INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

I.515

(11/1988)

SERIES I: INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

Internetwork interfaces

Parameter exchange for ISDN interworking

Reedition of CCITT Recommendation I.515 published in the Blue Book, Fascicle III.9 (1989)

NOTES

1 CCITT Recommendation I.515 was published in Fascicle III.9 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

Recommendation I.515

PARAMETER EXCHANGE FOR ISDN INTERWORKING

(Melbourne, 1988)

1 General

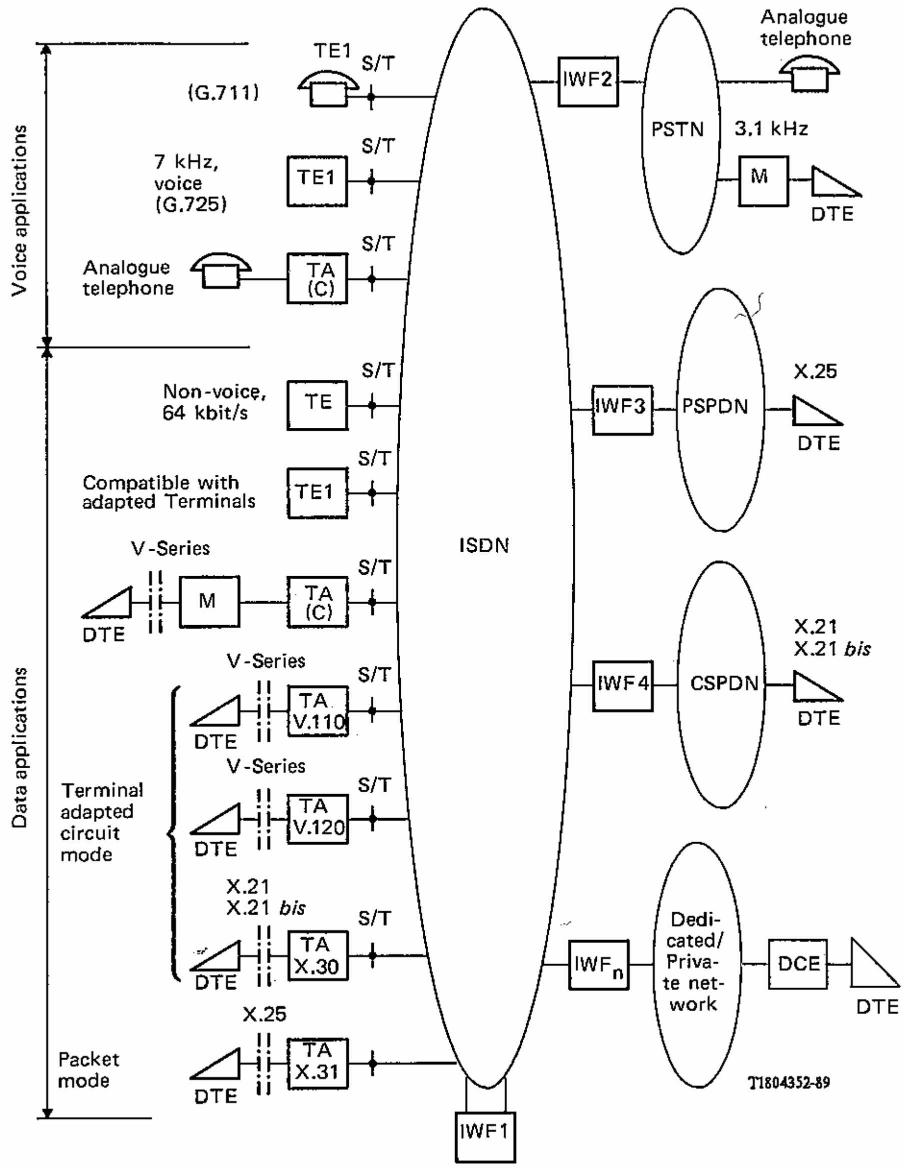
1.1 *Scope*

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

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

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

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



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

M Modem

TA(C) Terminal adaptator with codec

Note 1 – IWFs may be located:

a) within the network(s),

b) separate to the network(s),

c) within the customer's premises.

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

Note 3 – This figure is not exhaustive.

FIGURE 1/I.515

1.2 *Definitions and abbreviations*

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

– **bearer capability information**

  Specific information defining the lower layer characteristics of the network.

– **low layer compatibility information**

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

– **high layer compatibility information**

  Information defining the higher layer characteristics of a terminal.

– **protocol identifier**

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

– **progress indicator**

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

– **out-band parameter exchange**

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

– **in-band parameter exchange**

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

2 Principles

2.1 *Types of parameter exchanges*

Three types of parameter exchange need to be considered:

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

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

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

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

2.2 *Relationship of parameter exchange to call establishment*

Parameter exchange may occur:

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

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

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

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

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

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

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

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

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

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

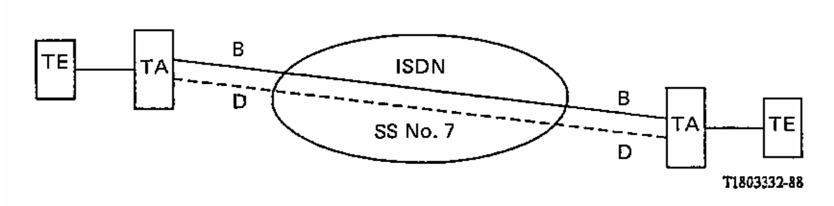
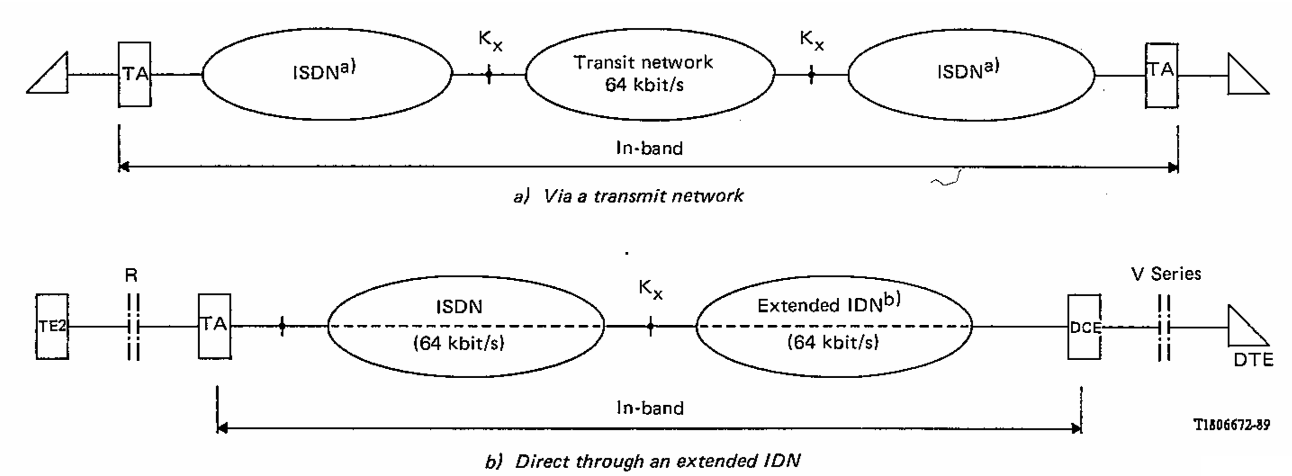


FIGURE 2/I.515

Out-band parameter exchange via D-channel



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

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

FIGURE 3/I.515

In-band parameter exchange

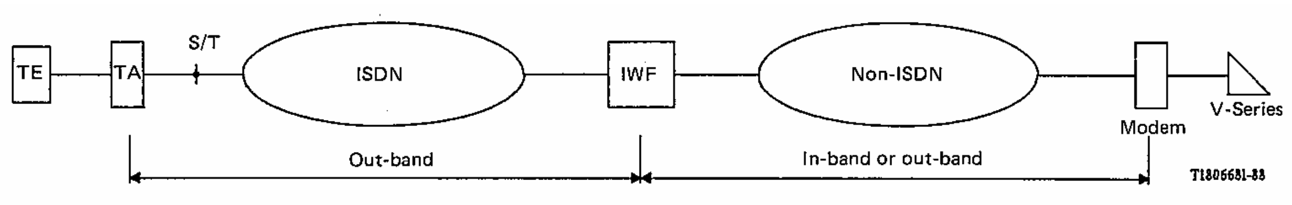


FIGURE 4/I.515

Parameter exchange to select IWFs

2.2.1.1 *Call negotiation types*

Three types of call negotiation are currently envisaged:

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

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

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

2.2.1.2 *Information elements available for call negotiation*

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

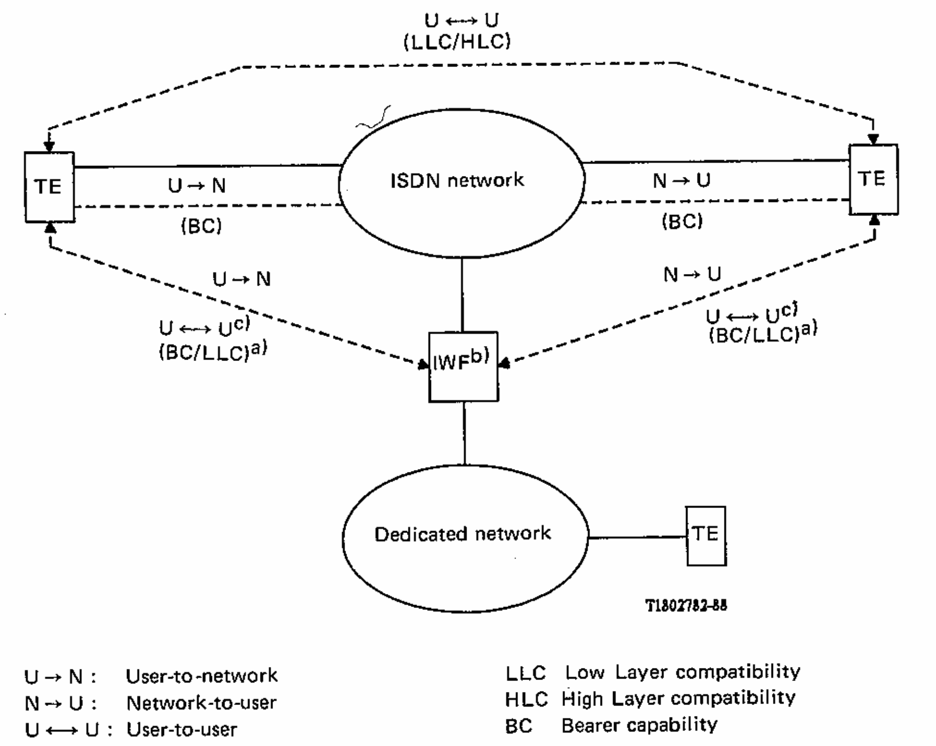
- bearer capability (BC);
- low layer compatibility (LLC);
- high layer compatibility (HLC).

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

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

2.2.1.3 *Transfer of information*

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



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

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

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

FIGURE 5/I.515

Transfer of information associed with call negotiation

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

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

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

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

2.2.3 *Parameter exchange during information transfer phase*

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

3 Parameter exchange procedures

3.1 *Out-band parameter exchange*

3.1.1 *Prior to call establishment*

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

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

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

3.1.3 *During information transfer phase*

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

3.2 *In-band parameter exchange*

3.2.1 *After call establishment and prior to information transfer*

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

– call establishment phase (e.g. refer to Recs. Q.931 and Q.764);

– originating terminal changes from idle condition to busy condition;

– connection enters paramters exchange phase;

– connection enters information transfer phase.

3.2.1.1 *Voice services*

Refers to Recommendation G.725.

3.2.1.2 *Parameter exchange mechanism for terminal adaption protocol identification*

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

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

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

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

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

3.2.2 *During the information transfer phase*

For further study.

4 Parameter exchange functions

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

4.1 *Numbering parameters*

– subscriber number;

– sub-address;

– terminal selection (see Recommendation I.333).

4.2 *Protocol control parameters*

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

4.3 *DTE/DCE configuration parameters*

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

– modem type (e.g., V-Series number)

– data rate (e.g., 9.6 kbit/s, 56 kbit/s)

– synchronization (e.g., synchronous or asynchronous)

– parity (odd, even or no parity)

– transmission mode (e.g., half or full duplex)

– number of start/stop bits (e.g., 1 or 2)

– terminal clock source (e.g., network provided, network independent)

– terminal interface signals (e.g., 106, 108)

– sub-channel information.

4.4 *Operations and maintenance parameters*

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

– terminal power (ON or OFF)

– terminal presence (connected or disconnected)

– terminal interface signals status (e.g., 106, 108)

– terminal clock source (e.g., network provided, network independent)

– loopback status (e.g., ON or OFF)

5 Parameter exchange for selection of IWF

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

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

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

5.1 *Single stage*

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

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

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

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

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

5.2 *Two stages*

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

6 Reference

See Recommendation I.500.

APPENDIX I

(to Recommendation I.515)

Protocol for identification of terminal adaption protocols

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

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

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

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

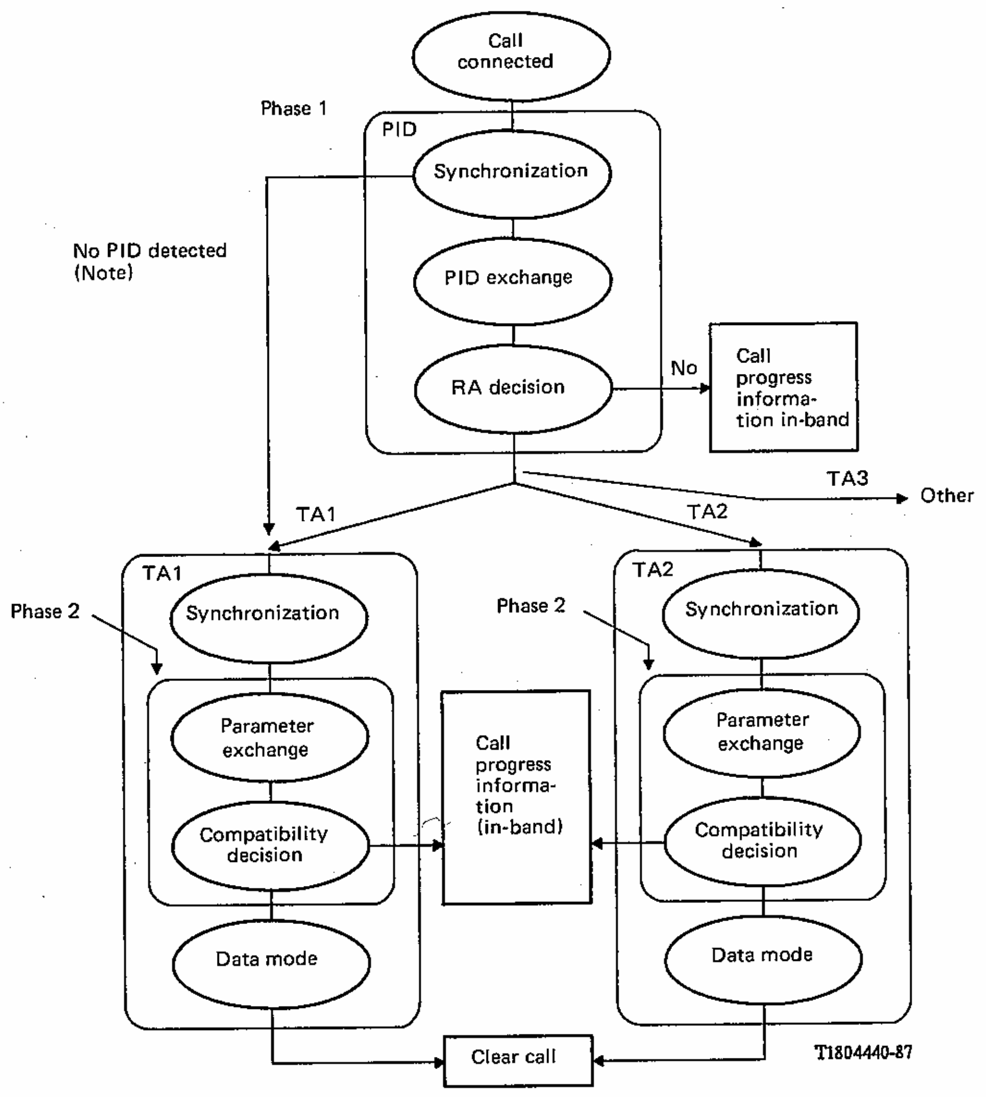
1) Phase 1 – PID: after call establishment PID phase begins.

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

– The IPE allows parameters to be exchanged between TA devices to ensure end-to-end compatibility before entering the data (information) phase.

– In the case of a successful IPE the protocol enters the data (information) phase.

– In the case of unresolvable differences between the TA devices, the IPE will provide a call progress message that can be used to take further action or clear the call.



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

FIGURE I-1/I.515

IPE flow diagram

I.2 *Identification procedure*

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

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

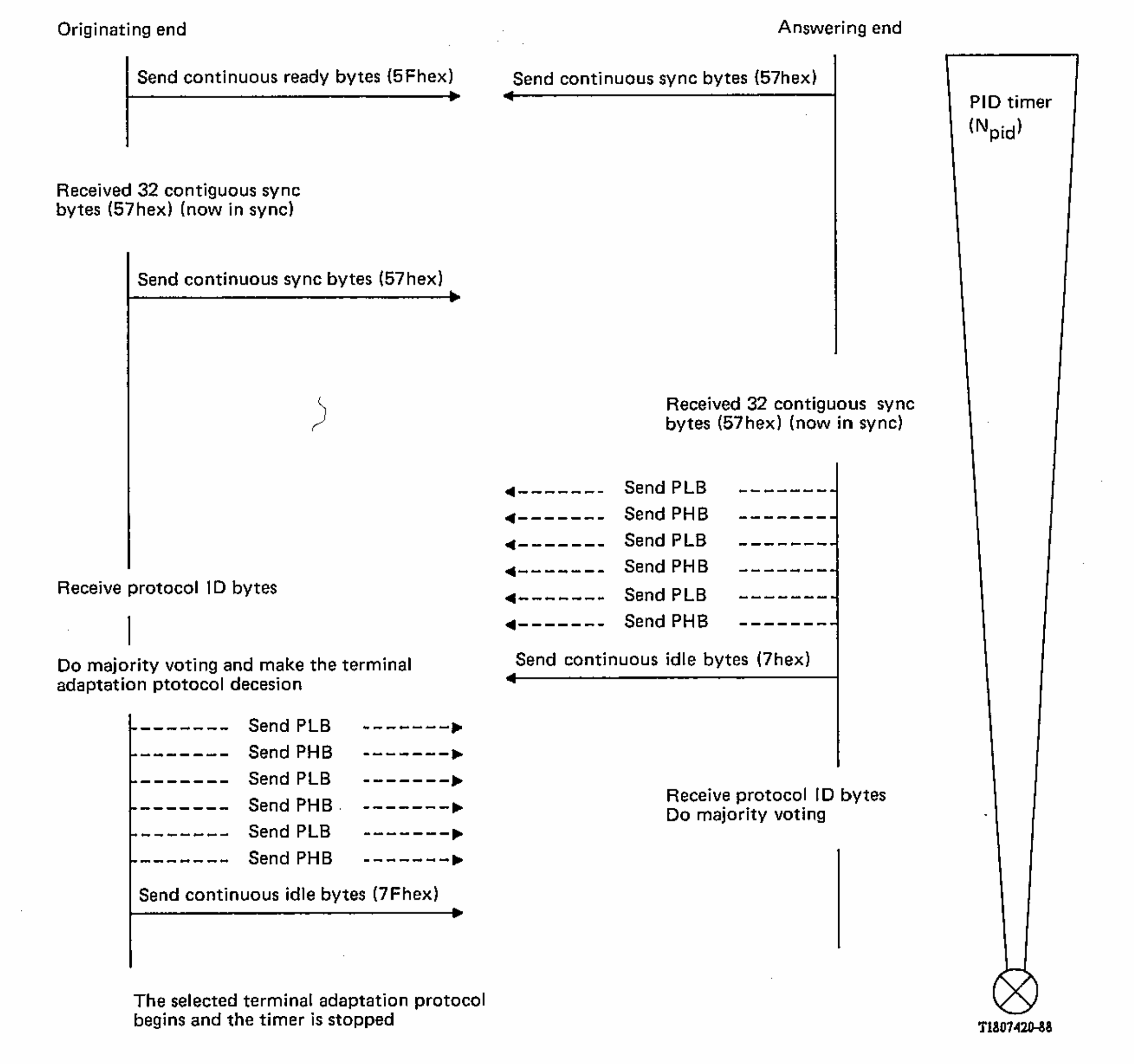
1) end-to-end synchronization;

2) passing the Protocol Identifier (PI);

3) making a decision regarding the type of TA to use for the call.

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

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



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

FIGURE I-2/I.515

Time sequence diagram of a successful protocol identification procedure

I.3 *End-to-end synchronization*

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

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

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

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

The synchronization method described in this section allows for:

1) settling of the physical circuit;

2) notice in the network;

3) positive identification of the fact that TA devices are present at both ends;

4) transmission on restricted 64 kbit/s links and through networks that use bit 8 for signalling; and

5) simple implementation.

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

Note 1 — B1 is transmitted and received first.

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

FIGURE I-3/I.515

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

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

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

The PI passing technique described in this section:

1) provides positive identification of the protocol bytes (low and high byte codes);

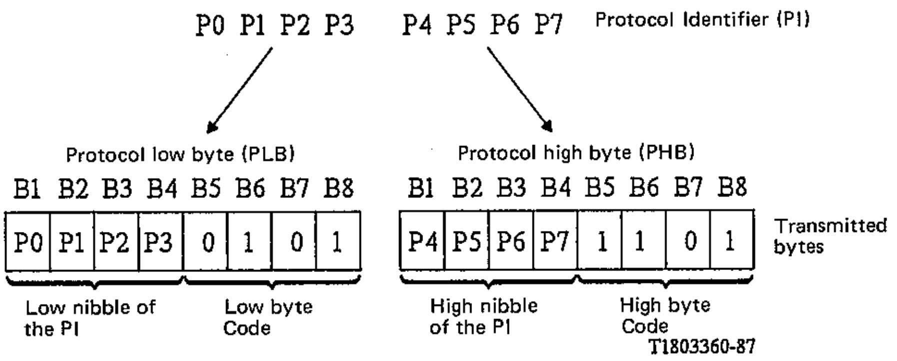
2) provides redundant pairs of byte codes which allows for a technique to determine the protocol identification in the presence of noise (i.e. repeated three times);

3) allows all eight bits of the PI to be used even on networks that use bit 8 for signalling; and

4) allows for operation on restricted 64 kbit/s networks and networks that use bit 8 for signalling (i.e. guarantees one's density, bit 8 set to 1).

I.5 *TA decision*

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



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

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

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

FIGURE I-4/I.515

Protocol identifier

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

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

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

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

FIGURE I-5/I.515

PI interpretation

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

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

Note 1 – B1 is transmitted and received first.

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

FIGURE I-6/I.515

Idle byte

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

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

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

FIGURE I-7/I.515

Null PI byte

The method described in this section:

a) supports various CCITT recognized forms of TA schemes;

b) allows for future TA schemes;

c) limits the proliferation of TA schemes;

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

e) provides a positive indication of a failed call.

APPENDIX II

(to Recommendation I.515)

TA protocol self identification

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

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

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

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

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

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

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

APPENDIX III

(to Recommendation I.515)

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

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

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

There are two general categories of modem selection techniques:

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

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

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

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

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

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

III.1.1.2 *Negotiation*

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

III.1.1.3 *Registration*

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

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

III.1.2.1 *Default identification*

Any DTE uses the same default modem characteristics.

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

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

III.2 *ISDN bearer capabilities for interworking*

III.2.1 *3.1 kHz ISDN bearer capability*

See Figure III-1/I.515.

In the scenario the following cases are considered:

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

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

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

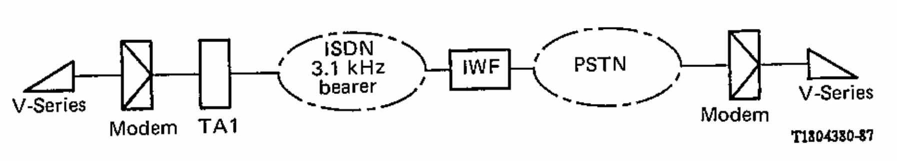


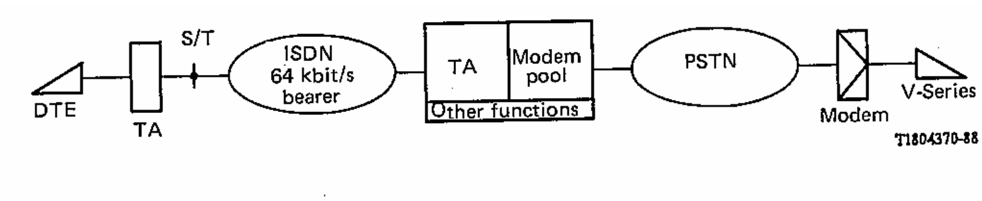
FIGURE III-1/I.515

IWF as defined for PSTN/3.1 kHz audio interworking

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

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

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



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

FIGURE III-2/I.515

ISDN-PSTN interworking for circuit switched calls

III.3 *Options for modem selection*

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

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

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

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

– data terminals on the ISDN have separate SNs;

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

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

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

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

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

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

III.3.1.2.1 *PSTN-to-ISDN call*

The terminating ISDN exchange recognizes that:

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

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

III.3.1.2.2 *ISDN-to-PSTN call*

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

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

III.3.2 *ISDN-to-PSTN calls*

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

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

III.3.3 *PSTN-to-ISDN calls*

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

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

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

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

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

– circuit data terminals on ISDN loops have separate SNs;

– PSTN terminals have suitable signalling capabilities to indicate the modem speed/type in response to a request from the terminating exchange;

– the ISDN exchange can distinguish whether an incoming call is from the PSTN or the ISDN (using call progress indicator); and

– the ISDN exchange maintains a data base on service profiles of terminals served by the exchange (analog *vs* digital, and speech *vs* data in case of digital subscribers).

The user must be aware of any special operational requirements.

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

– the call is coming from the PSTN; and

– the call is intended for a digital data terminal on the ISDN.

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

ITU-T I-SERIES RECOMMENDATIONS

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

GENERAL STRUCTURE	
Terminology	I.110–I.119
Description of ISDNs	I.120–I.129
General modelling methods	I.130–I.139
Telecommunication network and service attributes	I.140–I.149
General description of asynchronous transfer mode	I.150–I.199
SERVICE CAPABILITIES	
Scope	I.200–I.209
General aspects of services in ISDN	I.210–I.219
Common aspects of services in the ISDN	I.220–I.229
Bearer services supported by an ISDN	I.230–I.239
Teleservices supported by an ISDN	I.240–I.249
Supplementary services in ISDN	I.250–I.299
OVERALL NETWORK ASPECTS AND FUNCTIONS	
Network functional principles	I.310–I.319
Reference models	I.320–I.329
Numbering, addressing and routing	I.330–I.339
Connection types	I.340–I.349
Performance objectives	I.350–I.359
Protocol layer requirements	I.360–I.369
General network requirements and functions	I.370–I.399
ISDN USER-NETWORK INTERFACES	
Application of I-Lettres Recommendations to ISDN user-network interfaces	I.420–I.429
Layer 1 Recommendations	I.430–I.439
Layer 2 Recommendations	I.440–I.449
Layer 3 Recommendations	I.450–I.459
Multiplexing, rate adaption and support of existing interfaces	I.460–I.469
Aspects of ISDN affecting terminal requirements	I.470–I.499
INTERNETWORK INTERFACES	**I.500–I.599**
MAINTENANCE PRINCIPLES	I.600–I.699
B-ISDN EQUIPMENT ASPECTS	
ATM equipment	I.730–I.739
Transport functions	I.740–I.749
Management of ATM equipment	I.750–I.799

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATIONS SERIES

Series A	Organization of the work of the ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	**Integrated services digital network**
Series J	Transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	Global information infrastructure and Internet protocol aspects
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2007