical viewpoint, it is however desirable that loopback 3 always be implemented (though it is not mandatory) and therefore the design of protocols for loopback control should include the operation of loopback 3.

Recommendation I.603

APPLICATION OF MAINTENANCE PRINCIPLES TO ISDN BASIC ACCESSES

(Melbourne, 1988)

1 Scope of application

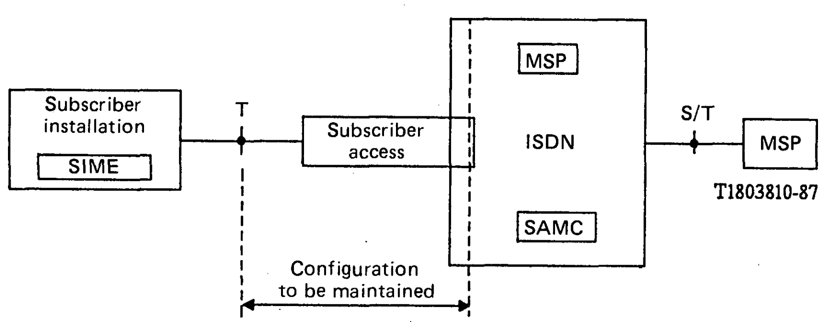
This Recommendation covers the maintenance of that part of the ISDN subscriber basic access which is controlled by the network. The Recommendation follows the maintenance principles as defined in Recommendation M.20 and applies to the basic access directly connected to the local exchange without any multiplexer or concentrator.

The principle of controlled maintenance (as defined in Recommendation M.20) is applied for maintaining the subscriber basic access.

Controlled maintenance is a method of sustaining a desired technical performance by the systematic application of supervision, testing and performance sampling in order to minimize preventive maintenance and to reduce corrective maintenance.

2 Network configuration for maintenance activities

Figure 1/I.603 is the basis for the general maintenance principles of the subscriber access.



SAMC Subscriber access maintenance centre
SIME Subscriber installation maintenance entities
MSP Maintenance service provider

Note 1 — The subscriber access contains a digital section which can use different varieties of transmission techniques and may also include a regenerator.

Note 2 — In some countries certain maintenance functions within the subscriber access may be controlled by the subscriber installation (SIME).

FIGURE 1/I.603

Configuration for the maintenance of the basic access

3 Failure detection

3.1 *General*

When the digital section (as seen by the exchange) of the ISDN subscriber basic access is in the active state, automatic supervision of the correct functioning of the layer 1 up to the NT1 is operating. This supervision is called continuous automatic supervision on layer 1.

When the ISDN subscriber basic access is in the active state (as seen by the exchange), automatic supervision of the correct functioning of the D-channel layers 2 and 3 is also operating. This supervision is called automatic supervision on layers 2 and 3 of the D-channel protocol.

When the ISDN subscriber basic access is not in an active state (as seen by the exchange), the subscriber access may be periodically tested by the exchange. This is called the continuity test.

3.2 *Automatic supervision*

3.2.1 *Continuous automatic supervision of layer 1*

3.2.1.1 *Objectives*

This supervision is realized by permanent automatic mechanisms located in the pieces of equipment of the subscriber basic access (see definition in Figure 1/I.601). These automatic mechanisms are continuously operational during the active period of the subscriber basic access. They are designed to detect malfunctioning of particular items, e.g. power supply, quality level of transmission, incoming signal, frame alignment.

The continuous automatic supervision mechanism should be in operation even if there is no subscriber installation connected to the T reference point. For this, it must be possible for the digital section to be placed in a state where the automatic supervision can be performed continuously although the T reference point may not be capable of full activation according to Recommendation I.430.

3.2.1.2 *Digital section functions*

Functions, which are allocated to the digital section are listed below:

- detection of loss of frame alignment within the digital system;
- detection of loss of frame alignment on the user-network interface as defined in Recommendation I.430;
- supervision of the power feeding;
- transmission performance monitoring.

Transmission performance monitoring mechanisms are for further study.

Note – In case the digital section has its own failure detection mechanism, failure indication signals may be sent to, and received by, the local exchange termination. Alternatively, the detection mechanisms are included in the exchange termination.

3.2.1.3 *Exchange termination functions*

Functions which are allocated to the exchange termination are listed below:

- supervision of information related, to or received from, the digital section;
- transmission performance evaluation.

The transmission performance evaluation is based on a permanent processing of the elementary results presented by the continuous error monitoring of the digital section.

The result of the processing will give information on at least one transmission quality level.

Definition of quality levels and evaluation of timing conditions are out of the scope of this Recommendation.

3.2.2 *Automatic supervision of layers 2 and 3 of the D-channel protocol*

This activity covers supervision of activities of layers 2 and 3 of the D-channel protocol. Automatic supervision on layers 2 and 3 will be made by self-acting mechanisms implemented in the network (e.g. in the ET).

There are three categories of automatic supervision which may be performed by layers 2 and 3 of the D-channel protocols:

- service provision incapability detection (e.g. incapability of layer 2 to establish a data link connection);
- protocol misoperation detection (e.g. at layer 2, detection of dual TE1 assignment);
- error monitoring (e.g. the layer 2 CRC check procedure can detect the occurrence of an errored frame).

These events (defined in Recommendations I.440 and I.450) should be recorded.

3.3 *Continuity test*

3.3.1 *General*

When the subscriber basic access is not active (normal case and/or unknown failure condition case) or has not been recently activated, a continuity test may be applied in order to detect a possible failure condition.

The test should be a simple go/no go test.

Note – The periodicity of testing on each access, if such test is performed on a periodical basis, shall be compatible with the failure detection time value (i.e. the time between failure occurrence and failure detection).

3.3.2 *Control of the continuity test*

The continuity test is based on a normal activation of layer 1. If the activation is confirmed by a positive result of the continuity test, the subscriber basic access is declared to be in good order for operation. No report is given to the SAMC.

If the activation is not confirmed by a positive result of the continuity test, or if a failure condition is detected during the process, then the exchange will automatically enter into the failure localization process, and will report to SAMC.

The result of the continuity test should be judged to be positive if the NT1 has the capability to signal that there is no failure on the subscriber basic access.

4 **System protection**

When a failure is detected which has an adverse effect on the availability and/or functionality of network equipment, the access is considered "out of service due to failure" and call attempts may be rejected to prevent further damage or to remove the adverse effect (see Recommendation I.601). In this condition, removal of power from the line may be required.

5 **Failure information**

A failure confirmed by the exchange and related to a subscriber basic access and/or subscriber installation shall be reported to the SAMC in a message.

The message could be presented after an automatic identification of a failed maintenance entity (ME) has been made (see § 6).

6 **Failure localization**

6.1 *Automatic confirmation of failure within the subscriber basic access*

An automatic test procedure to confirm a detected possible failure condition within the subscriber basic access should be provided. It should be initiated by an automatic reaction of the exchange, following abnormal conditions which have been detected by the processes presented above, i.e. continuous supervision, supervision on layer 2 and layer 3, continuity test.

The process is based on loopback techniques which allows the exchange to verify that there is no failure within the network and that the failure condition, if any, is not of a temporary nature.

If failures are detected in the D-channel layers 2 and 3 communication, clear differentiation between failures within the subscriber installation and within the subscriber access should be possible.

6.2 *Failed maintenance entity identification*

6.2.1 *General*

Such a function has to be made on demand or automatically following the indication of failed conditions by the network or following a subscriber complaint. It is necessary, before undertaking the appropriate action, to identify (i.e., to know) the maintenance entity affected by the failure.

6.2.2 *Objectives*

The main objective of this function, which is controlled by the SAMC is to indicate to the SAMC, if the failure is:

- within the ET and/or the LT;
- within the line and/or the NT1, the localization specified between NT1 or line if possible;
- within the subscriber installation.

6.3 *Loopbacks*

6.3.1 *Locations of loopbacks within the subscriber basic access*

Loopback locations for failure localization and verification controlled by the local exchange are shown in Figure 2/I.603.

Note – Other loopbacks might be necessary.

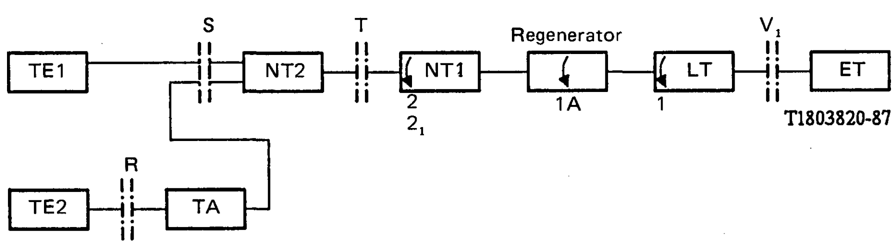


FIGURE 2/I.603

Loopback locations within the subscriber basic access

6.3.2 *Characteristics of loopbacks within the subscriber access*

The characteristics of loopbacks within the subscriber access are given in Table 1/I.603. Other loopbacks used in support of maintaining the subscriber installation from within the subscriber installation are specified in Recommendation I.602.

6.3.3 *Use of loopbacks*

If the loopback 2 is established, the network part of the subscriber basic access is considered to be correctly functioning. No report is given to the SAMC.

If loopback 2 cannot be established and/or if faulty network conditions are detected, the exchange:

- either goes further in the identification of the failed maintenance entity (see § 6.2) and reports to the SAMC later once the failed maintenance entity has been identified; or
- informs the SAMC that the network is affected by a failure, in the case where the non-automatic identification process of the failed maintenance entity is implemented.

6.4 *Command controlled tests and measurements*

For more precise failure localization, it would be necessary to obtain line parameter measurements indicating that the value of an electrical parameter is within a certain margin or showing the precise value of the parameter.

For further study.

TABLE 1/I.603

Characteristics of loopbacks within the subscriber access

Loop-back	Location	Channel(s) looped back	Loopback type	Control point	Control mechanism	Application	Implementa-tion
1	In LT, as near as possible to the line, towards the ET	Complete loopback (2 B + D at least)	Complete, transparent or non-trans-parent (Note 1)	Under control of local exchange	Layer 1 signals	Failure localization + verification	Recom-mended
1A	In the regenerator	Complete loopback	Complete, transparent or non-trans-parent (Note 1)	Under control of local exchange	Layer 1 signals	Failure localization	Optional
2	See Appendix I of Recommendation I.430						
2_1	See Appendix I of Recommendation I.430						

Note 1 – Whether the loopback is transparent or non-transparent is for further study. Whether or not a transparent loopback is used, the loopback should not be affected by configurations and conditions beyond the point at which the loopback is provided, e.g. by the presence of short circuits, open circuits or foreign voltages.

Note 2 – Network control signals for loopbacks may not be harmonized.

7 Logistic delay time

See Recommendation M.20.

8 Failure correction

See Recommendation M.20.

9 Verification

The verification that the failure has been corrected is made on demand of the staff.

Tests described in §§ 3, 6 and 11 may be used.

10 Restoration

After the failure has been rectified and the correct operation of the access verified (during which time the access will be in either the "out of service due to failure" or "degraded transmission" conditions), the access shall be returned to the "in service" condition. The mechanism/procedure for returning the access to the "in service" condition (e.g. automatic or manual) is not a subject of this Recommendation (see Recommendation I.601).

11 Overall performance measurements

Overall performance measurements could, from the point of view of the exchange:

- concern a limited number of subscriber accesses at the same time;
- be made only on demand.

These tests and/or measurements shall not influence the conditions of the subscriber installation for incoming and outgoing calls. This gives the advantage of enabling measurement of the performance independently of the activity in the different channels of the subscriber basic access and also over a long period of time.

For the performance evaluation of a digital transmission system (over a long period of time, with permanent activation of the subscriber basic access) the network Administration shall have arrangements for the calculation of the performance levels according to Recommendation G.821.

Recommendation I.604

APPLICATION OF MAINTENANCE PRINCIPLES TO ISDN PRIMARY RATE ACCESSES

(Melbourne, 1988)

1 Scope of application

This Recommendation covers the maintenance of that part of the ISDN subscriber primary rate access which is controlled by the network. The Recommendation follows the maintenance principles as defined in Recommendation M.20 and applies to the primary rate access connected to the local exchange.

The scope of this Recommendation is to describe the minimum functions required to maintain the subscriber primary rate access. They are applicable to any primary rate access.

The principle of controlled maintenance (as defined in Recommendation M.20) is applied for maintaining the subscriber primary rate access.

Controlled maintenance is a method of sustaining a desired technical performance by the systematic application of supervision, testing and performance sampling in order to minimize preventive maintenance and to reduce corrective maintenance.

2 Network configuration for maintenance activities

Figure 1/I.604 gives the basis for the general maintenance principles of the subscriber access, in accordance with Figure 2/I.601 which defines the ISDN subscriber access.

3 Failure detection

3.1 *General*

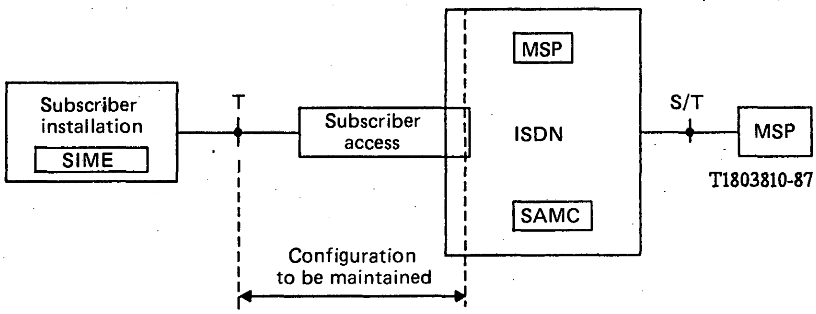
Unlike the ISDN basic access, the digital section of the ISDN subscriber primary rate access is never deactivated (as seen by the exchange); continuous automatic supervision of the correct functioning of layer 1 up to NT2 is always operating. This supervision is called continuous automatic supervision of layer 1.

Automatic supervision of the correct functioning of the D-channel layers 2 and 3 is also operating. This supervision is called automatic supervision of layers 2 and 3 of the D-channel protocol.

3.2 *Automatic supervision*

3.2.1 *Objectives*

This supervision is realized by continuous automatic mechanisms located in various pieces of equipment of the ISDN primary rate access.



SAMC Subscriber access maintenance centre
SIME Subscriber installation maintenance entities
MSP Maintenance service provider

Note 1 – The subscriber access contains a digital link which can use different varieties of transmission techniques and media. Figure 2/I.604 shows examples of configurations made by using existing digital line systems and multiplexers complying with G.700 and G.900-Series of Recommendations.

Note 2 – A local exchange should be able to connect different types of digital line systems and different types of subscriber installations at V_3 interfaces complying with Recommendation Q.512.

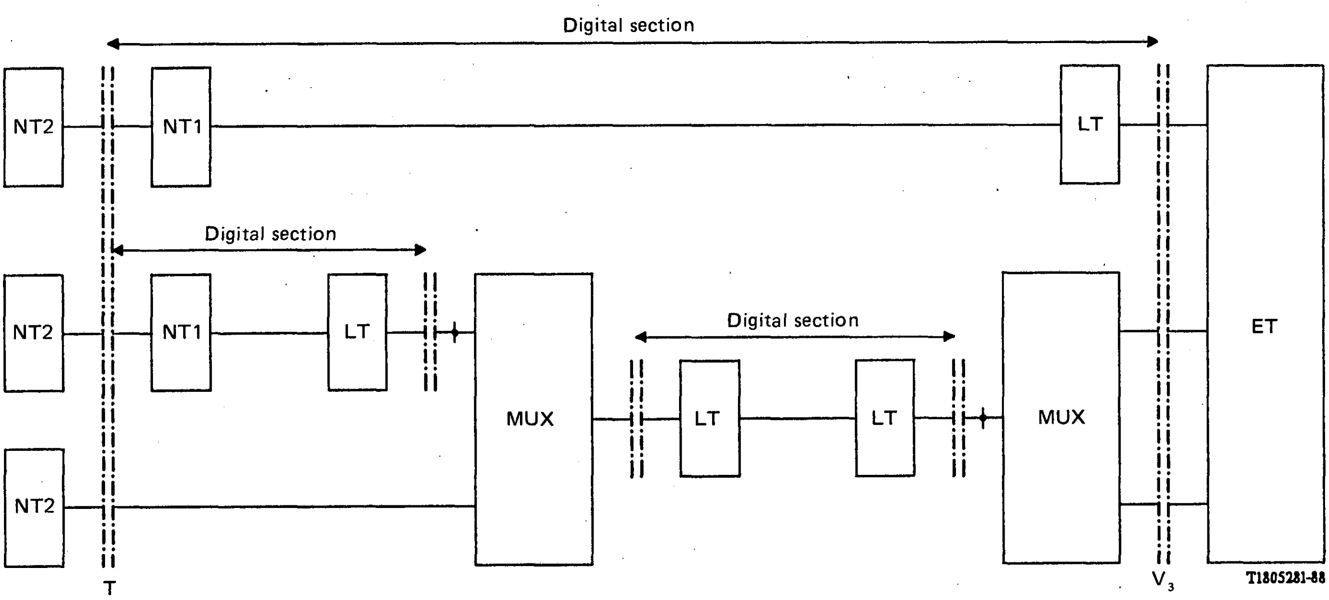
Note 3 – The use of different types of digital line systems shall not affect the subscriber installation complying with Recommendation I.431.

Note 4 – The subscriber access shall comply with the CRC procedure defined in Recommendations G.704 and G.706.

Note 5 – In some countries the subscriber installation is allowed to control certain maintenance functions in the subscriber access.

FIGURE 1/I.604

Network configuration for maintenance of the subscriber access



Note – The digital sections may include one or more regenerators.

FIGURE 2/I.604

Examples of equipment configurations in the ISDN subscriber primary rate access

These automatic mechanisms are never deactivated and are generally based on the operation of CRC information which is given by the CRC procedure associated with the link between the customer and the local exchange. These mechanisms are complemented by the detection of malfunctioning of particular items, e.g. loss of power supply, loss of incoming signal, loss of frame alignment. Minimum functions which could be allocated to the subscriber installation and exchange termination are listed below. Further details of these functions and those of the digital section are found in Annex A, where various options concerning the handling of CRC functions are described.

3.2.2 *NT2 termination functions*

The functions allocated to the NT2 are listed below:

- detection of loss of incoming signal;
- detection of loss of frame alignment;
- detection of AIS and RAI;
- generation of frame signal;
- CRC code generation;
- RAI generation;
- CRC monitoring of the incoming signal (network-to-user);
- detection of CRC error information (user-to-network);
- CRC error reporting to the network (optional in 1544 kbit/s).

3.2.3 *Exchange termination (ET) functions*

The functions which are allocated to the ET are listed below:

- detection of loss of incoming signal;
- detection of loss of frame alignment;
- detection of AIS, generation of AIS (optional in 1544 kbit/s);
- detection of RAI;
- generation of frame signal;
- CRC code generation;
- RAI generation;
- CRC monitoring of the incoming signal (user-to-network);
- detection of the CRC error information (network-to-user);
- CRC error reporting to the user (optional in 1544 kbit/s).

The exchange termination may optionally detect the CRC error information reported by the user side.

The RAI is generated towards NT2 upon detection by the ET of a fault in the input direction (loss of signal, loss of frame alignment, detection of AIS).

The exchange termination has the option to evaluate the transmission performance based on the statistical treatment of the local and remote CRC error reports and on the fault indications.

The transmission performance evaluation is based on a permanent processing of the elementary results presented by the continuous error monitoring of the digital transmission link. The result of this processing will give information on the transmission quality level (normal quality, degraded quality, unacceptable quality) and on the unavailability of the access (see § 5.6).

3.3 *Automatic supervision of layers 2 and 3 of the D-channel protocol*

This covers supervision of activities of layers 2 and 3 of the D-channel protocol. Automatic supervision of layers 2 and 3 will be made by self-acting mechanisms implemented in the network (e.g. in the ET).

There are three categories of automatic supervision which may be performed by layer 2 and layer 3 of the D-channel protocols:

- service provision incapability detection (e.g. incapability of layer 2 to establish a data link connection);
- protocol misoperation detection;
- error monitoring (e.g. the layer 2 CRC check procedure can detect the occurrence of an errored frame).

These events (defined in Recommendations I.440 and I.450) should be recorded.

4 System protection

When a confirmed fault is detected which has an adverse effect on the availability and/or functionality of network equipment, the access is considered "out of service due to failure" and call attempts may be rejected to prevent further damage or to remove the adverse effect (see Recommendation I.601).

5 Failure indication

5.1 *Default indication signals*

a) AIS – as defined in Recommendation I.431.

b) RAI – as defined in Recommendation I.431.

5.2 *State tables*

State tables associated with failures in the primary rate access are given in Recommendation I.431.

5.3 *Generation of defect indication signals by the NT2*

The NT2 functions are listed in § 3.2.2.

The generation of RAI toward the ET is used to indicate the loss of incoming layer 1 capability.

5.4 *Generation of defect indication signals by the subscriber access*

The digital link functions are listed in Annex A for each option within the access.

5.5 *Generation of defect indication signals by the exchange termination*

The exchange termination functions are listed in § 3.2.3.

The generation of RAI toward the NT1 is used to indicate the loss of incoming layer 1 capability.

5.6 *Transmission quality monitoring by the exchange*

5.6.1 *Error performance parameters*

According to Recommendations M.20 and M.550, the anomaly and defect indications are treated on a statistical basis.

5.6.2 *Error performance evaluations*

The access is considered by the local exchange to be "unavailable", "unacceptable" or "degraded" according to Recommendation M.550.

5.7 *Failure information from the exchange*

A defect confirmed by the exchange and related to a subscriber access and/or a subscriber installation shall be reported to the SAMC in a message.

The detection of a degraded or unacceptable quality level or of the unavailability of the access by the exchange shall be reported to the SAMC in a message.

The message could be presented after an automatic identification of a failed Maintenance Entity (ME) has been made (see § 6).

5.8 *Failure information to the subscriber installation*

The detection of a degraded or unacceptable quality level by the exchange may be reported to the user by the transmission of a state indication.

6 Failure localization

6.1 *Automatic confirmation of failure within the subscriber primary rate access*

An automatic test procedure to confirm a detected possible failure condition within the subscriber access should be provided. It shall be initiated by an automatic reaction of the exchange, following abnormal conditions which have been detected by the processes presented above, i.e. continuous supervision of layer 1, supervision of layers 2 and 3 of the D-channel protocol.

If failures are detected in the D-channel layers 2 and 3 communication, clear differentiation between failures within the subscriber installation and within the subscriber access should be possible.

6.2 *Failed maintenance entity identification*

6.2.1 *General*

Such a function has to be made on demand or automatically following the indication of failure conditions by the network or following a subscriber complaint. It is necessary, before undertaking the appropriate action, to identify (i.e. to know) the maintenance entity affected by the failure.

6.2.2 *Objectives*

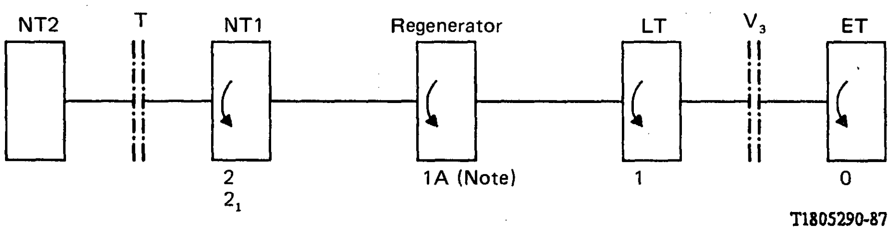
The main objective of this function, which is controlled by the SAMC, is to indicate to the SAMC whether the failure is:

- within the ET;
- within the digital transmission link (NT1 to LT);
- within the subscriber installation.

6.3 *Loopbacks for maintenance of the subscriber primary rate access*

6.3.1 *Location of loopbacks*

Possible loopback locations for failure localization and verification controlled by the SAMC are shown in Figure 3/I.604.



Note – The digital section may contain one or more regenerators.

FIGURE 3/I.604

Location of the loopbacks for the maintenance of the general equipment configuration of the subscriber primary rate access

6.3.2 *Characteristics of loopbacks*

The characteristics of the loopbacks are given in Table 1/I.604.

TABLE 1/I.604

Characteristics of the loopbacks for primary rate subscriber access

Loop-back	Location	Channel(s) looped back	Loopback type	Control point	Control mechanism	Application	Implementa-tion
0	In ET, as close as possible to V_3	Part of ET self-test					Optional
1	In LT, as near as possible to the line, towards LT	Complete loopback	Complete	FS	Layer 1 signals (Note 1)	Failure localization and verification	Optional
1A	In the regenerator, towards V_3	Complete loopback	Complete	FS	Layer 1 signals (Note 1)	Failure localization and verification	Optional
2	In NT1, as near as possible to T, towards ET (Note 2)	Complete loopback	Complete	FS	Layer 1 signals (Note 2)	Failure localization and verification	Optional
2_1	In NT1	Per channel FS	FS	FS	FS	FS	FS

FS Further study required.

Note 1 – These layer 1 signals may not be in the frame signals. They may be line signals.

Note 2 – In the case of using existing digital systems, a manual loopback may replace loopback 2. This loopback is implemented between NT2 and NT1 and is controlled by the user on demand of the network staff.

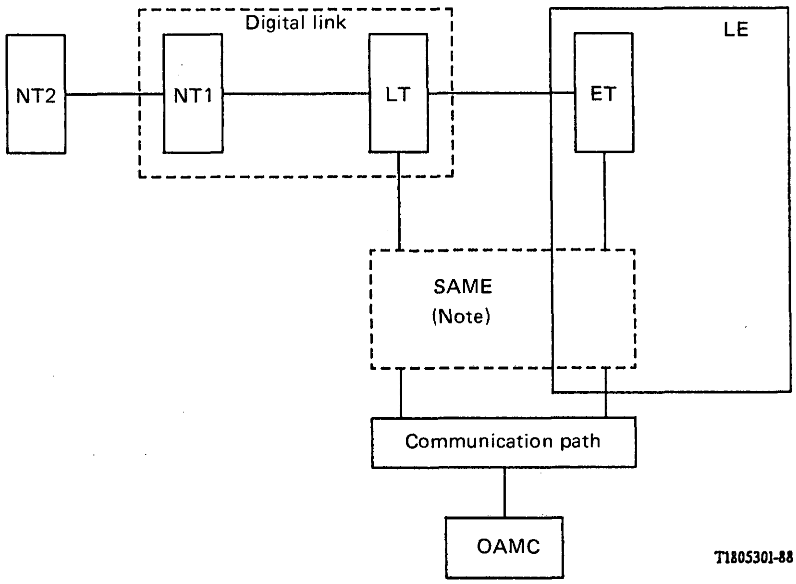
6.4 *Failure localization mechanisms*

See Figure 4/I.604.

If a subscriber access failure is confirmed by the exchange and if the failure is not located in the exchange, then:

– either the loopback 2 can be established under control of the exchange, in which case:
  - i) if the loopback 2 is successful, the exchange considers the subscriber access to be functioning correctly;
  - ii) if the loopback 2 is unsuccessful, the exchange reports to the OAMC;
– or, if the loopback 2 cannot be established under control of the exchange, then the exchange informs the OAMC that the digital link is affected by a failure.

In the case of a failed maintenance entity being detected, an automatic localization process is initiated. This process could localize the failure within the digital link by the use of loopbacks or subscriber access fault information.



Note – SAME functions may be distributed in different equipment.

FIGURE 4/I.604

Example of network architecture for the failure localization within the subscriber primary rate link

6.4.1 *Initial failure localization performed by the ET and/or NT2 (TE)*

The initial failure localization capability depends on the CRC option used in the network. For further information about different CRC options which may be applied in the access, see Annex A.

In general, CRC error information and fault indication signals may be used by either the NT2 or ET to deduce the location of some failures in operational conditions.

Failure localization in the case of option 2 refers to the capability to distinguish between a failure occurring either:

- between NT2 and NT1; or
- between NT1 and ET.

Failure localization in the case of option 3 refers to the capability to distinguish between a failure occurring either:

- between NT2 and NT1; or
- between NT1 and LT; or
- between LT and ET.

Failure localization in the case of option 4 refers to the capability to distinguish between a failure occurring either:

- between NT2 and NT1; or
- between NT1 and ET.

This localization may be achieved by either the NT2 or the ET obtaining additional information from the NT1. The means to obtain this information is for further study.

6.4.1.1 *Failure localization performed by the NT2*

In options 2 and 3 the combination of CRC error information and RAI received from the interface allows the NT2 to localize a fault in the upstream direction of the access as follows:

- receipt of RAI by the NT2 with no, or a very small number of, reported CRC errors indicates a failure inside the network; or
- receipt of RAI by the NT2 with constantly, or a very high number of, reported CRC errors indicates a fault between NT2 and NT1.

This capability is not provided by option 1.

Concerning the downstream direction of the access, failure localization can be made in options 1, 2 and 3 by distinguishing between the following conditions at the receiving side of the NT2:

- AIS, indicating a fault inside the network; or
- loss of incoming signal or loss of frame alignment, indicating a failure between NT1 and NT2.

6.4.1.2 *Failure localization performed by the ET*

The failure localization capability of the ET depends on the CRC option used in the access, on the fault detection and reporting capability of the equipment installed and the provision of optional loopbacks as given in Table 1/I.604. For further information about different CRC options applied in the access, see Annex A.

6.4.2 *Further failure localization*

For more precise localization, further techniques may be necessary, e.g. line parameter measurements.

This is for further study.

6.4.3 *Additional signals*

The use and definition of additional signals for transmission direction indication, extension of remote CRC reporting mechanisms and specific equipment signals is for further study.

7 Logistic delay time

See Recommendation M.20.

8 Failure connection

See Recommendation M.20.

9 Verification

The verification that the failure has been corrected is performed on demand of the staff.

Tests described in §§ 3, 6 and 11 may be used.

10 Restoration

After a failure has been rectified and the correct operation of the access verified (during which time the access will be in either the "out of service due to failure" or "degraded transmission" conditions), the access shall be returned to the "in service" condition. The mechanism/procedure for returning the access to the "in service" condition (e.g. automatic or manual) is not a subject of this Recommendation.

11 Overall performance measurements

Overall performance measurements could, from the point of view of the exchange:

- concern a limited number of subscriber accesses at the same time;
- be made only on demand.

These tests and/or measurements shall not influence the conditions of the subscriber installation for incoming or outgoing calls. This gives the advantage of enabling measurement of the performance independently of the activity in the different channels of the subscriber access and also over a long period of time.

For the performance evaluation of a digital transmission system (over a long period of time) the Administration network shall have arrangements for calculating the performance levels according to Recommendation G.821.

ANNEX A

(to Recommendation I.604)

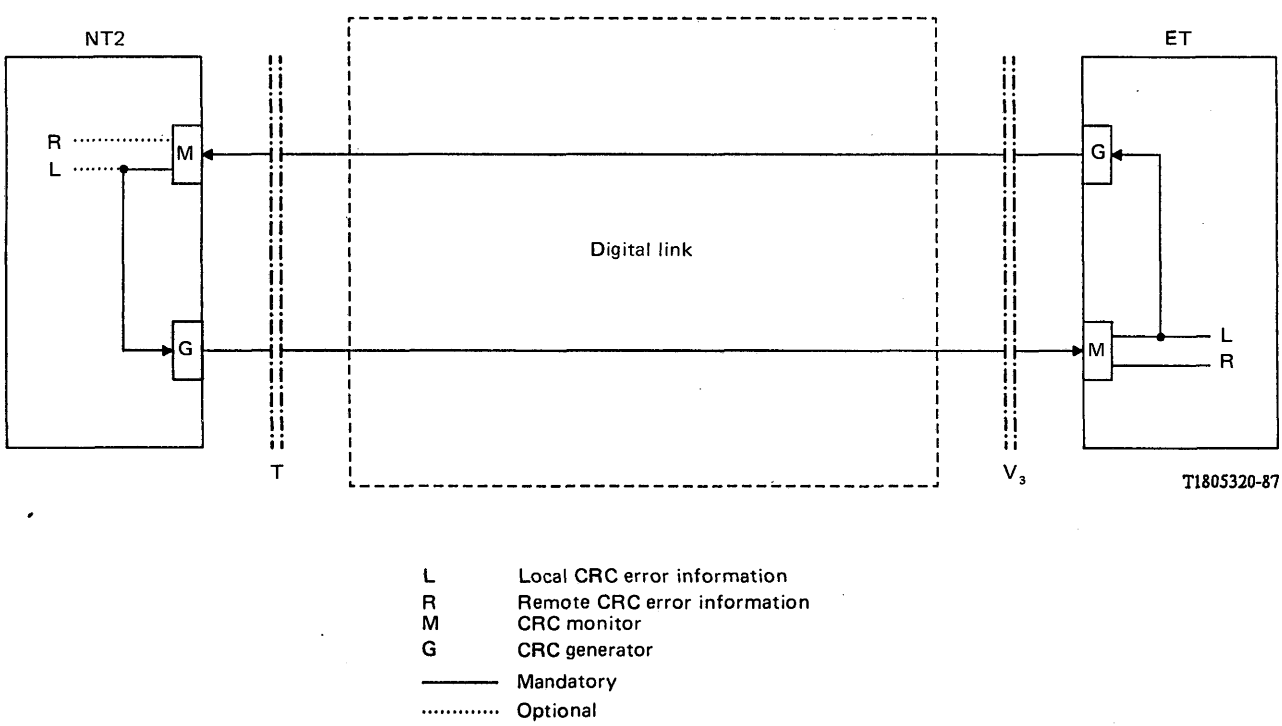
Subscriber access option

A.1 *Digital link without CRC processing (option 1)*

A.1.1 *Definition*

The transmission equipment used between interfaces at the T and V reference points (multiplexers, NT1-LT) could be existing equipment which have standard functions of supervision and detection of defects and faults.

In this case, the digital link is said to be "without CRC processing": the CRC procedure is between the ET and NT2 (see Figure A-1/I.604).



Note – CRC error reporting may require storage functions in the NT2 and ET.

FIGURE A-1/I.604

Digital link without CRC processing

A.1.2 *Digital link functions*

Functions allocated to the digital link are listed below:

- detection of loss of incoming signal on either side and inside the transmission section, and generation of AIS "downstream";
- detection of AIS inside the transmission section and generation of AIS "downstream";
- detection of defects and anomalies in the digital link.

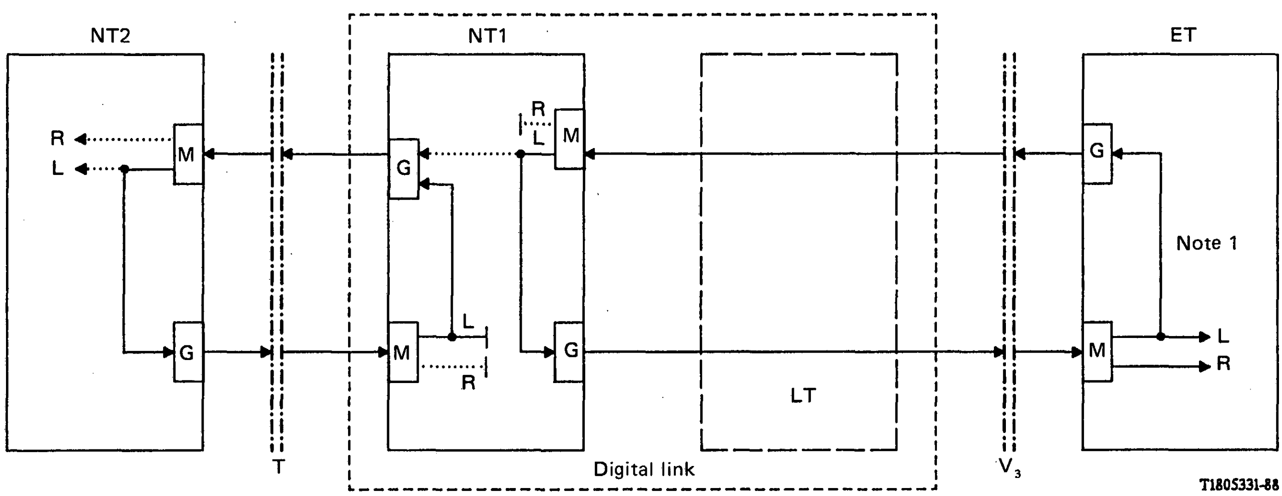
A.1.3 *NT2 functions*

Functions allocated to the NT2 are given in § 3.2.2.

A.2 *Digital link with CRC processing in the NT1 (option 2)*

A.2.1 *Definition*

The transmission equipment used between interfaces at the T and V reference points could be new equipment with CRC processing in the NT1 (see Figure A-2/I.604). In this case, the digital link is said to be with "CRC processing in the NT1".



L Local CRC error information
R Remote CRC error information
M CRC monitor
G CRC generator
——— Mandatory
.... Optional

Note 1 – Optional in 1544 kbit/s systems.

Note 2 – CRC error reporting may require storage functions in the NT2, NT1 and ET.

FIGURE A-2/I.604

Digital link with CRC processing in NT1

A.2.2 *Digital link functions*

Functions allocated to the digital link are listed below:

- detection of loss of signal at either side of the NT1 or inside the transmission section;
- detection of loss of frame alignment at either side of the NT1;
- generation of AIS downstream in the direction to the user;

- supervision of power supply (optional);
- CRC generation towards the user and towards the ET;
- CRC monitoring at both sides of the NT1 and detection of CRC blocks received with error;
- when a block with CRC error is received from NT2, transmission of CRC error information towards NT2 (Note);
- when a block with CRC error is received from ET, transmission of CRC error information towards ET;
- when a block with CRC error is received from ET, transmission of CRC error information towards NT2 (optional);
- detection of defect and anomaly in the digital link.

Note – To fulfill the requirement of failure localization, the NT1 has to report the CRC error information toward the NT2 even when loss of frame alignment has occurred. This is different from the procedure described in Recommendation G.706.

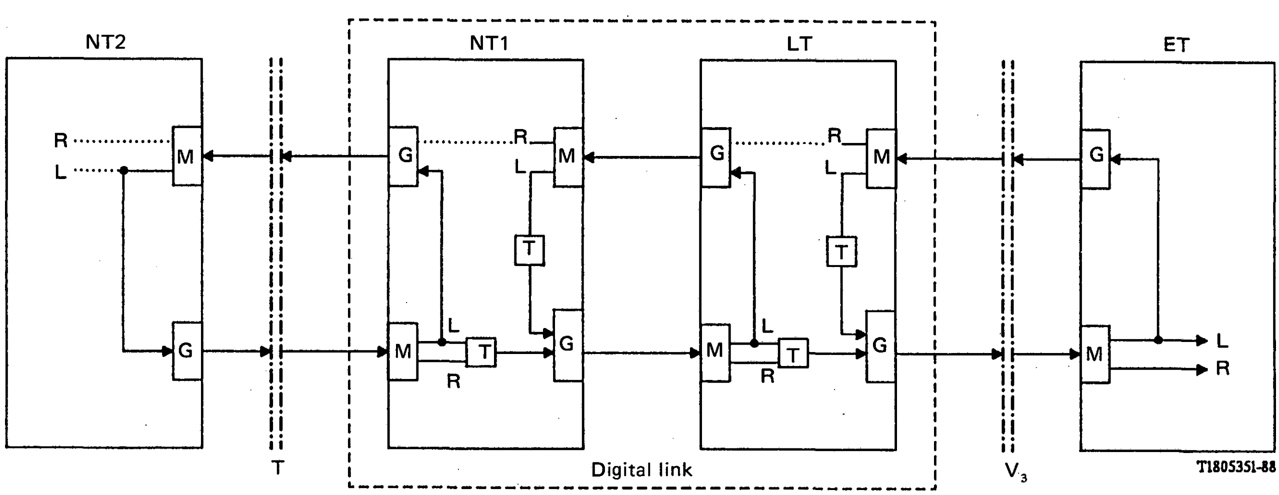
A.2.3 *NT2 functions*

Functions allocated to the NT2 are given in § 3.2.2.

A.3 *Digital link with CRC processing in the LT and NT1 (option 3)*

A.3.1 *Definition*

The transmission equipment used between interfaces at the T and V reference points may be new equipment with CRC processing, treatment and reporting of the results of that processing in the NT1 and LT (see Figure A-3/I.604). In this case the digital link is said to be with Figure A-3/I.604). In this case the digital link is said to be with "CRC processing and reporting in the NT1 and the LT".



L	Local CRC error information
R	Remote CRC error information
M	CRC monitor
G	CRC generator
T	CRC error treatment and reporting
———	Mandatory
....	Optional

Note – CRC error reporting may require storage and processing functions in the NT2, NT1, LT and ET.

FIGURE A-3/I.604

Digital link with CRC processing and reporting in the LT and NT1

A.3.2 *LT functions*

Functions allocated to the LT are listed below:

- detection of loss of signal at either side of the LT;
- detection of loss of frame alignment at either side of the LT;
- detection of RAI at either side of the LT;
- generation of AIS downstream in the direction of the NT1;
- supervision of power supply (optional);
- generation of CRC towards NT1 and ET;
- monitoring of CRC from both sides of the LT and detection of CRC blocks received with error;
- when a block with CRC error is received from NT1, transmission of CRC error information toward NT1;
- when a block with CRC error is received from ET, transmission of CRC error information toward ET;
- when a block with CRC error is received from ET, transmission of CRC error information toward NT1 (optional);
- supervision of the numbers of CRC blocks received with error, from ET and from NT1 separately;
- checking thresholds corresponding to errored seconds, severely errored seconds and degraded minutes;
- reporting errored seconds, severely errored seconds and degraded minutes.

A.3.3 *NT1 functions*

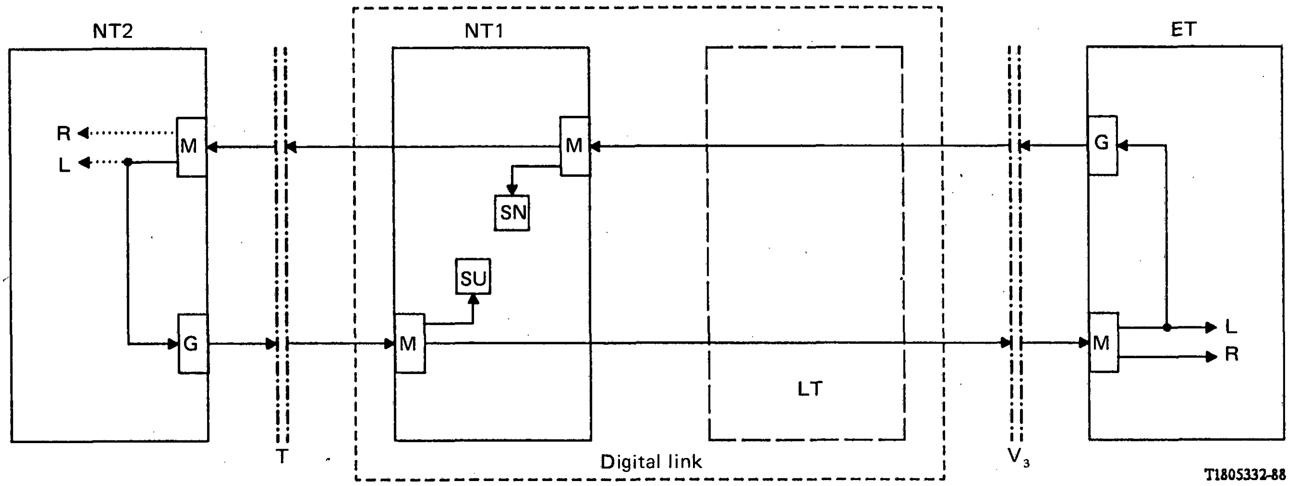
Functions allocated to the NT1 are listed below:

- detection of loss of signal at either side of the NT1;
- detection of loss of frame alignment at either side of the NT1;
- detection of RAI at either side of the NT1;
- generation of AIS downstream in the direction of the NT2;
- supervision of power supply (optional);
- generation of CRC towards NT2 and LT;
- monitoring of CRC from both sides of the NT1 and detection of CRC blocks received with error;
- when a block with CRC error is received from NT2, transmission of CRC error information toward NT2;
- when a block with CRC error is received from LT, transmission of CRC error information toward LT;
- when a block with CRC error is received from LT, transmission of CRC error information toward NT2 (optional);
- supervision of the numbers of CRC blocks received with error, from LT and NT2 separately;
- checking thresholds corresponding to errored seconds, severely errored seconds and degraded minutes;
- reporting errored seconds, severely errored seconds and degraded minutes.

A.4 *Digital link with CRC monitoring in the NT1 (option 4)*

A.4.1 *Definition*

The transmission equipment used between interfaces at the T and V reference points could be new equipment with CRC monitoring in the NT1 (see Figure A-4/I.604). In this case, the digital link is said to be "with CRC monitoring in the NT1".



L	Local CRC error information
R	Remote CRC error information
M	CRC monitor
G	CRC generator
SN	Storage for network side monitor
SU	Storage for user side monitor
———	Mandatory
…………	Optional

FIGURE A-4/I.604

Digital link with CRC monitoring in NT1

A.4.2 *NT1 functions*

Functions allocated to the NT1 are listed below:

- detection of loss of signal or loss of frame alignment at either side;
- generation of AIS toward either side when signal or frame alignment on opposite side is lost;
- monitor CRC from both directions;
- store information derived from the CRC monitoring.

The information derived from the CRC monitoring and stored in the NT1 may be retrieved from either the NT2 or ET. The means of this retrieval is for further study.

A.4.3 *NT2 function*

In addition to the functions described in § 3.2.2, NT2s may also, optionally, have the capability of retrieving from the NT1 the stored information derived from CRC monitoring.

A.4.4 *ET function*

In addition to the functions described in § 3.2.3, ETs may also, optionally, have the capability of retrieving from the NT1 the stored information derived from CRC monitoring.

APPLICATION OF MAINTENANCE PRINCIPLES TO STATIC MULTIPLEXED ISDN BASIC ACCESSES

(Melbourne, 1988)

1 Scope of application

This Recommendation covers the maintenance of the static multiplexed basic rate access, controlled by the network, and describes the operations and maintenance aspects of the V_4 interface.

The V_4 interface is defined in Recommendation Q.512. The specification of the operations and maintenance aspects of the V_4 interface is the subject of this Recommendation.

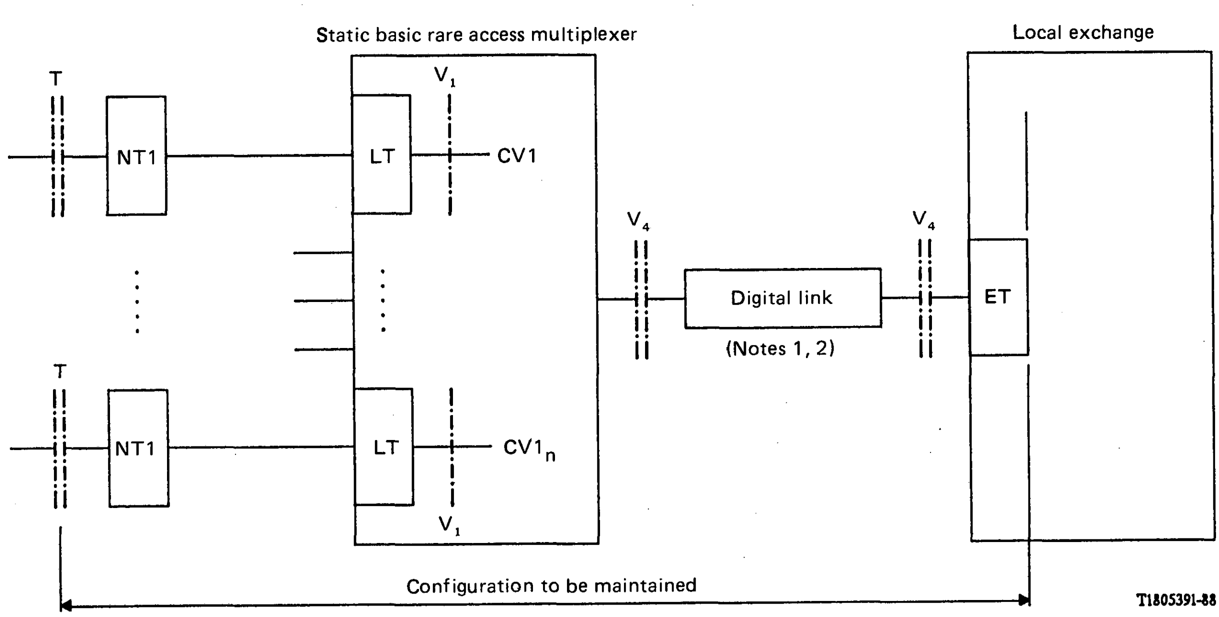
This Recommendation follows the maintenance principles as defined in Recommendation M.20 and applies to the basic rate access connected to the exchange via a multiplexer.

The principle of controlled maintenance is applied for maintaining the static multiplexed basic rate access.

Controlled maintenance is a method of sustaining a desired technical performance by the systematic application of supervision, testing and performance sampling in order to minimize preventive maintenance and to reduce corrective maintenance.

2 Network configuration for maintenance activities

Figure 1/I.605 shows the general reference configuration of the multiplexed basic rate access, connected via a digital link to the Exchange Termination (ET).



Note 1 – The digital link, as defined in Recommendation G.701, can make use of a veriety of transmission techniques and media complying with Recommendations G.703 and G.704.

Note 2 – The digital link may not be present. (Colocated configuration).

FIGURE 1/I.605

Equipment configuration for maintenance of the multiplexed basic rate access

3 Relationship to the maintenance of the basic rate access

The same principles as given in Recommendation I.603 for the ISDN basic rate accesses directly connected to the local exchange, should be applied. Therefore, the NT1 and LT for the basic rate accesses connected via a static basic access multiplexer to the local exchange must have the same functions as NT1 and LT for the basic rate accesses connected directly to the local exchange.

(The loopback mechanism must be implemented according to Recommendation I.603.)

In order to support these principles, operation and maintenance information has to be exchanged between the digital section for the ISDN basic rate access and the exchange termination (ET). This information is conveyed in the CV1-channel, which is defined in Recommendation Q.512. This CV1-channel is shown in Figure 2/I.605.

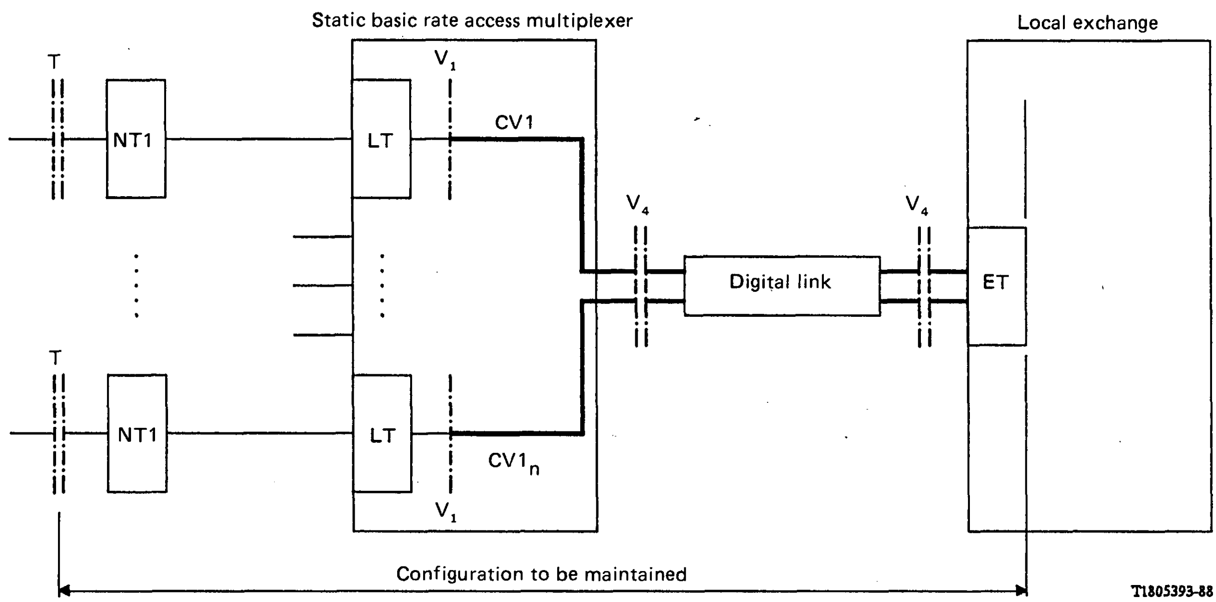


FIGURE 2/I.605

Information exchange between the digital section for the ISDN basic rate access and the local exchange termination (ET)

The functions which are allocated within this CV1-channel are defined in Recommendation G.960 on the digital section for the ISDN basic rate access.

These functions can be classified according to:

- activation/deactivation procedures;
- error and status reporting to the ET;
- failure localization within the digital section for the ISDN basic rate access;
- conveyance of control information from the ET to the digital section of the ISDN basic rate access.

4 Maintenance of the digital link and basic access multiplexer

4.1 *Failure detection*

Unlike the ISDN basic access, the digital link and basic access multiplexer are always in the active state (as seen by the exchange). Continuous automatic supervision, supervising the correct functioning of layer 1 up to the basic access multiplexer, is operating. This supervision is called continuous automatic supervision on layer 1.

4.1.1 *Functions applied to the ET*

The functions which are allocated to the ET are listed below:

- detection of loss of incoming signal;
- detection of loss of frame alignment;
- detection of AIS;
- detection of RAI;
- generation of the frame signal;
- CRC code generation;
- RAI generation;
- CRC monitoring of the incoming signal (basic access multiplexer to the ET);
- detection of CRC error information;
- CRC error reporting (ET to the basic access multiplexer) (optional);
- AIS generation.

The implementation of these functions should be the same as for the ET in the ISDN primary rate access, as defined in Recommendation I.604 for the exchange termination (ET).

4.1.2 *Functions applied to the static basic access multiplexer*

The functions which are allocated to the basic access multiplexer are listed below:

- detection of loss of incoming signal;
- detection of loss of frame alignment;
- detection of AIS;
- detection of RAI;
- generation of the frame signal;
- CRC code generation;
- CRC monitoring of the incoming signal (network to basic access multiplexer) and detection of CRC error information (if provided from the ET);
- CRC error reporting (basic access multiplexer to the ET).

The implementation of these functions should be the same as for the NT2 in the primary rate access, as defined in Recommendation I.604.

In addition, the following functions are allocated to the basic access multiplexer:

- sending of AIS on the V_4 interface, in case of a defect in the basic access multiplexer between the V_1 reference point and the V_4 interface of the multiplexer;
- signalling to all the basic rate accesses the condition "out of service due to failure", in the case of a defect occurring in the basic access multiplexer, between the V_1 reference point and the V_4 interface of the multiplexer, and in the digital link.

4.1.3 *Functions allocated to the digital links*

The functions, which are allocated to the digital links are:

- detection of loss of incoming signal on either end and within the digital link;
- generation and transmission of AIS within the digital link.

4.2 *System protection*

When a defect is detected in the digital link or basic access multiplexer, which has an adverse effect on the availability and/or functionality of all the ISDN basic rate accesses, all the ISDN basic rate accesses connected via this digital link and basic access multiplexer are considered to be "out of service due to failure" and call attempts may be rejected.

When a defect is detected in the digital link or basic access multiplexer, which has an adverse efect on the availability and/or functionality of only one basic rate access, then this particular basic access is considered to be "out of service due to failure" and call attempts may be rejected.

4.3 *Failure information*

When a defect is detected in the basic access multiplexer or digital links, this should be reported to the SAMC by a message.

4.4 *Failure localization*

When a defect is detected in the digital link, additional information for failure localization may be required from other network management entities.

4.5 *Logistic delay time*

See Recommendation M.20.

4.6 *Failure correction*

See Recommendation M.20.

4.7 *Verification*

The verification that the failure has been corrected is performed on demand of the SAMC.

4.8 *Restoration*

After a failure has been rectified and the correct operation of all the accesses verified (during which time the accesses will be in either the "out of service due to failure" or "degraded transmission" conditions), the accesses shall be returned to the "in service" condition. The mechanism/procedure for returning the accesses to the "in service" condition (e.g. automatic or manual) is not a subject of this Recommendation.

4.9 *Overall performance measurements*

See Recommendation I.603 for the performance related to the digital section of the basic rate access, and Recommendation I.604 for the V_4 digital section.

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