ETSI TECHNICAL REPORT

ETR 326

November 1996

Source: ETSI TC-TM

Reference: DTR/TM-03007

ICS: 33.020

Key words: Access, ATM, B-ISDN, mux, network, SDH, transmission, UNI, V interface

Transmission and Multiplexing (TM); Broadband Integrated Services Digital Network (B-ISDN) access

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 4 92 94 42 00 - Fax: +33 4 93 65 47 16

Contents

Foreword

This ETSI Technical Report (ETR) has been produced by the Transmission and Multiplexing (TM) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

Introduction

This ETR reflects the work carried out in ETSI TM3 concerning Broadband Integrated Services Digital Network (B-ISDN) access, with relevance to the ITU-T G.96x series of Recommendations [5] and ITU-T Recommendation G.902 [4].

When the work started, problems were identified in the definition and contents of mentioned in the ITU-T G.96x series of Recommendations [5], specifying the Broadband Access Digital Section (B-ADS) as the functional entity ensuring the interoperability between the Broadband Terminal Equipment (B-TE) and the Broadband Exchange Termination (B-ET) (or Service Node Termination using the terminology adopted in ITU-T Recommendation Q.2512 [15]): one of the main problems was due to the fact that the first Asynchronous Transfer Mode (ATM) network element (e.g. an ATM Virtual Path Cross-Connect (VP XC)) in the Access Network (AN) was considered as the termination point of the B-ADS, while interoperability of B-ET and B-TE should be ensured also when network elements operating at the ATM layer (not only at the physical layer, like Synchronous Digital Hierarchy (SDH) add-drop multiplexers), are part of the AN.

The presence of network elements operating at the ATM layer makes the broadband AN quite different from the Narrowband Integrated Services Digital Network (N-ISDN) AN, and explains the reason for the definition of a Broadband Access Digital Link (B-ADL), which covers the full span from the B-ET to the B-TE, even when the AN includes ATM network elements, while the B-ADS covers only the transmission path and does not include any ATM element.

Considering that:

1) the inclusion of all the above mentioned network elements can determine a large span of the broadband AN;

2) the best way to ensure the B-TE/B-ET interoperability is at the ATM layer;

the functional modelling defined in ITU-T Recommendations I.326 [13] and G.803 [20] was then applied to describe some alternatives of the AN, in order to individuate commonalities between them.

The functions required both at the ATM and physical layer are also summarized in tables similar to those already used for the narrowband case.

A separate clause contains the description and functional models of an AN supported through a $V_{B5.1}$ interface, currently under definition in ETSI STC-SPS3.

Annex A describes functional solutions for the support of dynamic bandwidth allocation in ANs based on ATM Passive Optical Networks (PONs).

Blank page

1 Scope

The scope of this ETR is to define the characteristics of the Broadband Access Digital Link (B-ADL) and the Broadband Access Digital Section (B-ADS).

The B-ADL and the B-ADS are introduced to allow a functional and procedural description and definition of the network requirements, needed to ensure the interoperability of a Broadband Terminal Equipment (B-TE) with a Broadband Exchange Termination (B-ET).

2 References

This ETR incorporates by dated and undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ITU-T Recommendation G.826 (1993): "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

[2] Draft ITU-T Recommendation G.827 (1995): "Availability parameters and objectives for path elements of international constant bit-rate digital paths at or above the primary rate".

[3] ITU-T Recommendation I.610 (1995): "B-ISDN operation and maintenance principles and functions".

[4] ITU-T Recommendation G.902 (1995): "Framework Recommendation on functional access networks – Architecture and functions, access types, management and service node aspects".

[5] ITU-T G.96x series of Recommendations: "Digital section and digital transmission systems for customer access to ISDN".

[6] ITU-T Recommendation I.432.1 (1996): "Integrated services digital network; ISDN user-network interfaces; B-ISDN user-network interface: Physical layer specification - General characteristics".

[7] ITU-T Recommendation I.432.2 (1996): "Integrated services digital network; ISDN user-network interfaces; B-ISDN user-network interface - Physical layer specification for 155 520 kbit/s and 622 080 kbit/s".

[8] ITU-T Recommendation I.432.3 (1996): "Integrated services digital network; ISDN user-network interfaces; B-ISDN user-network interface - Physical layer specification for 1 544 kbit/s and 2 048 kbit/s".

[9] ITU-T Recommendation I.432.4 (1996): "Integrated services digital network; ISDN user-network interfaces; B-ISDN user-network interface - Physical layer specification for 51 840 kbit/s".

[10] ITU-T Recommendation I.311 (1993): "B-ISDN general network aspects".

[11] Draft 3R Revised ITU-T Recommendation I.356 (1995): "B-ISDN ATM layer cell transfer performance".

[12] ITU-T Draft Recommendation I.732 (1996): "Functional characteristics of ATM equipment".

[13] ITU-T Recommendation I.326 (1995): "Functional architecture of transport networks based on ATM".

[14] ETR 257 (1996): "V interfaces at the digital Service Node (SN); Identification of the applicability of existing protocol specifications for a VB5 reference point in an access arrangement with Access Networks (ANs)".

[15] ITU-T Recommendation Q.2512 (1995): "B-ISDN network node interfaces for subscriber access".

[16] ETS 300 299: "Broadband Integrated Services Digital Network (B-ISDN); Cell based user network access for 155 520 kbit/s and 622 080 kbit/s; Physical layer interfaces for B-ISDN applications".

[17] ETS 300 300: "Broadband Integrated Services Digital Network (B-ISDN); Synchronous Digital Hierarchy (SDH) based user network access Physical layer interfaces for B-ISDN applications".

[18] ETS 300 324: "Signalling Protocols and Switching (SPS); V interfaces at the digital Local Exchange (LE) V5.1 interface for the support of Access Network (AN)".

[19] ETS 300 347: "Signalling Protocols and Switching (SPS); V interfaces at the digital Local Exchange (LE) V5.2 interface for the support of Access Network (AN)".

[20] ITU-T Recommendation G.803: "Architectures of transport networks based on the synchronous digital hierarchy (SDH)".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of this ETR, the following definitions apply:

Broadband Access Digital Link (B-ADL): The B-ADL corresponds to the ATM End-to-End (EtoE) Virtual Path Connection (VPC) (*End-to End VP Trail)* between the Broadband User Network Interface (B-UNI) at the T_B reference point, as defined in ITU-T Recommendations I.432.1 [6], I.432.2 [7], I.432.3 [8] and I.432.4 [9] (also under study in TM3 - see annex B), and the first ATM switching element (service node) at the V_B reference point, as defined in ETR 257 [14] (ITU-T Recommendation Q.2512 [15]).

This definition implies that the AN does not include Virtual Channel (VC) Cross-Connect (XC) functions but can include VP XC functions.

The definition of the B-ADL as a set of ATM VC Links (*VC Link Connections*) between the B-TE and the B-ET (in order to match the case in which the AN includes also VC XC functions), is left for further study.

The definition of the B-ADL, being based only on ATM layer functions, ensures independence from the underlying physical layer. Its applicability is then independent from the definition of B-UNI physical layer: the aim is just to define functions, associated with the B-ADL, which will remain valid independently from the evolution of the B-UNI physical layer.

Broadband Access Digital Section (B-ADS): The B-ADS, as defined in the ITU-T G.96x series of Recommendations [5], corresponds to the transmission path (*Trail)* between the B-UNI at the T_B reference point and the first ATM element in the AN, at V_{B1} reference point. When the AN does not include ATM elements, the first ATM element corresponds to the B-ET.

The functions of the B-ADS are dependent from the physical layer used at the B-UNI.

The network element terminating, on the network side, the B-ADS, is referred to as the AN end system: in case the AN does not include ATM layer functions, this element is the B-ET.

3.2 Symbols

For the purposes of this ETR, the following symbols apply:

F4: maintenance flow for the VP layer (see ITU-T Recommendation I.610 [3]);

F5: maintenance flow for the VC layer (see ITU-T Recommendation I.610 [3]);

T_B: reference point at B-UNI;

V5.1: reference point defined in ETS 300 324 [18];

V5.2: reference point defined in ETS 300 347 [19];

V_B: reference point between service node and AN for B-ISDN;

V_{B1}: reference point on the network side, delimiting the B-ADS;

$V_{B5.1}$: reference point between the service node and the multi-customer AN (under study in SPS3 - see annex B).

3.3 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

AAL1	ATM Adaptation Layer 1
ADL	Access Digital Link
ADSL	Asymmetrical Digital Subscriber's Line
AN	Access Network
A-PON	Access network PON
ATM XC	ATM cross Connect
ATM	Asynchronous Transfer Mode
B-ADL	Broadband Access Digital Link
B-ADS	Broadband Access Digital Section
BCC	Bearer Channel Control
B-ET	Broadband Exchange Termination
B-NT2	Broadband Network Termination type 2
B-OLT	Broadband Optical Line Termination
B-ONU	Broadband Optical network Unit
B-TE	Broadband Terminal Equipment
B-UNI	Broadband User Network Interface
EtoE	End to End
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
HOPT	Higher Order Path Termination
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LUP	Logical User Port
MST	Multiplex Section Termination
N-ISDN	Narrowband ISDN
NPC	Network Parameter Control
NT1	Network Termination type 1
O&M	Operation and Maintenance (sometime or most common used is OAM&P)
OLT	Optical Line Termination
ONU	Optical Network Unit
PL O&M	Physical Layer Operation & Maintenance
PMD	Physical Medium Dependent
PMDA	Physical Medium Dependent Adaptation
PON	Passive Optical Network
PSTN	Public Switched Telephone Network
PTI	Payload Type Identifier
QoS	Quality of Service
RST	Regenerator Section Termination

SDB	Switched Digital Broadcast
SDH	Synchronous Digital Hierarchy
SPS3	ETSI Sub-Technical Committee Signalling Protocol & Switching-3
SVC	Signalling Virtual Channel
TBD	To Be Determined
TE	Terminal Equipment
TTP	Trail Termination Point
UNI	User Network Interface
UPC	User Parameter Control
VC	Virtual Channel
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VP XC	Virtual Path Cross Connect
VP	Virtual Path
VPC	Virtual Path Connection
VPI	Virtual Path Identifier
XC	Cross Connect

4 Field of application

The B-ADL and the B-ADS are introduced to allow a functional and procedural description and definition of the network requirements, needed to ensure the interoperability of a B-TE with a B-ET.

Performances of the B-ADS and B-ADL have to fulfil the requirements specified in ITU-T Recommendations G.826 [1] (as far as concerns the physical layer) and ITU-T Recommendation I.356 [11] (ATM layer), while B-ADS and B-ADL availability have to fulfil requirements specified in ITU-T Recommendation G.827 [2].

4.1 Configurations

Five examples are included to illustrate different configurations, using the modelling defined in ITU-T Recommendations I.326 [13] and G.803 [20]. The intention is to identify an exhaustive set of different network elements which can be included in the access and the relevant functions necessary to guarantee interoperability between the user installation and the first switching element (B-ET of the service node) in the broadband network.

Figure 1 gives an example of an AN not including ATM elements.

Figure 2 gives an example of an AN including an ATM VP XC.

Figure 3 gives an example of a simple access link where the digital access section is terminated at the same interface of the access link.

Figure 4 shows the ATM functions of the ADL for an AN including ATM VP XC functions.

Figure 5 shows the ATM functions of the ADL for an Optical Access Network (OAN) based on an ATM PON system; in figures 4 and 5 physical layer functions are not shown but are present (e.g. NT1).

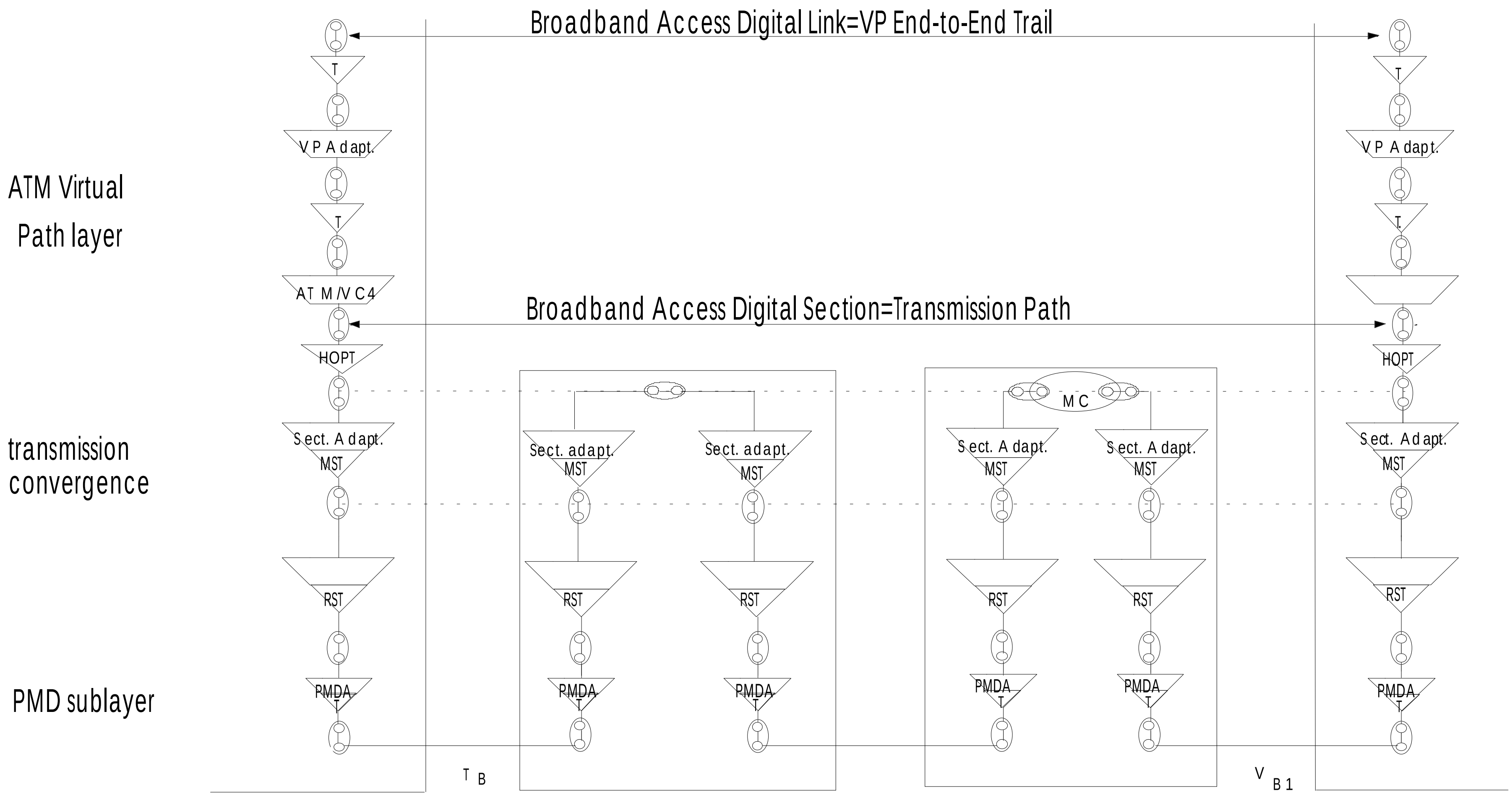


Figure 1: Example of B-ADL functions when ATM elements are not included in the AN

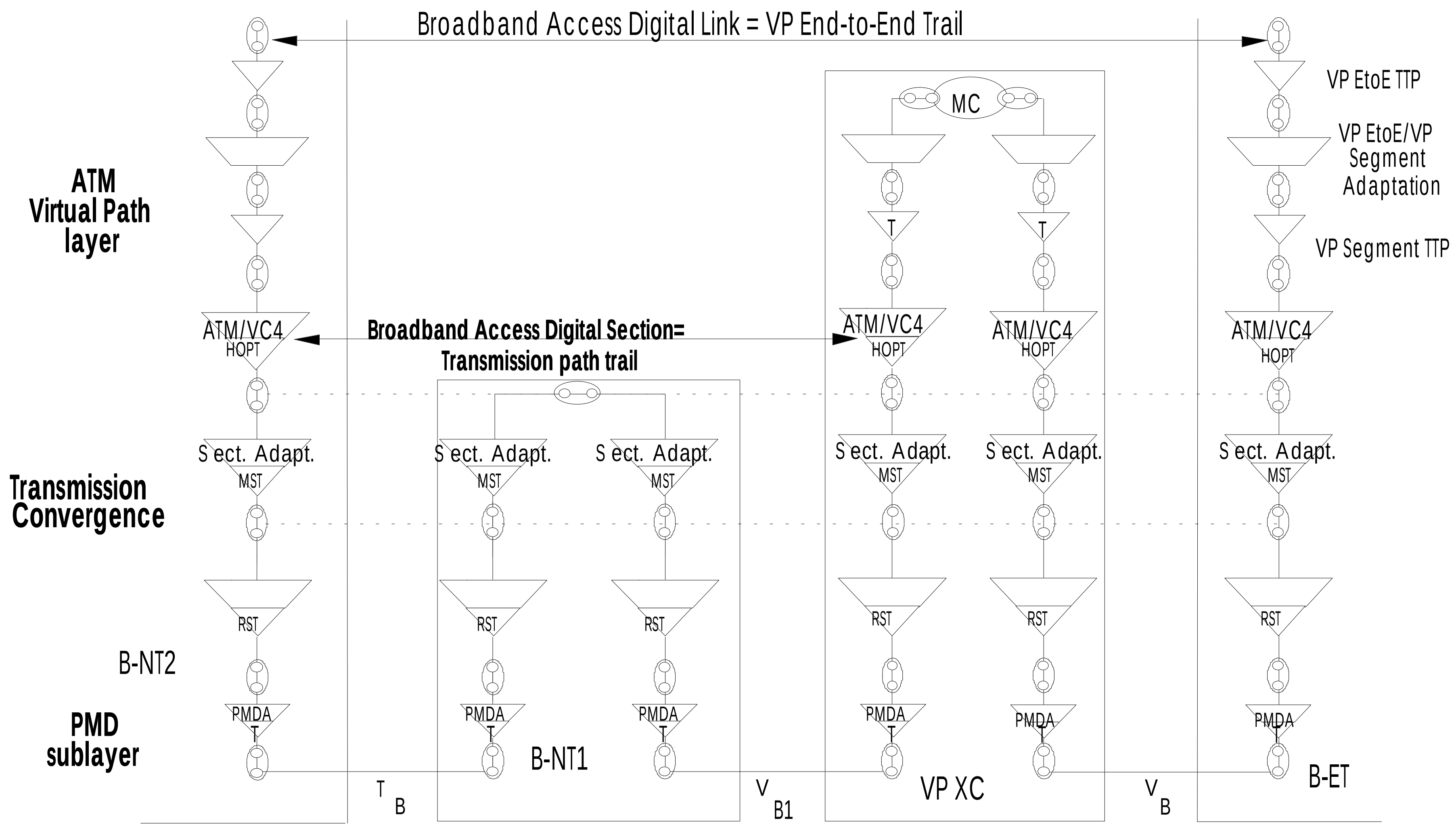


Figure 2: Example of B-ADL including ATM elements

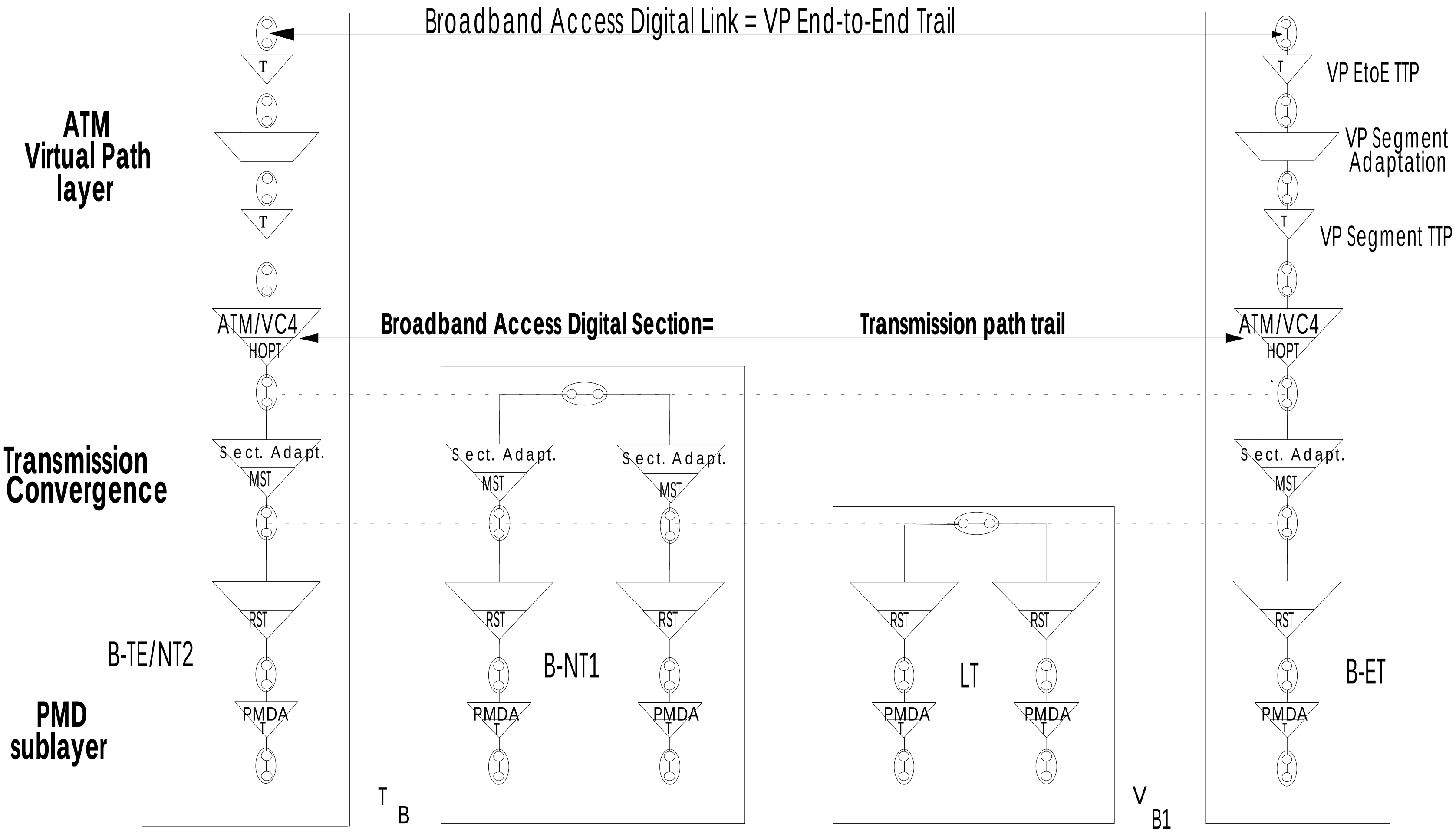


Figure 3: Example of B-ADL not including ATM elements

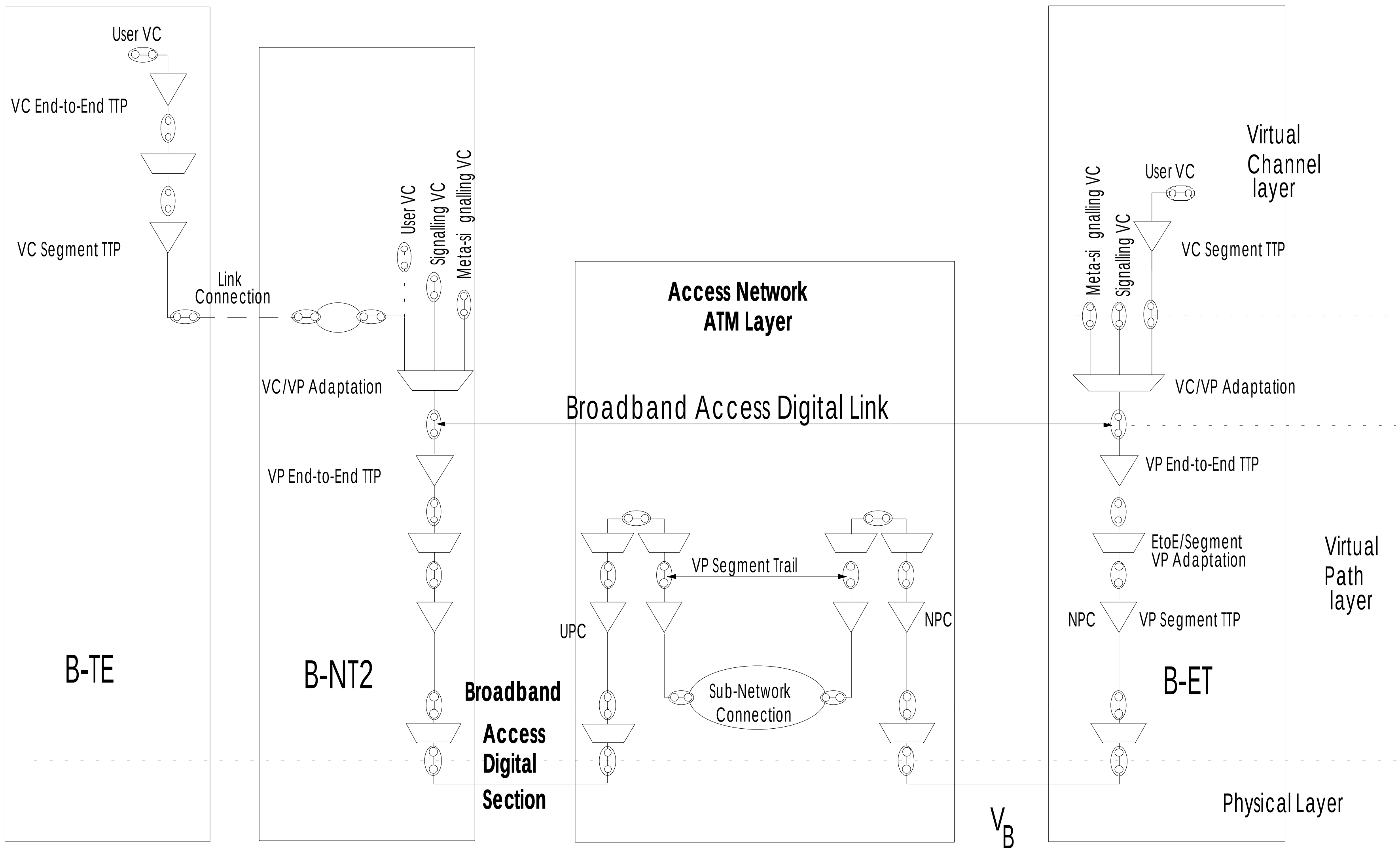


Figure 4: ATM layer functions of the B-ADL

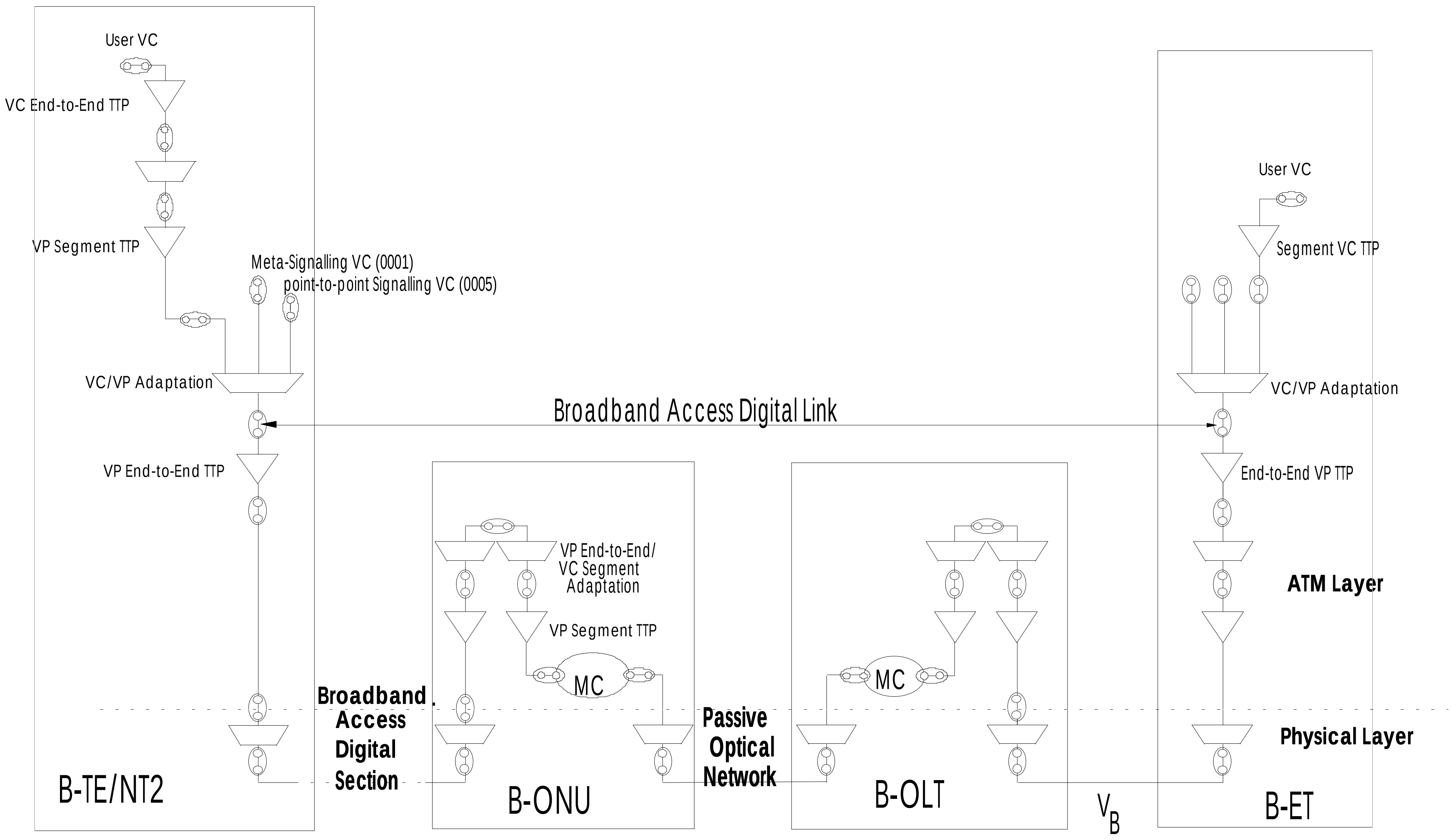


Figure 5: Example of ATM layer functions for an A-PON based AN (more than one ATM element part of the AN)

5 Functions of the Access Digital Link (ADL)

The functions of the Access Digital Link (ADL), between the B-UNI (B-TE or B-NT2) at the T_B reference point and the service node (B-ET) at the V_B reference point, (for any type of broadband access network) are the following:

Table 1: Functions of the ADL

T_B		V_B	
↔	Virtual Channel (VC) links	↔	ATM layer
↔	Broadband meta-signalling (through Meta-Signalling VC Connection - MSVCC)	↔	
↔	Broadband signalling (through Signalling VCCs - SVCC)	↔	
↔	VCs O&M	↔	
↔	VP trails	↔	
↔	VPs O&M	↔	
↔	AN ATM layer controls	↔	
↔	Cell delineation	↔	Physical Layer
↔	Transmission path termination	↔	
↔	Transmission section termination	↔	
↔	Physical layer O&M	↔	
↔	Bit timing	↔	
↔	Activation	↔	
←	Deactivation	←	
← → →	Power feeding	NA	

This table includes as well those functions which cross one of the two referenced interfaces but not necessarily reach the other one.

6 Functions of the Access Digital Section (ADS)

The functions of the Access Digital Section (ADS), between the B-TE (or NT2) at T_B reference point and the first ATM element in the AN at V_{B1} reference point, are given in table 2.

Table 2: Functions of the ADS

T_B		V_{B1}	
↔	Cell delineation	↔	Physical Layer
↔	Transmission path termination	↔	
↔	Transmission section termination	↔	
↔	Physical layer O&M	↔	
↔	Bit timing	↔	
↔	Activation	↔	
←	Deactivation	←	
← → →	Power feeding	NA	

7 Description of the functions

The description of these functions given in this clause has to be considered preliminary and possibly incomplete.

The terminology used for the titles of this clause corresponds to ITU-T Recommendation I.311 [10] terminology for the main titles, to ITU-T Draft Recommendations I.732 [12] and I.326 [13] for those given in brackets (*italic*).

7.1 ATM Layer

The functions of the ATM layer ADL are shown in detail in figure 4.

In figure 4 the VP layer is split into two sublayers, to show both VP segment and EtoE termination and adaptation functions.

The physical layer functions are not shown in details for simplicity, but they are represented by the two transmission path trails between the B-NT2 and the ATM XC sub-network, and between the ATM XC sub-network and the B-ET.

The B-NT2 and B-TE functions are split in two different elements, but the dashed user VC termination in the B-NT2 represents the case when B-NT2 and B-TE functions are integrated in a single element. It is not the purpose of this ETR to define and assign functions to NT2s or TEs; ATM functions defined in this ETR are independent from the physical configuration of the customer premises network. Some of the functions described in this subclause are optional.

7.1.1 VC links (*Segment Link Connections)*

Bidirectional or unidirectional streams of cells identified by a specific header, between the B-TE and the B-ET, carrying user information.

B-TE and B-ET are connection points (*Connection Termination Points*) of these links (*Link Connections*).

Their characteristics should be specified in term of:

- Virtual Path Identifier (VPI);
- Virtual Channel Identifier (VCI);
- Payload Type Identifier (PTI);
- traffic parameters;
- TBD.

Relevant Recommendations/ETSs: ITU-T Recommendation I.311 [10], etc.

7.1.2 Broadband meta-signalling

Function which allows to activate/deactivate a specific SVCC (*Network connection*).

It is based on the use of a MSVCC (*Network connection*), whose endpoints (or *Connection Termination Points*) are within the B-TE and the B-ET. In case the AN includes ATM VP multiplexing/cross-connecting functions, the MSVCC (*MSVC Network connection*) should include VPI translation functions (intermediate *Matrix connections or connection points*).

Characteristics should be specified in terms of:

- TBD.

Relevant Recommendations/ETSs: ITU-T Recommendation I.311 [10], etc.

NOTE: The *MSVC Network Connection* here identified, when mapped to the functional architecture, should perhaps correspond to a *MSVC Trail*, if *MSVC Trail Terminations* are required within B-ET and B-TE (and have to be standardized). This point has yet to be clarified.

7.1.3 Broadband signalling

Function which allows to activate/deactivate a specific VCC, which includes, within the AN, the above defined VC link.

Broadband signalling is not used in the AN to activate/deactivate Virtual Path EtoE connections.

It is based on the use of a SVCC (*SVC Network Connection*), whose endpoints (*Termination Connection Points*) are within the B-ET and the B-TE.

In case the AN includes ATM VP (and VC) multiplexing/cross-connecting functions, the SVCC (*SVC Network Connection*) should include VPI (and VCI) translation functions (intermediate *Matrix Connections or Connection points*).

Characteristics should be specified in terms of:

- TBD.

Relevant Recommendations/ETSs: ITU-T Recommendation I.311 [10], etc.

NOTE: The *SVC Network Connection* here identified, when mapped to the functional architecture, should perhaps correspond to a *SVC Trail*, if *SVC trail terminations* are required within B-ET and B-TE (and have to be standardized).

7.1.4 VCs O&M

Functions which provide all the required features to maintain and operate the above defined VC layer functions, to ensure their full operational capability with the required grade of service (availability).

They include alarm and performance monitoring/reporting, loop-back facilities, etc..

They should be based on F5 segment flows and are represented in the functional architecture by the VC segment trail termination functions (shown in figure 4 only for the user VCC).

Whether these functions should be specific for each of the above defined VC layer functions or should be common to all of them, or in some cases should be not required, is for further study, as well as their characteristics.

Relevant Recommendations/ETSs: ITU-T Recommendation I.610 [3], etc.

7.1.5 End-to-End Virtual Path connections (*End-to-End VP Trails*)

Bidirectional or unidirectional streams of cells, identified by a specific VPI, between the B-TE and the B-ET.

The presence of such trails implies that the AN does not include EtoE Virtual Path Connection (VPC) termination points.

A VPC can be activated or deactivated only through management procedures. However its bandwidth characteristics are not only determined through management operations.

The EtoE VPC endpoints (*Trail Termination Points*) are within the B-ET and the B-TE.

An EtoE VPC (*End-to-End VP Trails)* can include more than a single segment VPC (*link connection* or *sub-network connection*).

Their characteristics should be specified in term of:

- VPI;
- traffic parameters;
- TBD.

Relevant Recommendations/ETSs: ITU-T Recommendation I.311 [10], etc.

7.1.6 VPs O&M

Functions which provide all the required features to mantain and operate the above defined VP layer functions, to ensure their full operational capability with the required grade of service (availability).

They include alarm and performance monitoring/reporting, loop-back facilities, etc..

They should be based on F4 segment and EtoE flows.

F4 segment can be used for the VP segment connections (*Link Connections*) corresponding to the operator ownership domain corresponding to the AN (or to part of it).

F4 EtoE is used for the complete ADL, and starts in the B-TE (B-NT2) and ends in the B-ET.

Relevant Recommendations/ETSs: ITU-T Recommendation I.610 [3], etc.

7.1.7 AN ATM layer controls (Bearer Channel Control (BCC) and control protocol)

These functions enable to correctly operate other functions of the ADL, setting up parameters or activating/deactivating other functions in the ADL.

They are separated from the O&M VC or VP functions, as they are strictly related to call events.

They do not operate between the B-TE and the B-ET, but are terminated within elements of the AN.

They are similar to the equivalent functions defined for the narrowband case in V5.1 and V5.2 interface specifications.

Examples of these functions are:

for the physical layer:

Remote activation: from V_B to T_B , from V_B to V_{B1}, etc.

Remote deactivation: from V_B to T_B, from V_B to V_{B1}, etc.

for the ATM layer:

Remote User Parameter Control (UPC) control: from B-ET (V_B) to V_{B1}, when these reference points are not coincident.

Upstream bandwidth allocation: from V_B to T_B, from V_B to V_{B1}.

These functions could be transported through the AN using specific VPC (*VP Network Connections*) or VCCs (*VC Network Connections*).

Relevant Recommendations/ETSs: under study in SPS3 (see annex B).

7.2 Physical layer

Relevant Recommendations/ETSs: ITU-T Recommendations I.432.1 [6], I.432.2 [7], I.432.3 [8] and I.432.4 [9], ETS 300 299 [16] and ETS 300 300 [17].

7.2.1 Cell delineation

Function which enables:

1) to transfer between B-TE and B-ET, across the AN, the timing information relevant to any cell going from B-TE to B-ET and vice versa;

2) to correctly individuate each field of any cell: this second function component is not required in all the AN elements (e.g., an SDH XC).

Its characteristics are for further study.

7.2.2 Transmission path termination

Dependent on the kind of transmission convergence format used.

7.2.3 Transmission section termination

Dependent on the kind of transmission convergence format used.

7.2.4 Bit timing

Function providing bit timing to enable the B-TE, the ADL and the B-ET to recover information from the aggregate bit stream.

7.2.5 Physical layer O&M

This function provides all the features required to operate and mantain the ADL physical layer functions to ensure their full operational capability with the required grade of service (availability).

7.2.6 Activation/Deactivation

The Activation function provides the capability to bring into a normal operating mode other physical layer functions/interfaces of the ADL which could have been powered down, keeping into account:

- power down mode;
- initial power up;
- a failure condition.

An activation should be possible to a state which allows maintenance actions to be performed in the ADL physical layer even when there is no customer equipment connected to the T_B reference point.

The Deactivation function permits the T_B reference point interface and possibly other transmission sections/paths of the ADL to be placed in a low power consumption mode.

Deactivation should be initiated only by the B-ET.

Relevant Recommendations/ETSs: TBD.

7.2.7 Power feeding

Power feeding could be required in either direction (from B-NT2 to B-NT1 or vice versa). Its characteristics are for further study.

Relevant Recommendations/ETSs: ITU-T Recommendations I.432.1 [6], I.432.2 [7], I.432.3 [8] and I.432.4 [9], TBD.

8 $V_{B5.1}$ supported ANs and relevant requirements

The configuration taken in consideration is shown in figure 6.

NOTE: This configuration has been chosen as it is fairly complex, but, at the same time, is highly realistic, as presently deployed ATM network facilities are exclusively based on ATM VP XC. The inclusion of ATM based AN end systems, based on point-to-multipoint "Hybrid Fibre Coax" or "Hybrid Fibre Twisted Pairs" infrastructure, and enabling the interconnection of small business or residential customers, brings just to the configuration shown in figure 6.

The corresponding functional architecture is shown in figure 7, and is relevant to the functions required for the support of point-to-point VPCs, equivalent to the B-ADL.

The functional representation of the B-NT1 is not appearing in these figures, showing only the ATM layer, as the B-NT1 is assumed not to include ATM layer functionalities.

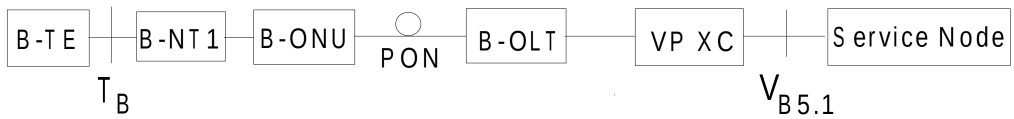


Figure 6: Considered AN configuration

Configurations including a larger number of VP XC do not add complexity to the configuration shown.

The most important point, resulting from the analysis of the AN architecture, is the need of differentiating between AN ATM transport elements, corresponding to VP XCs, and the last ATM element in the AN. Such element, which is referred to as the AN end system, supports directly the Logical User Ports (LUPs), as it terminates the ADS: then it needs to terminate the $V_{B5.1}$ control protocol.

Any other AN element operating only below the ATM layer does not affect the ATM layer functions and requirements: however such elements need to be taken into account for the correct AN performance evaluation (e.g. transfer delay): their performance characteristics are defined through the definition of the corresponding transmission path trails.

Such element can be a VP (VC) multiplexer, or, for an OAN, is the B-ONU: however, because the B-ONU is strictly slaved to the B-OLT operating behaviour, and the intermediate B-OLT/B-ONU protocol, able to correctly set up the distributed ATM functionalities, is not (yet) standardized, the $V_{B5.1}$ control protocol termination point can be considered the B-OLT (which has, on the network side, the capability of supporting directly a V_{B5} interface).

To meet $V_{B5.1}$ specifications, as well as the general ATM O&M principles, a number of AN requirements are identified. Most of these requirements are generally applicable to all types of ATM (B-ISDN) ANs, which transport ATM up to the customer installation (either B-TE or B-NT2).

$V_{B5.1}$ does not directly induce any additional requirement on the AN physical layer (although it could constrain some topological AN characteristics, like the distance between TE and ET, or the number of cascaded ATM XCs, in order to achieve certain QoS performances for specific $V_{B5.1}$ protocols), with respect to those generally applicable to transmission systems supporting broadband traffic.

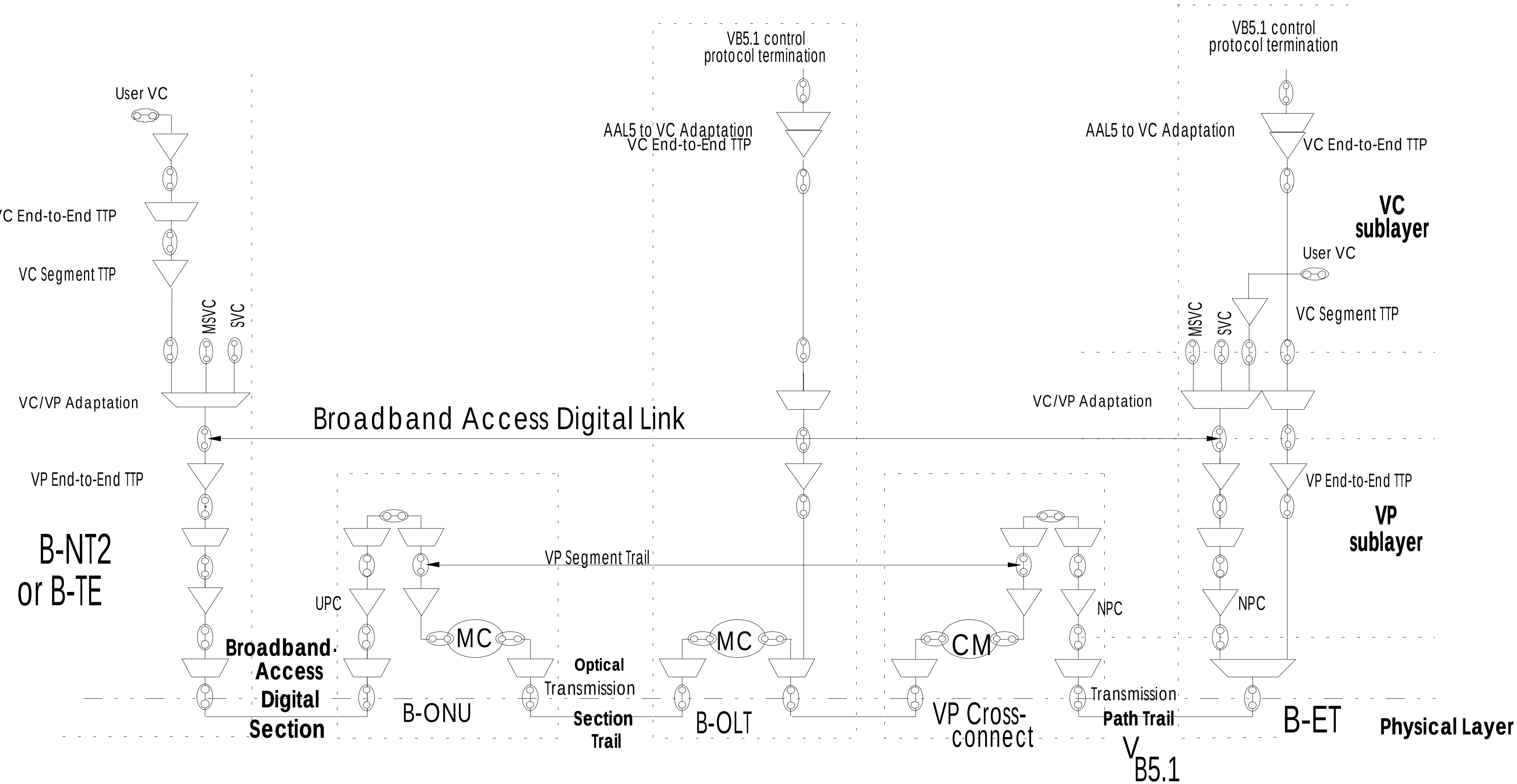


Figure 7: Functional architecture for configuration shown in figure 6

8.1 Use of VP/VC layers

The AN is operated mostly at VP layer: point-to-point VPCs are semi-permanent and are operated through management functions.

For the support of non-ATM services (e.g. LAN emulation), adaptation functions and VPC/VCC termination functions are required: these functions are not subject of standardization (unless standardized non ATM interfaces are supported) and are considered outside the boundaries of the ATM AN, as part of dedicated equipment (whether this equipment is owned by the network operator or the customer is irrelevant).

8.2 Support of narrowband services

N-ISDN/POTS services can be directly supported through V5.1 or V5.2 interface between the AN and the service node, and dedicated transmission path functions inside the AN (in parallel to the ATM VP layer functions), using common optical transmission section functions (the same optical transmission section function supports both ATM and V5 paths). Whenever such common transmission section functions are not available (are able only to support ATM VPCs), such services can be supported through the use of ATM Adaptation Layer 1 (AAL1) and semi-permanent VCCs.

AAL1 and VCC termination has to be performed at the boundaries of the AN (on dedicated SUs inside the B-ONU) in compliance with relevant standards.

8.3 Support of Switched Digital Broadcast (SDB) service

The relevant architecture requirements and functions are for further study.

8.4 Transport of $V_{B5.1}$ control protocols

$V_{B5.1}$ control protocol (user port control) currently under definition is transported transparently through the AN up to the AN end system.

In the AN end system the relevant VPC and VCC are terminated.

As the control protocols are terminated inside the AN (not in the TE), a dedicated VPC is required, otherwise the AN would require as well VC XC functions.

It is for further study which ATM maintenance flows have to be used for the maintenance of the control protocol VCCs and VPC: it is suggested to use only F4 EtoE maintenance flow, as $V_{B5.1}$ control protocol has a dedicated VPC.

8.5 Header Conversions (VP XCs)

The AN end system need to include header translation functions, from the $V_{B5.1}$ header layout (or any other internal AN header layout, based on 12 bits VPIs), based on a 12 bit VPI, to the B-UNI header layout, based on 8 bit VPI.

VPI conversions in figure7 correspond to matrix connections and relevant VP/transmission path adaptation functions.

Starting from the B-ET and going toward the customer, the following conversions are operated:

- inside the VP XC, conversion from the $V_{B5.1}$ VPI value to the value used on the transmission path trail between the VP XC and the B-OLT (this first conversion is fully conformal to the normal VP XC specifications);

- inside the B-OLT from the previous value to the internal APON value;

- inside the B-ONU from the internal APON value to the B-UNI value.

The two last conversions have to be considered part of the same AN end system. They are required for the following reasons:

- the B-OLT conversion is required for the correct routing of VPCs inside the point-to-multipoint optical access section;

  NOTE: ETR 257 [14] specifies that the preferrable way of routing ATM traffic inside the AN, is based on the use of the ATM routing information, i.e. VPIs and VCIs);

- the B-ONU conversion is required to translate the 12 bit VPI value used inside the point-to-multipoint optical access section to the 8 bit VPI value standardized for the B-UNI).

8.6 ATM O&M flows

8.6.1 F4 segment

Figure 7 shows an F4 segment covering the boundaries of the AN: such flow can be used when the AN operator is different from the core network operator, owning the B-ET.

8.6.2 F4 End-to-End

F4 EtoE flow, relevant to B-ET and B-TE operational state machines, needs to be carried transparently through the AN, from the B-TE/NT2 to the B-ET and vice versa: it has not to be terminated inside the AN, otherwise is no longer relevant to the LUP status.

The LUP is the set of VPCs, relevant to the same B-ET, crossing the B-UNI. The VPC status needs to be known in the B-ET, for correctly performing actions like call set-up/release and generally all the other typical ET O&M functions.

F4 EtoE Trail Termination Points (TTPs) are then located in B-ET, at the network side, and in the customer B-TE or NT2 at the customer side.

8.6.3 F5 segment

For user VCCs, F5 segment is terminated outside the AN, so it is no pertinent to the AN.

For the $V_{B5.1}$ control protocol, dedicated VCC(s) it is assumed not to use F5 segment, as already F4 EtoE and F5 EtoE provide the required degree of maintenance.

8.6.4 F5 End-to-End

For user VCCs, F5 EtoE is terminated outside the AN, so it is not pertinent to the AN.

For the $V_{B5.1}$ control protocol dedicated VCC, F5 EtoE can be used: however if a dedicated VPC is used, F4 EtoE could already provide the required degree of maintenance.

8.7 Usage Parameter Control (Upstream Policing)

8.7.1 UPC over VPCs

In accordance with ITU-T Recommendations I.326 [13], and I.732 [12], User Parameter Control (UPC) functions are included for VPC or VCCs, in the segment TTP.

When VP segment trail termination functions are not used (no segment maintenance is used), UPC functions are included in the VP EtoE trail termination functions.

ITU-T Recommendation I.371, which also specifies all the other UPC characteristics in detail, says that UPC over a VPC (VP Network Connection), or respectively over a VCC, has to be performed at the network point where the first VP link (*link connection* for ITU-T Recommendation I.326 [13]), or respectively the first VC link, is terminated within the network.

UPC over VPCs is essential to guarantee the correct operation of VP multiplexing functions inside the AN.

Applying this requirements to the AN considered case, VP UPC functions have to be performed within the B-ONU: this functions are shown by the VP segment trail termination block, on the B-ONU left side, shown in figure 7.

The VP UPC function is performed, in the upstream direction (user-to-network) on each user VPC, including, when present, F4 EtoE maintenance cells.

F4 segment cells, being inserted after the UPC functions, do not affect the UPC function.

NOTE: UPC functions are operated over the aggregate traffic composed of user and F4 cells carried over the same VPC, because F4 EtoE cells, being generated in the B-TE (so the generation process is not under the direct control of the AN), could be incorrectly generated. The alternative solution of filtering out, inside the AN, possible faulty F4 EtoE streams, causes the need of continuously monitoring all the F4 streams in the AN : such a solution is actually unnecessary complicated).

The presence of VPC UPC functions implies that the B-TE (or NT2) need to be compliant to VPC allocated traffic parameters.

8.7.2 UPC over VCCs

UPC over user VCCs is not required for $V_{B5.1}$, as the AN is not dealing with the VC layer.

For the only VCCs terminated inside the AN, those carrying $V_{B5.1}$ Switched Digital Broadcast (SDB) and control protocols, the relevant UPC functions are inside the B-ET.

8.8 Network Parameter Control (NPC)

8.8.1 NPC over VPCs

NPC functions can be performed at the boundaries between different operator domains, in compliance with ITU-T Recommendation I.610 [3].

NPC is performed, for the upstream traffic, in the B-ET (it is not correct to name VP UPC the policing function on the upstream VP traffic, as such traffic has been already processed in the AN): as the B-ET is not considered in this ETR, it will be not further described.

NPC is performed, for the downstream traffic, by the first ATM element in the AN owned by the AN operator: in figure 7 it is assumed that the ATM XC is owned by the AN operator, so it includes NPC functions (these functions are not shown in figure 7).

NPC functions are not affected by the F4 segment maintenance flow used within the AN, as this flow is inserted after the NPC operation.

It is assumed that NPC functions are operated over the aggregate traffic, composed of all the cells, including F4 EtoE cells, pertaining to the same VPC, crossing the $V_{B5.1}$ interface (as shown in figure7).

8.8.2 NPC over VCCs

NPC over VCCs is not required, as the AN is not dealing with the VC layer, apart for the treatment of $V_{B5.1}$ protocols VCCs.

NPC over the VCC(s) used to transport the $V_{B5.1}$ protocols can be considered redundant if such protocols are transported over a dedicated VPC, which is subject of NPC at VP layer: moreover the traffic associated with such protocols should be quite limited.

Annex A: Dynamic VPC control in the access network

A.1 Introduction

Dynamic control of VPC relevant characteristics is not fully defined in ITU-T, at least as far as concerns signalling requirements and relevant recommendations, up to now defined only for VC switching.

However ITU-T Recommendation I.311 [10] has already considered, specifically for the user access, the possibility of having switched VPC (see Clause 3.3 "Possible communication scenarios for typical configurations at the user access", and in particular case d of figure 8 of ITU-T Recommendation I.311 [10]).

In subclause 6.1 of ETR 257 [14] the possibility of dynamic control of UNI VP characteristics is marked as not to be considered, unless ITU-T changes its position on the matter.

Dynamic control of VPCs (*End-to-End VP Trails* in ITU-T Recommendation I.326 [13] terminology) can be performed at two levels:

1) activating and releasing VPCs;
2) only modifying VPC bandwidth.

The first level would impact on the management architecture, because the VPC entity within the management plane should be taken off, as VPCs would be directly "managed" by the control plane.

The second level causes instead a minimal impact on the management plane and functions, as only a specific parameter (the VPC bandwidth) would be no longer directly dealt with within the management plane, but within the control plane, for dynamic VPCs: semi-permanent VPCs can be still managed by the management plane (the same is applicable at VC layer). Considering that management functions in the AN need to perform mostly AN Operation and Maintenance (O&M), while the dynamic allocation of service related characteristics (like just the VPC bandwidth) is useful to achieve the best efficiency (and consequently the highest cost effectiveness), this ETR shows that the application of the second level is highly beneficial, if not necessary, for the ATM PON based ANs.

A.2 Reference scenario

Figure. A.1 shows the most complicated scenario, as it is presently considered in SPS3.

Two ATM service nodes, belonging to different network operators, are interconnected, through ATM VP XCs, to different ATM access systems, an ATM PON and an ATM concentrator (called sometimes access adapter, if it supports ADSL lines).

Additional cross-connect functions, as well as transmission equipment (e.g. SDH XCs) not dealing with the ATM layer, could be added without increasing the AN complexity, and, for this reason, are not included.

Each service node is connected to the AN with $V_{B5.2}$ interfaces: the VP XCs enable each service node to reach both AN end systems, the ATM PON and the ATM concentrator.

The bandwidth over the connection between the cross-connects and the AN end systems is then shared by the two service nodes. This bandwidth sharing is performed in a semi-permanent way, as the VP XCs cannot modify dynamically the bandwidth allocation: this is in compliance with present specifications of VP XCs.

To achieve the best bandwidth efficiency in the AN end systems, where the cost of any resource is higher, because it is shared between a more and more limited number of customer, it is desirable that the bandwidth is allocated in a dynamic way.

This is the reason why it is necessary to perform VPC dynamic allocation.

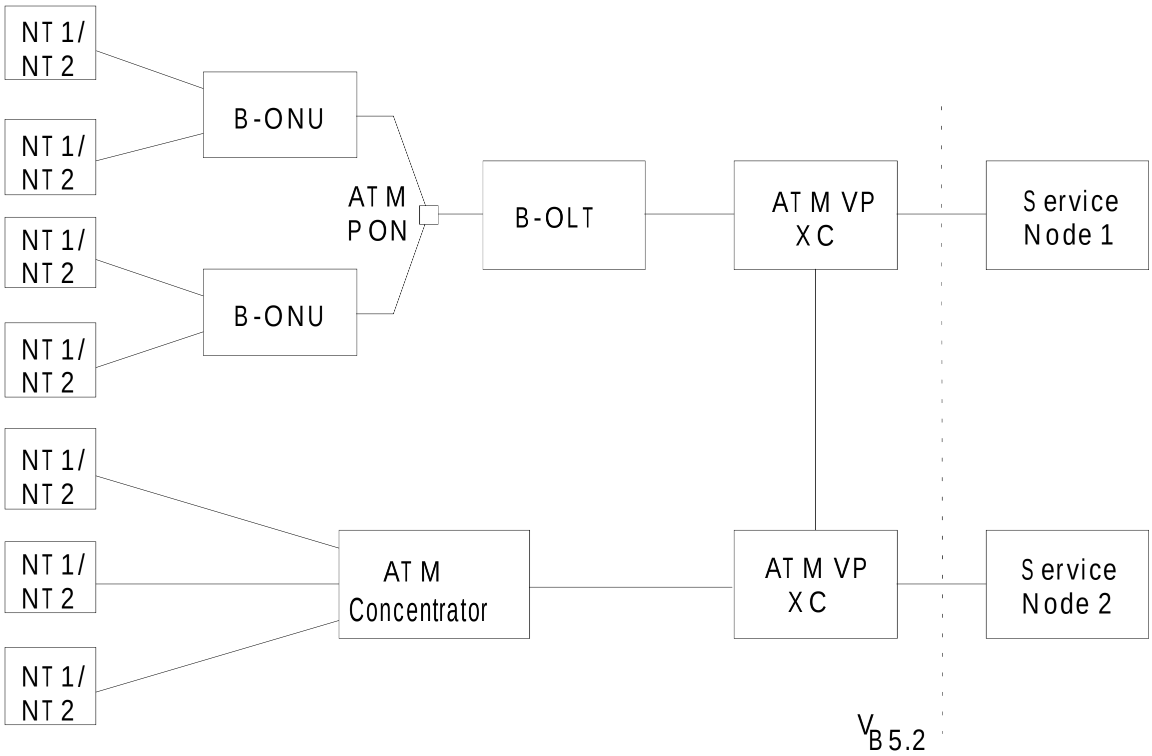
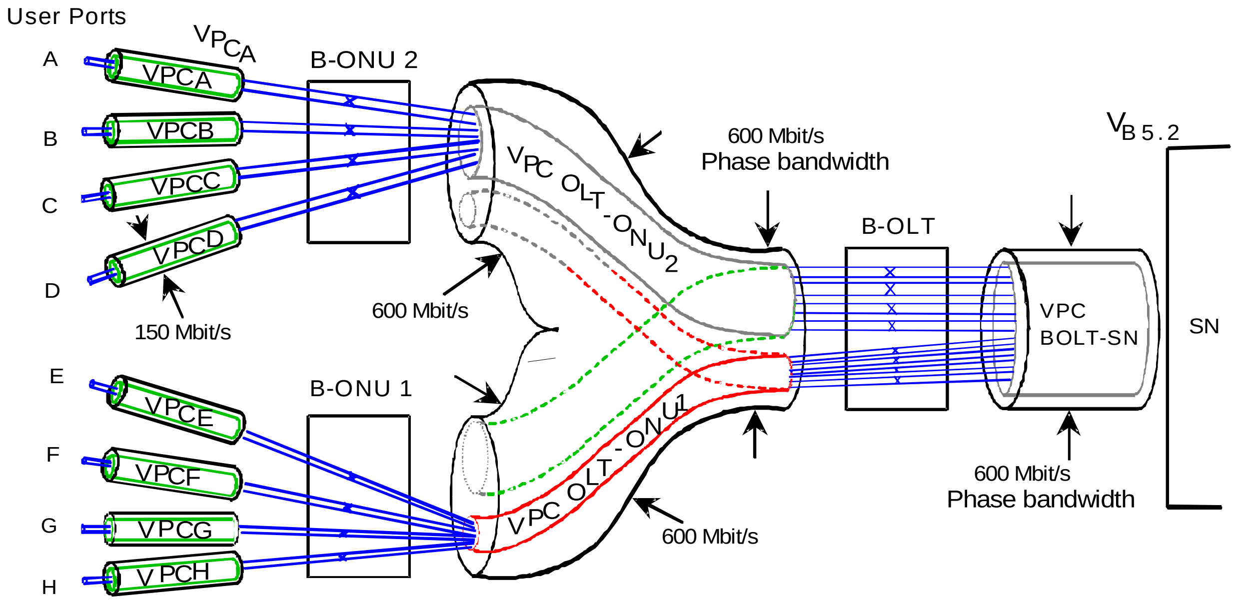


Figure A.1: Reference scenario

A.3 Dynamic bandwidth allocation in ATM PON systems

While, in the case of the ATM concentrator, VC dynamic allocation is performed in a single element, i.e. the ATM concentrator, in case of ATM PON systems there are two elements which can perform VC dynamic allocation (cross-connection), the OLT and the ONU.

Considering that both OLT and ONU perform dynamic VC allocation, this means that both elements deal with the VC layer, and consequently terminate the VPCs on their interfaces. This situation is shown in figure A.2.



VPC A = VPC B = VPC C = ... = VPC H = 150 Mbit/s

VPC OLT-ONU1 = VPC OLT-ONU2 <= Phase bandwidth = 600 Mbit/s

VPC OLT-SN = 600 Mbit/s

Figure A.2: VC Dynamic allocation in OLT and ONUs

Separate VPCs (Trails) are going from the OLT to the ONUs (only two ONUs are shown without loss of generality.

If such VPCs need still to have semi-permanently allocated bandwidth, as presently considered, this situation prevents from having concentration (through dynamic bandwidth allocation) between traffic going or coming to different ONUs. For example, if the VPC from OLT to ONU 1 is assigned 300 Mbit/s, the other VPC going from OLT to ONU2 cannot be assigned more than 300 Mbit/s, resulting from the difference between the overall PON capacity and the bandwidth assigned to OLT-ONU1 VPC.

This situation means that once a certain number of VPCs (to support the traffic from or toward two different service nodes, as in figure A.1, at least two VPCs are required for each ONU) has been set-up, their bandwidth can be modified only through management, not enabling any traffic concentration, on a call by call basis, between different ONUs. This result is certainly not what is desired in the AN end systems, and is the reason why it is proposed to consider VPC dynamic bandwidth allocation, at least in those systems where the physical bandwidth is shared.

A.4 Alternative solution

What is proposed is then the solution shown in following figure A.3, where the OLT performs VC XC functions, but the ONU does not. This solution has additional advantages, outlined at the end of this clause, after describing some additional features needed by the proposed solution.

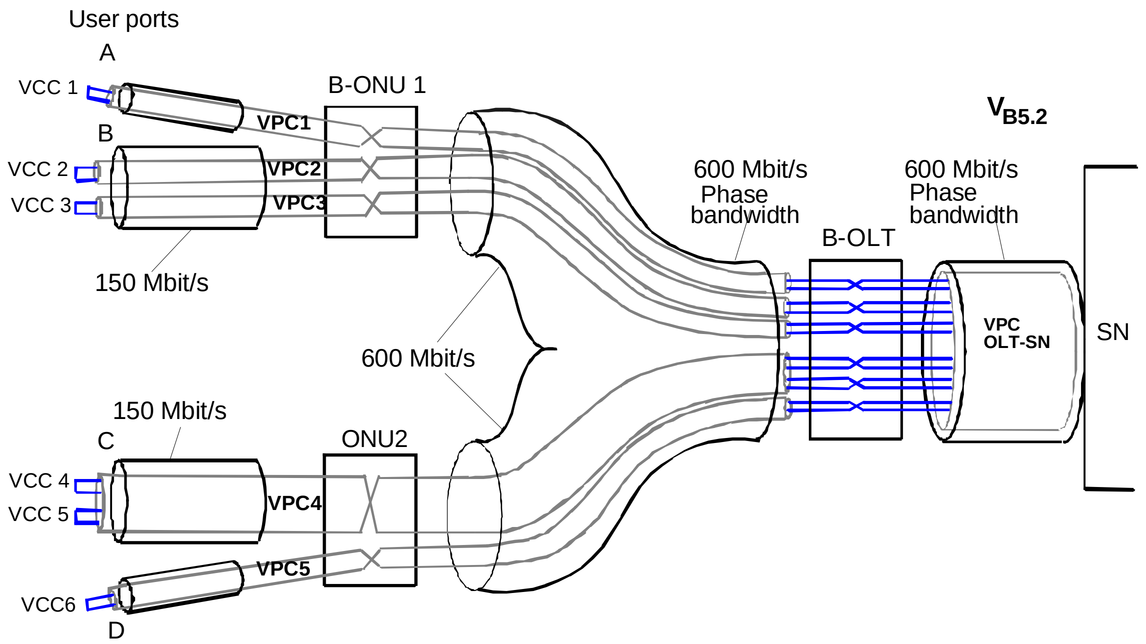


Figure A.3: Alternative solution

In the downstream direction the OLT terminates the VPCs, carrying switched VCCs, coming from the XCs, extracting from each of them all the switched VCCs relevant to a single customer. All the semi-permanent VPCs already relevant to a single customer, carrying leased lines (Virtual Private Networks) are simply VP cross-connected in the OLT and the ONU.

The switched VCCs coming from the same service node and relevant to the same customer are inserted in a customer specific VPC.

If the same customer is connected to service node 1 with a certain group of VCCs and to service node 2 with another group of VCCs, each group is inserted in a specific VPC.

In this way from the OLT directly to each customer there is a group of VPCs, each of them containing a certain number of VCCs. Each VPC of this group will be called in the following a UNI VPC, as its termination on the customer side will be in the NT2 or in the TE.

The ONU is completely transparent to VCCs.

In the usptream direction the OLT performs the specular functions, terminating the UNI VPCs, VP cross-connected (in order to change the UNI VPI value in a 12 bit VPI value) in the ONUs. The VCCs extracted from the UNI VPCs are then properly inserted in the VPCs going to the different switches.

The ONUs need to include, additionally with respect to the downstream direction, VPC (and optionally also VCC) policing functions.

The number of VCCs contained in each VPC can vary dynamically, depending on the user demand, and is determined on the basis of signalling messages between the customer and the service node. The LE interacts with the OLT to properly control VCCs through the broadband bearer channel control protocol or in equivalent way.

When a new VCC is activated, both the service node and the OLT (through the broadband BCC protocol) know which UNI VPC the new VCC has to be inserted in: the VPC is in fact a part of the LUP, as presently defined in SPS3.

The OLT then modifies, when and if required, using an internal control protocol, the VPC policing parameters, relevant to the upstream VPC, in the ONU supporting the LUP involved, and all the other bandwidth related internal control functions (bandwidth control over the PON).

The modification of VPC policing parameters is required to prevent not authorized bandwidth utilization, which could damage, in a shared access system, traffic coming from other customers. VPC bandwidth has to correspond to the sum of VCCs peak bandwidth.

VPC policing functions need to be inserted in the ONU, as the ONU is the first ATM multiplexing point in the network.

NOTE: Equivalent policing operations at VC levels are required in case the ONU operates at VC level.

In the downstream direction, apart from the proper VCI conversion in the OLT, no other operations have to be performed on a call by call basis in the OLT or in the ONU. The VPI conversion, required in the ONU, from the $V_{B5.2}$ 12 bit VPI value to the 8 bit UNI VPI value, are operated by the management plane on a semi-permanent basis.

The situation would be different if the ONU should operate also at VC level: in this case it should perform proper VCI conversion and VCC set-up/release functions every time a new VCC has to be activated or released.

The solution proposed can be thought as an extension of the VPCs part of the LUP from the TE/NT1 up to the OLT (while it would be only between TE/NT1 and ONU in case the ONU operates at VC level).

The difference, with respect to the present definiton of the dedicated UNI from the user to the LE, is that VPC policing has to be performed on each VPC, and VPC bandwidth needs to be always equal to the sum of all the individual VCC peak bandwidths.

A.4.1 Advantages

The most important result of this solution is the capability of performing concentration on a call by call basis, between VPCs pertinent to different ONUs.

This does not mean full ATM statistical multiplexing, because also in the proposed solution each VPC is given the peak bandwidth: full statistical multiplexing in upstream direction can be studied and applied for future systems, when the upstream bandwidth demand could increase.

It has also to be outlined that in downstream direction concentration (and also statistical multiplexing) is directly performed be the LE on the $V_{B5.2}$ interface.

This is important to be understood, because the nature of the traffic will be mostly asymmetric, and the greatest efficiency will be required in the downstream direction.

The simple application of presently accepted assumptions (static VP bandwidth) would prevent also the VP bandwidth dynamic allocation in the downstream direction.

An important additional advantage of the proposed solution is the simplification of the ONU O&M functions (no longer required to be operated at VC and VP level, but only at VP level), while maintaining the same degree of fault detection, performance monitoring and reporting.

Annex B: Bibliography

- ITU-T Recommendation I.414 (1993): "Overview of Recommendations on layer 1 for ISDN and B-ISDN customer accesses";

- DE/SPS-03019-1: "Broadband Integrated Services Digital Network (B-ISDN); Q3 interface for the management and control of the ATM switching network element";

- DE/SPS-03045-1: "V interfaces at the digital Service Node (SN); Management interfaces associated with the $V_{B5.2}$ reference point; Part 1: Interface specification";

- DE/SPS-03046-1: "V interfaces at the digital Service Node (SN); Interfaces at the $V_{B5.1}$ reference point for the support of broadband or combined narrowband and broadband Access Networks Part 1: Interface specification";

- DE/SPS-03047-1: "V interfaces at the digital Service Node (SN); Interfaces at $V_{B5.2}$ reference point for the support of broadband or combined narrowband and broadband Access Networks; Part 1: Interface specification";

- DE/SPS-03049-1: "V interfaces at the digital Service Node (SN); Management interfaces associated with the $V_{B5.1}$ reference point; Part 1: Interface specification";

- ETR 249 (1996): "Transmission and Multiplexing (TM); Harmonisation of transport network architecture and protocol reference model for the transport of Asynchronous Transfer Mode (ATM) cells";

- DE/TM-3018: "Digital section for a monomode distribution network".

History

Document history	
November 1996	First Edition

ISBN 2-7437-1015-2
Dépôt légal : Novembre 1996