5i'

MONTAGE: FIN DE LA RECOMMANDATION I.515 EN-T | TE DE CETTE PAGE

GENERAL ARRANGEMENTS FOR NETWORK INTERWORKING

BETWEEN ISDNs

(Melbourne, 1988)

1 Introduction

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

2 Scope

The purposes of this Recommendation are:

1) to identify the general arrangements for ISDN-ISDN interworking, and

2) to define the functions and other requirements for the ISDN-ISDN interface.

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

Recommendation I.520

3 Required information and information handling

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

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

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

iii) information is transferred through the IWF transparently;

iv) information is newly generated at the IWF.

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

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

Figure 1/I.520, p.

H.T. [T1.520]

TABLE 1/I.520

Information required for IWF between ISDNs for circuit mode bearer services

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

Note 1 — For charging use.

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

Note 3 — These indicators are used to identify:

1) international incoming call,

2) available end-to-end signalling system,

3) charged call/noncharged call.

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

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

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

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

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

Tableau 1/I.520 [T1.520], p. 2

H.T. [T2.520]
TABLE 2/I.520
Information required for IWF between ISDNs for circuit mode supplementary services

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

Tableau 2/I.520 [T2.520], p. 3

H.T. [T3.520]
TABLE 3/I.520
Information required for IWF between ISDNs for packet mode bearer services (in-band signalling)

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

Note — The relationship between X.25 facilities and ISDN supplementary services is for further study.
Tableau 3/I.520 [T3.520], p. 4

4 Description of ISDN-ISDN interworking configurations

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

See Figure 2/I.520.

Figure 2/I.520, p.

4.1.1 *Bearer services*

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

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

4.1.2 *Supplementary services*

4.1.2.1 *Other than user-to-user signalling*

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

4.1.2.2 *User-to-user signalling services*

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

4.1.3 *Signalling System No. 7 for the control of circuit mode services at the N*

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

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

See Figure 3/I.520.

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

Figure 3/I.520, p.

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

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

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

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

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

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

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

Figure 4a/I.520, p.

Figure 4b/I.520, p.

4.4 *ISDN-ISDN interworking via a transit network*

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

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

Figure 5/I.520, p.

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

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

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

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

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

This section is for further study.

5 Interworking functions

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

5.1 *Echo control processing and speech processing*

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

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

H.T. [T4.520]

TABLE 4/I.520

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

Speech processing functions	Bearer service 1	2	3	4	
Echo control | uc) { A-μ law conversion | uf) }	E | ud) | ue)	E | ud) | ue)	FD	e)	FD
	E	E	FD	E	FD
DSI	O	O | ug)	FD	O	FD
LRE	O	O | ug)	FD	O	FD
DCM	O	O | ug)	FD | uh)	O | ui)	FD | ui)
Analog facilities	O	O | ug)	P	P	P

E Essential

O Optional

P Prohibited

FD Functionally disabled

DSI Digital speech interpolation

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

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

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

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

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

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

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

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

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

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

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

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

Table 4/I.520 [T4.520], p.

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

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

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

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

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

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

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

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

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

5.2.1 *Unsuccessful call delivery*

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

5.2.2 *Successful call delivery*

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

5.3 *Call negotiation between ISDNs*

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

5.3.1 *Service agreement between ISDNs*

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

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

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

2) The call may be cleared.

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

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

5.3.2 *Connection agreement between ISDNs*

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

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

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

5.4 *Compatibility checking between end users of different ISDNs*

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

Compatibility checking items between end users are as follows:

1) *Low layer compatibility*

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

2) *High layer compatibility*

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

3) *User defined compatibility checking*

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

6 Functional interworking requirements for data transmission services

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

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

7 References

See Recommendation I.500.

APPENDIX I

(to Recommendation I.520)

ISDN connections involving

restricted 64 kbit/s transfer capability

I.1 *General*

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

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

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

Figure I-1/I.520, p.

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

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

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

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

Blanc

Tableau I-1/I.520, p. 12 (a traiter comme figure MEP)

Figure I-2/I.520, p. 13

Recommendation I.530

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

(Melbourne, 1988)

1 General

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

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

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

2 Scope

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

3 Abbreviations

DP Dial Pulse

DTE Data Terminal Equipment

DTMF Dual-tone Multiple Frequency

IDN Integrated Digital Network

ISDN Integrated Services Digital Network

ISUP ISDN User Part

LE Local Exchange

NT Network Termination

PABX Private Automatic Branch Exchange

PSTN Public Switched Telephone Network

SS No. 7 Signalling System No. 7

TE Terminal Equipment

TA Terminal Adaptor

TUP Telephone User Part.

4 Interworking configuration and network characteristics

4.1 *Interworking configurations*

See Figure 1/I.530.

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

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

4.2.1 *Location of interworking functions*

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

Figure 1/I.530, p.

Points where interworking may exist are:

— within the local exchange;

— at transit exchange;

— at international gateway offices.

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

5 ISDN bearer services suitable for ISDN-PSTN interworking

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

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

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

i) circuit mode 64 kbit/s, 8 kHz structured bearer services, usable for speech information transfer (Note 1);

ii) circuit-mode 64 kbit/s, 8 kHz structured bearer services, usable for 3.1 kHz audio information transfer (Note 2);

iii) circuit-mode 64 kbit/s unrestricted, 8 kHz structured bearer service (Note 3).

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

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

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

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

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

H.T. [T1.530]

TABLE 1/I.530

Key ISDN and PSTN characteristics

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

Interworking functions:

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

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

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

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

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

f — Further study required.

Table 1/I.530 [T1.530], p.

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

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

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

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

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

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

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

Note — Detailed mechanisms are for further study.

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

(For further study.)

6 Connection type suitable for ISDN-PSTN interworking

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

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

7 Functional requirements for ISDN-PSTN interworking

7.1 *Interworking between signalling systems*

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

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

7.2 *Provision of interworking indications*

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

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

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

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

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

H.T. [T2.530]

TABLE 2/I.530

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

Interworking	{	64 kbit/s unrestricted	Speech	3.1 kHz audio	Packet
ISDN to PSTN (circuit)	64 kbit/s unrestricted	Y	N	N	N
	Speech	R	Y	Y	N
	3.1 kHz audio	R	FS	Y	N
PSTN to ISDN (circuit)	64 kbit/s unrestricted	Y	N	N	N
	3.1 kHz audio	R	N	Y	N

Table 2/I.530 [T2.530], p.

The following interworking scenarios have been recognized:

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

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

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

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

7.2.1 *Network indication of modification of communication characteristics*

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

— interworking with another network;

— resource constraints in the network.

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

— downgrading of service;

— upgrading of service.

For most interworking cases, user acceptance is not applicable.

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

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

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

7.2.2 *Failure indication*

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

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

7.3 *Generation of in-band tones and announcements*

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

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

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

Furthermore, two call scenarios exist:

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

b) the call is delivered successfully.

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

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

7.3.1.1 *Unsuccessful call delivery*

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

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

— If the out-band message can be sent all the way through to the gateway exchange, then the gateway exchange should pass the information to the PSTN using the PSTN's normal procedures (i.e. out-band if the PSTN supports the out-band message, otherwise in-band).

— If the message cannot be sent out-band all the way to the gateway exchange, then the appropriate in-band tone or announcement should be provided by the ISDN at the point where out-band signalling is no longer capable of handling the message.

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

7.3.1.2 *Successful call delivery*

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

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

7.3.2.1 *Unsuccessful call delivery*

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

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

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

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

7.3.2.2 *Successful call delivery*

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

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

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

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

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

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

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

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

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

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

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

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

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

7.5 *Control of speech processing and echo control devices*

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

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

Similar Recommendations should apply to the ISDN/PSTN interworking case. In particular, both echo suppressors and echo cancellers must be located within a range limitation of the four-wire/two-wire interface. These limits are mentioned in Recommendations G.131, § 2.2, G.164, § 1.1.3 and G.165, § 3.2. If echo control devices are included in the ISDN connection, they will need to be disabled using the 2.1 kHz echo control disabling tone generated by the modem

as is current practice in the PSTN. While echo suppressors should respond to a 2100 Hz tone (Recommendation G.164), echo cancellers should only respond if the tone includes phase reversals as specified in Recommendation G.165. It is recommended that the 2.1 kHz tone should not be converted into an ISDN signalling message and vice-versa.

7.6 *A/μ law encoding*

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

8 References

See Recommendation I.500.

Recommendation I.540

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

FOR THE PROVISION OF DATA TRANSMISSION

(Melbourne, 1988)

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

Recommendation I.550

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

FOR THE PROVISION OF DATA TRANSMISSION

(Melbourne, 1988)

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

Recommendation I.560

REQUIREMENTS TO BE MET IN PROVIDING THE TELEX SERVICE

WITHIN THE ISDN

(Melbourne, 1988)

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

Blanc