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Broadband Integrated Services Digital Network (B-ISDN); General principles and functional requirements for interworking B-ISDN and Narrowband-ISDN (N-ISDN)

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Foreword

This ETSI Technical Report (ETR) has been produced by the Network Aspects (NA) Technical Committee of the European Telecommunications Standards Institute (ETSI).

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1 Scope

The scope of this ETSI Technical Report (ETR) is to define general principles and functional requirements for interworking between Broadband Integrated Services Digital Network (B-ISDN) and Narrowband-ISDN for the provision of bearer services. Particular emphasis is put on the possible interworking scenarios characterizing the coexistence of B-ISDN and N-ISDN.

Teleservices and supplementary services to be provided through B-ISDN/N-ISDN interworking are out of the scope of this ETR.

Specific interworking issues at protocol level are discussed in ETR 263 [18].

2 Normative References

This ETR incorporates by dated and undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1]   CCITT Recommendation E.166: "Numbering plan interworking for E.164 and X.121 numbering plans".

[2]   CCITT Recommendation I.327: "B-ISDN network functional architecture".

[3]   CCITT Recommendation I.340: "ISDN connection types".

[4]   CCITT Recommendation I.411: "ISDN user-network interface".

[5]   CCITT Recommendation I. 413: "B-ISDN user-network interface".

[6]   CCITT Recommendation I.510: "Definition and general principles for ISDN interworking".

[7]   ITU-T Recommendation I.580: "General arrangement for interworking between B-ISDN and 64 kbit/s based ISDN".

[8]   CCITT Recommendation X.300: "General principle for interworking between public networks and between public networks and other networks for the provision of data transmission services".

[9]   ITU-T Recommendation I.363: "B-ISDN ATM Adaptation Layer (AAL) specification".

[10]   ITU-T Recommendation I.365.1: "Frame Relay Service Specific Convergence Sublayer (FR-SSCS)".

[11]   ITU-T Recommendation Q.922: "ISDN Data Link Layer specification for Frame Mode Bearer Service".

[12]   ITU-T Recommendation Q.2100: "B-ISDN Signalling ATM Adaptation layer (SAAL) overview description".

[13]   ITU-T Recommendation Q.2110: "B-ISDN Signalling ATM Adaptation Layer (AAL) Service Specific Connection Oriented Protocol (SCCOP)".

[14]   ITU-T Recommendation Q.2130: "Service Specific Coordination Function (SSCF) for the support of signalling at the UNI".

[15]   ITU-T Recommendation Q.2140: "Service Specific Coordination Function (SSCF) for the support of signalling at the NNI".

[16]   ETR 316: "Broadband Integrated Services Digital Network (B-ISDN); Numbering and addressing in B-ISDN".

[17]   ETS 300 467: "Broadband Integrated Services Digital Network (B-ISDN); Support of Frame Relay Bearer Service (FRBS) in B-ISDN and frame relay interworking between B-ISDN and other networks".

[18]   ETR 263: "Broadband Integrated Services Digital Network (B-ISDN); Specific interworking functionalities with B-ISDN".

[19]   ITU-T Recommendation Q.933: "Digital Subscriber Signalling System No.1 (DSS1) - Signalling specification for frame mode basic call control".

[20]   ITU-T Recommendation I.233.1: "ISDN Frame relaying bearer service".

[21]   ITU-T Recommendation Q.921: "ISDN user-network interface - Data link layer specification".

[22]   ITU-T Recommendation Q.931: "ISDN user-network interface layer 3 specification for basic call control".

[23]   ITU-T Recommendation Q.2931: "Digital Subscriber Signalling System No. 2 - User-Network Interface (UNI) layer 3 specification for basic call/connection control".

3   Definitions, Symbols and abbreviations

3.1   Definitions

For the purposes of this ETR, the following definitions apply:

concatenation: Is an interworking configuration where two remote homogeneous networks are interconnected via a third different network. The third network is usually called transit network.

heterogeneous networks: Are networks implementing different protocols and providing different sets of services.

homogeneous networks: Are networks implementing the same protocols and providing the same set of services.

interconnection: Is an interworking configuration where two heterogeneous networks are directly interconnected.

InterWorking Functions (IWFs): As defined in CCITT Recommendation I.510 [6].

interworking: As defined in CCITT Recommendation I.510 [6].

InterWorking Unit (IWU): Is a network element supporting IWFs.

3.2   Abbreviations

For the purposes of this ETR, the following abbreviations apply:

|	
ATM	Asynchronous Transfer Mode
BCOBS-C	Broadband Connection-Oriented Bearer Service Class C
B-ISDN	Broadband ISDN
FRSF	Frame Relay Service Function
FR SVC	Frame Relay Switched Virtual Connection
FR PVC	Frame Relay Permanent Virtual Connection
IWFs	Interworking Functions
IWU	Interworking Unit
LAPD	Link Access Procedure on the D-channel

LE	Local Exchange
N-ISDN	Narrowband ISDN - 64kbit/s based ISDN
PVC	Relay Permanent Virtual Connection
QoS	Quality of Service
SAAL	Signalling ATM Adaptation Layer
SSCF	Service Specific Coordination Function
SSCOP	Service Specific Connection Oriented Protocol
TN	Transit Node
TE	Terminal Equipment

4　Interworking scenarios

The process of introduction and deployment of B-ISDN spans a considerable period of time and follows different ways according to specific national planning strategies. Although an analysis of the national planning strategies is out of the scope of this ETR, it is important to identify some possible interworking scenarios that can characterize the coexistence of B-ISDN and N-ISDN.

Bearing in mind that B-ISDN can be regarded as an "evolution" of N-ISDN, some appropriate arrangements should be developed to guarantee an adequate interworking level between B-ISDN and N-ISDN. In this context an adequate interworking level means that B-ISDN supports, directly or indirectly, the N-ISDN existing bearer services allowing broadband and narrowband users to communicate.

Figure 1 shows possible B-ISDN/N-ISDN interworking scenarios without taking into account the case where only broadband or only narrowband capabilities are available end-to-end.
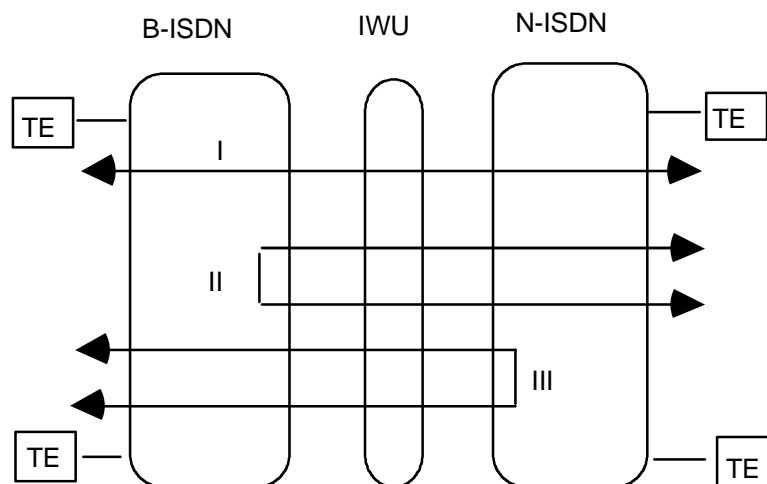
Figure 1: Interworking scenario B-ISDN/N-ISDN

Scenario I represents an interconnection scenario between B-ISDN and N-ISDN. In this case the service capabilities provided through the user access points are limited to the narrowband services. The user interfaces are those currently provided by B-ISDN and N-ISDN.

Scenario II represents a concatenation scenario of N-ISDNs via B-ISDN. In this case the interfaces and the service capabilities provided through the user access points are the same that are currently provided by N-ISDN.

Scenario III represents a concatenation scenario of B-ISDNs via N-ISDN. In this case the service capabilities provided through the user access points are limited to the narrowband services. The user interfaces are those currently provided by B-ISDN.

For the above mentioned scenarios, interworking aspects related to the numbering plans are discussed in ETR 316 [16] and in CCITT Recommendation E.166 [1].

4.1 Indirect and direct provision scenarios for N-ISDN bearer services

B-ISDN can satisfy the requirement to support the N-ISDN bearer services in two ways:

- **indirectly**: the capabilities necessary to handle the N-ISDN bearer services are located outside B-ISDN. B-ISDN only provides a transparent ATM connection either permanent, semi-permanent or on demand between network elements outside B-ISDN able to support the narrowband capabilities; or

- **directly**: the capabilities necessary to handle the N-ISDN bearer services are located inside B-ISDN. B-ISDN should support not only broadband capabilities but also narrowband capabilities allowing the establishment of ATM connections able to support the N-ISDN bearer services (in the following such connections will be named ISDN connections based on ATM).
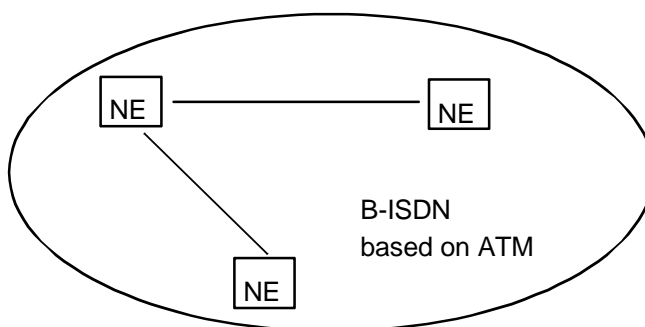
Figure 2 depicts the two cases above mentioned.
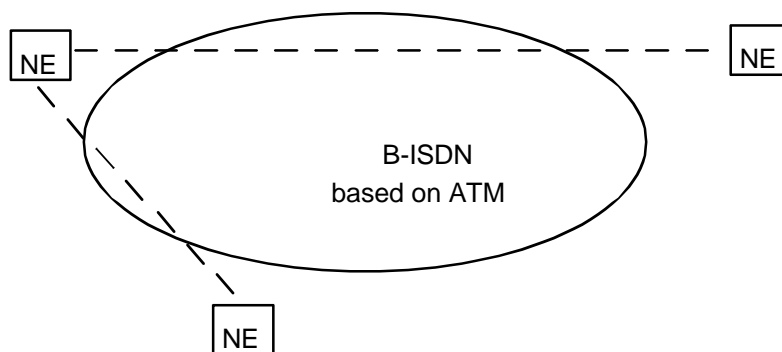
NE = Network Element able to support N-ISDN capabilities

— — = ATM transparent connection

Figure 2a: Indirect provision scenario

NE = Network Element able to support N-ISDN capabilities

——— = ISDN connection based on ATM

Figure 2b: Direct provision scenario

Figure 2: Provisioning of N-ISDN services

The indirect provision scenario may take place in an interim period characterized by the absence of signalling broadband capabilities or by the presence of signalling broadband capabilities which do not integrate all the N-ISDN services. In particular in many countries the initial development of B-ISDN will be based on the deployment of ATM cross connects unable to provide on demand services.

Only in a second phase, with the availability of ATM switches, B-ISDN will be able to provide on demand services and interwork at the level of control plane with N-ISDN. The direct provision scenario may then operate in a second phase characterized by the availability of broadband signalling capabilities supporting N-ISDN services.

5 Interworking configurations

With reference to the various interworking scenarios identified in clause 4 the respective interworking configurations are briefly discussed. In addition, annex A shows possible configurations to connect N-ISDN and B-ISDN terminals to B-ISDN. The presence of N-ISDN terminals connected to B-ISDN impacts on the possible interworking scenarios.

5.1 B-ISDN to N-ISDN interconnection

The interworking configuration of B-ISDN to N-ISDN interconnection is shown in figure 3. B-ISDN and N-ISDN users can communicate each others limiting their communications to those supported by the N-ISDN bearer services. The interworking functions to be performed at the boundary between B-ISDN and N-ISDN are provided by the IWU.
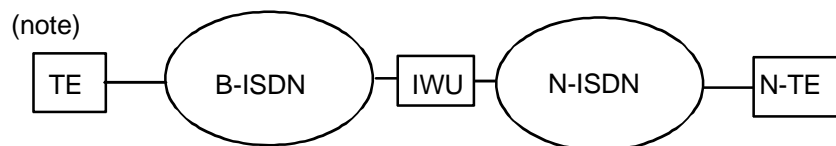
(note)

NOTE: Terminal Equipment (TE) represents a generic N-ISDN or B-ISDN terminal (see annex A)

Figure 3: Interworking configuration of B-ISDN to N-ISDN interconnection

The functions performed by the IWU depend on the capacity of B-ISDN to provide indirectly or directly the N-ISDN bearer services. In the case of indirect provision, the IWU allows terminals connected to B-ISDN to access network elements in N-ISDN. Transparent ATM connections are used to transparently transport user and control information between the terminals connected to B-ISDN and the IWU.

In CCITT Recommendation X.300 [8], this category of interworking is defined as "interworking by port access".

The case of direct provision implies the establishment of ISDN connections based on ATM in the B-ISDN portion of the network and the IWU performs adaptation and interworking functions at the level of user and control plane. In particular, the IWU translates the B-ISDN and N-ISDN signalling flows performing termination, generation and protocol conversion of the N-ISDN and B-ISDN signalling messages.

In CCITT Recommendation X.300 [8], this category of interworking is defined as "by call control mapping".

5.2 Concatenation of N-ISDNs via B-ISDN

The interworking configuration of a concatenation of N-ISDNs via B-ISDN is shown in figure 4. In this case the service provided by end-to-end communications are those currently supported by N-ISDN. The interworking functions to be performed at the boundary between B-ISDN and N-ISDN are provided by the IWU.
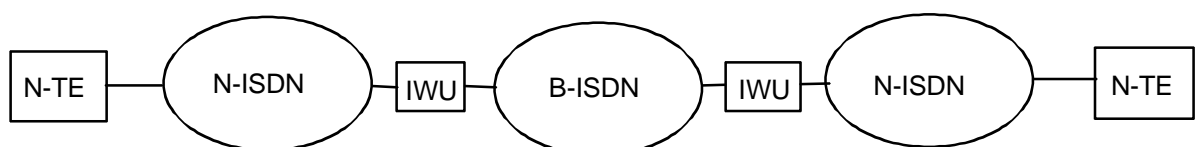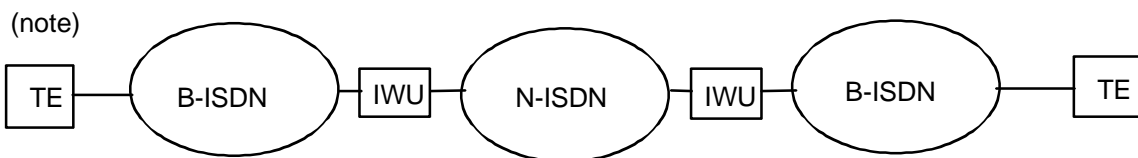
Figure 4: Interworking configuration of concatenation of ISDNs via B-ISDN

If B-ISDN supports indirectly the N-ISDN bearer services the IWU should perform the necessary adaptation functions and establish a transparent ATM connection to transparently transport through B-ISDN signalling and user information. The transparent ATM connection is established between the IWU and the first network element capable to support the ISDN bearer services. In this specific case the first network element is the other IWU.

If B-ISDN supports directly the N-ISDN services the IWU should perform the necessary interworking functions and set an appropriate ISDN connection based on ATM between itself and a network element inside B-ISDN able to handle the N-ISDN capabilities. Interworking functions at the level of user and control plane take place in the IWU.

5.3 Concatenation of B-ISDNs via N-ISDN

The interworking configuration of a concatenation of B-ISDNs via N-ISDN is shown in figure 5. The choice of using N-ISDN to connect remote B-ISDNs creates a "bottleneck" limiting dramatically the end-to-end services offered to the B-ISDN users. In particular B-ISDN users can only request broadband services that in terms of characteristics and Quality of Service (QoS) have a N-ISDN equivalent. This strong constraint makes this interworking configuration little attractive.

NOTE: TE represents a generic N-ISDN or B-ISDN terminal (see annex A)

Figure 5: Interworking configuration of concatenation B-ISDN via N-ISDN

The IWU should perform the necessary adaptation and interworking functions and set a N-ISDN connection between the IWUs to support the N-ISDN bearer service corresponding to the broadband service.

6 Relationship between N-ISDN and B-ISDN bearer services and connection types

Considering its low layer capabilities N-ISDN can be decomposed in four main functional capabilities:

- circuit switched;
- packet switched;
- frame mode; and
- transmission capabilities.

Focusing the attention on the first third capabilities, CCITT Recommendation I.340 [3] describes the N-ISDN connection types used to support the circuit, packet and frame mode bearer services.

The B-ISDN connection types are discussed in CCITT Recommendation I.327 [2].

In the case of interworking between B-ISDN and N-ISDN, the N-ISDN connections should be related to the broadband connections with the appropriate ATM Adaptation Layer (AAL) types and the N-ISDN bearer services should be related to the B-ISDN bearer services with the appropriate AAL service classes.

The association between N-ISDN and B-ISDN connection types can be performed in two ways: one to one correspondence and K (K>1) to one correspondence.

In the one to one correspondence each N-ISDN connection corresponds to a broadband connection characterized by the appropriate AAL type. The N-ISDN connection type categories may correspond to the AAL types as indicated in table 1.

Table 1: Corresponding of N-ISDN connection types to AAL types

ISDN connection type categories	AAL types
64 kbit/s unrestricted	AAL 1
Speech	AAL 1
3.1 kHz audio	AAL 1
multi rate nX64	AAL 1
Packet	Not applicable (note)
Frame	AAL 5
NOTE:	In the specific case of the ISDN packet connection type there is not a direct mapping between a specific AAL type and the ISDN packet connection type. In subclause 7.2 the use of the AAL5 defined to support the Frame Relay service is suggested to provide the LAPD/B core functions.

The network performance attributes of the N-ISDN and B-ISDN connections should match as well as the QoS classes of the N-ISDN and B-ISDN bearer services supported by the given connections.

In N-ISDN and B-ISDN, the modes to establish and release a given connection are: switched, semi-permanent and permanent. In the first case the interworking functions for the establishment of the connection take place at the level of control plane. On the contrary in the other two cases the interworking functions affect the management plane.

In the K to one correspondence, multiple N-ISDN connections are bundled without distinguishing between the constituent connections and the bundle corresponds to one broadband connection with an appropriate AAL type.

As indicated for the one to one correspondence, the N-ISDN network performance attributes and the QoS classes should properly be related to the B-ISDN ones. In the case where same N-ISDN connection type categories are bundled, the association N-ISDN connection types and AAL types is indicated in table 1.

The K to one correspondence requires the presence of remote peer-to-peer N-ISDN systems able to distinguish and handle the multiple N-ISDN connections that are bundled and transported in an aggregated way through B-ISDN. Remote peer-to-peer N-ISDN systems may be two ISDN terminals, an ISDN terminal and an ISDN network element or two ISDN network elements.

7 Interworking functional requirements

The bearer services supported by B-ISDN are classified into the following two categories:

- Broadband specific ISDN bearer services that are services requiring the presence of a network able to provide end-to-end broadband capabilities;

- Narrowband ISDN bearer services that are services equivalent to the bearer services currently provided by N-ISDN.

In a situation of interworking between B-ISDN and N-ISDN, the bearer services supported by the two networks can be classified into three categories:

- circuit mode bearer service;
- packet mode bearer service;
- frame mode bearer service.

The following subclauses describe the interworking requirements and functions for the provision of the above mentioned categories of bearer services. Specific interworking issues at protocol level are not investigated. The protocol stacks shown in the following clauses only aim at better illustrating the functionalities of the various network elements involved in the interworking B-ISDN/N-ISDN for the provision of bearer services.

### 7.1 Interworking functions for circuit mode bearer services

7.1.1 B-ISDN to N-ISDN interconnection

Figure 6 shows a number of interworking situations that take place to support a circuit mode bearer service in the interworking configuration of B-ISDN to N-ISDN interconnection.

The N-ISDN circuit mode bearer service interworks to the Broadband Connection-Oriented Bearer Service Class A (BCOBS-A) supported by AAL type 1 as described in ITU-T Recommendation I.363 [9].

In particular figure 6.a depicts the circuit mode bearer service interworking for the user plane. In this specific case the terminal connected to B-ISDN is a broadband terminal. Clause A.2 describes the user plane interworking functions performed by the functional group B-NT2 when the terminal connected to B-ISDN is a narrowband terminal.

Regardless of the nature of the terminals connected to B-ISDN (i.e. narrowband or broadband) and the presence of the B-NT2, the IWU supports the adaptation functions between the N-ISDN and B-ISDN interfaces and packetizes/depacketizes the user information flow in/from an ATM cell flow. To emulate the N-ISDN circuit mode bearer service within B-ISDN, the AAL 1 is used.
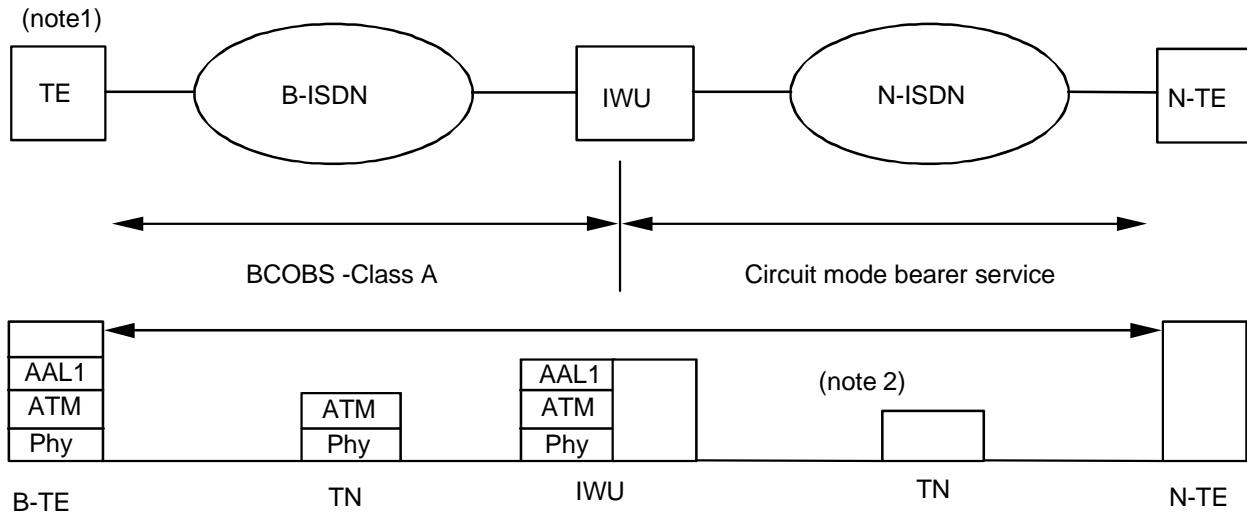
NOTE 1: TE represents a generic N-ISDN or B-ISDN terminal (see annex A)

NOTE 2: N-ISDN provides a circuit mode connection over which any user protocol may be transferred

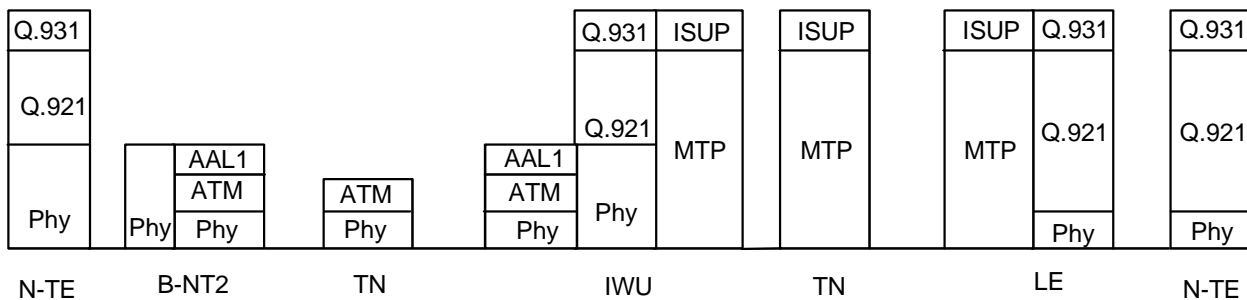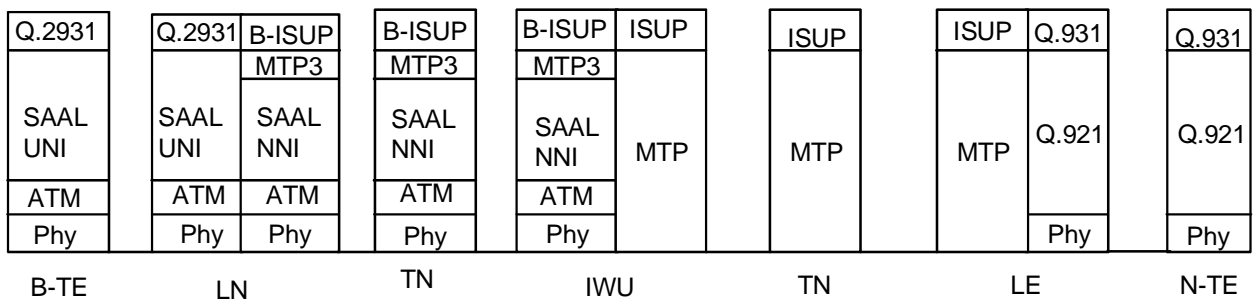**Figure 6a: Circuit mode interworking - user plane**

Figure 6b: Circuit mode interworking. Indirect provision scenario - control plane

Q.2931			B-ISUP		B-ISUP	ISUP		ISUP		ISUP	Q.931		Q.931

Q.2931	Q.2931	B-ISUP	B-ISUP	B-ISUP	ISUP	ISUP	ISUP	Q.931	Q.931
		MTP3	MTP3	MTP3					
SAAL UNI	SAAL UNI	SAAL NNI	SAAL NNI	SAAL NNI	MTP	MTP	MTP	Q.921	Q.921
ATM	ATM	ATM	ATM	ATM					
Phy	Phy	Phy	Phy	Phy				Phy	Phy
B-TE	LN		TN	IWU		TN		LE	N-TE

Figure 6c: Circuit mode interworking. Direct provision scenario - control plane

Figure 6: Circuit mode interworking relating to the B-ISDN to N-ISDN interconnection

For the control plane, two different interworking situations take place according to the indirect and direct provision scenarios of N-ISDN bearer services.

Figure 6.b shows the circuit mode bearer service interworking for the control plane in the case of the indirect provision scenario. In this scenario, B-ISDN is transparent to the N-ISDN call control. In particular, figure 6.b depicts the case of a N-ISDN terminal connected to B-ISDN through the B-NT2. The N-ISDN signalling messages generated by the N-ISDN terminal connected to B-ISDN are transparently transported by an ATM connection. Clause A.2 describes the interworking functions performed by the B-NT2.

The IWU packetizes/depacketizes the N-ISDN signalling messages in/from ATM cell flows and may terminates the N-ISDN signalling messages.

Figure 6.c shows the circuit mode bearer service interworking for the control plane in the case of the direct provision scenario. In this scenario B-ISDN supports ISDN connections based on ATM. The SAAL UNI is an ATM Adaptation Layer that has SSCOF-UNI located on the top SSCOP. The SAAL NNI is an ATM Adaptation Layer that has SSCOF-NNI located on the top of SSCOP. The SCCOP resides on the top of CPCS AAL5. The structure and the components of the SAAL are specified in ITU-T Recommendations Q.2100 [12], Q.2110 [13], Q.2130 [14] and Q.2140 [15].

In particular, figure 6.c illustrates the case of a broadband terminal connected to B-ISDN. The case of a N-ISDN terminal connected to B-ISDN is described in figure A.4. In this case, the B-NT2 provides the appropriate interworking functions between the two different signalling systems.

Regardless of the type of terminal connected to B-ISDN, the IWU terminates the N-ISDN and B-ISDN signalling messages and perform the appropriate translation among the narrowband and broadband signalling flows.

7.1.2 Concatenation of N-ISDNs via B-ISDN

Figure 7 shows a number of interworking situations that take place to support a circuit mode bearer service in the interworking configuration of concatenation of N-ISDNs via B-ISDN.

The service perceived by the end user is the circuit mode bearer service offered by N-ISDN. The N-ISDN circuit mode bearer service interworks to the Broadband Connection-Oriented Bearer Service Class A (BCOBS-A) supported by AAL type 1 as described in ITU-T Recommendation I.363 [9].

In particular figure 7.a depicts the circuit mode bearer service interworking for the user plane. The IWU supports the adaptation functions between the N-ISDN and B-ISDN interfaces and packetizes/depacketizes the user information flow in/from an ATM cell flow. To emulate the N-ISDN circuit mode bearer service within B-ISDN the AAL 1 is used.

For the control plane two different interworking situations occur according to the indirect and direct provision scenarios of N-ISDN bearer services.

For the indirect provision scenario, figure 7.b describes the circuit mode bearer service interworking relating to the control plane. In this scenario B-ISDN is transparent to the N-ISDN call control. The N-ISDN signalling messages are transparently transported by B-ISDN.

The IWU packetizes/depacketizes the N-ISDN signalling messages in/from ATM cell flows and, if necessary, terminates the N-ISDN signalling messages. It should be noted that the termination of the N-ISDN signalling messages at the boundaries of B-ISDN may be performed, instead of the IWUs, by ISDN nodes belonging to the remote ISDNs. In this case the IWU should only provide the adaptation functions to transport by a flow of ATM cells the N-ISDN signalling messages.

Figure 7.c shows the circuit mode bearer service interworking for the Control plane in the case of the direct provision scenario. In this scenario B-ISDN supports ISDN connection based on ATM. The IWU terminates the N-ISDN and B-ISDN signalling messages and performs the appropriate translation between the narrowband and broadband signalling flows.
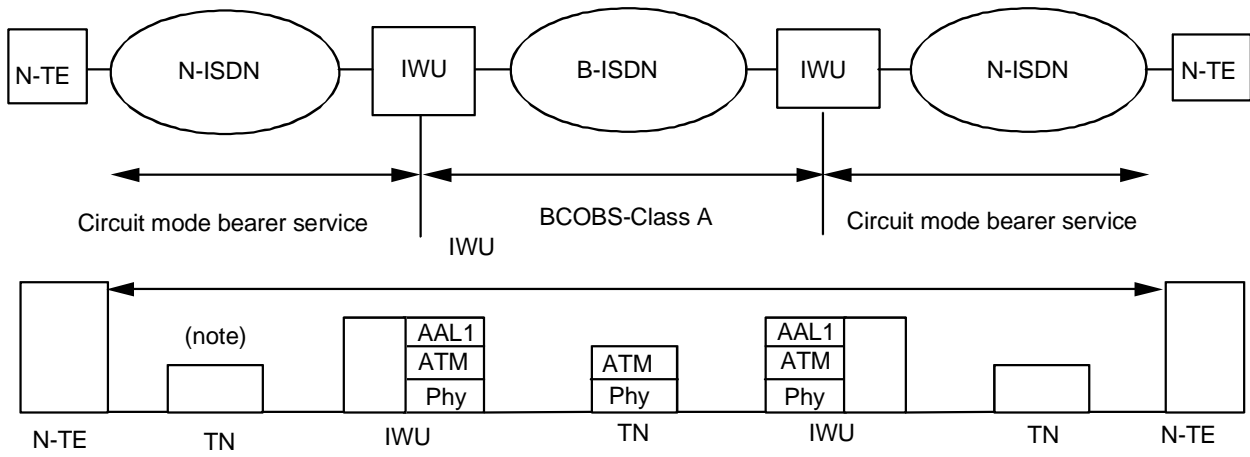
NOTE: N-ISDN provides a circuit mode connection over which any user protocol may be transferred

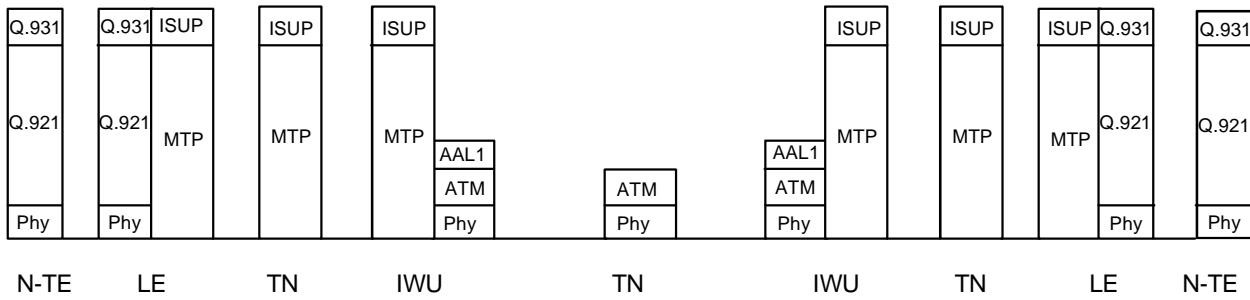**Figure 7.a: Circuit mode interworking - user plane**

Figure 7.b: Circuit mode interworking. Indirect provision scenario - control plane
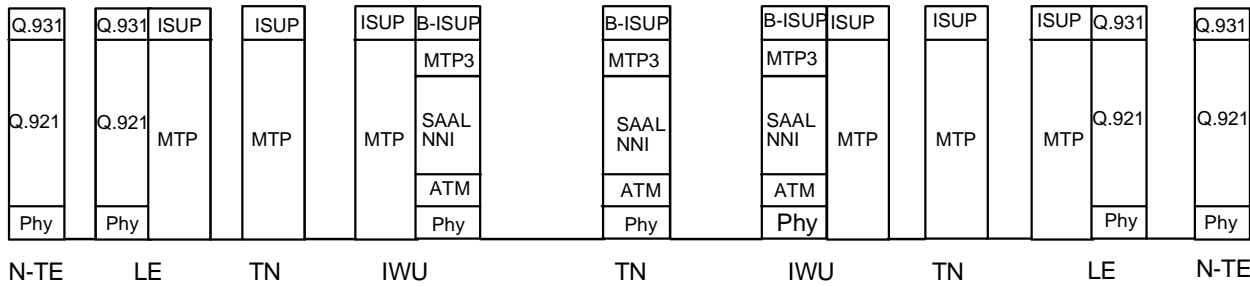
Figure 7.c: Circuit mode interworking. Direct provision scenario - control plane

Figure 7: Circuit mode interworking relating to the concatenation of N-ISDNs via B-ISDN

7.1.3 Concatenation of B-ISDNs via N-ISDN

Figure 8 describes a number of interworking situations that take place to support a circuit mode bearer service in the interworking configuration of concatenation of B-ISDNs via N-ISDN.

The N-ISDN circuit mode bearer service interworks to the Broadband Connection-Oriented Bearer Service Class A (BCOBS-A) supported by AAL type 1 as described in ITU-T Recommendation I.363 [9]. The service perceived by the users connected to B-ISDN is that of a N-ISDN circuit mode bearer service. B-ISDN users may be informed by an appropriate indication that an interworking situation occurs with heavy limitations to the bearer services offered to the remote users.

In particular figure 8.a depicts the circuit mode bearer service interworking for the user plane. In this specific case the terminal connected to B-ISDN is a broadband terminal. In the case of a narrowband terminal connected to B-ISDN the user plane interworking functions performed by the functional group B-NT2 are described in clause A.2.

Regardless of the nature of the terminals connect to B-ISDN (i.e. narrowband or broadband) and the presence of the B-NT2, the IWU supports adaptation functions between the N-ISDN and B-ISDN interfaces and packetizes/depacketizes the user information flow in/from ATM cell flows. To emulate the N-ISDN circuit mode bearer service within B-ISDN the AAL 1 is used.

For the control plane two different interworking situations take place according to the indirect and direct provision scenarios of N-ISDN bearer services. In particular if B-ISDN does not support signalling capabilities (indirect provision scenario) the IWU does not perform interworking functions at the level of control plane. In the specific case that both the two terminals connected to remote B-ISDNs are narrowband terminals, the N-ISDN signalling messages are transparently transported through B-ISDN. B-ISDN networks allow ISDN terminals to access network resources within the core ISDN able to terminate the narrowband ISDN signalling.

In a direct provision scenario, as shown in figure 8.b, the IWU ensures the interworking functions between the narrowband and broadband signalling systems. In particular figure 8.b illustrates the case of a broadband terminal connected to B-ISDN. The case of an ISDN terminal connected to B-ISDN is described in figure A.4. In this case the B-NT2 provides the appropriate interworking functions between the different signalling systems.

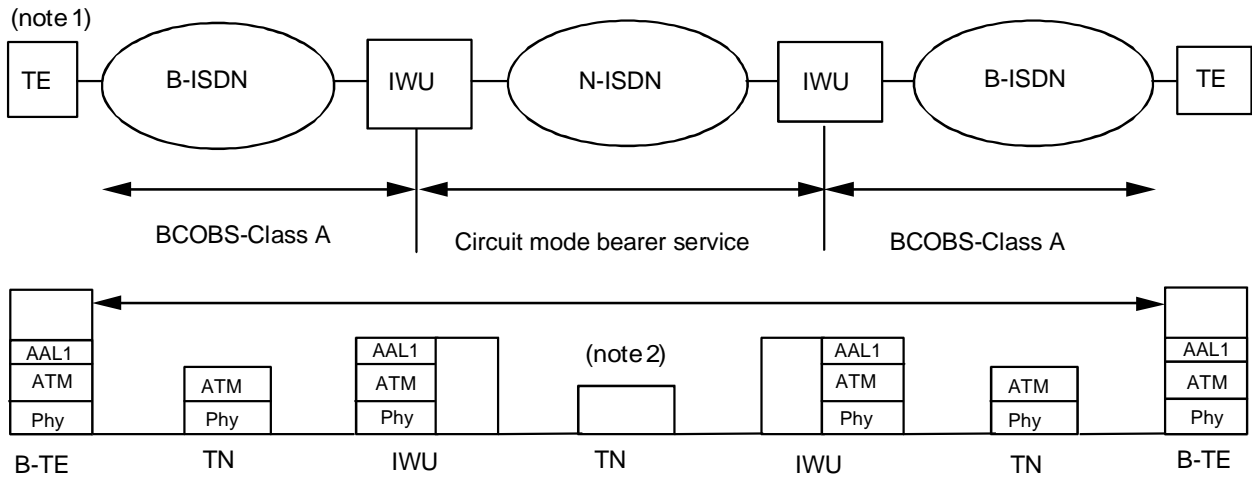### 7.2 Interworking functions for packet mode bearer service

In discussing the interworking functions for the provision of the packet mode bearer service the following assumptions are made:

- B-ISDN does not directly support the packet mode bearer service but only provides a transparent ATM connection between network elements outside B-ISDN able to support the packet mode bearer service;

- for the narrowband portion of the network only the specification defined in ITU-T Recommendation X.31 case B is considered for the provision of the packet mode bearer service. The X.31 case A is not discussed.

7.2.1 B-ISDN to N-ISDN interconnection

Figure 9 shows an interworking situation that takes place to support the packet mode bearer service in the interworking configuration of B-ISDN to N-ISDN interconnection.
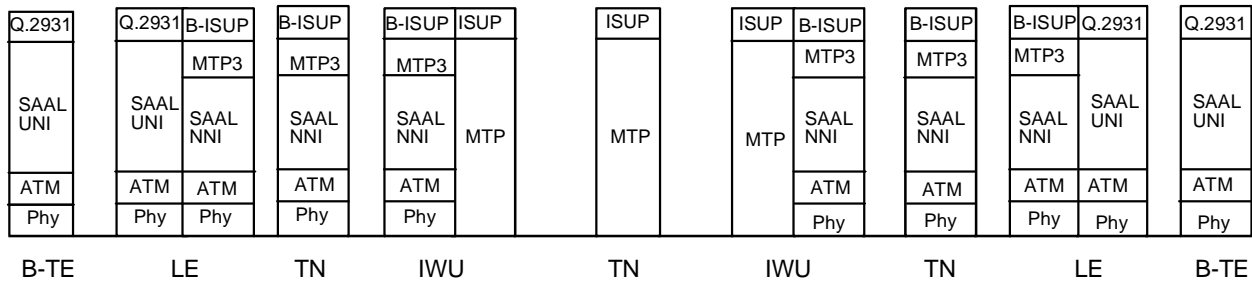
The N-ISDN packet mode bearer service interworks to the Broadband Connection-Oriented Bearer Service Class C (BCOBS-C) supported by an appropriate AAL5 type. In particular the AAL5 described in ITU-T Recommendation I.365.1 [10] is used to provide the LAPD/B core functions.

(note 1)

| TE | B-ISDN | IWU | N-ISDN | IWU | B-ISDN | TE |

BCOBS-Class A | Circuit mode bearer service | BCOBS-Class A

| | B-TE | | TN | | IWU | | TN (note 2) | | IWU | | TN | | B-TE |

B-TE: AAL1 / ATM / Phy
TN: ATM / Phy
IWU: AAL1 / ATM / Phy
TN: (note 2)
IWU: AAL1 / ATM / Phy
TN: ATM / Phy
B-TE: AAL1 / ATM / Phy

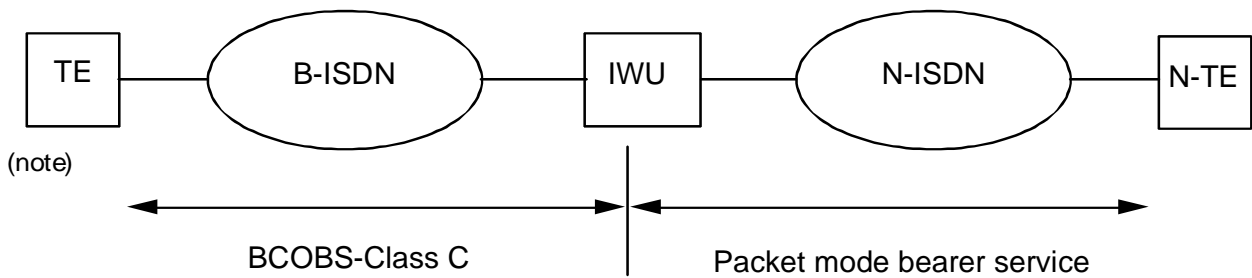NOTE 1:   TE represents a generic N-ISDN or B-ISDN terminal

NOTE 2   N-ISDN provides a circuit mode connection over which any user protocol may be transferred

Figure 8.a: Circuit mode interworking - user plane

B-TE: Q.2931 / SAAL UNI / ATM / Phy
LE: Q.2931 / SAAL UNI / ATM / Phy ; B-ISUP / MTP3 / SAAL NNI / ATM / Phy
TN: B-ISUP / MTP3 / SAAL NNI / ATM / Phy
IWU: B-ISUP / MTP3 / SAAL NNI / ATM / Phy ; ISUP / MTP
TN: ISUP / MTP
IWU: ISUP / MTP ; B-ISUP / MTP3 / SAAL NNI / ATM / Phy
TN: B-ISUP / MTP3 / SAAL NNI / ATM / Phy
LE: B-ISUP / MTP3 / SAAL NNI / ATM / Phy ; Q.2931 / SAAL UNI / ATM / Phy
B-TE: Q.2931 / SAAL UNI / ATM / Phy

Figure 8.b: Circuit mode interworking. Direct provision scenario - control Plane

Figure 8: Circuit mode interworking relating to the concatenation of B-ISDNs via N-ISDN

| TE | B-ISDN | IWU | N-ISDN | N-TE |

(note)

BCOBS-Class C | Packet mode bearer service

B-TE: X.25 PLP / AALp / ATM / Phy
TN: (note) ATM / Phy
IWU: AALp / ATM / Phy ; X.25 PLP / LAPB/LAPD / Phy
PH: X.25 PLP / LAPB/LAPD / Phy
N-TE: X.25 PLP / LAPB/LAPD / Phy

NOTE: TE represents a generic N-ISDN or B-ISDN terminal

Figure 9: Packet mode interworking relating to the B-ISDN to N-ISDN interconnection

The protocol stacks shown in figure 9 depict the packet mode bearer service interworking. In this specific case, the terminal connected to B-ISDN is a broadband terminal. Clause A.2 describes the interworking functions performed by the functional group B-NT2 when the terminal connected to B-ISDN is a narrowband terminal.

The IWU supports adaptation functions between the N-ISDN and B-ISDN interfaces and packetizes/depacketizes the information flow in/from an ATM cell flow.

7.2.2   Concatenation of N-ISDNs via B-ISDN

Figure 10 shows an interworking situation that takes place to support the packet mode bearer service in the interworking configuration of concatenation of N-ISDNs via B-ISDN.

The service perceived by the end user is the packet mode bearer service offered by N-ISDN. The N-ISDN packet mode bearer service interworks to the Broadband Connection-Oriented Bearer Service Class C (BCOBS-C) supported by an appropriate AAL5 type.

As shown in figure 10, the X.25 layer 3 packets are transparently transported throughout B-ISDN.

The IWU supports adaptation functions between the N-ISDN and B-ISDN interfaces and packetizes/depacketizes the user information flow in/from an ATM cell flow.

7.2.3   Concatenation of B-ISDNs via N-ISDN

Figure 11 illustrates a situation that takes place to support the packet mode bearer service in the interworking configuration of concatenation of B-ISDNs via N-ISDN.

The N-ISDN packet mode bearer service interworks to the Broadband Connection-Oriented Bearer Service Class C (BCOBS-C) supported by an appropriate AAL5.

The protocol stacks shown in figure 11 depict the packet mode bearer service interworking. In this specific case, the terminal connected to B-ISDN is a broadband terminal. In the case of a narrowband terminal connected to B-ISDN, the interworking functions performed by the functional group B-NT2 are described in clause A.2.

The IWU supports adaptation functions between the N-ISDN and B-ISDN interfaces, packetizes/depacketizes the user information flow in/from ATM cell flows. The X.25 layer 3 packets are transparently transported by B-ISDN which is used an "access network" to access the packet handler located in N-ISDN.

7.3   Interworking functions for frame relaying bearer service

Among the recommended set of frame mode bearer services, this subclause focuses the attention on the ISDN frame relaying bearer service as described in ITU-T Recommendation I.233.1 [20].

7.3.1   B-ISDN to N-ISDN interconnection

Figure 12 shows a number of interworking situations that take place to support a frame relaying bearer service in the interworking configuration of B-ISDN to N-ISDN interconnection.

The N-ISDN frame relaying bearer service interworks to the Broadband Connection-Oriented Bearer Service Class C (BCOBS-C) supported by AAL type 5 as described in ITU-T Recommendation I.365.1 [10].

In particular figure 12.a depicts the frame relaying bearer service interworking for the user plane. In this specific case the terminal connected to B-ISDN is a broadband terminal. Clause A.2 describes the user plane interworking functions performed by the functional group B-NT2 when the terminal connected to B-ISDN is a narrowband terminal.
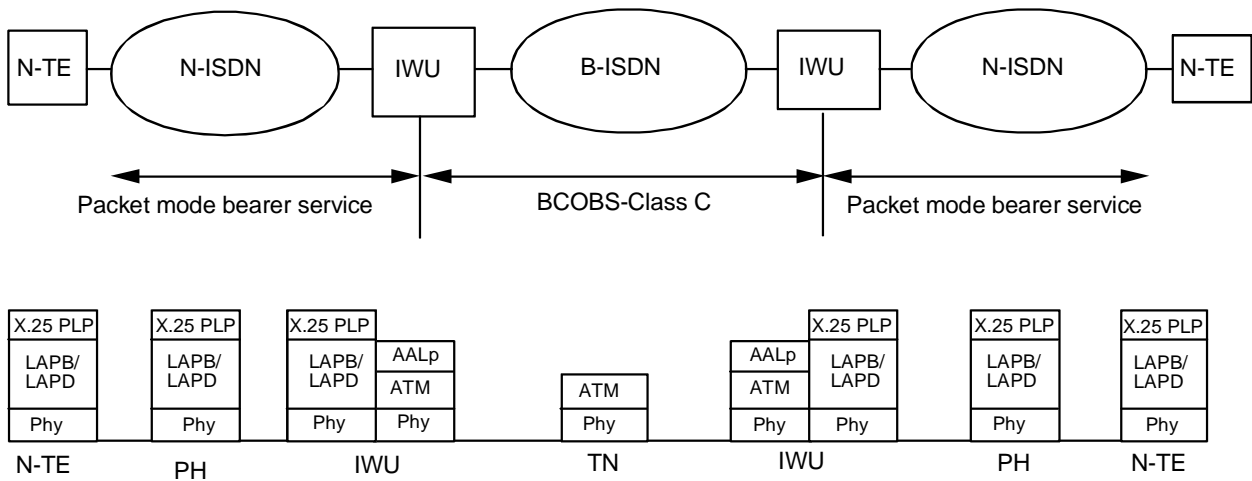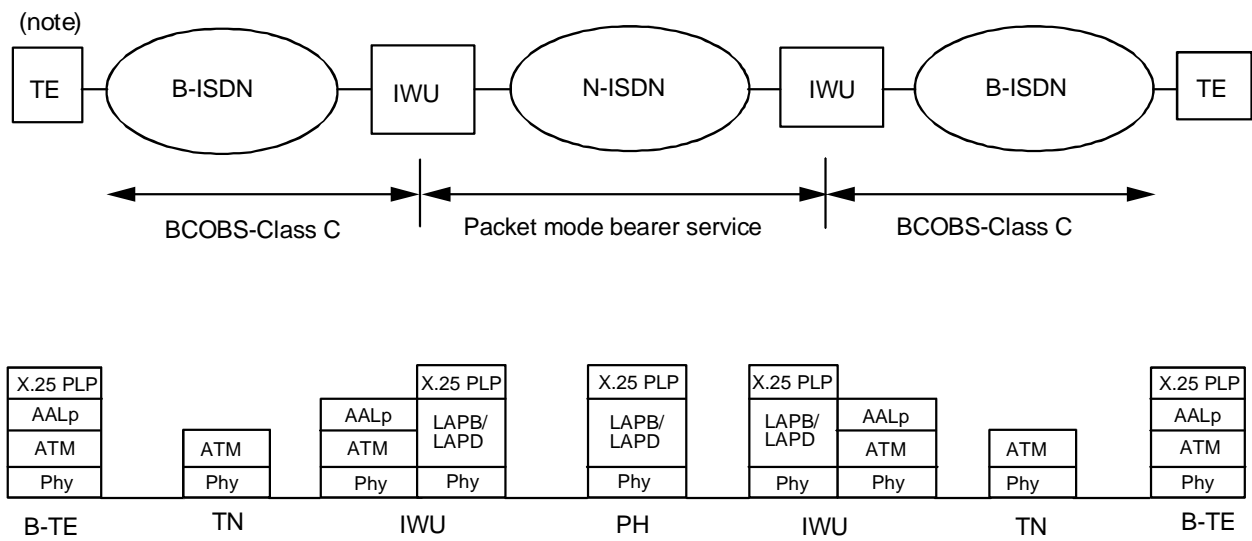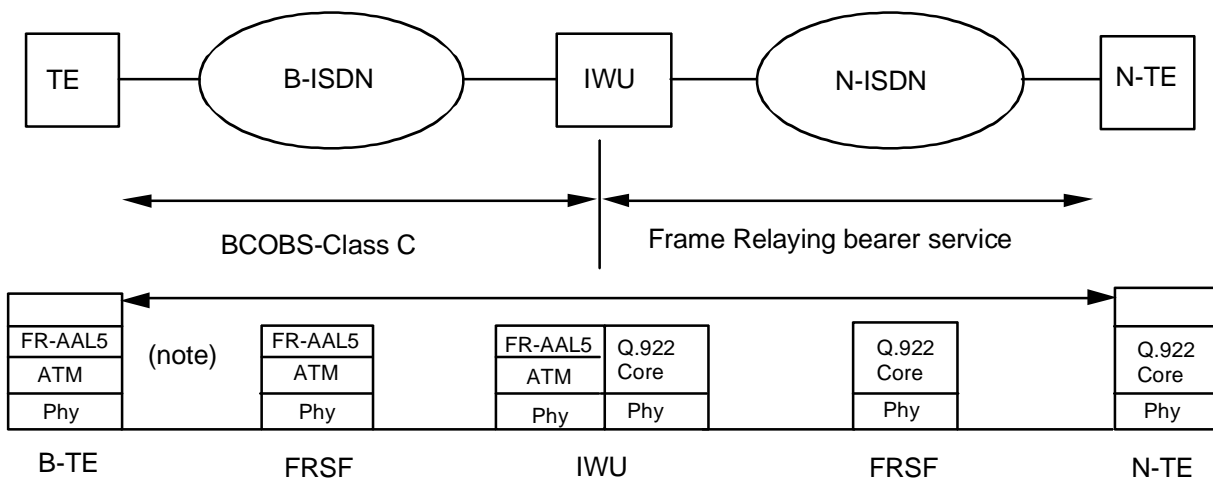
Figure10: Packet mode interworking relating to the concatenation of N-ISDNs via B-ISDN

NOTE: TE represents a generic N-ISDN or B-ISDN terminal.

Figure 11: Packet mode interworking relating to the concatenation of B-ISDNs via N-ISDN

NOTE: FR-AAL5 is a short form to indicate an ATM Adaptation Layer that has a FR-SSCS located on the top of the AAL5 SAR and CPCS as defined in ITUT Recommendation I.363 [9].

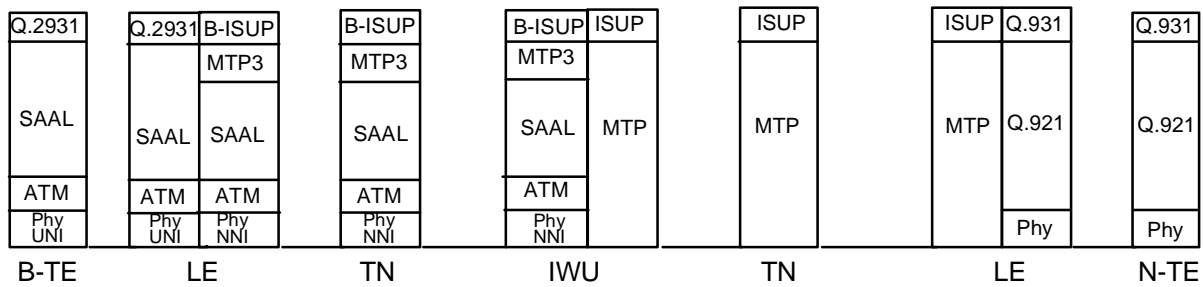**Figure 12.a: Frame relaying interworking - user plane**

Q.2931	Q.2931	B-ISUP	B-ISUP	B-ISUP	ISUP	ISUP	ISUP	Q.931	Q.931

(Protocol stack diagram)

B-TE   **LE**   **TN**   **IWU**   **TN**   **LE**   **N-TE**

Figure 12.b: Frame relaying interworking. Control plane - Establishment circuit connection (Step 1)

(Protocol stack diagram)

B-TE   **FRSF**   **FRSF**   **IWU**   **FRSF**   **FRSF**   **N-TE**
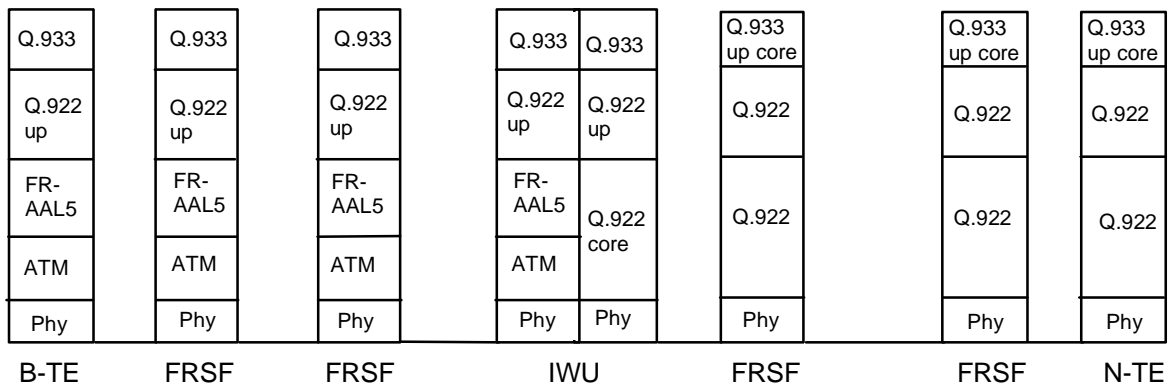
Figure 12.c: Frame relaying interworking. Control plane - Establishment frame relay connection (Step 2)

Figure 12: Frame relaying interworking relating to the B_ISDN to N-ISDN interconnection

Regardless of the nature of the terminals connect to B-ISDN (i.e. narrowband or broadband) and the presence of the B-NT2, the IWU provides protocol mapping between ITU-T Recommendation Q.922 [11] core and AAL5.

Figure 12.a shows the case where both N-ISDN and B-ISDN directly support the frame relaying bearer service. The case where N-ISDN and B-ISDN do not directly provide the Frame relaying bearer service are respectively described in subclauses 7.3.1.4 and 7.4.1.4 of ETS 300 467 [17].

If the frame relay service provided by the B-ISDN/N-ISDN interworking is a Frame Relay Permanent, Virtual Connection (FR PVC) mapping functions take place between the N-ISDN and B-ISDN management procedures for PVC handling. The N-ISDN procedures for PVC handling are described in annex A of ITU-T Recommendation Q.933 [19], whereas the B-ISDN procedures for PVC handling are described in annex A of ETS 300 467 [17].

For the provision of Frame Relay Switched Virtual Connection (FR SVC), interworking functions are required between the signalling systems. In particular, figures 12.b/c illustrate the Control plane interworking functions in the case of the "two step signalling method" where both N-ISDN and B-ISDN directly support the Frame Relaying bearer service.

In particular, figure 12.b shows the interworking functions between the narrowband and broadband signalling systems to establish the ISDN and the ATM connections that precede the establishment of the Frame Relay connections. Figure 12.c describes the Control plane interworking for the establishment of the Frame Relay connections in the narrowband and broadband portions of the network by using the ITU-T Recommendation Q.933 [19] procedures.

If N-ISDN or B-ISDN do not directly support Frame Relaying bearer service, the ITU-T Recommendations Q.922 [11] and Q.933 [19] protocols are not present respectively in the N-ISDN and B-ISDN portions of the network. These protocols are implemented in FRSFs located outside N-ISDN and B-ISDN.

7.3.2 Concatenation of N-ISDNs via B-ISDN

Figure 13 shows a number of interworking situations that take place to support a frame relaying bearer service in the interworking configuration of concatenation of N-ISDNs via B-ISDN.

The service perceived by the end users is the frame relaying bearer service offered by N-ISDN. The N-ISDN frame relaying bearer service interworks to the Broadband Connection-Oriented Bearer Service Class C (BCOBS-C) supported by AAL type 5 as described in Recommendation I.365.1 [10].

In particular, figure 13.a shows the frame relaying bearer service interworking for the user plane. In figure 13 both N-ISDN and B-ISDN directly support the frame relaying services. Subclause 7.4.1.3 of ETS 300 467 [17] describes the case where B-ISDN does not directly support the frame relaying service.

As described in subclause 7.3.1, if the frame relaying service provided by the B-ISDN/N-ISDN interworking is a PVC service, the PVC handling procedures defined in N-ISDN and B-ISDN should be correlated.

For the provision of the Frame Relay Switched Virtual Connection (FR SVC), interworking functions are required between the signalling systems. In particular, figures 13.b/c illustrates the control plane interworking functions in the case of the "two step signalling method" where both N-ISDN and B-ISDN directly support frame relaying bearer service.

In the first step described in figure 13.b, the IWU provides interworking functions between the N-ISDN and B-ISDN signalling systems for the establishment of the circuit connections. The second step focused on the signalling procedures for the establishment of the frame relay connection, is shown in figure 13.c.
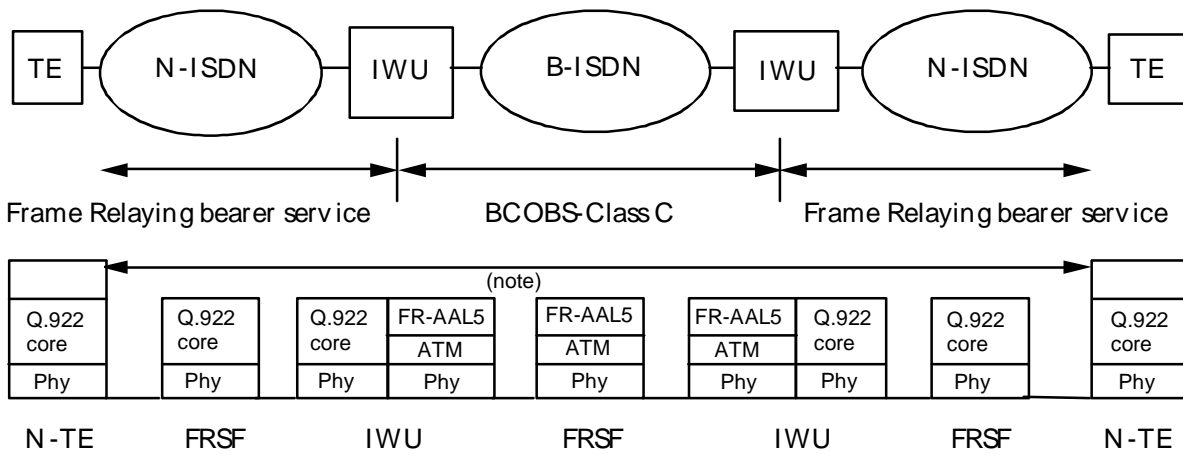
NOTE: FR-AAL5 is a short form to indicate an ATM Adaptation Layer that has a FR-SSCS located on the top of the AAL5 SAR and CPCS as defined in ITUT Recommendation I.363 [9].

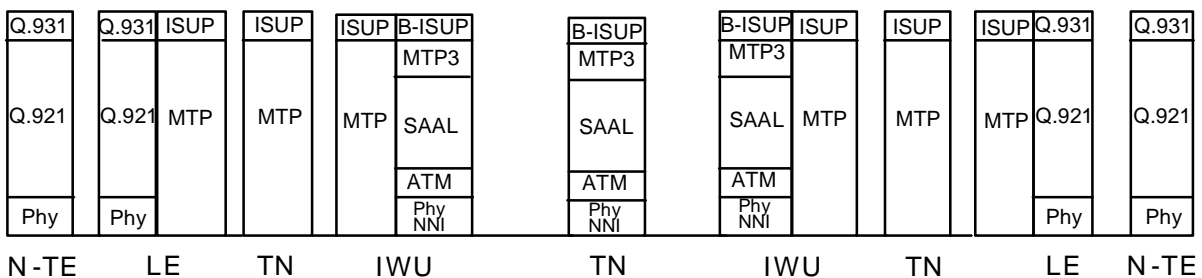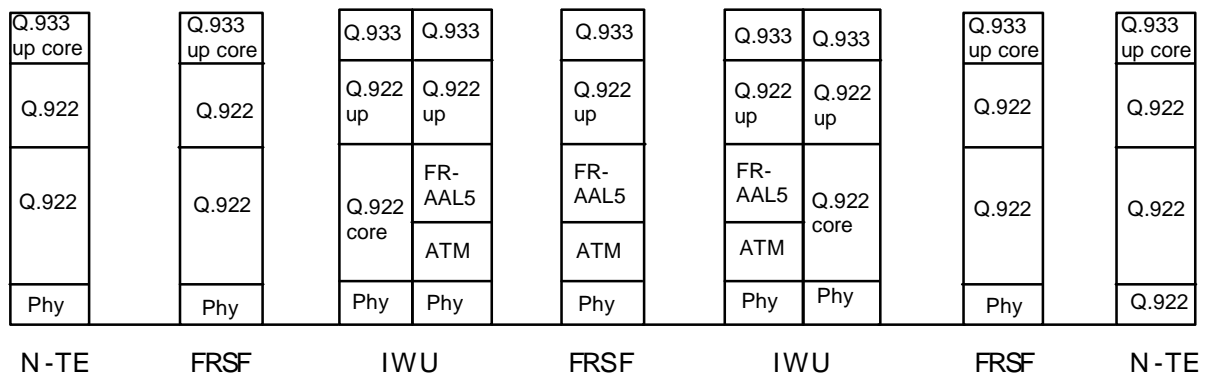**Figure 13.a: Frame relaying interworking - user plane**

Figure 13.b: Frame relaying interworking. control plane - Establishment circuit connection (Step 1)

Q.933 up core		Q.933 up core		Q.933	Q.933		Q.933		Q.933	Q.933		Q.933 up core		Q.933 up core
Q.922		Q.922		Q.922 up	Q.922 up		Q.922 up		Q.922 up	Q.922 up		Q.922		Q.922
Q.922		Q.922		Q.922 core	FR-AAL5		FR-AAL5		FR-AAL5	Q.922 core		Q.922		Q.922
					ATM		ATM		ATM					
Phy		Phy		Phy	Phy		Phy		Phy	Phy		Phy		Q.922
N-TE		FRSF		IWU			FRSF		IWU			FRSF		N-TE

Figure 13.c: Frame relaying interworking. control plane - Establishment frame relay connection (Step 2)

Figure 13: Frame relaying interworking for the concatenation of ISDNs via B-ISDN

In the case N-ISDN or B-ISDN do not directly support the Frame Relaying bearer service, the signalling protocols to establish the frame relay connection are implemented in FRSFs outside N-ISDN and B-ISDN.

7.3.3 Concatenation of B-ISDNs via N-ISDN

Figure 14 shows a number of interworking situations that take place to support a frame relaying bearer service in the interworking configuration of concatenation of B-ISDNs via N-ISDN.

The N-ISDN frame relaying bearer service interworks to the Broadband Connection-Oriented Bearer Service Class C (BCOBS-C) supported by AAL type 5 as described in ITU-T Recommendation I.365.1 [10]. The service perceived by the users connected to B-ISDN is that of a narrowband ISDN frame relaying bearer service. B-ISDN users may be informed by an appropriate indication that an interworking situation occurs with heavy limitations to the bearer services offered to the remote users.

In particular figure 14.a depicts the Frame Relaying bearer service interworking for the user plane. In this specific case the terminal connected to B-ISDN is a broadband terminal. The user plane interworking functions performed by the functional group B-NT2 when the terminal connected to B-ISDN is a narrowband terminal are described in subclause A.2.

The protocol mapping between the ITU-T Recommendation Q.922 [11] core protocol and the AAL5 protocol deployed respectively in the narrowband and in the broadband portions of the network is performed by the IWU.

If the service provided by the B-ISDN/N-ISDN interworking is a PVC service only limited adaptation functions are required between the narrowband and broadband PVC handling procedures.

For the provision of the Frame Relay Switched Virtual Connection (FR SVC) the IWU provides interworking functions between the signalling systems. In particular figures 14.b/c illustrates the control plane interworking functions, provided by the IWU, in the case of the "two step signalling method" where both N-ISDN and B-ISDN directly support the frame relaying bearer service.

As described in the subclauses 7.3.1 and 7.3.2 if the N-ISDN and B-ISDN do not directly support the frame relaying bearer service the signalling protocols to establish the FR connection are implemented outside N-ISDN and B-ISDN.
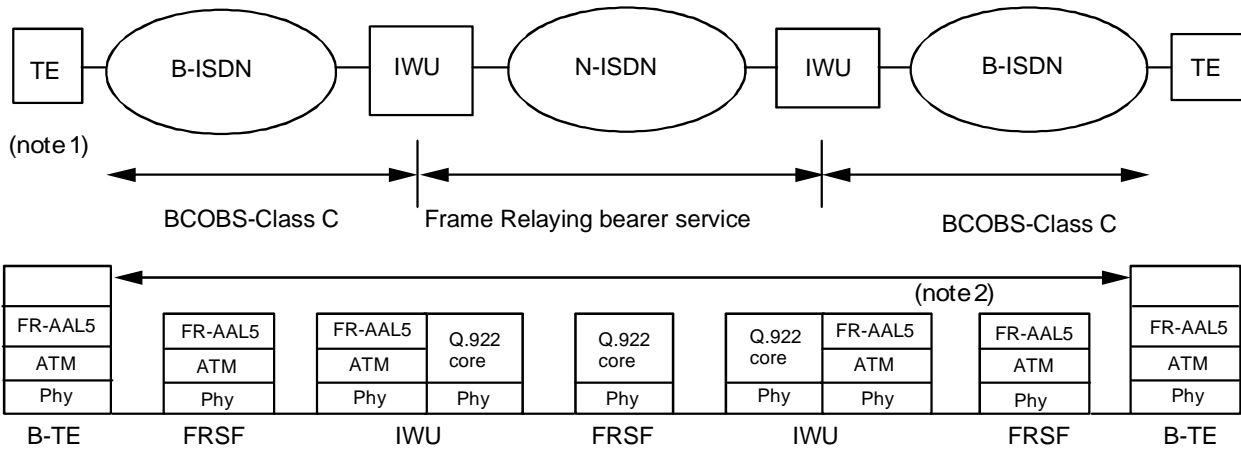
NOTE 1:   TE represents a generic N-ISDN or B-ISDN terminal.

NOTE 2:   FR-AAL5 is a short form to indicate an ATM Adaptation Layer that has a FR-SSCS located on the top of the AAL5 SAR and CPCS as defined in ITUT Recommendation I.363 [9].

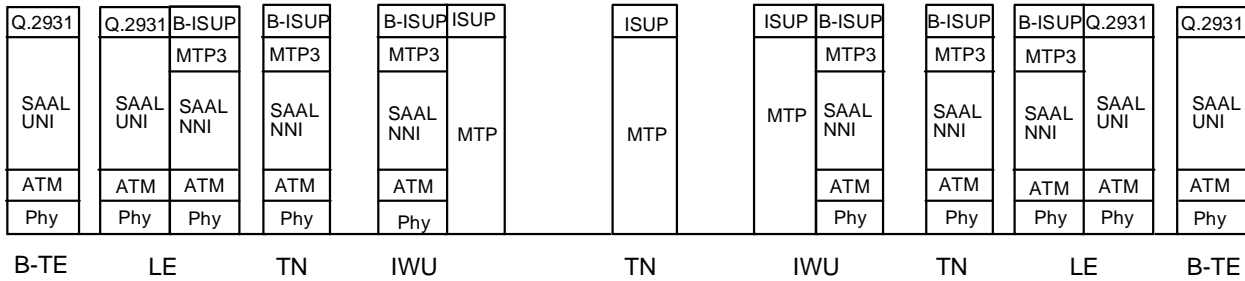**Figure 14.a: Frame relaying interworking - user plane**

Figure 14.b: Frame relaying interworking. control plane - Establishment circuit connection (Step 1)
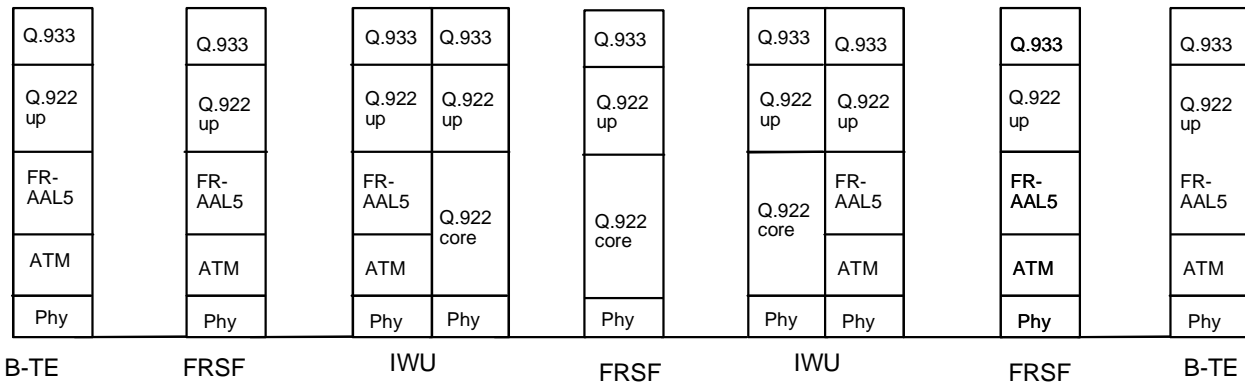

Figure 14.c: Frame relaying interworking. control plane - Establishment frame relay connection (Step 2)

**Figure 14: Frame relaying interworking for the concatenation of B-ISDNs via N-ISDN**

Annex A: Connection configurations to N-ISDN and B-ISDN

A.1 Configuration to connect narrowband and broadband terminals to B-ISDN

The objective of this annex is to describe configurations to connect terminals to B-ISDN. The terminals considered are both narrowband and broadband terminals. Configurations involving narrowband terminals require the presence of adaptation functions between the narrowband and broadband interfaces.

Figure A.1 illustrates the possible configurations to connect narrowband and broadband terminals to B-ISDN. According to CCITT Recommendation I.413 [5], the interfaces at the reference points S_B and T_B will be standardized and support all the ISDN services. The reference points and the functional groups mentioned in this annex are the same defined in CCITT Recommendations I.411 [4] and I.413 [5].

N-TE = TE1 or TA+TE2
B-TE = B-TE1 or B-TA+B-TE2/TE2
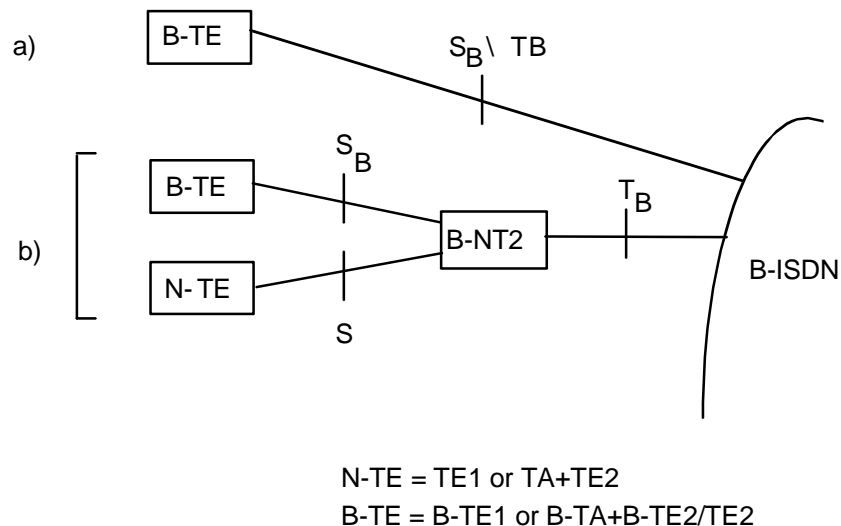
Figure A.1: Configuration for narrow and broadband terminals

The possibility that the reference points S_B and T_B are coincident or separated (in this second case the functional groups B-NT2 and B-NT1 are distinct) determines the presence of two different configuration scenarios.

In particular, figure A.1 case a) shows a configuration where S_B and T_B are coincident. A narrowband terminal (TE2) can be connected to B-ISDN by exploiting the adaptation functions between the narrowband and broadband interfaces performed by the functional group B-TA.

Figure A.1 case b) describes the separate interfaces at the reference points S, S_B and T_B. In this case, the B-NT2 provides the interface capabilities for both narrowband and broadband S reference points. Narrowband terminals (TE1 and TE2) can be connected to B-ISDN through the functional group B-NT2 that provides the appropriate interworking functions.

A.2 Interworking functions performed by B-NT2

This clause describes the interworking functions to be supported by the functional group B-NT2 when a N-ISDN terminal is connected to B-ISDN through the B-NT2 (figure A.1 case b)).

The interworking functions involve both the user and control Planes. Figure A.2 describes the interworking functions related to the user plane. In this specific case, the B-NT2 packetizes/depacketizes the N-ISDN user information in/from ATM cell flows. The type of AAL present in the B-NT2 depends on the class of service supported in B-ISDN.
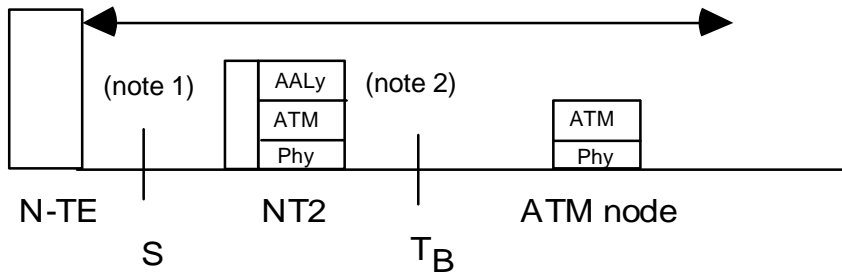
NOTE 1: Specific protocols are used on the basis of the specific ISDN bearer service supported.

NOTE 2: The type of AAL depends on the class of service used in B-ISDN to interwork to the N-ISDN service.

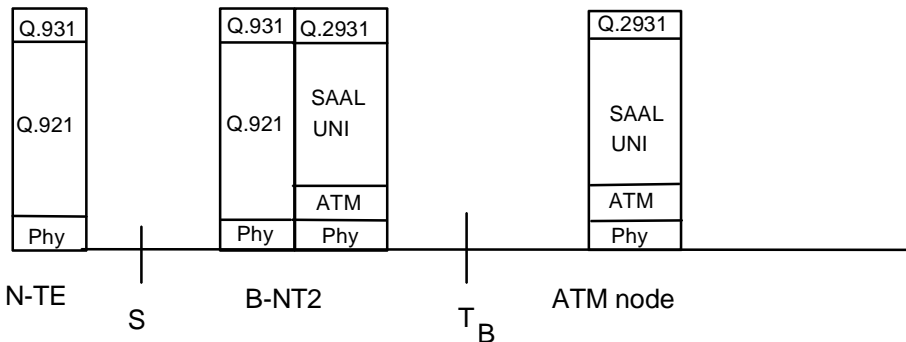**Figure A.2: B-NT2 interworking functions - user plane**

The interworking functions performed by the B-NT2 relating to the control plane are different according to the indirect and direct provision scenario. As shown in figure A.3, in the case of indirect provision scenario the B-NT2 does not terminate the narrowband ISDN signalling messages that are transparently transported through B-ISDN. The B-NT2 packetizes/depacketizes the N-ISDN signalling messages in/from ATM cell flows.

The N-ISDN signalling messages may be terminated by either the IWU or a N-ISDN node.
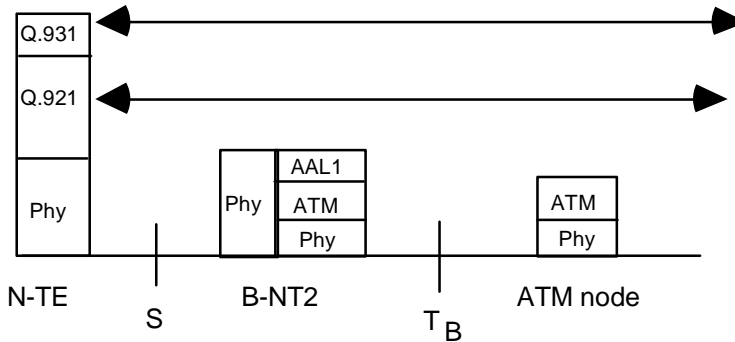
Figure A.3: B-NT2 interworking functions. Indirect provision scenario - control plane

Figure A.4 shows the control plane interworking functions performed by the B-NT2 in the case of direct provision scenario. The B-NT2 terminates both the N-ISDN and B-ISDN signalling flows and ensures the appropriate translation between the narrowband and broadband signalling messages.

Figure A.4: B-NT2 interworking functions. Direct provision scenario - control plane

History

Document history	
December 1996	First Edition