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Recommendation I.324

ISDN NETWORK ARCHITECTURE

(Melbourne, 1988)

1 General

1.1 *Basic philosophy*

The objective of this Recommendation is to provide a common understanding of the CCITT studies on the general architecture of an ISDN from the functional point of view. The model is not intended to require or exclude any specific implementation of an ISDN, but only to provide a guide for the specification of ISDN capabilities.

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1.2 *Definitions*

A number of terms used in this Recommendation are described in more detail in other Recommendations. To assist the understanding of the reader, the following particular definitions apply in this Recommendation:

1) **reference configurations** are conceptual configurations which are useful in identifying various possible arrangements in an ISDN. The reference configurations are based on association rules of functional groupings and reference points. Detailed descriptions of reference configurations for ISDN connection types are given in other I-series Recommendations. For user-to-network access they are defined in Recommendation I.411 and for interworking between networks they are defined in the I.500-series of Recommendations.

2) **functional groupings** are sets of functions which may be needed in ISDN arrangements. The relationship between generic functions and specific functions allocated to particular entities (or functional groupings) in the ISDN are explained in Recommendation I.310.

3) **reference points** are the conceptual points at the conjunction of two functional groupings. In a particular example, a reference point may correspond to a physical interface between pieces of equipment, or in other examples there may not be any physical interface corresponding to the reference point. Interfaces will not be defined by CCITT for an ISDN unless the corresponding reference points have been already specified.

2 General architecture of an ISDN

In practical ISDN implementations some of the ISDN functions will be implemented within the same network elements, whereas other specific ISDN functions will be dedicated to specialized network elements. Various different ISDN implementations are likely to be realized depending on national conditions.

A basic component of an ISDN is a network for circuit switching of end-to-end 64 kbit/s connections. In addition to this connection type, depending on national conditions and evolution strategies, the ISDN will or will not support other connection types, such as packet mode connection types and $n \times 64$ kbit/s circuit mode connection types, and other broadband connection types.

2.1 *Basic architectural model*

A basic architectural model of an ISDN is shown in Figure 1/I.324. This shows the seven main switching and signalling functional capabilities of an ISDN:

— ISDN local Connection Related Functions (CRF), see § 4.2.2.1;

— narrow-band (64 kbit/s) circuit switching functional entities;

— narrow-band (64 kbit/s) circuit non-switched functional entities. (The identification and definition for 8, 16, 32 kbit/s or non-switched functional entities is left for further study.);

— packet switching functional entities;

— common channel inter-exchange signalling functional entities, for example conforming to CCITT Signalling System No. 7;

— switched functional entities at rates greater than 64 kbit/s;

— non-switched functional entities at rates greater than 64 kbit/s.

These components need not be provided by distinct networks, but may be combined as appropriate for a particular implementation.

Higher layer functions (HLF) which may be implemented within (or associated with) an ISDN may be accessed by means of any of the above-mentioned functional entities. Those functional entities could be implemented totally within an ISDN or be provided by dedicated networks or specialized service providers. Both cases may provide the same ISDN teleservices (see Recommendation I.210) from the user's point of view.

Figure 1/I.324, (N), p. 1

2.2 *Architectural components of the ISDN*

Recommendation I.310 describes the functions of an ISDN. These functions are by their nature static (i.e., time-independent). The relative distribution and allocation of these functions is the subject of the architecture of the ISDN and is described in this Recommendation. The dynamic aspects of these functions are modelled in Recommendation I.310 as Executive Processes.

Therefore the key components in this architectural model are: what functions are contained in the ISDN, where they are located, and what is the relative topology for their distribution in the ISDN.

3 Aspects of the architecture of the ISDN

The architecture of the ISDN includes low layer capabilities and high layer capabilities. These capabilities support services both within the ISDN and via interworking (see § 5) to other networks.

3.1 *Low layer capabilities*

From the main functional capabilities of the ISDN, as shown in Figure 1/I.324, four main functional capabilities require further description.

3.1.1 *Circuit switching capabilities*

Circuit-switched connections with information transfer rates up to 64 kbit/s are carried by B-channels at the ISDN user-network interfaces and switched at 64 kbit/s by the circuit-switching functional entities of the ISDN. Circuit switching can also be applied to information transfer rates greater than 64 kbit/s.

Signalling associated with circuit switched connections is carried by the D-channel at the ISDN user-network interface and processed by the local CRF (see § 4.2.2.1). User-to-user signalling could be carried through the common channel signalling functional entities (in the transit connection elements).

User bit rates of less than 64 kbit/s are rate adapted to 64 kbit/s, as described in Recommendation I.460, before any switching can take place in the ISDN. Multiple information streams from a given user may be multiplexed together in the same B-channel, but for circuit switching an entire B-channel will be switched to a single user-network interface. This multiplexing should be in accordance with Recommendation I.460. Furthermore, circuit switched data services with bit rates less than 64 kbit/s (in accordance with Recommendation X.1 user classes of service) may be handled by a dedicated circuit switched public data network to which the user gains access by means of an ISDN connection.

The narrow-band ISDN circuit switching capabilities are based on 64 kbit/s switching. Connection types at higher bit rates could also be provided on a semi-permanent basis. Switched connections at these bit rates could also be provided by broadband switching functional entities.

3.1.2 *Packet switching capabilities*

A number of packet mode bearer services are described in the I.230-series of Recommendations. Different network solutions and corresponding architectures may be adopted in different countries to support these services.

Recommendations I.310 (functional principles of ISDN), I.462 (definitions of minimum and maximum integration scenarios) and Q.513 (description of exchange connections) constitute the basis for the description of packet switchng functions in an ISDN.

Two types of functional groupings are involved in the provision of packet switched bearer services by an ISDN:

— packet handling functional groupings , which contain functions relating to the handling of packet calls within the ISDN;

— interworking functional groupings , which ensure interworking between ISDN and packet switched data networks.

The solutions which could be used to access packet bearer services are:

— via the B-channel, with the following cases:

— circuit (switched or semi-permanent) access through ISDN to an interworking function within a PSPDN,

— circuit (switched or semi-permanent) access associated with packet handling functions and/or interworking functions in the ISDN,

— circuit (switched or semi-permanent) access associated with packet handling functions within the ISDN;

— via the D-channel, with the following cases:

— packet handling functions and interworking functions within the ISDN,

— packet handling functions in the ISDN (without interworking functions).

Note — This classification does not preclude a combination of the solutions described above.

Depending on national considerations, the ISDN packet handling and interworking functions can be centralized or distributed. The following cases may be encountered:

— packet handling and interworking functions are not integrated in the local CRF (e.g., they are located in a transit CRF);

— packet handling functions are integrated in the local CRF;

— packet handling functions and/or interworking functions are integrated in the local CRF.

3.1.3 *Other switching capabilities*

For the support of broadband connections, other switching capabilities in addition to the above-mentioned switching capabilities could be employed.

3.1.4 *Transmission capabilities*

In addition to the normal transmission capabilities of the IDN (Integrated digital network) the following transmission aspects are important when considering the architecture of the ISDN. Services which do not require unrestricted digital information transfer capability, such as telephony, may also employ non-transparent channels (e.g., packetized voice, digital speech interpolation). Channels at 8, 16, 32 kbit/s may be used in the transmission part of the network; they may be used to support some services (e.g., voice-band connection types). They may also be used in cases where a B-channel (at the S or T reference point) carries user data streams at bit rates lower than 8, 16, 32 kbit/s respectively.

3.2 *High layer capabilities*

Normally the high layer functions (HLFs) are involved only in the terminal equipment, but for the support of some services, provision of HLFs could be made via special nodes in the ISDN belonging to the public network or to centres operated by other organizations and accessed via ISDN user-network or inter-network interfaces. Some services such as message handling service (MHS) may be used on a large scale and the relevant functional entities could be provided within the ISDN exchanges. For both cases the protocols used to activate such services should be identical and integrated with the general user procedures defined for the activation of ISDN teleservices.

4 Location of functions in the ISDN

4.1 *Overall*

In considering an ISDN call (i.e. an instance of a telecommunication service) two major functional areas are involved:

i) the customer equipment (TE and optional customer network);

ii) the public ISDN connection type.

Recommendation I.411 describes the functional groupings and reference configurations for the customer network, while Recommendation I.412 describes the channel structures to be used at reference points S and T. The partitioning of the functions involved in ii), the public ISDN connection type, is described in § 4.2 below.

Figure 2/I.234 illustrates this overall division of functions involved in a communication across the ISDN.

4.2 *Partitioning of the ISDN connection type*

The distribution of functions within the ISDN connection type is known as the connection type reference configuration described below. The detailed reference configurations for groups of connection types can be found in Recommendation I.325.

Figure 2/I.324, (N), p. 2

4.2.1 *Connection elements*

The first level of partitioning of the ISDN connection type is the connection element change of signalling system and the international transmission system(s). These two points generate three connection elements: access connection element , national transit connection element , and international transit connection element elements allow the description of both the access and transit capabilities to support services. However, in the case of performance allocation, for example, the access connection element and the national transit connection element may be fused into one national connection element. This allows for the variation in the nature of the local plant and regulatory environments in different countries according to national policies.

The partitioning into connection elements is shown in Figure 3/I.234.

Figure 3/I.324, (N), p.

4.2.1.1 *Access connection element*

The access connection element is bounded by the T reference point at the customer end and the reference point which marks the transition from the access signalling system to the common channel signalling system on the network side.

The model for the access connection element in the case of 64 kbit/s circuit switched is shown in Figure 4/I.234. Depending on the national situations and on the type of access, a number of different possibilities are available for this element, in particular with regard to the use of multiplexer (MPX) or remote switching units (RSU).

Figure 4/I.324, (N), p.

4.2.1.2 *National transit connection element*

The national transit connection element is bounded by the transition from access signalling system to common channel signalling systems and the *first* | international switching centre. In the case of a national connection this would default to a ‘‘transit connection element’’, i.e. between two local CRFs, but could involve network elements from more than one network operator.

In some instances, the first international exchange (and the international CRF) may be in close proximity to the local and national transit CRF. This is a national matter.

The model for the national transit connection is shown in Figure 5/I.324.

Figure 5/I.324, (N), p.

4.2.1.3 *International connection element*

The international connection element is bounded by the originating and destination International Switching Centre (ISC). A number of transit international exchanges may be involved to bridge long international connections. With satellite connections, fewer international transits may be required.

Figure 6/I.324 shows an international connection element model. Figure 7/I.324 shows an international connection element model made by a concatenation of several links and exchanges.

Figure 6/I.324, (N), p.

Figure 7/I.324, (N), p.

4.2.1.4 *Future additional connection elements*

Connection elements for interworking and connection to specialized resources and services are also required.

4.2.2 *Basic connection components*

The Basic Connection Components (BCC) allow for the analysis of system performance. There are three forms of BCC: connection related function, access links and transit links. Broadly, CRFs cover switching aspects, and links cover transmission aspects.

4.2.2.1 *Connection related function*

The connection related function includes all aspects involved in establishing and controlling the connections within the particular connection element. This includes functions such as exchange terminations, switching, control, network management, operation and maintenance. The specific capabilities of each CRF are not specified in the general reference model: this is done in the reference configuration for each group of connection types.

4.2.2.2 *Access link*

The access link includes the NT1 and may include a multiplexer, along with the required transmission equipment to link the customer network to the local CRF.

4.2.2.3 *Transit link*

The transit link is a digital link as described in Recommendations G.701 and G.801.

4.2.3 *Functional groupings*

Functional groupings are sets of functions which may be needed in the ISDN. In a particular instance, specific functions in a functional group may or may not be present. Note that specific functions in a functional group may be performed in one or more pieces of equipment. Examples of functional groupings are Line Termination (LT), Exchange Termination (ET), and Packet Handling (PH) function. Further study is required on functional groupings for the public ISDN connection type.

4.2.4 *Reference points*

The other element involved in the description of a reference configuration is the reference point concept. The I-series already identifies reference points S and T (in Recommendation I.411) and K, M, N, P (in the present Recommendation). As can be seen from Figure 4/I.324, some further internal reference points need to be identified. Further study is required to see whether these and any further reference points need to be defined.

In describing the reference configuration for the public ISDN connection types, an important consideration vis-a-vis the reference points is the following. In Figure 3/I.324 the end points of the overall connection is shown as being at the T reference point. The reason for this is as follows. Reference point S is identifical to reference point T when the NT2 function is null (cf Recommendation I.411). When the NT2 function is non-zero, then the performance of the overall connection will be made up of the performance of the ISDN network connection (i.e. between the two interfaces at reference point T) and the sum of the performance of the customer network connections (i.e. between the interfaces at reference points S and T at each end). Recommendation G.801 also uses this approach by defining the areas of the digital hypothetical reference connection (HRX) as being at the T reference point.

5 Architectural relationship between the ISDN and other networks including ISDN

A key element of service integration for an ISDN is the provision of a limited set of standard multi-purpose user-network interfaces.

It is important to note that the introduction of ISDN capabilities into a network requires a massive development effort. Consequently, Administrations will be introducing various ISDN functions successively over a course of time. For example, the 64 kbit/s circuit switched capability may be introduced initially, followed by provision of packet switching features, and so on.

An ISDN will therefore have to interwork with a set of various dedicated networks or terminals in order to:

i) provide ISDN connections to non-ISDN terminal equipments (TE2) through dedicated networks;

ii) provide a non-ISDN terminal equipment (TE2) connected by means of a terminal adaptor (TA) with access to non-ISDN services provided by a dedicated services network;

iii) ensure that an ISDN terminal connected to ISDN interworks with a non-ISDN terminal connected to a dedicated network.

The dedicated networks will offer services (e.g. public data network services) that are either available or not available within an ISDN. Some of the dedicated networks could be integrated into the ISDN in the future, depending on national conditions. Connections have to be allowed between terminals, both connected to an ISDN, or for terminals where one is connected to the ISDN and the other is connected to the dedicated network.

The I.500-series of Recommendations describe the characteristics of interworking.

The I.400-series of Recommendations describe the characteristics of user-network interfaces for the following cases:

1) access of a single ISDN terminal;

2) access of a multiple ISDN terminal installation;

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

4) access of non-ISDN terminal;

5) access of specialized storage and information processing centres.

In addition, considering that the evolution to a comprehensive ISDN will take place over a long period of time, the connection of non-ISDN customers to an ISDN via analogue lines as well as interworking with existing networks or other ISDNs will be necessary. These cases include:

1) access to the existing telephone network and to dedicated networks (e.g. packet network, telex network);

2) access to another ISDN;

3) access to service providers outside the ISDN.

The ISDN user-network interfaces or internetwork interfaces may be used in the above cases. The definition of internetwork interfaces is necessary for these arrangements for interworking and administrative requirements.

Interworking with other networks or other ISDNs requires in some cases the provision of Interworking Functions (IWF), either within the ISDN or in the other network (see Recommendations of the I.500-series). These functions would ensure interworking between different protocols and user procedures.

Within a country or geographical area, an ISDN connection may be formed across several interconnected networks, each of which is characterized by the attributes of one or more ISDN connection types (as defined in Recommendation I.340).

Figure 8/I.324 depicts the ISDN user-network reference points as defined in the I.400-series of Recommendations, as well as reference points at which internetwork interfaces between an ISDN and other networks (including other ISDNs) may exist. Whether internetwork interfaces at all of these reference points will be defined by CCITT Recommendations is for further study.

Figure 8/I.324, (N), p.

Examples of possible interworking situations are given in Figures 9/I.324, 10/I.324 and 11/I.324.

Figure 9/I.324 shows cases where some ISDN services are also provided to subscribers connected to dedicated networks. In these circumstances ISDNs have to interwork with such networks.

Figure 10/I.324 primarily shows cases where a dedicated network is used to carry a given class of ISDN services. As an example, a dedicated packet switched network providing X.25 services to its subscribers could be used to set up ISDN packet connections between two ISDN subscribers. From an ISDN services perspective, this could be viewed as a subset of ISDN.

The dedicated network may be composed of dedicated transmission and switching facilities or be restricted to a set of special nodes linked together via connections, provided through the circuit switched part of the ISDN network, as illustrated in Figure 11/I.324, for the example of a packet switched network.

Figure 9/I.324, (N), p. 9

Figure 10/I.324, (N), p. 10

Figure 11/I.324, (N), p. 11

Recommendation I.325

REFERENCE CONFIGURATIONS FOR ISDN CONNECTION TYPES

(Melbourne, 1988)

1 Summary

In order to apply the network performance parameters to the ISDN, some form of hypothetical reference connections (HRXs) are necessary. These HRXs should be based on appropriate reference configurations for the connection types to which the network performance parameters refer. This Recommendation shows how reference configurations can be developed for the ISDN connection types and what form such reference configurations should take.

2 Introduction

2.1 *Objective*

The general architectural model of the ISDN (see Figure 1/I.325) is given in Recommendation I.324. The detailed network capabilities of the ISDN, as described by connection types in Recommendation I.340, are described topologically by this Recommendation giving reference configurations as appropriate for (an) ISDN connection type(s). These reference configurations do not give details on the number of switching nodes, length of connection, transmission facilities used, etc. However, they do give the details on the reference configuration (or topological configuration) of all matters described by the connection type to which they refer. Therefore they should include details on the signalling, existence of switching functions, channels, etc. Based on these reference configurations, appropriate HRXs should be developed which will be particular to network performance parameters or groups of network performance (NP) parameters. The details on these HRXs will be appropriate for the NP parameters in question.

In order to keep the task of developing reference configurations and the subsequent HRXs, and the allocation of performance values to these HRXs, to manageable proportions, it is necessary to have as limited a set as possible of specific reference configurations. Consequently the ISDN connection types in Recommendation I.340 need to be arranged in different classes which differ significantly from each other such that they require a separate reference configuration model.

Figure 1/I.325, (N), p.

2.2 *Relationship to other I-series Recommendations*

The concept of reference configurations has already been used in a number of areas of standardization of the ISDN. It is therefore necessary to consider the concept of connection type reference configurations in the context of these developments.

2.2.1 *ISDN architecturural model*

It should be noted that defining a set of reference configurations presupposes a particular architectural model of an ISDN (see Figure 2/I.325). The architecturural model for the ISDN is contained in Recommendation I.324. In addition, Recommendation I.310 on the ISDN network functional principles, when considered together with Recommendation I.324, gives the general basis of the architecture of the ISDN from which it is possible to develop reference configurations for ISDN connection types.

Figure 2/I.325, (N), p.

2.2.2 *ISDN user-network interfaces*

The concept of reference configurations was first used in the ISDN work to describe the topological association of functional groupings at the user-to-network interface points. Recommendation I.411 (ISDN user-network interfaces — Reference configurations) is the complete description of these particular reference configurations. The key factors in the definition of reference configurations in Recommendation I.411 are the concepts of functional groupings and reference points.

2.2.3 *Recommendations X.30 and X.31 (I.461 and I.462)*

Recommendations X.30 and X.32 on the adaption of X.21 and X.25 based DTEs to the ISDN also use the concept of reference configurations to explain the topological configuration of functional groupings involved in these kinds of terminals accessing the ISDN.

3 Development of the concept of reference configurations

3.1 *Definitions*

As can be inferred from Recommendation I.411, a **reference configuration** is defined to be ‘‘a conceptual configuration based on association rules of functional groupings and reference points.’’

3.2 *Principles for developing reference configurations for ISDN connection types*

Overall, the concept of the ISDN connection elements, as introduced in Recommendations I.324 and I.340, can be effectively used to demarcate the different sections of the reference configuration. Because of the complicated nature and evolutionary potential of the ISDN, it may not be possible to internationallly specify a detailed end-to-end reference connection (such as Recommendation X.92 for data networks). Consequently a functional approach is adopted to specifying the structure of the ISDN connection types and the associated ISDN reference configurations. In order to keep the number of reference configurations manageable, only a restricted list of connection types and a limited number of models of frequently realized connection topologies are considered.

3.3 *Connection elements*

From the concepts of connection elements introduced in Recommendation I.324 a diagram, as shown in Figure 3/I.325 can be developed which can be considered as the general reference configuration of the ISDN. It is valid for all ISDN connection types. Particular ISDN connections may be local, national transit, international or international transit [i.e. transit switched through intermediate country(ies)]. In each case the appropriate parts of the general reference configuration would be involved.

Recommendation I.324 shows that three types of connection element have been defined (so far):

— access connection element;

— national transit connection element;

— international transit connection element.

Figure 3/I.325, (N), p.

3.4 *Functional groupings*

As stated in the definition in § 3.1 above, in order to define reference configurations, it is necessary to define certain functional groupings and also reference points which are the conceptual points dividing these functional groupings.

In the description of the connection type reference configuration, some of the major functional groupings involved can be considered under the concept of connection related functions (CRF) as described in § 4.2.2.1 of Recommendation I.324. The concept of the CRF includes all the functional groupings involved in establishing and controlling the connections within the particular connection element. In the case of the international transit connection element, two CRFs are shown in Figure 3/I.325 in order to retain the symmetry of the diagram. The specific capabilities of each CRF are not specified in the general reference model, this is done in the reference configuration for each group of connection types. The boundary of the CRF should not be associated with the boundary of an exchange as these may not correspond to each other.

Other functional groupings which are necessary for the complete description of the connection type reference configuration include line termination (LT), digital link, packet handling (PH) function and various functions associated with the signalling network.

3.5 *Reference points*

The other element involved in the description of a reference configuration is the reference point concept. The I-series already identifies reference points S and T (in Recommendation I.411) and K_X, M, N_X and P (in Recommendation I.324). As can be seen from Figure 3/I.325, some further internal reference points need to be identified. Further study is required to see whether these and any further reference points need to be defined.

In describing the reference configuration for the ISDN connection types, an important consideration vis-a-vis the reference points is the following. In Figure 3/I.325, and the following diagrams, the end points of the overall connection is shown as being at the T reference point. The reason for this is as follows. Reference point S is identical to reference point T when the NT2 function is null (cf Recommendation I.411). When the NT2 function is non-zero, then the performance of the overall connection will be made up of the performance of the ISDN network connection (i.e. between the two interfaces at reference point T) and the sum of the performance of the customer network connections (i.e. between the interfaces at reference points S and T at each end). Recommendation G.801 also uses this approach by defining the ends of the digital HRX as being at the T reference point.

4 Specific reference configurations

This general reference model needs now to be associated with specific connection types in order to develop specific reference configurations. However, Recommendation I.340 allows for so many variations in its different attributes, leading to a very large number of potential connection types, that is necessary to consider only certain dominant attributes in order to produce a shorter list of reference configurations. For an initial analysis, only the first two of the four dominant attributes listed in Recommendation I.340 need to be considered. Therefore the ‘‘information transfer mode’’ and ‘‘information transfer rate’’ will lead to three general classes of ISDN connection types, viz:

— circuit:

— 64 kbit/s,

— greater than 64 kbit/s (broadband);

— packet.

The other two dominant attributes (‘‘information transfer’’ and ‘‘establishment of connection’’) do not require separate reference configurations but will manifest themselves by different performance values.

This limited set of connection types is subsequently modelled in the associated reference configurations taking into account a limited number of frequently realized connection topologies.

4.1 *64 kbit/s class*

This class includes connection types A1 to A12 of Table 2/I.340, i.e. unrestricted digital, speech and 3.1 kHz audio information transfer susceptances and switched semi-permanent and permanent establishments.

The variation of the information transfer capability is determined by the network performance parameter values allocated to each portion of the connection. For example, use of digital speech interpolation in the international connection element would restrict the connection type to speech or 3.1 kHz audio. Likewise, the differences between permanent connection types and switched connection types would manifest themselves in differences in the value of parameters such as connection establishment time, etc.

This approach means that there is a small number of reference configurations, but that all of the different connection types listed in Recommendation I.340 would need to be tabulated for the allocation of performance values.

Figure 4/I.325 shows the reference configuration that is proposed for this class of ISDN connection types.

Figure 4/I.325, (N), p.

4.2 *Packet class*

Recommendation X.31 illustrates the scenarios involved in providing packet switched capability in the ISDN. These are in fact reference configurations for the access connection element. The possible reference configurations for the B-channel access packet mode connection type class are shown in Figures 5/I.325 and 6/I.325.

It should be noted that the Recommendations in the X.130-series also use the concepts of national and international portions of the connection for the purposes of the allocation of the division of network performance parameter values. In those cases the boundary between the national and the international portions is in the middle of the International Data Switching Exchange (IDSE) [or International Switching Centre (ISC)]. Further study is required to see if this approach should be taken in the ISDN.

Figure 5/I.325, (N), p. 16

Figure 6/I.325, (N), p. 17

4.3 *Broadband class*

Further study is required to determine what the salient features of this class of ISDN connection types are. According to Recommendation I.340 it would include permanent and semi-permanent connections at 384, 1536 or 1920 kbit/s.

Recommendation I.326

REFERENCE CONFIGURATION FOR RELATIVE NETWORK RESOURCE | REQUIREMENTS

(Melbourne, 1988)

1 General

The purpose of this Recommendation is to evaluate the relative network resource requirements associated with the provision of ISDN telecommunication services to subscribers as they are defined in the I.200-series.

The evaluation of relative network resource requirements and the definition of reference configuration is the first step in cost evaluation for ISDN services. Such cost evaluation is not covered in this Recommendation.

2 Relative resource requirements

2.1 *Relation with service provision*

For each service requested by a user the network has to provide network resources. These network resources involve switching, signalling and transmission capabilities. The selection of the appropriate network resource is part of the routing function.

The combination of permissible network resources is described by the logical concept of ISDN connection types. The list of agreed ISDN connection types can be found in Recommendation I.340.

The network resources described by an ISDN connection type are given in Figure 1/I.326.

The network resource has an overall scope and may imply several subnetworks, each having to provide an appropriate part of the overall network resource.

H.T. [T1.326]

Network resource	— Switching capability — Transmission capability — Signalling capability

{
FIGURE 1/I.326
Network resource components
}	

Figure 1/I.326, (comme tableau), [T1.326], p.

2.2 *Information transfer on network resource usage*

Information on ISDN network resources utilized and on resources utilized of any interworked networks needs to be gathered for charging or for accounting purposes and conveyed to possibly several points within the network(s). Much of this information is likely to be derived from data carried on the signalling network (e.g. information associated with set-up, clear-down, and/or change of status of connections). It may be passed in batch-mode between Administrations or may be conveyed in real-time.

3 Reference configuration for charging

3.1 *Development*

Recommendation I.340 and other relevant Recommendations (I.310, I.324, I.325) are considered as the starting point for the development of the reference configuration for relative cost evaluation.

ISDN resources would be represented by network functions, as for example:

— transmission functions (local, transit) using different techniques (digital, analogue, speech interpolation, etc.);

— switching functions (local, transit) for circuit-mode, packet-mode;

— interworking functions;

— high layer functions.

3.2 *Situations*

Reference configurations should include a description of the various situations encountered in international interconnections. This description should include the originating country, boundary, destination country, interworking unit location, international transit.

3.3 *Reference configuration for circuit-mode*

The reference configuration for circuit-mode ISDN connection types is made of three connection elements:

— access connection element;

— national transit connection element;

— international transit connection element.

The minimum relative resource requirements for international transit connection elements are described in Table 1/I.326.

H.T. [T2.326]
TABLE 1/I.326

Service request Possible resources for an international transit connection element } Relative resource requirement | ud) }	{ {	
1) 64 kbit/s unrestricted	64 kbit/s	1
2) Speech 64 kbit/s, DSI/LRE gain 5:1 | ua) A/µ, echo control | ub) }	{ As low as 0.2	
3) 3.1 kHz audio 64 kbit/s, LRE gain 2:1 | uc) A/µ, echo control | ub) }	{ As low as 0.5	

[a] State-of-the-art voice processing technology is capable of achieving a circuit gain of up to 5:1 on speech calls by using a combination of digital speech interpolation (DSI) and low rate encoding (LRE) at 32 kbit/s. Even higher gains are conceivable in the future with advances in LRE technology.

[b] The need for echo control in end-to-end ISDN connections is under study.

[c] ISDN services when used to support voice-band data via modems cannot benefit from DSI gains.

[d] The values mentioned in the third column represent relative resource requirements (i.e. traffic allowed in terms of bit rate or bandwidth) and should not be interpreted as cost evaluation.

Tableau 1/I.326, [T2.326], p.

3.4 *Reference configuration for packet-mode*

For further study.

3.5 *Reference configuration for high layer functions (HLF)*

For further study.

3.6 *Reference configuration for additional low layer functions (ALLF)*

For further study.

3.7 *Reference configuration for public land mobile telecommunication services*

Reference configuration for public land mobile telecommunication systems can be found in Recommendation D.93.

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SECTION 3

NUMBERING, ADDRESSING AND ROUTING

Recommendation I.330

ISDN NUMBERING AND ADDRESSING PRINCIPLES

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

1 Introduction

1.1 This Recommendation provides the general concepts, principles, and requirements for addressing reference points located at subscriber premises, for addressing other functions, and for allowing communications with terminals.

1.2 Recommendation I.331 (E.164) describes the numbering plan for the ISDN era. Closely related information is contained in Recommendation I.332 on numbering principles for interworking between ISDNs and dedicated networks with different numbering plans. Recommendation I.333 on terminal selection and Recommendation I.334 on principles relating ISDN numbersB/Fsubaddresses to the OSI reference model network layer addresses represent additional sources of information having direct application to Recommendation I.330.

1.3 The following understanding of relevant nomenclature is established:

a) an ISDN number is one which relates to an ISDN network and ISDN numbering plan;

b) an ISDN address comprises the ISDN number and the mandatory andB/For optional additional addressing information;

c) private communications facilities are communication capabilities confined to use by one or more particular subscribers, as opposed to facilities which are shared by subscribers of public networks. Examples of private communications facilities include local area networks (LANs), PABXs, and other private network arrangements.

1.4 Depending on the different cases and stages identifiable within an addressing process, an ISDN number may be (see Figure 10/I.330):

a) an international ISDN number;

b) a national ISDN number;

c) an ISDN subscriber number.

An ISDN address comprises:

i) the ISDN number;

ii) mandatory andB/For optional additional addressing information.

1.5 As an objective, all ISDNs should evolve towards a single numbering plan, namely the ISDN numbering plan. Considering the wide penetration of the telephone network in the world and existing telephone network resources, the ISDN numbering plan has been developed by building from Recommendation E.163. Therefore, it is recommended that the telephone country code (TCC) be used to identify a particular country.

1.6 An existing numbering plan may interwork and thus co-exist with the ISDN numbering plan. A framework for interworking between an ISDN and existing numbering plans is given in Recommendation I.332. Recommendations E.166 and X.122 provide information describing selected interworking situations which have been considered by appropriate Study Groups. Preference should be given to single stage selection methods whenever possible.

1.6.1 It is recognized that some of the present data networks, for instance, could retain the X.121 numbering structure and interwork with ISDNs. A critical element of such interworking is numbering plan identification. Two approaches have been recommended:

1) the escape code method, now recognized within the format structures of Recommendations E.164 and X.121;

2) the NPI (Numbering Plan Identifier) method which applies distinct protocol provisions to distinguish numbering plan identity from address content.

Method 1) is intended for near-term applications while method 2) may be applied to both near-term and long-term interworking, with a view to general use of method 2) after year-end 1996.

1.6.2 It should be understood that call routing at each switching system is guided by reference to a destination numbering plan which is identified by either method 1) or method 2), not both. Method 1) interprets numbers in terms of the numbering plan incorporated into the basic operation of the switching system, unless incoming circuit class logic or an escape code explicitly overrides that interpretation, substituting a different numbering plan. Under method 2) an explicit numbering plan identifier is presented on each call.

1.6.3 When transmission of the calling party's number is appropriate, the numbering plan of the calling party is established in a comparable manner. For a given direction of transmission, either method 1) is used for both called and calling numbers or method 2) is applied in both cases.

1.6.4 After a switching system selects an outgoing route, the logical needs of the next switching system must be considered. Interworking between numbering plans may occur. The method used to inform the subsequent switch about applicable numbering plans may need to be adjusted, but numbering content should not be altered. Preference should be given to method 2) when it is practicable to introduce it since method 1) places constraints on maximum number length in some circumstances.

2 Principles for relating an ISDN number to ISDN user-network reference configurations

2.1 An ISDN number shall be able unambiguously to identify (a) particular:

a) physical interface at reference point T (see Figure 1/I.330);

b) virtual interface at reference point T; i.e., for an NT2 + NT1 configuration (see Figure 2/I.330);

c) multiple interfaces (physical or virtual) at reference point T (see Figure 3/I.330);

d) for point-to-point configurations, physical interface at reference point S (see Figure 4/I.330);

Country or geographical area.

e) for point-to-point configurations, virtual interface at reference point S (see Figure 5/I.330);

f) for point-to-point configurations, multiple interfaces (physical or virtual) at reference point S (see Figure 6/I.330);

g) for multi-point configurations (e.g. passive bus), all of the interfaces at reference point S (see Figure 7/I.330).

As a result, from the viewpoint of the network side of the interface, an ISDN number is associated with one (or a multiple of) D-channels used to signal to the user.

2.2 A particular interface, or multiple of interfaces, may be assigned more than one ISDN number. An example is shown in Figure 8/I.330.

2.3 All ISDNs shall be able to assign an ISDN number to an interface at reference point T or S. However, a particular ISDN number fulfills only one of the functions identified in § 2.1.

2.4 For mobile services an ISDN number shall be capable of unambiguously identifying an interface in the mobile subscriber's premises, as defined in § 2.1 (see Figure 9/I.330).

2.5 The ISDN number is not required to identify a particular connection where, on a particular interface, more than one connection may be present at a given instant.

2.6 The ISDN number is not required to identify directly a particular channel, where, within a particular interface, there may be more than one channel. Indirect identification of particular channels may occur: e.g. when the ISDN number identifies a particular interface and there is a one-to-one correspondence between that interface and particular channels.

3 Relationships between ISDN number, transit network/RPOA selection (when permitted), service indication, and quality of service indication

The establishment of an ISDN connection will require an ISDN address. In addition separate non-address related information may be necessary for completing a connection.

3.1 Routing of ISDN connections shall take into account the following information, when supplied by the user:

a) ISDN numbers, including destination network identification and digits for direct dialling-in (DDI) where applicable;

b) service identification, possibly including requested quality of service parameters such as transit delay, throughput, and security;

c) multiple transit RPOA/network selection, when permitted by the originating ISDN.

Note — The need for remote transit RPOA/network selection by the user of an ISDN which has no local transit RPOA/network selection is for further study.

In addition, transit RPOA/network selections by the originating ISDN, if provided, shall also be evaluated in the routing of a connection.

In national networks on a particular connection, the user may choose to specify some or all of this information, at either subscription time or connection-establishment time.

The ISDN number does not identify the particular nature of the service, type of connection, or quality of service to be used, nor does it identify a transit RPOA/network.

3.2 In the case where an ISDN number identifies a mobile TE or a TE served by several interfaces or networks, an ISDN may need to map from the ISDN number on to a specific interface designation.

Figure 1/I.330, (MC), p. 20

Figure 2/I.330, (MC), p. 21

Figure 3/I.330, (MC), p. 22

Figure 4/I.330, (MC), p. 23

Figure 5/I.330, (MC), p. 24

Figure 6/I.330, (MC), p. 25

Figure 7/I.330, (MC), p. 26

Figure 8/I.330, (MC), p. 27

Figure 9/I.330, (MC), p. 28

Country or geographical area.

4 ISDN number design considerations

4.1 Numbering plan design information is covered by Recommendation I.331 (E.164).

4.2 The ISDN number shall include an unambiguous identification of a particular country

The ISDN number is allowed to include an unambiguous identification of a particular geographic area within a country

4.3 As an objective, all ISDNs should evolve towards a single numbering plan. However, an existing numbering plan may interwork and thus coexist with the ISDN numbering plan.

4.4 When a number of public or private ISDNs exist in a country , it shall not be mandatory to integrate the numbering plans of the ISDNs. Methods for interworking are for further study, with the objective that connections between the TEs on these various networks can be completed by using only the ISDN address. See also Recommendatin I.332.

4.5 The ISDN number shall be capable of containing an identification of the ISDN to which the called user is attached. For a private network which spans more than one country , the international ISDN number will cause delivery of a call to the particular private network in the country specified by the country code.

4.6 The ISDN number shall be capable of providing for interworking of TEs on ISDNs with ‘‘TEs’’ on other networks. As an objective, with respect to the ISDN number, the procedure for interworking should be the same for all cases. The single-stage method of interworking is the preferred approach.

5 Structure of the ISDN address

5.1 The structure of the ISDN address is illustrated in Figure 10/I.330. A function marking the end of the ISDN number shall always be provided if a subaddress is present. The end of number function may also be provided even if no subaddress is present. When there is no subaddress present, the end of number and end of address functions are coincident, when used.

Figure 10/I.330, (M), p.

5.2 The ISDN address may be of variable length.

5.3 *International ISDN number*

5.3.1 The structure of the international number and the maximum number length are as defined in Recommendation I.331 (E.164).

5.3.2 In a particular international ISDN number, the exact number of digits shall be governed by national and international requirements.

5.3.3 The ISDN numbering plan shall provide substantial spare capacity to accommodate future requirements.

5.3.4 The ISDN number shall be a sequence of decimal digits.

5.3.5 The ISDN number shall include the capability for direct dialling inward where this facility is offered.

5.4 *ISDN subaddress*

5.4.1 The subaddress is a sequence of digits, the maximum length of which shall be 20 octets (40 digits).

5.4.2 All ISDNs shall be capable of conveying the ISDN subaddress transparently and shall not be required to examine or operate on any of the subaddress information.

5.4.3 Special attention is drawn to the fact that subaddressing is not to be considered as part of the numbering plan, but constitutes an intrinsic part of ISDN addressing capabilities. The subaddress shall be conveyed in a transparent way as a separate entity from both ISDN number and user-to-user information. See also Recommendation I.334.

6 Representation of ISDN address

6.1 At the person-machine interface, the objective is to establish one method of distinguishing between abbreviated and complete representations of an ISDN number. This method is for further study. Internationally recommended methods will be chosen.

6.2 The method of distinguishing between an ISDN number and a number from another numbering plan shall be by separate identification of the applicable numbering plan. If such methods are required, internationally recommended procedures will be chosen.

Recommendation I.331

NUMBERING PLAN FOR THE ISDN AREA

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

See Recommendation E.164, Volume II, Fascicle II.2.

Recommendation I.332

NUMBERING PRINCIPLES FOR INTERWORKING BETWEEN ISDNs AND DEDICATED NETWORKS WITH DIFFERENT NUMBERING PLANS

(Melbourne, 1988)

1 Introduction

Different public networks currently make use of different numbering plans. Single-stage interworking between ISDNs and dedicated networks as recommended in Recommendation I.330 requires adoption of solutions which make it possible to convey the addressing needs from one network to another.

This Recommendation represents a framework by which progress on numbering plan interworking within the various CCITT Study Groups may be coordinated. Detailed recommendations for numbering plan interworking are contained in Recommendations E.166 and X.122.

The ISDN international number exceeds the addressing capability of present dedicated public networks. Therefore, these networks may not be able to reach subscribers' terminals connected to an ISDN if these terminals make use of the 15 digits allowed in ISDN.

In order to support numbering plan interworking between ISDNs and present dedicated networks, procedures have to be identified which offer single-stage interworking solutions for the near term, while recognizing that other solutions supporting the 15 digits capability of the ISDN number will have to be supported in the future.

One of the major objectives of introducing the concept of Time *T* | (given in Recommendation E.165), is to provide a target date by which the long-term numbering plan interworking solutions will be in place.

2 Principles for Time T

ISDNs are expected to interwork with dedicated networks. However, due to the different addressing capabilities between the ISDN and existing numbering plans some temporary constraints need to be imposed on the number length and digit analysis required to access the user network interfaces of the ISDNs, before Time *T* .

2.1 *Numbering constraints before Time T*

2.1.1 *ISDNs interworking with dedicated networks*

To allow numbering plan interworking with dedicated networks before Time *T*, an ISDN will not assign international E.164 (I.331) numbers longer than 12 digits to its user network interfaces capable of receiving calls from dedicated networks.

2.1.2 *ISDNs which do not interwork with dedicated networks*

These ISDNs are allowed to assign numbers to user network interfaces according to the full capability of the numbering plan for the ISDN era.

2.2 *Evolution after Time T*

After Time *T* , ISDNs and PSTNs can make use of the full capability of E.164 numbers to identify their user network interfaces and terminals respectively.

2.3 *Evolution up to Time T*

Between now and Time *T* , any new network or user equipment, in ISDNs, or networks intending to interwork with ISDNs, should be installed with the identified relevant post-*T* capability(ies).

3 Single-stage interworking between ISDNs and dedicated networks

3.1 Numbering plan interworking procedures for short-term and for long-term will be required between:

i) ISDN (E.164) to/from PSPDN (X.121)

ii) ISDN (E.164) to/from CSPDN (X.121)

Note — Requirements for Telex (F.69) are inc luded in Recommendation U.202.

As defined in Recommendation I.451 (Q.931).

3.2 The recommended long-term numbering plan interworking solution is based on the NPI/TON field in the ISDN call set-up message. The NPI elements is the numbering plan identifier (e.g. Recommendations E.164/E.163, X.121, F.69), whereas the TON indicates the type of number (e.g. local, national, international). This NPI/TON field will be carried as part of the call set-up message to the originating exchange, which will use this information to route the call. The NPI element will also be available within the network as part of the Initial Address Message in Recommendation Q.763.

An equivalent NPI/TON feature in Recommendations X.25/X.75 will also be available to support long-term numbering plan interworking between ISDNs and PSPDNs, employing X.31 procedures.

3.3 The short-term, single-stage interworking arrangements will use prefixes and escape codes to indicate the type of number and the numbering plan of the destination network, respectively. Definitions of prefixes and escape codes are provided in Annex A. As indicated in Annex A, prefixes are not part of the number and are not signalled over internetwork or international boundaries to that they are not subject to international standards. Escape codes however, may be carried forward through the originating network and across internetwork and international boundaries Therefore, the values of escape codes need to be standardized.

Note — The details on short-term interworking using escape codes are included in Recommendations E.166 and X.122.

3.4 Table 1/I.332 illustrates numbering considerations for single-stage interworking using the example of interworking between an ISDN and PDN.

3.5 *Principles for consistent interworking*

When considering Table 1/I.332, the following points should be taken into account:

1) It should be noted that X.25 procedures (containing E.164 numbers) may be used on ISDN subscriber-to-ISDN subscriber calls where no PDN is used. The choice of method for X.25/X.75 should allow this application.

2) During the interim period (pre-*T*), ISDN interfaces not interworking with any existing dedicated networks may be assigned E.164 numbers up to 15 digits in length. (Other ISDN subscribers would be assigned E.164 numbers according to Table 1/I.332).

3) The treatment of various addresses during call interworking, as outlined in Table 1/I.332, should apply to all kinds of addresses, e.g. calling party, redirecting, etc.

H.T. [T1.332]

TABLE 1/I.332

Accommodation of numbers during ISDN/PDN interworking

Call type	Man machine selection	User-network interface	Gatenay between networks
ISDN to PDN *Interim* Recs. E.166 and X.122 or long-term solution *By time T* Numbering plan = Rec. X.121 Number = DNIC (DCC + NN) + NTN Type of number: international (DNIC present), national (DNIC omitted), or network specific } *Interim* Recs. E.166 and X.122 or long-term solution *By time T* Numbering plan = Rec. X.121 Number = DNIC (DCC + NN) + NTN Type of number: international (DNIC present), national (DNIC omitted), or network specific }	Terminal specific {	{	
PDN to ISDN e.g Recs. X.25/X.31, X.21/X.30 } PAD/DTE implementation specific for support of user-network interface } *Interim* Modified X-Series to support Rec. I.330 principles Numbering plan = Rec. E.164 (CC + NDC + SN) 12 digits *By time T* Modified Recs. X.25 and I.451 to support long-term interworking solution Numbering plan = Rec. E.164 (CC + NDC + SN) 15 digits } *Interim* Modified X-Series to support Rec. I.330 principles Numbering plan = Rec. E.164 (CC + NDC + SN) 12 digits *By time T* Modified Recs. X.25, X.75 and Q.763 to support long-term interworking solution Numbering plan = Rec. E.164 (CC + NDC + SN) 15 digits }	e.g. Request for PAD e.g Recs. X.75, X.71 { { {	{	
CC	Country code	NDC	National destination code

SN Data network identification code }	Subscriber number	DNIC	{
DCC NTN	Data country code Network terminal number	NN	National number

Note 1 — Numbering plan interworking between ISDNs and between ISDN and PSTN is not required since a common numbering plan is used.

Note 2 — Other solutions at particular interfaces may *also* be supported by some networks. Such solutions should not conflict with the use of the indicated method. The method indicated should be supported by all networks.

Tableau 1/I.332 [T1.332], p.

4 Requirements by Time T

4.1 By Time *T* | the numbering plan identifier and type of number (NPI/TON) capability should be exploited for calls within the ISDN and between ISDN and a dedicated network (e.g. PSPDN in the following cases:

i) NPI/TON must be used across internetwork and international boundaries where Signalling System No. 7 ISUP is used;

ii) the NPI/TON equivalent feature in the X.25 packet layer must be used when interworking from ISDN to a PSPDN employing X.31 procedures. (Reference Table 1/I.332)

4.2 Where ISDN is provided such that there is a mixture of PSTN and ISDN customers and traffic on a local exchange, the manner in which NPI/TON is used in the network is at the discretion of the Administration, taking due account of prevailing commercial, technical and regulatory considerations. Although Time *T* is not directly relevant to this decision, networks not fully exploiting the NPI/TON capability after *T* shall place no burden on those that do.

4.3 In those parts of a PSTN where inter-exchange signalling is other than Signalling System No. 7 ISUP, prefixes/escape digits may have to continue to be used.

ANNEX A

(to Recommendation I.332)

Prefixes and escape codes for numbering plan interworking

A.1. *Prefix*

The prefix is an indicator consisting of one or more digits, allowing the selection of different types of address formats (e.g. local, national, or international address formats), transit network and/or service selection. Prefixes are not part of the number and are not signalled over internetwork or international boundaries.

Note — When prefixes are used, they are always entered by the user or automatic calling equipment.

A.2 *Escape code*

An escape code is an indicator consisting of one or more digits. The indicator is defined in a given numbering plan, and is used to indicate that the following digits are a number from a different numbering plan. Escape codes are currently established within the X.121 and E.164 numbering plans.

An escape code may be carried forward through the originating network and can be carried across internetwork and international boundaries. Therefore, the digits for escape codes should be standardized.

Note — There may be cases when a standardized escape code may be numerically equal to a prefix already in use in the network. In this case a different digit (special prefix) other than the standardized escape code may be used, and the translation from the ‘‘special prefix’’ to the standardized escape code is performed by the network.

Introduction of NPI may take place prior to Time *T* , provided that no burden is placed on networks not supporting the NPI when interworking unless bilaterally agreed.