INTERNATIONAL TELECOMMUNICATION UNION

CCITT

I.610

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

INTEGRATED SERVICES
DIGITAL NETWORK (ISDN)
INTERNETWORK INTERFACES
AND MAINTENANCE PRINCIPLES

OAM PRINCIPLES OF THE B-ISDN ACCESS

Recommendation I.610

Geneva, 1991

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation I.610 was prepared by Study Group XVIII and was approved under the Resolution No. 2 procedure on the 5th of April 1991.

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CCITT NOTES

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

2)   A list of abbreviations used in this Recommendation can be found in Annex A.

Preamble to B-ISDN Recommendations

In 1990, CCITT SG XVIII approved a first set of Recommendations on B-ISDN. These are:

I.113 – Vocabulary of terms for broadband aspects of ISDN

I.121 – Broadband aspects of ISDN

I.150 – B-ISDN asynchronous transfer mode functional characteristics

I.211 – B-ISDN service aspects

I.311 – B-ISDN general network aspects

I.321 – B-ISDN Protocol Reference Model and its application

I.327 – B-ISDN functional architecture

I.361 – B-ISDN ATM Layer specification

I.362 – B-ISDN ATM Adaptation Layer (AAL) functional description

I.363 – B-ISDN ATM Adaptation Layer (AAL) specification

I.413 – B-ISDN user-network interface

I.432 – B-ISDN user-network interface - Physical Layer specification

I.610 – Operation and maintenance principles of B-ISDN access

These Recommendations address general B-ISDN aspects as well as specific service- and network-oriented issues, the fundamental characteristics of the asynchronous transfer mode (ATM), a first set of relevant ATM oriented parameters and their application at the user-network interface as well as impact on operation and maintenance of the B-ISDN access. They are an integral part of the well established I-Series Recommendations. The set of Recommendations are intended to serve as a consolidated basis for ongoing work relative to B-ISDN both within CCITT and in other organizations. They may also be used as a first basis towards the development of network elements.

CCITT will continue to further develop and complete these Recommendations in areas where there are unresolved issues and develop additional Recommendations on B-ISDN in the I-Series and other series in the future.

Recommendation I.610

OPERATION AND MAINTENANCE PRINCIPLES OF THE B-ISDN ACCESS

1 Introduction

1.1 *General*

Considerations on operation and maintenance (OAM) functions are based on OAM principles applied to the 64 kbit/s-based ISDN to which the following Recommendations are relevant:

–   Recommendation M.20:   Maintenance philosophy for telecommunications networks

–   Recommendation M.30:   Principles for a telecommunications management network

–   Recommendation M.36:   Principles for the maintenance of ISDNs

–   Recommendation I.113:   Vocabulary of terms for broadband aspects of ISDN

–   Recommendation I.150:   B-ISDN asynchronous transfer mode functional characteristics

–   Recommendation I.311:   B-ISDN general network aspects

–   Recommendation I.321:   B-ISDN Protocol Reference Model and its application

–   Recommendation I.413:   B-ISDN user-network interface

–   Recommendation I.432:   B-ISDN user-network interface – Physical Layer specification

–   Recommendations of I.600-Series.

1.2 *Scope of application*

This Recommendation primarily covers the maintenance of the B-SDN UNI and the customer access controlled by the network. It follows the maintenance principles as defined in Recommendation M.20. Whenever the term "customer access" is referred to in this Recommendation, it includes the UNI.

The scope of this Recommendation is to describe the minimum functions required to maintain the Physical Layer and the ATM Layer of the customer access. They are applicable to any customer access, whatever structure it may have.

The functions of the layers above the ATM Layer are not considered but are for further study.

The basic requirements of § 3 of this Recommendation may be applicable to the B-ISDN as a whole.

2 OAM principles

The following five phases have been applied in specifying the OAM functions of the B-SDN.

a)   *Performance monitoring*

Normal functioning of the managed entity is monitored by continuous or periodic checking of functions. As a result maintenance event information will be produced.

b)   *Defect and failure detection*

Malfunction or predicted malfunctions are detected by continuous or periodic checking. As a result maintenance event information or various alarms will be produced.

c) *System protection*

Effect of failure of a managed entity is minimized by blocking or changeover to other entities. As a result the failed entity is excluded from operation.

d) *Failure or performance information*

Failure information is given to other management entities. As a result alarm indications are given to other management planes. Response to a status report request will also be given.

e) *Fault localization*

Determination by internal or external test systems of a failed entity if failure information is insufficient.

Note – The last phase and others (as described in § 5 of Recommendation M.20) are at present not subject to the description in this Recommendation.

2.1   *Network configuration for maintenance activities*

Figure 1/I.610 gives the general arrangement for the maintenance of the customer access. It is based on the general principles of Recommendation I.601.
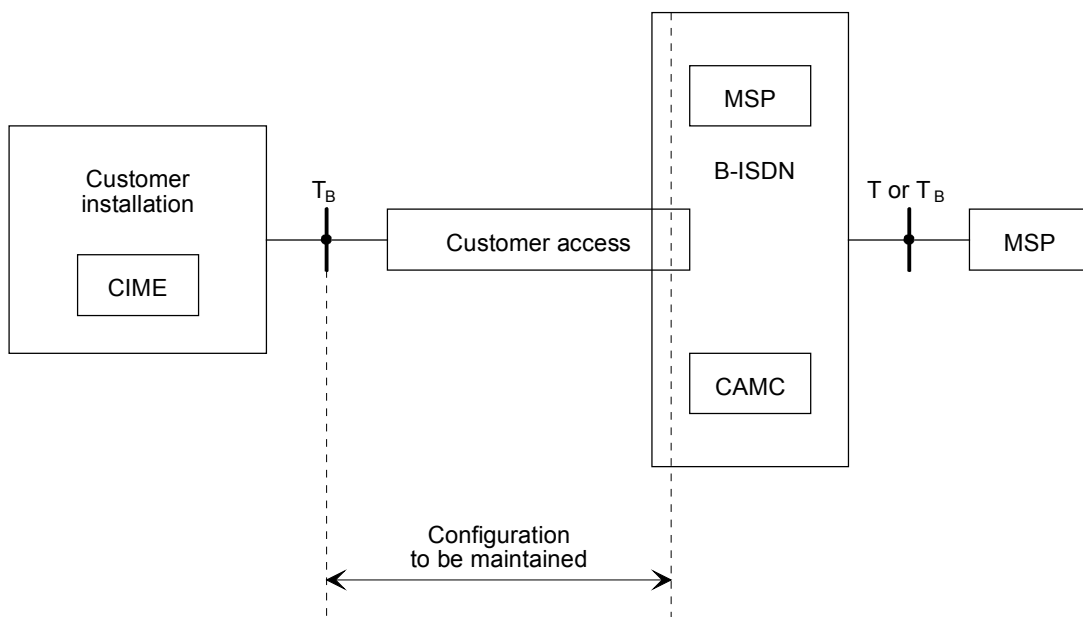
CAMC   Customer access maintenance centre
CIME   Customer installation maintenance entities
MSP   Maintenance service provider

Note – The term "customer" used in these abbreviations is not consistent with other Recommendations in the I.600-Series which use instead the term "subscriber".

FIGURE 1/I.610

Network configuration for maintenance of the customer access

2.2 *Relation with the telecommunication management network (TMN)*

An example of a network architecture describing the relation with the TMN is given in Figure 2/I.610. The protocols used for maintenance are specified through Q-interfaces and may include the transmission section between B-NT2 and B-NT1.

Network element internal monitoring functions are not the subject of standardization. The results of that monitoring will be delivered to the TMN via Q-interfaces.
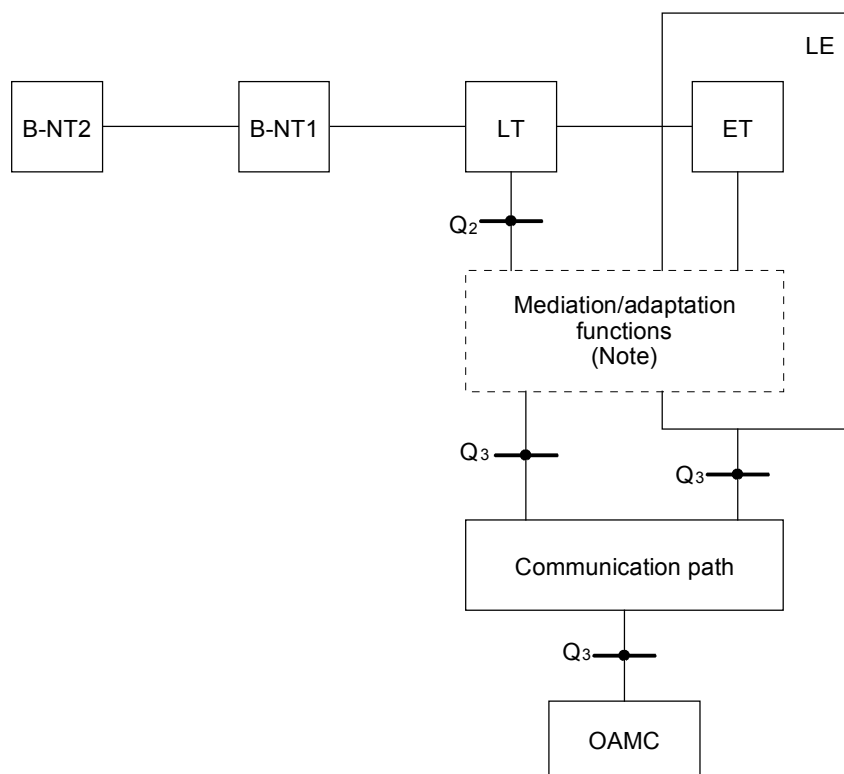
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LT   Line termination
ET   Exchange termination
OAMC   Operation, administration and maintenance centre

Note – Mediation/adaptation functions may be distributed in different equipment.

FIGURE 2/I.610

Example of TMN architecture for the customer access

3   Basic requirements

3.1   *OAM levels in the network*

OAM functions in the network are performed on five OAM hierarchical levels associated with the ATM and Physical Layer of the protocol reference model. The functions result in corresponding bidirectional information flows F1, F2, F3, F4 and F5 referred to as OAM flows (see Figure 3/I.610). Not all of these levels need to be present. The OAM functions of a missing level are performed at the next higher level. The levels are as follows:

– *Virtual channel level:* Extends between network elements performing virtual channel connection termination functions and is shown extending through one or more virtual path connections (see also Recommendation I.311, § 2.2.2).

– *Virtual path level:* Extends between network elements performing virtual path connection termination functions (see § 2.2.2 in Recommendation I.311) and is shown extending through one or more transmission paths.

– *Transmission path level:* Extends between network elements assembling/disassembling the payload of a transmission system and associating it with its OAM functions. Cell delineation and header error control (HEC) functions are required at the end points of each transmission path. The transmission path is connected through one or more digital sections.

– *Digital section level:* Extends between section end points and comprises a maintenance entity according to the definition of Recommendation M.20, § 3.

– *Regenerator section level:* A regenerator section is a portion of a digital section and as such is a maintenance sub-entity.

3.2   *Relationship of OAM functions with the B-ISDN Protocol Reference Model*

OAM functions are allocated to the Layer Management of the B-ISDN Protocol Reference Model (see Recommendation I.321).

Within the Layer Management different functions are correlated with the various layers. The primitives exchanged between the layers and the management plane are for further study.

This layered concept and the requirements of independence of the layers from each other lead to the following principles:

1) OAM functions related to OAM levels are independent from the OAM capabilities of other layers and have to be introduced at each layer.

2) Each layer, where OAM functions are required, is able to carry out its own processing to obtain quality and status information. These results are provided to the layer management or, if defined, to the adjacent higher layer. Higher layer functions are not necessary to support the OAM of the lower layer.

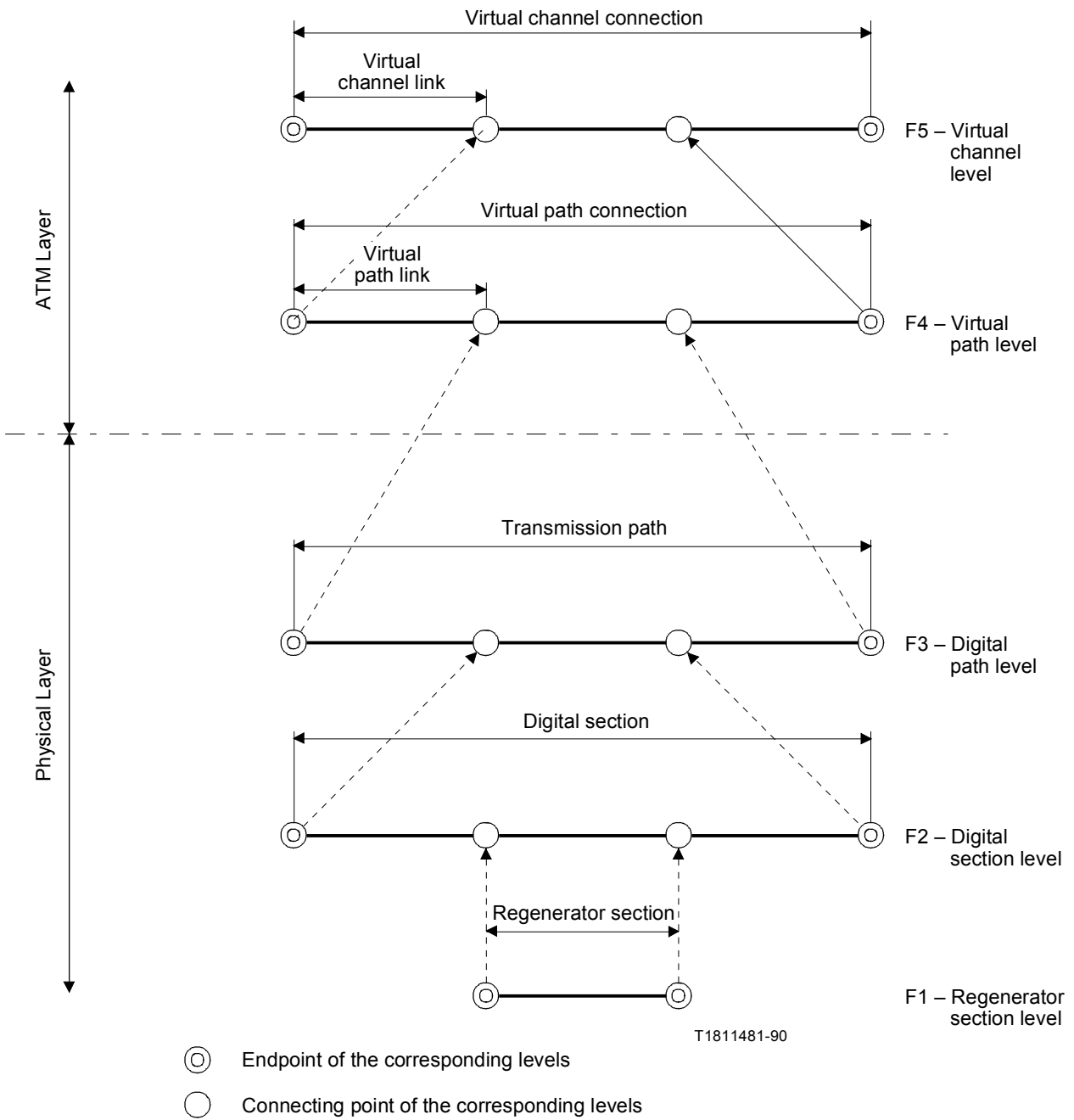The functions of the layers above the ATM Layer are not considered in this Recommendation.

FIGURE 3/I.610

OAM hierarchical levels and their relationship with the ATM Layer and Physical Layer

4 Mechanisms to provide OAM flows

4.1 Physical Layer mechanisms

The Physical Layer contains the three lowest OAM levels as outlined in Figure 3/I.610. The allocation of the OAM flows is as follows:

- F1: Regenerator section level;

- F2: Digital section level;

- F3: Transmission path level.

The mechanisms to provide OAM functions and to generate OAM flows F1, F2 and F3 will depend on the format of the transmission system as well as on the supervision functions contained in NT1 and NT2 for the section crossing the T_B reference point. Three types of transmission systems can be foreseen for the customer access.

4.1.1 *SDH-based transmission systems* (Recs. G.707 to G.709)

Flows F1 and F2 are carried on bytes in the section overhead (SOH), Flow F3 is carried in the path overhead (POH) of the transmission frame. Part of the F3 flow could also be carried by Physical Layer operation and maintenance (PL-OAM) cells. The need and feasibility of this is for further study.

4.1.2 *Cell-based transmission systems*

Such transmission systems may use an interface structure as specified in Recommendation I.432, § 4.2. OAM flows (F1, F2 and F3) are carried through maintenance cells for the Physical Layer using a specific pattern in the header for F3, F2 and F1. These cells are not passed to the ATM Layer.

4.1.3 *PDH based transmission systems* (Recs. G.702 and G.703)

These systems may only be used on the network side of the B-NT1. Specific means to monitor the section performance (e.g. violation code counting CRC, etc.) are specified for these systems. The capability to carry OAM information other than bit messages is very limited.

4.2 *ATM Layer mechanisms*

The ATM Layer contains the two highest OAM levels as outlined in Figure 3/I.610. The allocation of the OAM flows is as follows:

- F4: Virtual path level;

- F5: Virtual channel level.

These OAM flows are provided by cells dedicated to ATM Layer OAM functions for both virtual channel connections (VCC) and virtual path connections (VPC). In addition, such cells are usable for communication within the same layers of the management plane. The implementation of these cells is for further study. For example, the OAM information could be conveyed by cells identified by the payload type (PT) identifier and VPIs/VCIs.

4.3   *Association of the OAM mechanisms with the transport functions*

Figure 4/I.610 gives an example of a virtual channel connection supported by all lower network levels according to the techniques described in Recommendation I.311, § 1. The associated OAM mechanisms for each level are also shown. The digital section and the regenerator section levels are shown combined under the term "section".
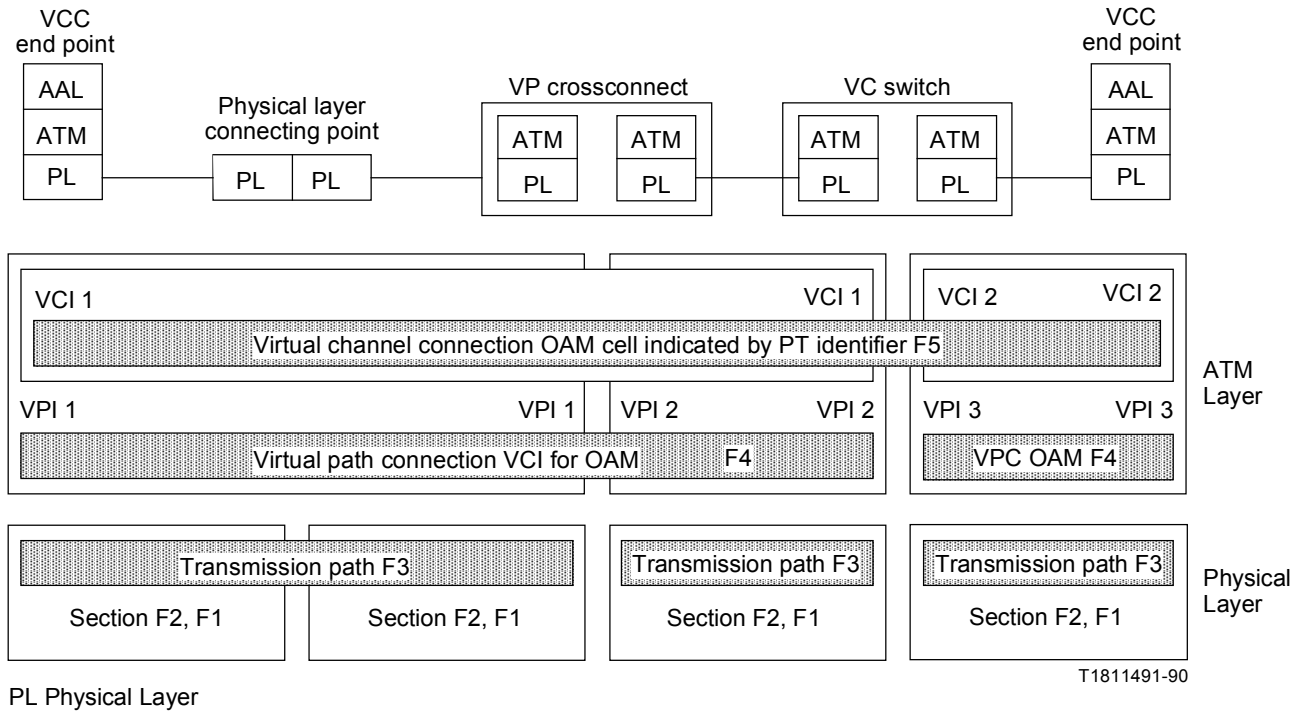

FIGURE 4/I.610

Example of mechanisms for OAM flows

5 OAM functions of the Physical Layer

5.1 *OAM flows in some physical configurations*

Figure 5/I.610 illustrates implementation examples of the OAM flows in some physical configurations for B-ISDN customer access.

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STM   Synchronous transfer mode
LT   Line termination
ET   Exchange termination

Note – Depending on the transmission system used (e.g. G.702, SDH, etc.) and its functional implementation (e.g. LT integrated in STM MUX) the related OAM flows may be implemented but are not shown.
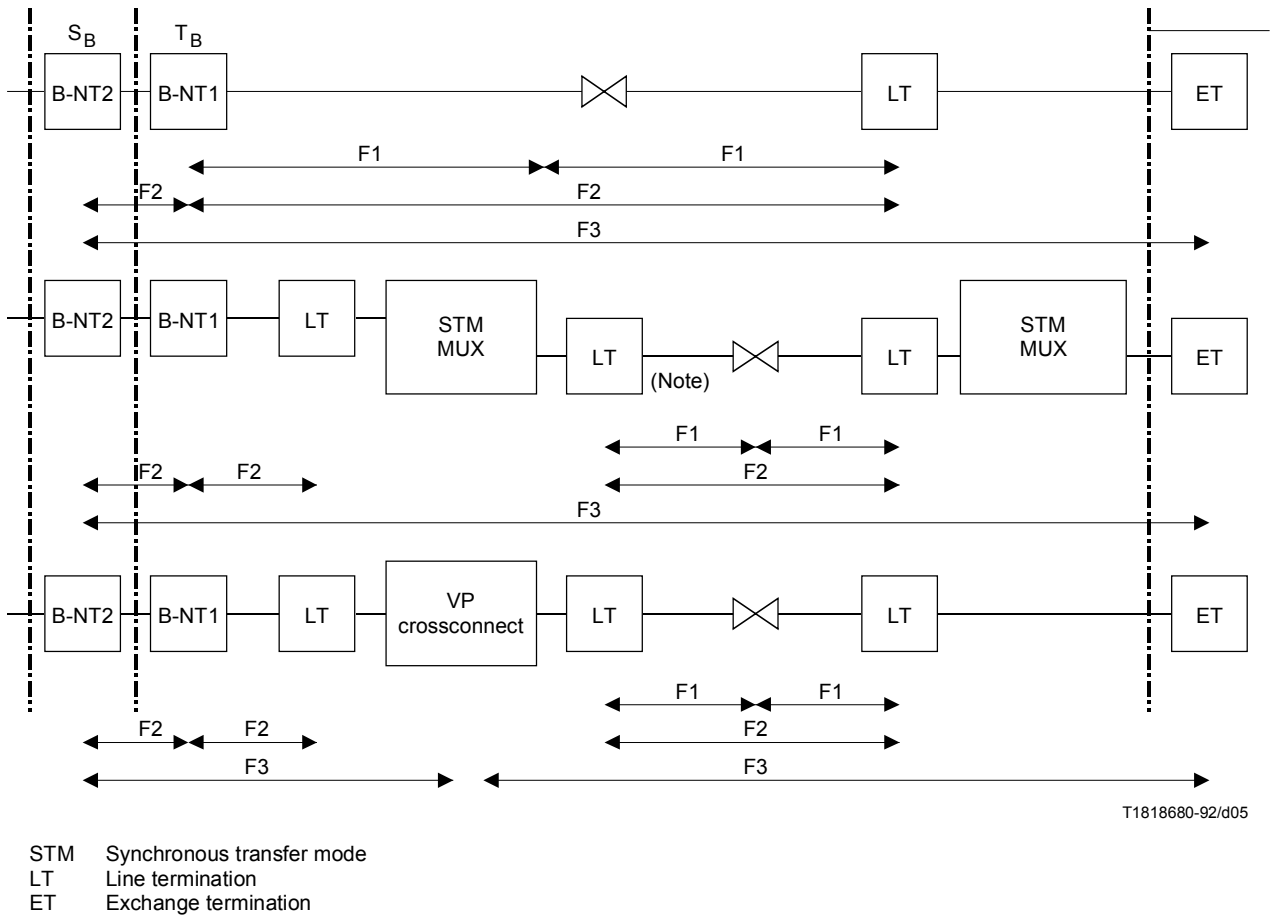
FIGURE 5/I.610

Examples of physical configurations and OAM flows at the Physical Layer

5.2   *OAM functions*

        Table 1/I.610 gives an overview of the OAM functions and the related OAM flows. It also lists the different failures to be detected together with the failure indications for the SDH-based Physical Layer, and Table 2/I.610 illustrates the same aspects for the cell based Physical Layer. The contents of Tables 1/I.610 and 2/I.610 are not exhaustive. At the regenerator section level loss of frame must be detected. In addition degraded error performances may be detected.

        At the digital section level loss of frame and degraded error performance must be detected. In the case of the cell-based option the loss of frame corresponds to the loss of PL-OAM cell recognition. Both failure detections are related to the F2 flow.

        At the transmission path level alarm indication signal for indication of customer network status (CN-AIS) degraded error performance, loss of cell delineation, degraded header error performance, etc., must be detected. These functions are related to the F3 flow.

        Definition of maintenance signals such as AIS and FERF in Tables 1/I.610 and 2/I.610 are defined in §§ 4.2.1.3.4 and 4.2.2.4.2 of Recommendation I.432.

OAM functions of the SDH based Physical Layer

Level	Function	Flow	Defect/failure detection	System protection and failure information		
				B-NT2 – B-NT1 section	B-NT1 – LT section (Note 3)	B-NT2 – Transmission path termination
Regenerator section	Frame alignment	F1	Loss of frame	Section AIS/FERF	(Note 1)	–
	Section error monitoring		Degraded error performance			
Digital section	Frame alignment	F2	Loss of frame	Section AIS/FERF	(Note 1)	–
	Section error monitoring		Degraded error performance	Section AIS/FERF		–
	Section error reporting		Degraded error performance	Section AIS/FERF		–
Transmission path	CN status monitoring	F3	CN-AIS	For further study		Path AIS
	Cell delineation		Loss of cell sync	Fault indication and reporting is for further study		
	Header error detection/correction		Uncorrectable header			
	Header error performance monitoring		Degraded header error performance			

TABLE 1/I.610 (*end*)

OAM functions of the SDH based Physical Layer

Level	Function	Flow	Defect/failure detection	System protection and failure information		
				B-NT2 – B-NT1 section	B-NT1 – LT section (Note 3)	B-NT2 – Transmission path termination
Transmission path	VC-4 offset	F3	Loss of AU-4 pointer	–	–	Path AIS/FERF (Note 2)
	Path error monitoring		Degraded error performance	–	–	Path AIS/FERF (Note 2)
	Path error reporting		Degraded error performance	–	–	Path AIS/FERF (Note 2)
	Cell rate decoupling		Failure of insertion and suppression of idle cells	–	–	For further study

Note 1 – Capabilities for reporting faults from the T_B reference point to the relevant Q-interface must be accommodate by the transmission equipment specification.

Note 2 – Use of H1/H2 byte for path AIS is provisional.

Note 3 – In accordance with the OAM Recommendation of the transmission system.

TABLE 2/I.610

OAM functions of the cell-based Physical Layer

Level	Function	Flow	Defect/failure detection	System protection and failure information		
				B-NT2 – B-NT1 section	B-NT1 – LT section (Note 2)	B-NT2 – Transmission path termination
Regenerator section	PLOAM cell recognition	F1	Loss of PLOAM cell recognition	Section AIS/FERF	(Note 1)	–
Digital section	PLOAM cell recognition	F2	Loss of PLOAM cell	Section AIS/FERF		–
	Section error monitoring		Degraded error performance	Section AIS/FERF	(Note 1)	–
	Section error reporting		Degraded error performance	Section AIS/FERF		–
Transmission path	CN status monitoring	F3	CN-AIS	For further study		Path AIS
	Cell delineation		Loss of cell sync	Fault indication and reporting is for further study		For further study
	Header error detection/ correction		Uncorrectable header			
	Header error performance monitoring		Degraded header error performance		–	
	Cell rate decoupling		Failure of insertion and suppression of idle cells	–		For further study

Note 1 – Capabilities for reporting faults from the T_B reference point to the relevant Q-interface must be accommodate by the transmission equipment specification.
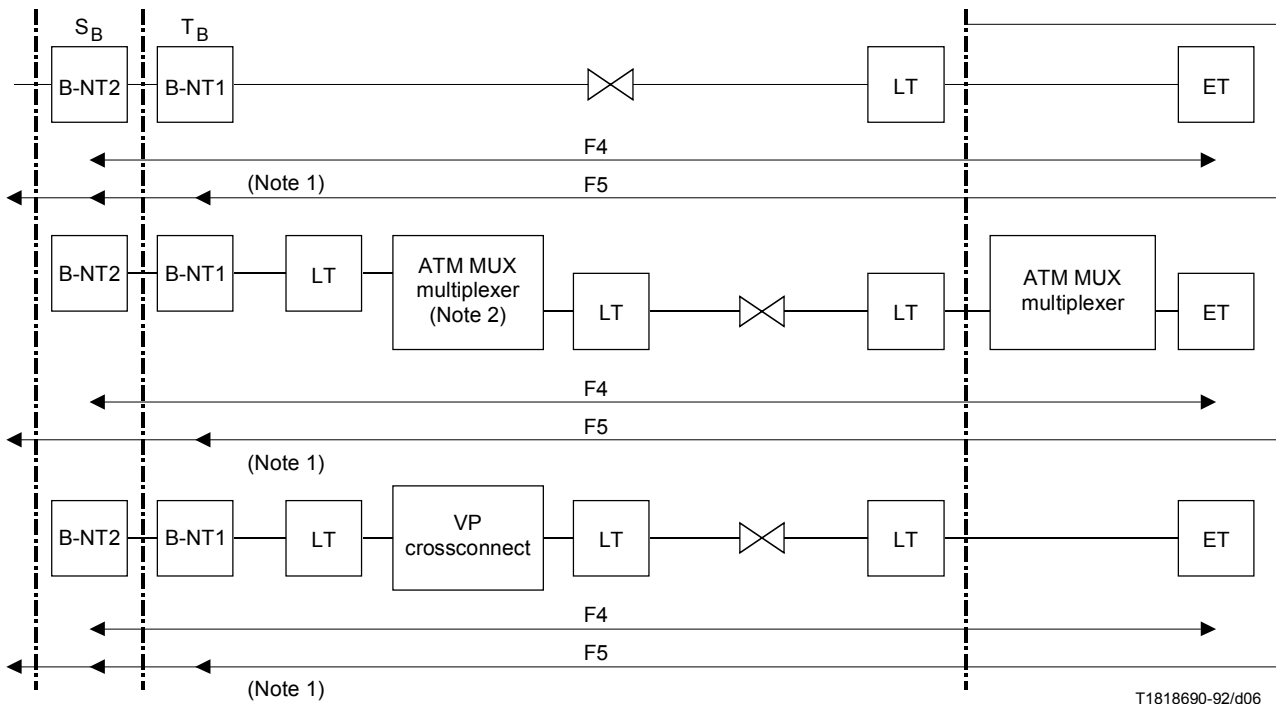
Note 2 – In accordance with the OAM Recommendation of the transmission system.

6 OAM functions of the ATM Layer

6.1 *OAM flows in some physical configurations*

Figure 6/I.610 illustrates the implementation examples of the above-mentioned OAM flows in some physical configurations for B-ISDN customer access.

Note 1 – Termination of the F5 flow at the B-NT1 is for further study.

Note 2 – ATM MUX without VP termination.

FIGURE 6/I.610

Examples of physical configurations and OAM flows at the ATM Layer

6.2 *OAM functions*

Table 3/I.610 gives an overview of the OAM functions and the related OAM flows. The contents of Table 3/I.610 are not exhaustive.

Monitoring of the availability is carried out at the virtual path level and monitoring of the performance at the virtual path and virtual channel levels.

TABLE 3/I.610

OAM functions of the ATM Layer

Level	Function	Flow	Defect/failure detection	System protection and failure information
Virtual path	Monitoring of path availability	F4	Path not available	For further study
	Performance monitoring		Degraded performance	
Virtual channel	Performance monitoring	F5	Degraded performance	For further study

ANNEX A

(to Recommendation I.610)

**Alphabetical list of abbreviations used
in this Recommendation**

CAMC   Customer access maintenance centre

CIME   Customer installation maintenance entities

DS   Digital section

ET   Exchange termination

LT   Line termination

MSP   Maintenance service provider

OAM   Operation and maintenance

OAMC   Operation, administration and maintenance centre

PL   Physical Layer

PL-OAM   Physical Layer-operation and maintenance

POH   Path overhead

PT   Payload type

SOH   Section overhead

STM   Synchronous transfer mode

TMN   Telecommunication management network

VCC   Virtual channel connection

VPC   Virtual path connection