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# I.555

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SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

Internetwork interfaces

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## Frame Relaying Bearer Service interworking

ITU-T Recommendation I.555

(Previously CCITT Recommendation)

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

## ITU-T RECOMMENDATION I.555

# FRAME RELAYING BEARER SERVICE INTERWORKING


## Summary

This Recommendation describes the functional requirements and configurations across interfaces for interworking between Frame Relaying Bearer Services (FRBS) and other services. The interworking arrangements covered in this Recommendation are: interworking between Frame Relaying and Frame Switching bearer services; interworking between FRBS and Recommendation X.25/X.31; interworking/interconnection of LANs and FRBS; interworking between FRBS and circuit-switched services; and interworking between FRBS and B-ISDN.



## Source

ITU-T Recommendation I.555 was revised by ITU-T Study Group 13 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 19th of September 1997.

# FOREWORD

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The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

## NOTE

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

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As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

# CONTENTS

# FRAME RELAYING BEARER SERVICE INTERWORKING

*(revised in 1997)*

## 1 Introduction

The Frame Relaying Bearer Service (FRBS) is described in Recommendation I.233.1. Other bearer services are described in the I.200-Series Recommendations. This Recommendation provides the functional requirements and configurations across interfaces for interworking between Frame Relaying Bearer Services and other services.

This Recommendation conforms to the principles of interworking as defined in the I.500-Series Recommendations.

The following interworking arrangements are in the scope of this Recommendation:

– interworking between Frame Relaying and Frame Switching bearer services;

– interworking between FRBS and Recommendation X.25/X.31;

– interworking/interconnection of LANs and FRBS;

– interworking between FRBS and circuit-switched services;

– interworking between FRBS and B-ISDN.

The functional requirements and configuration for each of these interworking scenarios is covered in the following clauses.

## 2 References

The following ITU-T Recommendations, and other references contain provision which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

– ITU-T Recommendation Q.933 (1995), *Integrated Services Digital Network (ISDN) Digital Subscriber signalling System No. 1 (DSS 1) – Signalling specifications for frame mode switched and permanent virtual connection control and status monitoring.*

– CCITT Recommendation Q.922 (1992), *ISDN data link layer specification for frame mode bearer services.*

– ITU-T Recommendation Q.2933 (1996), *Digital Subscriber signalling System No. 2 (DSS 2) – Signalling specification for frame relay service.*

– ITU-T Recommendation Q.2931 (1995), *Digital Subscriber signalling System No. 2 (DSS 2) – User-Network Interface (UNI) layer 3 specification for basic call/connection control.*

– ITU-T Recommendation X.76 (1995), *Network-to-network interface between public data networks providing the frame relay data transmission service.*

– ITU-T Recommendation I.610 (1995), *B-ISDN operation and maintenance principles and functions.*

## 3 Definitions and abbreviations

In addition to the terms and definitions contained in Recommendations I.112, I.113, X.200 and X.300, the following two terms are defined:

**3.1** **encapsulation**: Occurs when the conversions in the network or in the terminals are such that the protocols used to provide one service make use of the layer service provided by another protocol. This means that at the interworking point, the two protocols are stacked. When encapsulation is performed by the terminal, this scenario is also called interworking by port access (see 3.2.11/X.300).

**3.2** **protocol mapping**: Occurs when the network performs conversions in such a way that within a common layer service, the protocol information of one protocol is extracted and mapped on protocol information of another protocol. This means that each communication terminal supports different protocols. The common layer service provided in this interworking scenario is defined by the functions which are common to the two protocols.

This Recommendation uses also the following abbreviations.

| | |
|---|---|
| AAL | ATM Adaptation Layer |
| AIS | Alarm Indication Signal |
| AR | Access Rate |
| ATC | ATM Transfer Capability |
| ATM | Asynchronous Transfer Mode |
| AU | Adapter Unit |
| B-ISDN | Broadband Integrated Services Digital Network |
| $B_c$ | Committed Burst |
| $B_e$ | Excess Burst |
| BECN | Backward Explicit Congestion Notification |
| CC | Continuity Check |
| CI | Congestion Indication |
| CIR | Committed Information Rate |
| CLR | Cell Loss Ratio |
| CPCS | Common Part Convergence Sublayer |
| DE | Discard Eligibility |
| DLCI | Data Link Connection Identifier |
| DTE | Data Terminal Equipment |
| DTP | Data Transfer Protocol |
| EFCI | Explicit Forward Congestion Indicator |
| FECN | Forward Explicit Congestion Notification |
| FH | Frame Handler |
| FLR | Frame Loss Ratio |
| FMBS | Frame Mode Bearer Service |
| FR-SSCS | Frame Relaying Service Specific Convergence Sublayer |
| FRBS | Frame Relaying Bearer Service |
| FRLME | Frame Relay Layer Management Entity |
| FSBS | Frame Switching Bearer Service |
| IWF | InterWorking Function |
| LAN | Local Area Network |
| LAPB | Link Access Procedure Balanced |
| LIV | Link Integrity Verification |

| | |
|---|---|
| LLC | Logical Link Control (in the case of LAN) |
| LLC | Lower Layer Compatibility (in the case of ISDN) |
| LP | Loss Priority |
| LSB | Least Significant Bit |
| MAC | Media Access Control |
| MBS | Maximum Burst Size |
| NA | Network Adapter |
| NLPID | Network Layer Protocol Identifier |
| NNI | Network Node Interface |
| PCI | Protocol Control Information |
| PCR | Peak Cell Rate |
| PDU | Protocol Data Unit |
| PH | Packet Handler |
| PLP | Packet Layer Protocol |
| PSPDN | Packet Switched Public Data Network |
| PVC | Permanent Virtual Connection |
| QOS | Quality of Service |
| RDI | Remote Defect Indication |
| SAPI | Service Access Point Identifier |
| SAR | Segmentation and Reassembly |
| SBR | Statistical Bit Rate |
| SCF | Synchronization and Coordination Function |
| SCR | Sustainable Cell Rate |
| SSCS | Service Specific Convergence Sublayer |
| SVC | Switched Virtual Connection |
| TA | Terminal Adapter |
| TE | Terminal Equipment |
| UU | User-User |
| VC | Virtual Connection |
| VCC | Virtual Channel Connection |
| VCI | Virtual Channel Identifier |
| VPC | Virtual Path Connection |
| VPI | Virtual Path Identifier |
| WAN | Wide Area Network |

# 4 Interworking between Frame Relaying and Frame Switching

It is an objective that interworking between Frame Relaying bearer services and Frame Switching bearer services shall be transparent as far as a terminal accessing such bearer services, or networks providing such services, are concerned.

Interworking between Frame Relaying and Frame Switching requires functions that act as a Frame Switching terminal, e.g. implementing congestion control procedures and informing calling terminals of eventual modification of QOS parameters.

## 4.1 Call control requirements

Call control procedures are identical in Frame Relaying and Frame Switching and are based on Recommendation Q.933.

For an ISDN having implemented both FRBSs, and for calls originating from a network having implemented at least one of these service modes, then the ISDN should attempt to establish the call in the requested mode first. If that fails, the other mode should be attempted. In this case, a notification of interworking should be sent back to the calling user.

## 4.2 Data transfer requirements

Frame Relaying terminals wishing to interwork with Frame Switching terminals must implement the Q.922 core and control procedures.

Figure 1 represents interworking configurations between Frame Relaying and Frame Switching bearer services.

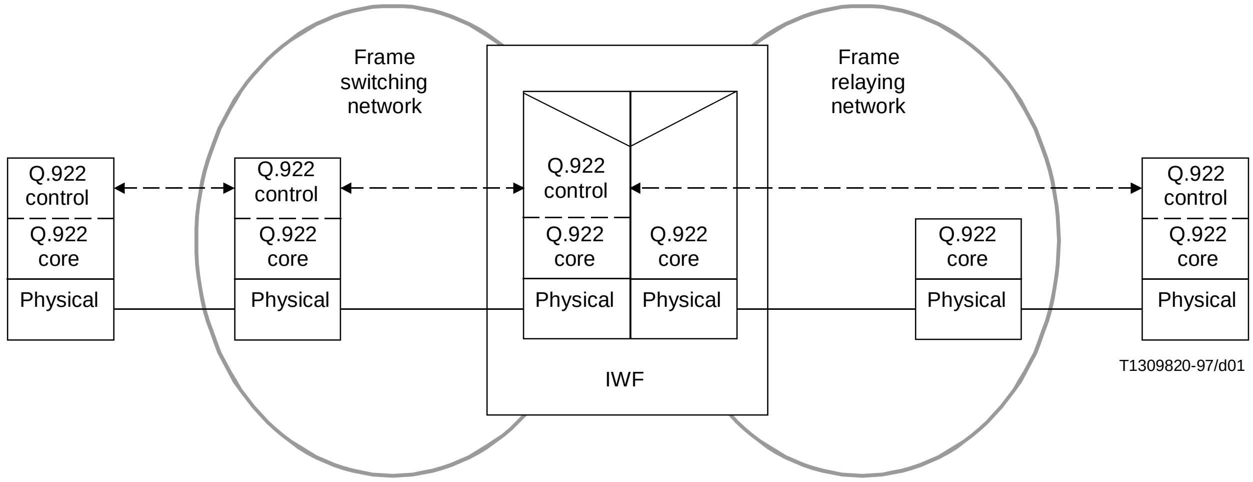



**Figure 1/I.555 – Interworking between Frame Relaying and Frame Switching: Data transfer procedures**

### 4.2.1 Interworking of congestion management procedures

For further study.

# 5 Interworking between FRBS and Recommendation X.25/X.31

The possible interworking scenarios are:

a) Port Access (using encapsulation) – invoking FRBS to provide access to a port on a PSPDN/ISDN (X.31) with which the X.25 procedures are used (Figure 2). In this case, there are two possibilities, as follows:

   – access by FRBS Permanent Virtual Connection (PVC) to X.25/X.31 service (providing X.25 Virtual Call or Permanent Virtual Circuit service);

   – access by FRBS Switched Virtual Connection (SVC) to X.25/X.31 service (providing X.25 Virtual Call service).

b) The other scenarios are for further study. These are as follows:

   – interworking by call control mapping between FRBS VC and X.25/X.31 virtual call;

   – NNI Access – invoking FRBS to provide an internal access of PSPDN/ISDN (X.31) where the TE is not aware of FRBS.

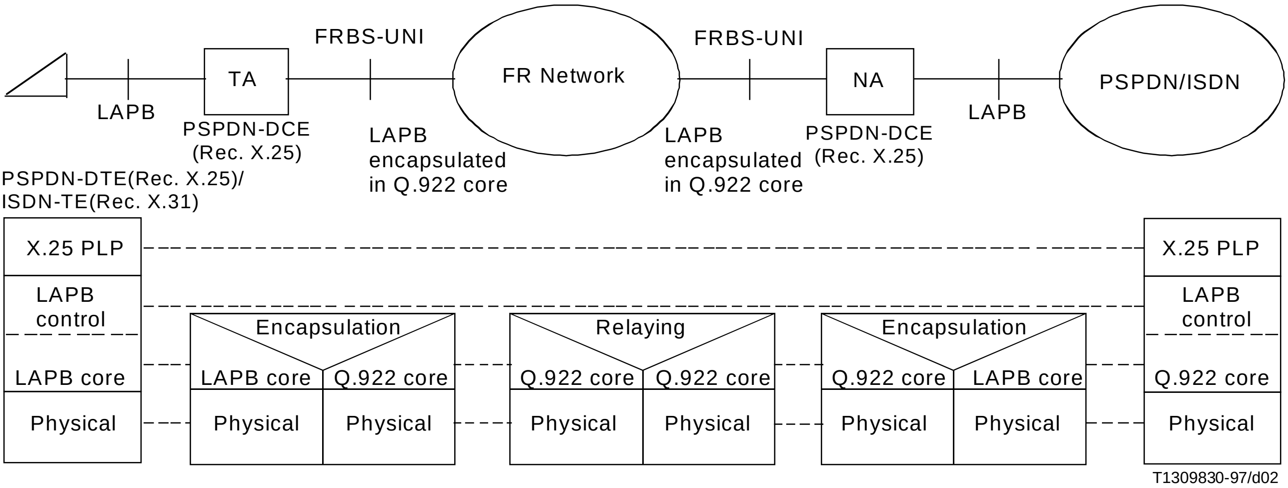
In all scenarios, the end-to-end service is an X.25 service. As such there is no service interworking. The interworking occurs at the sub-network level.

This clause specifies the interworking between:

– FRBS and PSPDN (Recommendation X.25);

– FRBS and ISDN (Recommendation I.232.1) – Case B of Recommendation X.31.

NOTE – The interworking between FRBS and ISDN offering Case A of Recommendation X.31 is identical to the case of interworking between FRBS and PSPDN (Recommendation X.25).




NOTE – LAPB is separated into two parts: LAPB core and LAPB control. LAPB core coresponds to the framing aspects described in 11.2/X.25 and a few items of 2.4/X.25 which are definitions of parameters related to framing aspects (e.g. idle channel timer T3 and maximum frame length N1). LAPB contains the protocol elements and procedures described in 2.3/X.25 and 2.4/X.25 with the exceptions mentioned above.

**Figure 2/I.555 – General X.25 access through FR network**

## 5.1 Data transfer requirements

Interworking between FRBS and Recommendation X.25 can be accomplished using X.25 PLP at the network layer and as a network option at the link layer:

– Q.922 control procedures with I-format; or

– LAPB control procedures with suitable provisions for congestion avoidance, and LAPB address, control and I-fields encapsulated in the Q.922 core, as shown in Figure 3a for the general case such as described in 5 a); or

– the encapsulation scheme shown in Figure 3b which is to be applied for the specific scenarios which are described in clause 5, where encapsulation is applied at the internal interface of existing PSPDN/ISDN network.

In the case of SVCs, the mode of operation will be signalled call by call, using appropriate coding of LLC (Octet 6) in Recommendation Q.933.

## 5.2 Interworking by FRBS PVC to PSPDN/ISDN (Recommendation X.31) virtual call/permanent virtual circuit by port access

Figures 4 and 5 illustrate this interworking scenario in the U-Plane. The TE A uses X.25 over a FRBS PVC. Once having established a FRBS PVC, TE A can make use of switching capabilities of the PSPDN to establish switched connections to DTEs connected to the PSPDN. At layer 3, X.25 PLP is used. This interworking scenario does not use any signalling procedures in the C-Plane for establishing the FRBS PVC.

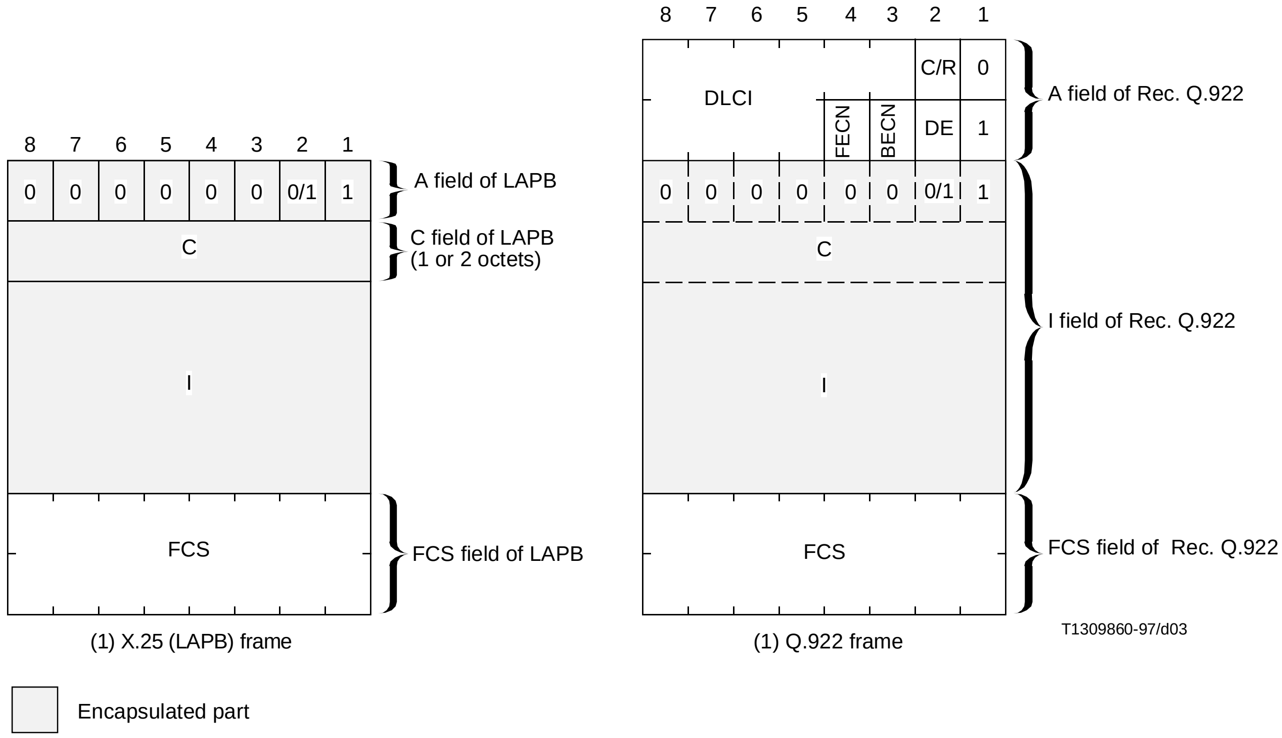



**Figure 3a/I.555 – Encapsulation of LAPB address, control and I-fields in Q.922 core**

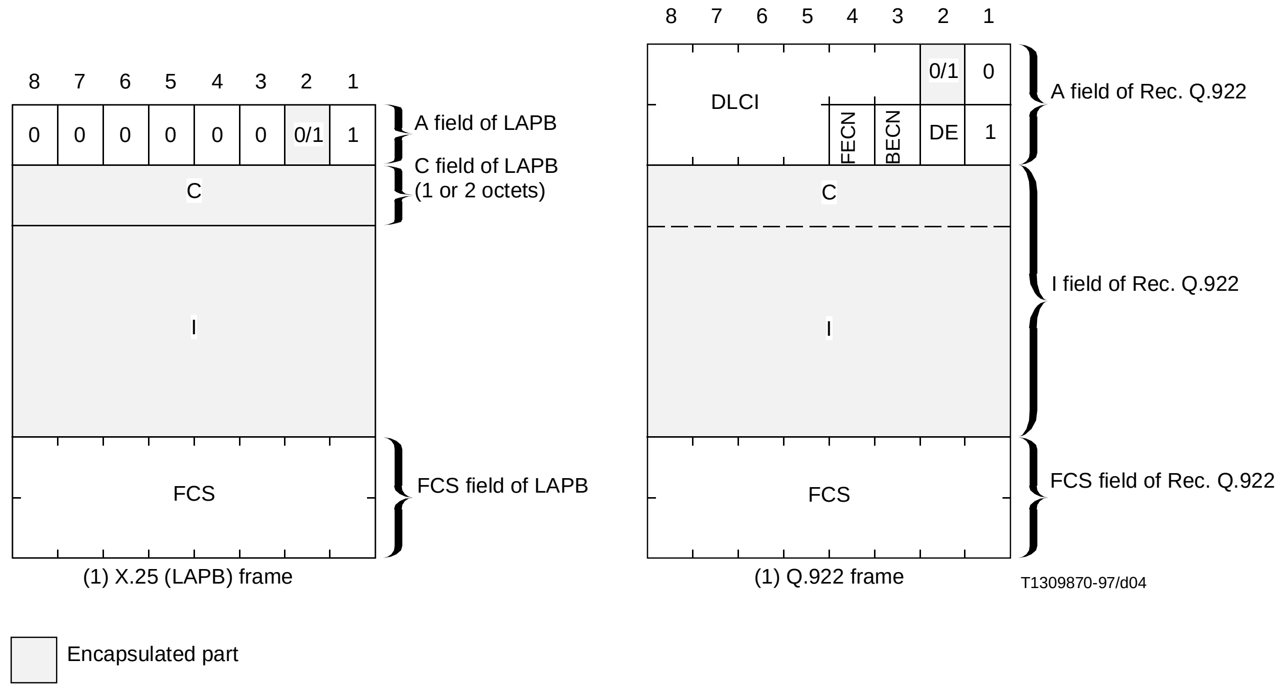



**Figure 3b/I.555 – Encapsulation of LAPB control and I-fields in Q.922 core**

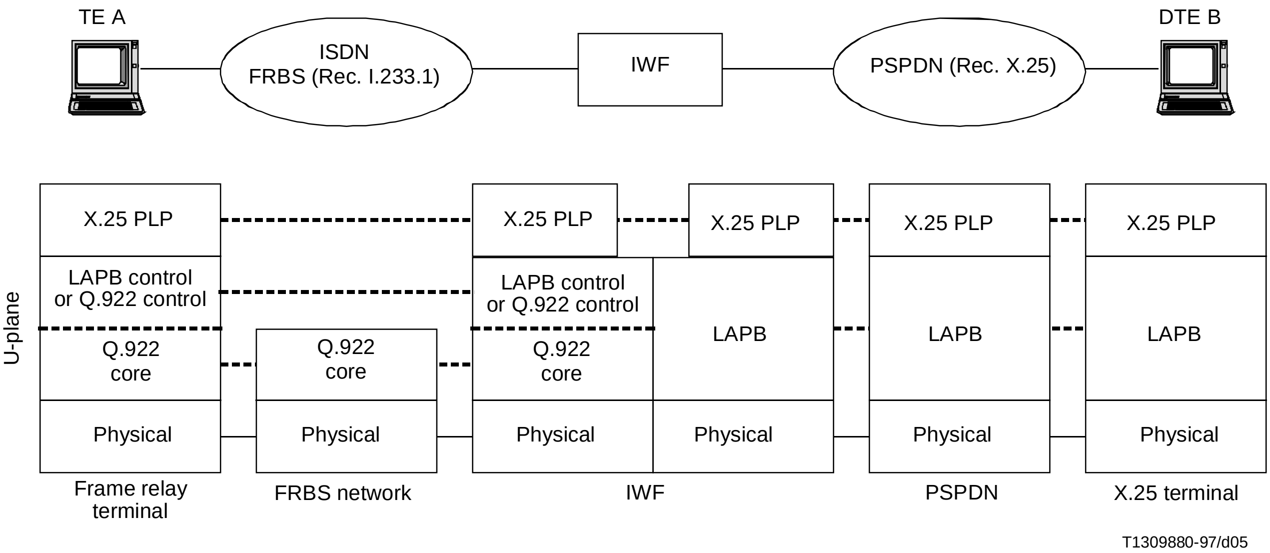
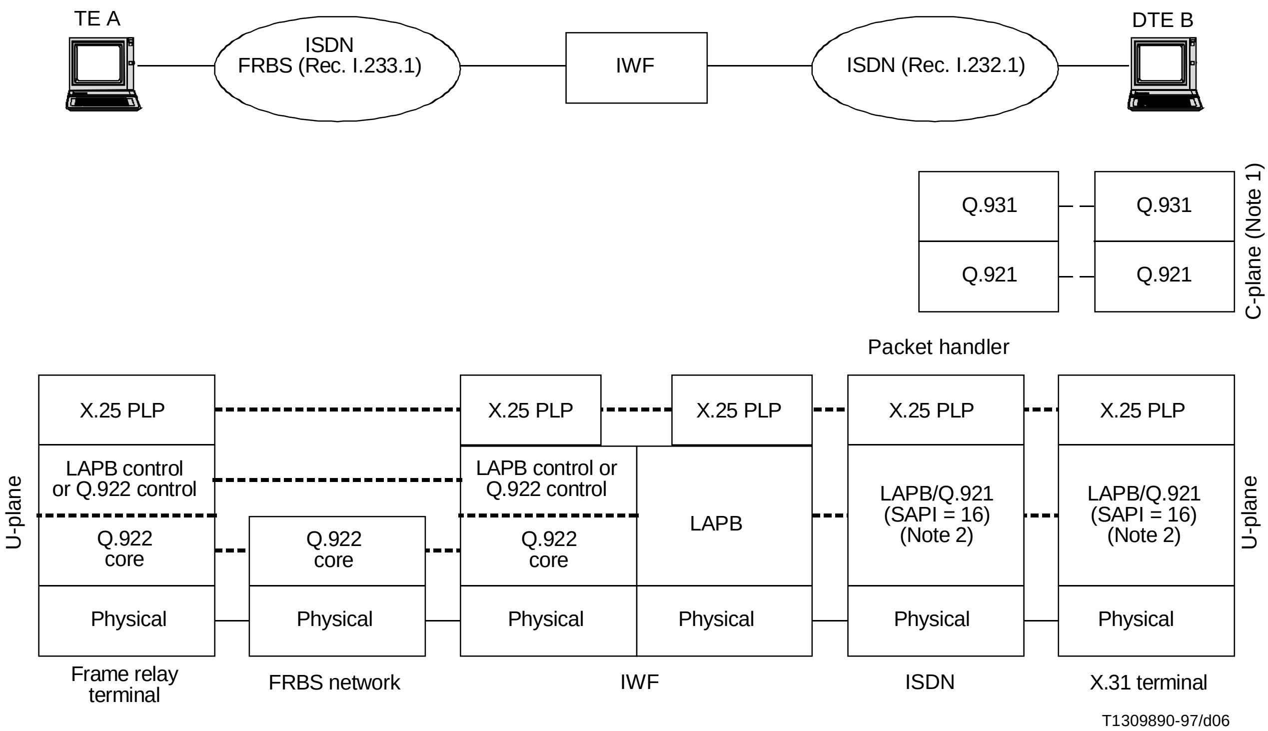



**Figure 4/I.555 – Interworking between FRBS PVC and PSPDN (X.25)
virtual call/permanent virtual circuit by port access**




NOTE 1 – C-plane procedures are used for outgoing calls on the B-channel (i.e. from DTE B) to establish an access connection to the Packet Handler (PH) in the ISDN and for incoming calls (i.e. to DTE B) when notification of an X.25 incoming call is required.

NOTE 2 – LAPB is used on the B-channel and Q.921 (SAPI = 16) is used on the D-channel.

**Figure 5/I.555 – Interworking between FRBS PVC and ISDN (X.31) by port access**

NOTE – The IWF in Figures 4 and 5 is called "Access Unit (AU)" in Recommendation X.33. In Recommendation X.33, the AU is shown as part of the network that provides Packet Mode Service.

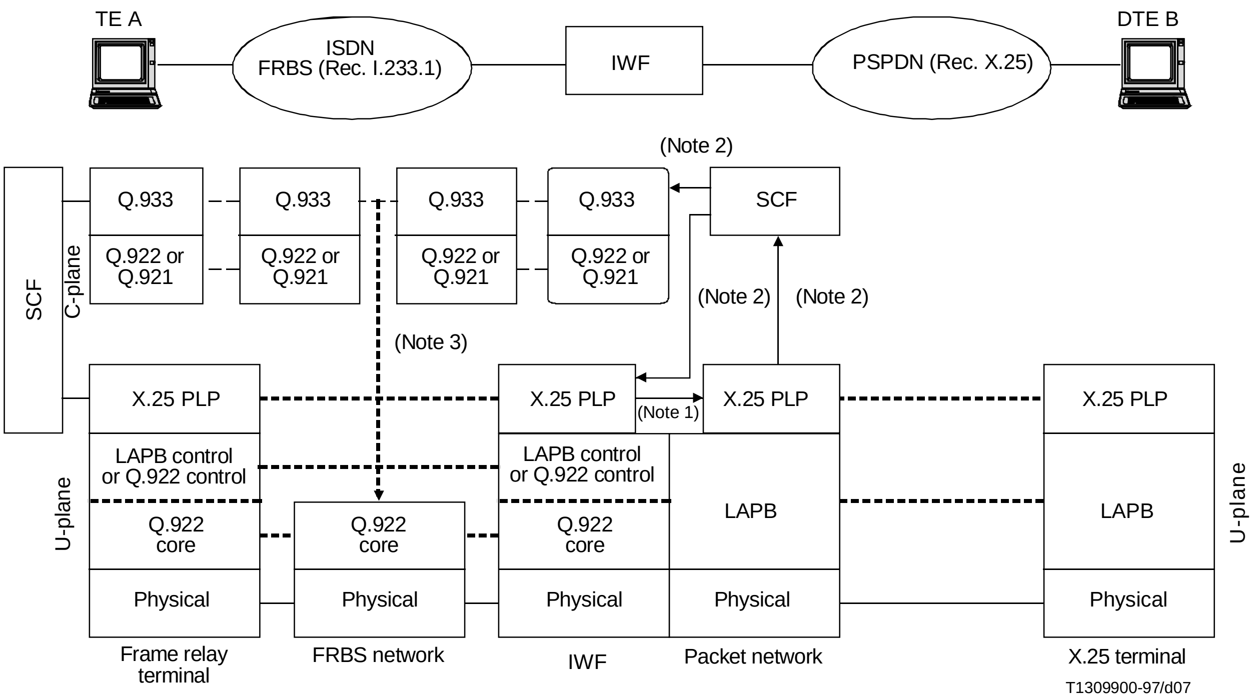
## 5.3 Interworking between FRBS SVC and PSPDN (X.25)/ISDN (X.31) virtual call by port access

Figures 6 and 7 illustrate the interworking case where FRBS is used for access to a PSPDN (X.25)/ISDN (X.31) by port access method. The calls from TE A to DTE B are based on a two-step approach. In the first step, a Frame Relay connection is established from TE A to IWF using Q.933 call control procedures. In the second step, the TE A sets up a X.25 virtual circuit within the U-plane using X.25 PLP procedures. Only the second step needs to be repeated to set up additional X.25 virtual circuits. The IWF is acting only as a relay for X.25 PLP information flows.

The two-step approach also applies to calls from DTE B to TE A. The coordination between control and user planes is the responsibility of the coordination function which resides in IWF. The Synchronization and Coordination Function (SCF) is responsible for coordination between control and user planes, and no interworking functionality is involved. In addition to C-plane and U-plane protocol coordination, the SCF has to relate network layer addresses of the PSPDN to ISDN addresses.

The release of the FRBS connection is under control of SCF to ensure that this connection is released after the last X.25 virtual call on that connection is released.

A PSPDN (X.25)/ISDN (X.31) in association with an IWF together behaves like a user terminal requesting FRBS from an ISDN FRBS. Therefore, the interworking arrangement can be based on FRBS. This scenario permits multiplexing of X.25 virtual circuits on an FRBS connection as illustrated in Figure 8.

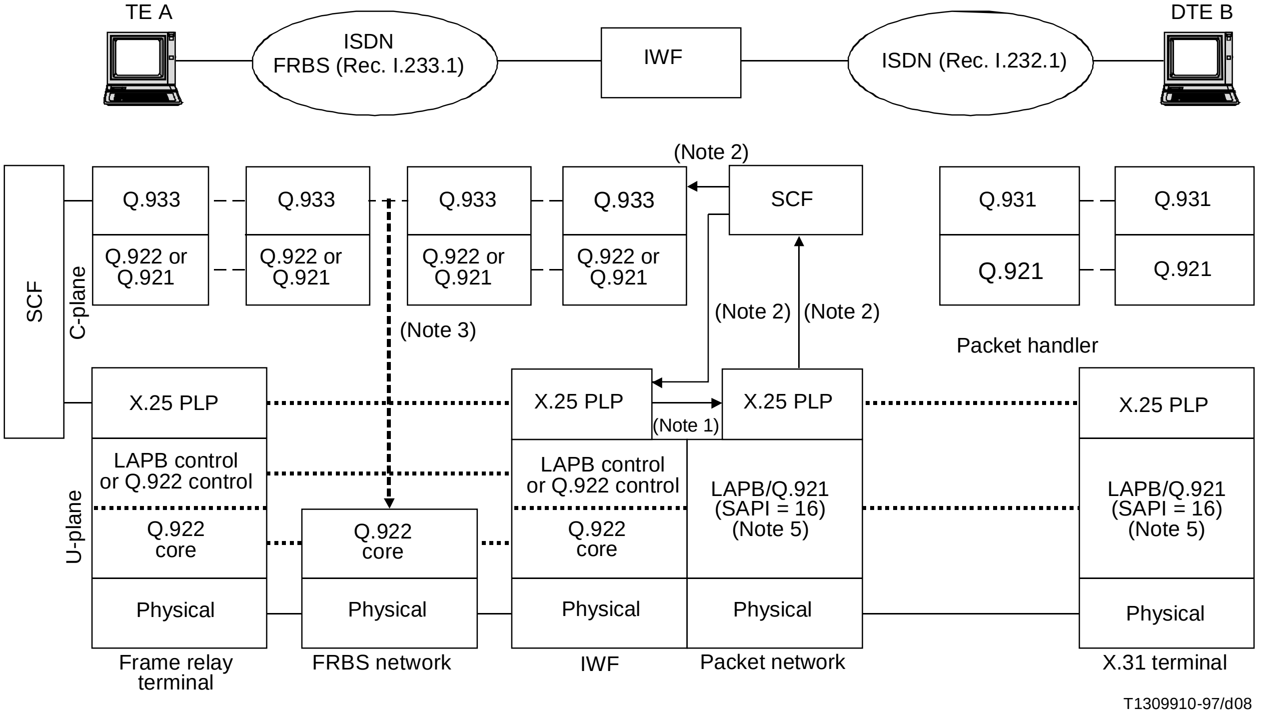



NOTE 1 – This call control relationship exists for calls from TE A only.

NOTE 2 – This call control relationship exists for calls to TE A only.

NOTE 3 – This reflects the passing of DLCI from Q.933 protocol entity to Q.922 core entity according to A.4/Q922.

**Figure 6/I.555 – Interworking between FRBS SVC and PSPDN (X.25) by port access**




NOTE 1 – This call control relationship exists for calls from TE A only.

NOTE 2 – This call control relationship exists for calls to TE A only.

NOTE 3 – This reflects the passing of DLCI from Q.933 protocol entity to Q.922 core entity according to A.4/Q.922.

NOTE 4 – C-plane procedures are used for outgoing calls on the B-channel (i.e. from DTE B) to establish an access connection to the Packet Handler (PH) in the ISDN and for incoming calls (i.e. to DTE B) when notification of an X.25 incoming call is required.

NOTE 5 – LAPB is used on the B-channel and Q.921 (SAPI = 16) is used on the D-channel.

NOTE 6 – End system protocol stacks are examples only.

**Figure 7/I.555 – Interworking between FRBS SVC and ISDN (X.31) by port access**

NOTE – The IWF in Figures 6 and 7 is called "Access Unit (AU)" in Recommendation X.33. In Recommendation X.33, the AU is shown as part of the network that provides Packet Mode Service.

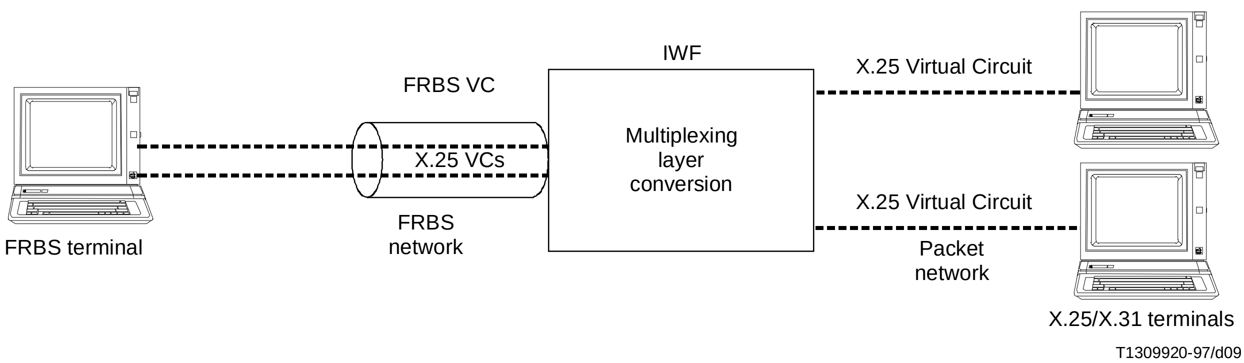



**Figure 8/I.555 – Multiplexing of X.25 VCs onto FRBS VC**

### 5.3.1 Call control requirements

Call control uses Q.933 on FRBS network and X.25 call control procedures on PSPDN. SCF provides synchronization and coordination functions between control and user planes with address translation.

Procedures for negotiation of traffic descriptors for X.25 and FRBS are for further study.

## 6 Interworking/interconnecting LANs and FRBS

This clause deals with the interconnection of Local Area Networks (LANs) using Frame Relay connections and interworking between LANs and Frame Relaying networks. The LAN interconnection/interworking can be provided by bridges and routers. There are two basic types of data packets that travel within a Frame Relaying network. These types are routed and bridged packets.

The routed and bridged packets are transported using connectionless network layer protocols. These packets have distinct formats and, therefore, must contain an indication so that the destination may correctly interpret the contents of the packet. This capability can be provided using Network Layer Protocol Identifier (NLPID) as defined in ISO/IEC TR 9577. Interworking is based on the encapsulation of bridged or routed packets within a Q.922 core frame.

Frame Relaying service provides a similar service as the LLC/MAC layer of the LAN, and hence can be used as a LAN interconnection service. The interworking/interconnection between FRBS and LANs can be realized at the following two layers:

– network layer; and

– data link layer.

Details on interworking/interconnecting LANs and FRBS are given in Appendix I.

## 7 Interworking between FRBS and Circuit Switched Service by port access

This clause describes how ISDN circuit mode connections can be used to provide access to a remote frame handler. Both switched and permanent connections may be supported by both the circuit and frame mode networks. Circuit Switched access to a remote FRBS is supported by first establishing a circuit connection to the remote frame handler. Alternatively, a permanent circuit mode connection may be used.

### 7.1 FRBS Switched Virtual Circuit (SVC) case

The SVC is established using FRBS call procedures in-band (see Recommendation Q.933) between the NT2 or TE and the remote frame handler (Figure 9a).

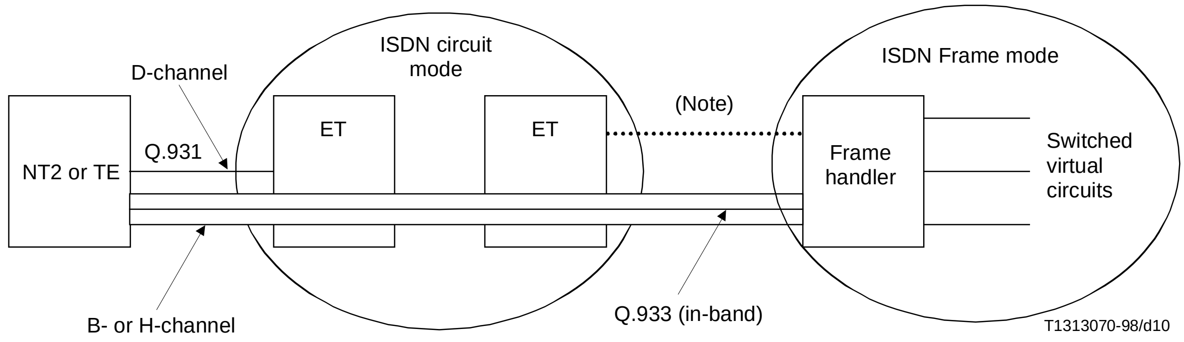
### 7.2 FRBS Permanent Virtual Circuit (PVC) case

Since the PVC has already been established in the frame mode network, the terminal may transmit frames using the DLCI value pre-allocated for access to the remote frame handler (Figure 9b).

NOTE – The mapping between the B- and H-channels and the FRBS SVCs and PVCs may be 1 to 1, 1 to N, N to 1 or N to N. In the 1 to 1 and 1 to N cases, 1 or more FRBS PVCs are carried in the B- or H-channel. In the N to 1 and N to N cases, a number of B-channels are aggregated to create a single higher rate channel which carries one or more FRBS SVCs or PVCs. A protocol for B-channel aggregation is described in Recommendation H.244.

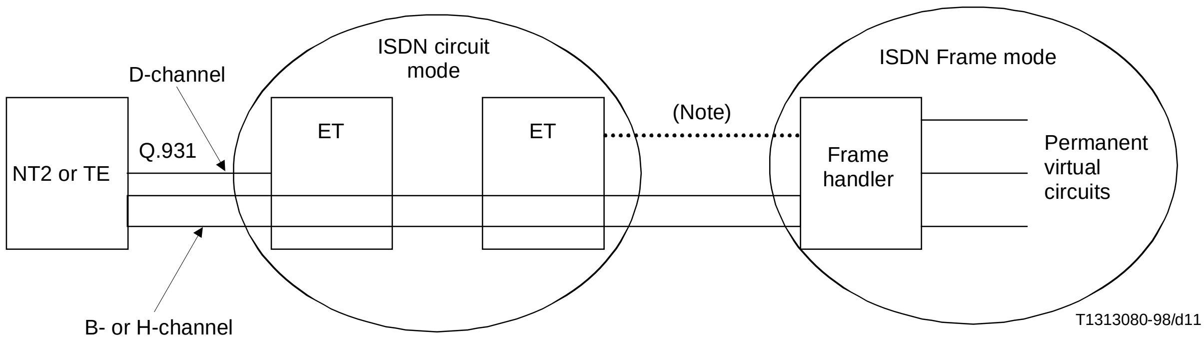
## 8 Interworking between FRBS and B-ISDN

In this clause interworking is described between FRBS and the Connection Oriented Variable Bit Rate Services provided by Class C services of B-ISDN.




NOTE – Examples of signalling used to set up this connection are SS No. 7 and DSS 1.

**Figure 9a/I.555 – Interworking between FRBS Switched VC and ISDN Circuit Switched Service**




NOTE – Examples of signalling used to set up this connection are SS No. 7 and DSS 1.

**Figure 9b/I.555 – Interworking between FRBS Permanent VC and ISDN Circuit Switched Service**

## 8.1 General description

The purpose of FR to B-ISDN interworking is to allow one or both of:

a) transportation of FR traffic over a B-ISDN network; and

b) customers on either type of network to communicate with one another.

The need to transport FR traffic over a B-ISDN network arises when network operators use a core B-ISDN infrastructure to provide multiple services, such as Frame Relay. There is also a need for FR and B-ISDN terminals to be able to communicate directly.

This Recommendation covers various aspects of FR to B-ISDN interworking. Two interworking types between B-ISDN and FR networks are defined; service interworking and Network Interworking.

Service interworking applies when a FRBS TE interacts with an ATM TE; the FRBS TE does not perform any ATM functions and the ATM TE does not perform any FR functions. All interworking is performed by an InterWorking Function (IWF). In contrast, with network interworking, the ATM TE performs specific functions in the FR-SSCS within the AAL layer.

In addition the Post access from B-ISDN (ATM-TE) to FRBS TE is based on a two-step approach. In the first step, a B-ISDN VCC is established between B-ISDN TE to IWF using Q.2931 call control procedures. Only the second step needs to be repeated to set up additional FR connections. The IWF is acting only as a relay for FR signalling and data flows. The release of the B-ISDN VCC is done after the last FR connections are released.

The generic interworking requirements are given below, and three interworking scenarios are outlined.

For the PVC interworking case, each interworking scenario is specified in detail covering the protocol mapping, management mapping, and OAM mapping between FR and ATM.

The SVC interworking case is also covered by this Recommendation.

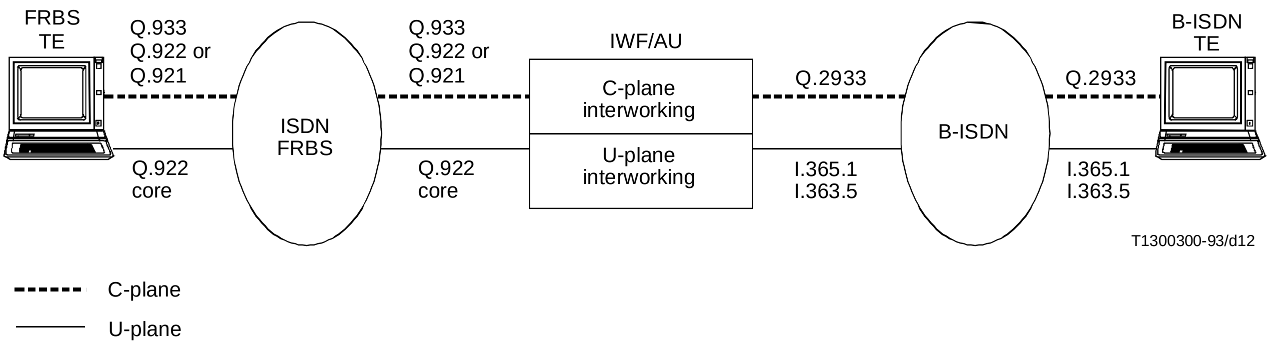
NOTE – Either UNI or NNI protocols can be used at the interfaces of IWF. However, the various cases described in this subclause use UNI signalling only.

## 8.2 Generic interworking requirements

Figure 10 is a representation of the generic FRBS to B-ISDN interworking arrangements defined in this Recommendation. This figure shows only interworking cases where UNI protocols are used on both sides of the IWF/AU. There are additional cases where NNI protocols are used on both sides of the IWF. The interworking arrangements are between FRBS and B-ISDN Class C, message mode, non-assured operation. Interworking between FRBS and B-ISDN Class C services is performed either by call control mapping (SVCs) or by provisioning (PVCs). The call control mapping procedures can be carried either by tunneling the FR signalling protocol through the ATM network (network interworking scenario) or by translation between the FR and ATM signalling protocols at the IWF (service interworking scenario).

Directly provisioned (PVC) interworking configurations are handled by the M-plane (Management Plane). Interworking configurations which are established on demand using SVCs must include the call control mappings in the C-plane (Control Plane). Once a connection through the interworking function has been established, either by the M-plane or by the C-plane, the user data is then subject to the interworking rules of the U-plane (User Plane).

The need for interworking between FRBS and B-ISDN Class C, message mode, assured operation is for further study.




NOTE 1 – Q.2933 is only used for network interworking and in the case of service interworking I.365.1 is not used but Q.2931 is used.

NOTE 2 – Both Q.933 Case A and Case B access methods on the Frame Relay side are supported.

NOTE 3 – Either UNI or NNI protocols may be used at the interfaces of IWF. NNI protocol X.76 is applicable at the interface between the ISDN and IWF.

**Figure 10/I.555 – Interworking between FRBS and B-ISDN**

A set of generic requirements for interworking between Frame Relaying and B-ISDN services are:

- mapping of the Frame Relaying loss priority and congestion control indications;
- negotiation procedures for Frame Relaying frame size;
- message mode unassured operation without flow control;
- immediate transfer of user data once the connection has been established without AAL parameter negotiation procedures.

### 8.2.1 Interworking in the M-plane

Permanent Virtual Circuit (PVC) interworking connections are established by creating separate permanent FR and B-ISDN connections on either side of the interworking function via M-plane communications.

The M-plane is responsible for establishing the FR PVC and B-ISDN PVC connections and assigning appropriate traffic parameters to them.

The traffic parameters used to describe a Frame Relay connection are CIR, $B_c$, $B_e$ and T. The corresponding traffic parameters used to describe the B-ISDN Class C service depend on the specific ATC chosen. The mapping between Frame Relay and B-ISDN traffic descriptors is carried out by the M-plane, and can be implemented in numerous ways, depending on how conservatively the loss ratios in both networks should match. One possible mapping of the traffic descriptors is covered in the FR/ATM element mappings clause, in the subclause on bandwidth mapping (8.4.1.3).

### 8.2.2 Interworking in the C-plane

The establishment and release of SVC interworking connections in the involved networks is carried out by the C-plane interworking. The general protocol stacks for C-plane network interworking between FRBS and B-ISDN is described in Annex C.

Only the 1 to 1 mapping of FR to B-ISDN VCCs is supported. The N to 1 mapping is for further study.

Since both the FRBS and the B-ISDN call control are handled in a separate call control plane, it is assumed similar call control functions are used, which can be appropriately mapped.

Call Control mapping is provided in a way that U-plane connections are established and released in both interworking networks, interconnected by the IWF. C-plane procedures must provide for the negotiation of U-plane parameters (e.g. throughput, maximum frame size).

The traffic parameters used to describe a Frame Relay connection are CIR, $B_c$, $B_e$ and T. The corresponding traffic parameters used to describe the B-ISDN Class C service depend on the specific ATC chosen. The mapping between Frame Relay and B-ISDN traffic descriptors is carried out by the C-plane, and can be implemented in numerous ways, depending on how conservatively the loss ratios in both networks should match. One possible mapping of the traffic descriptors is covered in the FR/ATM element mappings section, in the subclause on bandwidth mapping (8.4.1.3).

Details of specific cases of C-plane interworking are discussed in 8.3.

### 8.2.3 Interworking in the U-plane

Interworking in the U-plane consists of interworking the FRBS and B-ISDN Class C services, message mode, unassured operation.

In particular, B-ISDN Class C, message mode, unassured operation provides basic similar functions (see Table 1) as the Frame Relaying core service, and as such supports the FRBS.

Recommendation I.363.5's AAL type 5 (SAR and CPCS), in conjunction with either the FR-SSCS (I.365.1) or the Null SSCS, provides the required B-ISDN support for the FRBS. AAL type 5 (SAR and CPCS) is common to all FRBS and B-ISDN interworking scenarios.

Subclause 8.3 provides more details on the protocol reference architecture for different interworking scenarios.

The B-ISDN ATC used to support interworking with B-ISDN will depend on the traffic parameter mapping chosen (see 8.4.1.3) and is left to the network operator's implementation.

## 8.3 Interworking scenarios

These interworking scenarios apply to both PVCs and SVCs.

### 8.3.1 Network interworking

#### 8.3.1.1 Network interworking – U-plane (Scenario 1)

Figure 11 represents the case, where B-ISDN is interposed between Frame Relaying networks to provide a high speed interconnection capability. In this case, the Frame Relaying networks are users of B-ISDN. The CPE and FR network are unaware of the underlying ATM backbone, due to the isolation provided by the interworking function at each interface to the ATM network.

The FR-SSCS, as shown in Figure 11, supports the Frame Relaying core functions of Recommendation I.233.1. Table 1 illustrates the division of core functions among FR-SSCS, CPCS, SAR sublayer and ATM layer.

The ATM layer should be in accordance with Recommendation I.361 and the AAL composed of the SAR and CPCS sublayers is specified in Recommendation I.363.5. AAL type 5 (SAR and CPCS) shall be used for Frame Relaying and B-ISDN interworking. The FR-SSCS should be in accordance with Recommendation I.365.1. The FR-SSCS-PDU has exactly the same structure as the Q.922 core frame without the flags, zero bit insertion and FCS, as specified in Recommendation I.365.1.

There are two methods of multiplexing FRBS connections over B-ISDN, N to 1 mapping and 1 to 1 mapping.

**N to 1 mapping case**

A number of Frame Relaying logical connections are multiplexed into a single ATM virtual channel connection. Multiplexing is accomplished at the FR-SSCS sublayer using DLCIs. This is illustrated in Figure 12.

**1 to 1 mapping case**

Each Frame Relaying logical connection is mapped to a single ATM virtual channel connection and multiplexing is accomplished at the ATM layer using VPI/VCIs. This is illustrated in Figure 13.

In both multiplexing schemes, the FRBS connections are identified by the Q.922 core DLCI.

The FR-SSCS links are identified by VPI/VCI in the 1 to 1 case. The FR-SSCS may provide for the multiplexing into the VCC, of the single user data stream and PVC status monitoring information in accordance with Annex A. The status monitoring stream shall use DLCI = 0 and the user data stream may use any DLCI not = 0. DLCI = 0 shall not carry any call control signalling in this case. Call control signalling can be carried on DLCI = 0 only for the N to 1 case.

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

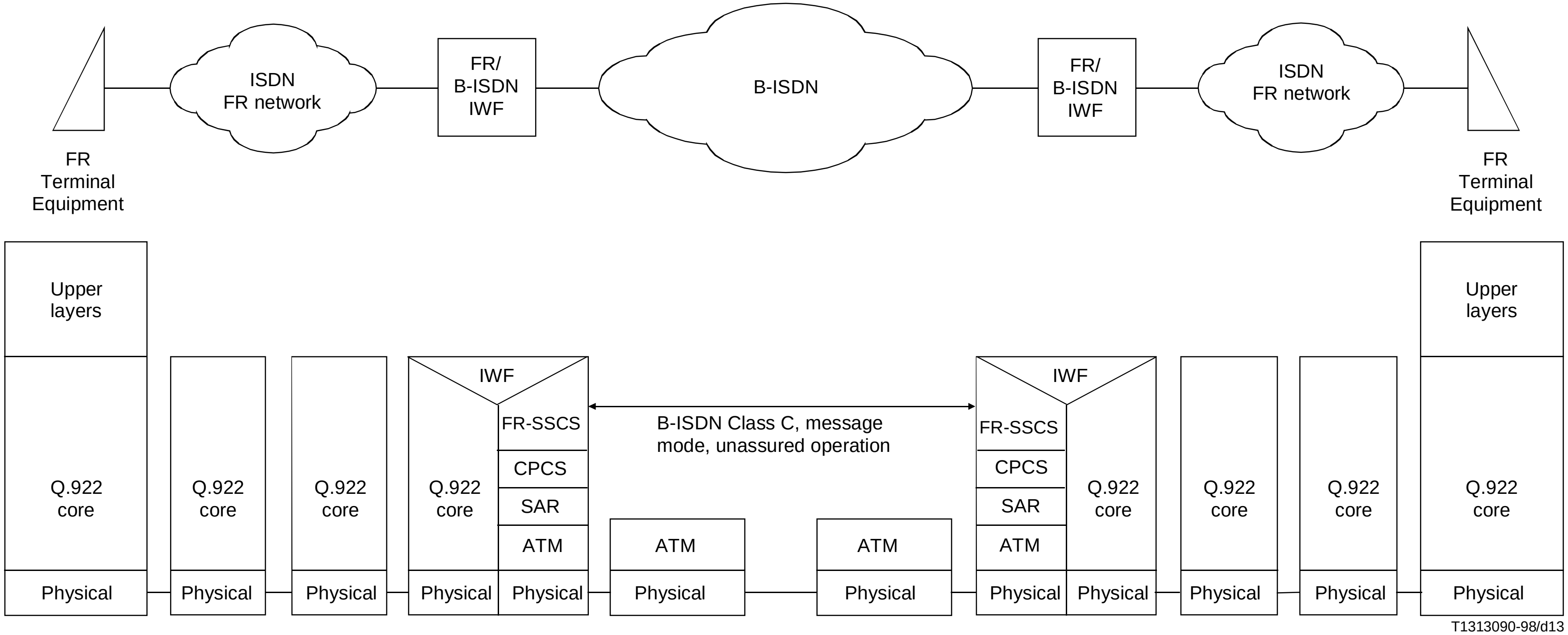



**Figure 11/I.555 – Frame Relay/B-ISDN network interworking U-Plane (Scenario 1)**

**Table 1/I.555 – Provision of I.233.1 core functions in the equivalent B-ISDN service**

| **FRBS** | **B-ISDN Class C, Message mode, Unassured** | | |
|---|---|---|---|
| I.233.1 core functions | ATM function | SAR and CPCS functions (AAL5) | FR-SSCS function |
| Frame delimiting, alignment and transparency | | Preservation of CPCS-SDU | |
| Frame multiplexing/demultiplexing using the DLCI field | Multiplexing/demultiplexing using VPI/VCI | | Multiplexing/demultiplexing using the DLCI field |
| Inspection of the frame to ensure that it consists of an integral number of octets | | | Inspection of the PDU to ensure that it consists of an integral number of octets |
| Inspection of the frame to ensure that it is neither too long nor too short | | | Inspection of the PDU to ensure that it is neither too long nor too short |
| Detection of (but not recovery from) transmission errors | | Detection of (but not recovery from) transmission errors | |
| Congestion control forward | Congestion control forward | | Congestion control forward |
| Congestion control backward | | | Congestion control backward |
| Command/response | | | Command/response |
| Congestion control discard eligibility | Cell loss priority | | Congestion control discard eligibility |

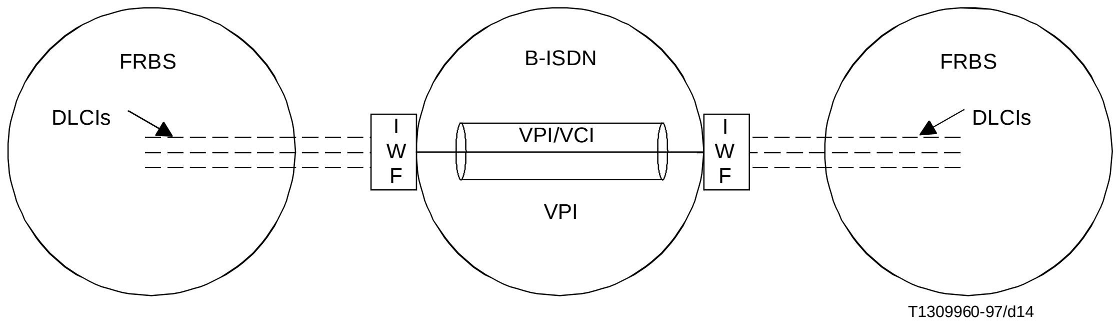



**Figure 12/I.555 – Multiple DLCIs multiplexed on a single ATM virtual channel connection**

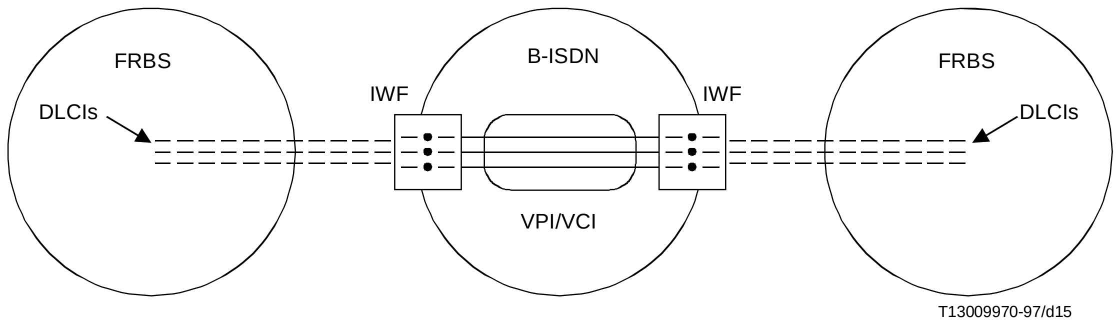



**Figure 13/I.555 – Each DLCI mapped into an ATM virtual channel connection and multiplexed on a virtual path**

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

The congestion management strategy for the two multiplexing methods is the subject of Recommendations I.370 and I.371.

The interworking between FR and B-ISDN is performed by:

– transferring unchanged the information fields of the Protocol Data Units (PDUs) between the FR Service Specific Convergence Sublayer (FR-SSCS) and Q.922 core;

– the Protocol Control Information (PCI) derived from the headers of the two interworked protocols (Q.922 and FR-SSCS) 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 these parameters (see 8.4.1) are also mapped to the parameters exchanged with the AAL5 CPCS. The format of the header of the interworked protocols is defined in Recommendation Q.922.

The mapping of the parameters exchanged between the Q.922 core and the FR-SSCS to/from the parameter exchanged with the AAL5 CPCS is described in 8.4.1.

The use of the B-ISDN network by the Frame Relaying network is not visible to the end users. The end user protocol suites remain intact.

#### 8.3.1.2 Network interworking – U-plane (Scenario 2)

This interworking scenario describes the transport of Frame Relay traffic between a Frame Relay user on a Frame Relay network and an ATM user on an ATM network (see Figure 14). The ATM terminal must have an in-built Frame Relay capability (i.e. FR-SSCS).

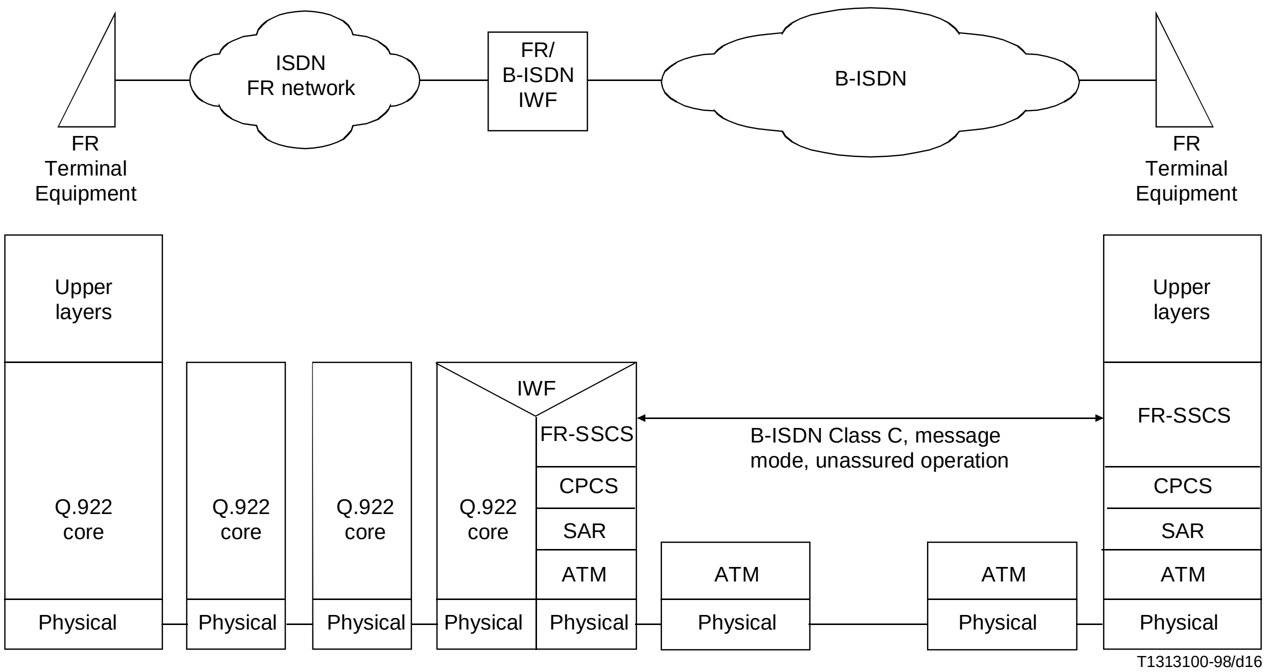


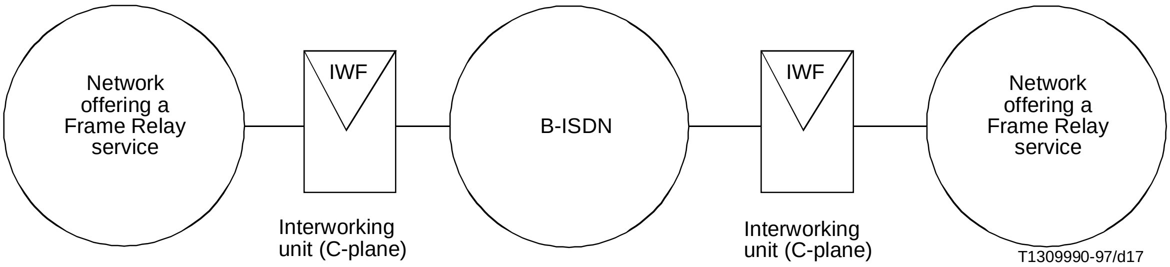

**Figure 14/I.555 – Frame Relay/B-ISDN network interworking (Scenario 2)**

The IWF is the same as described in Scenario 1. The functions of the FR-SSCS at the B-ISDN terminal and IWF are described in Recommendation I.365.1. The mapping of parameter values of the primitives among Q.922, FR-SSCS and AAL5 CPCS is described in the FR/ATM element mappings clause, see 8.4.

#### 8.3.1.3 Network Interworking C-Plane (scenario 1)

Figure 15 illustrates the case of network interconnection between B-ISDN and a network providing the Frame Relay service. For this case, the B-ISDN is invisible to the users; it acts as a pipe between the Frame Relay networks carrying Frame Relay signalling and user data in the U-plane. In general with the network interworking approach, multiple Frame Relay connections may be multiplexed within one ATM VCC.

The interworking function may not translate between Frame Relay signals and Q.2933. Frame Relay signalling information may be carried unchanged and transparently across the B-ISDN network. The need for translation in this case is for further study. The interworking function must, however, recognize Frame Relay signalling messages and information elements to take appropriate actions on the B-ISDN side. For example when a Frame Relay SETUP message arrives, the interworking function must determine whether the SETUP message can be sent over an existing VCC or a new one must be created, (i.e. two stage set-up procedures).



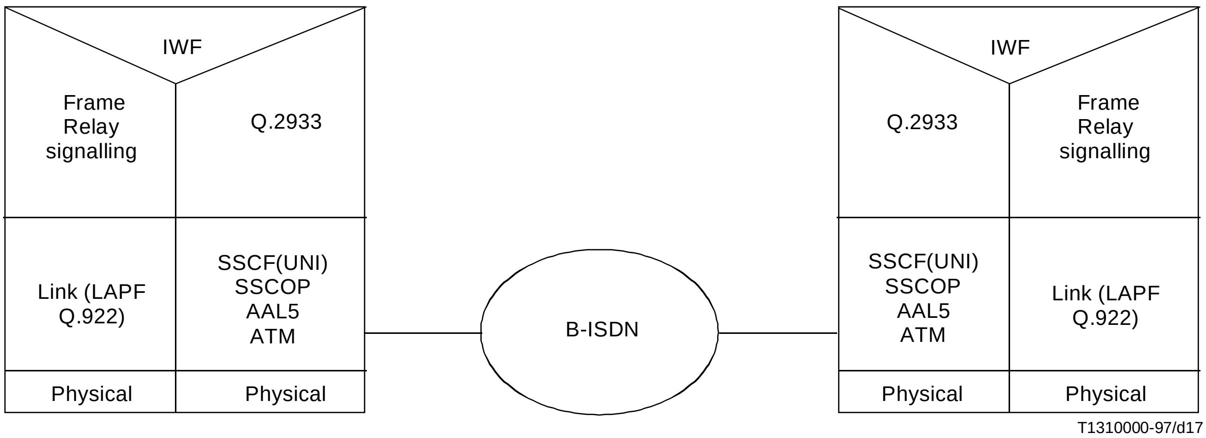
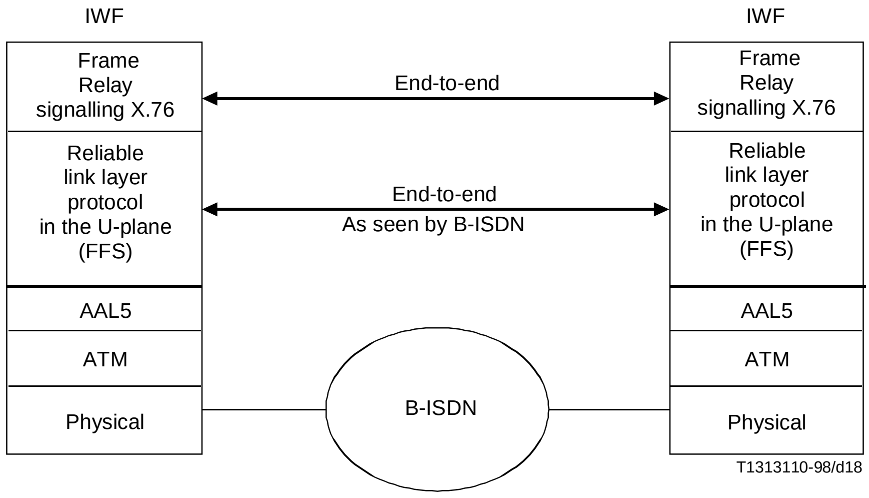




**Figure 15/I.555 – Network interworking in the C-plane between a network providing the Frame Relay service and B-ISDN (Scenario 1)**

There are two components to the interworking function between a network supporting a Frame Relay service and B-ISDN: The first one is in the C-plane; it involves the two interworking functions, the B-ISDN and DSS 2 signalling.

The second component is in the U-plane as shown in Figure 16. It strictly involves Frame Relay signalling performed between the two interworking functions transparently over the B-ISDN. The Frame Relay signalling protocol requires a reliable link layer protocol in the U-plane. The choice of link layer protocol is for further study.




FFS For further study

**Figure 16/I.555 – U-plane signalling component of the interworking function for the network interworking case**

#### 8.3.1.4 Network Interworking C-Plane (scenario 2)

Figure 17 depicts the case of network interconnection between B-ISDN and an ISDN providing FR service. For this case, the FR terminal implements Q.933 for signalling and B-ISDN terminal implements Q.2933 in the C-Plane. Due to signalling restrictions within Recommendation Q.2933, only 1 to 1 mapping is possible. Future support of N to 1 mapping is not excluded.

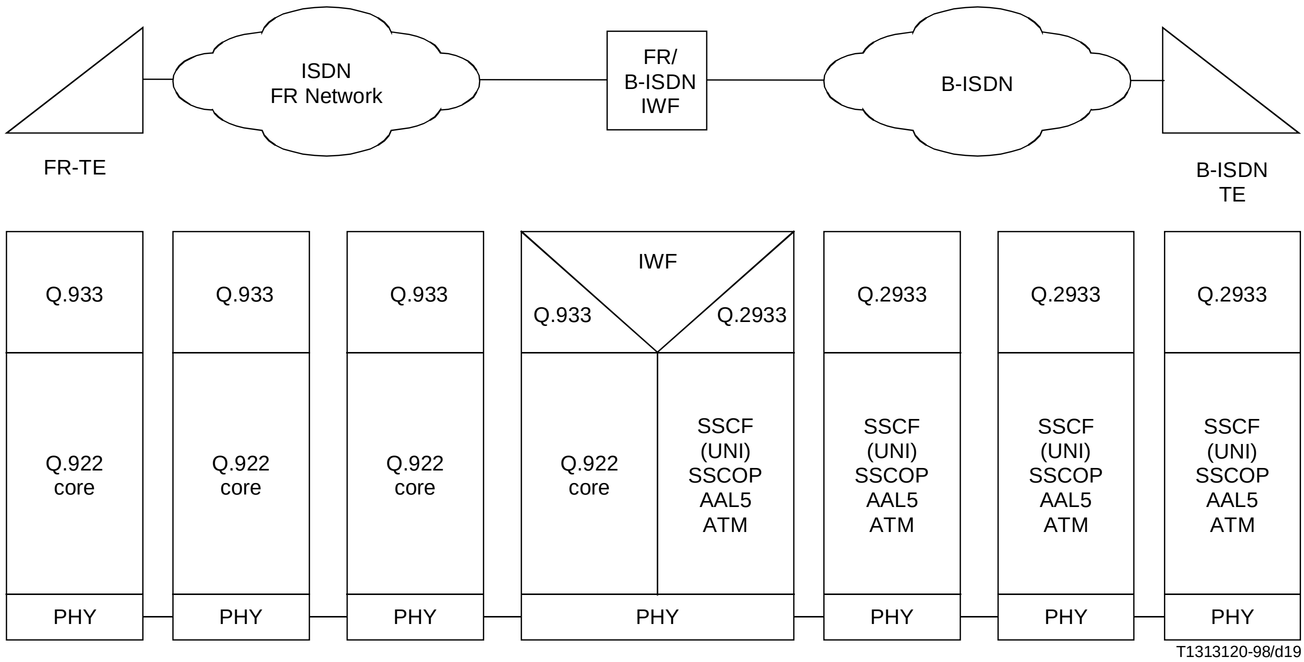



**Figure 17/I.555 – Network interworking in the C-plane between an ISDN providing the Frame Relay service and B-ISDN (Scenario 2)**

### 8.3.2 Service interworking

This section only deals with service interworking between an ISDN providing FRBS and B-ISDNs. The case of two concatenated FRBS networks via B-ISDN is covered by network interworking scenario (see Figure 15).

#### 8.3.2.1 U-plane interworking

Service Interworking describes the transport of higher layer protocol Service Data Units (SDUs) between a Frame Relay terminal on a Frame Relay network and a B-ISDN terminal on a B-ISDN network. The interworking function between the FR and B-ISDN networks extracts the higher layer protocol SDUs from FR frames and transfers them into ATM cell payloads. Service interworking is illustrated in Figure 18.

The B-ISDN service user performs no Frame Relaying specific functions and the Frame Relaying service user performs no B-ISDN service specific functions. All interworking functionalities are performed by the IWF. Since the B-ISDN terminal does not support the I.233.1 type core service, higher layer interworking functions are needed.

The network provider can configure or provision one of the two modes of operation for each pair of interoperable Frame Relay and ATM virtual channels regarding upper layer user protocol encapsulation. One of the following two modes is selected for each PVC at configuration time or SVC during call set-up in order to achieve end-to-end service interoperability between terminal equipment. Upper layer user protocol encapsulation is optional in the IWF. The IWF may provide one, some or none of the protocols discussed in this subclause.

Mode 1: Transparent Mode – when encapsulation methods do not conform to the standards cited in Mode 2 but they are compatible between terminal equipment (e.g. packetized voice), the IWF shall forward the encapsulation unaltered. No mapping nor fragmentation/reassembly shall be performed.

Mode 2: Translation mode – Encapsulation methods for carrying multiple upper layer user protocols (e.g. LAN to LAN) over a Frame Relay virtual channel and an ATM virtual channel conform to RFC 1490 and RFC 1483 respectively. The IWF shall perform mapping between the two encapsulations due to the incompatibilities of the two methods. Translation Mode supports the interworking [routed and/or bridged] protocols.

An example of service interworking using translation mode is provided in Appendix II.

#### 8.3.2.2 C-plane interworking

Figure 19 illustrates the service interworking case for the C-plane. It requires an interworking function connected at the UNI of each network. Interconnection using other interfaces than the UNI are for further study. On the B-ISDN side, the interworking function implements DSS 2 protocol layers with Q.2931 as the signalling protocol. On the Frame Relay side, Recommendation Q.933 is used for signalling.

From the C-plane perspective, the IWF of the interworking function shall:

– interface with the signalling protocol entities of each side of the interworking function;

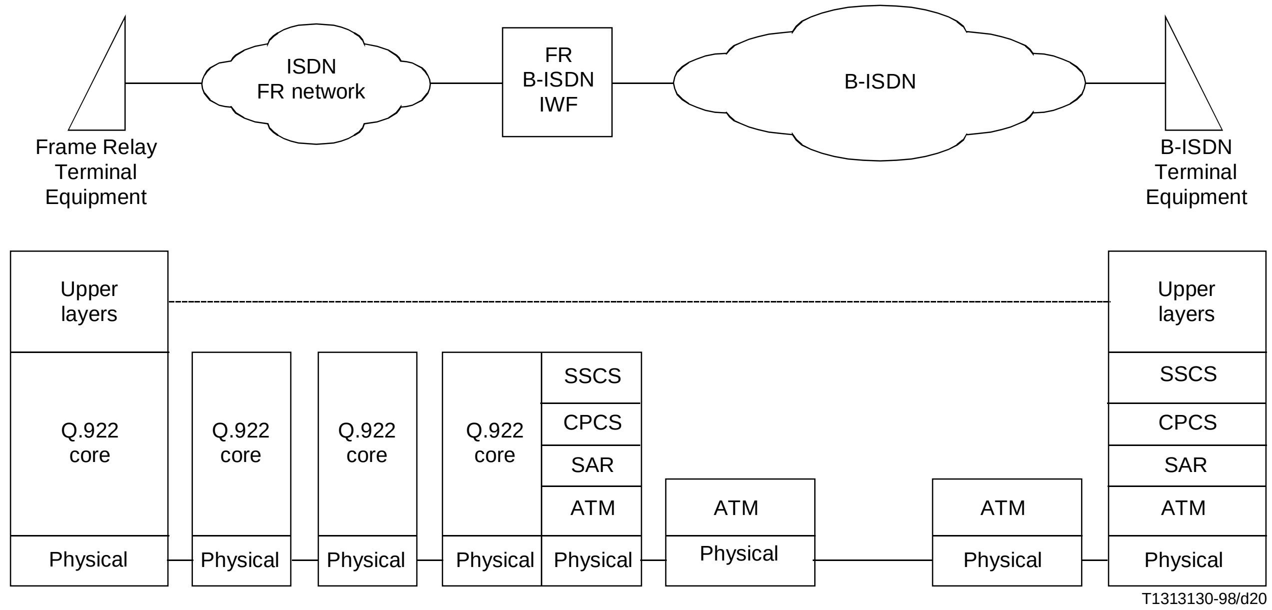
– translate between Q.933 signalling information and the corresponding Q.2931 signalling information;

– correlate the call reference and DLCI of Frame Relay switched virtual connection with the corresponding call reference and VPI + VCI assigned to the corresponding B-ISDN virtual channel connection. Note there is a one-to-one correspondence between a Frame Relay switched virtual connection and an ATM VCC. The requirements for address translation are for further study;

– set-up a call on one network at the receipt of a call set-up request from the other network;

– clear a call on one side at the receipt of a clear request from the other side;

– react to different events received from one side and translate them to corresponding events on the other side.




NOTE – Where SSCS corresponds to a B-ISDN service which can interwork with FRBS.

**Figure 18/I.555 – Frame Relay/B-ISDN service interworking**

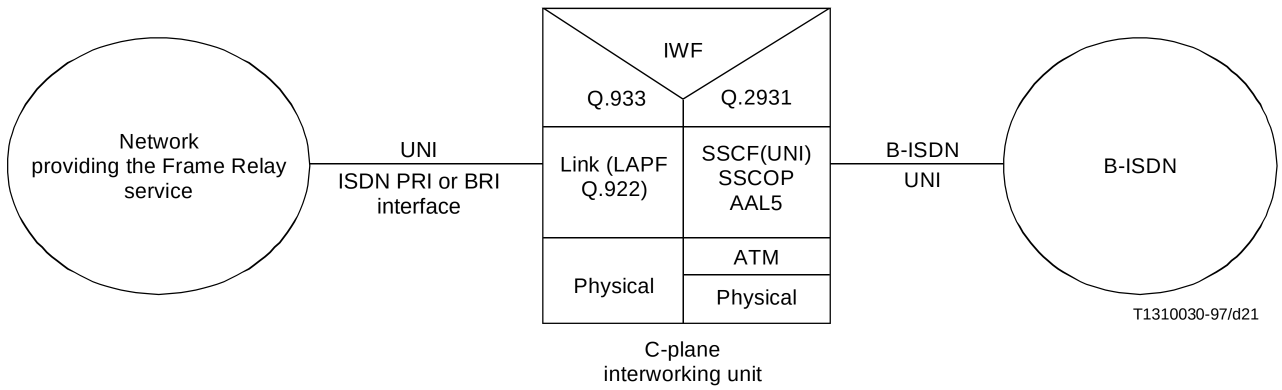



**Figure 19/I.555 – Service interworking in the C-plane between a network providing the Frame Relay service and B-ISDN**

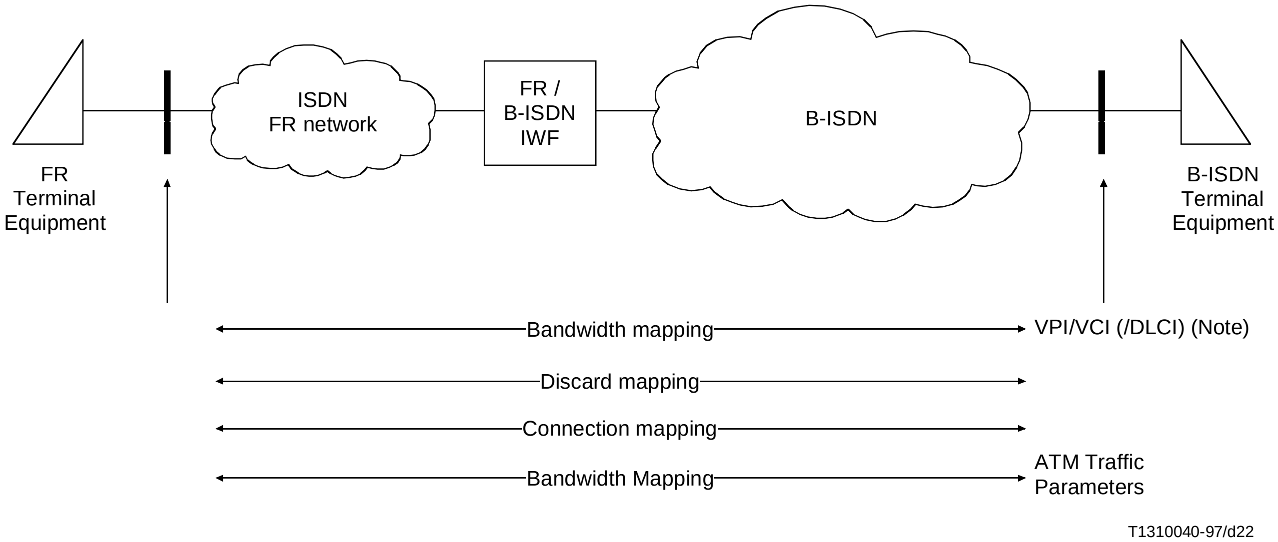
## 8.4 FR/ATM element mappings

### 8.4.1 Protocol mappings

Figure 20 shows the protocol parameter mappings required between FRBS and B-ISDN Class C Service.

#### 8.4.1.1 Discard eligibility and loss priority mapping

For the network interworking scenarios the following mappings apply, as shown in Figure 21. For the service interworking case the FR-SSCS is replaced with a Null SSCS, and the upper layer protocols make direct use of the CPCS primitives.




NOTE – The DLCI parameter identifies FR connections at the FR interface. The VPI/VCI parameter identifies the ATM connection at the B-ISDN interface.The connection identifiers only have local significance, and accordingly there is no requirement to map between the FR DLCI and the ATM VPI/VCI parameters The DLCI is only significant on the B-ISDN side in the case of N to 1 mapping.

**Figure 20/I.555 – Protocol mappings between Frame Relay and B-ISDN**

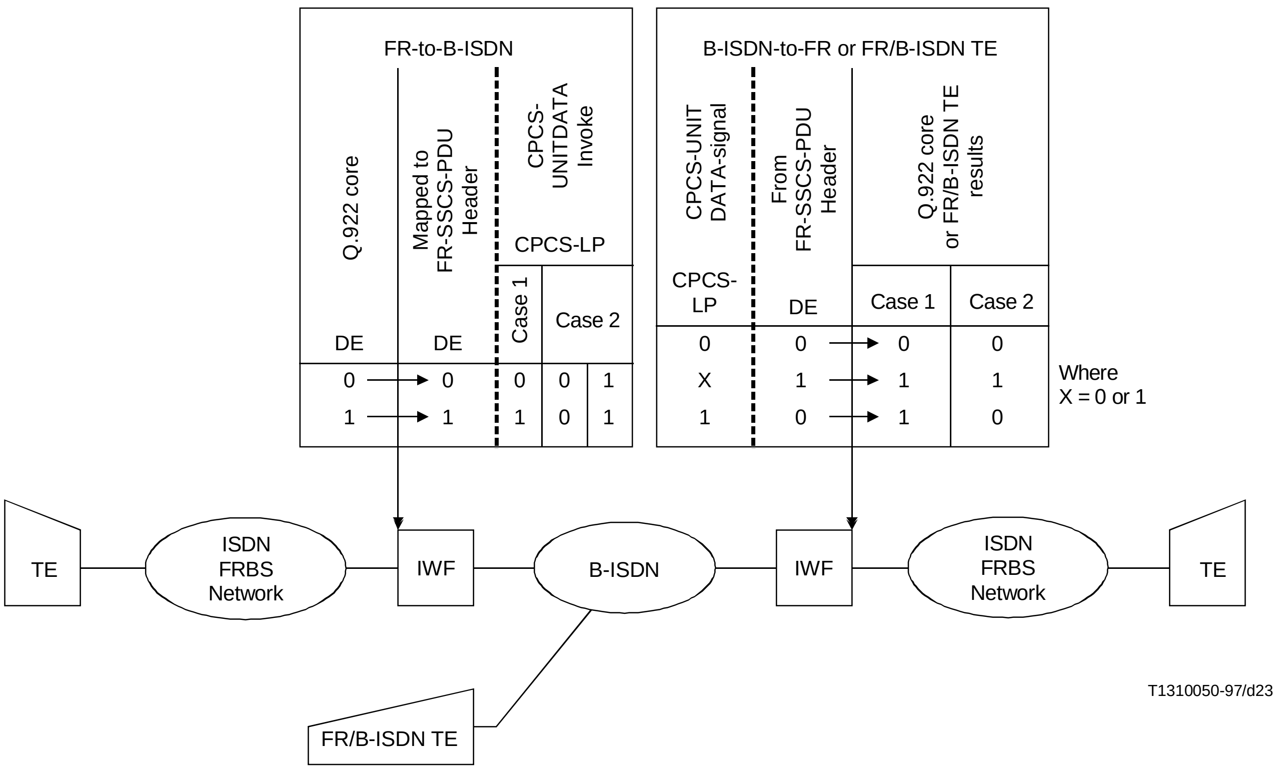



**Figure 21/I.555 – DE/CLP mappings**

a) *Loss priority mapping in FR-to-B-ISDN direction*

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

*Case 1* – set to the value of the parameter Discard Eligibility of the DL-CORE DATA request primitive or the IWF-DATA request primitive; or

*Case 2* – always set to zero or to one.

The choices between two cases can be made during connection set-up or through subscription on a CPCS basis, and is a Network administration issue.

b) *Loss priority mapping in B-ISDN-to-FR Direction*

The Discard Eligibility (DE) parameter shall be set to either:

*Case 1* – 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; or

*Case 2* – the value of the DE field in the FR-SSCS-PDU.

Both cases 1 and 2 above shall be supported by the IWF so that network operators can decide at connection set-up or subscription on a CPCS connection by CPCS connection basis which one is used. The method of selection between the two cases outlined above is outside the scope of this Recommendation.

NOTE – The mapping of the CPCS-LP parameter into the CLP bit of the ATM cell is specified in Recommendation I.363.5 (AAL type 5).

#### 8.4.1.2 Congestion indication mapping

##### 8.4.1.2.1 Network Interworking

For the network interworking scenarios the following mappings between the Frame Relaying FECN parameter and the B-ISDN CI parameter apply, as shown in Figure 22.

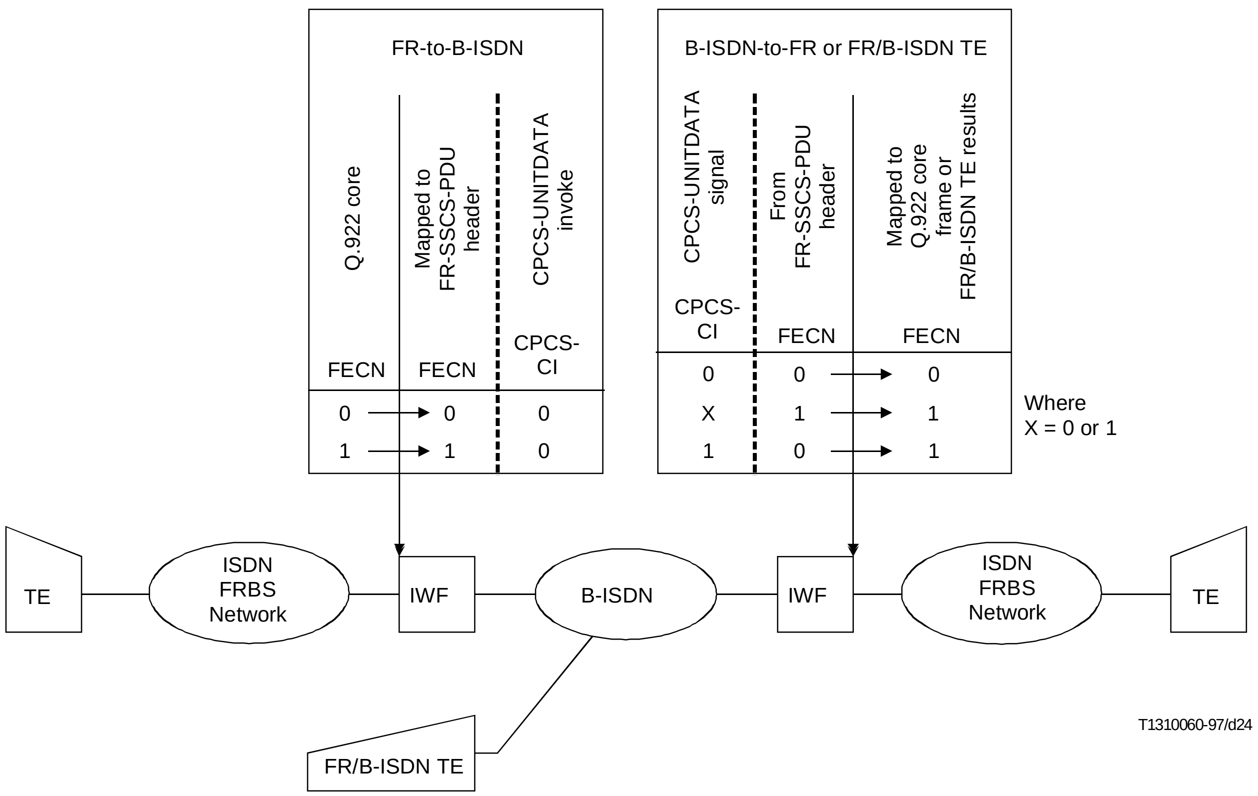



**Figure 22/I.555 – Forward congestion indication mappings**

a) *Congestion indication mapping in FR-to-B-ISDN direction*

The FECN in the Q.922 core frame is mapped into the FR-SSCS-PDU header FECN. The CPCS-CI parameter value of the CPCS-UNITDATA invoke primitive shall be set to 0 by the FR-SSCS. Thus separate indications exist for congestion occurring in either the ATM network or FR network.

The BECN field in the FR-SSCS-PDU is set to "1" by the IWF if either of the following two conditions is met:

1) BECN is set in the Q.922 Core Frame, relayed in the FR to B-ISDN direction; or

2) the CPCS-CI parameter of the most recent CPCS-UNITDATA signal primitive received for this connection if the reverse direction was set.

b) *Congestion indication mapping in B-ISDN-to-FR direction*

If the CPCS-CI parameter value of the CPCS-UNITDATA signal primitive is 0 and FR-SSCS-PDU header FECN = 0, then FECN shall be set to 0 in the Q.922 core frame.

If the FR-SSCS-PDU header FECN = 1, then FECN shall be set to 1 in the Q.922 core frame, irrespective of the CPCS-CI parameter value of the CPCS-UNITDATA signal primitive.

If the CPCS-CI parameter value of the CPCS-UNITDATA signal primitive is 1, and the FR-SSCS-PDU header FECN = 0, then FECN shall be set to 1 in the Q.922 core frame.

The BECN field in the FR-SSCS-PDU is copied unchanged into the BECN field of the Q.922 core frame.

#### 8.4.1.2.2 Service Interworking

For the service interworking case the FR-SSCS is replaced with a Null SSCS, and the upper layer protocols make direct use of the CPCS primitives, by applying the following mappings. The BECN field of the Q.922 core frame does not have an equivalent field in the CPCS frame.

a) *Congestion indication mapping in FR-to-B-ISDN direction*

The CPCS-CI parameter shall be either:

*Case 1* – set to the value of the FECN bit in the Q.922 core frame; or

*Case 2* – always set to zero.

Both cases 1 and 2 above shall be supported so that network operators can decide at connection set-up or subscription on a CPCS connection by CPCS connection basis which mapping is used. The method of selection between the two mapping cases outlined above is outside the scope of this Recommendation.

The value of the BECN field in the Q.922 core frame shall be ignored.

b) *Congestion indication mapping in B-ISDN-to-FR direction*

The FECN field in the Q.922 core frame shall be set to the value of the CPCS-CI parameter of the CPCS-UNITDATA signal primitive.

The BECN field in the Q.922 core frame shall always be set to zero.

NOTE – The mapping of the CPCS-CI parameter into the EFCI bit of the ATM cell is specified in Recommendation I.363.5 (AAL type 5).

#### 8.4.1.3 Bandwidth mapping

This mapping is done at PVC connection establishment time.

The traffic parameters used to describe a Frame Relay connection are CIR, $B_c$, $B_e$ and T (I.370). The corresponding traffic parameters used to describe the B-ISDN Class C service are dependent on the particular ATC chosen (Recommendation I.371).

One conservative mapping method for service interworking using the SBR Configuration 1 ATC is described in Annex D. This one method shall be included in the set of bandwidth mapping alternatives offered by the interworking function, and is required to support the interoperation between network operators that both offer interworking functions.

Other traffic parameter mapping methods may be used at the discretion of the network operator.

#### 8.4.2 Mappings specific to service interworking

The Frame Relay C/R protocol bit is copied directly into the LSB of the CPCS-UU byte.

#### 8.4.3 OAM mappings

Recommendation I.610 covers B-ISDN OAM principles and functions.

Recommendation I.620 covers FRBS OAM principles and functions.

Interworking requirements and mappings between B-ISDN OAM procedures and FRBS OAM procedures is for further study.

#### 8.4.4 PVC status management mappings

Annex A describes the FR/ATM PVC status reporting procedures for network interworking.

Annex B describes the FR/ATM PVC status monitoring procedures for service interworking.

## Annex A

## FR/ATM PVC status reporting procedures for network interworking

This Annex provides information an appropriate additional procedures which may be used to report the status of Frame Relay Permanent Virtual Connections (FR PVCs) using unnumbered information frames.

The procedures are defined in Annex A/Q.933 and describes the means for notification of outage of a FR PVC carried on ATM between two FR-SSCS Layer Management Entities (FRLMEs), and recovery from such a condition. A FRLME is located within a FR/B-ISDN Interworking Unit or a FR B-ISDN TE. For implementations where the Frame Relay side supports only FR PVCs, unacknowledged mode of operation at layer 2 (see Recommendation Q.933), the procedures are also 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.

The higher layer messages are transferred across the ATM VCC using layer 2 unnumbered information frames (as defined in Recommendation Q.922) 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.

NOTE – Subclause A.6/Q.933 also defines optional bidirectional procedures which can be used.

# Annex B

# FR/ATM PVC status monitoring for service interworking

For service interworking between the Frame Relay and ATM networks the procedures relating to FR/ATM Permanent Virtual Circuit (PVC) status management are defined below.

For FR networks the status of the FR PVC may be communicated across the FR part of the network using the procedures defined in Annex A/Q.933. These procedures should be applicable up to the Interworking Function (IWF). (See Figure B.1.)

For ATM networks the status of a configured ATM PVC can be inferred from the ATM Layer Management mechanisms in accordance with Recommendation I.610.

## B.1 Requirements for FR/ATM PVC status management

The ATM PVC status information can be derived by the IWF from the OAM cell flows. The configuration information may require additional (out-of-band) mechanisms. It may be provided via the Network Management interfaces.

Consequently the FR/ATM PVC interworking requirements are:

1) all PVC status information is handled by the OAM flows and Annex A/Q.933 procedures;

2) configuration of PVCs is by administrative procedures, but may be verified by end-to-end loopback of OAM cells.

## B.2 FR PVC management procedures

On the FR network side of the IWF the FR PVC management procedures defined in Annex A/Q.933 shall be used. The bidirectional procedures apply.

The Link Integrity Verification (LIV) procedures may be used to assure the link between the IWF and the attached FR network is operational.

If the IWF detects a service affecting condition, it will indicate this to the ATM Layer Management Entity (ATMLME) which will initiate the sending of F5 (or F4) AIS on the configured ATM PVCs in accordance with I.610 procedures (see the Note below with regard to the use of interworking OAM cells).

When the FR service affecting condition is cleared as indicated according to the Annex A/Q.933 procedures, the IWF will stop sending the AIS cells downstream towards the ATM side (see the Note below with regard to the use of interworking OAM cells).

NOTE – At present AIS cells are used in some implementations to convey the status of the FR connections. The optional use of a dedicated OAM cell for interworking purposes is for further study. In such cases the IWF would generate an OAM cell to convey the status of the FR connections.

### B.2.1 Handling of new/deleted FR PVCs

When the FR network indicates to the IWF that a PVC is "new", the IWF logs this information for use in subsequent PVC status monitoring.

If the end-to-end Continuity Check (CC) function is supported as an option, the IWF may initiate end-to-end CC cells on the corresponding configured ATM PVC.

If the CC option is not supported on the connection, the IWF may transfer this information to the ATM Network Management System via a management interface if required.

When the FR network indicates to the IWF that a PVC is "deleted" by removing the PVC Information Element (IE) from the full status report (and optionally by the async status message), the IWF logs this information as above.

If the CC function is supported as an option, the IWF stops sending end-to-end CC cells on the corresponding ATM PVC.

### B.2.2 Active/inactive FR PVCs

The criteria for determining "inactive" FR PVC state are:

1) the FR network explicitly indicates in a full status report (and optionally by the async status message) that this FR PVC is "inactive";

2) the LIV indicates the link from the IWF to the FR network is down.

NOTE – When the IWF is informed a FR PVC is "deleted" via the PVC IE no longer present in the full status report (and optionally by the asynchronous status message), the IWF may also consider the PVC to be "inactive".

In either case the "inactive" state maps across to the corresponding ATM PVC. The inactive state results in the sending of the F5 (or F4) AIS cells by the IWF on the corresponding ATM PVC if there is a configured ATM PVC available.

The IWF determines if the ATM PVC is configured by means of the end-to-end loopback cell procedures in accordance with Recommendation I.610.

The criteria for determining "active" FR PVC state are:

1) when a full status report (or the optional async status message) indicates a FR PVC is "active"; and

2) the LIV indicates the FR-to-IWF link is "up".

The IWF maps the active state to the corresponding ATM PVC. The active state results in the suppression of the AIS state in the IWF (no AIS cells are transmitted).

## B.3 ATM PVC management procedures

The ATM PVC management procedures utilize:

1) AIS/RDI OAM cells to convey ATM PVC status information to the IWF;

   NOTE – Absence of AIS/RDI state indicates PVC is "up"; presence of AIS/RDI cells indicates PVC is "down".

2) under System Management control OAM loopback cells may be initiated by the IWF to verify ATM PVC configuration/availability, and for fault localization;

3) end-to-end CC cells if this option is supported on the connection.

The status and configuration information obtained by the IWF from the above procedures is then mapped to the corresponding FR status indicators and delivered to the FR network.

### B.3.1 Handling of added/deleted ATM PVCs

When a new ATM PVC is configured (by management action), the IWF initiates loopback using end-to-end loopback OAM cells at intervals of 5 seconds. When three (3) consecutive loopback cells are returned to the IWF, the IWF will declare the ATM connection "added".

The IWF maps this to the corresponding FR PVC. The "new" indication will be reported to the FR network in a full status report.

When an ATM PVC is removed or deconfigured (by management action), the IWF maps this indication to the FR PVC management procedures.

NOTE – In the case of management action to deconfigure a remote segment of the ATM connection, this information may not be available in real time since a management (or other administrative) interfaces may be utilized to convey such information back to the IWF.

The "deleted" indication will be reported by the IWF to the FR network in a full status report by removing the corresponding PVC IE (and optionally in the async status message). The FR network will infer that the PVC is inactive and propagate the "deleted" status to the FR connection end point.

When the IWF and B-TE is configured to support the CC function, the IWF declares the ATM PVC "down" when no user cells and no CC cells arrive in the interval specified in Recommendation I.610.

When the CC option is not available on the connection loopback, cells may be initiated under system management control to verify ATM PVC availability.

### B.3.2 Active/inactive ATM PVCs

The criteria for determining "inactive" ATM PVC are:

1) a PVC is not deleted from the ATM network and the ATM network explicitly indicates via AIS/RDI OAM cells that this PVC is "down";

2) a loopback procedure indicates the link from the IWF to the ATM network is "down";

3) the IWF is configured to receive end-to-end CC and absence of CC cells or user cells for the specified period indicates the ATM PVC is "down".

If any of the inactive criteria are met, the ATM PVC (or PVCs) are considered inactive. The mapped "inactive" indication results in the sending of Active bit = 0 in the full status report (and optionally in the async status message) by the IWF into the FR network for the corresponding FR PVC(s) if there is a corresponding PVC configured.

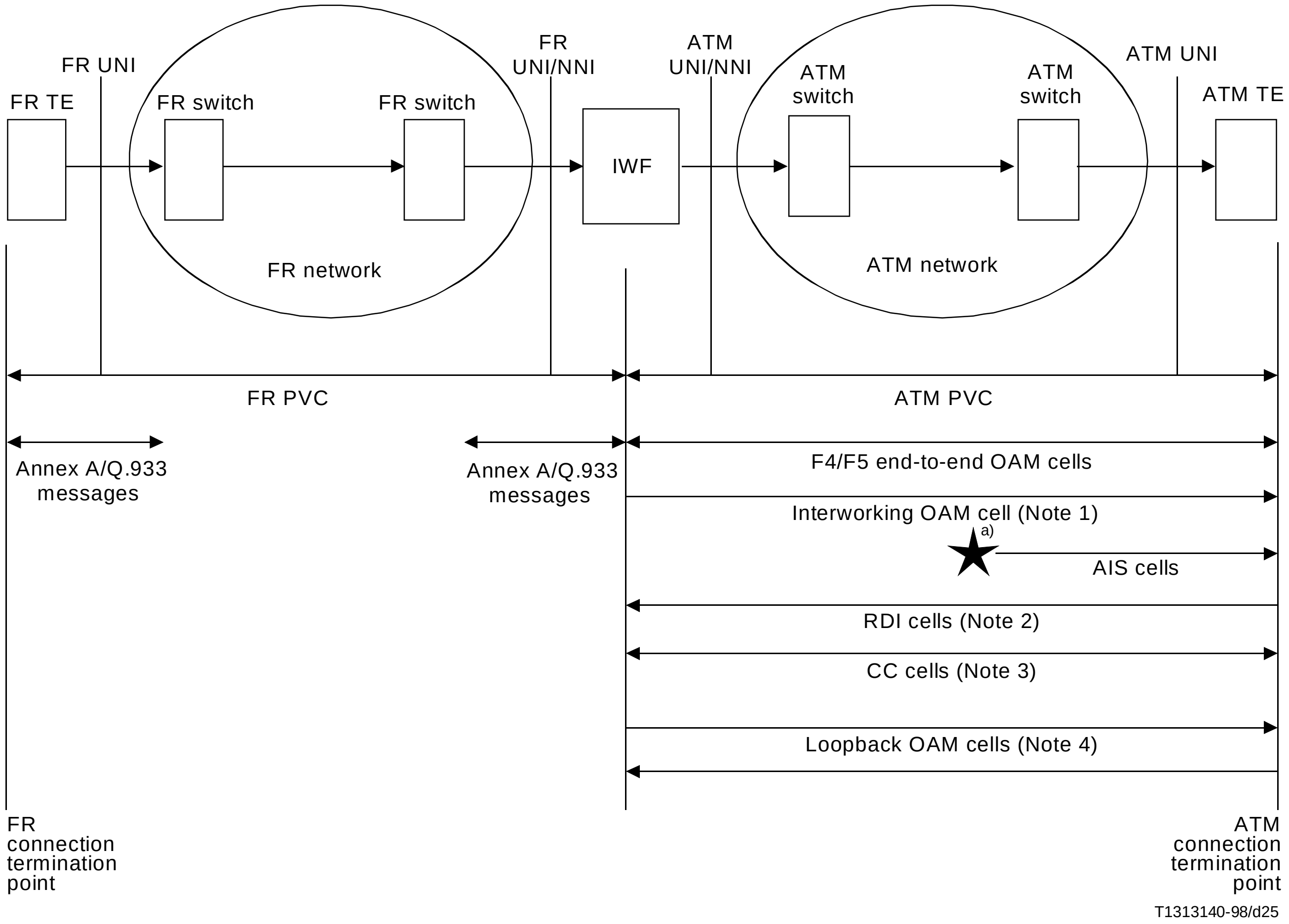
(The IWF knows if the FR PVC is configured since this information is conveyed by the network full status reports.)

After an ATM PVC has been added, the criteria for determining that this PVC is active are:

1) no AIS/RDI OAM cells are received from the ATM network for a time interval as defined in Recommendation I.610; and

2) loopback procedures indicate the link to the ATM network is up.

The IWF maps this state on to the corresponding FR PVC "active" indication.




[a] It indicates defect/disruption in ATM network.

NOTE 1 – See Note of B.2 and B.2.2.

NOTE 2 – See B.3.2.

NOTE 3 – See B.3.

NOTE 4 – See B.2.2 and B.3.

**Figure B.1/I.555 – Management of ATM/FR PVC interworking**

# Annex C

## C-plane interworking between N-ISDN and B-ISDN for FR

This Annex refers to C-plane interworking between FRBS network and B-ISDN network as described in 8.2.2.

There are two ways of mapping FR connections into ATM Virtual Channel Connections (VCCs):

- 1 to 1 mapping, in which every FR connection is individually mapped into an ATM VCC;
- N to 1 mapping, in which multiple FR connections are mapped into a single ATM VCC.

C-plane interworking for the N to 1 mapping case is for further study.

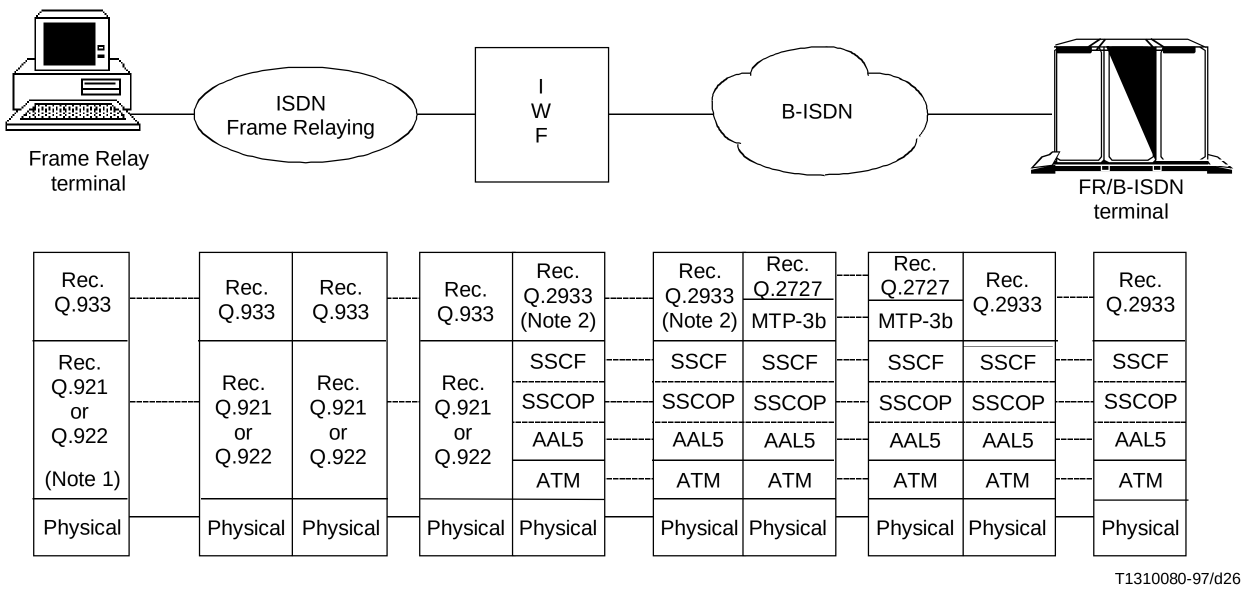
The IWF defines the association between the bearer channel and DLCI value on the FR side and the VPI/VCI value and the DLCI value on the B-ISDN side, for the routing of frame relay PDUs during the data transfer phase.

Figure C.1 shows the protocol stacks for signalling interworking. For the 1 to 1 mapping case only, Q.2933 procedures shall be used to establish the FR connection through the ATM network. The IWF shall support mapping between Q.933 procedures in the FR network and Q.2933 procedures in the ATM network.

If the call is originated on the FR side, the IWF will first support the set-up of the circuit switched connection with the FR TE in accordance with Q.931 procedures. The IWF will provide the mapping of this connection into an ATM VCC.

If the call is originated on the B-ISDN side, the IWF will support the set-up of the ATM VCC and the frame mode connection in accordance with Q.2933 procedures.

When the IWF has an ATM NNI, the ATM call set-up procedures are in accordance with B-ISUP (Recommenda-tion Q.2727) and MTP-3b.




NOTE 1 – When Q.933 case A procedure is used, a circuit mode connection from FR TE to Frame Handler is first established using Q.931 over Q.921. A frame mode connection is next established using Q.933 over Q.922 on the B-H-channel. When Q.933 case B procedure is used, a frame mode connection is directly established using Q.933 over Q.921 on the D-channel.

NOTE 2 – Both UNI and NNI are applicable at the interface of IWF. When NNI is applied at the interface, the part of Q.2933 of protocol stack is changed to B-ISUP.

NOTE 3 – B-ISUP is described in Recommendations Q.2727 and MTP-3b.

**Figure C.1/I.555 – Interworking of signalling procedures between FRBS network and B-ISDN**

# Annex D

## Mapping of traffic parameters using the SBR Configuration 1 ATC

This Annex defines a conservative mapping of the FRBS traffic parameters to the SBR Configuration 1 traffic parameters (Recommendation I.371) in the case of service interworking.

The following definitions apply for the purpose of specifying the parameter value mappings.

AR = Frame Relay Access Rate (bit/s)

T = $B_c$ / CIR; where $B_c$ is in bits and CIR is in bit/s.

EIR = $B_e$ / T

N = Number of user information bytes carried in a FR frame (bytes)

Y = Number of cells required to carry one frame of user information (cells/frame)

= Round up{ (N + 8 + K) / 48 }, where 8 bytes of AAL5 overhead are included

K = A number between 0 and 6 representing the additional overhead for the specific encapsulation used for service interworking

M = Number of bytes required to carry one frame of user information (bytes/frame)

= N + 5, where 5 bytes include the FR flag, header, and FCS.

The mapping from FRBS to B-ISDN traffic parameters is calculated as follows:

$PCR_{0+1}$ = (AR / 8 bit/byte) × (1 / M) × (Y)

$PCR_{0+1}$ = ((CIR + EIR) / 8 bit/byte) × (1 / N) × (Y)

$MBS_{0+1}$ = (($B_c$ + $B_e$) / 8 bit/byte ) × [(1 / (1 – (CIR + EIR)/AR)) + 1] × (1 / N) × (Y)

CLR = FLR × (Y / M), approximately (FLR = Frame Loss Ratio)

The mapping from B-ISDN to FRBS traffic parameters is calculated as follows:

CIR = ($SCR_{0+1}$) × (1 / Y) × (N) × 8 bit/byte

Bc = ($MBS_{0+1}$) × (1 / Y) × (N) × 8 bit/byte

Be = 0 (non zero values are for further study)

FLR = CLR × (M / Y), approximately

# Appendix I

## Interworking/interconnection of LANs and FRBS

### I.1 General

Local Area Networks (LANs) provide efficient, high-speed data transport within user establishments. Integrated Services Digital Network (ISDN) facilities will provide data transport both within user establishments and across public or private networks.

Two scenarios illustrate the concept of simplified interconnection of LANs via FRBS. The first scenario is LAN to LAN interconnected via an ISDN Frame Relaying Network (see Figure I.1).

The second scheme is interconnected LANs connected through an ISDN Frame Relaying Network to an ISDN Terminal (see Figure I.2).

The Terminal Equipment (TE) refers to the end-user's equipment which may consist of an ISDN frame mode terminal, or a combination of an existing data terminating equipment attached to an ISDN terminal adapter.

The LAN IWF refers to a device which may consist of a router or a MAC-LLC bridge. Its service characteristics may include but not be limited to: LAN protocol identification; segmentation/reassembly; encapsulation of frames; mapping of Q.922 to ISO/IEC 8802-1/8802-2 protocol elements.

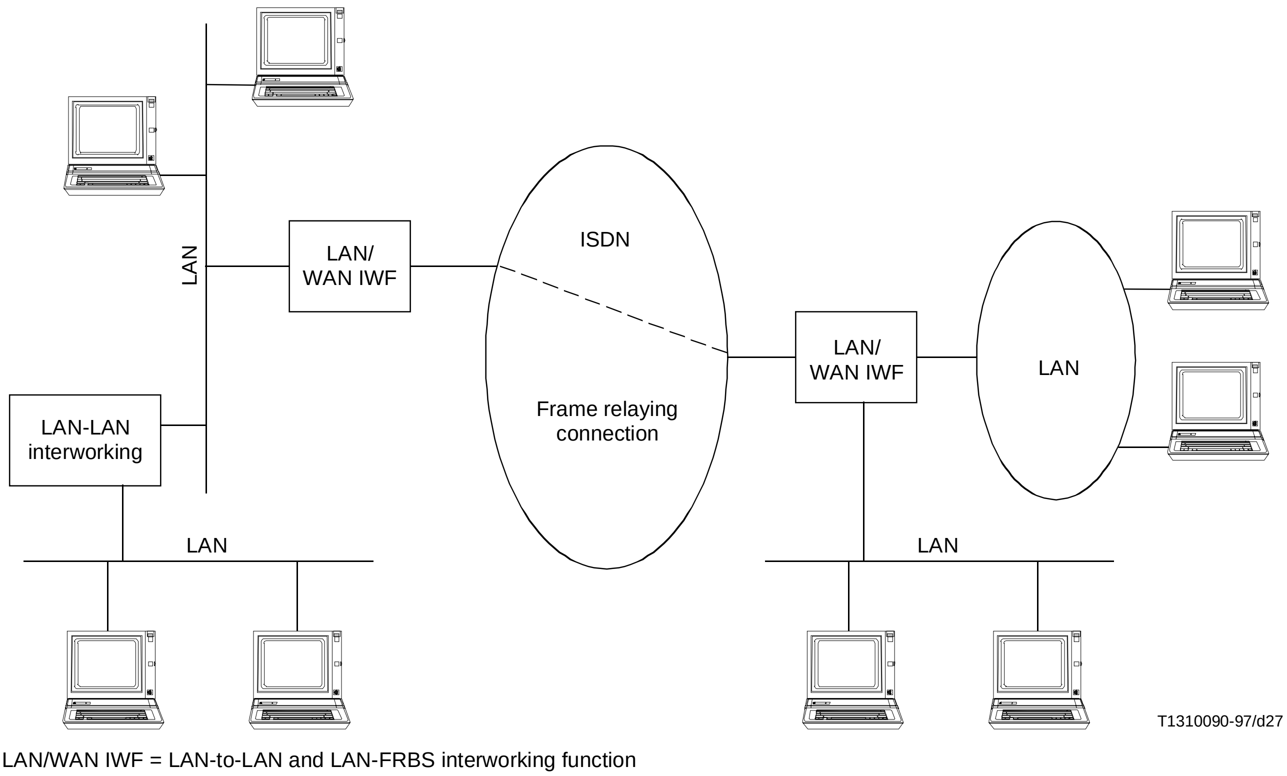



**Figure I.1/I.555 – LAN-LAN interconnection via ISDN Frame Relaying**

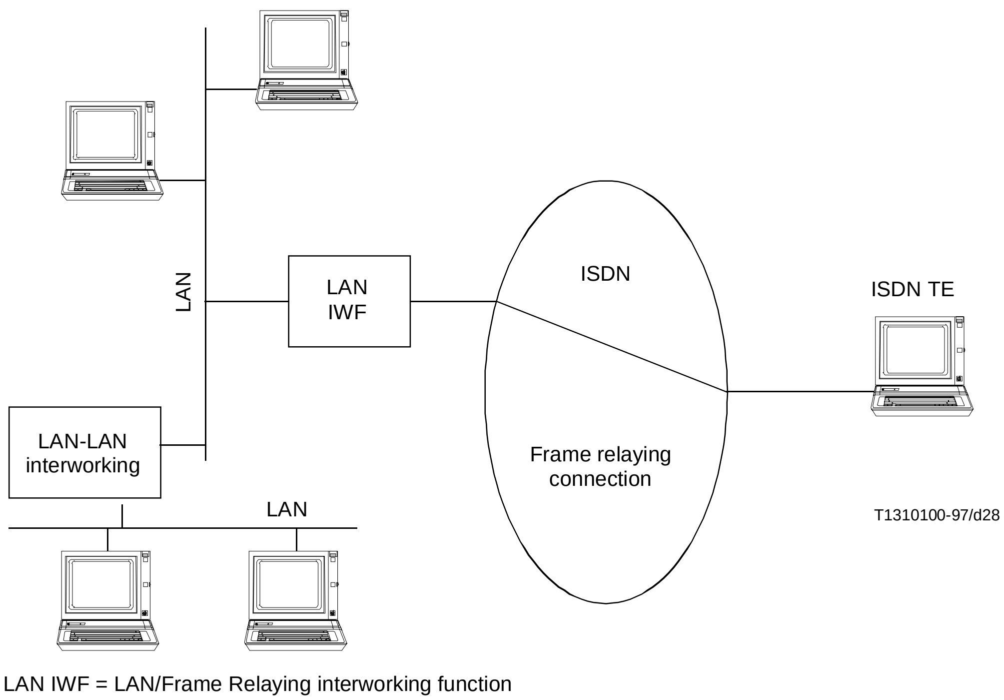



**Figure I.2/I.555 – Interconnecting LANs to an ISDN TE**

## I.2 Interworking between FRBS and LANs at network layer

The LAN/WAN IWF should have the following functions to interconnect LANs via a Frame Relaying Network:

– Encapsulation of any LAN protocol packets within an FRBS (see Recommendation I.233.1) frame. In addition the FRBS frames should contain information necessary to identify the protocol carried within the PDU, thus allowing the far-end LAN/WAN IWF or ISDN TE to properly process the incoming packets.

– The network layer of the connectionless protocol used in the LAN should support segmentation and reassembly of packets when the packet size is greater than the maximum frame size provided by the Frame Relaying network. The IWF should encapsulate the segmented packets.

  The general format of segmented packet should be the same as any other encapsulated packet, except for the inclusion of encapsulation header. Large packets should be divided into frames appropriate for the given Frame Relaying network and should be encapsulated using Frame Relaying segmentation format. The receiving LAN/WAN IWF should reassemble the segmented packet. The order of the segments should be preserved. If any of the segments is received in error or lost, then the higher layer protocol is responsible for retransmission.

– LAN/WAN IWF should be capable of dynamically resolving a Network Service Access Point (NSAP) protocol address.

## I.3 Interworking between FRBS and LANs at data link layer (ISO/IEC 8802)

The previous subclause dealt with FRBS interworking with network layer of LANs and this subclause will address the requirements for FRBS interworking with data link layer (see ISO/IEC 8802) of LANs. This is called bridging. The objective is to allow any terminal on a LAN to communicate with any other terminal on a different LAN which is physically separated but interconnected by a Wide Area Network (WAN) based on Frame Relaying.

There are two cases to consider:

1) interworking is performed at the Media Access Control (MAC) layer. This applies only to interworking between local area networks;

2) interworking is performed at the Logical Link Control (LLC) layer.

### I.3.1 Media access control interworking

Interworking between local area network segments is at the MAC layer [see ISO/IEC 8802-1 (d)]. LAN to LAN interconnect using Frame Relaying connections are provided by a pair of bridges. The bridged packets have distinct format and therefore must contain an indication so that the destination may correctly interpret the contents of the frame. This indication can be provided using Network Layer Protocol Identifiers (NLPID) as defined in ISO/IEC TR 9577. This encapsulation is used to carry multiple protocols over Frame Relaying connections.

Bridges that support this encapsulation method, must know which virtual connection will carry the encapsulation. The bridged packets are encapsulated using an NLPID value of Hex 80 indicating IEEE Sub-Network Access Protocol (SNAP). The SNAP header identifies the format of the bridged packet.

The SNAP header consists of three octets of an Organization Unique Identifier (OUI) followed by the two octet Protocol Identifier (PID). Together they identify the bridged frame. The OUI value used for bridge encapsulation is the ISO/IEC 8802 organization code. The PID specifies the format of the MAC header, which immediately follows the SNAP header. Additionally, the PID indicates whether the original FCS is preserved within the bridged packet.

### I.3.2 Logical link control interworking by mapping

A station attached to a local area network and utilizing ISO/IEC 8802-2 logical link control may need to communicate with another station which is attached to a remote local area network, or which is attached through a FRBS interface, or some other interface which has been mapped by an interworking function to FRBS.

The local area network station employs ISO/IEC 8802-2 Logical Link Control (LLC) for communicating on the LAN. The interworking function must translate between ISO/IEC 8802-2 and Q.922 logical link control.

– The control fields for 8802-2 and Q.922 are equivalent, but the details of translation between them requires further study.

– ISO/IEC 8802-2 provides a multiplexing/addressing capability at the logical link control layer which is not available in Recommendation Q.922. Each 8802-2 logical connection, represented as the 4-tuple (destination MAC address, source MAC address, destination service access point index, source service access point index) must be mapped to a specific FRBS DLCI. In addition, the RI field of the MAC header must be recalled and generated in frames transmitted on the LAN segment.

To ensure interworking between FRBS and LANs may require use of more than two-octet DLCIs on the FRBS interface.

# Appendix II

## Example of service interworking using translation mode

This Appendix illustrates the translation mode of service interworking. The interworking function may implement the translation between Annex E/Q.933 (Multiprotocol Encapsulation over FR) and RFC 1483 (Multiprotocol Encapsulation over ATM) between the FR and B-ISDN sides. Figure II.1 illustrates service interworking between FR and B-ISDN using this translation.

NOTE – Annex E/Q.933 is substantially the same as RFC 1490.

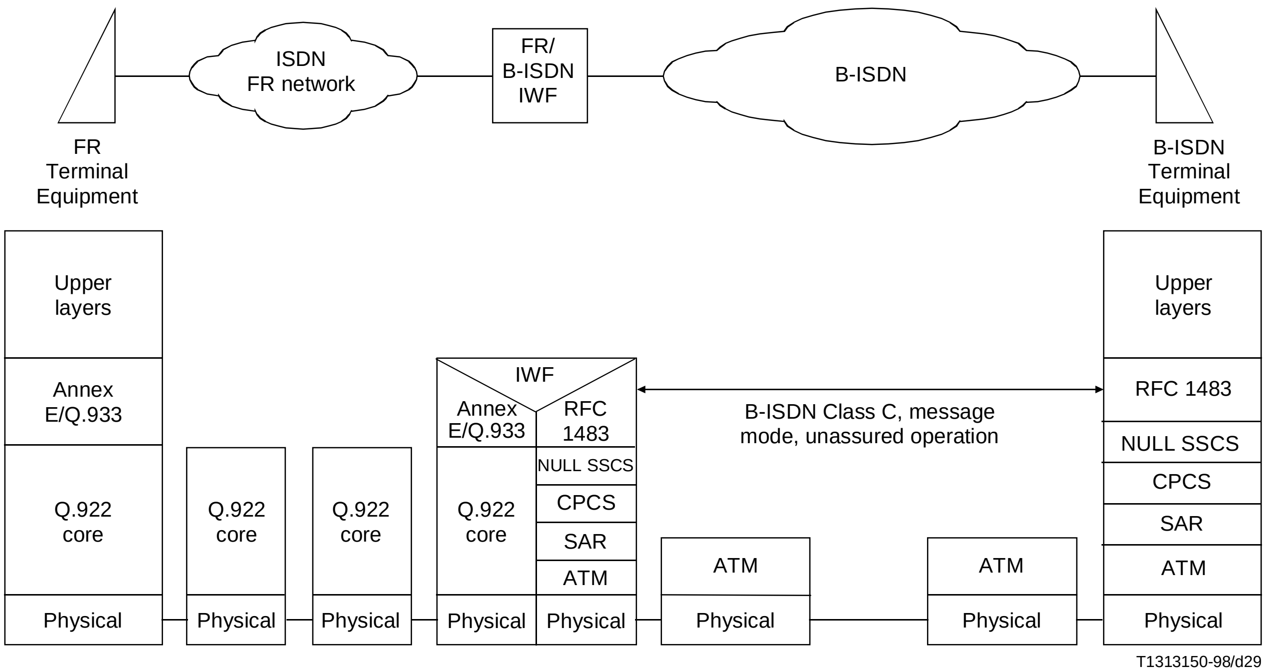



**Figure II.1/I.555 – Frame Relay/B-ISDN service interworking using translation mode**

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