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Technical Report TRQ.2830: ATM-MPLS network interworking signalling requirements

ITU-T Q-series Recommendations – Supplement 46

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
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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

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Supplement 46 to ITU-T Q-series Recommendations

Technical Report TRQ.2830: ATM-MPLS network interworking signalling requirements

Summary

This Supplement provides the signalling requirements to enable ATM services to be provided over an MPLS network in a network interworking environment.

Source

Supplement 46 to ITU-T Q-series Recommendations was agreed by ITU-T Study Group 11 (2001-2004) on 12 September 2003.

FOREWORD

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CONTENTS

		Page
1	Scope	1
2	References	1
3	Definitions	1
4	Abbreviations	2
5	Role of ATM signalling	2
6	Relationship between ATM connection and MPLS LSP	3
	6.1 Encapsulating ATM connections	4
7	Signalling information requirements	5
	7.1 Negotiation	6
8	Signalling information flows	6
	8.1 Signalling procedures overview	6
	8.2 Signalling objects	7
	8.3 Successful ATM connection establishment information flows	8
	8.4 Unsuccessful ATM connection establishment information flows	11
	8.5 ATM connection release information flows	12

Supplement 46 to ITU-T Q-series Recommendations

Technical Report TRQ.2830: ATM-MPLS network interworking signalling requirements

1 Scope

MPLS has the potential to consolidate service provider networks and services, for example, ATM, Frame Relay (FR), circuit emulation, voice and IP services, over a single common core infrastructure. This Supplement provides a general overview of ATM-MPLS network interworking and defines the signalling architecture and requirements.

The scope is indicated in Figure 1.

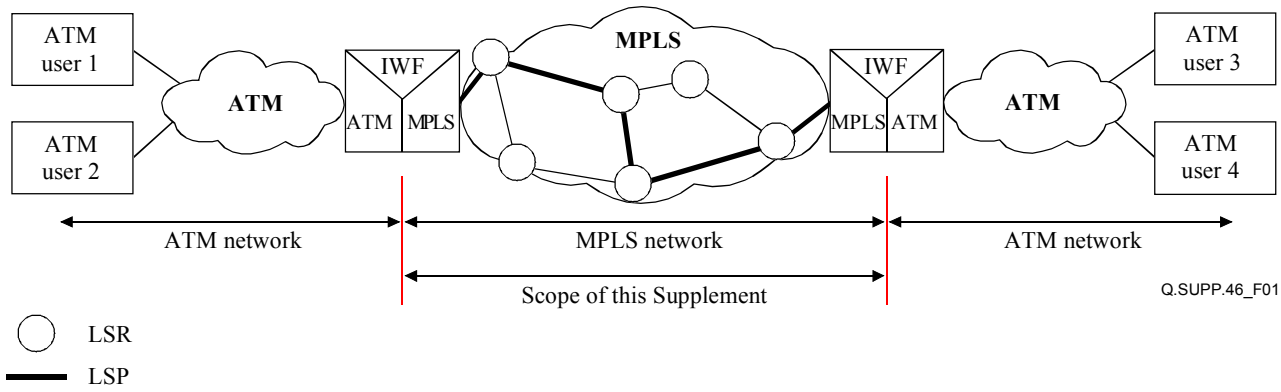


Figure 1 – Reference network architecture for ATM-MPLS network interworking and scope of this Supplement

Initially, point-to-point and point-to-multi-point ATM connections are covered. Other connection types are for further study. For point-to-multi-point connections it is assumed that the replication point is at or beyond the succeeding IWF.

2 References

[1] IETF RFC 3031 (2001), *Multiprotocol Label Switching Architecture*.

[2] ATM Forum Specification af-aic-0178.000 (2001), *ATM-MPLS Network Interworking Version 1.0*.

[3] ITU-T Recommendation Y.1411 (2003), *ATM-MPLS network interworking – Cell mode user plane interworking*.

[4] ITU-T Recommendation Y.1412 (2003), *ATM-MPLS network interworking – Frame Mode User plane interworking*.

3 Definitions

This Supplement defines the following terms:

3.1 signalling objects: The description of one of the characteristics of an ATM call/connection or of an MPLS LSP.

3.2 cell concatenation: See ITU-T Rec. Y.1411 [3].

3.3 interworking: See ITU-T Rec. Y.1411 [3].

3.4 preceding IWF: The IWF initiating the establishment of an ATM VCC or VPC within an interworking LSP.

3.5 succeeding IWF: The IWF receiving a request to establish an ATM VCC or VPC within an interworking LSP.

3.6 forward LSP: A transport or interworking LSP carrying the traffic in the forward call direction from the preceding IWF to the succeeding IWF.

3.7 backward LSP: A transport or interworking LSP carrying the traffic in the backward call direction from the succeeding IWF to the preceding IWF.

3.8 Transport LSP: See ITU-T Rec. Y.1411 [3].

3.9 Interworking LSP: See ITU-T Rec. Y.1411 [3].

4 Abbreviations

This Supplement uses the following abbreviations:

ATM	Asynchronous Transfer Mode
FR	Frame Relay
I-LSP	Interworking LSP
IWF	Interworking Function
LSP	Label Switched Path
MPLS	Multi-Protocol Label Switching
PDU	Protocol Data Unit
SDU	Service Data Unit
T-LSP	Transport LSP
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VCL	Virtual Channel Link
VPC	Virtual Path Connection
VPI	Virtual Path Identifier
VPL	Virtual Path Link

5 Role of ATM signalling

Figure 1 provides the reference architecture for ATM-MPLS network interworking. The Transport MPLS Label Switched Paths (LSPs) connect pairs of Interworking Functions (IWF). For each Transport LSP, one of the IWFs acts as a source of data flow and the other acts as a sink.

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. In the ATM-MPLS network interworking configuration addressed by this Supplement, the role of ATM signalling is to establish interworking LSPs between IWFs during ATM VCC or VPC establishment and to perform related signalling functions.

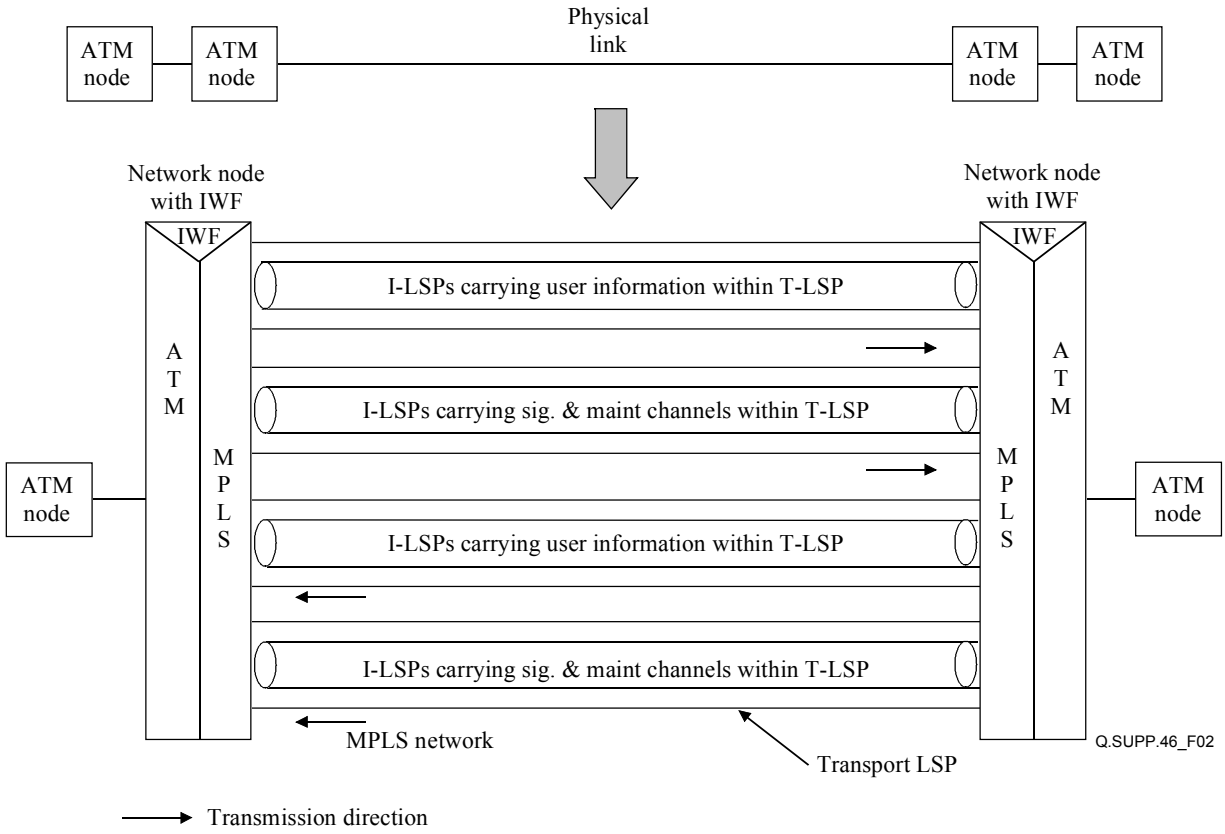


Figure 2 – MPLS transport system as an abstraction of an ATM physical link

6 Relationship between ATM connection and MPLS LSP

ATM connections (VPCs and VCCs) are usually considered to be bi-directional entities mainly because of the way they are created and identified. A single ATM layer identifier (a VPI or a VCI respectively) refers to the two directions of a VPC or VCC. ATM signalling establishes the two directions simultaneously with the same message flows, although each direction of a VPC or VCC may have different traffic and QoS characteristics, and the resource management of ATM implementations treats each direction independently. MPLS LSPs, on the other hand, are unidirectional entities from every perspective including set-up, labeling, data flow, traffic and QoS engineering.

ATM-MPLS network interworking requires ATM VPC or VCC to interwork with MPLS LSP. An ATM VCC is a sequence of Virtual Channel Links (VCL) and an ATM VPC is a sequence of Virtual Path Links (VPL). During the creation of a VCC or VPC, a pair of interworking LSPs will have to be established between two IWFs. Each interworking LSP will carry traffic in one direction only. The Interworking LSP identifies the VCL or VPL for the MPLS segment for the call.

Each interworking LSP is established in a Transport LSP such that the flow of data within the multiplexed interworking LSPs is aggregated within the flow of data allowed in the corresponding Transport LSP.

Figure 3 illustrates the relationship between Transport LSP, Interworking LSP and ATM VCC or VPC.

For the purposes of this Supplement, it is assumed that Transport LSPs are already available.

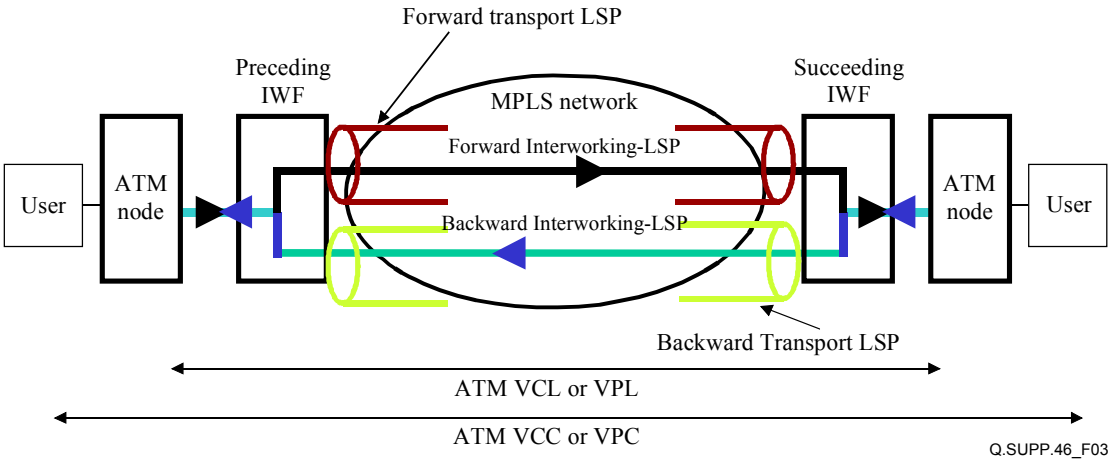


Figure 3 – ATM VCC and VPC and MPLS LSP

Within each forward and backward Transport LSP there may exist several Interworking LSPs. Nested LSPs may be present as shown in Figure 4. Each Interworking LSP may carry:

- user data;
- signalling messages, and/or routing and management messages.

The signalling channel of a Transport LSP is used to setup and control interworking LSPs within the transport LSP.

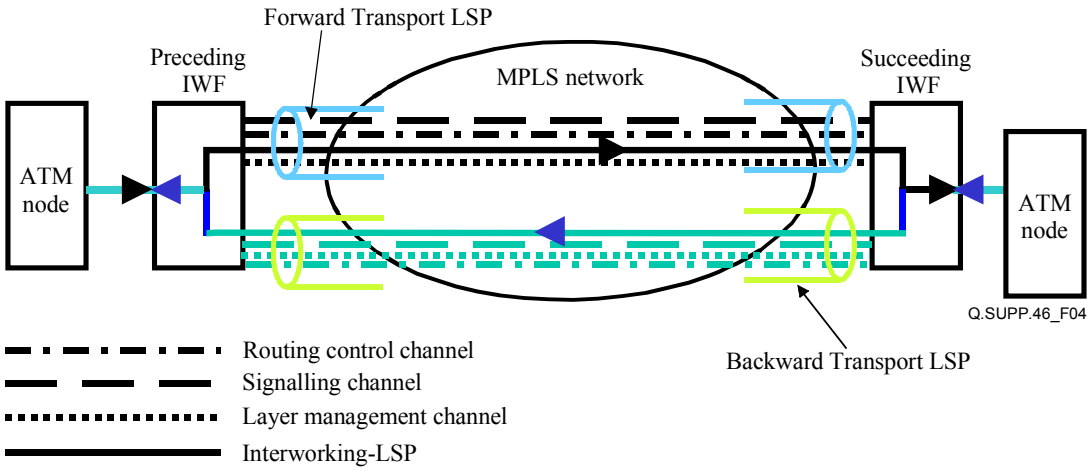


Figure 4 – Transport LSPs and their potential nested LSPs

6.1 Encapsulating ATM connections

Cell and frame are two encapsulation modes identified in ITU-T Recs Y.1411 [3] and Y.1412 [4] respectively. ITU-T Rec. Y.1411 defines two encapsulation formats for cell mode. One format allows for one VCC or VPC to be encapsulated into one interworking LSP (One-to-one mode), and the other allows cells belonging to one or more VCCs or VPCs to be encapsulated into one interworking LSP (N-to-one mode).

ITU-T Rec. Y.1412 defines two encapsulation formats. One allows for encapsulation of AAL5 PDUs and the other allows for encapsulation of AAL5 SDUs.

Detailed procedures for these encapsulation formats are provided in [3] and [4].

7 Signalling information requirements

At the preceding IWF, the ATM VPC/VCCs are encapsulated into an interworking LSP according to procedures described in [3] and [4]. An overview of the user plane encapsulation characteristics to be associated between VPC/VCC and an interworking LSP, summarized from [3] and [4], is shown in Figure 5.

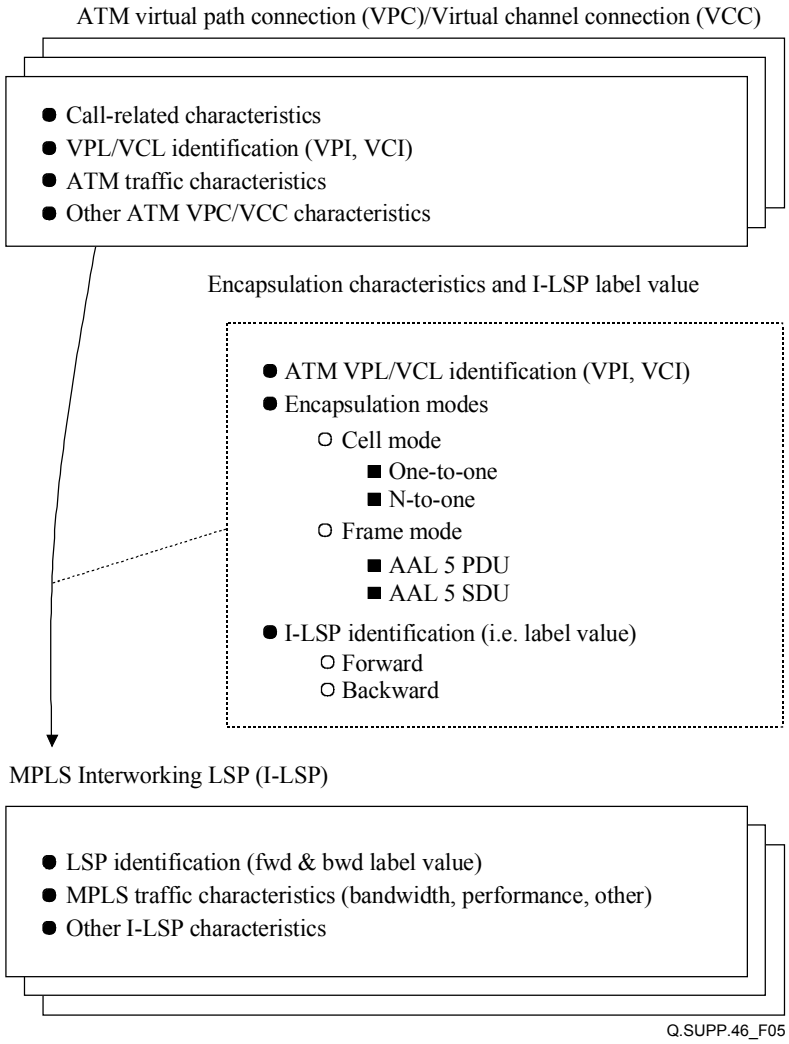


Figure 5 – Encapsulation characteristics

To establish VPCs/VCCs over an MPLS link requires the following information to be signalled between the IWFs on each side of the MPLS link:

- Forward and backward interworking LSP label values;
- Encapsulation mode:
  - cell (One-to-one or N-to-one):
    - single cell;
    - concatenated cells.
  - Frame
  - AAL 5 PDU:
    - Fragmented or Not fragmented.
  - AAL 5 SDU.

- Forward and backward maximum number of cells that can be received;
- VPI/VCI or VCI values in both One-to-one and N-to-one modes;
- Presence or absence of the Common interworking indicators field [3]:
  - Whether or not the sequence number field is used;
  - Whether or not the length field is used;
  - In the case of N-to-one cell mode, whether or not the control field is used.
- Selection of an interworking LSP:
  - Use existing interworking LSP (i.e., preprovisioned for the One-to-one or N-to-one modes and for subsequent VPC/VCCs in the N-to-one mode – signal only the VPI/VCI and the interworking LSP label used.
  - Set-up interworking LSP on demand (i.e., for the One-to-one mode or for the first VPC/VCC in the N-to-one mode).

Both cases are required.

NOTE – Some of the encapsulation formats in the user plane don't carry the VPI/VCI values.

7.1 Negotiation

It is required to negotiate the encapsulation mode from the options in clause 7.

8 Signalling information flows

8.1 Signalling procedures overview

The signalling messages sent by the preceding IWF may be carried in the forward transport LSP. Similarly, the signalling messages sent by the succeeding IWF may be carried in the backward transport LSP.

The signalling procedures to set up an ATM VPC or VCC across MPLS network include:

- Reception of request from the preceding ATM node to establish a VCC or VPC by the preceding IWF;
- Initiation of the request by preceding IWF for establishment of a pair of Interworking LSPs between preceding and succeeding IWFs in forward and backward directions;
- Progression of the establishment of the ATM VPCs or VCCs by the succeeding IWF towards the called user;
- Establishment of a pair of Interworking LSPs between preceding and succeeding IWFs in forward and backward directions after confirmation by succeeding IWF.

Clauses 8.3 through 8.5 illustrate, through the information flows, the establishment (successful and unsuccessful) and release of an ATM connection (VCC or VPC) when it passes over an MPLS network. These flows are intended to be protocol independent. To achieve this, the flows between the preceding IWF (X) and succeeding IWF (Y) in the MPLS network contain options to allow for different methods of MPLS label distribution. To draw a parallel with MPLS architecture as defined in RFC 3031, the label assignment method allows both "downstream on demand" or "unsolicited downstream" assignment.

Call-related signalling information following connection set-up is conveyed transparently across the MPLS network.

8.2 Signalling objects

The signalling objects used in the signalling information flows are described as follows:

8.2.1 Call reference

Circuit independent information identifying a particular call.

8.2.2 Bearer characteristics

Information sent in the forward direction to indicate a requested ATM bearer service to be provided by the network.

8.2.3 Called party end point address

Uniquely defines the end point address of the called party.

8.2.4 Calling party end point address

Uniquely defines the end point address of the calling party.

8.2.5 Connection identifier

Identifies the ATM connection within a call between peer signalling entities.

8.2.6 ATM traffic characteristics

The set of parameters that capture the traffic characteristics requested from the network for an ATM connection.

8.2.7 Quality of service characteristics

The set of parameters that capture the QoS characteristics requested from the network for an ATM connection.

8.2.8 User information

Information generated by one of the ATM end points and transferred transparently through the network between the requesting and terminating ATM endpoints.

8.2.9 Failure reason

Information sent in either the forward or the backward direction indicating where and why the call failed.

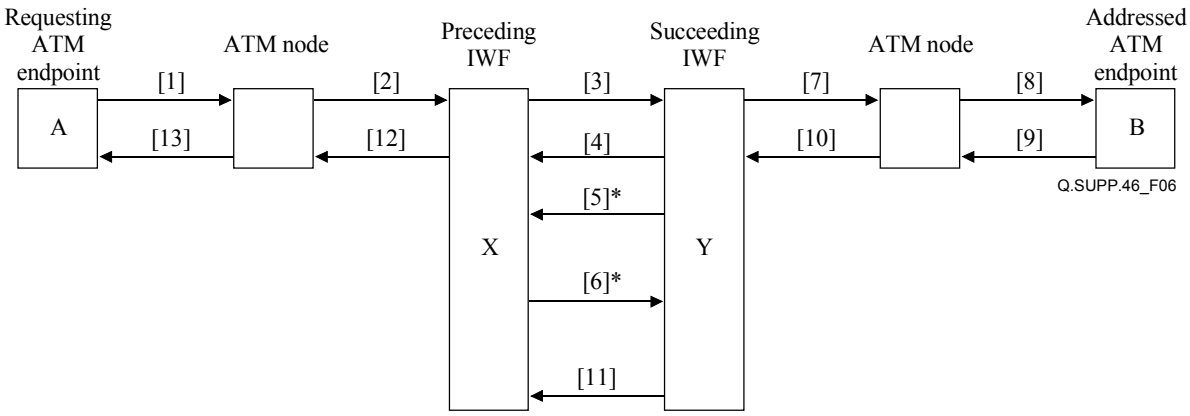
8.2.10 Release reason

Information sent in either the forward or the backward direction indicating where and why the call was released.

8.2.11 Optional additional LSP parameters

Additional bearer parameters related to the LSP between the two interworking nodes.

8.3 Successful ATM connection establishment information flows



* Optional flow

Figure 6 – Successful ATM connection establishment information flows

The information flows illustrated in Figure 6 are as follows:

Flow [1] – Setup-Request-ready

Direction

From Requesting ATM end-point A to ATM node

Signalling objects

Call reference

Bearer characteristics

Called party endpoint address (B address)

Calling party endpoint address (A address)

Connection identifiers

Traffic characteristics

QoS characteristics

User information

Initiation of information flow: The requesting endpoint starts to establish an ATM connection (VCC or VPC).

Processing upon receipt: The ATM node selects a route towards the addressed endpoint that can provide enough resources to carry the ATM connection. It then issues Information Flow 2.

Flow [2] – Setup-Request-ready

Direction

From ATM node to preceding IWF

Signalling objects

Call reference

Bearer characteristics

Called party endpoint address (B address)

Calling party endpoint address (A address)

Connection identifiers

Traffic characteristics

QoS characteristics

User information

Processing upon receipt: The preceding IWF (X) selects a route towards the addressed endpoint that can provide enough resources to carry the ATM connection to be established. It then issues Information Flow 3 to the succeeding IWF (Y).

Flow [3] – Setup-Request-Backward-ready

Direction

From preceding IWF (X) to the succeeding IWF (Y)

Signalling objects

Call reference

Bearer characteristics

Called party endpoint address (B address)

Calling party endpoint address (A address)

Connection identifiers including backward LSP label value (optional)

Optional additional LSP Parameters

Traffic characteristics

QoS characteristics

User information

The preceding IWF provides the required encapsulation mode or, optionally, a list of encapsulation modes in preference order.

Processing upon receipt: The succeeding IWF (Y) selects a route towards the addressed endpoint that can provide enough resources to carry the ATM connection to be established. It selects also an LSP label for the forward LSP and then issues Information Flow 4 to the preceding IWF (X).

If the optional "Connection identifiers including backward LSP label value" is received, then it issues information Flow 7 to the next ATM node. In this case, optional information Flows 5 and 6 are not initiated. The succeeding IWF (Y) stores the backward LSP label value.

If the optional "Connection identifiers including backward LSP label value" is not received, it then requests a backward LSP label value by issuing information Flow 5 to the preceding IWF (X) In this case, information Flow 7 is delayed toward the next ATM node until information Flow 6 has been received from the preceding IWF (X).

Flow [4] – Setup-Request-Forward-ready

Direction

From succeeding IWF (Y) to the preceding IWF (X)

Signalling objects

Call reference

Connection identifiers including forward LSP label value

Optional additional LSP Parameters

The succeeding IWF responds with the encapsulation mode selected. If the succeeding IWF cannot support any encapsulation requested the succeeding IWF releases the connection.

Processing upon receipt: The preceding IWF stores the forward MPLS LSP label value and waits for either the Setup-Request-Commit or, optionally, the Backward-LSP-Label-Value-Request information flow.

Flow [5] – Backward-LSP-Label-Value-Request (Optional)

Direction

From succeeding IWF (Y) to the preceding IWF (X)

Signalling objects

Call reference

Optional additional LSP Parameters

Processing upon receipt: The preceding IWF (X) selects the backward MPLS LSP label, issues the Backward-LSP-Label-Value information flow toward the succeeding IWF (Y) and waits for the Setup-Request-Commit information flow.

Flow [6] – Backward-LSP-Label-Value (Optional)

Direction

From (preceding) IWF (X) to the succeeding IWF (Y)

Signalling objects

Call reference

Connection identifiers including backward LSP label value

Optional additional LSP Parameters

Processing upon receipt: The succeeding IWF (Y) which has previously selected a route towards the addressed endpoint that can provide enough resources to carry the ATM connection to be established. It now issues the previously delayed Information Flow 7 to the next ATM node.

Flow [7] – Setup-Request-ready

Direction

From succeeding IWF to ATM node

Signalling objects

Call reference

Bearer characteristics

Called party endpoint address (B address)

Calling party endpoint address (A address)

Connection identifiers

Traffic characteristics

QoS characteristics

User information

Processing upon receipt: The ATM node checks that there are enough resources towards the addressed endpoint to carry the ATM connection to be established. It then issues Information Flow 8.

Flow [8] – Setup-Request-ready

Direction

From ATM node to Addressed ATM endpoint

Signalling objects

Call reference

Bearer characteristics

Called party endpoint address (B address)

Calling party endpoint address (A address)

Connection identifiers

Traffic characteristics

QoS characteristics

User information

Processing upon receipt: The addressed endpoint ensures that enough resources in the endpoint remain for the new ATM connection. It then notifies the user and issues Information Flow 9 to confirm the establishment.

Flow [9] – Setup-Request-confirm

Direction

From Addressed ATM endpoint to ATM node

Signalling objects

Call reference

Processing upon receipt: The ATM node propagates the confirmation of the ATM connection as Flows 10, 11, 12 and 13.

Flow [10, 11, 12 and 13] – Setup-Request-confirm

Direction

From ATM node or IWF to a preceding node and ultimately to the requesting ATM endpoint

Signalling objects

Call reference

Processing upon receipt: Each ATM node or IWF propagates the confirmation of the ATM connection as Flow 10, 11, 12 and 13. Upon receiving Flow 13, the requesting endpoint informs the served user about the completion of the requested ATM connection establishment.

8.4 Unsuccessful ATM connection establishment information flows

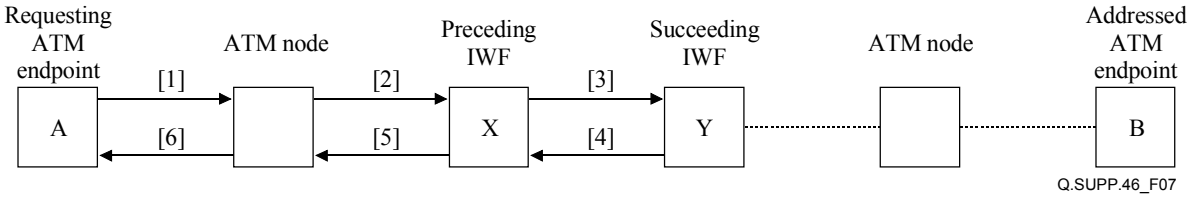


Figure 7 – Unsuccessful ATM connection establishment information flows

The information flows illustrated in Figure 7 are as follows:

Flow [1] – Setup-Request-ready

Direction

From Requesting ATM end-point A to ATM node

Signalling objects

Same as flow [1] for the successful connection establishment (see 8.3).

Initiation of information flow: Procedure as per 8.3.

Processing upon receipt: Procedure as per 8.3.

Flow [2] – Setup-Request-ready

Direction

From ATM node to IWF

Signalling objects

Same as flow [2] for the successful connection establishment (see 8.3).

Processing upon receipt: Procedures as per 8.3.

Flow [3] – Setup-Request-Backward-ready

Direction

From preceding IWF to succeeding IWF

Signalling objects

Same as Flow [3] for the successful connection establishment

Processing upon receipt: The succeeding IWF attempts to select a route towards the addressed endpoint; however, no route is available that can provide enough resources to carry the ATM connection to be established: The establishment process has to be cancelled. The succeeding IWF then releases all resources already committed to the new ATM network connection and issues Flow 4.

Flow [4] – Setup-Request-cancel

Direction

From succeeding IWF to the preceding IWF

Signalling objects

Call reference

Failure reason

Processing upon receipt: The preceding IWF releases all resources already committed to the new ATM connection and propagates the cancellation of the ATM connection establishment as Flows 5 and 6.

Flows [5] and [6] – Setup-Request-cancel

Direction

From preceding IWF to the previous ATM node and ultimately to the requesting ATM endpoint

Signalling objects

Call reference

Failure reason

Processing upon receipt: The IWF or ATM node propagates the cancellation of the ATM connection request as Flow 5 and 6 until it reaches the requesting ATM endpoint. Upon receiving Flow 6, the requesting endpoint informs the served user about the cancellation of the requested ATM connection establishment.

8.5 ATM connection release information flows

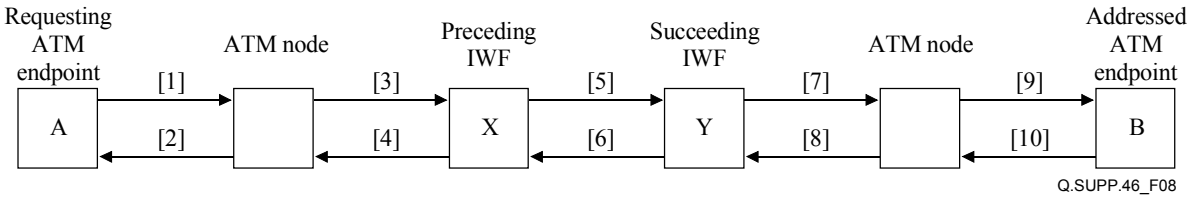


Figure 8 – ATM connection release information flows

The flows illustrated in Figure 8 are as follows:

Flow [1] – Release-Request-ready

Direction

From Requesting ATM end-point A to ATM node

Signalling objects

Call reference

Optional release reason

Initiation of information flow: The requesting endpoint initiates the release of an ATM connection.

Processing upon receipt: The ATM node may release the resources committed to the ATM connection, issues information Flow 2 to confirm the release and information Flow 3 to propagate the release along the route of ATM connection.

Flow [2] – Release-Request-commit

Direction

From ATM node to requesting ATM endpoint A

Signalling objects

Call reference

Optional release reason

Processing upon receipt: The requesting endpoint releases all resources committed to the ATM connection if it has not done already and confirms the release of the ATM connection to the served user.

Flow [3] – Release-Request -ready

Direction

From ATM node to preceding IWF

Signalling objects

Call reference

Optional release reason

Processing upon receipt: The preceding IWF may release the resources committed to the ATM connection, issues information Flow 4 to confirm the release and Information Flow 5 to propagate the release.

Flow [4] – Release-Request-commit

Direction

From preceding IWF to ATM node

Signalling objects

Call reference

Optional release reason

Processing upon receipt: The ATM node release all resources committed to the ATM connection if it has not done already.

Flow [5] – Release-Request -ready

Direction

From preceding IWF to succeeding IWF

Signalling objects

Call reference

Optional release reason

Processing upon receipt: The succeeding IWF releases the resources committed to the ATM connection, issues information Flow 6 to confirm the release and Flow 7 to propagate the release.

Flow [6] – Release-Request-commit

Direction

From succeeding IWF to preceding IWF

Signalling objects

Call reference

Optional release reason

Processing upon receipt: The preceding IWF releases all resources committed to the ATM connection if it has not done already. At this stage the resources used for the two interworking LSPs carrying the traffic in opposite directions are released.

Flow [7] – Release-Request -ready

Direction

From succeeding IWF to ATM node

Signalling objects

Call reference

Optional release reason

Processing upon receipt: The ATM node releases the resources committed to the ATM connection, issues information Flow 8 to confirm the release and Flow 9 to propagate the release.

Flow [8] – Release-Request-commit

Direction

From ATM node to succeeding IWF

Signalling objects

Call reference

Optional release reason

Processing upon receipt: The succeeding IWF releases all resources committed to the ATM connection if it has not done already.

Flow [9] – Release-Request-ready

Direction

From ATM node to addressed ATM endpoint B

Signalling objects

Call reference

Optional release reason

Processing upon receipt: The addressed endpoint releases all resources committed to the ATM connection, issues Flow 10 to confirm the release and informs the ATM connection served user about the release of the ATM connection.

Flow [10] – Release-Request-commit

Direction

From ATM endpoint B to ATM node

Signalling objects

Call reference

Optional release reason

Processing upon receipt: The ATM node releases all resources committed to the ATM connection if it has not done already.

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Geneva, 2003