INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.1712

(01/2004)

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT GENERATION NETWORKS

Internet protocol aspects – Operation, administration and maintenance

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OAM functionality for ATM-MPLS interworking

ITU-T Recommendation Y.1712

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ITU-T Recommendation Y.1712

OAM functionality for ATM-MPLS interworking

Summary

This Recommendation describes OAM functionality for interworking between ATM and MPLS networks; specifically, procedures for interworking ATM OAM functionality (as described in ITU-T Rec. I.610) and MPLS OAM functionality (as described in ITU-T Rec. Y.1711) for fault management, notification and alarm suppression.

Source

ITU-T Recommendation Y.1712 was approved on 10 January 2004 by ITU-T Study Group 13 (2001-2004) under the ITU-T Recommendation A.8 procedure.

Keywords

ATM, interworking, MPLS, OAM

FOREWORD

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ITU-T Recommendation Y.1712

OAM functionality for ATM-MPLS interworking

1 Scope

This Recommendation addresses the interworking of ATM (I.610) and MPLS (Y.1711) OAM functionality in two scenarios:

The first is network interworking, whereby ATM is transported (as the client layer) by MPLS (as the server layer) as defined in ITU-T Rec. Y.1411 or similar Recommendations.

The second is layer network interworking [5], whereby the traffic's data-plane for a p2p path is constructed of concatenated ATM and MPLS data-plane partitions.

Defect states and consequent actions resulting from interworking of payload adaptation between ATM and MPLS is for further study (an example would be MTU or sequencing problems).

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.

[1] ITU-T Recommendation Y.1711 (2004), *Operation and maintenance mechanism for MPLS networks*.

[2] ITU-T Recommendation I.610 (1999), *B-ISDN operation and maintenance principles and functions*.

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

[4] ITU-T Recommendation I.732 (2000), *Functional characteristics of ATM equipment*.

[5] ITU-T Recommendation G.805 (2000), *Generic functional architecture of transport networks*.

[6] ITU-T Recommendation I.357 (2000), *B-ISDN semi-permanent connection availability*.

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

3 Definitions and terminology

This Recommendation uses definitions and terminology from ITU-T Recs G.805, I.610, I.732, Y.1411 and Y.1711.

4 Abbreviations

This Recommendation uses the following abbreviations:

AIS Alarm Indication Signal

ATM Asynchronous Transfer Mode

BDI Backward Defect Indication

CC	Continuity Check
CP	Connection Point
CV	Connectivity Verification
e-t-e	end-to-end
FDI	Forward Defect Indication
LC	Link Connection
LMI	Layer Management Interface
LSH	Label Switch Hop
LSP	Label Switch Path
ME	Maintenance Entity
MPLS	Multi-Protocol Label Switching
NE	Network Element
NS	Native Service
RDI	Remote Defect Indication
TP	Transmission Path
VCC	Virtual Channel Connection
VCLC	Virtual Channel Link Connection
VPC	Virtual Path Connection
VPLC	Virtual Path Link Connection

5 ATM-MPLS network interworking management model (overview)

The ATM-MPLS interworking function is composed of two management planes: the ATM management plane and the MPLS management plane. This Recommendation focuses on OAM information that has to be communicated between the two network data-planes without making any attempt to specify the mechanism for interaction between the two management planes.

There are two classes of maintenance entities (MEs) in the case of ATM-MPLS network interworking:

– ATM and MPLS MEs (for example, a VPC/VCC in case of ATM, and an LSP in case of MPLS);

– Network interworking MEs (NI-MEs), which refer to the portion of the ATM ME that is interworked between the IWF ATM connection points.

Note that an MPLS trail here is proving a link connection in the ATM layer network. This is a G.805 client/server relationship. It is useful to note that between other ATM nodes (in either of the end partitions) there will be trails of other (for example) L1 CO-CS technology providing the link connections between the ATM nodes. The same is expected to be true for the link connections between the MPLS nodes. These relationships are also examples of network interworking.

For layer network interworking, there is only one class of ME: the ATM and MPLS maintenance entities. This is a G.805 layer network interworking relationship in which both entities have common semantics and simply require translation of the trail overhead at the interworking point. The link connections in either the ATM or MPLS layer networks can be provided by CO-CS server trails as in the previous case (and where the relationship here is networking-interworking).

6 Network interworking management functional model

Figure 6-1 shows the ATM-MPLS network interworking management reference model.

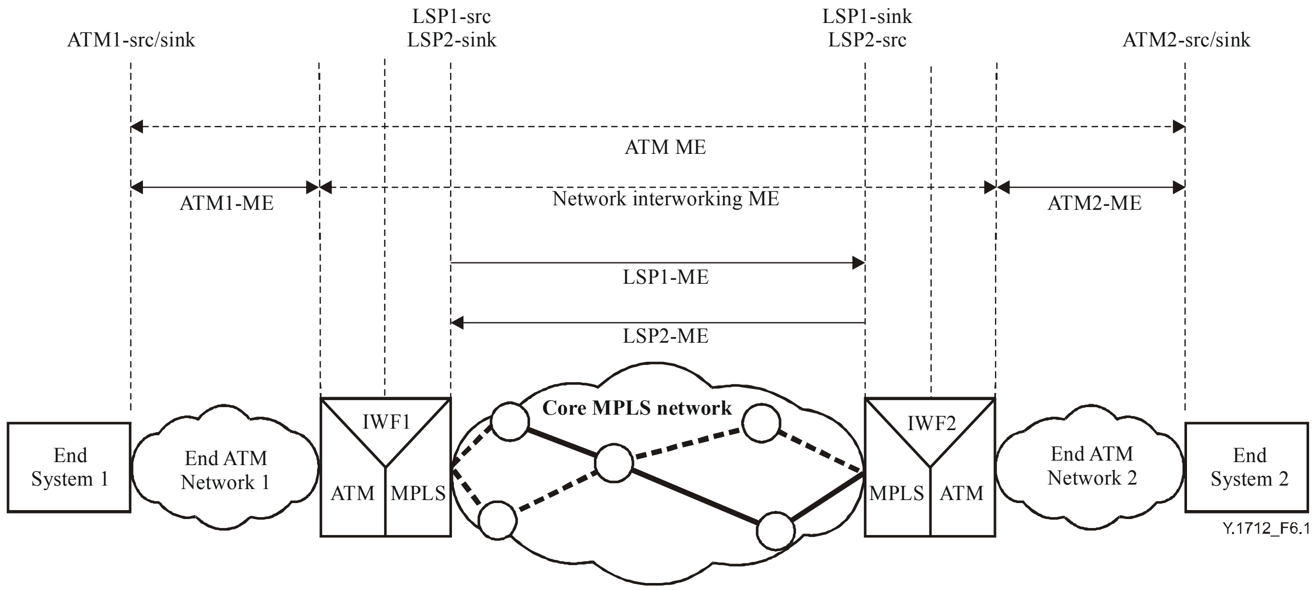

Figure 6-1/Y.1712 – ATM-MPLS network interworking management reference model

The key components of the model are:

– ATM ME: the ATM VCC or VPC transported between the ATM layer network trail termination points.

– End Systems 1 and 2: the ATM layer trail partitions that have a trail termination point at the end system and a connection point at the IWF.

– IWF1, IWF2: interworking functions that use procedures defined in ITU-T Rec. Y.1411 to encapsulate/decapsulate ATM for transport over MPLS.

– LSP1-ME, LSP2-ME: the pair of unidirectional interworking LSPs that together provide bidirectional server layer transport for the ATM client link connection between IWF1 and IWF2.

– Network interworking ME: the portion of the ATM ME that exists between the ATM connection points at IWF1 and IWF2.

– ATM1-ME, ATM2-ME: elements of the ATM ME that are exclusive of the network interworking ME. The ATM layer trail partitions that have a trail termination point at the end system and a connection point at the IWF.

This model assumes that the ATM ME is most usefully partitioned into a minimum of three ATM OAM segments. One or more ATM OAM segments exist between end system 1 and the IWF1 CP. One OAM segment is delineated by the connection points (CPs) co-located with IWF1 and IWF2. One or more ATM OAM segments exist between the IWF2 CP and end system 2.

This model may be mapped onto the I.610 reference model. In the network-interworking case, the MPLS MEs are interposed as a new level between the F3 and F4 OAM levels as illustrated in Figure 6-2. As such, the strict F*x* OAM flow numbering relationships should not be taken too literally. The only issue that is relevant is that a link connection in a given client layer network is provided by a trail in a server layer network, and that the OAM flows in each client/server layer network are independent. The VPLC/VCLC transported by the LSP1/2-MEs corresponds to the network interworking ME.

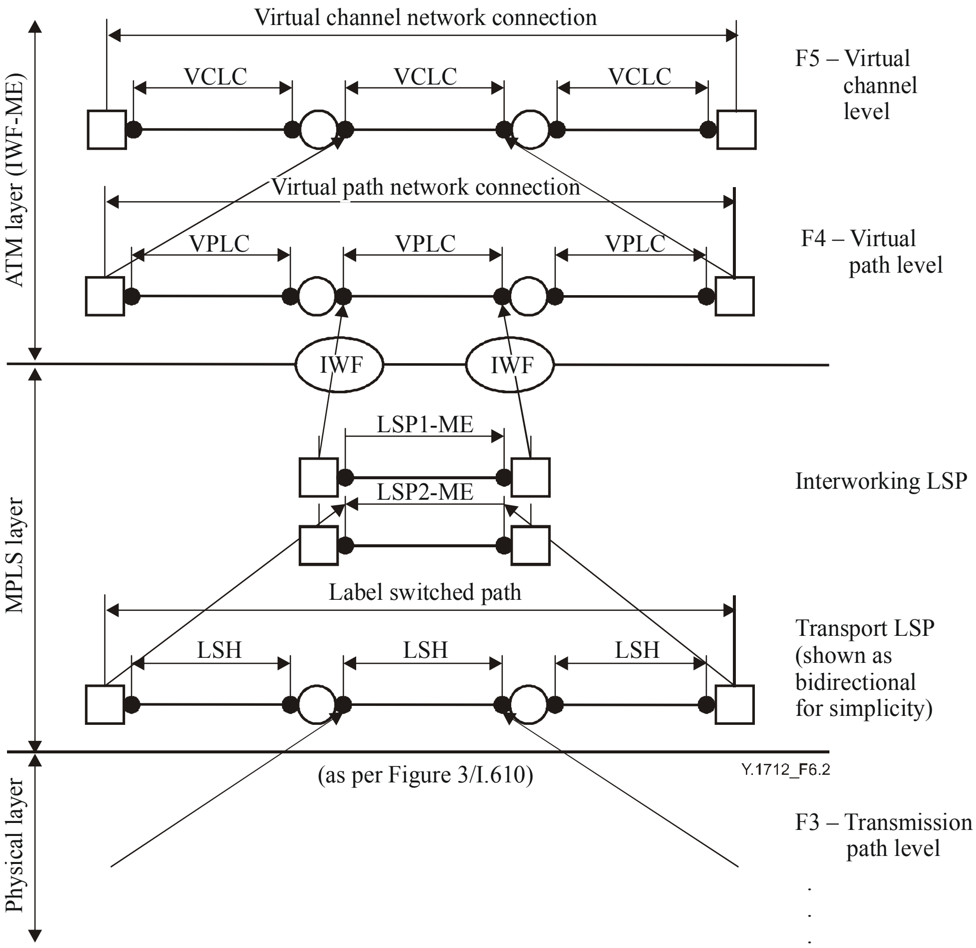

Figure 6-2/Y.1712 – OAM hierarchy: I.610 view

It is also possible to illustrate the network interworking scenario using G.805 as in Figure 6-3:

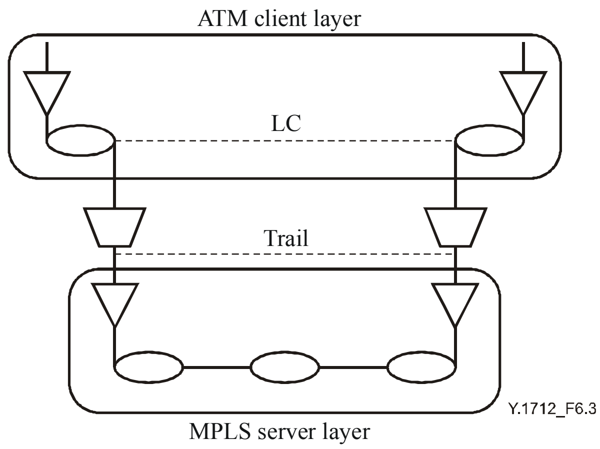

Figure 6-3/Y.1712 – Network interworking of ATM over MPLS: G.805 context

7 Network interworking defect, availability and performance considerations

Network interworking of client/server OAM fault management relationships are possible when the server layer trail termination has knowledge of the client layer maintenance entities such that suitable entry to and exit from fault notification states can be performed. Based on ITU-T Recs I.610 and Y.1711, this is possible for Y.1411 [3] one-to-one mode or for N-to-one mode when the egress IWF has knowledge of the client VPCs and VCCs transported by the interworking LSP.

The MPLS network in this scenario is invisible to the ATM end-user, as indeed it should be in any client/server layer network relationship. Therefore, the availability and performance of the IWF is perceived based on the availability of the end-end ATM trail (i.e., compliance to ITU-T Recs I.610 and I.357). However, the end-to-end ATM trail availability and performance is dependent on the availability and performance of the MPLS network and is inherited from the constituent lower layers via ATM-MPLS interworking mechanisms. The same is true with respect to QoS metric collection. Since any MPLS layer (or lower CO-CS layer) defects will appear as ATM layer defects, it is vital to be able to suppress alarms and perform fault notification in all the layer networks above the one in which the defect originates. Therefore, it is required that MPLS fault conditions be communicated to the ATM management plane at the interworking function. In practice, this means we must map a FDI from the MPLS server layer data-plane trail termination point or lower layer defect indications noted by MPLS layer management into the supported ATM, client's data-plane (in ATM, the FDI function is provided by AIS cells).

8 Network interworking: procedures at the egress IWF

The OAM interworking specified in this Recommendation is an interaction of the near-end defect handling state machine for the MPLS LSP and the transported ATM VCCs and/or VPCs.

The MPLS LSP defect state acts as an input to the ATM layer management function (as outlined in [4]). An MPLS layer defect acts as a transmission path (TP) failure indicator to the ATM layer management function via the FDI OAM function.

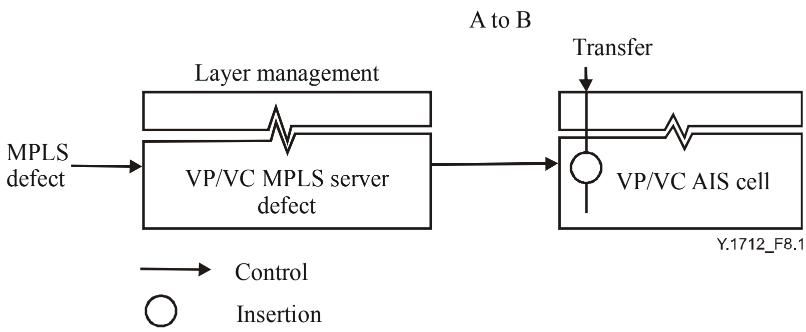

Figure 8-1/Y.1712 – MPLS defects as input to ATM LMIs at LSP egress for VPL/VCL T: I.732 view

ITU-T Rec. I.732 defines an ATM layer management model that includes A and B reference points which denote directionality. The A-to-B direction refers to ITU-T Rec. I.732-defined reference points.

Note that the possibility of dTTSI_Mismerge/dTTSI_Mismatch MPLS layer defects means that TP failure can occur without interruption of F4/F5 flows and user traffic at the ATM layer. This is addressed by the transition to the "AIS state".

1) Upon entry of the LSP-ME near-end to a defect state:

The egress IWF will instruct the ATM layer management function of each ATM ME that is a client of the unavailable LSP-ME to enter the end-to-end and (if used) seg-AIS-generation condition with corresponding suppression of user-traffic (which includes any CC or PM OAM flow) transiting the network interworking ME.

2) Upon exit of the LSP-ME near-end from a defect state:

The egress IWF will instruct the ATM layer management function to exit end-to-end and seg-AIS-generation condition and re-enable transit of network interworking traffic (which includes any CC or PM OAM flow) across the IWF.

3) ATM LMI:

Other ITU-T Rec. I.732-defined ATM layer management interface functions are unaffected.

9 Layer network interworking management reference model

9.1 Overview

Layer network interworking of ATM VCCs and/or VPCs with MPLS PW LSPs requires interworking of OAM fault management functions. In the VCC case, the payload interworking function would be client-specific; in the VPC case, the client is usually expected (though does not have to be) to be ATM VCCs that would be transported by MPLS using Y.1411 procedures defined for the "many-to-one" mode. This is irrespective of how the ATM payload is adapted onto the MPLS LSPs. The ATM VCC/VPC is a maintenance entity and is concatenated with the LSPs as a peer-level MPLS maintenance entity.

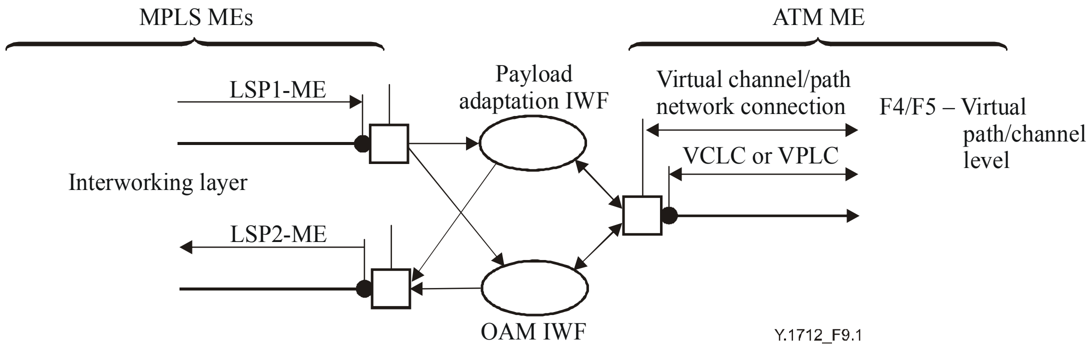

Figure 9-1/Y.1712 – ATM-MPLS layer network interworking – LSP to VCC/VPC

There is no interworking of OAM fault management protocols per se, but there is functional translation/interaction between the termination connection points and associated defect state handling at the boundary between the respective maintenance entities.

The ATM trail termination is also considered to be a segment boundary in this model. Note that the ATM trail termination points are now not in each of the end-systems (as was the case for the previous networking interworking case), but in the end-system and the IWF. The same is true on the other side for the LSP trail termination points.

9.2 Layer network interworking in the ITU-T Rec. G.805 context

Figure 9-2 uses ITU-T Rec. G.805 to describe ATM-MPLS layer network interworking whereby the trail transporting the client layer is constructed of a concatenation of ATM and MPLS trails connected with unidirectional interworking functions.

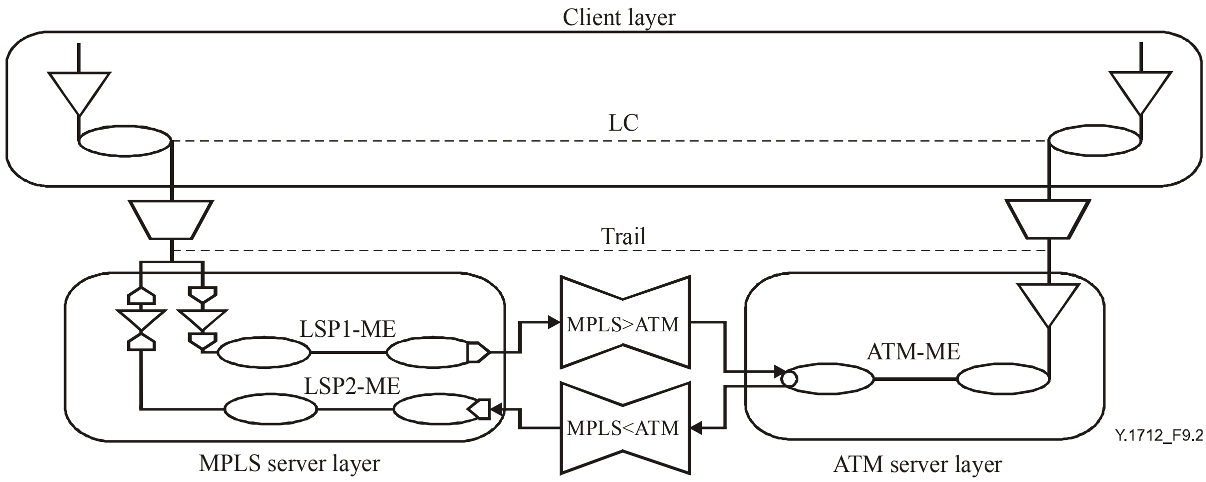

Figure 9-2/Y.1712 – ATM-MPLS layer network interworking: G.805 view

10 Layer network interworking defect, availability and performance considerations

Since layer network interworking of OAM fault management is possible (as defined later), this enables control of the collection of QoS metrics for the service based upon availability of all constituent service components (both ATM and MPLS MEs). Note that care has been taken to ensure that both ATM and MPLS have harmonized defect and availability definitions to allow simple SLAs to be created when using layer network interworking.

As in the previous ATM/MPLS networking interworking case, we still have client/server networking interworking of the link connections between adjacent ATM or MPLS nodes as provided by the server layer trails of a say, CO-CS technology.

11 Layer network interworking procedures at an IWF

1) Transition of MPLS near-end termination from defect-free state to a defect state

   The MPLS termination connection point upon transition from the defect-free state to a defect state as a result of an MPLS layer defect (or even lower layer defect) will direct the ATM termination point to:

   - enter AIS cell generation condition as per ITU-T Rec. I.610, and suspend traffic and any e2e CC or PM cell generation, if enabled;
   - suspend any seg-CC or PM cell generation, if seg-OAM is enabled.

2) Transition of MPLS near-end termination from a defect state to the defect-free state

   The MPLS near-end termination connection point upon transition from a defect state to the defect-free state as a result of correction of an MPLS layer defect (or even lower layer defect) will direct the ATM termination point to release AIS, and resume traffic and any CC/PM cell generation (if activated for the ME).

3) Transition of MPLS far-end termination from the defect-free state to a defect state

   The MPLS far-end termination connection point upon transition from the defect-free state to a defect state as a result of detection/notification of an MPLS (or lower) layer defect will send a BDI in the LSP in the opposite direction, i.e., towards the IWF. This will be mapped across the IWF by directing the ATM termination point to enter e-t-e_RDI_cell generation condition.

4) Transition of MPLS far-end termination from a defect state to the defect-free state

   The MPLS far-end termination connection point upon transition from a defect state to the defect-free state as a result of the absence of notification of an MPLS (or lower) layer defect will stop sending a BDI in the LSP in the opposite direction, i.e., towards the IWF. This will direct the ATM termination point to release e-t-e_RDI_generation condition.

5) Entrance of ATM termination into a near-end e2e-AIS-state or seg_AIS_state (if used)

   As a consequence of an ATM layer detected defect via CC (or lower layer defect mapped upwards), the near-end ATM termination will enter the e2e-AIS-state or seg_AIS_state (if used). This will direct the MPLS LSP in the same direction on the other side of the IWF to initiate FDI generation and to suspend traffic and CV generation. The FDI defect type field is set to dPeerME (0x0102) to indicate that the problem does not reside within the domain of the MPLS maintenance entity (MPLS layer or any MPLS server layer). The ATM termination in the other direction at the IWF MAY enter the e2e-RDI-generation state. The reason the word 'may' is used here is to take into account the following: when the MPLS FDI is received at the LSP trail termination point (in the direction away from the IWF), this will cause a BDI to be returned and this will get mapped across the IWF into the ATM partition as a RDI signal (see case 3 above). So, there is a logical 'or' function here w.r.t. to how the ATM partition RDI is generated.

6) Release of the near-end e2e-AIS-state and seg_AIS_state at the ATM termination

   Once the ATM layer (or lower layer) defect has been recovered, the near-end ATM termination will release the e2e-AIS-state and seg_AIS_state (if used). This will direct the MPLS LSP in the same direction on the other side of the IWF to cease FDI generation and resume traffic and CV generation (if configured to do so).

7) Entrance of far-end ATM termination into e2e-RDI-state or seg_RDI_state

   Due to a defect detected in the ATM partition in the direction away from the IWF, the ATM termination in the direction towards the IWF will enter the e2e-RDI-state and seg_RDI_state (if used) and the incoming RDI at the IWF will direct the MPLS LSP in the same direction on the other side of the IWF to initiate BDI generation. This must also use the defect type dPeerME (0x0102) to indicate that the problem does not reside within the domain of the MPLS maintenance entity (MPLS layer or any MPLS server layer). Note that there is no impact to any CV flow on this LSP.

8) Release of e2e-RDI-state and seg_RDI_state

   When the defect detected in the ATM partition in the direction away from the IWF is recovered, the ATM termination in the direction towards the IWF will exit the e2e-RDI-state and seg_RDI_state (if used), and stop sending RDI towards the IWF. This will direct the MPLS LSP in the same direction on the other side of the IWF to stop sending BDI generation. Note that there is no impact to any CV flow on this LSP.

12 Security considerations

This Recommendation does not raise any security issues that are not already present in either the MPLS or ATM architectures. The overall level of security being that of the lowest common denominator in both the layer network and network interworking cases. The MPLS architecture assumes all trail terminations within a given layer are trusted, and provides arbitrary hierarchy such that untrusted clients can be isolated from the trusted network. The ATM architecture is connection-oriented and explicitly scopes ATM trail connectivity to authenticated peers. This is critical for OAM where untrusted ingresses may leverage OAM mechanisms to perform denial of service attacks on the network infrastructure.

Annex A

Modifications to Y.1711 codepoints

A.1 Additional Y.1711 Defect Type codepoints

Defect Type	DT code (hex)	Meaning
dPeerME	01 02	Any peer maintenance entity defect arising outside the MPLS subnetwork. It is not suggested that these are individually identified and defined for each type of peer network. Hence, only an indication is needed that it is not a defect in the MPLS subnetwork. Note that this defect is not generated by MPLS OAM mechanisms; rather, it is the result of an input to MPLS OAM from a layer network interworking function.

A.2 Modification to existing Y.1711 Defect Type codepoints

Defect Type	DT code (hex)	Meaning
dLOCV	02 01	Simple Loss of Connectivity Verification due to missing CV OAM packets with expected TTSI. Note that: – if the cause of dLOCV is the server layer (i.e., there is also an incoming FDI signal from the server layer), then the DT codepoint 01 0[1]Hex is used; – if the cause of dLOCV is the peer maintenance entity (i.e., there is also an incoming FDI signal from the IWF with a DT codepoint of 01 02), then the DT codepoint 01 02 Hex is used; – the dLOCV codepoint 02 0[1]Hex is only used for MPLS layer simple connectivity failures only.

Appendix I

ATM-MPLS network interworking fault scenarios

Maintenance of the ATM ME requires the following maintenance functions:

- Automatic fault detection;
- Automatic consequent actions (as appropriate to type of defect);
- Fault indication;
- Diagnostic functions for fault investigation (e.g., loopback and path trace);
- Performance measurement (though these may only require an ad hoc use);
- Fault recovery functions (e.g., protection switching).

I.1 Automatic fault detection

Automatic fault detection is achieved by monitoring ATM F4/F5 CC on the ATM ME or Network Interworked ME (if uniquely defined as an ATM segment) as per ITU-T Rec. I.610.

i) The ATM ME is monitored by e-t-e F4/F5 CC. In the forward direction, the F4/F5 CC flow is set up between the ATM VPC/VCC connection endpoints. ATM CC OAM cells are inserted at the ATM End System 1-src. At IWF1-CP the CC cell is encapsulated as per ITU-T Rec. Y.1411 and transported over the MPLS network. At IWF2-CP the CC cell is de-encapsulated and sent to ATM End System 2-sink.

ii) ATM segments are monitored by segment F4/F5 CC flows. When the ATM CPs at IWF1 and IWF2 are defined as segment boundaries, segment CC provides a fault detection mechanism of maximum coverage of network interworking components (this may be used with or without e-t-e ATM OAM flows).

Note that Seg_CC flow over the network-interworked ME may be used for getting a rough estimate of availability and performance of the MPLS network where the LSP-MEs are not monitored. (See Figure I.1.)

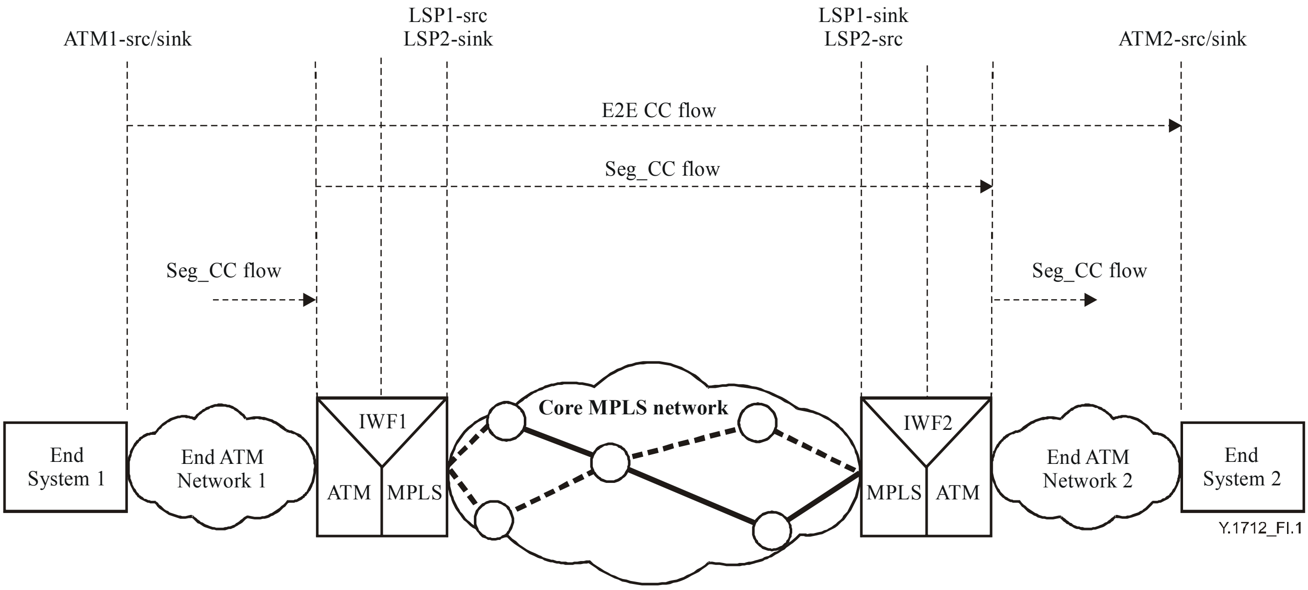

Figure I.1/Y.1712 – Forward direction CC flows in network interworking

I.2 Fault indication

Figure I.2 shows a number of fault scenarios in network interworking. Each scenario is analysed as follows.

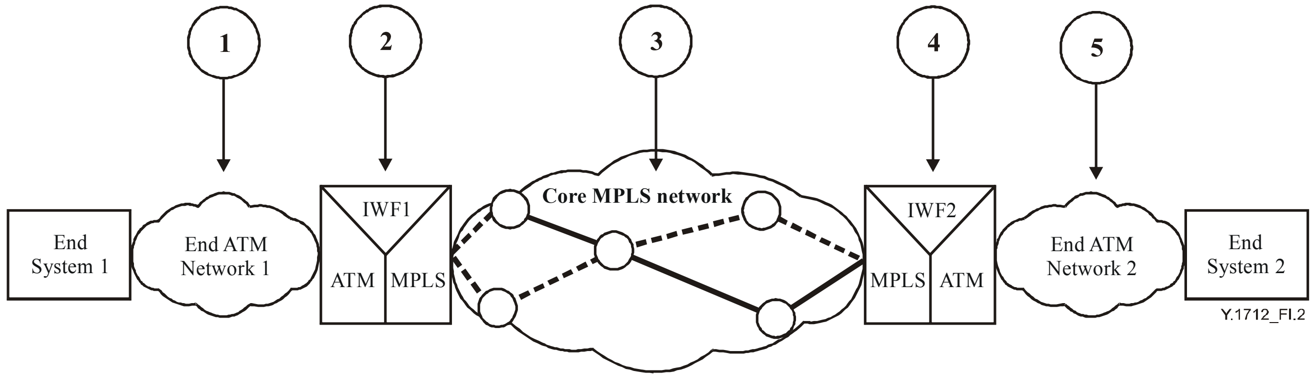

Figure I.2/Y.1712 – Important Fault Locations

I.2.1 Fault on the upstream ATM network (fault location 1)

Detection of a fault (including LOC) on the upstream ATM network (End ATM Network 1) results in flow of e-t-e_VP-AIS/e-t-e_VC-AIS cells in the forward direction. At IWF1 the e-t-e_AIS cell is encapsulated as per ITU-T Rec. Y.1411 and transported over the MPLS network. At IWF2 the e-t-e_AIS cell is de-encapsulated and sent to the ATM ME sink at End System 2.

Arrival of the AIS cell on the ATM ME sink at End System 2 results in generation of e-t-e_RDI cells in the backward direction. At IWF2 the e-t-e_RDI cell is encapsulated as per ITU-T Rec. Y.1411 and transported over the MPLS network. At IWF1 the e-t-e_RDI cell is de-encapsulated and sent to the ATM ME sink at End System 1.

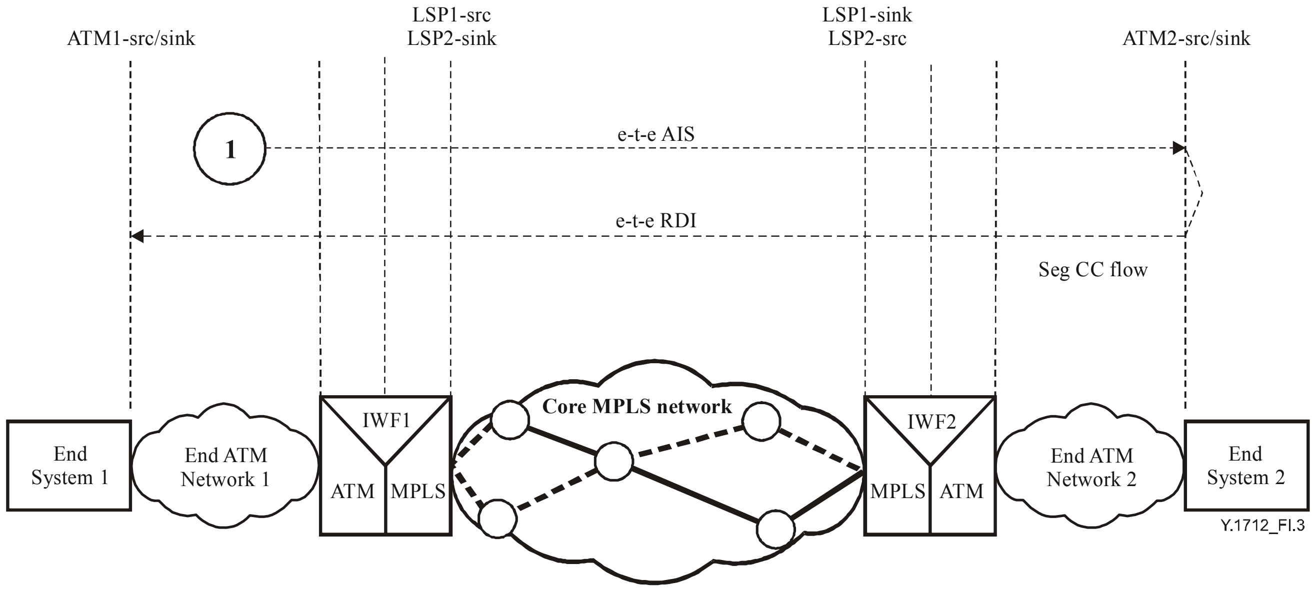

Figure I.3/Y.1712 – Fault in the upstream ATM network

I.2.2 Fault on the upstream IWF (fault location 2)

When there is a fault on the IWF1, e-t-e_CC OAM cells originating with ATM1-src will not reach their destination. This results in detection of dLOC at the ATM ME sink at End System 2. Therefore, e-t-e_VP-RDI/e-t-e_VC-RDI cells are generated in the reverse direction. At IWF2 the RDI cell is encapsulated as per ITU-T Rec. Y.1411 and transported over the MPLS network. If the failure is unidirectional, at IWF1 the e-t-e_RDI cell is de-encapsulated and sent to ATM ME sink at End System 1 (otherwise the defect is assumed to affect the path in both directions, the ATM ME sink at End System 1 will also detect dLOC and also generate e-t-e_RDI towards IWF1). This is illustrated in Figure I.4.

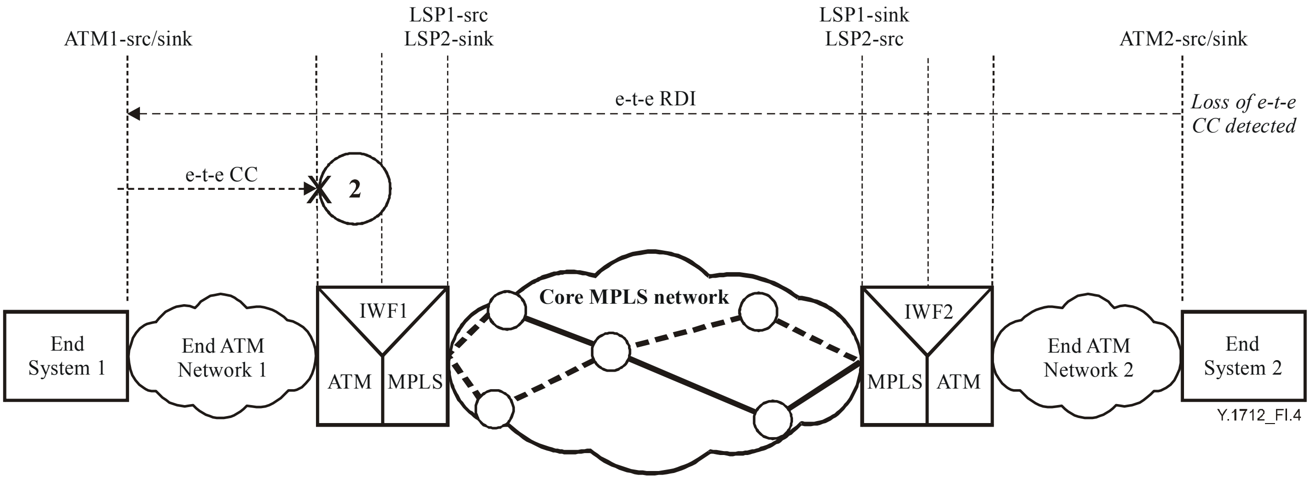

Figure I.4/Y.1712 – Fault in the upstream IWF (no impact on LSP1-ME)

Note that an IWF failure may also disrupt Seg_CC flows (if used) across the network interworking ME if the IWFs are defined as segment boundaries. In this scenario, the ATM Layer Management function at IWF2 will detect the loss of CC and enter seg/e-t-e_AIS generation.

A fault at IWF1 may disrupt MPLS layer CV insertion. This results in LSP1-ME near-end OAM processing at IWF2 entering a dLOCV defect state. IWF2 communicates this defect via the local ATM LMI and e-t-e_AIS is inserted into the ATM ME towards End System 2. The ATM trail termination at End System 2 enters the AIS state. This should now map an appropriate FDI into any higher layer clients that it carries. End System 2 should also send e-t-e_VP-RDI/e-t-e_VC-RDI cells (as appropriate) in the reverse direction. At IWF2 the RDI cell is encapsulated as per ITU-T Rec. Y.1411 and transported over the MPLS network. If the failure is unidirectional, at IWF1 the e-t-e_RDI cell is de-encapsulated and sent to ATM ME sink at End System 1 (otherwise, the defect is assumed to affect the path in both directions, and the ATM ME sink at End System 1 will also detect dLOC and also generate e-t-e_RDI towards IWF1). This is illustrated in Figure I.5.

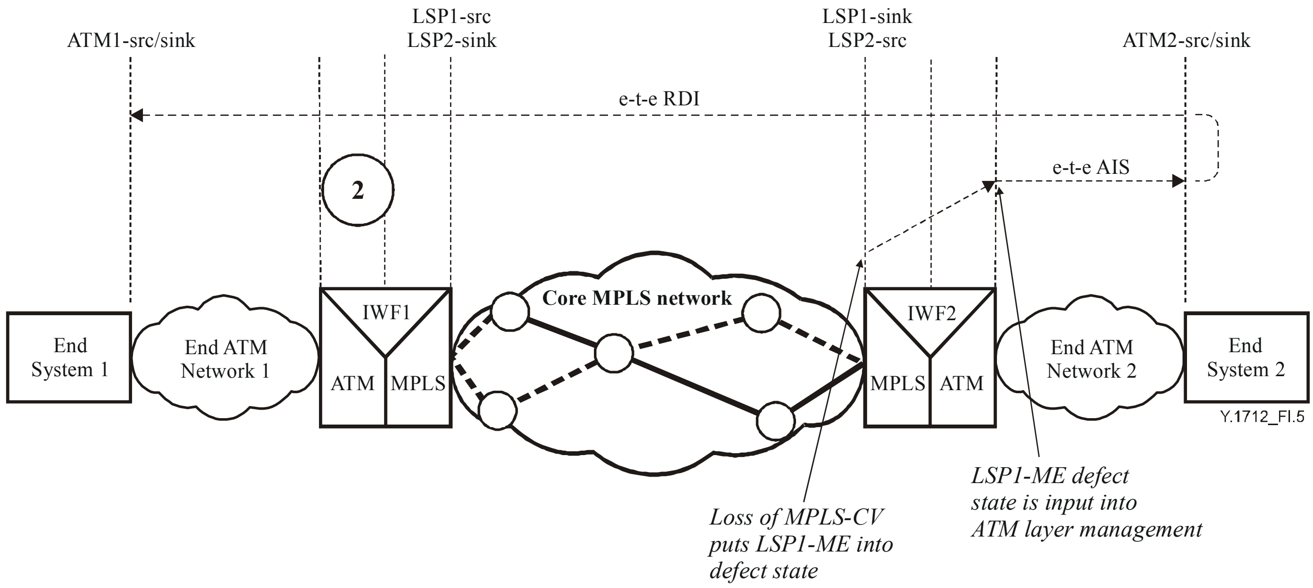

Figure I.5/Y.1712 – Fault in the upstream IWF (impacts LSP1-ME)

I.2.3 Fault on the interworking LSP (fault location 3)

If Y.1711 CV flows are monitored on the interworking LSP, faults in the MPLS layer will be detected at the LSP1-ME near-end trail termination. Serving layer defects are detected and may be indicated to the LSP1-ME near-end trail termination via FDI flows or via indications to the MPLS layer management function directly from the serving layer if the defect is local to the LSP-ME near-end termination.

Serving layer defects (Figure I.6) and MPLS layer defects (Figure I.7) are communicated to the local ATM LMI. Upon receipt of server layer defect notification, ATM layer management functions local to IWF2 shall generate and send (in the forward direction) e-t-e_VP-AIS/e-t-e_VC-AIS cells on all affected active VPC/VCCs.

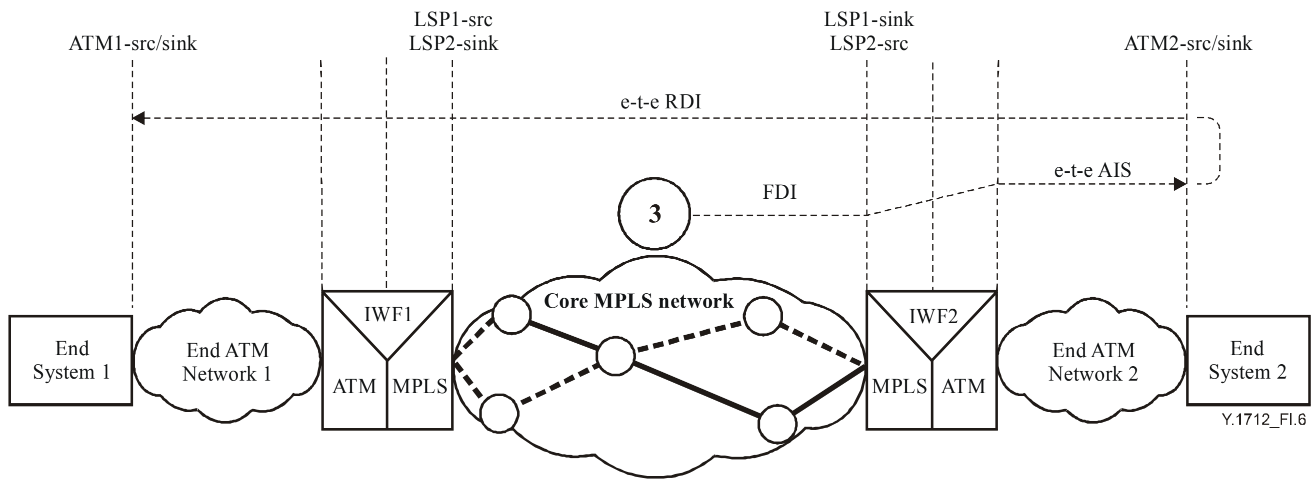

Figure I.6/Y.1712 – Fault in the MPLS network (server layer failure)

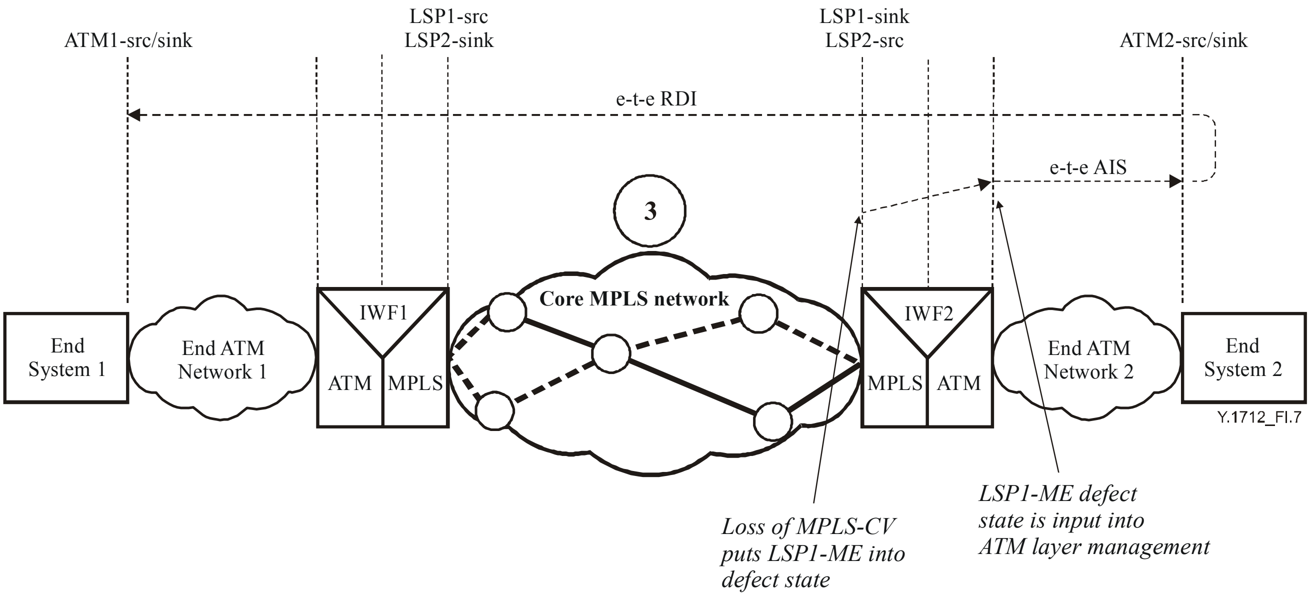

Figure I.7/Y.1712 – Fault in the MPLS network (MPLS layer failure)

I.2.4 Fault on the downstream IWF (fault location 4)

If the fault is detected without impacting local ATM layer management functions and is communicated via the local ATM LMI, IWF2 shall generate e-t-e and (if used), seg F4/F5 AIS (as explained in the previous scenario) because it is the network element that has detected the fault. Otherwise, the IWF may not be able to generate AIS. When there is a fault on the IWF2, e-t-e and seg_CC OAM cells do not reach their destination. In this case, dLOC is detected at the ATM End System 2 connection endpoint. Therefore e-t-e_VP-RDI/e-t-e_VC-RDI cells are generated in the backward direction. At IWF2 the RDI cell is encapsulated as per ITU-T Rec. Y.1411 and transported over the MPLS network. At IWF1 the RDI cell is de-encapsulated and sent to the ATM sink at End System 1. (See Figure I.8.)

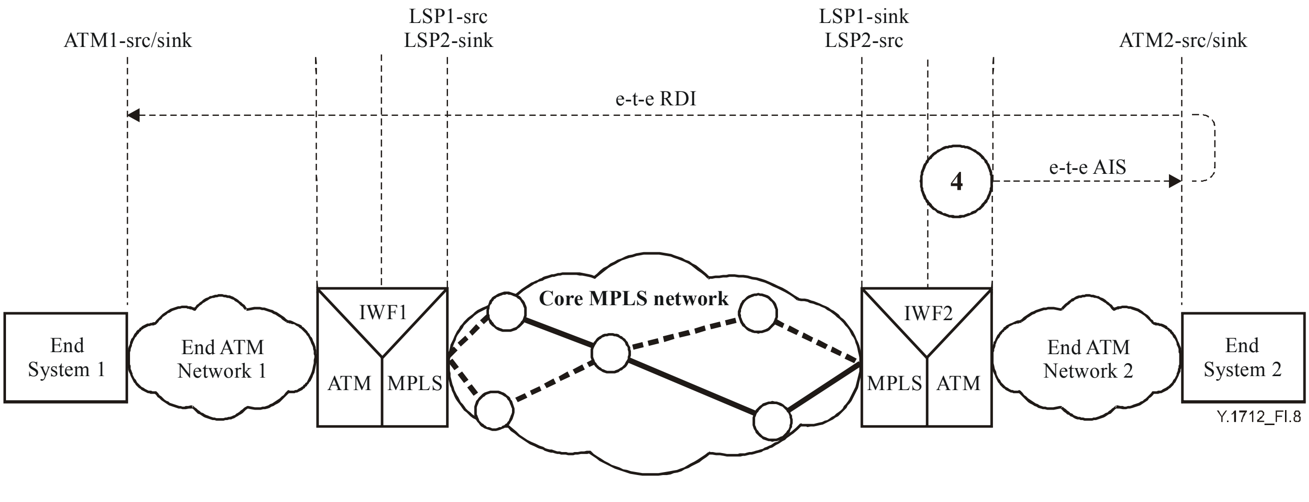

Figure I.8/Y.1712 – Fault in the downstream IWF

I.2.5 Fault on the downstream ATM network (fault location 5)

The ATM network element that detects a fault will generate e-t-e_VP-AIS/e-t-e_VC-AIS. This will result in generation of end-to-end RDI on the backward direction. At IWF2 the RDI cell is encapsulated as per ITU-T Rec. Y.1411 and transported over the MPLS network. At IWF1 the RDI cell is de-encapsulated and sent to ATM ME sink at End System 1. (See Figure I.9.)

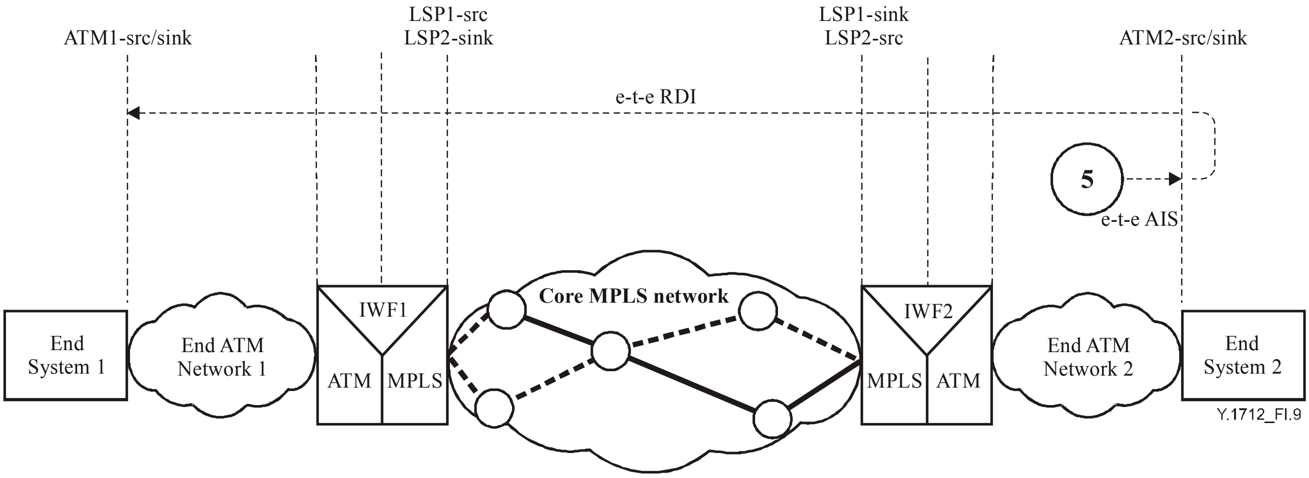

Figure I.9/Y.1712 – Fault in the downstream ATM network

Appendix II

Layer network interworking fault scenarios

II.1 Fault detection/notification/availability

Automatic fault detection is achieved by monitoring continuity check probes (I.610 CC or Y.1711 CV) and lower layer failure indications on the respective maintenance entities and interworking defect states between the maintenance entities such that the availability of the concatenated trail (and associated collection of QoS metrics) is the logical 'OR' of the individual maintenance entities transited by the concatenated trail.

Within the layer network interworking model there are four defect locations of primary interest. These are illustrated in Figure II.1 and are examined in detail in the following clauses.

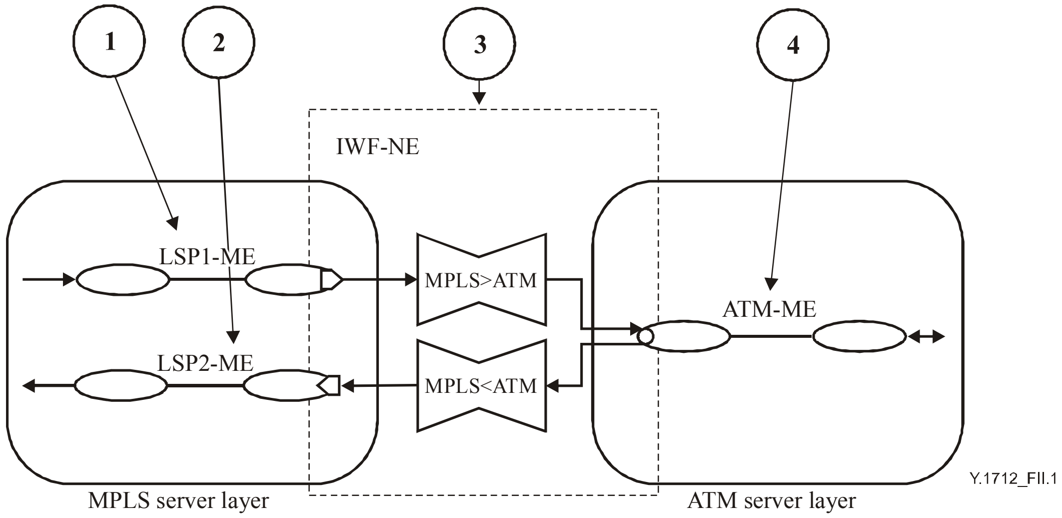

Figure II.1/Y.1712 – Important fault locations

II.2 LSP1-ME failure (fault location 1)

LSP1-ME failure can be two sources: server layer failure or MPLS layer failure. If server layer failure, the near-end termination is notified via FDI. If MPLS layer failure (or server layer failure not accompanied by FDI), observed loss of CV results in entry of LSP1-ME into the defect state.

The OAM IWF passes the LSP1-ME defect state as an input to the ATM ME layer management function, which enters the AIS generation state.

The ATM ME on entry to the AIS state will return seg_RDI and e-t-e_RDI to the IWF ATM ME termination. Entry of the IWF-NE ATM ME termination into the RDI state instructs LSP2-ME far-end termination to begin BDI generation via the OAM IWF. The LSP2-ME near-end OAM processing notifies the LSP1-ME far end QoS metric collection of the defect state. (See Figure II.2.)

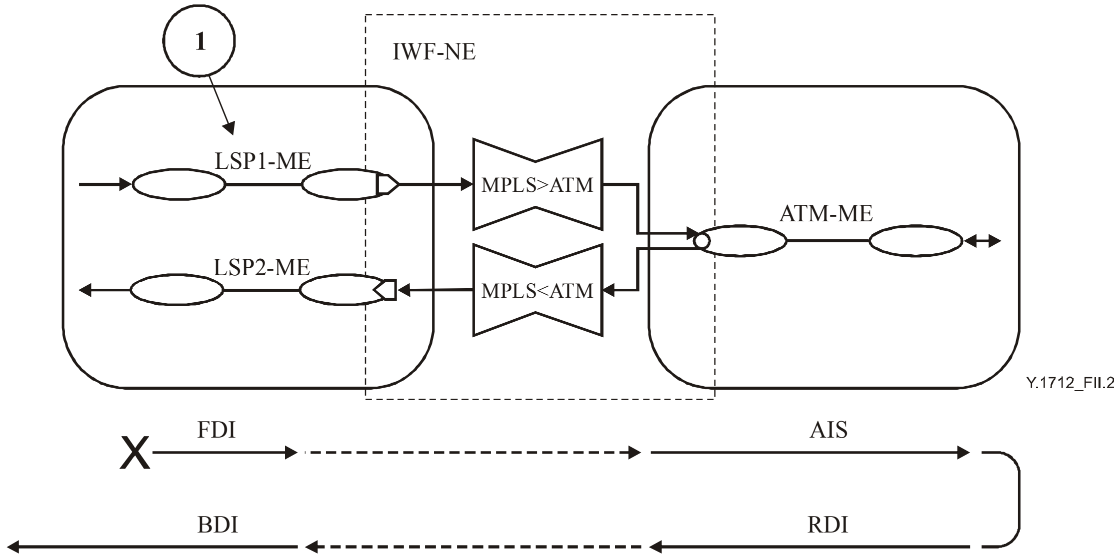

Figure II.2/Y.1712 – LSP1-ME failure (fault location 1)

II.3 LSP2-ME failure (fault location 2)

LSP2-ME failure can be two sources: server layer failure or MPLS layer failure. If server layer failure, the near-end termination is notified via FDI. If MPLS layer failure (or server layer failure not accompanied by FDI), observed loss of CV results in entry of LSP1-ME into the defect state.

The LSP2-ME near-end trail termination directs the LSP1-ME far-end trail termination to commence BDI generation which propagates defect notification to the LSP1-ME near-end termination at the IWF-NE.

The IWF-NE directs the corresponding ATM ME layer management function to commence seg and e-t-e_RDI generation.

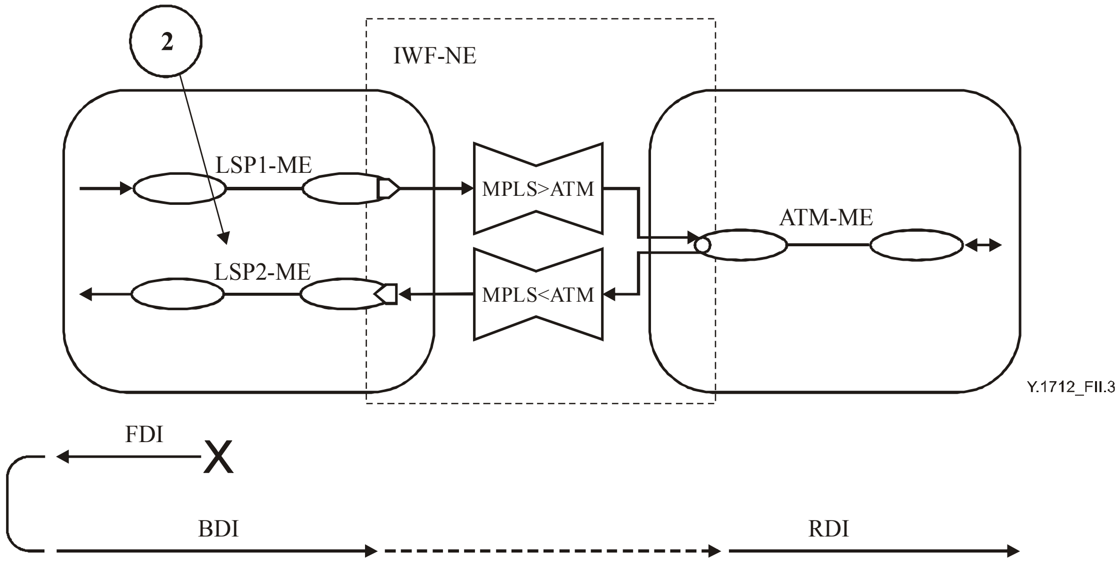

Figure II.3/Y.1712 – LSP2-ME failure (fault location 2)

II.4 LSP1-ME and LSP2-ME failure (fault locations 1 and 2)

In some circumstances, LSP1-ME and LSP2-ME may be impacted by the same failure. In this case, notification procedures for the IWF-NE (LSP1-ME near-end trail termination, and LSP2-ME far-end trail termination) and the ATM ME are as per fault location 1. The notification procedures for the LSP1-ME far-end trail termination and LSP2-ME near-end trail termination are as per fault location 2.

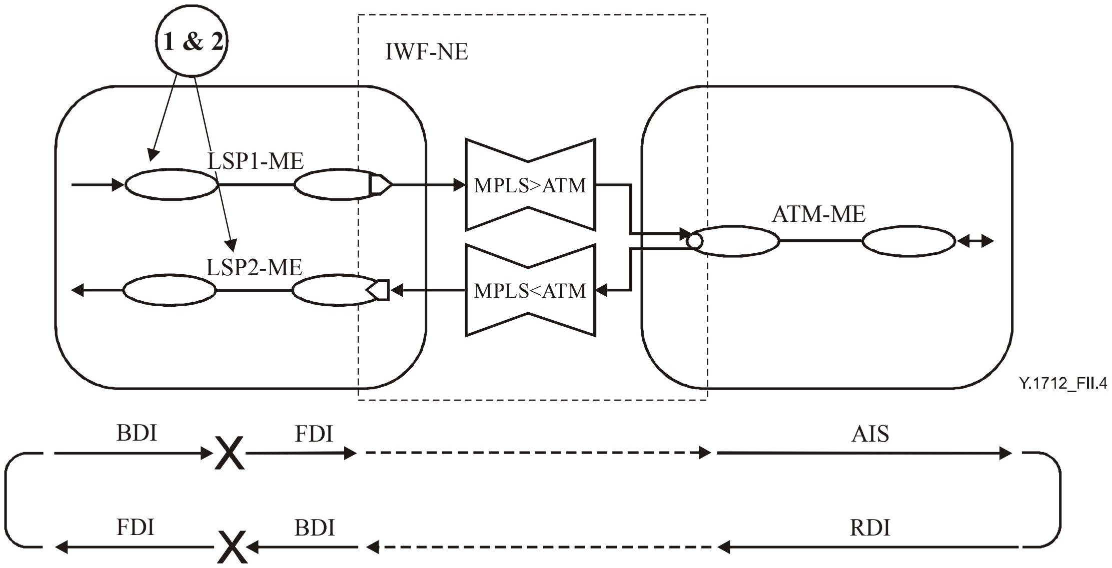

Figure II.4/Y.1712 – LSP1-ME and LSP2-ME failure (fault locations 1 and 2)

II.5 Fault in the IWF-NE (fault location 3)

A fault in the IWF-NE MAY occur in a fashion that is "silent", that is to say that it does not impact any of the associated maintenance entities and may only be detected via client layer OAM mechanisms. Where the fault is detected, either via interruption of trail source functions or failure in the sink function, it will behave similarly to faults in the individual MEs.

II.6 Fault in the ATM ME (fault location 4)

A fault in the ATM ME may occur in three forms: unidirectional in either direction, or impacting both directions of the ATM ME.

Where the fault is unidirectional and detected by the ATM ME trail termination remote from the IWF-NE trail termination via loss of CC or notified via seg or e-t-e_AIS, the ATM ME remote trail termination will direct seg and e-t-e_RDI to the IWF-NE ATM ME termination. The LSP2-ME far-end OAM function is directed via the OAM-IWF to begin BDI generation. This is illustrated in Figure II.5.

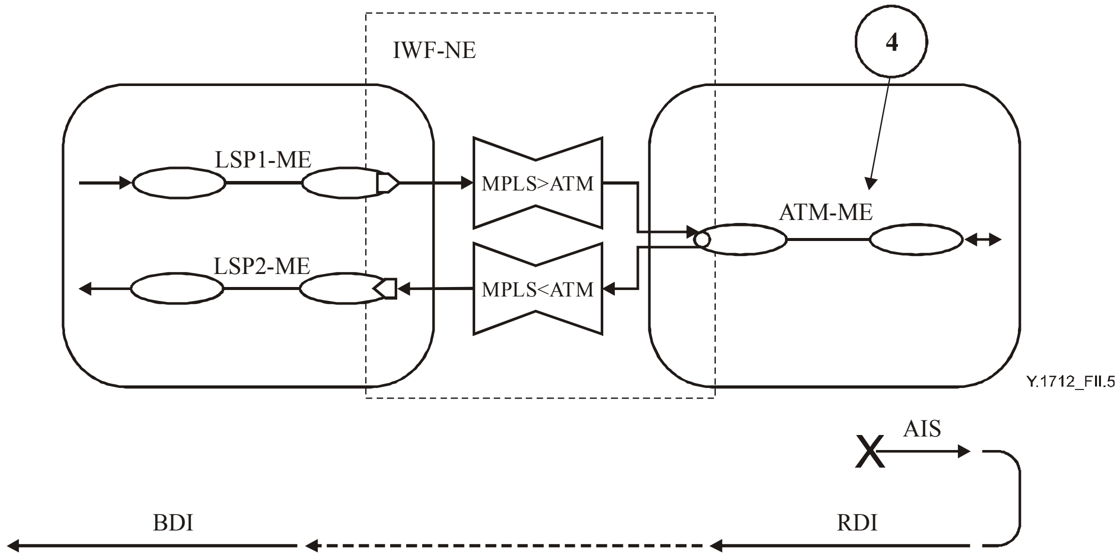

Figure II.5/Y.1712 – ATM ME unidirectional failure (fault location 4)

Where the fault is unidirectional and detected by the ATM ME trail termination at the IWF-NE via loss of CC or notified via receipt of either seg or e-t-e_AIS, the ATM ME will notify the LSP2-ME far-end termination to begin FDI generation. The LSP2-ME near-end termination upon receipt of FDI will direct the LSP1-ME far-end termination to begin BDI generation. The LSP1-ME near-end termination (co-located with the IWF-NE) upon receipt of BDI, will direct (via the OAM IWF) the ATM ME trail termination to commence RDI generation. This is illustrated in Figure II.6.

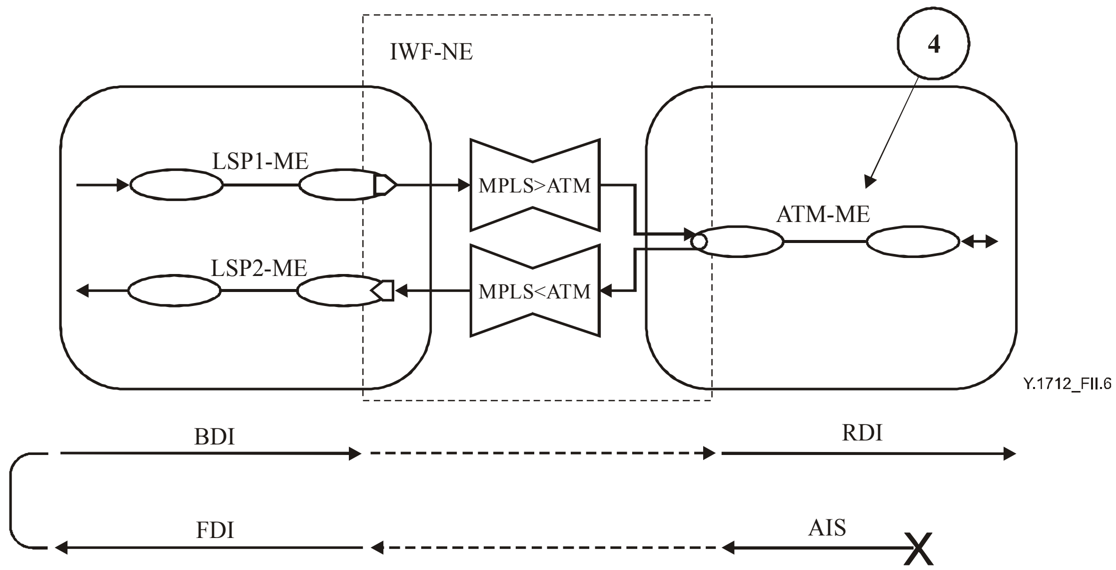

Figure II.6/Y.1712 – ATM ME unidirectional failure (fault location 4)

Where the fault is bidirectional and impacts both directions of the ATM ME, the system responds as a hybrid of the unidirectional fault scenarios outlined above. This is illustrated in Figure II.7.

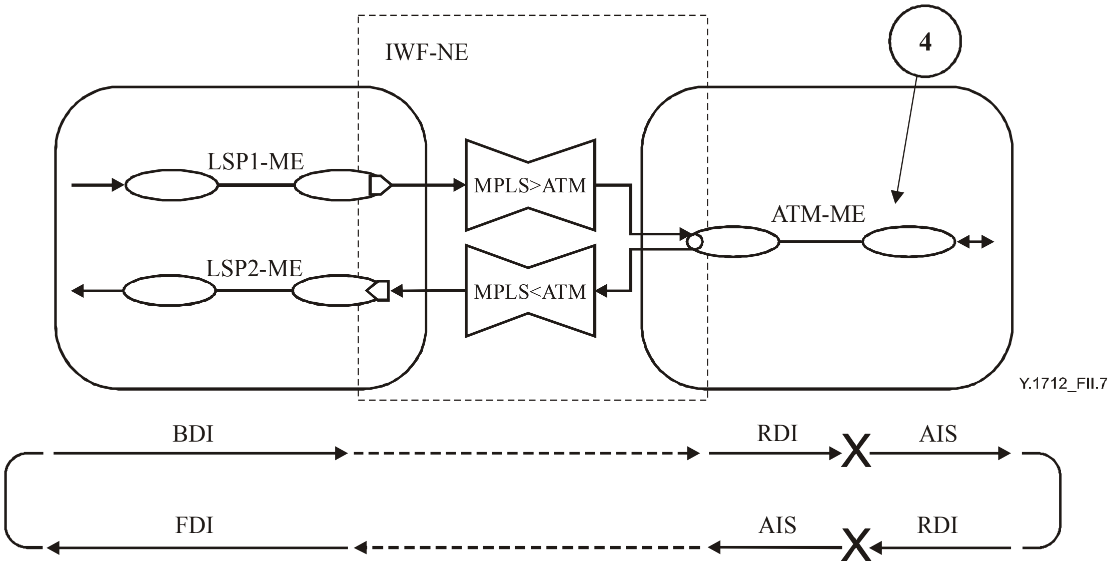

Figure II.7/Y.1712 – ATM ME bidirectional failure (fault location 4)

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Geneva, 2004