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SERIES Q: SWITCHING AND SIGNALLING

Broadband ISDN – B-ISDN application protocols for
access signalling

**Broadband integrated services digital network
(B-ISDN) – Digital Subscriber Signalling
System No. 2 (DSS 2): Call/connection control
for the support of ATM-MPLS network
interworking**

ITU-T Recommendation Q.2920

ITU-T Q-SERIES RECOMMENDATIONS
SWITCHING AND SIGNALLING

SIGNALLING IN THE INTERNATIONAL MANUAL SERVICE	Q.1–Q.3
INTERNATIONAL AUTOMATIC AND SEMI-AUTOMATIC WORKING	Q.4–Q.59
FUNCTIONS AND INFORMATION FLOWS FOR SERVICES IN THE ISDN	Q.60–Q.99
CLAUSES APPLICABLE TO ITU-T STANDARD SYSTEMS	Q.100–Q.119
SPECIFICATIONS OF SIGNALLING SYSTEMS No. 4, 5, 6, R1 AND R2	Q.120–Q.499
DIGITAL EXCHANGES	Q.500–Q.599
INTERWORKING OF SIGNALLING SYSTEMS	Q.600–Q.699
SPECIFICATIONS OF SIGNALLING SYSTEM No. 7	Q.700–Q.799
Q3 INTERFACE	Q.800–Q.849
DIGITAL SUBSCRIBER SIGNALLING SYSTEM No. 1	Q.850–Q.999
PUBLIC LAND MOBILE NETWORK	Q.1000–Q.1099
INTERWORKING WITH SATELLITE MOBILE SYSTEMS	Q.1100–Q.1199
INTELLIGENT NETWORK	Q.1200–Q.1699
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR IMT-2000	Q.1700–Q.1799
SPECIFICATIONS OF SIGNALLING RELATED TO BEARER INDEPENDENT CALL CONTROL (BICC)	Q.1900–Q.1999
BROADBAND ISDN	Q.2000–Q.2999
General aspects	Q.2000–Q.2099
Signalling ATM adaptation layer (SAAL)	Q.2100–Q.2199
Signalling network protocols	Q.2200–Q.2299
Common aspects of B-ISDN application protocols for access signalling and network signalling and interworking	Q.2600–Q.2699
B-ISDN application protocols for the network signalling	Q.2700–Q.2899
B-ISDN application protocols for access signalling	Q.2900–Q.2999

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

ITU-T Recommendation Q.2920

Broadband integrated services digital network (B-ISDN) – Digital Subscriber Signalling System No. 2 (DSS 2): Call/connection control for the support of ATM-MPLS network interworking

Summary

MPLS has the potential to consolidate service provider networks and services over a single common network core infrastructure. Different services and technologies such as ATM, frame relay, circuit emulation and IP can be supported over MPLS networks. DSS 2 may be used for setting up and controlling ATM connections between two ATM/MPLS network nodes attached to an MPLS network. Extensions to DSS 2 information elements and procedures are defined to allow the exchange of MPLS LSP labels and other parameters specific to support ATM services over MPLS networks.

Source

ITU-T Recommendation Q.2920 was approved on 22 December 2003 by ITU-T Study Group 11 (2001-2004) under the ITU-T Recommendation A.8 procedure.

Keywords

ATM, control plane, interworking, MPLS, network.

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CONTENTS

	Page
1 Scope	1
2 References.....	1
3 Definitions	2
4 Abbreviations.....	2
5 Description.....	3
5.1 Reference network architecture	3
5.2 Transport and Interworking LSP	3
5.3 Encapsulating ATM VCCs or VPCs into MPLS packets	4
5.4 Establishment and maintenance of LSPs.....	4
5.5 Signalling channel Interworking LSP	4
6 Operational requirements.....	4
7 Primitives.....	5
8 Coding requirements.....	5
8.1 Messages.....	5
8.2 Information elements coding.....	6
9 Procedures for the support of ATM-MPLS network interworking	10
9.1 Interworking label exchange and VPCI/VCI allocation.....	10
9.2 Indication and negotiation of Encapsulation mode	11
9.3 Call/connection clearing procedure	13
9.4 Restart procedures	13
BIBLIOGRAPHY	14

ITU-T Recommendation Q.2920

Broadband integrated services digital network (B-ISDN) – Digital Subscriber Signalling System No. 2 (DSS 2): Call/connection control for the support of ATM-MPLS network interworking

1 Scope

This Recommendation specifies extensions to the Digital Subscriber Signalling System No. 2 (DSS 2) protocol to allow the use of DSS 2 between two ATM/MPLS network equipments being connected via a Multi-Protocol Label Switching (MPLS) network as specified in ITU-T Recs Y.1411 and Y.1412.

This Recommendation addresses the role of ATM signalling to establish Interworking LSPs between IWFs (Interworking Functions) during ATM VCC or VPC establishment and to perform related signalling functions.

This Recommendation is part of the DSS 2 family of ITU-T Recommendations. It specifies extensions to DSS 2 Recommendations and does not repeat states, information elements, messages and procedures contained therein. DSS 2 extensions defined in this Recommendation are limited to point-to-point connections. Point-to-multipoint connections may be considered in the future.

This Recommendation is applicable to equipment, supporting DSS 2 signalling capabilities as defined, in particular, in ITU-T Recs Q.2931, Q.2934 and other DSS 2-related Recommendations.

TRQ.2830 [1] provides the signalling requirements for the support of ATM-MPLS network interworking.

2 References

The following ITU-T Recommendations and other references contain provisions 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; 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. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- ITU-T Recommendation Y.1411 (2003), *ATM-MPLS network interworking – Cell mode user plane interworking*.
- ITU-T Recommendation Y.1412 (2003), *ATM-MPLS network interworking – Frame mode user plane interworking*.
- ITU-T Recommendation Q.2931 (1995), *Digital Subscriber Signalling System No. 2 – User-Network Interface (UNI) layer 3 specification for basic call/connection control*.
- ITU-T Recommendation Q.2934 (1998), *Digital Subscriber Signalling System No. 2 – Switched virtual path capability*.
- ITU-T Recommendation Q.2610 (1999), *Usage of cause and location in B-ISDN user part and DSS 2*.

3 Definitions

This Recommendation defines the following terms:

- 3.1 backward LSP:** A Transport or Interworking LSP carrying the traffic in the backward call direction from the succeeding IWF to the preceding IWF.
- 3.2 cell concatenation:** See ITU-T Rec. Y.1411.
- 3.3 forward LSP:** A Transport or Interworking LSP carrying the traffic in the forward call direction from the preceding IWF to the succeeding IWF.
- 3.4 interworking LSP:** See ITU-T Rec. Y.1411.
- 3.5 interworking:** See ITU-T Rec. Y.1411.
- 3.6 interworking LSP label:** See ITU-T Rec. Y.1411.
- 3.7 preceding IWF:** The IWF initiating the establishment of an ATM VCC or VPC within an Interworking LSP.
- 3.8 succeeding IWF:** The IWF receiving a request to establish an ATM VCC or VPC within an Interworking LSP.
- 3.9 transport LSP:** See ITU-T Rec. Y.1411.

4 Abbreviations

This Recommendation uses the following abbreviations:

AAL	ATM Adaptation Layer
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband Integrated Services Digital Network
CII	Common Interworking Indicators
CPCS	Common Part Convergence Sub-layer
DSS 2	Digital Subscriber Signalling System No. 2
IE	Information Element
I-LSP	Interworking LSP
IWF	InterWorking Function
LSP	Label Switched Path
LSR	Label Switching Router
MPLS	Multi-Protocol Label Switching
PHY	Physical
SAAL	Signalling ATM Adaptation Layer
SSCF	Service Specific Convergence Function
SSCOP	Service Specific Connection Oriented Protocol
T-LSP	Transport LSP
UNI	User-Network Interface
VCC	Virtual Channel Connection
VPC	Virtual Path Connection

5 Description

5.1 Reference network architecture

A general ATM-MPLS network interworking reference architecture is provided in ITU-T Rec. Y.1411 and is reproduced in Figure 1. It consists of the following main elements:

- an MPLS core network consisting of MPLS nodes;
- preceding and succeeding IWFs;
- ATM switches or nodes;
- ATM users.

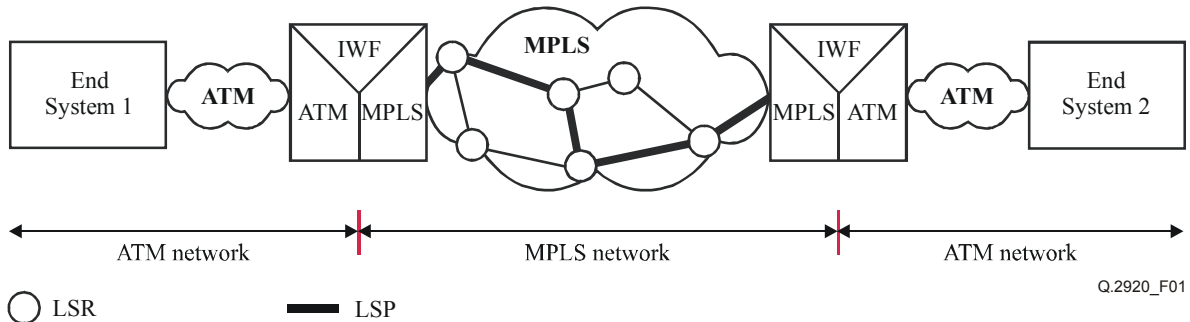


Figure 1/Q.2920 – Reference network architecture for ATM-MPLS network interworking

5.2 Transport and Interworking LSP

From an ATM signalling perspective, the MPLS network and Transport LSPs can be considered as an abstraction of a physical link established between two ATM nodes. Figure 2 captures this view.

For information regarding cell and frame mode encapsulations into MPLS packets, refer to ITU-T Recs Y.1411 and Y.1412 respectively.

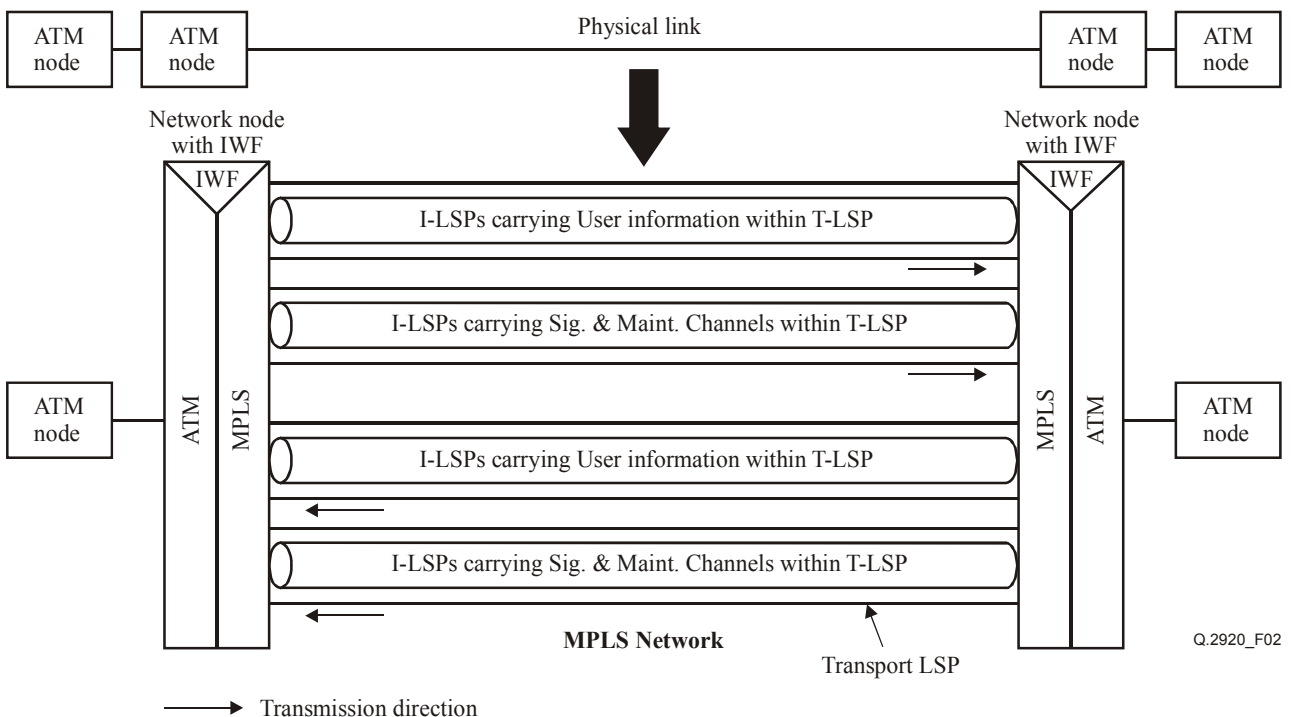


Figure 2/Q.2920 – MPLS transport system as an abstraction of an ATM physical link

5.3 Encapsulating ATM VCCs or VPCs into MPLS packets

For information regarding cell and frame mode encapsulations into MPLS packets, refer to ITU-T Recs Y.1411 and Y.1412 respectively.

5.4 Establishment and maintenance of LSPs

A pair of Transport LSPs shall be established between the IWFs, one Transport LSP for each direction of the data flow.

Interworking LSPs are established and controlled with DSS 2 as specified in this Recommendation. When an ATM user initiates VPC or VCC establishment, a pair of Interworking LSP will be established between the IWFs, one Interworking LSP for each direction of the data flow.

5.5 Signalling channel Interworking LSP

In ATM, there is a default signalling channel, VCI = 5, in VPI = 0. DSS 2 signalling messages are carried in this signalling channel. Likewise within each Transport LSP there will be a dedicated Interworking LSP to carry DSS 2 messages. Signalling channel LSPs are established like any other Interworking LSP (i.e., dynamically or by provisioning).

Figure 3 shows the protocol stack for ATM-MPLS control plane interworking.

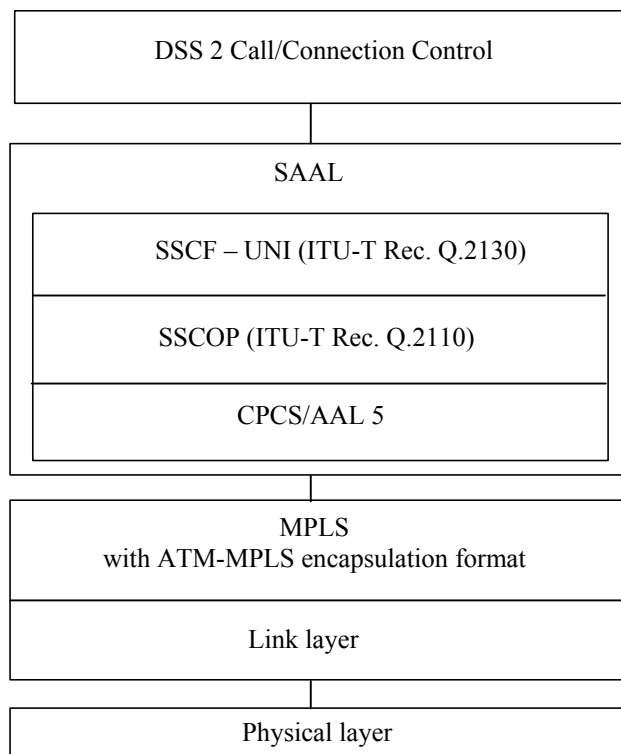


Figure 3/Q.2920 – Protocol stack for ATM-MPLS control plane interworking

6 Operational requirements

Prior to using DSS 2 signalling defined in this Recommendation between two IWFs, a pair of Transport LSPs and the signalling LSP shall be established and operational between them.

In addition, since some DSS 2 procedures are not symmetrical – some functions vary depending on whether equipment is "user side" or "network side" – an IWF shall be configured with the role it will assume: "user side" or "network side". To eliminate the need of configuring an IWF as "user

side" or "network side", the use of Annex H/Q.2931 symmetrical procedures and the avoidance of any "user side" specific procedures are recommended.

7 Primitives

No new primitives are required to support this capability.

8 Coding requirements

8.1 Messages

No new DSS 2 messages are required to support signalling for ATM-MPLS network interworking. However, a new information element is required to carry interworking-related parameters as specified in 8.2.2. In addition, the Connection identifier information element is extended as specified in 8.2.1.

The following Q.2931 messages may carry both or one of the above two information elements:

- CALL PROCEEDING;
- CONNECT;
- RESTART;
- RESTART ACKNOWLEDGE;
- SETUP.

Changes to the structure of these messages are provided below.

8.1.2 Call proceeding

Table 1 provides changes to the structure of this message from that shown in Table 3-3/Q.2931.

Table 1/Q.2920 – Changes to CALL PROCEEDING message content

Message type: CALL PROCEEDING				
Significance: Local				
Direction: Both				
Information element	Reference	Direction	Type	Length
Connection identifier	8.2.1	Both	O (Notes 1, 3)	4-14 (Note 4)
NOTE 3 – Mandatory if this IE is used for ATM-MPLS network interworking.				
NOTE 4 – Increased upper limit for the length of this IE applies for ATM-MPLS network interworking.				

8.1.3 Connect

Table 2 provides changes to the structure of this message from that shown in Table 3-4/Q.2931.

Table 2/Q.2920 – Changes to CONNECT message content

Message type: CONNECT				
Significance: Global				
Direction: Both				
Information element	Reference	Direction	Type	Length
Interworking	8.2.2	Both	O (Note 8)	8-14
NOTE 8 – Mandatory if this IE is used for ATM-MPLS network interworking.				

8.1.4 Restart

Table 3 provides changes to the structure of this message from that shown in Table 3-22/Q.2931.

Table 3/Q.2920 – Changes to RESTART message content

Message type: RESTART Significance: Local Direction: Both				
Information element	Reference	Direction	Type	Length
Connection identifier	8.2.1	Both	O (Note 2)	9-14 (Note 3)
NOTE 3 – Increased limits for the length of this IE apply for ATM-MPLS network interworking.				

8.1.5 Restart Acknowledge

Table 4 provides changes to the structure of this message from that shown in Table 3-23/Q.2931.

Table 4/Q.2920 – Changes to RESTART ACKNOWLEDGE message content

Message type: RESTART ACKNOWLEDGE Significance: Local Direction: Both				
Information element	Reference	Direction	Type	Length
Connection identifier	8.2.1	Both	O (Note 2)	9-14 (Note 3)
NOTE 3 – Increased limits for the length of this IE apply for ATM-MPLS network interworking.				

8.1.6 Setup

Table 5 provides changes to the structure of this message from that shown in Table 3-8/Q.2931.

Table 5/Q.2920 – Changes to SETUP message content

Message type: SETUP Significance: Global Direction: Both				
Information element	Reference	Direction	Type	Length
Connection identifier	8.2.1	Both	O (Notes 9, 17)	14 (Note 18)
Interworking	8.2.2	Both	O (Note 17)	8-59 (Note 19)
NOTE 17 – Mandatory if this IE is used for ATM-MPLS network interworking. NOTE 18 – Increased maximum length for this IE applies for ATM-MPLS network interworking. NOTE 19 – Increased upper limit due to the fact that octet group "Encapsulation Id" may appear six times within this IE.				

8.2 Information elements coding

The Connection identifier information element is extended to carry MPLS Interworking label between the two IWFs. A new information element, the Interworking information element, is defined to carry ATM-MPLS network interworking-related parameters.

8.2.1 Connection identifier information element

The Connection identifier information element is extended to allow the carriage of the forward or backward Interworking LSP between two IWFs. The new maximum length of the Connection identifier information element is 14 octets. The extensions to the Connection identifier information element (Figure 4-22/Q.2931) are shown in Figures 4 and 5.

8	7	6	5	4	3	2	1	Octet
ATM-MPLS network interworking identifier								10* (Note 4)
0	0	0	0	0	0	0	1	
ATM-MPLS network interworking length								10.1*
ATM-MPLS network interworking value								10.2*-10.4*

NOTE 4 – Octet group 10 is only present when connection is established over an MPLS interface.

Figure 4/Q.2920 – Extensions to the Connection identifier information element

- Preferred/Exclusive field (octet 5)

bits

3 2 1

0 1 1 Any VPCI, any VCI (Note 1)

1 0 0 Exclusive VPCI, no VCI (Note 2)

1 0 1 Any VPCI, no VCI (Note 1)

NOTE 1 – Codepoints "011" and "101" are new Codepoints specific to ATM-MPLS network interworking.

NOTE 2 – This Codepoint is defined in ITU-T Rec. Q.2934.

- ATM-MPLS network interworking length (octet 10.1)

Length of the ATM-MPLS Network Interworking contents in octets, i.e., excluding the octets used for ATM-MPLS Network Interworking length and identifier.

- ATM-MPLS network interworking value (octets 10.2 to 10.4)

8	7	6	5	4	3	2	1	Octet
Spare				Interworking LSP label (Most significant 4 bits)				10.2 (Note)
0	0	0	0					
Interworking LSP label (2nd most significant 8 bits)								10.3
Interworking LSP label (3rd most significant 8 bits)								10.4

NOTE – The Interworking LSP label (4 bits of octet 10.2 and octets 10.3 and 10.4) is a 20-bit number. The valid label value range is from 16 to 1048575. The label values from 1 to 15 are reserved.

Figure 5/Q.2920 – Coding of Interworking LSP label

8.2.2 Interworking information element

The Interworking information element is used to indicate and negotiate encapsulation modes used. This information element is used for ATM-MPLS network interworking and may be extended for other applications. The Interworking information element structure is shown in Figure 6.

8	7	6	5	4	3	2	1	Octet
Interworking								1
0	1	1	1	1	0	1	0	
information element identifier								2
1	Coding standard		Flag	Res.	IE instruction field			
ext.					IE action ind.			
Length of interworking contents								3
								4
Related standard								5
Encapsulation identifier								6 (Notes 1, 2)
0	0	0	0	0	0	0	1	
Length of encapsulation contents								6.1
								6.2
CII flag	Encapsulation mode							6.3* (Note 3)
Forward maximum number of cells identifier								
0	0	0	0	0	0	1	0	
Forward maximum number of cells value								6.3.1*
								6.3.2*
Backward maximum number of cells identifier								6.4* (Note 3)
0	0	0	0	0	0	1	1	
Backward maximum number of cells value								6.4.1*
								6.4.2*
Forward maximum frame size identifier								6.5* (Note 4)
0	0	0	0	0	1	0	0	
Forward maximum frame size value								6.5.1*
								6.5.2*
Backward maximum frame size identifier								6.6* (Note 4)
0	0	0	0	0	1	0	1	
Backward maximum frame size value								6.6.1*
								6.6.2*

NOTE 1 – When present in the SETUP message, the octet group may be repeated up to six times in the order of preference for the encapsulation mode to be used, where the first appearance is considered to be the most desirable.

NOTE 2 – The octet groups within octet group 6 are identified using subfield identifiers and are position independent, i.e., they need not appear in a certain order within octet group 6.

NOTE 3 – The Forward/Backward maximum number of cells octet groups may be included for One-to-one cell mode, N-to-one cell mode, and AAL type 5 PDU mode. Absence of these subgroups indicates single cell mode.

NOTE 4 – The Forward/Backward maximum frame size octet groups are required for AAL type 5 SDU mode.

Figure 6/Q.2920 – Interworking information element

– *Related Standard (octet 5)*

bits

8 7 6 5 4 3 2 1

0 0 0 0 0 0 0 1 ATM-MPLS network interworking

All other values are reserved.

– *Encapsulation (octet group 6)*

This octet group defines an encapsulation for this call.

– *Length of encapsulation contents (octet 6.1)*

Length of the Encapsulation contents in octets, i.e., excluding octets 6 and 6.1.

– *Encapsulation mode (octet 6.2 bits 1-7)*

bits

8 7 6 5 4 3 2 1

0 0 0 0 0 1	One-to-one cell mode with no VCIP optimization [Y.1411] (Note 1)
0 0 0 0 1 0	One-to-one cell mode with VCIP optimization [Y.1411] (Note 1)
0 0 0 0 1 1	AAL type 5 PDU frame mode [Y.1412] (Note 2)
0 0 0 0 1 0 0	N-to-one cell mode with single call restriction [Y.1411] (Notes 3, 4)
0 0 0 0 1 0 1	AAL type 5 SDU frame mode [Y.1412]

NOTE 1 – If the Forward/Backward maximum number of cells is set to "1", then the encapsulation mode shall be One-to-one cell mode with single cell encapsulation [Y.1411]. If the Forward/Backward maximum number of cells is set to a value greater than "1", then the encapsulation mode shall be One-to-one cell mode with concatenated cell encapsulation [Y.1411].

NOTE 2 – If the Forward/Backward maximum number of cells is set to "1", then the encapsulation mode shall be One-to-one or N-to-one cell mode with single cell encapsulation [Y.1411].

NOTE 3 – If the Forward/Backward maximum number of cells is set to "1", then the encapsulation mode shall be N-to-one cell mode with single cell encapsulation [Y.1411]. If the Forward/Backward maximum number of cells is set to a value greater than "1", then the encapsulation mode shall be N-to-one cell mode with concatenated cell encapsulation [Y.1411].

NOTE 4 – The single call restriction means each Interworking LSP is restricted to encapsulate only one VCC or one VPC.

– *Common interworking indicators (octet 6.2, bit 8)*

This bit indicates the presence of the Common interworking indicators field [Y.1411].

bits

8 7 6 5 4 3 2 1

0	Common interworking indicators field absent
1	Common interworking indicators field present

– *Forward Maximum Number of Cells Value (octets 6.3.1 to 6.3.2)*

The forward maximum number of cells value specifies the maximum number of cells that the preceding side shall encapsulate into a single MPLS packet, using the One-to-one cell, AAL type 5 PDU frame, or N-to-one cell mode.

– *Backward Maximum Number of Cells Value (octets 6.4.1 to 6.4.2)*

The backward maximum number of cells value specifies the maximum number of cells that the succeeding side shall encapsulate into a single MPLS packet, using the One-to-one cell, AAL type 5 PDU frame, or N-to-one cell mode.

– *Forward Maximum Frame Size value (octets 6.5.1 to 6.5.2)*

The forward maximum frame size value specifies the maximum size in octets of the AAL type 5 SDU frame (for AAL type 5 SDU mode) that can be transported over the forward Interworking LSP.

– *Backward Maximum Frame Size value (octets 6.6.1 to 6.6.2)*

The backward maximum frame size value specifies the maximum size in octets of the AAL type 5 SDU frame (for AAL type 5 SDU mode) that can be transported over the backward Interworking LSP.

9 Procedures for the support of ATM-MPLS network interworking

This clause defines the signalling procedures to support ATM-MPLS network interworking signalling. The procedures for the basic call control in clause 5/Q.2931 and all its amendments (if applicable) shall apply with the additions or modifications described in this clause. This Recommendation also supports procedures for establishing, maintaining, and clearing of switched virtual path connections by means of the Digital Subscriber Signalling System No. 2 (DSS 2) protocol in a point-to-point call/connection as specified in ITU-T Rec. Q.2934.

The following terminology is adopted:

The preceding IWF is the IWF initiating the establishment of an ATM VCC or VPC within an Interworking LSP. The succeeding IWF is the IWF receiving a request to establish an ATM VCC or VPC within an Interworking LSP. The forward LSP is a Transport or Interworking LSP carrying the traffic in the forward call direction from the preceding to the succeeding IWF. The backward LSP is a Transport or Interworking LSP carrying the traffic in the backward call direction from the succeeding to the preceding IWF.

9.1 Interworking label exchange and VPCI/VCI allocation

9.1.1 Procedures at the preceding IWF

When the preceding IWF receives a setup request, the procedures for the Connection identifier (VPCI/VCI) allocation/selection in ITU-T Recs Q.2931 and Q.2934 modified as follows, shall apply:

For non-associated signalling:

Replace case "c" of 5.1.2.2/Q.2931 with:

c) Any VPCI; any VCI.

Replace case "c" of 5.2.3.2/Q.2931 with:

c) Any VPCI; any VCI.

Replace case "c" of 9.1.2/Q.2934 with:

c) Any VPCI; no VCI; or

Replace case "c" of 9.2.2/Q.2934 with:

c) Any VPCI; no VCI; or

NOTE – In some of the ATM-MPLS encapsulation modes (e.g., One-to-one cell mode, AAL type 5 PDU mode, AAL type 5 SDU mode, N-to-one cell mode with single call restriction), the allocated VCI/VCI values are not used during user plane data transfer.

The preceding IWF shall assign a backward interworking label and encode it into the Connection identifier information element included in the SETUP message. If the preceding IWF cannot allocate a backward interworking label, the call shall be cleared with cause #47 [Q.2610], "*Resource unavailable, unspecified*".

When the preceding IWF supporting ATM-MPLS network interworking receives a CALL PROCEEDING message, then:

- 1) if the Connection identifier information element is NOT present in the message, the preceding IWF shall invoke the procedures for mandatory information element missing as defined in 5.6.7.1/Q.2931;
- 2) if the Connection identifier information element is present, with octet group 10 missing, then the preceding IWF shall clear the call by invoking mandatory information element content error procedures as defined in 5.6.7.2/Q.2931;

- 3) if Connection identifier IE is present and carrying the octet group 10, it shall retrieve the forward interworking label:
 - If the preceding IWF determines that the label is in use, then:
 - the call shall be released with cause #35 [Q.2610], "*Requested VPCI/VCI not available*", and shall notify the entity controlling the use of that label.
 - If the preceding IWF determines that the label is NOT in use, then:
 - the preceding IWF shall use the received forward interworking label for the Interworking LSP in the forward direction.

9.1.2 Procedures at the succeeding IWF

When the succeeding IWF supporting ATM-MPLS network interworking receives a SETUP message, then:

- 1) if the Connection identifier information element is NOT present in the message, the succeeding IWF shall invoke the procedures for mandatory information element missing as defined in 5.6.7.1/Q.2931;
- 2) if the Connection identifier information element is present in the message, with octet group 10 missing, then the succeeding IWF shall clear the call by invoking mandatory information element content error procedures as defined in 5.6.7.2/Q.2931;
- 3) if the Connection identifier IE is present and carrying the octet group 10, it shall retrieve the backward interworking label:
 - If the succeeding IWF determines that the label is in use, then:
 - the call shall be released with cause #35, "*Requested VPCI/VCI not available*", and shall notify the entity controlling the use of that label.
 - If the succeeding IWF determines that the label is NOT in use, then:
 - the succeeding IWF shall use the label for the Interworking LSP in the backward direction; and
 - the succeeding IWF shall allocate the forward interworking label and shall encode it into the Connection identifier information element included in the CALL PROCEEDING message sent in reply to the SETUP message. If the succeeding IWF cannot allocate a forward interworking label, the call shall be cleared with cause #47, "*Resource unavailable, unspecified*".

9.2 Indication and negotiation of Encapsulation mode

Within this clause, the term "Encapsulation mode octet" refers to the combination of the Encapsulation mode (octet 6.2, bits 1-7) and the CII flag (octet 6.2, bit 8) of the Interworking information element.

9.2.1 Procedures at the preceding IWF

The preceding IWF shall include the Interworking information element in the SETUP message. The IE instruction field of the Interworking information element shall be set as follows: bit 5 shall be set to 1 ("follow explicit instruction") and the IE action indicator shall be set to "000" ("clear call").

If the preceding IWF does not allow negotiation of the encapsulation mode (including the CII flag), then the Interworking information element in the SETUP message shall contain only a single octet group comprised of the Encapsulation mode octet and Forward/Backward maximum number of cells or maximum frame size.

If the preceding IWF allows negotiation of the encapsulation mode, then the preceding IWF shall encode multiple Encapsulation octet groups in the Interworking information element in the SETUP

message. Each Encapsulation octet group shall contain the Encapsulation mode octet and Forward/Backward maximum number of cells or maximum frame size.

When the preceding IWF supporting ATM-MPLS network interworking receives a CONNECT message, then:

- 1) if the Interworking information element is NOT present in the CONNECT message, then the preceding IWF shall invoke the procedures for mandatory information element missing as described in 5.6.7.1/Q.2931;
- 2) if the Interworking information element contains an Encapsulation octet group indicating an Encapsulation mode octet that was not included in any Encapsulation octet group of the Interworking information element sent in the SETUP message, then the preceding IWF shall clear the call with cause #100, "*Invalid information element contents*";
- 3) if the Interworking information element contains more than one Encapsulation octet group, then the preceding IWF shall clear the call with cause #100, "*Invalid information element contents*";
- 4) if in the Interworking information element the Forward/Backward maximum number of cells value (for One-to-one cell mode, AAL type 5 PDU mode, or N-to-one cell mode) or Forward/Backward maximum frame size value (for AAL type 5 SDU mode) exceeds the corresponding value specified for the matching Encapsulation mode octet in the SETUP message, then the preceding IWF shall clear the call with cause #100, "*Invalid information element contents*";
- 5) if Interworking information element has no error as specified in 2, 3 and 4 above, then the preceding IWF shall use the encapsulation mode, CII flag value and, if applicable, Forward and Backward maximum number of cells or maximum frame size indicated in the received Encapsulation octet group.

9.2.2 Procedures at the succeeding IWF

If the Interworking information element with the Encapsulation octet group is not present in the SETUP message, then the succeeding IWF shall invoke the procedures for mandatory information element missing as described in 5.6.7.1/Q.2931.

The succeeding IWF shall check the validity of each Encapsulation octet group against the conditions listed below:

- 1) The Encapsulation mode is not supported.
- 2) The CII flag value is not supported for the indicated encapsulation mode.
- 3) A Forward/Backward maximum number of cells or maximum frame size that is required for the indicated encapsulation mode is missing.
- 4) A Forward/Backward maximum number of cells or maximum frame size that is not supported for the indicated encapsulation mode is specified.

If any of the above conditions are true, then the Encapsulation octet group will be considered as not supported.

If the succeeding IWF does not support encapsulation mode negotiation, it shall only process the first Encapsulation octet group and it shall ignore any additional Encapsulation octet groups.

If the succeeding IWF supports encapsulation mode negotiation and multiple Encapsulation octet groups were received, the succeeding IWF shall attempt to support the most preferred Encapsulation octet group (i.e., the first Encapsulation octet group). If the most preferred Encapsulation octet group is not supported for this call, the succeeding IWF shall attempt to support the second most preferred Encapsulation octet group (i.e., the second Encapsulation octet group) and so on.

If none of the received Encapsulation octet group can be supported for this call, the call shall be released with cause #127 *"Interworking, unspecified"*.

The succeeding IWF shall include the Interworking information element with the selected Encapsulation octet group in the CONNECT message. The values of the Forward and Backward maximum number of cells or maximum frame size present in the Encapsulation octet group may be negotiated downwards from the values received in the SETUP message.

The IE instruction field of the Interworking information element in the CONNECT message shall be set as follows: bit 5 shall be set to 1 ("follow explicit instruction") and the IE action indicator shall be set to "000" ("clear call").

The succeeding IWF shall use the indicated encapsulation mode, CII flag value and, if applicable, Forward and Backward maximum number of cells or maximum frame size.

9.3 Call/connection clearing procedure

The procedures of 5.4/Q.2931 shall apply with the following additions:

"On sending or receipt of a RELEASE message, the IWF shall not transmit user plane traffic on the corresponding Interworking LSPs, and discard received traffic on the corresponding Interworking LSP. On sending or receipt of a RELEASE COMPLETE message, the IWF shall clear the corresponding Interworking LSPs including label release.

If the preceding or succeeding IWF receives a RELEASE message while in the Release Request State, the IWF shall also clear the corresponding Interworking LSPs (including label release and withdraw)."

9.4 Restart procedures

9.4.1 VPCI/VCI restart procedures

The procedures in 5.5/Q.2931 shall apply. As a result of these procedures, the Interworking LSP labels associated with the restarted connections shall also be released.

9.4.2 Interworking LSP restart procedures

In order to restart a single Interworking LSP the restart procedures in 5.5/Q.2931 shall be followed with the following modifications:

The Restart indicator information element included in the RESTART and RESTART ACKNOWLEDGE messages shall be encoded with Class set to "000" (indicated virtual channel). Note that although Class is set to "000", the Interworking LSP being restarted may correspond to an ATM VPC or VCC.

The Connection identifier information element shall be included in the RESTART message and encoded as follows:

- The Coding Standard field shall be set to "00" (ITU-T specified).
- The Preferred/Exclusive field shall be set to "011" ("any VPCI; any VCI").
- Octet group 10 shall be present and shall contain the corresponding Interworking LSP label allocated for reception.

The entity receiving the RESTART message shall initiate the appropriate actions to return the Interworking LSP label specified in octet 10 of the Connection identifier information element (locally used for transmission), any corresponding connections, and any corresponding Interworking LSP labels (locally used for reception) to the idle condition and to release all associated call references.

Even if the specified interworking LSP label is in the idle condition or already in the process of restart to the idle condition, the receiving entity shall send a RESTART ACKNOWLEDGE message to the originator upon receiving a RESTART message.

When an IWF transmits a RESTART ACKNOWLEDGE message, the Connection identifier information element shall contain the same Interworking LSP label as specified in the RESTART message received from the originator.

When a RESTART or RESTART ACKNOWLEDGE message is received with:

- the Preferred/Exclusive field set to "011" (any VPCI; any VCI) and the octet group 10 is not present in the Connection identifier information element; or
- the Class in the Restart indicator information element not coded as "000" (indicated virtual channel),

the Connection identifier information element shall be treated as described in 5.6.7.2/Q.2931.

When an Interworking LSP label has been specified in a Restart Request state, the label shall not be considered free for reuse until the restart procedures have been completed.

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