EUROPEAN TELECOMMUNICATION STANDARD

DRAFT
pr **ETS 300 467**
March 1995

Source: ETSI TC-NA

Reference: DE/NA-053204

ICS: 33.080

Key words: Broadband, frame relay, interworking, ISDN

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

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

Contents

Blank page

Foreword

This draft European Telecommunication Standard (ETS) has been produced by the Network Aspects (NA) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Public Enquiry phase of the ETSI standards approval procedure.

This draft European Telecommunication Standard (ETS) describes the definition of the B-ISDN Frame Relay Bearer Service (FRBS) and its interworking with other frame relay services.

Proposed transposition dates	
Date of latest announcement of this ETS (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Blank page

1 Scope

This draft European Telecommunication Standard (ETS) describes the definition of the B-ISDN Frame Relay Bearer Service (FRBS) and its interworking with other frame relay services. The B-ISDN FRBS belongs to Class C (connection-oriented, variable bit rate, no timing relation) non-assured broadband services. U-plane procedures are being studied with the highest priority, because services are foreseen to be based on Permanent Virtual Connections (PVCs) in the first phase.

2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative 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 ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETS 300 298-2: "Network Aspects (NA); Basic characteristics and functional specification of Asynchronous Transfer Mode (ATM) Part 2: B-ISDN ATM layer specification".

[2] ETS 300 299: "Broadband Integrated Services Digital Network (B-ISDN); Cell based user network access; Physical layer interfaces for B-ISDN applications".

[3] ETS 300 300: "Broadband Integrated Services Digital Network (B-ISDN); Synchronous Digital Hierarchy (SDH) based user network access; Physical layer interfaces for B-ISDN applications".

[4] ETS 300 337: "Transmission and Multiplexing (TM); Generic frame structures for the transport of various signals (including Asynchronous Transfer Mode (ATM) cells and Synchronous Digital Hierarchy (SDH) elements) at the CCITT Recommendation G.702 hierachical rates of 2 048 kbit/s, 34 368 kbit/s and 139 264 kbit/s".

[5] prETS 300 399-1: "Frame relay services; Part 1: General description".

[6] prETS 300 428: "Broadband Integrated Services Digital Network (B-ISDN); Asynchronous Transfer Mode (ATM) Application Layer (AAL) specification - type 5".

[7] prETS 300 455: "Broadband Integrated Services Digital Network (B-ISDN); Vitual Path Service (VPS) for reserved and permanent communications".

[8] ITU-T Recommendation F.811 (1993): "Broadband connection-oriented bearer service".

[9] ITU-T Recommendation G.804 (1994): "ATM cell mapping into plesiochronous digital hierarchy (PDH)".

[10] ITU-T Recommendation G.832 (1994): "Transport of SDH elements on PDH networks: Frame and multiplexing structures".

[11] CCITT Recommendation I.233.1 (1992): "ISDN frame relaying bearer service".

[12] ITU-T Recommendation I.362 (1993): "B-ISDN ATM adaptation layer (AAL) functional description".

[13] ITU-T Recommendation I.363 (1994): "B-ISDN ATM adaptation layer (AAL) specification".

[14] ITU-T Recommendation I.365.1 (1994): "Frame relaying service specific convergence sublayer (FR-SSCS)".

[15] CCITT Recommendation I.370 (1992): "Congestion management for the ISDN frame relaying bearer service".

[16] ITU-T Recommendation I.371 (1993): "Traffic control and congestion control in B-ISDN".

[17] ITU-T Recommendation I.372 (1993): "Frame relaying bearer service network-to-network interface requirements".

[18] ITU-T Recommendation I.555 (1994): "Frame relaying bearer service interworking".

[19] CCITT Recommendation Q.922 (1992): "ISDN data link layer specification for frame mode bearer services".

[20] ITU-T Recommendation Q.933 (1994): "Digital Subscriber Signalling System No.1 (DSS1) - Signalling specification for frame mode basic call control".

3 Symbols and abbreviations

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

AAL	ATM Adaptation Layer
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband Integrated Services Digital Network
B-TE	B-ISDN Terminal
BAI	B-ISDN Access Interface
BECN	Backward Explicit Congestion Notification
C/R	Command/Response bit
CPCS	Common Part Convergence Sublayer
CPCS-CI	CPCS - Congestion Indication
CPCS-LP	CPCS - Loss Priority
CPCS-UU	CPCS - User-to-User Indication
D/C	DLCI or DL-CORE control indicator
DE	Discard Eligibility
DLCI	Data Link Connection Identifier
DTE	Data Terminal Equipment
EA	Address Extension bit
FECN	Forward Explicit Congestion Notification
FH	Frame Handler
FR	Frame Relay
FR-BNNI	Frame Relay Broadband Network-to-Network Interface
FR-IWP	Frame Relay Interworking Point
FR-SSCS	Frame Relay Service Specific Convergence Sublayer
FRBS	Frame Relay Bearer Service
FRDTS	Frame Relay Data Transmission Service
FRSF	Frame Relay Service Function
ID	Interface Data
IWF	Interworking Function
N-ISDN	Narrow-band ISDN
NNI	Network Node Interface
PDN	Public Data Network
PDU	Protocol Data Unit
PN	Private Network
PVC	Permanent Virtual Connections
RFH	Remote Frame Handler
SAP	Service Access Point
SAR	Segmentation and Reassembly Sublayer
SDU	Service Data Unit
SSCS	Service Specific Convergence Sublayer
TE	Terminal Equipment
VC	Virtual Channel
VCI	Virtual Channel Identifier

VP	Virtual Path
VPI	Virtual Path Identifier

4 Service description

This description of FRBS in B-ISDN is in accordance with:

- ITU-T Recommendation F.811 [8]; which provides a service description of a Broadband connection oriented bearer service. ITU-T Recommendation F.811 [8] includes the following service subcategories:

  - sub-category A: Constant Bit Rate (CBR);
  - sub-category B: Variable Bit Rate (VBR) with timing;
  - sub-category C: VBR without timing:

    C1: emulation of packet mode bearer services;
    C2: emulation of frame mode bearer services;
    C3: others;

  - sub-category X: Asynchronous Transfer Mode (ATM) Adaptation Layer (AAL) defined by user;

- CCITT Recommendation I.233.1 [11]; which defines ISDN FRBS;

- ETS 300 399-1 [5].

4.1 Basic principles

B-ISDN is capable of supporting data transfer between B-ISDN customers based on frame relay transfer techniques. It need not directly imply frame relay methods implemented within B-ISDN. In the B-ISDN, virtual channels are established at the ATM layer by means of the connection oriented technique. Frame relay protocol can be supported in the U-plane using the B-ISDN in the following three ways:

a) FRBS provided by Frame Relay Service Function (FRSF) inside B-ISDN;

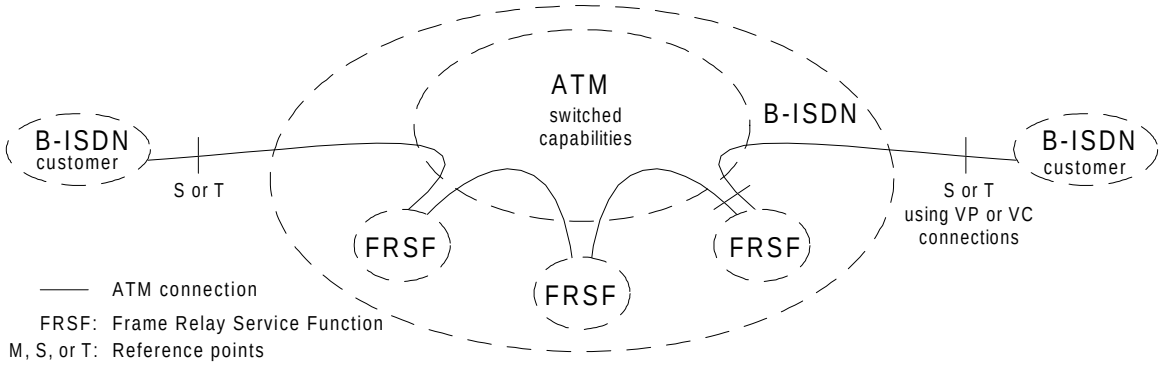
b) FRBS provided by FRSF outside B-ISDN, accessed via ATM bearer capabilities;

c) frame relay protocol support via ATM bearer capabilities.

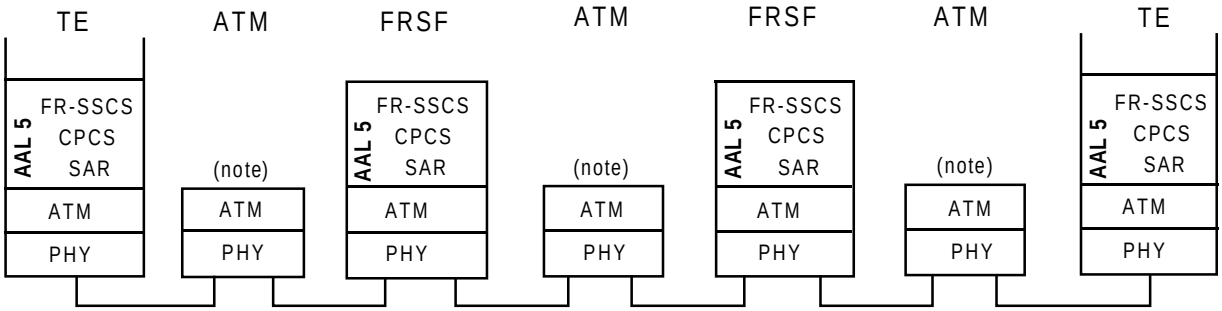
In all cases the protocol stack implemented in B-ISDN customer equipment is identical as shown in figures 1, 2 and 3. The management and control plane functions which need to be provided in the network in all cases are for further study. The three cases are outlined in the following paragraphs.

4.1.1 FRBS provided by FRSF inside B-ISDN

In this case the FRSF is provided within the B-ISDN. The FRSF handles frame relay protocols and routes data according to routing information provided during frame relay connection establishment. This case is illustrated in figures 1a and 1b.



a: FRBS provided by FRSF inside B-ISDN



NOTE: The ATM switching capabilities can be integrated with FRSF.

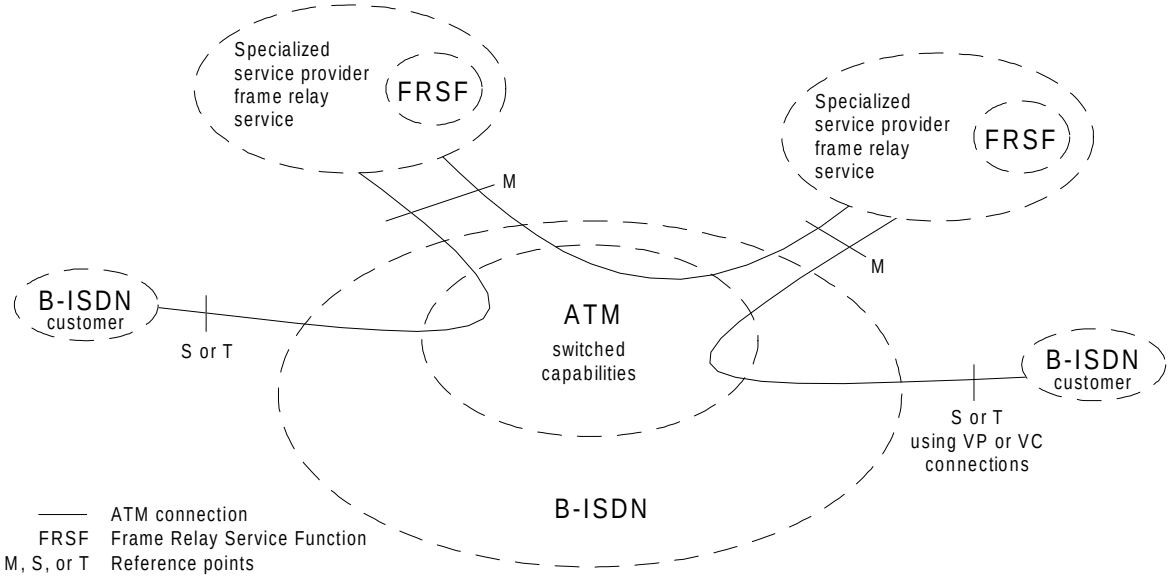
b: Protocol stack of FRBS provided by FRSF inside B-ISDN

Figure 1

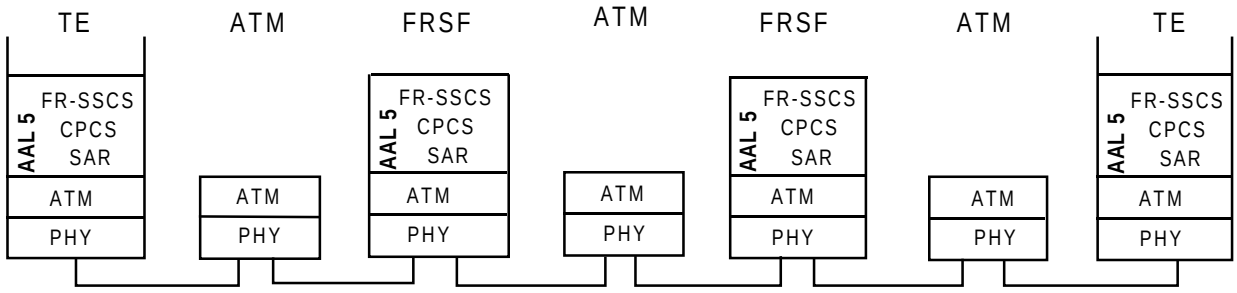
The statistical multiplexing is done at the frame level, and the bearer service required from the ATM network can be met by the Virtual Path (VP) bearer service already defined in ETS 300 455 [7], with peak bandwidth allocation. VBR Virtual Channel (VC) bearer service may also be deployed. The way of mapping the frame relay parameters into ATM VP service parameters is for further study.

4.1.2 FRBS provided by FRSF outside B-ISDN, accessed via ATM bearer capabilities

In this case a transparent connection of the ATM layer, either permanent, reserved or on demand, is used between B-ISDN interfaces (at reference points S_B/T_B or M). Frame relay protocols operating on and above the adaptation layer are transparent to the B-ISDN. The frame relay service and adaptation layer functions are implemented outside the B-ISDN. This case is illustrated in figures 2a and 2b.



a: FRBS provided by FRSF outside B-ISDN



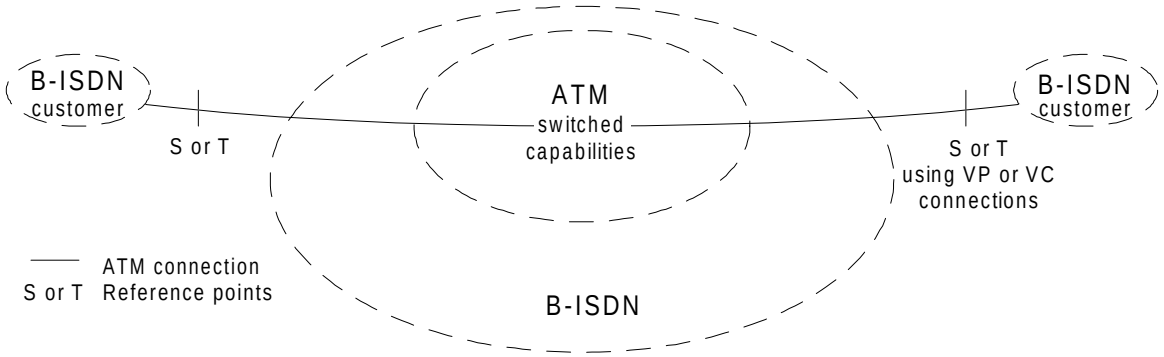
b: Protocol stack of FRBS provided by FRSF outside B-ISDN

Figure 2

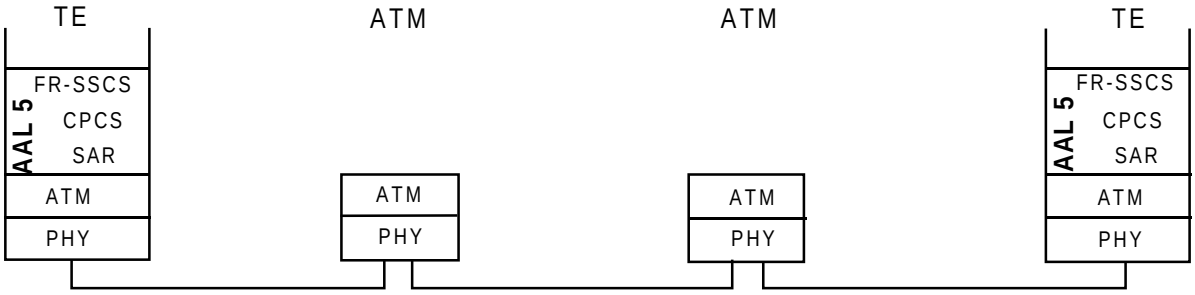
The requirements on the ATM layer are the same as in subclause 4.1.1.

4.1.3 Frame relay protocol support via ATM bearer capabilities

A frame relay protocol may also be carried by ATM bearer capabilities as shown in figures 3a and 3b. In this case a transparent connection of the ATM layer, either permanent, reserved or on demand, is used between B-ISDN UNIs (at reference point S_B/T_B). Frame relay protocols operating on and above the adaptation layer are transparent to the B-ISDN and they are implemented in the Terminal Equipments (TEs) at B-ISDN UNIs.



a: A frame relay protocol carried by an ATM bearer service



b: Protocol stack of frame relay protocol carried by an ATM bearer service

Figure 3

The switching and statistical multiplexing is done at the ATM level. Optionally a VBR VC bearer service should be deployed. The preliminary list of requirements for such a VBR service is as follows:

- Virtual Channel Identifier (VCI) based switching;
- isolation between connections: e.g. usage parameter control, network parameter control;
- delay and delay variation;
  adapted to data applications;
- network congestion: the random discarding of cells can badly impact the PDU loss rate and hence discarding of cells may take into account the AAL5-SAR structure;
- a minimum bandwidth requirement per connection has to be met.

5 Interfaces and protocols

5.1 Frame Relay B-ISDN Access Interface (FR-BAI)

Frame relay direct provision is performed through the use of specialised network functions (FRSF). User equipment may have direct access to the equipment realizing FRSF at the S_B/T_B reference points. The protocol stack includes the UNI physical and ATM layer both in the user equipment on one side of the FR-BAI and in the network equipment realizing FRSF on the other side. Usage Parameter Control (UPC) functions, as foreseen for ATM user access, are performed on the network side of the FR-BAI.

Indirect user access to the FRSF through one or more ATM nodes is also possible. In this case the interface between the user equipment and the adjacent ATM node is defined at the S_B/T_B reference points, while that between the equipment realizing the FRSF and the adjacent ATM node(s) is defined at the P/M reference points.

At the S_B/T_B reference points, the physical and ATM layer of the FR-BAI stack are terminated in the user equipment and the ATM node(s). They are based on the ATM UNI. UPC functions as foreseen for ATM user access are performed by the ATM network elements at the network side of the UNI.

At the P/M reference points, the physical and ATM layer of the FR-BAI stack are terminated in the equipment realizing FRSF and the ATM node(s) and are based on the ATM Network Node Interface (NNI).

The functions performed by the frame relay specific layer (AAL 5 SAR, CPCS and Frame Relay Service Specific Convergence Sublayer (FR-SSCS)) are the same both in the direct and indirect access cases. The protocol stack for the direct and indirect access is shown in figure 4. The FR-SSCS protocol functions and elements are defined in subclause 5.3.

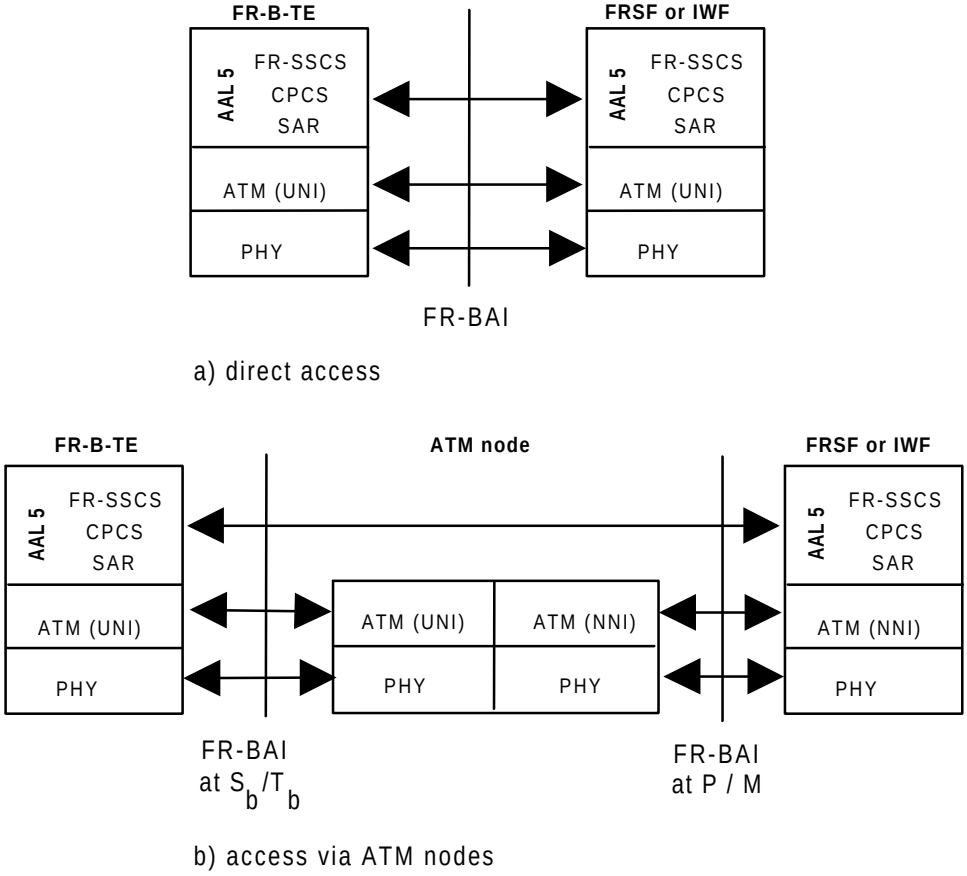


Figure 4: Frame Relay Broadband Access Interface (FR-BAI) U-plane protocol reference architecture

5.1.1 Physical Layer

All B-ISDN physical layer specifications are applicable (e.g. ETS 300 300 [3] and ETS 300 299 [2], ETS 300 337 [4], ITU-T Recommendations G.804 [9] and G.832 [10]).

5.1.2 ATM layer

As defined in ETS 300 298-2 [1].

5.1.3 AAL

5.1.3.1 AAL5 SAR and CPCS

As defined in ETS 300 428 [6].

5.1.3.2 FR-SSCS

As defined in subclause 5.3.

5.2 Frame relay B-ISDN Network-to-Network Interface (FR-BNNI)

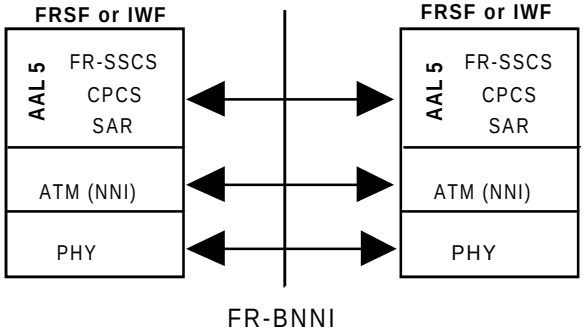
The FR-BNNI supports frame relay service provision, allowing transfer of frame relay service data units within the ATM network.

The FR-BNNI protocol stack is based on the ATM Network Node Interface (NNI).

Equipment realizing the FR-BNNI stack may be connected directly. Indirect linking through one or more ATM nodes is also possible.

The U-plane protocol reference architecture for the FR-BNNI is given in figure 5.

a) direct access



b) access via ATM nodes

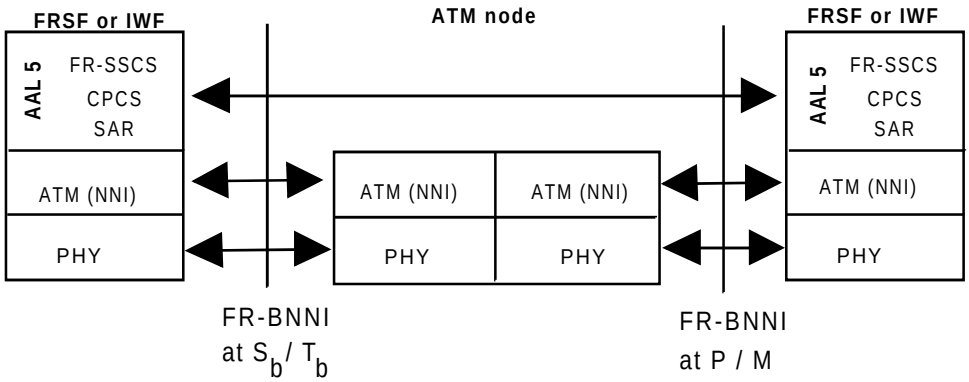


Figure 5: FR-BNNI U-plane protocol reference architecture

5.2.1 Physical Layer

All B-ISDN physical layer specifications are applicable (e.g. ETS 300 300 [3] and ETS 300 299 [2], ETS 300 337 [4], ITU-T Recommendations G.804 [9] and G.832 [10]).

5.2.2 ATM layer

As defined in ETS 300 298-2 [1].

5.2.3 AAL

5.2.3.1 AAL5 SAR and CPCS

As defined in ETS 300 428 [6].

5.2.3.2 FR-SSCS

As defined in subclause 5.3.

5.3 FR-SSCS

NOTE: This subclause is in line with ITU-T Recommendation I.365.1 [14], but they are not exactly the same.

The FR-SSCS is located in the upper part of the AAL on top of the Common Part Convergence Sublayer (CPCS) of AAL type 5, as specified in ITU-T Recommendation I.363 [13], § 6 and shown in figures 6 and 7. The FR-SSCS is used at the B-ISDN TE to emulate the FRBS in B-ISDN. It is also used for interworking between a B-ISDN and a frame relay network.

5.3.1 Service provided by FR-SSCS

At the DL-CORE-SAP the FR-SSCS provides the core service as described in of CCITT Recommendation I.233.1 [11], annex C. The core service primitives, exchanged between the core service user and the core service provider (FR-SSCS) are summarized in table 1 according to the table contained in CCITT Recommendation Q.922 [19], § A.4.2.2. The primitives and their parameters are described in detail in of CCITT Recommendation I.233.1 [11], annex C (see figure 6).

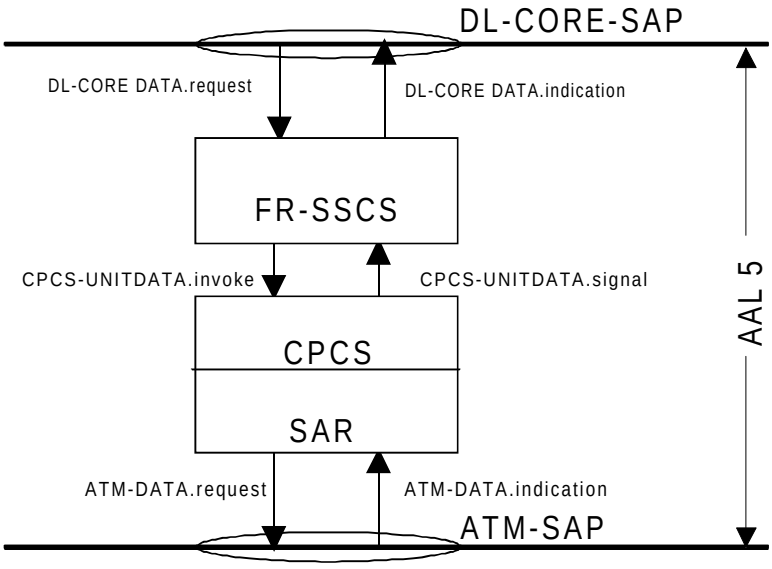


Figure 6: Location of the FR-SSCS in the B-ISDN protocol reference model for a B-ISDN TE

The exchange of information at the Frame Relay Interworking Point (FR-IWP) is described by IWF-DATA.indication and IWF-DATA.request primitives (figure 7). The parameters of those primitives are contained in table 2.

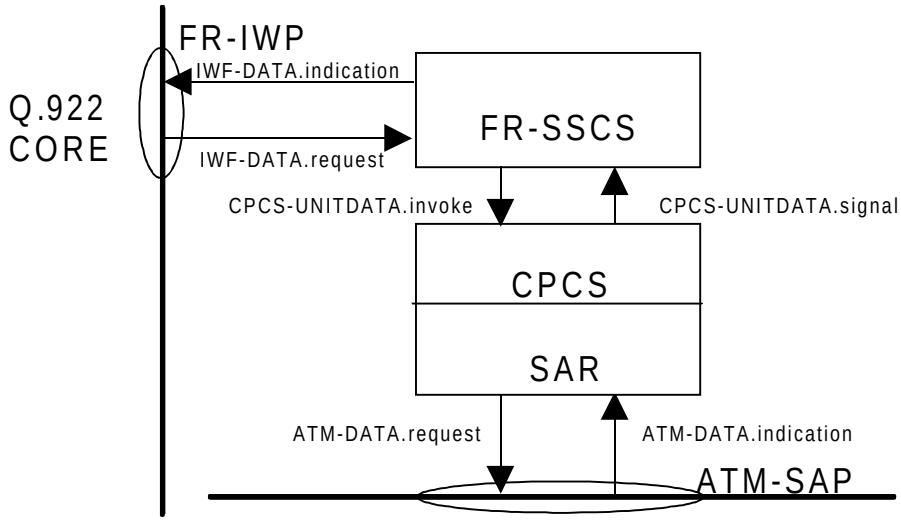


Figure 7: Location of the FR-SSCS in the B-ISDN protocol reference model for the IWF between a frame relay network and a B-ISDN and for the FRSF supporting FRBS on B-ISDN

The FR-SSCS preserves the FR-SSCS-SDU sequence integrity. It uses the CPCS message mode service without the corrupted data delivery option.

5.3.1.1 Primitives

The primitives exchanged across the DL-CORE-SAP are described in table 1.

Table 1: Core service primitives and parameters at the DL-CORE-SAP

Primitive Parameter (note)	DL-CORE DATA. request	DL-CORE DATA. indication	FR-SSCS-PDU field
DL-CORE user data	X	X	Information field
Discard Eligibility	X		DE
Congestion encountered backward		X	BECN
Congestion encountered forward		X	FECN
DL-CORE-Service-User protocol control information	X	X	C/R bit
X: parameter is present			
NOTE: Whether the DL-CORE control parameter and the DLCI or DL-CORE control indicator parameter are included in the DL-CORE DATA primitives is for further study.			

The primitives exchanged across the FR-IWP are described in table 2.

Table 2: Primitives and parameters at the FR-IWP

Primitive Parameter	IWF-DATA. request	IWF DATA. indication	FR-SSCS-PDU field
DL-CORE user data	X	X	Information field
Discard Eligibility	X	X	DE
Congestion encountered backward	X	X	BECN
Congestion encountered forward	X	X	FECN
DL-CORE-Service-User protocol control information	X	X	C/R bit
DLCI or DL-CORE control indicator (note 1)	X	X	D/C
DL-CORE control (note 2)	X	X	DL-CORE control
X: parameter is present			
NOTE 1: If this parameter is set = C it indicates the existence of the DL-CORE control parameter.			
NOTE 2: This parameter only exists as indicated by the DLCI or DL-CORE control indicator parameter.			

The primitives exchanged across the boundary between the FR-SSCS and the CPCS of AAL type 5 are described in ITU-T Recommendation I.363 [13], § 6.1.2.2.1.

5.3.1.2 Description of connections

Multiple FR-SSCS connections may be associated with a single CPCS connection (and with the corresponding ATM connection), allowing multiplexing at the FR-SSCS. Within a CPCS connection the FR-SSCS connections are uniquely identified by the Data Link Connection Identifiers (DLCIs).

5.3.2 Interaction with the management and control plane

For further study.

5.3.3 Functions, structure and coding of FR-SSCS

5.3.3.1 Functions in FR-SSCS

The functions provided by the FR-SSCS include:

a) Multiplexing/demultiplexing

This function provides the capability to multiplex multiple FR-SSCS connections into a single CPCS connection.

b) Inspection of the FR-SSCS-PDU length

These functions inspect the FR-SSCS-PDU to ensure that it consists of an integral number of octets and to ensure that it is neither too long nor too short as specified in CCITT Recommendation I.233.1 [11].

c) Congestion control

These functions provide the means for the network to notify the end user, in forward and backward direction, that congestion avoidance procedures should be initiated, where applicable (congestion control forward and congestion control backward). In addition the functions provide the means for the end user and/or the network to indicate what frames should be discarded in preference to other frames in a congestion situation (congestion control discard eligibility). Congestion management procedures are described in CCITT Recommendation I.370 [15].

5.3.3.2 FR-SSCS-PDU structure and coding

The peer-to-peer communication between FR-SSCS entities uses FR-SSCS-PDUs. The format of the FR-SSCS-PDU structure is shown in figure 8.

NOTE: The structure is exactly the same as the CCITT Recommendation Q.922 [19] frame relay frame without the flags, ZERO bit insertion and FCS. The details of the formats and the coding of the fields are given in CCITT Recommendation Q.922 [19], § A.3.

As every octet of an ATM-PDU is defined to be transmitted from the Most Significant Bit (MSB) to the Least Significant Bit (LSB), the FR-SSCS-PDU in the ATM-PDU is also to be transmitted from MSB to LSB. Though this bit transmission order is different from that of CCITT Recommendation Q.922 [19], the user of the FR-SSCS should regard the transmission order of the FR-SSCS to be the same as CCITT Recommendation Q.922 [19], as the original bit order is restored after receipt.

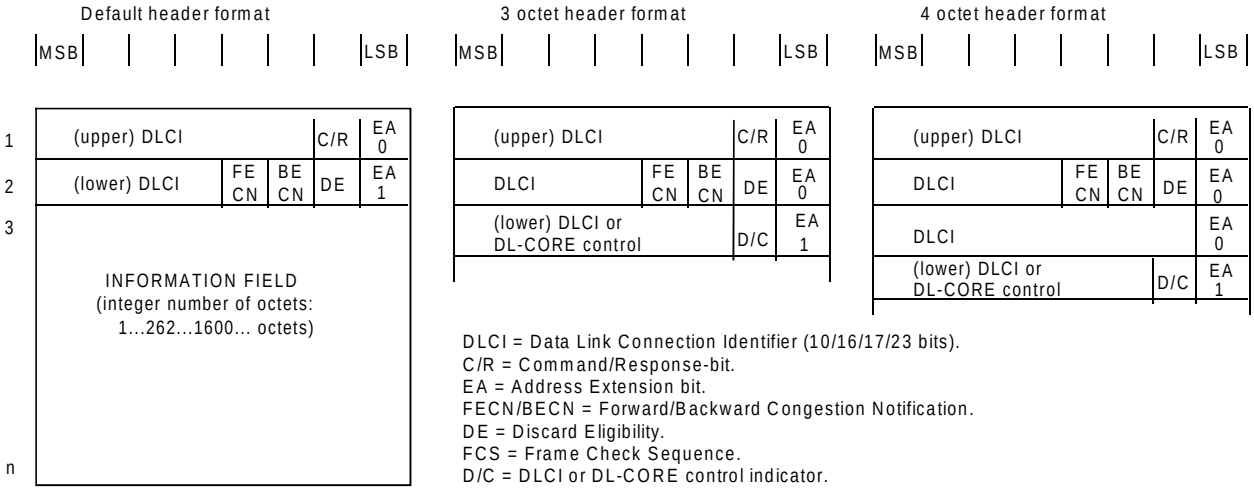


Figure 8: Structure of FR-SSCS-PDU with 2, 3 and 4 octet header formats

The support of the default (2 octet) header format is mandatory. The support of 3 and 4 octet header formats is optional.

5.3.4 Procedures for the FR-SSCS

5.3.4.1 State variable

Most_recent_CI_received:

This variable is initialized to "0". This variable records the value of the CPCS-CI parameter of the most recent CPCS-UNITDATA.signal primitive received for this CPCS connection in the reverse direction.

5.3.4.2 Procedures at the sender side

When FR-SSCS receives:

- a DL-CORE DATA.request from the core service user in a B-TE; or
- a IWF-DATA.request from the CCITT Recommendation Q.922 [19] CORE in a IWF,

it shall construct the FR-SSCS-PDU as specified in table 3, according to the format in figure 8.

Table 3: Values for the FR-SSCS-PDU at the sender side

	VALUE set by the FR-SSCS	
FR-SSCS-PDU FIELD	**in B-TE**	**in IWF or in FRSF**
DLCI	is set to the value which is associated to the FR-SSCS connection during the connection set-up or at the subscription	(as in B-TE)
C/R	is set to the value of the parameter DL-CORE-Service-User protocol control information	(as in B-TE)
FECN	is set to "0"	is set to the value of the parameter Congestion encountered forward. It may also be set in case of internal congestion of the equipment.
BECN	is set to "0" or optionally to the value of the variable Most_recent_CI_received (see note)	is set to logical OR of the values of the variable Most_recent_CI_received and the parameter Congestion encountered backward. It may also be set in case of internal congestion of the equipment.
DE	is set to the value of the parameter Discard Eligibility	(as in B-TE)
DL-CORE control	for further study	(as in B-TE)
D/C	is set to indicate whether the last header octet is negotiated during the connection set-up or at subscription to contain DLCI bits or the DL-CORE control field	(as in B-TE)
EA	is set to "0" at the first octet(s) of the header and to "1" at the last octet of the header	(as in B-TE)
Information field	is set to the value of the parameter DL-CORE user data	(as in B-TE)
NOTE: The BECN setting is a terminal option.		

The FR-SSCS-PDU is then forwarded to the CPCS sublayer in the Interface Data (ID) parameter of the CPCS-UNITDATA.invoke primitive. Other parameters of that primitive are set as follows:

- the CPCS - Loss Priority (CPCS-LP) parameter is either:

  case a) set to the value of the parameter Discard Eligibility of the DL-CORE DATA.request primitive or the IWF-DATA.request primitive; or
  case b) always set to "0";
  case c) always set to "1".

  All options above shall be supported, so that it can be negotiated at connection set-up or subscription on a CPCS connection by CPCS connection basis which one is used;

- the CPCS - Congestion Indication (CPCS-CI) parameter is always set to "0";

- the CPCS - User-to-User Indication (CPCS-UU) parameter is always set to "0".

5.3.4.3 Procedures at the receiver side

Upon reception of a CPCS-UNITDATA.signal primitive, the variable Most_recent_CI_received is set to the value of the parameter CPCS - Congestion Indication (CPCS-CI) and the FR-SSCS-PDU is extracted from the parameter ID. The FR-SSCS-SDU, contained in the FR-SSCS-PDU information field is then passed:

- to the upper layer, in the case of a B-TE, using the DL-CORE DATA.indication primitive; or

- to the CCITT Recommendation Q.922 [19] CORE, in the case of a IWF, using the IWF-DATA.indication primitive.

The parameters of the primitives are defined in table 4.

Table 4: Values for the parameters of DL-CORE DATA.indication and IWF-DATA.indication primitives at the receiver side

Parameters:	**DL-CORE DATA.indication primitive (B-TE)**	**IWF-DATA.indication primitive (IWF or FRSF)**
DL-CORE user data	FR-SSCS-SDU (information field)	(as in B-TE)
Discard Eligibility	see note 1	see note 2
Congestion encountered backward	is set to the value of the BECN field in the FR-SSCS-PDU	(as in B-TE)
Congestion encountered forward	is set to the logical OR of the values of the FECN field in the FR-SSCS-PDU and the parameter CPCS-CI of the CPCS-UNITDATA.signal primitive	(as in B-TE)
DL-CORE-Service-User protocol control information	is set to the value of the C/R field in the FR-SSCS-PDU	(as in B-TE)
DLCI or DL-CORE control indicator	(for further study)	is set to the value of the D/C field in the FR-SSCS-PDU
DL-CORE control	(for further study)	is set to the value of the DL-CORE control field in the FR-SSCS-PDU, if present

NOTE 1: At the receiver side of the B-TE the information in the CPCS-LP parameter at the FR-SSCS may be conveyed to other entities, e.g. management.

NOTE 2: At the receiver side of the IWF or FRSF the Discard Eligibility (DE) parameter shall be set to either:

case d) the value of the DE field in the FR-SSCS-PDU; or

case e) the logical OR of the values of the DE field in the FR-SSCS-PDU and the parameter CPCS-LP of the CPCS-UNITDATA.signal primitive.

Both cases d) and e) above shall be supported by the IWF or FRSF so that it can be negotiated at connection set-up or subscription on a CPCS connection by CPCS connection basis which one is used.

5.3.4.4 Summary of parameters and values on the FR-SSCS connections

The information in table 5 needs to be known at CPCS-connection establishment and the value of the parameters for all FR-SSCS connections on a single CPCS-connection are the same.

Table 5: Parameters and values on a CPCS connection

Option parameter	Significance	Value/range	Reference
CPCS-LP parameter setting (see note 1)	Local sender	a) Discard Eligibility parameter b) "0" c) "1"	5.3.4.2
Discard Eligibility parameter setting (see note 1)	Local receiver	d) DE field (default, see note 2) e) DE field (logical OR) CPCS-LP parameter	5.3.4.3
NOTE 1: The values applied for these two parameters are independent. However some combinations depending on ATM connection characteristics may not be meaningful. NOTE 2: When the characteristics of the overall ATM-connection (expanded over more than 1 network) are not completely known, the default option shall be applied.			

Information on table 6 needs to be known at a FR-SSCS connection establishment.

Table 6: Parameters and values on a FR-SSCS connection

Option parameter	Significance	Value/range	Reference
Max CPCS-SDU length	peer-to-peer	[1 604 - (64k-1)] octets	I.363, § 6
Max FR-SSCS-SDU length (see note)	peer-to-peer	[1 600 - (64k-5)] octets	5.3.3.2
I.363: ITU-T Recommendation I.363 [13]. NOTE: The value of this parameter shall always be lower than or equal to the value of the max CPCS-SDU length - 4.			

5.3.5 Frame Relay Permanent Virtual Connection (FR-PVC) monitoring

The following guidelines are identified in order to simplify the procedures necessary for the connection monitoring:

- management of the ATM layer and the FR-PVC monitoring of the FR-SSCS shall be regarded as being *decoupled*. Each layer has its own responsibility for the layer management (e.g. some functions of the management in the ATM layer will be performed by the usage of OAM cell flow);

- permanent virtual connection monitoring procedures discussed here only cover the FR-PVC carried by the ATM-network;

- management of the FR-SSCS shall be performed by symmetric PVC management procedures adopted from ITU-T Recommendation Q.933 [20]. The messages shall be significant for the VCC carrying the messages. This shall apply also for the B-ISDN TE. This also covers the case given in subclause 4.1.3.

- for FR-BAI in the cases given in subclauses 4.1.1 and 4.1.2, the management of the FR-SSCS may be, on a bilateral agreement basis, optionally performed by asymmetric PVC management procedures equivalent to procedures in ITU-T Recommendation Q.933 [20], annex A.

- for FR-PVC monitoring of frame relay connections carried by an ATM VCC, DLCI = 0 is used to identify and exchange FR-PVC monitoring messages between IWF(s) and/or B-ISDN TE(s) emulating frame relay (frame relay B-ISDN TE) and/or FRSF(s). All FR-PVC monitoring messages created by the FR-SSCS are transported transparently across the ATM network.

The symmetric management procedures are given in annex A.

6 Interworking

Frame relay interworking between B-ISDN and other networks (N-ISDN, PDN providing Frame Relay Data Transmission Service (FRDTS) and PN) is described is this clause.

6.1 Interworking configurations

Figure 9 shows possible configurations for the frame relay interworking between B-ISDN and other networks which provide frame relay service.

The networks are:

- B-ISDN providing FRBS;

- ISDN providing FRBS;

- Public Data Network (PDN) providing FRDTS; and

- Private Network (PN).

The Interworking Functions (IWFs) shown in figure 9 have the same functionalities in the U-plane but may differ in the C-plane and/or M-plane. The figure is not fully exhaustive, but details on all interworking cases are given in the following subclauses of this ETS.

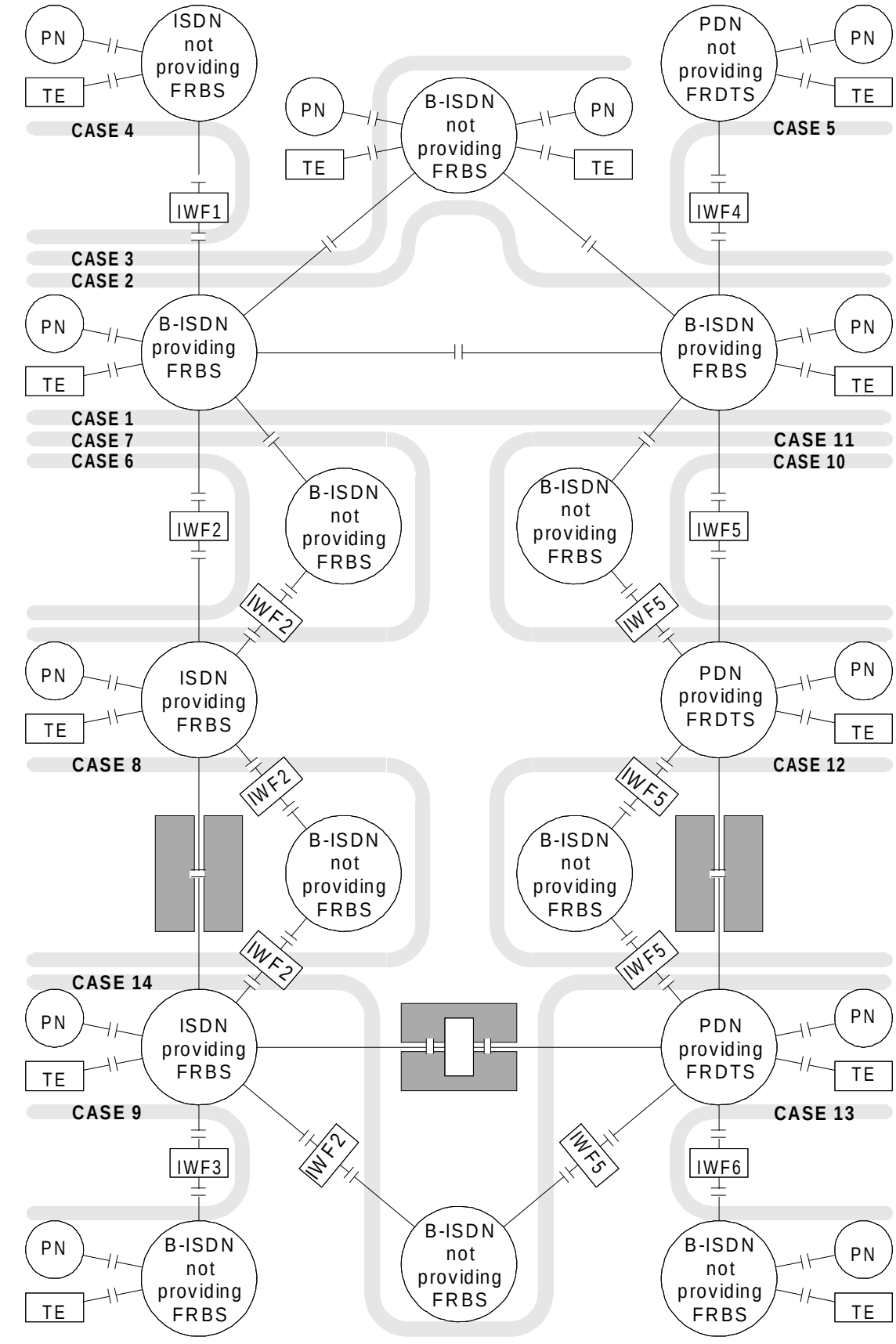
NOTE: Any of the IWFs shown in this figure can be physically integrated with one or the other of the connected networks.

The interworking between B-ISDN and another networks, ISDN and PDN (providing or not providing frame relay services), is performed by:

- transferring unchanged the information field of the Protocol Data Units (PDU) between the FR-SSCS and CCITT Recommendation Q.922 [19] core; and

- the Protocol Control Information (PCI) derived from the headers of the two interworked protocols (FR-SSCS and CCITT Recommendation Q.922 [19] core) is exchanged via parameters in primitives. These parameters are processed to create the header of the PDU in each of the interworked protocols. In the FR-SSCS, some of the parameters are also mapped to the parameters exchanged with the AAL type 5 CPCS. The mapping of the parameters exchanged between the CCITT Recommendation Q.922 [19] core and the FR-SSCS to/from the parameter exchanged with the AAL type 5 CPCS is described in clause 5. The format of the header of the interworked protocols is defined in CCITT Recommendation Q.922 [19].

Additional functionalities to allow interworking with PN are for further study.



These interworking cases are not defined in this ETS

Figure 9: Frame relay interworking configurations

6.2 General principles

6.2.1 Multiplexing of FRBS over B-ISDN

There are two schemes of multiplexing FRBS connections over B-ISDN:

- multiplexing at the FR-SSCS:
  - a number of frame relay logical connections are multiplexed into a single ATM virtual channel connection. Multiplexing is accomplished at the FR-SSCS using DLCIs. This is illustrated in figure 10;
- multiplexing at the ATM layer:
  - each frame relay logical connection is mapped to a single ATM virtual channel connection and multiplexing is accomplished at the ATM layer using Virtual Path Identifier/Virtual Channel Identifier (VPI/VCI). This is illustrated in figure 11.

In both multiplexing schemes, the FRBS connections are identified by the CCITT Recommendation Q.922 [19] core DLCI. The FR-SSCS links are identified by VPI/VCI and FR-SSCS DLCIs for the first multiplexing scheme. The FR-SSCS links are identified by VPI/VCIs for the second multiplexing scheme (DLCI value at the FR-SSCS does not convey additional information).

All the above mentioned link identifiers have only local significance and their values have to be negotiated by subscription for both sides of the IWF.

In both multiplexing schemes, the DLCI value(s) used between two FR-SSCS entities (IWFs or FR-B-ISDN TEs) shall be agreed upon. The same FR-PVC monitoring procedures shall apply for both multiplexing schemes.

The first scheme of multiplexing (DLCI-based multiplexing) may only be used for FRBS VCs that terminate on the same ATM based end-systems (i.e. end-users or IWFs). FRBS VCs from a single source that terminate on different ATM-based end-systems shall be mapped to different ATM connections. In this case, the second scheme of multiplexing or a combination of the two schemes can be used.

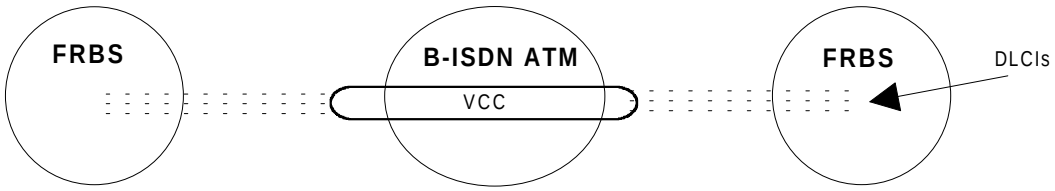


Figure 10: Multiple DLCIs multiplexed on a single ATM virtual channel connection

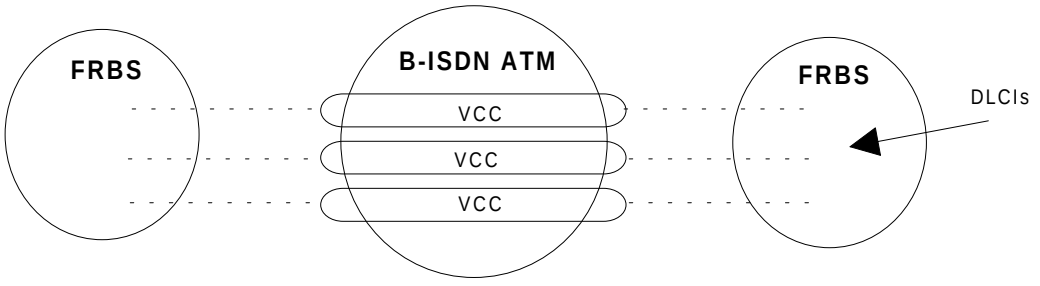


Figure 11: Each DLCI mapped into a separate ATM virtual channel connection

6.2.2 Congestion management strategy

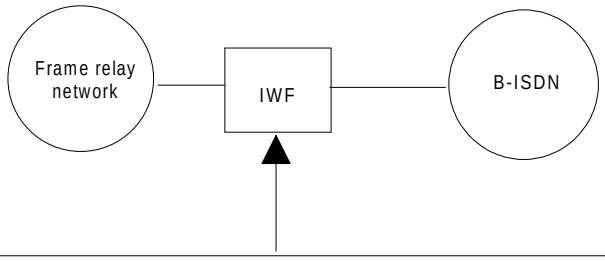
The recommended congestion management strategy for the two multiplexing methods is as follows:

At the ingress point of the B-ISDN, in the first scheme the VCC may be composed of a large number of frame relay connections multiplexed to form a VCC. In the second scheme, a VPC may be composed of a large number of VCCs carrying frame relay traffic. If the number of frame relay connections or the number of VCCs is in fact large, then according to the law of large numbers the resultant combined traffic over the ATM VCC or the VPC behave almost as constant bit rate. As a consequence, statistical smoothing of the aggregate traffic at the ingress point to the B-ISDN will enable resource management on peak bandwidth allocation of the VCC or VPC, respectively, to achieve acceptable efficiency. The frame relay network congestion management option would then operate as usual. The FECN and BECN parameter values are not mapped to the AAL5 CPCS and ATM layer. However, congestion indication generated by the B-ISDN shall be taken into account when generating FECN/BECN towards the frame relay networks. This approach provides an averaged QoS over all ATM connections for frame relay carriage, and uses the preventative control of network resource management concept described in CCITT Recommendations I.370 [15] and I.371 [16].

6.2.3 Interworking of Loss Priority and Congestion Indication

6.2.3.1 Summary of Loss Priority Mapping

This subclause summarizes the Loss Priority Mapping as specified in subclause 5.3 (FR-SSCS) and the mapping of the DE bit at the Interworking Function to CPCS-LP and vice versa, as illustrated in figures 12 and 13. The input column of the figures reflects the input parameter of the IWF and the output column the output parameter of the IWF.

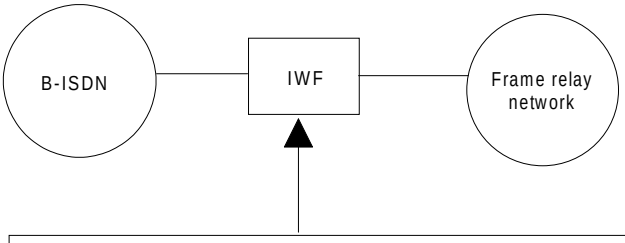


Mapping of DE to CPCS-LP

Input	*Intermediate*	*Output*			
Q.922 core	**FR-IWP** IWF-DATA. request	**FR-SSCS** mapped to FR-SSCS PDU header	**CPCS** CPCS-UNITDATA.invoke		
DE	*Discard Eligibility*	*DE*	*CPCS-LP* (note)		
			Case a)	Case b)	Case c)
0	0	0	0	0	1
1	1	1	1	0	1

NOTE: An explanation of cases a), b) and c) can be found in subclause 5.3.4.2 and table 3.

Figure 12: Loss Priority mapping at the sender side (Direction frame relay to B-ISDN)



Mapping of CPCS-LP to DE

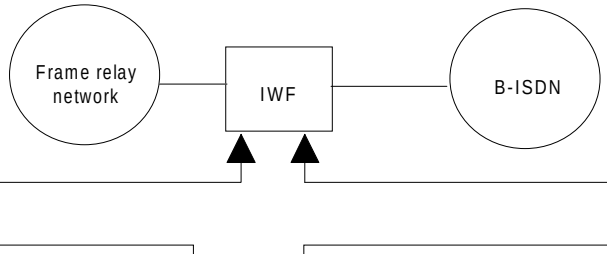
Input		*Intermediate*		*Output*	
CPCS CPCS-UNITDATA. signal	**FR-SSCS** from FR-SSCS PDU header	**FR-IWP** IWF-DATA.indication		**Q.922 core**	
CPCS-LP	*DE*	*Discard Eligibility*		*DE* (note)	
		Case d)	Case e)	Case d)	Case e)
0	0	0	0	0	0
X	1	1	1	1	1
1	0	0	1	0	1

NOTE: Explanation of cases d) and e) can be found in subclause 5.3.4.3 and table 4.

Figure 13: Loss Priority mapping at the receiver side (Direction B-ISDN to FR)

6.2.3.2 Summary of Congestion Indication Mapping

This subclause summarizes the Congestion Indication Mapping as specified in subclause 5.3 (FR-SSCS) and the mapping of the FECN/BECN bit at the Interworking Function to CPCS-CI and vice versa, as illustrated in figures 14 and 15.



Mapping of FECN to CPCS-CI

Input	*Intermediate*	*Output*	
Q.922 core	**FR-IWP** IWF-DATA. request	**FR-SSCS** mapped to FR-SSCS PDU header	**CPCS** CPCS-UNITDATA. invoke
FECN	*CEF*	*FECN*	*CPCS-CI*
0	0	0	0
1	1	1	0

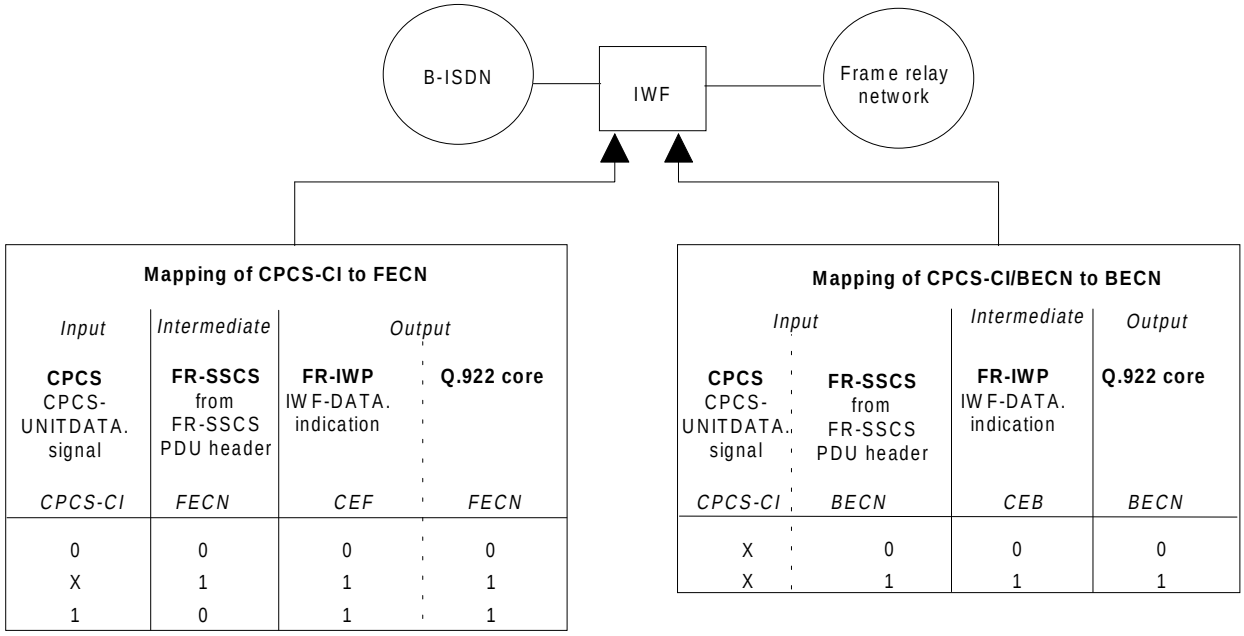
Mapping of BECN/CPCS-CI to BECN

Input		*Intermediate*	*Output*
Q.922 core	**CPCS** most_recent_ CI_received (note)	**FR-IWP** IWF-DATA. request	**FR-SSCS** mapped to FR-SSCS PDU header
BECN	*CPCS-CI*	*CEB*	*BECN*
0	0	0	0
1	0	1	1
X	1	X	1

X: 0 or 1.
CEB: Congestion Encountered Forward
CEF: Congestion Encountered Backward

NOTE: As recorded from the value of the CPCS-CI parameter of the most recent CPCS-UNITDATA.signal primitive received from the reverse direction (see subclause 5.3.4.1).

Figure 14: Congestion Indication mapping at the sender side (Direction frame relay to B-ISDN)



CEB: Congestion Encountered Forward
CEF: Congestion Encountered Backward

Figure 15: Congestion Indication mapping at the receiver side (Direction B-ISDN to FR)

6.3 Interworking between B-ISDNs

In this subclause, interworking is described between different B-ISDNs.

6.3.1 Interworking in the U-plane

There are two interworking scenarios for interworking between two B-ISDNs providing FRBS and three scenarios where the terminal is attached to a network not providing frame relay services:

case 1: Direct interconnection between two B-ISDNs providing FRBS;

case 2: Interconnection between two B-ISDNs providing FRBS via a B-ISDN not providing FRBS;

case 3: B-ISDN providing FRBS servicing a terminal attached to a B-ISDN not providing FRBS;

case 4: B-ISDN providing FRBS servicing a terminal attached to an ISDN not providing FRBS;

case 5: B-ISDN providing FRBS servicing a terminal attached to a PDN not providing FRDTS.

The FR-BAI and the FR-BNNI are defined in clause 5.

6.3.1.1 Direct interconnection between two B-ISDNs providing FRBS (case 1)

Figure 16 represents the case where two B-ISDNss providing FRBS are directly interconnected. In this case, no interworking functions are required.

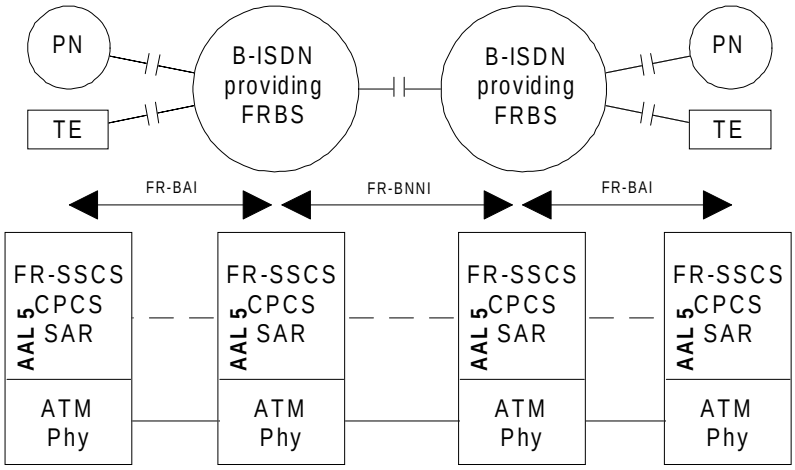


Figure 16: Case 1: Direct interconnection between two B-ISDNs providing FRBS

6.3.1.2 Interconnection between two B-ISDNs providing FRBS via a B-ISDN not providing FRBS (case 2)

Figure 17 represents the case where two B-ISDNs providing FRBS are interconnected via a B-ISDN not providing FRBS. Also in this case, no interworking functions are required. The frame relay related interface FR-BNNI is deployed through the intervening network.

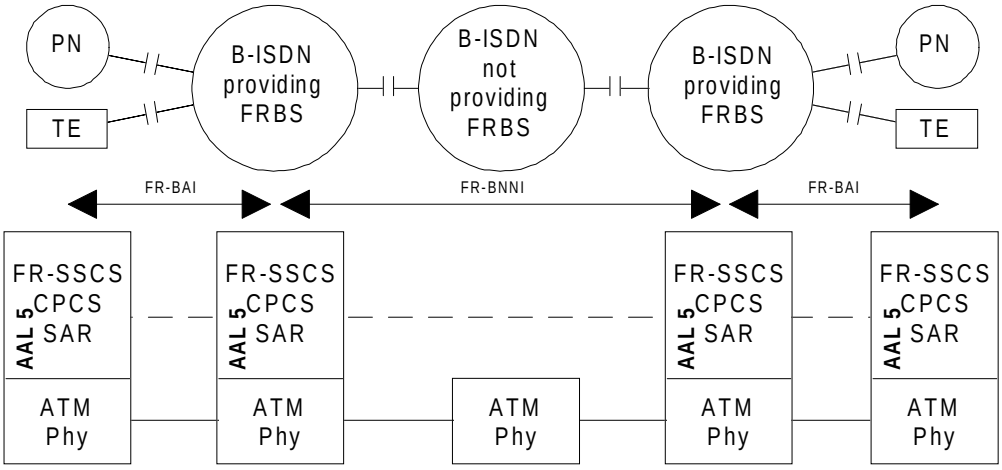


Figure 17: Case 2: Interconnection between two B-ISDNs providing FRBS via a B-ISDN not providing FRBS

6.3.1.3 B-ISDN providing FRBS servicing a terminal attached to a B-ISDN not providing FRBS (case 3)

Figure 18 represents the case where a B-ISDN frame relay terminal is served by a B-ISDN providing FRBS through a B-ISDN not providing FRBS. The frame relay related interface FR-BAI is deployed through the intervening network.

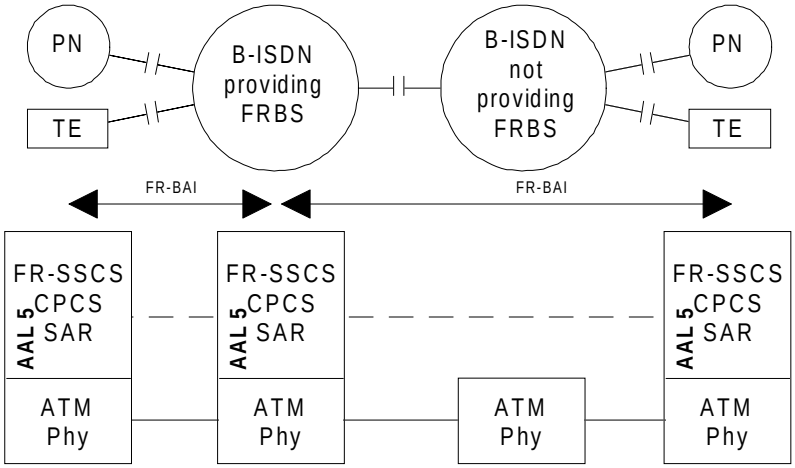
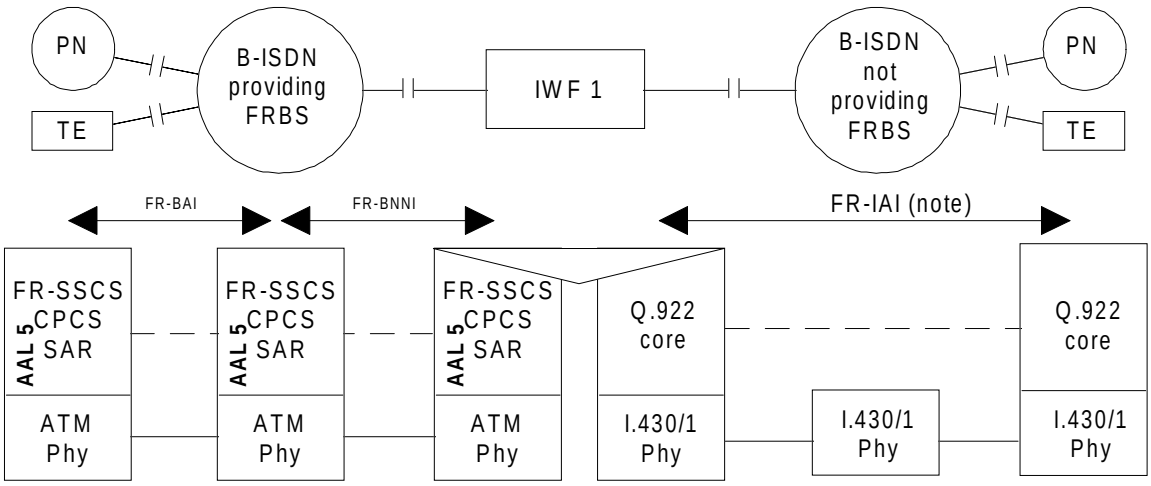


Figure 18: Case 3: B-ISDN providing FRBS servicing a terminal attached to a B-ISDN not providing FRBS

6.3.1.4 B-ISDN providing FRBS servicing a terminal attached to an ISDN not providing FRBS (case 4)

Figure 19 represents the case where a B-ISDN providing FRBS is servicing a terminal that is attached to an ISDN not providing FRBS. The Interworking Function 1 is performing the mapping between the frame relay related interfaces FR-BNNI and the Frame Relay ISDN Access Interface (FR-IAI). This interface is deployed through the intervening ISDN not providing FRBS.

NOTE: The FR-IAI is not defined in this ETS.

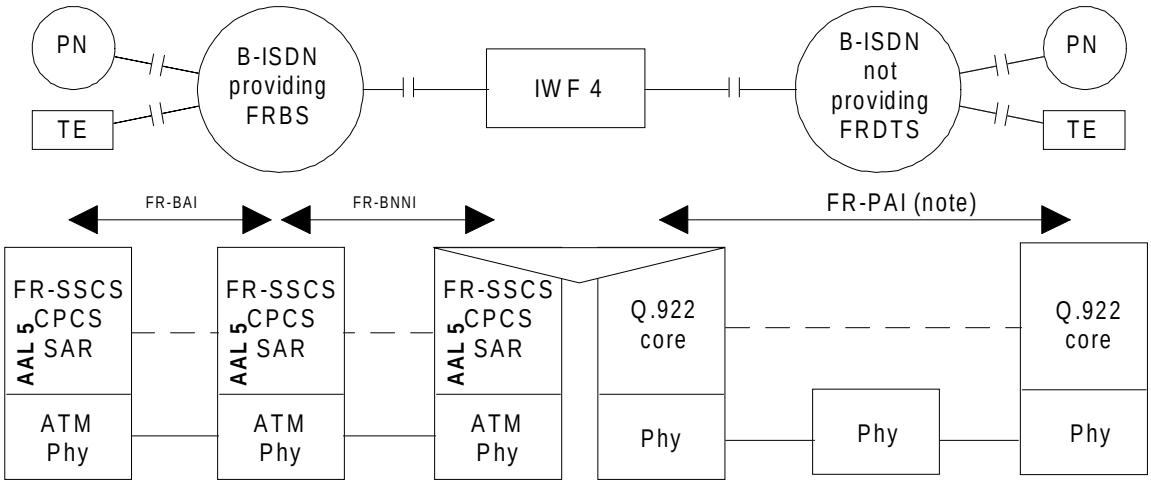


NOTE: The definition of this interface is outside the scope of this ETS.

Figure 19: Case 4: B-ISDN providing FRBS servicing a terminal attached to an ISDN not providing FRBS

6.3.1.5 B-ISDN providing FRBS servicing a terminal attached to a PDN not providing FRDTS (case 5)

Figure 20 represents the case where a B-ISDN providing FRBS is servicing a terminal that is attached to a PDN not providing FRDTS. The Interworking Function 4 is performing the mapping between the frame relay related interfaces FR-BNNI and the Frame Relay PDN Access Interface (FR-PAI). This interface is deployed through the intervening PDN not providing FRDTS (see note in figure 20).



NOTE: The definition of this interface is outside the scope of this ETS.

Figure 20: Case 5: B-ISDN providing FRBS servicing a terminal attached to a PDN not providing FRDTS

6.3.2 Interworking in the C-plane

For further study.

6.3.3 Interworking in the M-plane

For further study.

6.4 Interworking between ISDN FRBS and B-ISDN

In this subclause, interworking is described between ISDN FRBS and B-ISDN.

6.4.1 Interworking in the U-plane

There are two interworking scenarios for interworking between ISDN FRBS and B-ISDN FRBS, one interworking scenario for interworking between two ISDNs FRBS, and one scenario where the ISDN providing FRBS is servicing a terminal is attached to a B-ISDN not providing FRBS services:

case 6: Direct interworking between B-ISDN providing FRBS and ISDN providing FRBS;

case 7: Interworking between B-ISDN providing FRBS and ISDN providing FRBS via a B-ISDN not providing FRBS;

case 8: Interworking between two ISDNs providing FRBS via a B-ISDN not providing FRBS;

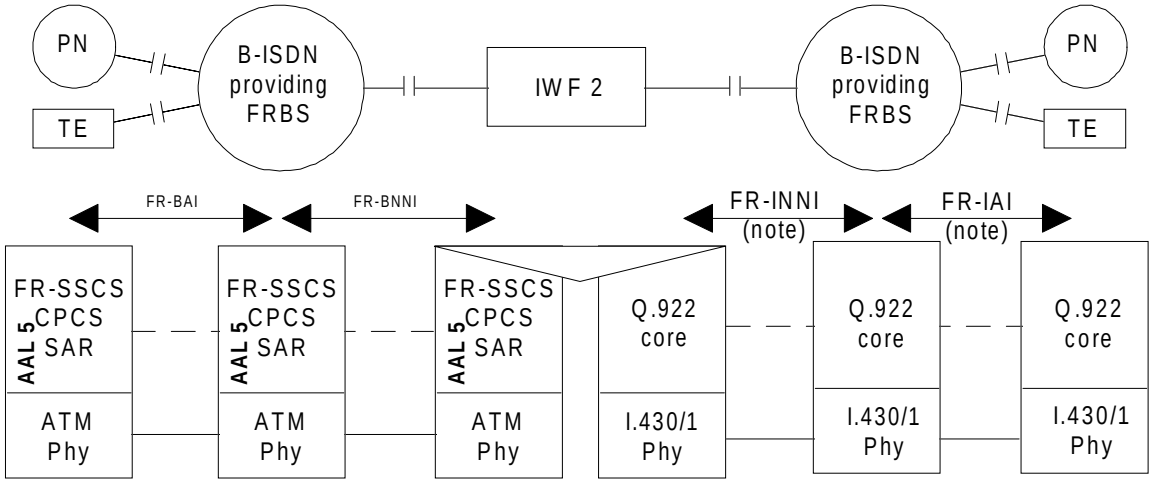
case 9: ISDN providing FRBS servicing a terminal attached to a B-ISDN not providing FRBS.

NOTE: Direct interconnection between two ISDNs providing FRBS is not covered in this ETS.

The FR-BAI and the FR-BNNI are defined in clause 5. The FR-IAI and the Frame Relay ISDN Network-to-Network Interface (FR-INNI) are not defined in this ETS.

6.4.1.1 Direct interworking between B-ISDN providing FRBS and ISDN providing FRBS (case 6)

Figure 21 represents the case where a B-ISDN providing FRBS is interconnected to an ISDN providing FRBS. The Interworking Function 2 is performing the mapping between the frame relay related interfaces FR-BNNI and the FR-INNI.



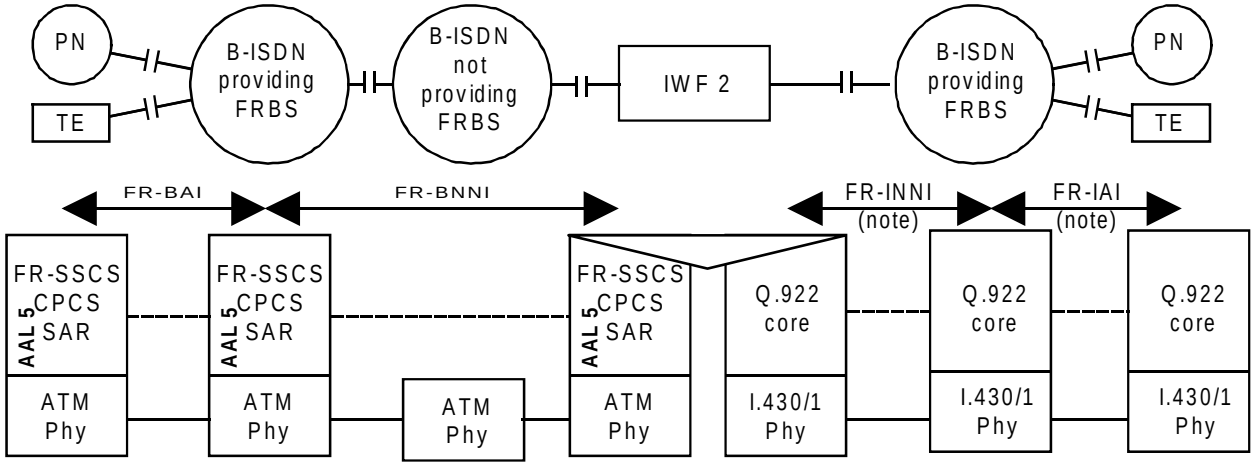
NOTE: The definition of this interface is outside the scope of this ETS.

Figure 21: Case 6: Direct interworking between B-ISDN providing FRBS and ISDN providing FRBS

6.4.1.2 Interworking between B-ISDN providing FRBS and ISDN providing FRBS via a B-ISDN not providing FRBS (case 7)

Figure 22 represents the case where a B-ISDN providing FRBS is interconnected to an ISDN providing FRBS via an intervening B-ISDN not providing FRBS. The Interworking Function 2 is performing the mapping between the frame relay related interfaces FR-BNNI and the FR-INNI. The (FR-BNNI is deployed through the intervening B-ISDN not providing FRBS.

NOTE: This case also covers the situation where two ISDNs providing FRBS are interconnected via a B-ISDN providing FRBS as every network with a frame relay service (e.g. the intervening B-ISDN providing FRBS) is able to act as a transit network.



NOTE: The definition of this interface is outside the scope of this ETS.

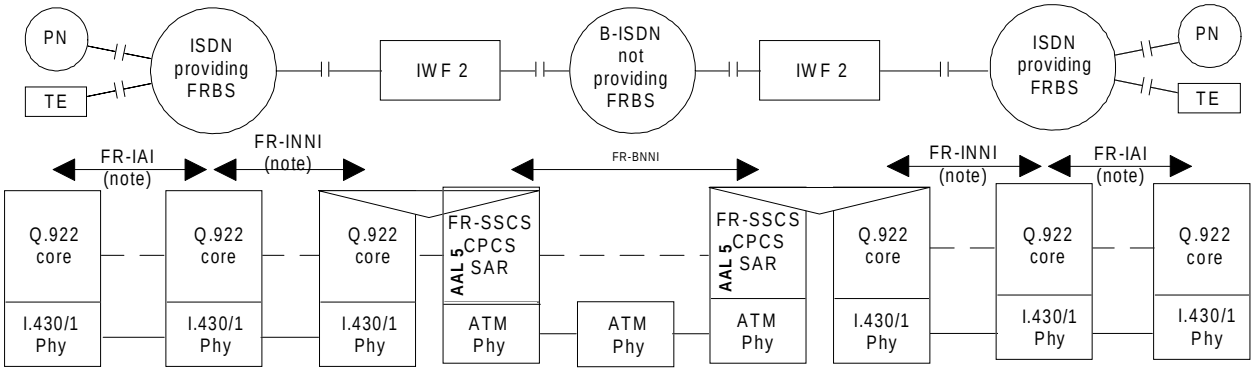
Figure 22: Case 7: Interworking between B-ISDN providing FRBS and ISDN providing FRBS via a B-ISDN not providing FRBS

6.4.1.3 Interworking between two ISDNs providing FRBS via a B-ISDN not providing FRBS (case 8)

Figure 23 represents the case where two ISDNs providing FRBS are interconnected via a B-ISDN not providing FRBS. Two Interworking Function 2 are performing the mapping between the frame relay related interfaces FR-INNI and FR-BNNI. The FR-BNNI is deployed through the intervening B-ISDN not providing FRBS.

NOTE 1: In ITU-T Recommendation I.555 [18], this case is named "Network Interworking Scenario 1".

NOTE 2: The B-ISDN may also provide FRBS, however, in this configuration it is utilized transparently. The use of the B-ISDN by the two ISDNs providing FRBS is not visible to the end users.



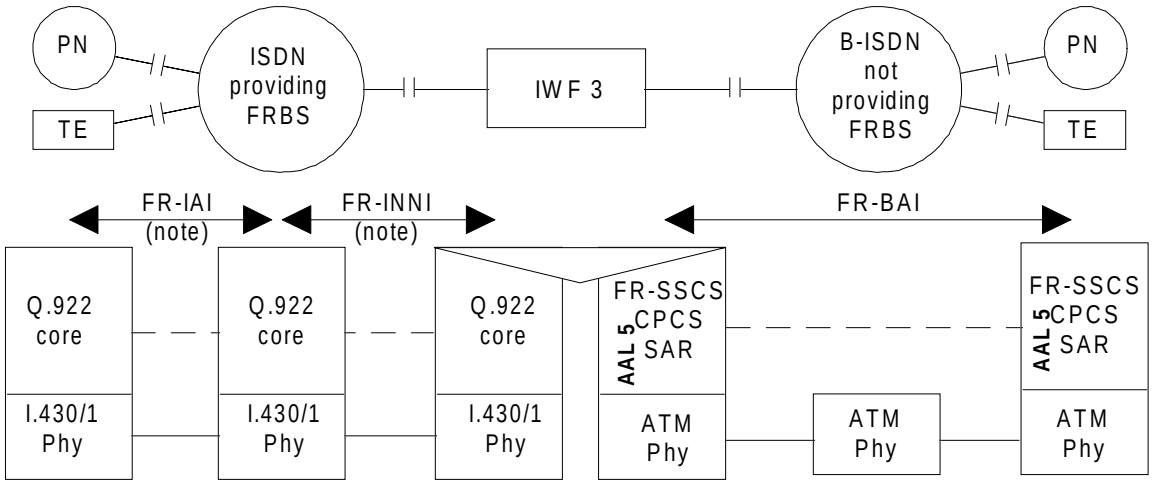
NOTE: The definition of this interface is outside the scope of this ETS.

Figure 23: Case 8: Interworking between two ISDNs providing FRBS via a B-ISDN not providing FRBS

6.4.1.4 ISDN providing FRBS servicing a terminal attached to a B-ISDN not providing FRBS (case 9)

Figure 24 represents the case where an ISDN providing FRBS is servicing a terminal that is attached to a B-ISDN not providing FRBS. The Interworking Function 3 is performing the mapping between the frame relay related interfaces FR-INNI and the FR-BAI. This interface is deployed through the intervening B-ISDN not providing FRBS.

NOTE: In ITU-T Recommendation I.555 [18], this case is named "Network Interworking Scenario 2".



NOTE: The definition of this interface is outside the scope of this ETS.

Figure 24: Case 9: ISDN providing FRBS servicing a terminal attached to a B-ISDN not providing FRBS

6.4.2 Interworking in the C-plane

For further study.

6.4.3 Interworking in the M-plane

For further study.

6.5 Interworking between PDN providing FRDTS and B-ISDN

In this subclause, interworking is described between PDN providing FRDTS and B-ISDN.

6.5.1 Interworking in the U-plane

There are two interworking scenarios for interworking between PDN providing FRDTS and B-ISDN FRBS, one interworking scenario for interworking between two PDN providing FRDTS, and one scenario where the PDN providing FRDTS is servicing a terminal is attached to a B-ISDN not providing FRBS services:

case 10: Direct interworking between B-ISDN providing FRBS and PDN providing FRDTS;

case 11: Interworking between B-ISDN providing FRBS and PDN providing FRDTS via a B-ISDN not providing FRBS;

case 12: Interworking between two PDN providing FRDTS via a B-ISDN not providing FRBS;

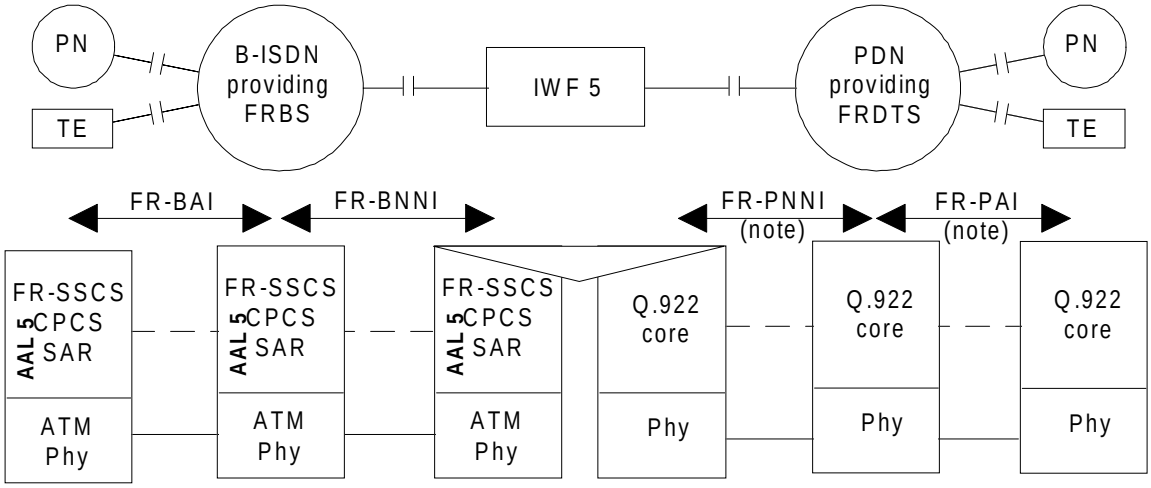
case 13: PDN providing FRDTS servicing a terminal attached to a B-ISDN not providing FRBS.

NOTE: Direct interconnection between two PDN providing FRDTS is not covered in this ETS.

The FR-BAI and the FR-BNNI are defined in clause 5. The FR-PAI and the Frame Relay PDN Network-to-Network Interface (FR-PNNI) are not defined in this ETS.

6.5.1.1 Direct interworking between B-ISDN providing FRBS and PDN providing FRDTS (case 10)

Figure 25 represents the case where a B-ISDN providing FRBS is interconnected to a PDN providing FRDTS. The Interworking Function 5 is performing the mapping between the frame relay related interfaces FR-BNNI and the FR-PNNI.



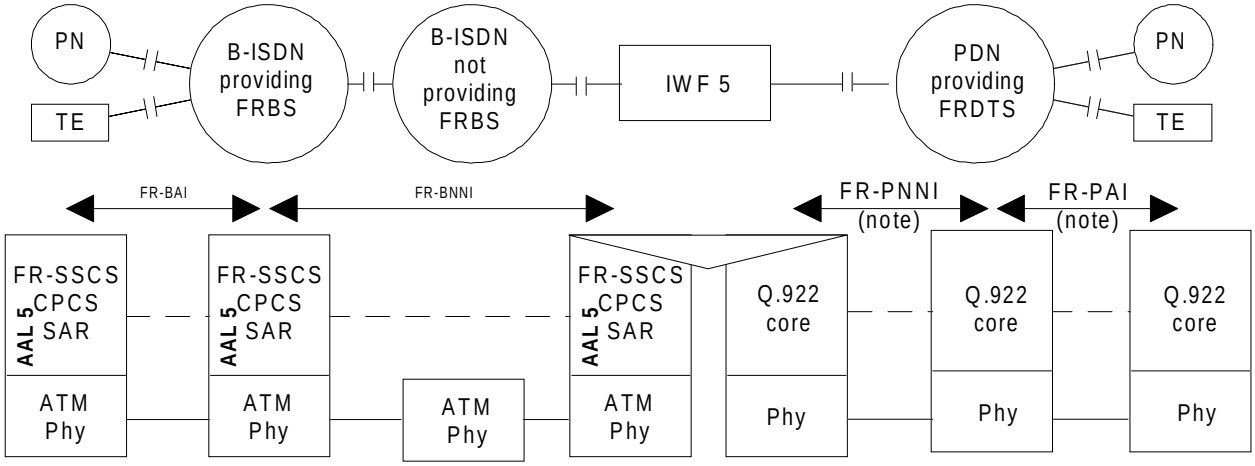
NOTE: The definition of this interface is outside the scope of this ETS.

Figure 25: Case 10: Direct interworking between B-ISDN providing FRBS and PDN providing FRDTS

6.5.1.2 Interworking between B-ISDN providing FRBS and PDN providing FRDTS via a B-ISDN not providing FRBS (case 11)

Figure 26 represents the case where a B-ISDN providing FRBS is interconnected to a PDN providing FRDTS via an intervening B-ISDN not providing FRBS. The Interworking Function 5 is performing the mapping between the frame relay related interfaces FR-BNNI and the FR-PNNI. The FR-BNNI is deployed through the intervening B-ISDN not providing FRBS.

NOTE: This case also covers the situation where two PDN providing FRDTS are interconnected via a B-ISDN providing FRBS as every network with a frame relay service (e.g., the intervening B-ISDN providing FRBS) is able to act as a transit network.



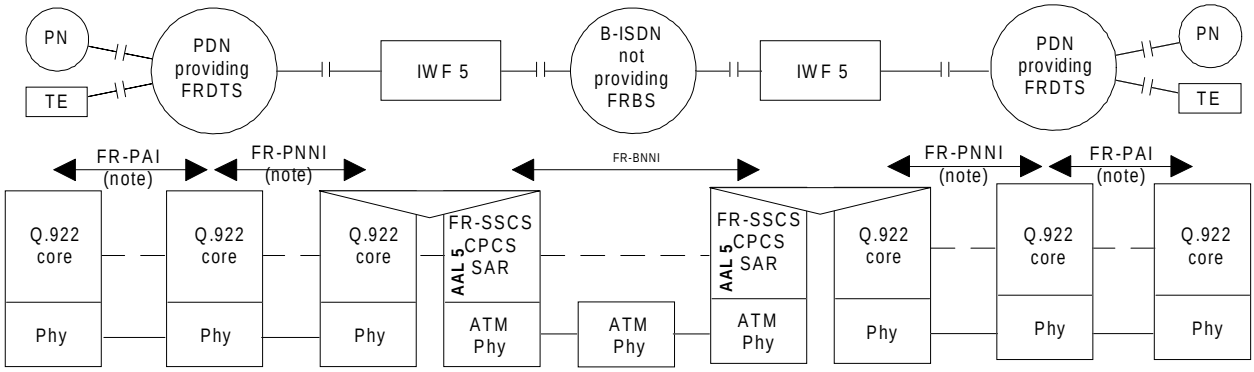
NOTE: The definition of this interface is outside the scope of this ETS.

Figure 26: Case 11: Interworking between B-ISDN providing FRBS and PDN providing FRDTS via a B-ISDN not providing FRBS

6.5.1.3 Interworking between two PDN providing FRDTS via a B-ISDN not providing FRBS (case 12)

Figure 27 represents the case where two PDN providing FRDTS are interconnected via a B-ISDN not providing FRBS. Two Interworking Function 5 are performing the mapping between the frame relay related interfaces FR-PNNI and FR-BNNI. The FR-BNNI is deployed through the intervening B-ISDN not providing FRBS.

NOTE: The B-ISDN may also provide FRBS, however, in this configuration it is utilized transparently. The use of the B-ISDN by the two PDN providing FRDTS is not visible to the end users.

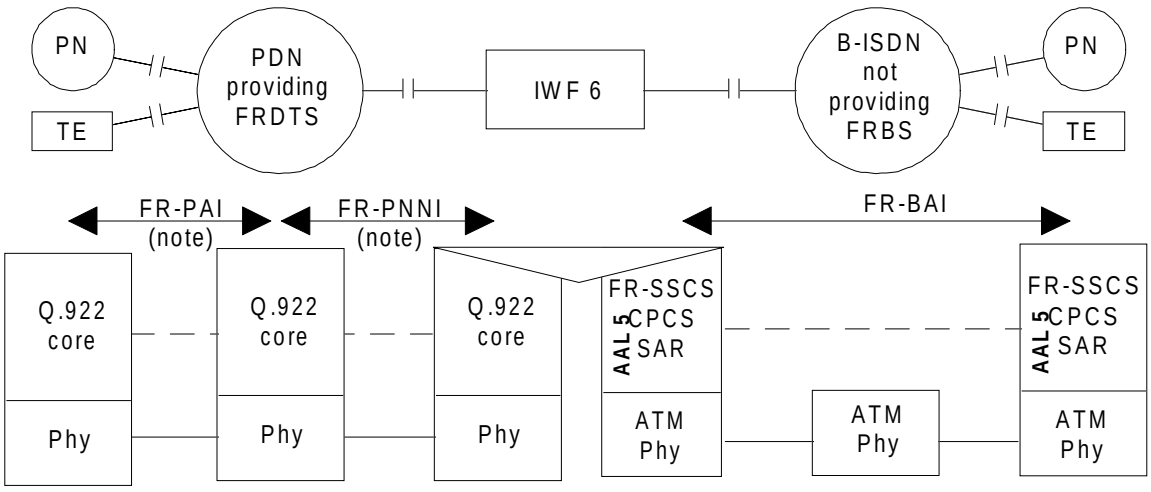


NOTE: The definition of this interface is outside the scope of this ETS.

Figure 27: Case 12: Interworking between two PDN providing FRDTS via a B-ISDN not providing FRBS

6.5.1.4 PDN providing FRDTS servicing a terminal attached to a B-ISDN not providing FRBS (case 13)

Figure 28 represents the case where a PDN providing FRDTS is servicing a terminal that is attached to a B-ISDN not providing FRBS. The Interworking Function 6 is performing the mapping between the frame relay related interfaces FR-INNI and the FR-BAI. This interface is deployed through the intervening B-ISDN not providing FRBS.



NOTE: The definition of this interface is outside the scope of this ETS.

Figure 28: Case 13: PDN providing FRDTS servicing a terminal attached to a B-ISDN not providing FRBS

6.5.2 Interworking in the C-plane

For further study.

6.5.3 Interworking in the M-plane

For further study.

6.6 Interworking between an ISDN providing FRBS and PDN providing FRDTS

In this subclause, interworking between an ISDN providing FRBS and a PDN providing FRDTS is described.

6.6.1 Interworking in the U-plane

There is one interworking scenario for interworking between an ISDN providing FRBS and a PDN providing FRDTS.

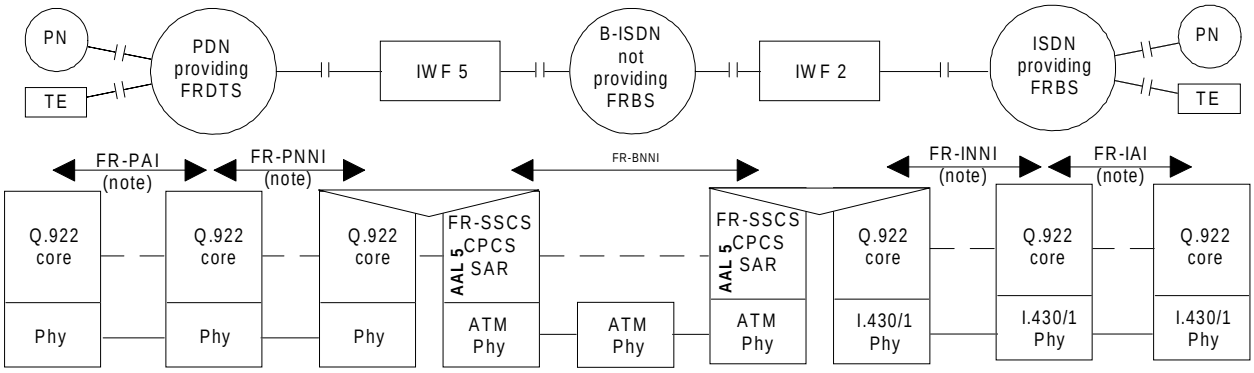
case 14: Interworking between ISDN providing FRBS and PDN providing FRDTS via a B-ISDN not providing FRBS.

NOTE: Direct interconnection between an ISDN providing FRBS and a PDN providing FRDTS is not covered in this ETS.

The FR-BNNI is defined in clause 5. The FR-INNI and the FR-PNNI are not defined in this ETS.

6.6.2 Interworking between ISDN providing FRBS and PDN providing FRDTS via a B-ISDN not providing FRBS (case 14)

Figure 29 represents the case where an ISDN providing FRBS and a PDN providing FRDTS are interconnected via a B-ISDN not providing FRBS. An Interworking Function 2 is performing the mapping between the frame relay related interfaces FR-INNI and FR-BNNI and an Interworking Function 5 is performing the mapping between the frame relay related interfaces FR-PNNI and FR-BNNI. The FR-BNNI is deployed through the intervening B-ISDN not providing FRBS.



NOTE: The definition of this interface is outside the scope of this ETS.

Figure 29: Case 14: Interworking between ISDN providing FRBS and PDN providing FRDTS via a B-ISDN not providing FRBS

6.7 Interworking between B-ISDN and FRDTS provided by a PN

For further study.

Annex A (normative): Additional procedures for Frame Relay Permanent Virtual Connections (FR PVCs) for the carriage on ATM using unnumbered information frame

The management procedures (symmetric and asymmetric) for the FR-PVCs are described in ITU-T Recommendation Q.933 [20], annex A.

For the application of the FR PVC to B-ISDN (FR-SSCS) the symmetric management procedures are rewritten from ITU-T Recommendation Q.933 [20], annex A taking into account the following modifications:

- entities involved are terminals (as in ITU-T Recommendation Q.933 [20]), FRSFs, and IWFs (included under the term "network" in ITU-T Recommendation Q.933 [20]);

- the procedures are executed within the LME of the FR-SSCS;

- the use of the symmetric and asymmetric procedures is specified in subclause 5.3.5;

- procedures are applied per ATM connection instead of per bearer channel.

Modifications to ITU-T Recommendation Q.933, annex A

This annex is based on ITU-T Recommendation Q.933 [20], annex A and describes the means for notifications of outage of a FR PVC carried on ATM between two FR-SSCS management entities (FRLMEs), and recovery from such a condition. A FRLME is located within a FR/B-ISDN Interworking Unit, a frame relay B-ISDN TE or a frame relay server, as described in the main part of this ETS. For implementations where the frame relay side supports only FR PVCs, unacknowledged mode of operation at layer 2 (see ITU-T Recommendation Q.933 [20]), the procedures given in this annex are applicable. The procedures may be initiated by any FRLME that supports FR PVCs and Unnumbered Information (UI) frame transfer only These procedures are intended to be used only for operational purposes (rather than maintenance and management).

These procedures include:

- notification of the addition of a FR PVC;

- detection of the deletion of a FR PVC;

- notification of the availability (active) or unavailability (inactive) state of a configured FR PVC:

    - inactive means that the FR PVC is configured but is not available to be used;

    - active means that the FR PVC is available to be used;

- link integrity verification.

    NOTE: Additional procedures for operation of FR PVCs may be a subject of future ITU-T Recommendations.

The higher layer messages are transferred across the ATM VCC using layer 2 unnumbered information frames (as defined in CCITT Recommendation Q.922 [19]) on DLCI 0, with the poll bit set to "0". The forward explicit congestion notification, backward explicit congestion notification, and the discard eligibility indicator bits shall be set to "0" on transmission. The settings of the CPCS-LP parameter, the CPCS-CI parameter and CPCS-UU parameter are described in clause xxx..

A.1 Messages used for FR PVC status

The messages for support of FR PVCs in the frame relay service are STATUS and STATUS ENQUIRY. These messages used for FR PVC status are sent using the dummy call reference (see § 4.3 of Recommendation Q.931) on DLCI =0.

A.1.1 STATUS

This message is sent in response to a STATUS ENQUIRY message to indicate the status of FR PVCs or for a link integrity verification. Optionally, it may be sent at any time to indicate the status of a single FR PVC.

Message type: STATUS Direction: both

Significance: local

Table A.1

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	1
Message type	4.4	both	M	1
Report type	A.3.1	both	M	3
Link integrity verification	A.3.2	both	O (note 1)	4
FR PVC status (note 2)	A.3.3	both	O (note 3)	5-7 (note 2)

NOTE 1: Mandatory if the type of report is **full status** or **link integrity verification only**. Not included in the optional asynchronous status message (report type equal to single FR PVC asynchronous status).

NOTE 2: Included in the case of a full status message. This is a STATUS message that contains the status of all FR PVCs on the ATM VCC. There is one FR PVC status information element for each FR PVC configured on that ATM VCC. The FR PVC status information elements are arranged in the message in ascending order of DLCIs; the FR PVC with the lowest DLCI is first, the second lowest DLCI is second, and so on. The maximum number of FR PVCs that can be indicated in a message is limited by the maximum frame size and the length of the FR PVC status information element. The optional asynchronous STATUS message contains a single PVC status information element.

NOTE 3: Mandatory if the report type information element indicated **full status** or **single FR PVC asynchronous status** and the ATM VCC has FR PVCs configured.

A.1.2 STATUS ENQUIRY

This message is sent to request the status of FR PVCs or to verify link integrity. Sending a STATUS message in response to a STATUS ENQUIRY message is mandatory.

Message type: STATUS ENQUIRY Direction: both

Significance: local

Table A.2

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	1
Message type	4.4	both	M	1
Report type	A.3.1	both	M	3
Link integrity verification	A.3.2	both	M	4

A.2 Information elements

A.2.1 Protocol discriminator

See § 4.2 of Recommendation Q.931.

A.2.2 Call reference

The dummy call reference value is used for these procedures. See § 4.3 of Recommendation Q.931.

A.2.3 Message type

See § 4.4 of Recommendation Q.931.

A.3 Information elements

A.3.1 Report type

The purpose of the Report type information element is to indicate the type of enquiry requested when included in a STATUS ENQUIRY message or the contents of the STATUS message. The length of this information element is 3 octets.

8	7	6	5	4	3	2	1	Octet
	report type							
0	1	0	1	0	0	0	1	1
	information element identifier							
Length of report type contents								2
Type of report								3

Type of report (octet 3)

Bits
8765 4321
0000 0000 Full status (status of all FR PVCs on the ATM VCC)
0000 0001 Link integrity verification only
0000 0010 Single FR PVC asynchronous status
All other values are reserved.

Figure A.1: Report type information element

A.3.2 Link integrity verification

The purpose of the link integrity verification information element is to exchange sequence numbers between two FRLMEs on a periodic basis. The length of this information element is 4 octets.

8	7	6	5	4	3	2	1	Octet
	link integrity verification							
0	1	0	1	0	0	0	1	1
	information element identifier							
Length of link integrity verification contents								2
Send sequence number								3
Receive sequence number								4

Send sequence number (octet 3)

The current send sequence number of the originator of the message. It is binary encoded.

Receive sequence number (octet 4)

The send sequence number received in the last received message. It is binary encoded.

Figure A.2: Link integrity verification information element

A.3.3 FR PVC status

The purpose of the FR PVC status information element is to indicate the status of existing FR PVCs on the ATM VCC. This information element can be repeated, as necessary, in a message to indicate the status of all PVCs on the ATM VCC. The length of this information element depends on the length of the DLCIs being used on the ATM VCC. The length of this information element is 5 octets when a default address format (2 octet) is used.

NOTE: Support of single FR PVC status is for further study.

8	7	6	5	4	3	2	1	Octet
0	FR PVC status 1 0 1 0 0 0 0 1 information element identifier							1
Length of FR PVC status contents								2
0 ext	0 spare	Data link connection identifier (Most significant 6 bits)						3 (note 1)
1 ext	Data link connection identifier (2nd most significant 4 bits)			0	0	0	spare	3a (note 2)
1 ext	0 0 0 spare			New	0 spare	Active	0 spare	4

NOTE 1: Bit 6 of octet 3 is the most significant bit in the data link connection identifier.

NOTE 2: When address extension octets are implemented, the structure (octets 3b and 3c) given in figure 4.3 of ITU-T Recommendation Q.933 [20] apply.

Data link connection identifier (octet 3 bits 6-1 and 3a bits 7-4)

Data link connection identifier is coded in binary.

New (octet 4):		**Active (octet 4):**	
Bit	(note 3)	Bit	(note 4)
4		2	
0	FR PVC is already present	0	FR PVC is inactive
1	FR PVC is new	1	FR PVC is active

NOTE 3: This bit has no significance in a single FR PVC asynchronous status.

NOTE 4: If the A bit is set to "0" in a FR PVC status information element, the FRLME should stop using the specified FR PVC. The FRLME sets this bit to "0" when the FRLME determines that the FR PVC is not operational.

Figure A.3: FR PVC status information element for default 2-octet address

A.4 Procedures

These procedures use periodic polling to determine the status of FR PVC connections and to verify the integrity of the link.

A.4.1 Periodic polling

Any FRLME may initiate the polling described below.

If a FRLME uses STATUS ENQUIRY messages, the peer FRLME shall respond with STATUS messages, as specified in these procedures:

a) every T391 seconds, the FRLME sends a STATUS ENQUIRY message to the peer FRLME and resets its polling timer (T391). The T391 interval between such messages is called the polling interval;

b) the STATUS ENQUIRY message typically requests a link integrity verification exchange only, (report type equal "0000 0001"). Every N391 polling cycles, the FRLME requests full status of all FR PVCs (report type equal "0000 0000");

c) the peer FRLME responds to each STATUS ENQUIRY message with a STATUS message and resets the T392 timer, which is used by the peer FRLME to detect errors (see A.5). The STATUS message sent in response to a STATUS ENQUIRY contains the link integrity verification and report type information elements. If the content of the report type information element specifies **full status**, then the STATUS message shall contain one FR PVC status information element for each FR PVC on the ATM VCC. If it is a full status message, the FRLME receiving this message should update the status of each configured FR PVC;

d) the FRLME shall interpret the omission of a previously reported FR PVC from the full status message as an indication, that the FR PVC is no longer provisioned for the ATM VCC.

NOTE: The optional single FR PVC asynchronous STATUS message is not part of the periodic polling process.

A.4.2 Link integrity verification

The purpose of the link integrity verification information element is to allow FRLMEs to determine the status of the PVC monitoring link (DLCI 0). This is necessary since these procedures use unnumbered information (UI) frames at layer 2:

- both FRLMEs maintain two sets of the following internal counters, one for each direction of polling (called polling counters and polled counters in the following):

  - the send sequence counter maintains the value of the send sequence number field of the last link integrity verification information element sent;

  - the receive sequence counter maintains the value of the last received send sequence number field in the link integrity verification information element and maintains the value to be placed in the next transmitted received sequence number field.

  The following procedure is used:

  a) before any messages are exchanged, both FRLMEs set the send sequence counters and receive sequence counters to "0";

  b) each time a FRLME equipment sends a STATUS ENQUIRY message, it increments the polling send sequence counter and places its value into the send sequence number field. It also places the current value of the polling receive sequence counter into the receive sequence number field of the link integrity verification information element. The FRLME increments the polling send sequence counter using modulo 256. The value ZERO is skipped;

  c) when the FRLME receives a STATUS ENQUIRY from the peer FRLME, the FRLME checks the receive sequence number received from the peer FRLME against its polled send sequence counter. The handling of error conditions is described in annex A, clause A.5.

     The received send sequence number is stored in the polled receive sequence counter. The FRLME then increments its polled send sequence counter and places its current value in the send sequence number field and the value of the polled receive sequence counter (the last received send sequence number within a STATUS ENQUIRY message) into the receive sequence number field of the outgoing link integrity verification information element. The FRLME then transmits the completed STATUS message back to the peer FRLME. The FRLME increments the polled send sequence counter using modulo 256. The value ZERO is skipped;

  d) when the FRLME receives a STATUS from the peer FRLME in response to a STATUS ENQUIRY, the FRLME checks the receive sequence number received from the peer FRLME against its polling send sequence counter. The handling of error conditions is described in annex A, clause A.5. The received send sequence number is stored in the polling receive sequence counter.

  NOTE: The value ZERO in the receive sequence number indicates that the field contents are undefined, this value is normally used after initialisation. The value ZERO cannot be sent in the send sequence number field so that the receive sequence number will never contain the value ZERO to differentiate the undefined condition from the normal modulo round off.

A.4.3 Reporting new FR PVCs

One of the functions of periodic polling is to notify the FRLMEs of newly added FR PVCs using a full status message. The FR PVC reporting procedure using a full status message ensures that a PVC cannot be deleted and another added using the same DLCI without the FRLME detecting the change. The FR PVC reporting procedures are defined as follows:

a) when a new permanent virtual circuit has been added, the FRLME sets the new bit to "1" in the FR PVC status information element for that FR PVC in a full status STATUS message;

b) the FRLME that has set the new bit shall not clear the new bit in the FR PVC status information element until it receives a STATUS ENQUIRY message containing a receive sequence number equal to the polled send sequence counter (i.e. the send sequence number transmitted in the last STATUS message);

c) when the FRLME receives a full status message containing a FR PVC status information element identifying an unknown DLCI and the new bit is set to "1", the FRLME marks this FR PVC as new and adds it to the list of FR PVC.

NOTE: The procedures for reporting of new FR PVCs are not supported by asynchronous status messages.

A.4.4 Reporting the availability of a FR PVC

The FRLME uses the FR PVC status message to detect a change in the status of configured FR PVCs. As described in annex A, subclause A.4.1, every N391 polling interval the FRLME sends a STATUS ENQUIRY message with a report type of full status. The peer FRLME responds with a STATUS message containing a FR PVC status information element for each FR PVC configured on that ATM VCC. Each FR PVC status information element contains an active bit indicating the availability or unavailability of that FR PVC.

The action the FRLME takes, based on the value of the active bit, is independent of the action based on the new bit. The FRLME could get a FR PVC status information element with the new bit set to "1" and the active bit set to "0".

If the FRLME receives a FR PVC status information element with the active bit set to "0", the FRLME shall stop transmitting frames on the FR PVC until it receives a FR PVC status information element for that FR PVC with the active bit set to "1". Other action taken by the FRLME is implementation dependent.

Since there is a delay between the time the FRLME makes a FR PVC available and the time it transmits a PVC status information element notifying the peer FRLME, there is a possibility of the peer FRLME receiving frames on a FR PVC marked as unavailable. The action the peer FRLME takes on receipt of frames on an unavailable FR PVC is implementation dependent.

Since there is a delay between the time the FRLME detects that a FR PVC has become unavailable and the time it transmits a FR PVC status information element notifying the peer FRLME, there is a possibility of the FRLME receiving frames on an unavailable FR PVC. The action the FRLME takes on receipt of frames for an unavailable FR PVC is implementation dependent and may include the dropping of frames on the unavailable FR PVC.

See the following subclause for conditions under which the FRLME sets the active bit to "0".

A.5 Error conditions

The FRLMEs use the information provided by periodic polling for error monitoring. The FRLMEs detect the following error conditions:

- PVC monitoring link (DLCI 0) reliability errors;
- PVC monitoring link protocol errors;
- internal problems.

Errors are detected as anomalies in the timing or content of events.

The FRLME shall set the active bit to "0" if it detects a service affecting condition (not defined here).

The FRLME detects the following errors:

- non-receipt of a STATUS ENQUIRY in T392 seconds;
- non-receipt of a STATUS message with report type equal to **full status** or **link integrity verification only** in a polling interval after transmission of a STATUS ENQUIRY;
- invalid contents of a link integrity verification information element. This consists of an invalid receive sequence number. The received receive sequence number is not valid when it is not equal to the last transmitted send sequence number.

NOTE: Asynchronous status messages do not satisfy the requirement for a status message in a give polling interval.

The loss of a frame at layer 2 (e.g. CRC error) will be detected in these procedures by non-receipt of a STATUS or STATUS ENQUIRY.

An event is defined as follows:

- receipt of a STATUS ENQUIRY message; or
- expiration of timer T392.

Following the detection of a service affecting condition , the FRLME should notify the remote peer FRLME for each FR PVC whose service is affected by setting the active bit to "0" in a full status STATUS message or optionally in the single FR PVC asynchronous STATUS message. One method for determining a service affecting condition is by detecting that N392 of the last N393 events are in error. The FRLME also may be notified of other service affecting conditions. (i.e. physical or ATM layer errors, CPCS-AAL errors, e.g. CRC errors and protocol errors with each FR PVC.)

When the FRLME detects that the service affecting condition is cleared, it resumes normal operation of active FR PVCs on the ATM VCC. One method to detect service restoration is by detecting that N392 consecutive events have occurred without error.

This procedure detects problems with the in-channel signalling link (DLCI 0) and does not detect problems with individual FR PVCs.

If the FRLME receives a FR PVC status information element for a FR PVC not currently defined and the new bit is set to "0", the FRLME records this as an error and adds the FR PVC to the active FR PVCs. Other actions taken by the FRLME are implementation dependent.

If the FRLME receives a full status STATUS message from the peer FRLME that is missing a FR PVC status information element for a FR PVC that the FRLME currently is using, the FRLME shall remove that FR PVC from its list of FR PVCs.

A.6 System parameters

Tables A.3 and A.4 summarise the acceptable values for the configurable parameters described in these procedures. Parameter values other than the default values are a subscription option. These system parameters need to be known prior to CPCS connection establishment.

Table A.3: System parameters - counters

Counter	Description	Range	Default	Usage
N391	Full status (status of all FR PVCs) polling counter	1-255	6	Polling cycles
N392	Error Threshold	1-10 (note 1)	3	Errors
N393	Monitored events count	1-10 (note 2)	4	Events
NOTE 1: N392 should be less than or equal to N393.				
NOTE 2: If N393 is set to a value much less than N391, then the link could go in and out-of-error condition without the FRLME being notified.				

Table A.4: System parameters - timers

Time	Description	Range (seconds)	Default (seconds)	Started	Stopped	Action taken when expired
T391	Link integrity verification polling	5-30	10	Transmit STATUS ENQUIRY	-	Transmit STATUS ENQUIRY. Record error if STATUS message not received
T392	Polling verification timer	5-30 (note)	15	Transmit STATUS	Receive STATUS ENQUIRY	Record error by incrementing N392. Restart
NOTE: T392 should be greater than T391.						

History

Document history	
March 1995	Public Enquiry PE 81: 1995-03-27 to 1995-08-18
June 1996	Converted into Adobe Acrobat Portable Document Format (PDF)