![ITU logo] **INTERNATIONAL TELECOMMUNICATION UNION**

# ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

# I.555

(11/93)

## INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

## INTERNETWORK INTERFACES

## FRAME RELAYING BEARER SERVICE INTERWORKING

**ITU-T Recommendation I.555**

(Previously "CCITT Recommendation")

# FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

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 (Helsinki, March 1-12, 1993).

ITU-T Recommendation I.555 was prepared by ITU-T Study Group 13 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 26th November 1993.

_____

NOTE

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

© ITU 1994

# CONTENTS

**Recommendation I.555**

# FRAME RELAYING BEARER SERVICE INTERWORKING

*(Geneva, 1993)*

## 1 Introduction

The Frame Relaying Bearer Services (FRBS) are 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 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 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:

**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.

**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.

| | |
|---|---|
| AAL | ATM Adaptation Layer |
| ATM | Asynchronous Transfer Mode |
| Bc | Committed Burst |
| Be | Excess Burst |
| BECN | Backward Explicit Congestion Notification |
| B-ISDN | Broadband Integrated Services Digital Network |
| CI | Congestion Indication |
| CIR | Committed Information Rate |
| CPCS | Common Part Convergence Sublayer |
| DE | Discard Eligibility |
| DLCI | Data Link Connection Identifier |

| | |
|---|---|
| DTE | Data Terminal Equipment |
| DTP | Data Transfer Protocol |
| FECN | Forward Explicit Congestion Notification |
| FMBS | Frame Mode Bearer Service |
| FRBS | Frame Relaying Bearer Service |
| FR-SSCS | Frame Relaying Service Specific Convergence Sublayer |
| FSBS | Frame Switching Bearer Service |
| IWF | InterWorking Function |
| LAN | Local Area Network |
| LAPB | Link Access Procedure Balanced |
| LLC | Lower Layer Compatibility (in the case of ISDN) |
| LLC | Logical Link Control (in the case of LAN) |
| LP | Loss Priority |
| MAC | Media Access Control |
| NLPID | Network Layer Protocol Identifier |
| PDU | Protocol Data Unit |
| PCI | Protocol Control Information |
| PLP | Packet Layer Protocol |
| PSPDN | Packet Switched Public Data Network |
| PVC | Permanent Virtual Connection |
| QOS | Quality of Service |
| SAPI | Service Access Point Identifier |
| SAR | Segmentation and Reassembly |
| SCF | Synchronization and Coordination Function |
| SSCS | Service Specific Convergence Sublayer |
| SVC | Switched Virtual Connection |
| TE | Terminal Equipment |
| VC | Virtual Connection |
| VCC | Virtual Channel Connection |
| VCI | Virtual Channel Identifier |
| VPC | Virtual Path Connection |
| VPI | Virtual Path Identifier |
| WAN | Wide Area Network |

# 3       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.

## 3.1 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.

## 3.2 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.
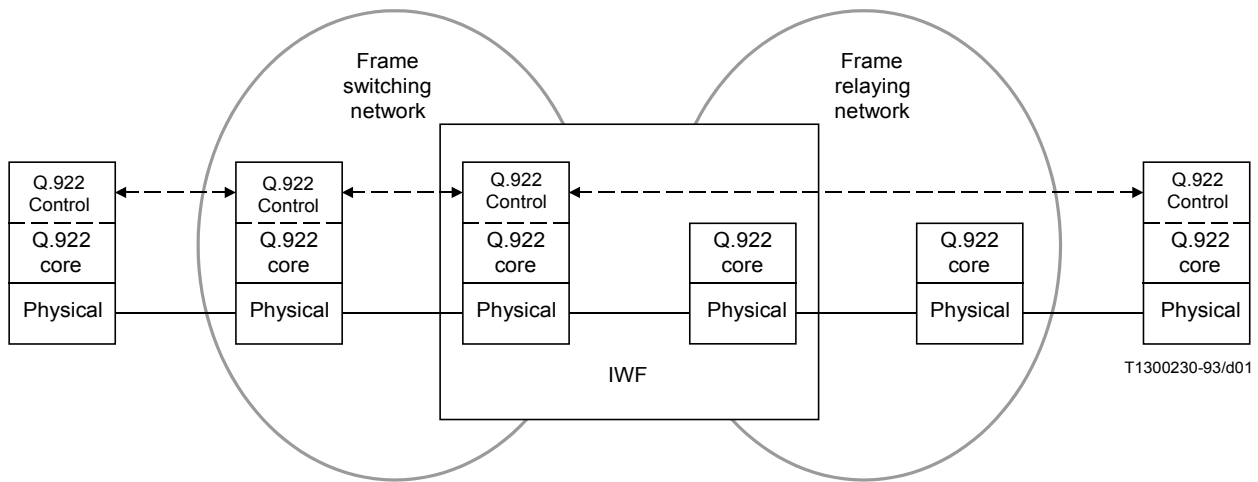


FIGURE 1/I.555

**Interworking between frame relaying and frame switching:
data transfer procedures**

### 3.2.1 Interworking of congestion management procedures

For further study.

## 4 Interworking between FRBS and X.25/X.31

The two possible interworking scenarios are:

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

        – access by FRBS Permanent Virtual Connection (PVC) to X.25/X.31 service (providing virtual call service – VC – and/or PVC service);

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

b)   Interworking by call control mapping between FRBS VC and X.25/X.31 VC. The need for this interworking method is for further study.

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

This clause specifies the interworking between:

–   FRBS and PSPDN (see Recommendation X.25);

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

Note that the interworking between FRBS and ISDN offering Case A of Recommendation X.31 is identical to the case of interworking between FRBS and PSPDN (see Recommendation X.25).

## 4.1      Data transfer requirements

Interworking between FRBS and X.25 can be accomplished using X.25 DTP or PLP at the network layer and as network options:

–   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 2a). Alternatively, encapsulation as shown in Figure 2b) may be used.

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

## 4.2      Interworking between FRBS PVC and PSPDN/ISDN (X.31) VC/PVC by Port Access

Figures 3 and 4 illustrate this interworking scenario in the U-Plane. The TE A uses X.25 over an FRBS PVC. Once having established an 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.
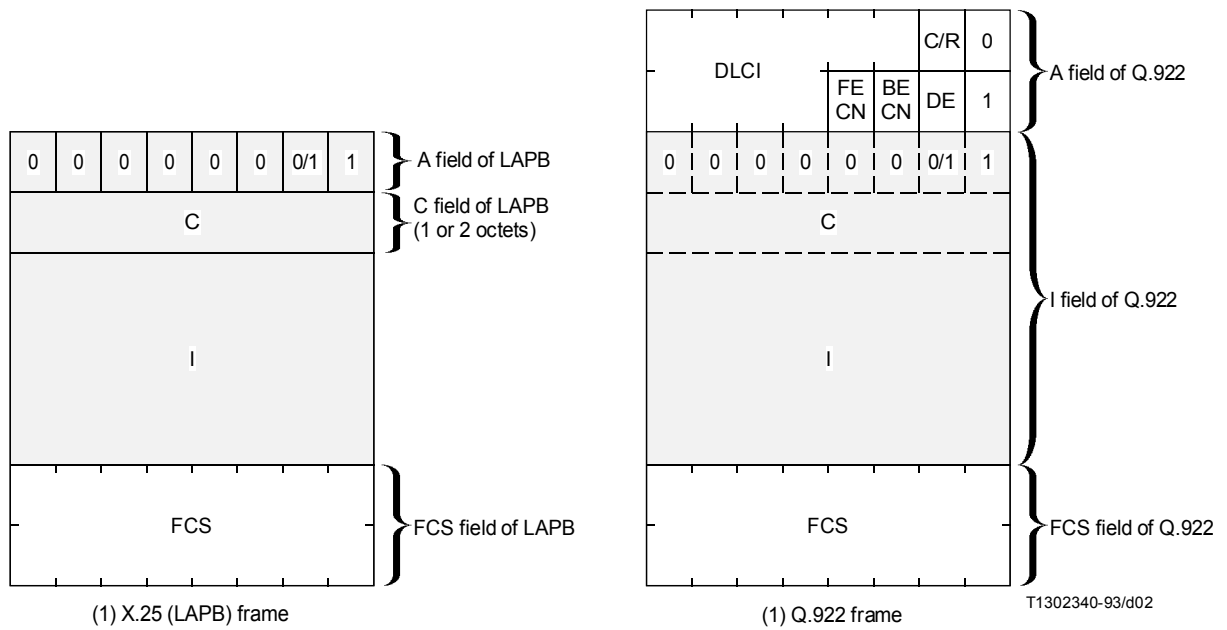
## 4.3      Interworking between FRBS SVC and PSPDN (X.25)/ISDN (X.31) VC by port access

Figures 5 and 6 illustrate the 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 an X.25 virtual connection within the U-plane using X.25 PLP procedures. Only the second step needs to be repeated to set up additional X.25 virtual connections. 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 VCs on an FRBS connection as illustrated in Figure 7.

a) Encapsulation of LAPB address, control and I fields
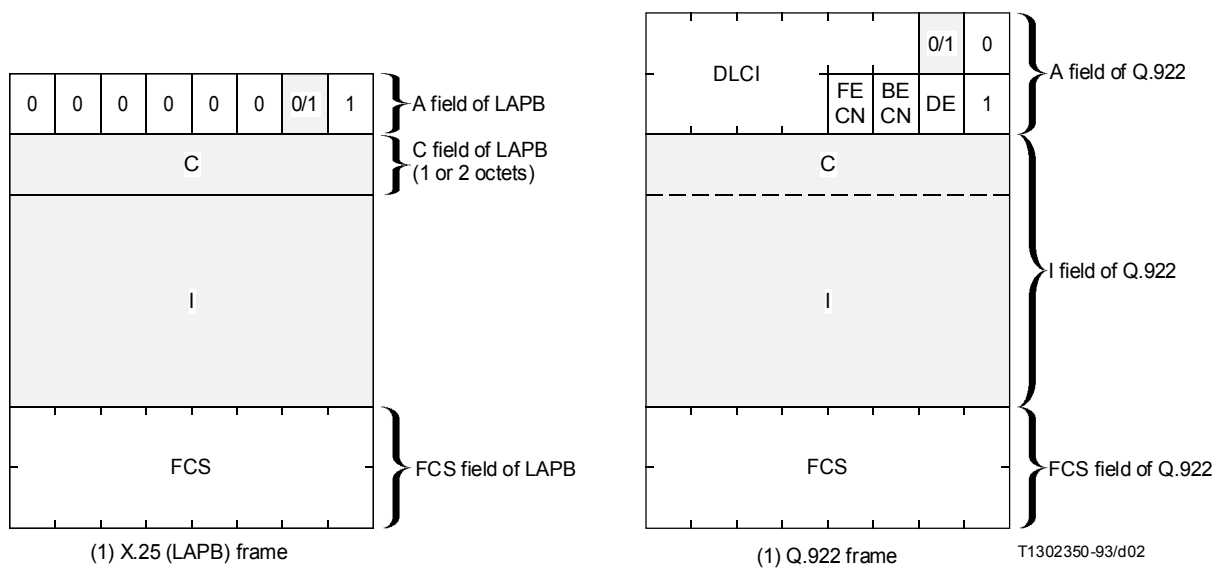


Encapsulated part

b) Encapsulation of LAPB Control and I fields

FIGURE 2/I.555
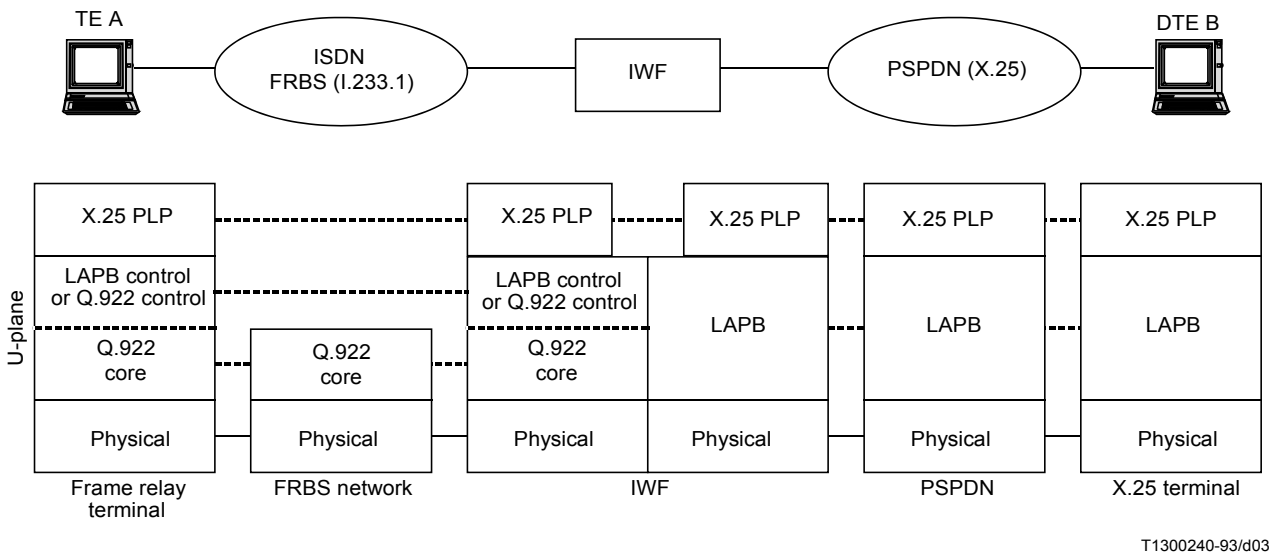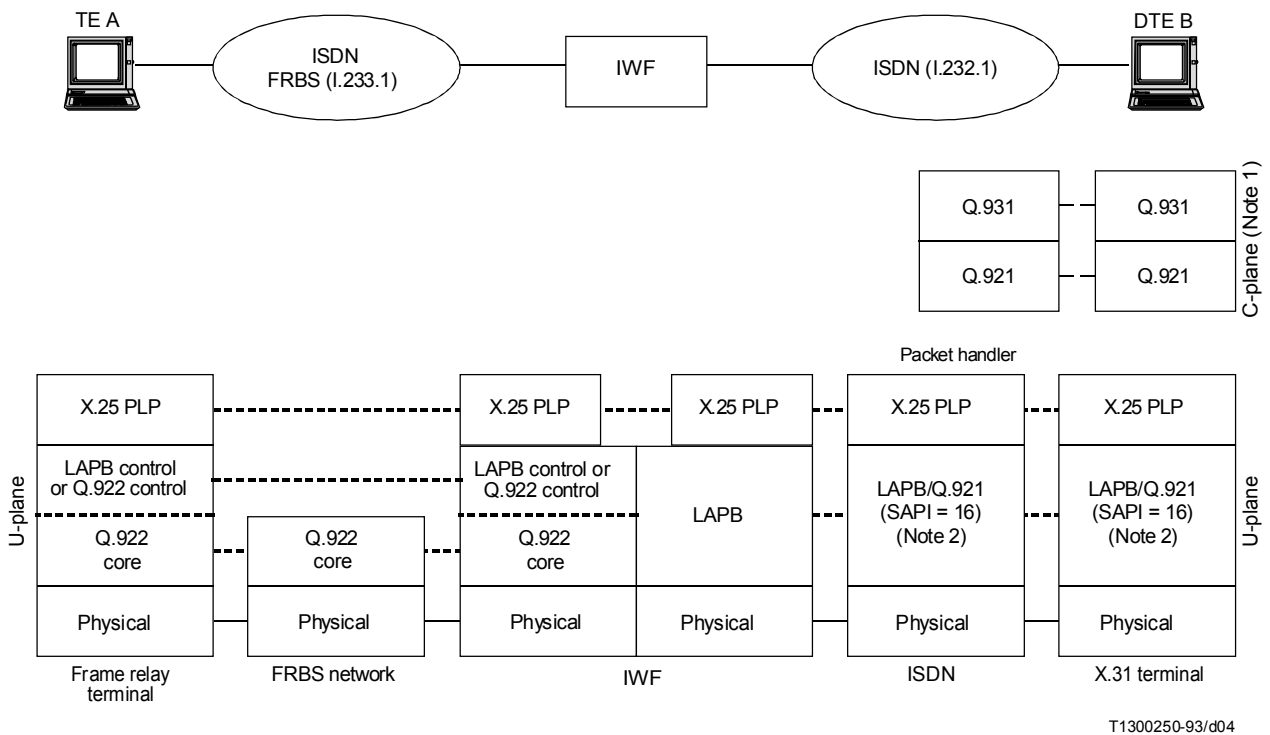
**LAPB encapsulation in Q.922 core**

T1300240-93/d03

FIGURE 3/I.555

**Interworking between FRBS PVC and PSPDN (X.25) VC/PVC by port access**



T1300250-93/d04

NOTES

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.

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

FIGURE 4/I.555

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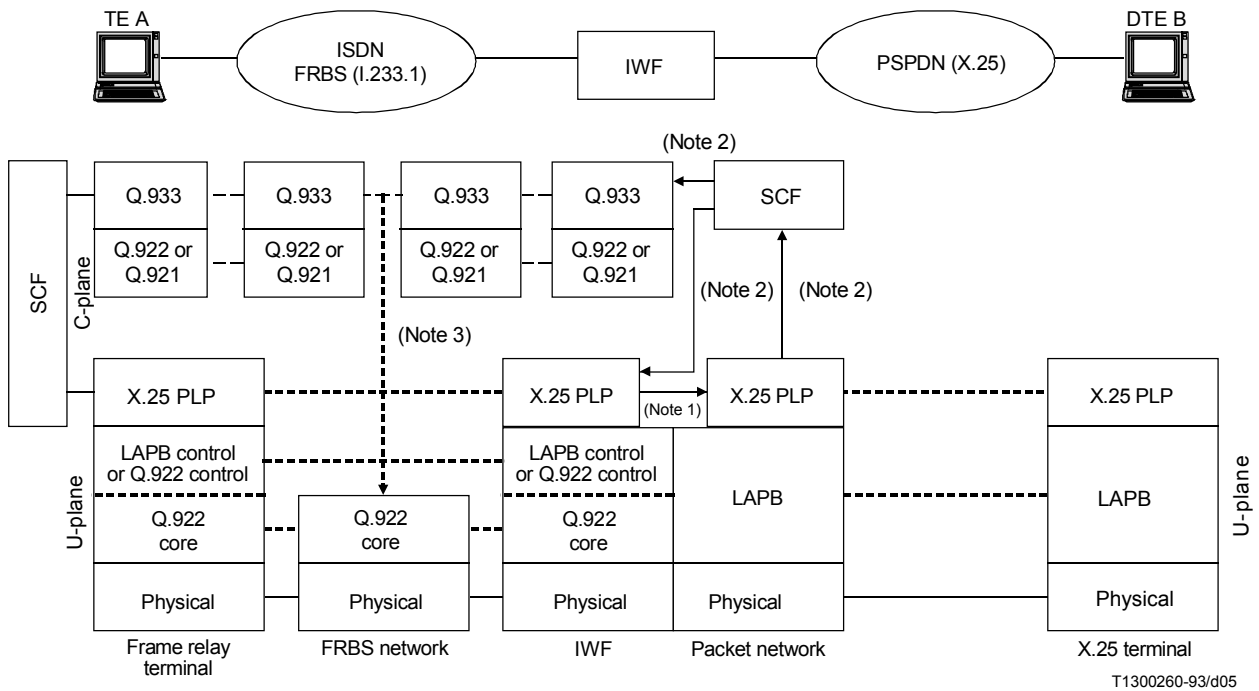
FIGURE 5/I.555

**Interworking between FRBS SVC and PSPDN (X.25) by port access**

NOTES

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

2    This call control relationship exists for calls from TE A only.

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

4    End system protocol stacks are examples only.

### 4.3.1    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.

## 5    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 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.
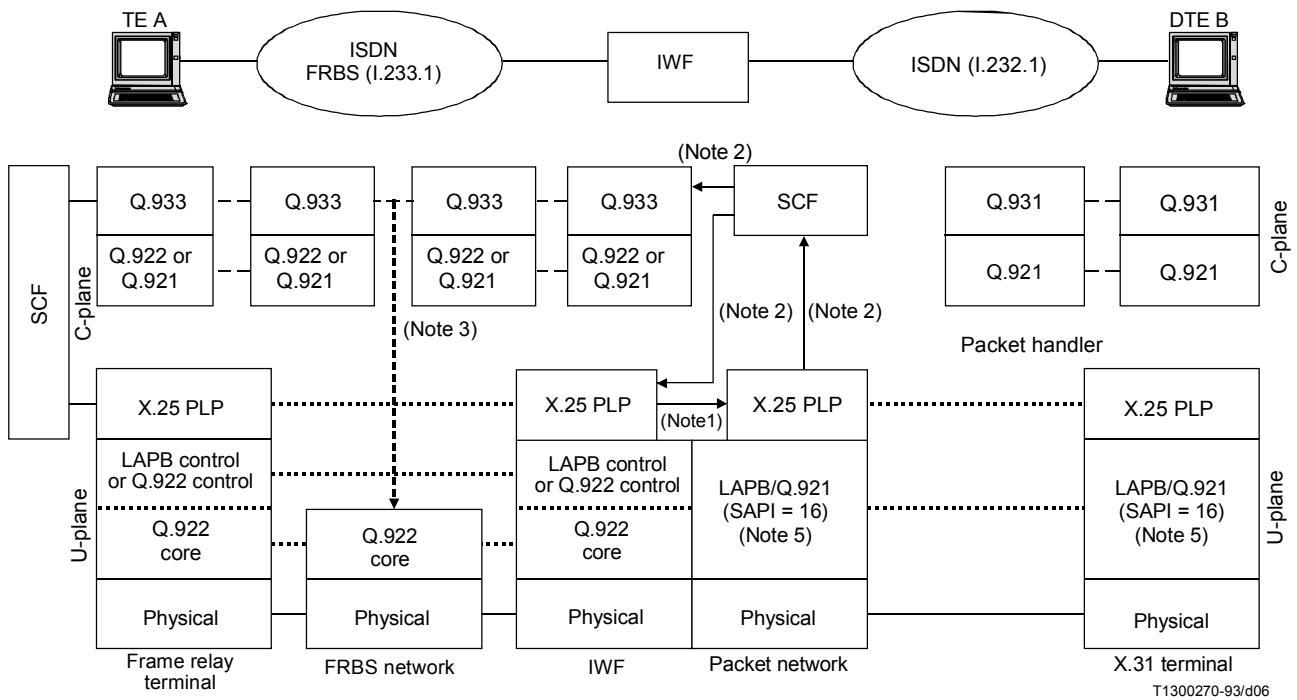


FIGURE 6/I.555

**Interworking between FRBS SVC and ISDN (X.31) by port access**

NOTES

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

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

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

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.

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

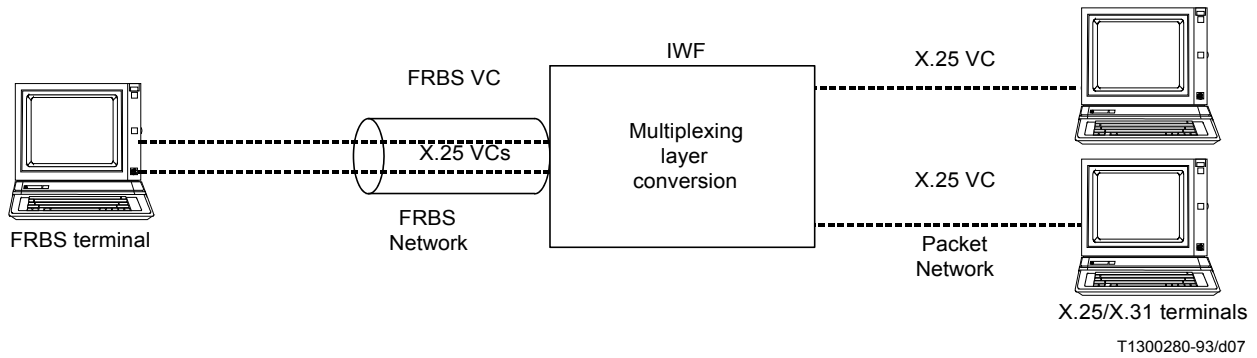6    End system protocol stacks are examples only.

FIGURE 7/I.555

**Multiplexing of X.25 VCs onto FRBS VC**

# 6 Interworking between FRBS and Circuit Switched Service by Port Access

Circuit Switched access to a remote FRBS is supported by first establishing a circuit connection to the remote frame handler (see Figure 8) using ISDN Circuit Mode Bearer Service out-of-band call procedures (see Recommendation Q.931). The virtual calls are then established using FRBS call procedures in-band (see Recommendation Q.933) between the terminals/NT2 and the remote handler. Permanent calls both in the ISDN circuit service/network and/or ISDN Frame Relaying service/network are also supported in this scenario. ISDN circuit mode can support B-, H-, or aggregate of B-channels up to 1920 kbit/s.

The detailed procedures are described in Recommendation Q.933, Case A.
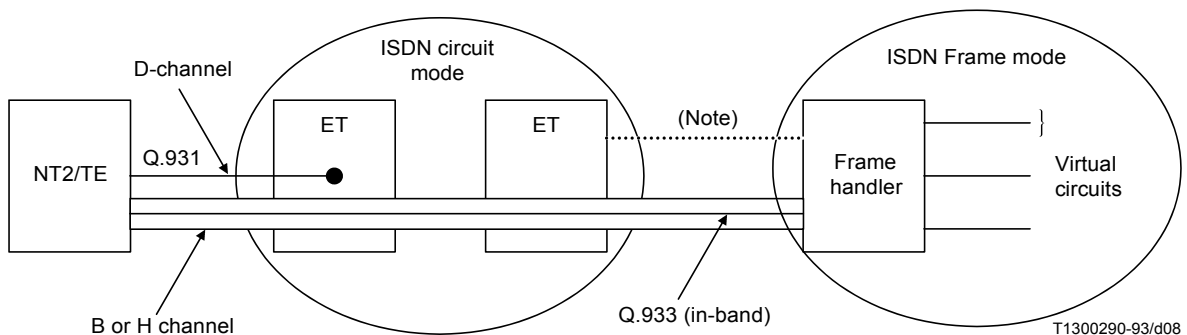


NOTE – Examples of signalling used to set up this connection are SS No. 7 and DSS 1.

FIGURE 8/I.555

**Interworking between FRBS and ISDN circuit switched service**

# 7 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.

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

– 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.

## 7.1 General description

Figure 9 represents the interworking arrangements considered. Interworking between FRBS and B-ISDN Class C services is performed either by call control mapping or by provisioning. Since in both the ISDN and the B-ISDN call control is handled in a separate call control plane, it is assumed similar call control functions are used. The interworking between the respective signalling systems is for further study.
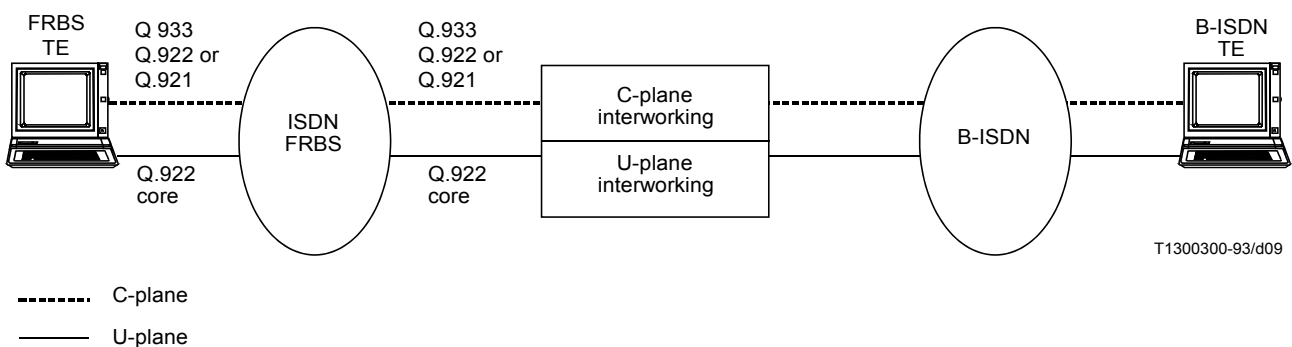


FIGURE 9/I.555

**Interworking between FRBS and B-ISDN**

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

Figure 10 illustrates the offering of Frame Relaying service by a Frame Relaying network. With the introduction of B-ISDN, it is necessary to provide interworking between Frame Relaying and B-ISDN. Following are the three interworking cases considered.

– Network interworking scenario 1 (see 7.2.2.1)

– Network interworking scenario 2 (see 7.2.2.2)

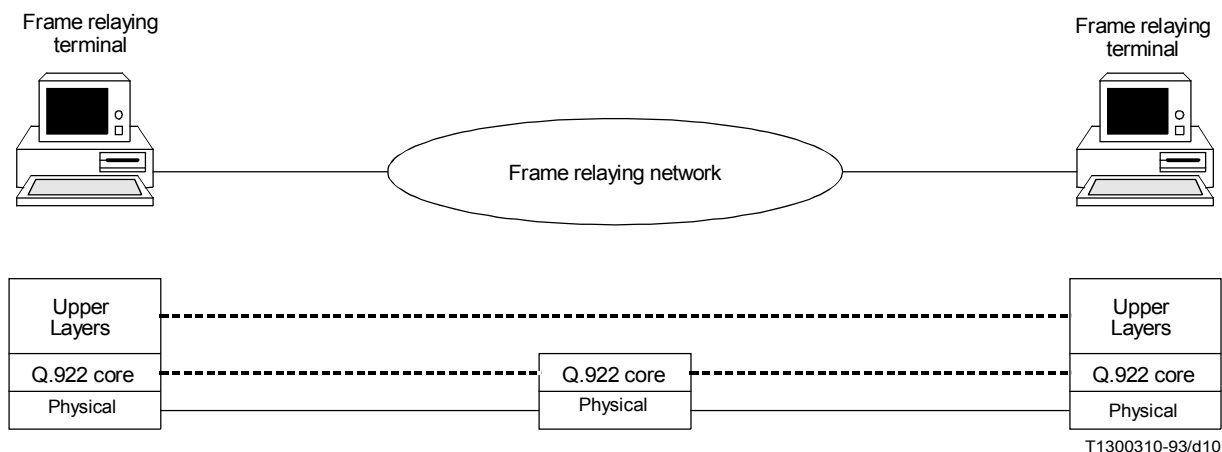– Services interworking (see 7.2.2.3)

FIGURE 10/I.555

**Frame relaying network**

## 7.2 Interworking requirements

The identified interworking arrangement is between FRBS and B-ISDN Class C, message mode, non-assured operation.

### 7.2.1 Interworking in the C-plane

Call Control mapping is provided in a way that U-plane connections are established and released in both interworking networks, interconnected in 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, Bc, Be and T. The mapping between Frame Relay and B-ISDN traffic descriptors is for further study.

### 7.2.2 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, with two sets of service conditions:

– the B-ISDN supports the FRBS (see Recommendation I.233.1);

– the B-ISDN supports another service (as yet unspecified) with which FRBS can interwork.

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

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

The ATM layer is specified in Recommendation I.361 and the AAL composed of the SAR and CPCS sublayers is specified in Recommendation I.363. AAL type 5 (SAR and CPCS) shall be used for Frame Relaying and B-ISDN interworking. The FR-SSCS is defined in 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.363.
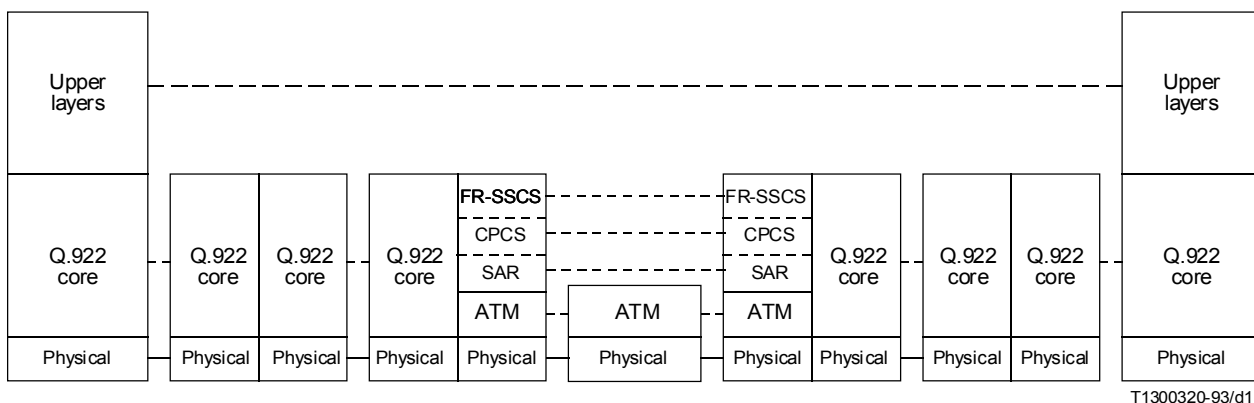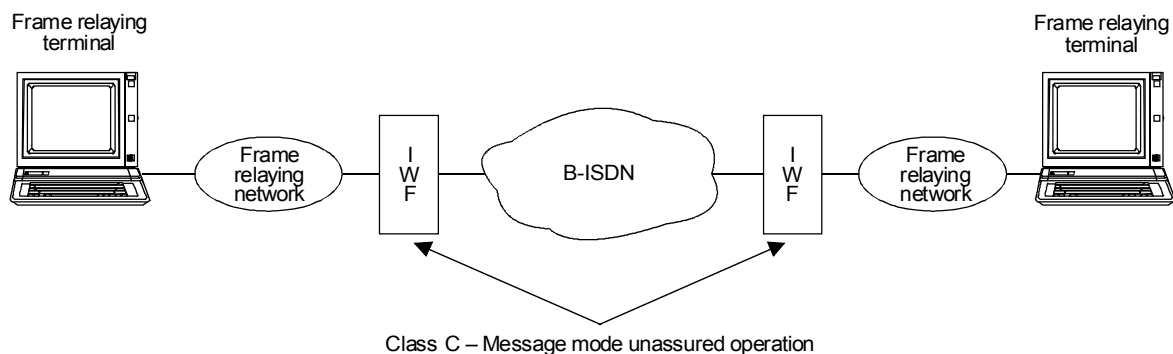
FIGURE 11/I.555

**Network interworking between FRBS and B-ISDN** (scenario 1)

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

–    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.

–    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 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 at call set-up or by subscription for both sides of the IWF.

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.

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 muxing/demuxing using the DLCI field | Muxing/demuxing using VPI/VCI | | Muxing/demuxing 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 |
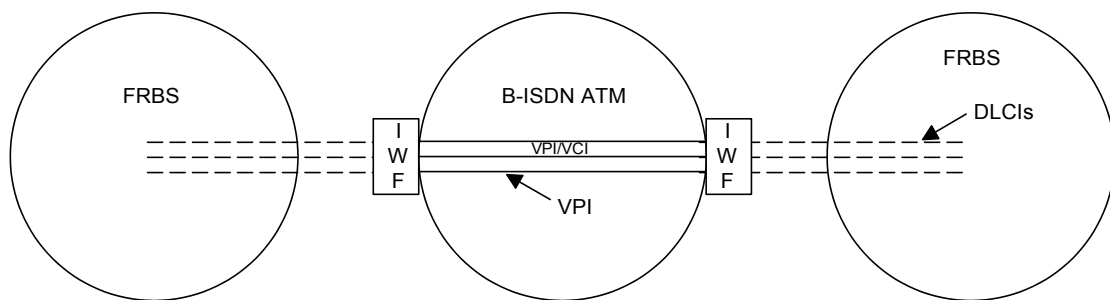


T1300330-93/d12

FIGURE 12/I.555

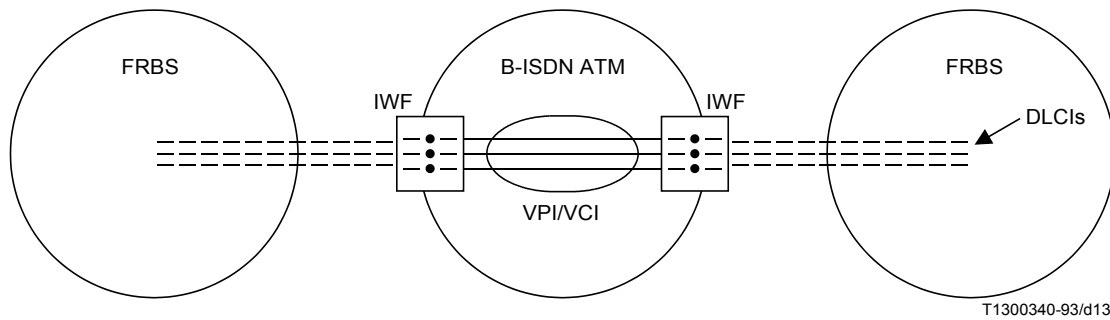**Multiple DLCIs multiplexed on a single ATM virtual channel connection**

FIGURE 13/I.555

**Each DLCI mapped into an ATM virtual channel connection
and multiplexed on a virtual path connection**

The impact on the C-plane of the use of the two schemes of multiplexing, alone or in combination, for FR Switched Virtual Channels (SVCs) is for further study. 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 Relaying 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 FR 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 of the B-ISDN will enable resource management on peak bandwidth allocation of the VCC or VPC, respectively, to achieve acceptable efficiency. The FR network congestion management would then operate as usual. The FECN and BECN parameter values are not mapped to the AAL5 CPCS and ATM layers. However, congestion indication generated by the B-ISDN shall be taken into account when generating FECN/BECN towards the FR networks. This approach provides an averaged QOS over all ATM connections for FR carriage, and uses the preventative control of network resource management concept described in 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 7.2.2.4) 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 7.2.2.4.

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.

### 7.2.2.2    Network interworking (Scenario 2)

Figure 14 represents the case where a B-ISDN terminal supporting FRBS (according to Recommendation Q.922 core) is connected via the B-ISDN to an IWF for accessing an FR terminal on an FR network. The IWF is the same as described in 7.2.2.1. 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 7.2.2.4.
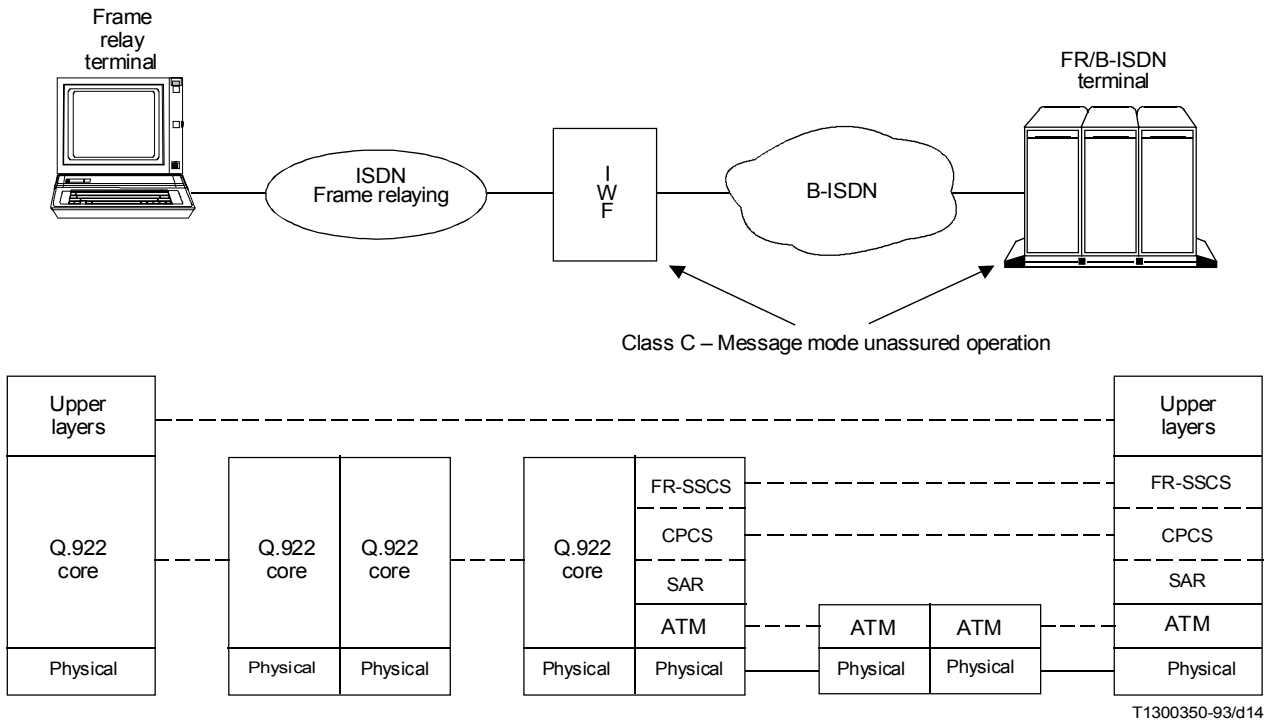
FIGURE  14/I.555

**Network interworking between FRBS and B-ISDN** (scenario 2)

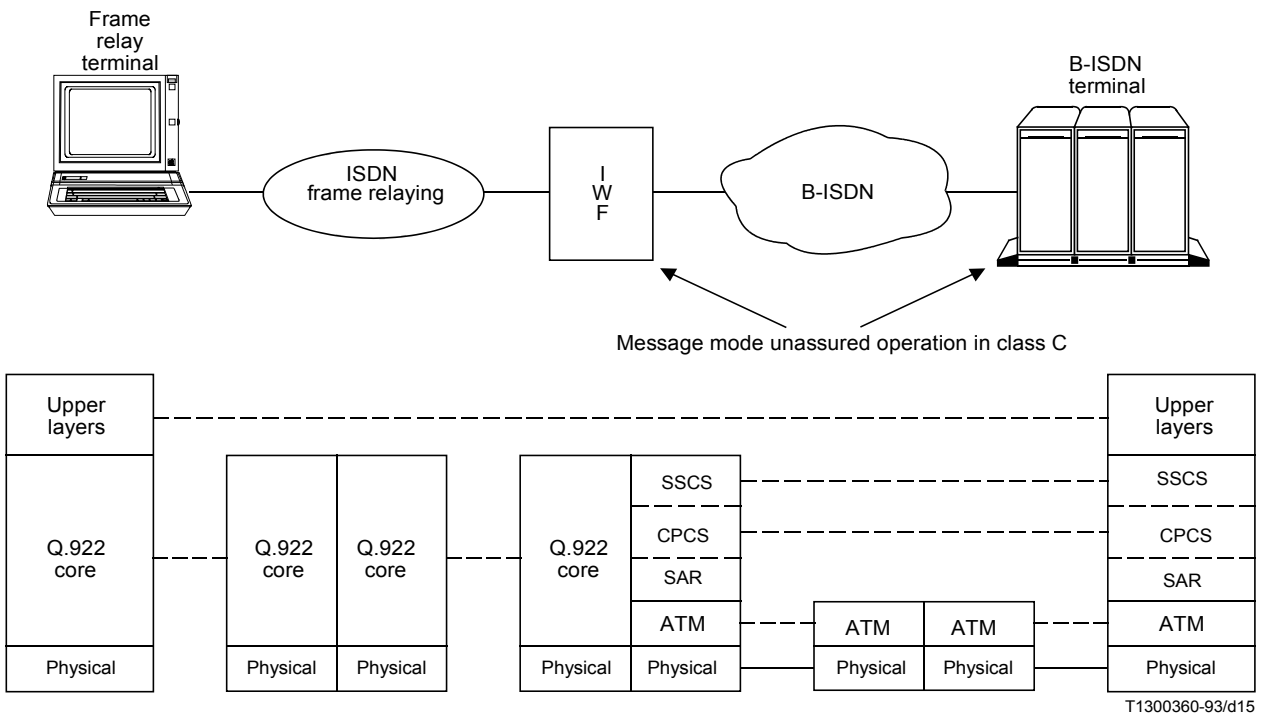### 7.2.2.3    Service interworking

Figure 15 illustrates services interworking between FRBS and B-ISDN. Services interworking applies when a Frame Relaying service user interworks with a B-ISDN service user and 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 may be needed. This case depends on the development of the B-ISDN protocols and needs further study.

### 7.2.2.4    Interworking of loss priority and congestion management

Interworking of loss priority and congestion management is achieved through mappings to/from FR and B-ISDN as indicated in Figures 16 and 17. These mappings are identical for either of the network interworking scenarios illustrated in Figures 11 and 14. Neither FECN nor DE shall be reset to zero by a network after this has been set to one.

### 7.2.2.4.1    Discard eligibility and loss priority mapping

Figure 16 illustrates the to and from mapping between discard eligibility and loss priority at the interworking function.

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

FIGURE 15/I.555
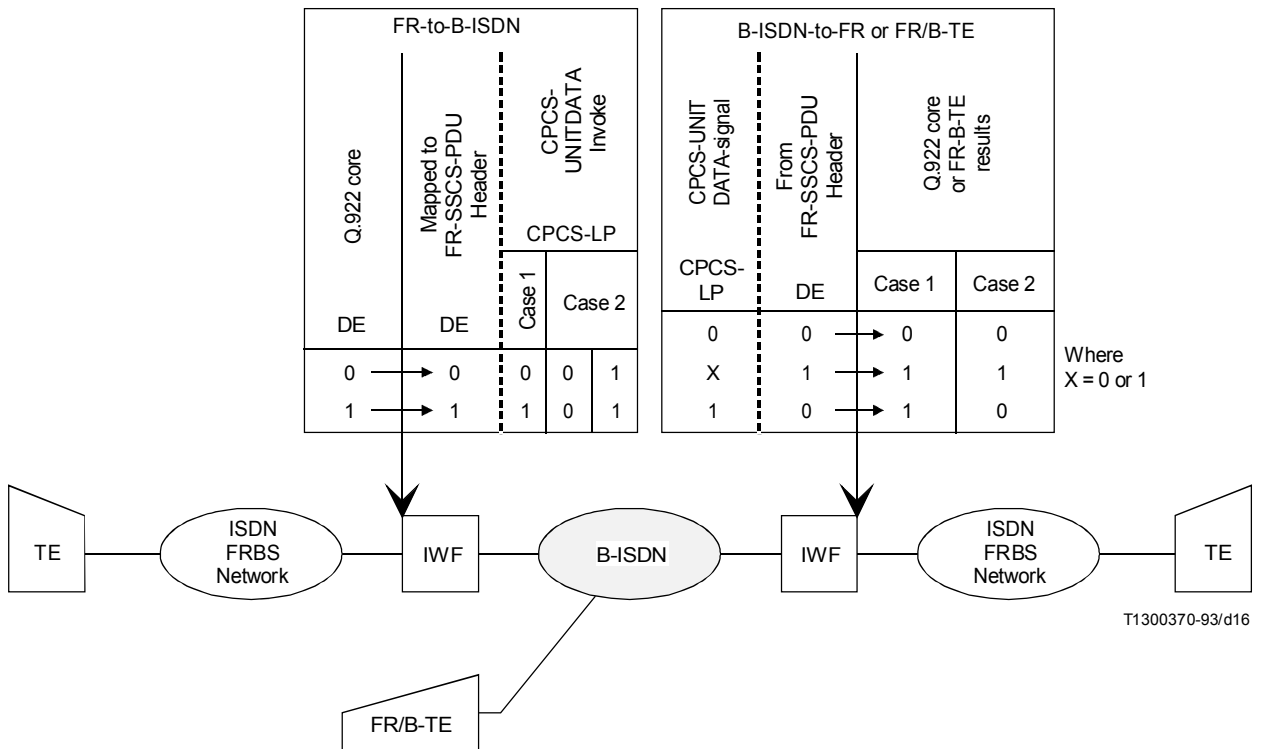
**Services interworking between FRBS and B-ISDN**



FIGURE 16/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.

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 one is used. The method of selection between the two cases outlined above is outside the scope of this Recommendation.

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.

### 7.2.2.4.2   Congestion indication mapping

Figure 17 illustrates the mapping between Frame Relaying FECN parameter and B-ISDN CI parameter.
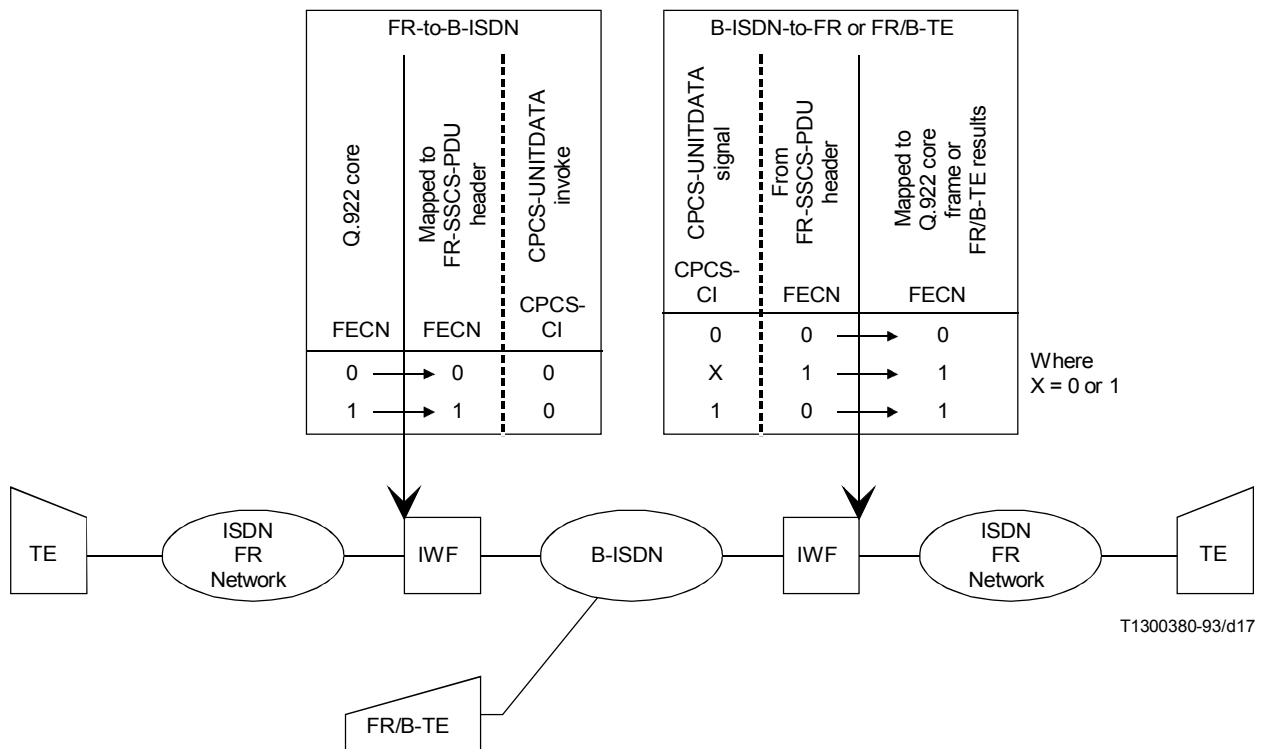


FIGURE  17/I.555

**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-UNIDATA 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 FEC = 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.

# Appendix  I

## Interworking/interconnection of LANs and FRBS

(This appendix does not form an integral part of this Recommendation)

## 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 8802-1/8802-2 protocol elements.
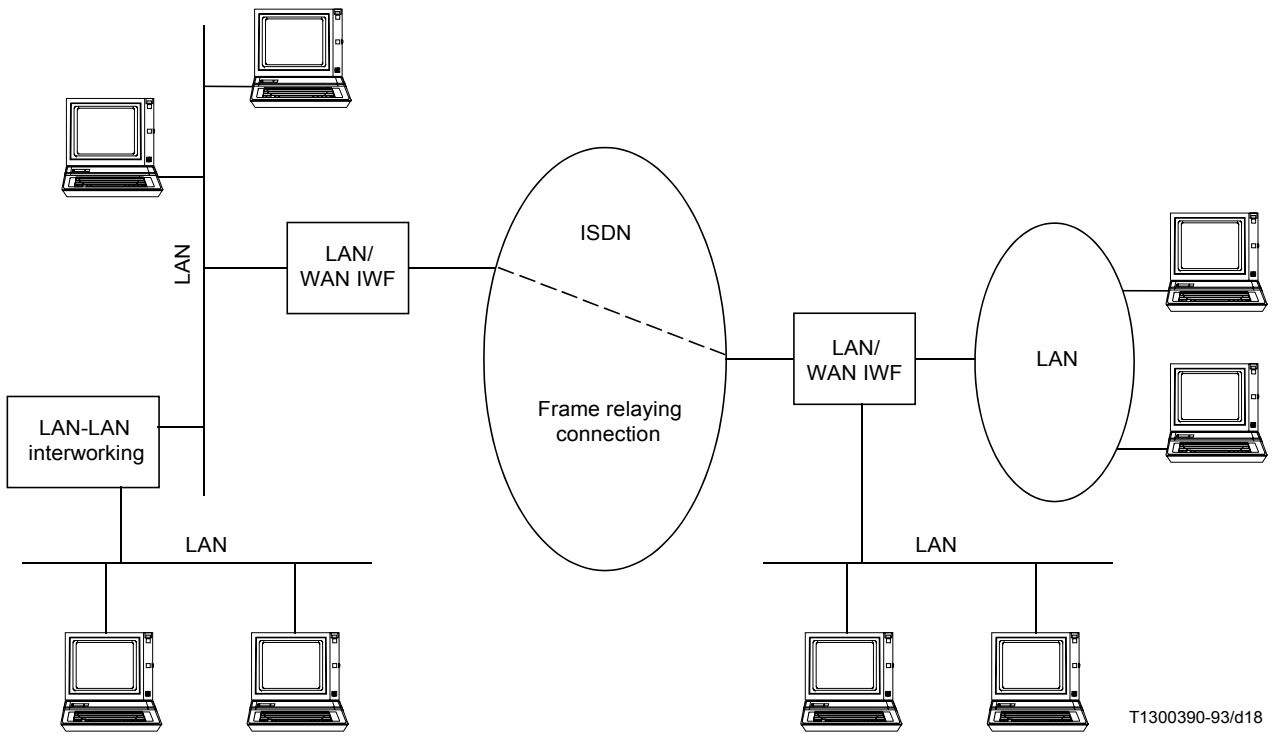
LAN/WAN IWF    LAN-to-LAN and LAN-FRBS interworking function

FIGURE  I.1/I.555

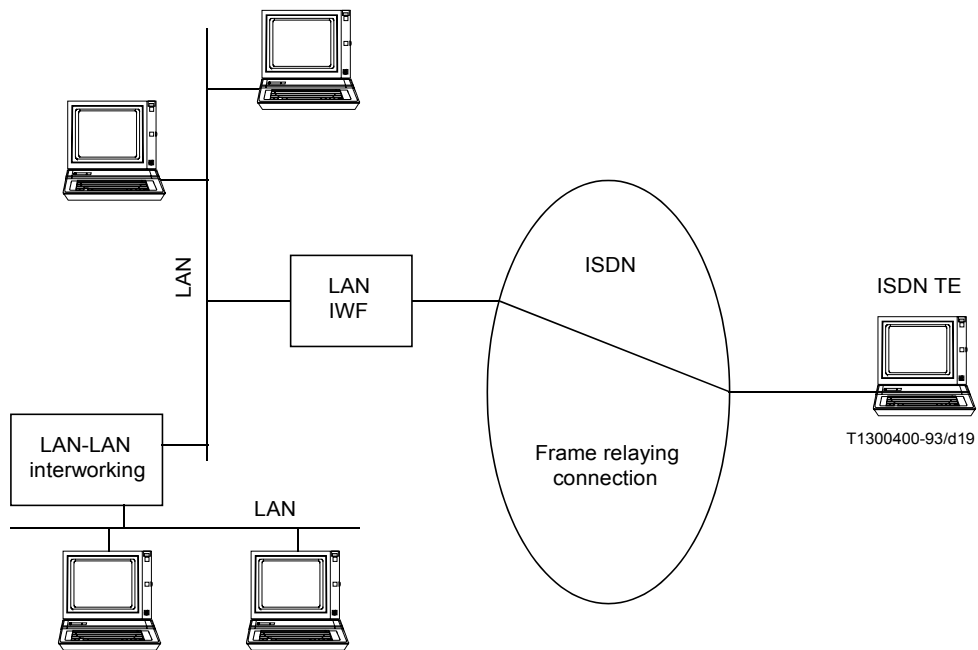**LAN-LAN interconnection via ISDN frame relaying**



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 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 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 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 TR9577. 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 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 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 8802-2 logical link control (LLC) for communicating on the LAN. The interworking function must translate between ISO 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 8802-2 provides a multiplexing/addressing capability at the logical link control layer which is not available in 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.