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# ITU-T

# I.510

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(03/93)

## INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

## INTERNETWORK INTERFACES

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# DEFINITIONS AND GENERAL PRINCIPLES FOR ISDN INTERWORKING

## ITU-T Recommendation I.510

(Previously "CCITT Recommendation")

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## FOREWORD

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

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation I.510 was revisd by the ITU-T Study Group XVIII (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

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NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

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

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# CONTENTS


| | | | *Page* |
|---|---|---|---|
| 1 | Introdution | | 1 |
| 2 | Scope | | 1 |
| 3 | Abbreviations | | 2 |
| 4 | Definitions | | 2 |
| | 4.1 | Definitions related to services and network capabilities | 2 |
| | 4.2 | Definitions related to general ISDN interworking configurations | 3 |
| 5 | Telecommunication services to be supported by ISDN interworking configurations | | 3 |
| 6 | ISDN interworking configurations | | 5 |
| | 6.1 | Reference points for network interconnections | 5 |
| | 6.2 | ISDN-to-ISDN interconnection | 6 |
| | 6.3 | Interworking between ISDNs and other networks | 7 |
| | 6.4 | ISDN internal interworking | 8 |
| | 6.5 | Network concatenation configurations | 8 |
| 7 | Interworking functional requirements – General aspects | | 10 |
| | 7.1 | Categories of interworking functions | 10 |
| | 7.2 | Mapping principles | 10 |
| | 7.3 | Guidelines on the description of mapping functions | 11 |
| | 7.4 | Functional requirements for lower layer service interworking | 11 |
| | 7.5 | Functional requirements for higher layer service interworking | 11 |
| 8 | General aspects of selection mechanisms for interworking functions | | 11 |

# DEFINITIONS AND GENERAL PRINCIPLES FOR ISDN INTERWORKING

*(Melbourne, 1988; amended at Helsinki, 1993)*

## 1 Introdution

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

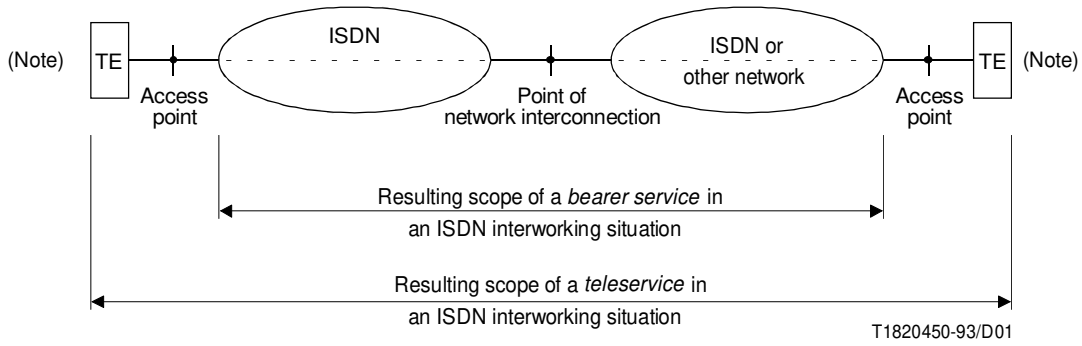
The definitions which follow are related to services and to network capabilities. In those instances where terms already are defined in other Recommendations, appropriate references are made to such Recommendations.

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 Recommendations.
- *Teleservice*, as defined in Recommendation I.210 and in the I.240-Series Recommendations, 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 Recommendations.
- *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- or 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 subclause provides concepts and definitions of terms relevant to the general ISDN interworking configuration. Figure 1 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

**Scope of a bearer service and a teleservice in an ISDN interworking situation**

In accordance with Figure 1, the following terms are defined:

**interworking**: Within the scope 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)**: These functions are 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.

# 5 Telecommunication services to be supported by ISDN interworking configurations

This clause 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);

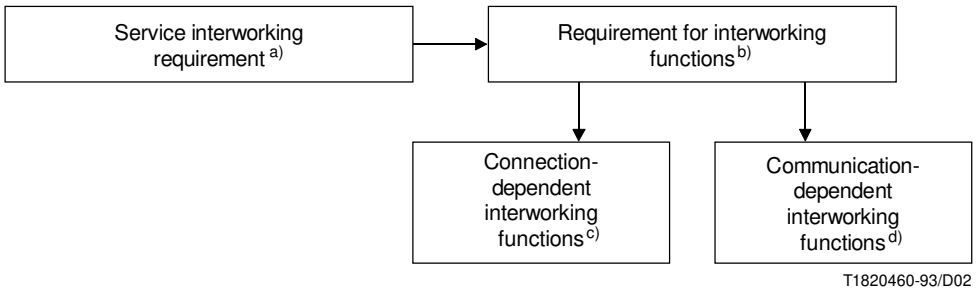
c) services to be offered with the ISDN and through interworking with ISDN.

End-to-end communication may require:

i) interworking at lower layers;

ii) interworking at higher layers;

iii) interworking at both lower and higher layers.




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**

Table 1 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 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 (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 |
| Facsimile | 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

NOTES

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

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

3 It is assumed for Table 1 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, 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 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 4.2.4/I.324.

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, 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).

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/X.300).

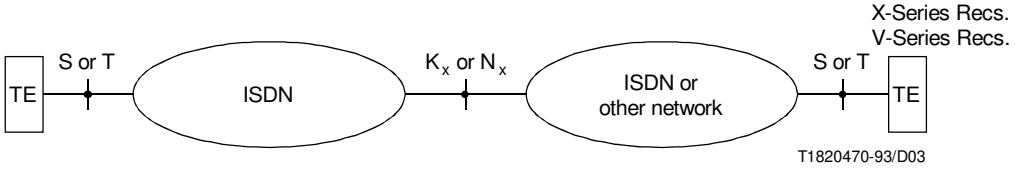



FIGURE 3/I.510

**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).

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.

NOTES

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

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

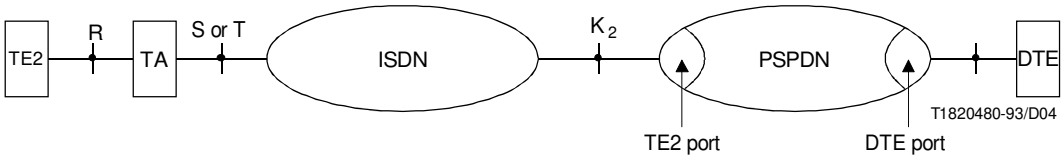



FIGURE 4/I.510

**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 Recommendations, the functionality required for bearer service interworking is contained in ISDN-to-ISDN internetwork interfaces.

Figure 5 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.

### 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);

c) *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).

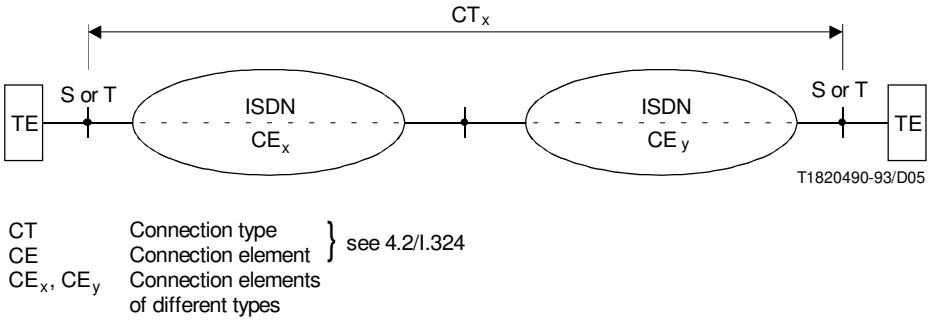



FIGURE 5/I.510

**Reference configuration where ISDN-to-ISDN interworking is required**

## 6.3 Interworking between ISDNs and other networks

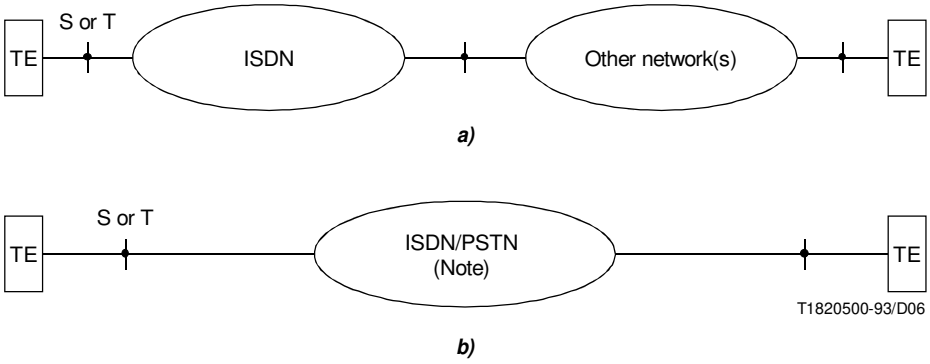
### 6.3.1 Reference configurations

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. 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, while b) of this Figure 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;
   - multi-use.

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.

*Applicable Recommendation: I.555*

a) ISDN frame mode-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

For interworking between ISDNs and private networks refer to Recommendation I.570.

### 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. The services offered at the endpoints may be different.

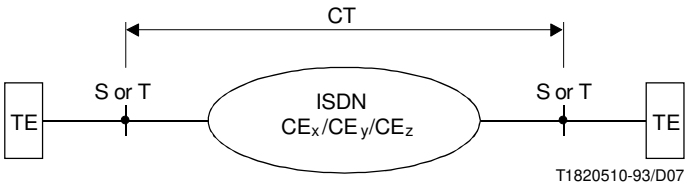
Not all aspects of internal ISDN interworking may be subject to standardization. The existence and functionality of such interworking, however, may have an impact on the required functionality of network interworking or ISDN-to-ISDN interworking.

### 6.5 Network concatenation configurations

NOTE – 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.

#### 6.5.1 Reference configurations

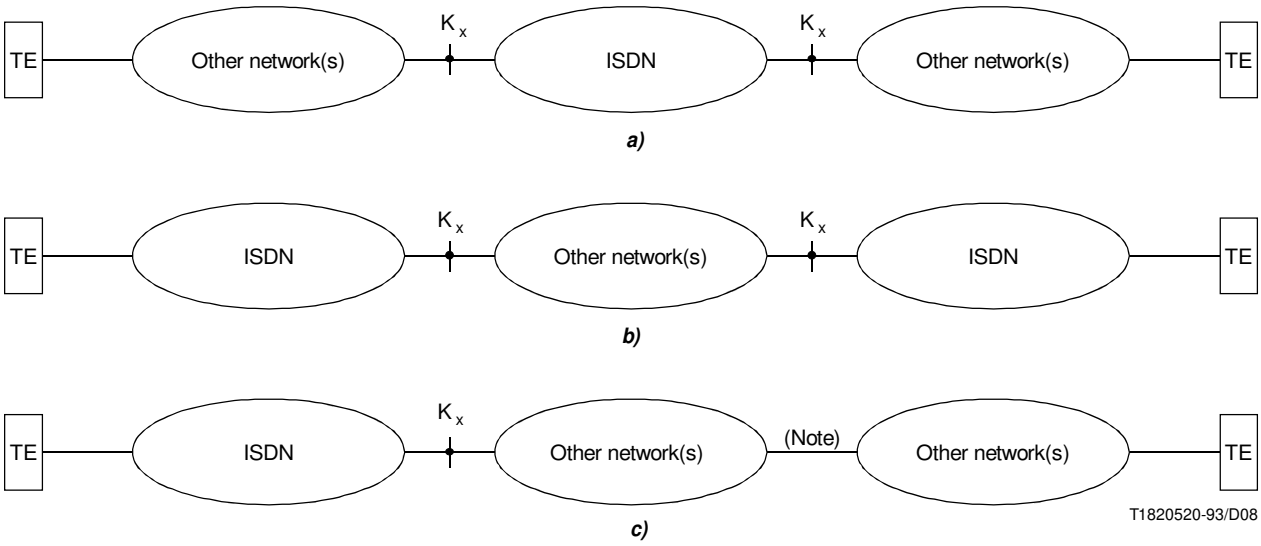
See Figure 8.




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**




NOTE – In the case of cascaded (concatenated) networks other than ISDN networks, a requirement may exist for inter-working functions between pairs of such networks.

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;

c) signals due to network operation and maintenance;

c) 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 functions 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 6/X.300).

## 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).

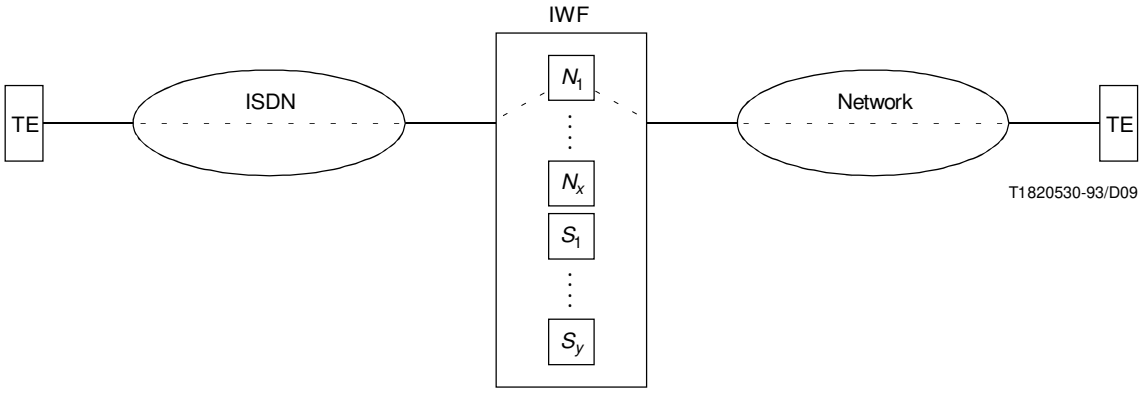
For further study.

### 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).




IWF Interworking functions
$N_1$ ... $N_x$ Connection-dependent interworking functions
$S_1$ ... $S_y$ 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.