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SERIES G: TRANSMISSION SYSTEMS AND MEDIA

Digital transmission systems – Digital sections and digital
line system – General

**Framework recommendation on functional
access networks (AN)**

**Architecture and functions, access types,
management and service node aspects**

ITU-T Recommendation G.902

(Previously «CCITT Recommendation»)

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FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T 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 World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation G.902 was prepared by ITU-T Study Group 13 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 2nd of November 1995.

NOTE

In this Recommendation, the expression “Administration” is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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SUMMARY

The evolution of the existing network in the local area to other switching and transport technologies requires a new concept for the implementation of access networks as a common infrastructure for all types of user accesses to the service nodes. Although there is a strong trend to use optical fibres as the transport medium for an access network, other transmission media shall not be excluded from the access network concept.

Access networks shall be capable of supporting existing types of accesses and digital bearer capabilities as well as broadband accesses. The objective of this Recommendation is to describe an access network concept that provides flexibility towards future access types, e.g. for interactive video services.

Access networks need to be connected to the service nodes by use of interfaces (Service Node Interfaces) with flexible multiplexing and/or concentration capability. Existing service node interfaces may not be sufficient for upcoming service demands especially not if broadband access types need to be incorporated.

FRAMEWORK RECOMMENDATION ON FUNCTIONAL ACCESS NETWORKS (AN)

ARCHITECTURE AND FUNCTIONS, ACCESS TYPES, MANAGEMENT AND SERVICE NODE ASPECTS

(Geneva, 1995)

1 Scope

This Recommendation defines the functional Access Networks and the functions and requirements above the transmission media layer according to Recommendation G.803. The layers within transmission media layer are outside the scope of this Recommendation.

This Recommendation identifies and describes:

- the architecture of the Access Network and its relation to the Service Nodes;
- the access types considered to be supported by the Access Network;
- the bearer transport capabilities and requirements;
- the management concept and requirements in conjunction with the Service Nodes; and
- the operation and control requirements of accesses,

which should be supported by the detailed functional specification of Access Networks and identified interfaces in the Access Network and of the Service Node Interfaces.

This concept does not constrain implementation of the provisions and requirements in equipment using different transmission media or technology. Nevertheless other Recommendations may be applicable for the implementation of the transmission media layer aspects.

The purpose of this Recommendation is to provide the framework for the future work regarding:

- service node interface Recommendation;
- access network Recommendation;
- service node Recommendation;
- user network interface Recommendation;
- access network internal interface Recommendation;
- definition of access types; and
- definition of access bearer capability requirements.

Because new technologies for switching, transport and control are evolving rapidly it is important to define this framework in a timely way as a basis for specifying interfaces. Nevertheless, the same speed of evolution that makes it necessary to have a timely framework document assures that whatever is written only reflects the current state of technology. Therefore, it will be subject to the need for frequent updating in order not to constrain that evolution.

The functional requirements for the Access Network are defined for the handling and transport of digital signals only. Analogue signals and bearers shall either be converted to digital signals or bearers, which may then be supported by the functional Access Network, or may be combined with the transport signals of the functional Access Network on the media dependent network layer for the transport on the same medium. This shall not have any impact on the requirements, functions and procedures of the functional Access Network and is therefore not within the scope of this Recommendation.

The functional Access Network can support multi-hosting, but as a consequence of the definition that the Access Network does not interpret signalling, multi-homing, as defined in clause 3, is not supported.

Annex A describes Access Network architecture aspects concerning access types and access functions for the support of the defined handling of access types.

Appendix I provides the current information available concerning access types and access bearer capability requirements which may be supported in access network implementations. The tables need frequent updating according to the status of work on other standards in ITU-T.

Appendix II gives examples of the lower network layers of access networks.

Appendix III gives examples of configurations that integrate circuit mode type and ATM type accesses into one Access Network using different network layers.

2 References

The following Recommendations 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 are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- [1] ITU-T Recommendation G.803 (1993), *Architecture of transport networks based on the Synchronous Digital Hierarchy (SDH)*.
- [2] ITU-T Recommendation I.112 (1993), *Vocabulary of terms for ISDNs*.
- [3] ITU-T Recommendation I.414 (1993), *Overview of Recommendations on layer 1 for ISDN and B-ISDN customer accesses*.
- [4] CCITT Recommendation M.3010 (1992), *Principles for a telecommunications management network*.
- [5] ITU-T Recommendation G.960 (1993), *Access digital section for ISDN basic rate access*.
- [6] ITU-T Recommendation G.962 (1993), *Access digital section for ISDN primary access at 2048 kbit/s*.
- [7] ITU-T Recommendation G.963 (1993), *Access digital section for ISDN primary access at 1544 kbit/s*.
- [8] ITU-T Recommendation G.964 (1994), *V-interfaces at the digital Local Exchange (LE) – V5.1 interface (based on 2048 kbit/s) for the support of Access Network (AN)*.
- [9] ITU-T Recommendation G.965 (1995), *V-interfaces at the digital Local Exchange (LE) – V5.2 interface (based on 2048 kbit/s) for the support of Access Network (AN)*.
- [10] ITU-T Recommendation Q.512 (1995), *Digital exchange interfaces for subscriber access*.
- [11] ITU-T Recommendation Q.2512¹⁾, *Network node interfaces for subscriber access*.
- [12] ITU-T Recommendation G.805 (1995), *Generic functional architecture of transport networks*.
- [13] ITU-T Recommendation I.430 (1993), *Basic user-network interface – Layer 1 specification*.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this Recommendation, the following definitions apply in addition to those Recommendations listed in clause 2.

3.1.1 access (user access): See Recommendation I.112. See also ISDN Customer Access in Recommendation I.414.

3.1.2 access bearer capability: The maximum information transport capacity supported by the access for a particular customer (which includes the Access Network and the relevant Service Node) at a particular UNI. This access bearer capability may be used for one or more than one connection at the same point in time and cannot exceed the UNI net bit rate, but may be lower to meet the specific needs of the customer and/or the provider(s) of the access.

3.1.3 access bearer structure: The structure of the access bearer capability for application information for services, signalling, operation and maintenance, as required for a particular customer access and UNI. The structure may be according to the principles of circuit mode, packet mode, frame mode, Asynchronous Transfer Mode (ATM) or any mix of several modes.

¹⁾ Presently at the stage of draft.

3.1.4 access connection element: See Recommendation I.112.

3.1.5 access network (AN): An implementation comprising those entities (such as cable plant, transmission facilities, etc.) which provide the required transport bearer capabilities for the provision of telecommunications services between a Service Node Interface (SNI) and each of the associated User-Network Interfaces (UNIs). An Access Network can be configured and managed through a Q3 interface. In principle there is no restriction on the types and the number of UNIs and SNIs which an Access Network may implement. The access network does not interpret (user) signalling.

3.1.6 AN system management function (AN-SMF): AN System Management function coordinates operations and maintenance of the User Port function, Service Port function, Core function and Transport function within the AN. It coordinates time critical management and operation requirements for the allocated user ports with the Service Node via the SNI. It communicates with the TMN via the Q3 interface for the purpose of being monitored and/or controlled.

3.1.7 AN transport layer: The AN transport layer consists of the transmission Media Layer, the Path layer and the Circuit Layer as defined in Recommendation G.803.

3.1.8 circuit layer: A layer which is concerned with the transfer of information between the circuit layer Access Points (AP)s. It is independent of the transmission path layer. The circuit layer provides users with telecommunication services such as circuit switched services, packet switched services and leased line services. Different circuit layers can be identified according to the services provided.

NOTE – This definition is based on Recommendation G.803.

3.1.9 core function (CF): This function adapts the individual User Port or Service Port bearer requirements into common transport bearers. The core function can be distributed in the AN.

3.1.10 functional group: See Recommendation I.112.

3.1.11 multi-homing: The dynamic associations of a user port or of an access bearer capability set of a user port to a service node selected from a set of SNs on a call by call basis.

3.1.12 multi-hosting: The change of the static association of a user port or of an access bearer capability set of a user port from one service node to another service node through re-provisioning.

3.1.13 multiplexing layer: A layer which may be media-dependent and which is concerned with the transfer of information between multiplex section layer access points.

NOTE – This definition is based on Recommendation G.803.

3.1.14 path layer: A layer which is concerned with the transfer of information between the transmission path layer APs in support of one or more circuit layers. The path layer is independent of the transmission media layer.

NOTE – This definition is based on Recommendation G.803.

3.1.15 physical media layer: A layer which is concerned with the actual medium, e.g. optical fiber, metallic pair, coax cable or radio, which supports the section layer network.

NOTE – This definition is based on Recommendation G.803.

3.1.16 q3 reference point: It is an access point for management information, configuration control, performance monitoring and maintenance as defined in Recommendation M.3010. A Q3 interface may be implemented at the Q3 reference point.

3.1.17 regenerator section layer: A layer which is media dependent and which is concerned with the transfer of information between regenerator section layer access points.

NOTE – This definition is taken from Recommendation G.803.

3.1.18 section layer: A layer which is concerned with the transfer of information between the section layer APs in support of one or more path layers, e.g. SDH and PDH paths.

NOTE – This definition is based on Recommendation G.803.

3.1.19 service layer: It is a layer concerned with the requirements of the various communications services.

3.1.20 service node (SN): A network element that provides access to various switched and/or permanent telecommunication services. In case of switched services, the SN is providing access call and connection control signalling, and access connection and resource handling.

3.1.21 service node interface (SNI): The Service Node Interface is an interface which provides customer access to a service node.

3.1.22 service port: An implementation of the service port function.

3.1.23 service port function (SPF): This function adapts the specific SNI requirements into the core and system management functions.

3.1.24 shared UNI: A UNI implementation with a single transmission media layer termination that supports multiple logical accesses which are provisioned independently to separate SNs. Each logical access has a corresponding logical UPF in the access network.

3.1.25 signalling: See Recommendation I.112.

3.1.26 SNI bearer capability: The maximum bit rate which is supported for a given SN. In case of circuit mode it is the bit rate for all the bearer channels provisioned to this SNI. In case of ATM it is the cell rate required (e.g. peak cell rate, sustainable cell rate) for the efficient application of services to be provided for the connections established through this SNI.

3.1.27 transmission media layer: A layer which may be media-dependent and which is concerned with the transfer of information between section layer access points in support of one or more path layer networks.

NOTE – This definition is based on Recommendation G.803.

3.1.28 transport function (TF): This function provides the network connections for the common bearers between different locations and the media adaptation.

3.1.29 UNI bearer capability: The maximum bit rate which is supported for a given user. In case of ATM this cannot exceed the bit rate, associated exclusively with transferring ATM cells, which the physical layer supports, but may be lower if required, to meet specific needs of the user and/or the network provider. Any such lower bit rate is not a limitation of the physical layer at the UNI, but is controlled by higher layers.

3.1.30 user network interface (UNI): See Recommendation I.112.

3.1.31 user port: An implementation of the User Port Function.

3.1.32 user port function (UPF): This function adapts the specific UNI requirements into the core and system management functions.

3.2 Abbreviations

For the purposes of this Recommendation, the following abbreviations are used:

AAL	ATM Adaptation Layer
AN	Access Network
AN-SMF	Access Network System Management Function
AP	Access Point
ATM	Asynchronous Transfer Mode
BA	Basic Access
B-ISDN	Broadband ISDN
CE	Circuit Emulator
CF	Core Function
CL	Circuit Layer
CM	Circuit Mode
CPE	Customer Premises Equipment
DS	(access) Digital Section

ET	Exchange Termination
ET-L1	ET-Layer 1 (of the OSI protocol layer model)
ET-L2	ET-Layer 2 (of the OSI protocol layer model)
IN	Intelligent Network
ISDN	Integrated Services Digital Network
MCF	Message Communication Function
MIB	Management Information Base
MPH	Management primitive of the PPhysical layer (of the OSI protocol layer model)
NEF	Network Element Function
NT	Network Termination
OSF	Operations System Function
OSF _{AN}	Operations System Function of the Access Network
OSF _{SN}	Operations System Function of the Service Node
PDH	Plesiochronous Digital Hierarchy
PH	Primitive of the PPhysical layer (of the OSI protocol layer model)
PRA	Primary Rate Access
PSTN	Public Switched Telephone Network
SDH	Synchronous Digital Hierarchy
SMF	System Management Function
SN	Service Node
SNI	Service Node Interface
SN-SMF	Service Node System Management Function
STM	Synchronous Transfer Mode
SPF	Service Port Function
TCP	Termination Connection Point
TE	Terminal Equipment
TF	Transport Function
TM	Transmission Media Layer
TMN	Telecommunications Management Network
TP	Transmission Path Layer
UNI	User Network Interface
UPF	User Port Function
VC	Virtual Channel
VP	Virtual Path

4 Access Network functional architecture and related functions

4.1 Introduction

The role and function of Access Networks should be considered in the context of a total telecommunications network. A telecommunications network comprises all the entities (such as equipment, plant, facilities) which together provide telecommunication services between different locations. The AN, being part of the access connection element, is responsible for the provision of the user network interface for the access of the user to telecommunication services. The entities that actually provide the service are the Service Nodes.

An Access Network is delimited by its interfaces. Users are connected via a User Network Interface (UNI) to the network. The AN is connected to the SN via the Service Node Interface (SNI) and to the TMN via a Q3 interface.

4.2 General Access Network architecture and boundaries

Figure 1 shows the AN with the UNI, SNI and Q3 interface as the boundaries to other network entities.

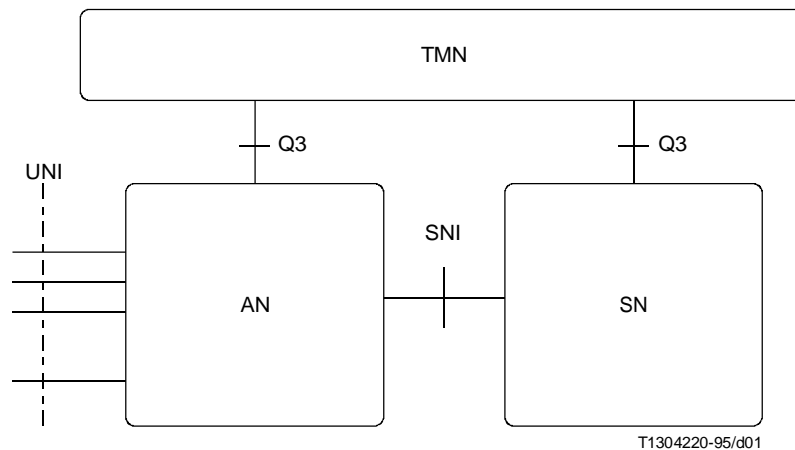


FIGURE 1/G.902
Access Network boundaries

The AN may be connected to multiple Service Nodes. In this way the AN can provide access to SNs that support specific services, but also to multiple SNs that support the same service. The association of a UNI to the SN is static, i.e. it is established through coordinated provisioning with the relevant SN. The allocation of access bearer capacity to an SN is also established through provisioning. From the point of view of the SNs this implies that the AN is perceived as subdivided into multiple virtual ANs, at least one for each SN, but implemented within one physical configuration with integrated management of all of the AN resources. It may be possible to allow for dynamic assignment of access bearer capacity by the SN, but this requires a mechanism by which the SN can establish the capacity available within the topology of an AN, which is for further study.

4.3 General protocol model for Access Network

The functional architecture of the AN is based on the layered approach defined in Recommendation G.803. This model is used for the definition of interaction of peer entities within the AN. Figure 2 describes the layers and their relationships.

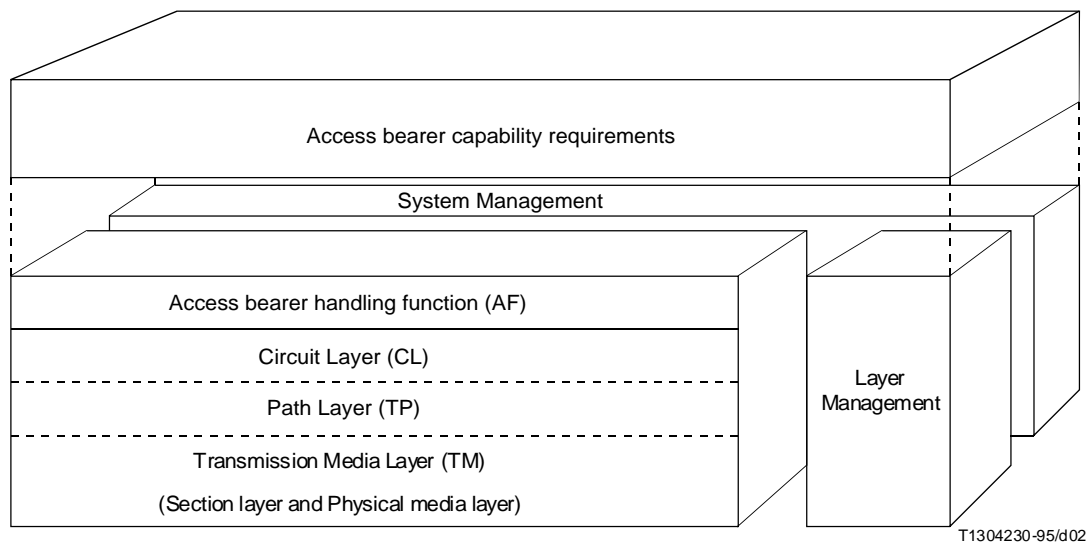


FIGURE 2/G.902
Example of a general protocol reference model for AN

4.4 Definition of individual functional groups

For the purpose of a more detailed description, the AN is broken down into the function groups User Port Function, Service Port Function, Core Function, Transport Function and AN-System Management Function which are defined in this subclause. Figure 3 gives an example of one AN functional architecture and how each of the functional groups are interconnected.

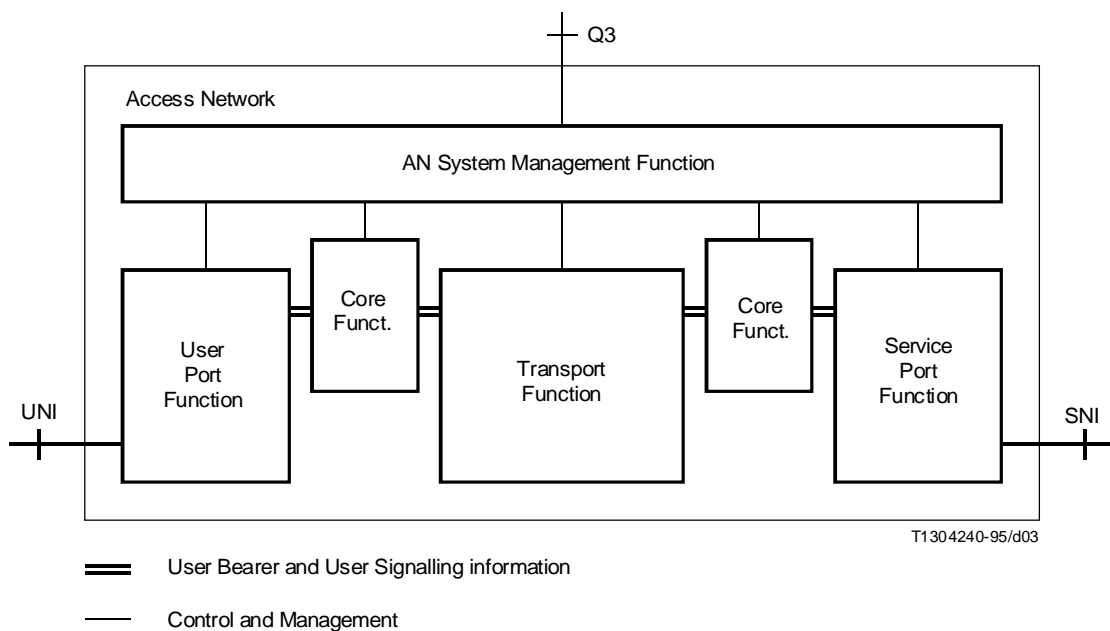


FIGURE 3/G.902
Example of functional architecture of an Access Network

Figure 4 shows an example of the layers that are processed in each functional group based on the example given in Figure 3.

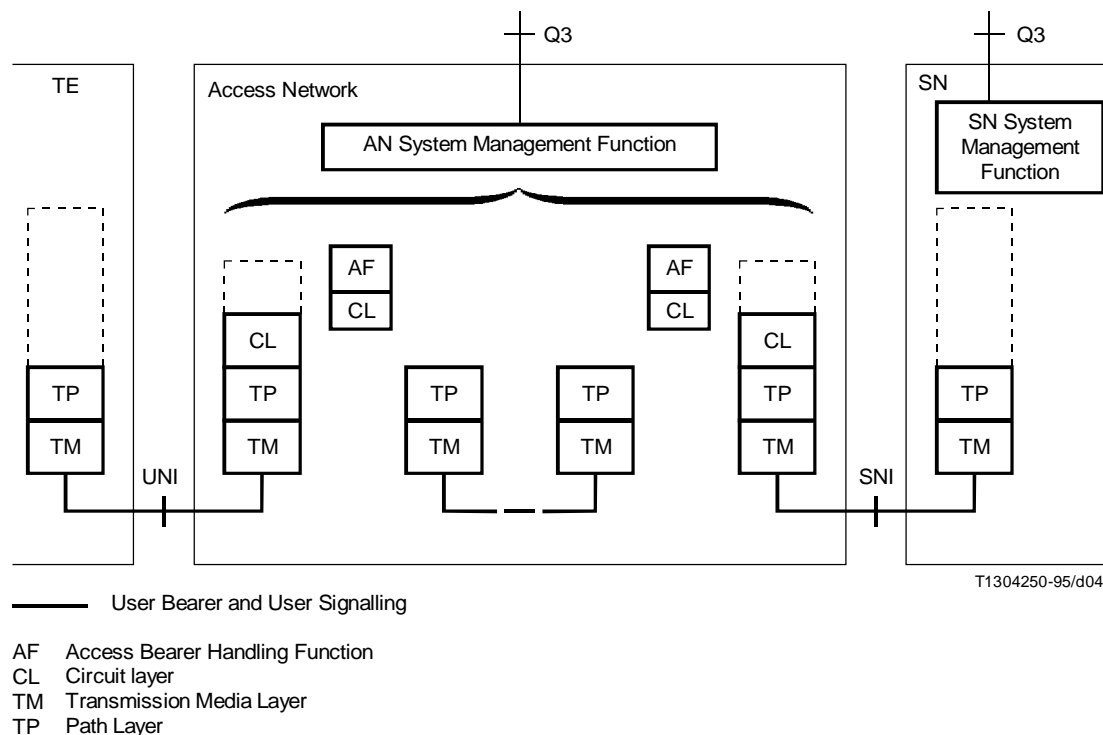


FIGURE 4/G.902

Functional architecture of an Access Network from a transport point of view

4.4.1 User Port Function

The User Port Function (UPF) adapts the specific UNI requirements to the core and management functions. The AN may support a number of different accesses and user network interfaces which require specific functions according to the relevant interface specification and the access bearer capability requirements, i.e. bearers for information transfer and protocols. Refer to clause 5 and Appendix I for further information on user network interfaces and accesses.

Examples of user port functions are:

- termination of the UNI functions;
- A/D conversion;
- signalling conversion;
- activation/deactivation of UNI;
- handling of the UNI bearer channels/capabilities;
- testing of UNI;
- maintenance of UPF;
- management functions;
- control functions.

4.4.2 Service Port Function

The Service Port Function (SPF) adapts the requirements defined for a specific SNI to the common bearers for handling in the core function and selects the relevant information for treatment in the AN system management function.

Examples of service port functions are:

- termination of the SNI functions;
- mapping of the bearer requirements and time critical management and operational requirements into the core function;
- mapping of protocols if required for particular SNI;
- testing of SNI;
- maintenance of SPF;
- management functions;
- control functions.

4.4.3 Core Function

The Core Function (CF) is located between the UPF and SPF to adapt the individual user port bearer or service port bearer requirements into common transport bearers. This includes the handling of protocol bearers according to the required protocol adaptation and multiplexing for transport through the AN. The core function can be distributed within the AN.

Examples of core functions are:

- Access bearer handling:
 - bearer channel concentration;
 - signalling and packet information multiplexing;
 - circuit emulation for the ATM transport bearer.
- Management functions.
- Control functions.

4.4.4 Transport Function

The Transport Function (TF) provides the paths for the transport of common bearers between different locations in the AN and the media adaptation for the relevant transmission media used.

Examples of transport functions are:

- multiplexing function;
- cross connect function including grooming and configuration;
- management functions;
- physical media functions.

4.4.5 AN System Management Function

The AN System Management Function (AN-SMF) coordinates the provisioning, operations and maintenance of the UPF, SPF, CF and TF within the AN. Further it coordinates operation functions with the SN via the SNI and the user terminal via the UNI as defined in the relevant interface specifications.

Examples of AN system management functions are:

- configuration and control;
- provisioning coordination;
- fault detection/indication;
- usage information and performance data collection;
- security control;
- coordination of time critical management and operation requirements for the UPF and the SN via SNI;
- resource management.

4.5.2 Service Node interface

The Service Node Interface (SNI) is the interface between the AN and a SN. If the AN-SNI side and SN-SNI side is not at the same location, the remote connection of an AN and SN should be used by a transparent transport path (refer to Annex A for further information).

Clause 8 discusses possible SNI interfaces.

4.5.3 Q3 interface

Management of the AN should fit into an overall TMN strategy. An AN should therefore interface to a TMN infrastructure common to all parts of the telecommunications network. It is necessary to have cooperation between different Network Elements [e.g. AN(s) and SN(s)] regarding the management of the UPF, TF and SPF to form the access and the access bearer capability as subscribed to by the customer. Therefore, standardized Q3 management interfaces are needed.

Clause 7 provides detailed information on the management functions in the AN and the information exchange with the TMN via the Q3 interface.

5 Support of access types in Access Networks

The access network needs to support a number of different access types to meet the customers needs. This includes the access types for:

- on-demand services (including semi-permanent leased lines), being supported by a Service Node interface connecting the access network to a Service Node;
- permanent leased lines services, being supported by a dedicated Service Node for permanent leased lines or the general transport network;
- other types of services not yet defined in all the necessary details so far.

It is evident, that a (user) access provided through an Access Network has to provide the same access bearer capability at the User Network interface, and therefore to the customer equipment, as in the directly connected access case. This ensures, that the user does not experience any difference between the various access implementations and thus the same “service” will be delivered regardless of the access implementation within the network.

Further, the required access bearer capability and other functions for a given user port form the basis for the definition of the required bearers, control functions and other support functions to be provided by the AN for the definition of Service Node interfaces.

Appendix I provides the access bearer capability information for those user accesses defined in ITU-T Recommendations or mentioned so far. It needs permanent update, if a Service Node interface is to be identified or an existing one is selected for enhancement of the capability. Nevertheless it seems important to keep Appendix I up to date independent from the need to define Service Node interface specifications, because the identified lack of detailed definition of the access bearer capability of a particular access type through Appendix I may initiate the required study by ITU-T to fill the gap, which in turn provides the possibility to cover this access type appropriately in a Service Node specification.

6 Transport capabilities

6.1 Transport layer model

The functional architecture for the access network is based on the layered approach defined in Figure 3-10/G.803. Each layer of the access network, layered as shown in Table 1, has a server/client relationship between any adjacent layers. For example a particular PDH path of the PDH path type is a client of the transmission section layer and a server for a particular circuit layer type. As Recommendation G.805 describes, any subnetwork may be partitioned into a number of smaller subnetworks interconnected by links.

Each element of a layer network may have several attributes which describe detailed capabilities for a particular element, e.g. the circuit mode type element of the Circuit Layer may have the attributes B-channel, H0-channel, H11-channel and others.

The Transmission Media Layer consisting of the Section layer and the Physical media layer is outside the scope of the functional architecture of the access network.

TABLE 1/G.902

Examples of attributes of layers in the access network

Access bearer capability requirements	User bearers	User signalling	Control	Management
Access bearer handling function	To be defined according to the SNI structure			
Circuit layer	Circuit mode type (STM type)	ATM type	Packet mode type	Frame mode type
Path layer	PDH type	SDH type	ATM type	Others
Transmission media layer	Section layer	Outside the scope of the functional architecture of the access network (Note)		
	Physical media layer			
NOTE – For examples of the section and physical media layer, see Recommendation G.803.				

6.2 Transport layer functions and requirements

Each layer is decomposed into three basic functions such as:

- Adaptation;
- Termination; and
- Matrix Connection.

These functions are well-defined in Recommendation G.803. The layered model can be useful in defining the managed objects at the Q3 interface of the access network. Each layer network may be defined independently of the other layers, and is able to have its own operations and maintenance capability such as protection switching and automatic failure recovery against malfunctions or failures and mis-operations. This capability minimizes the operations and maintenance action and the influence in other layers of the access network.

For example, to transport an ATM circuit over an SDH type path, the adaptation function between the ATM circuit layer (client) and the SDH path layer (server) provides for the mapping of the ATM circuit into the SDH path.

Some examples to describe an access network layered model with the method defined in Recommendation G.803 are provided in Appendix II.

7 Management, control and operation issues

Coordinated management of an Access Network (AN) connected to a Service Node (SN) involves all relevant functions of the access network and the service node. However, certain time-critical coordination via the SNI may be required. This clause defines the required management architecture and the AN management functions.

7.1 Functional Management Architecture

Figure 6 shows a general functional architecture from the management point of view. The AN and SN functions defined in the functional architecture are subject of management. They are represented to the TMN by a Q3 Agent and the Management Information Base (MIB). Together, these functions form the Network Element Function (NEF) block according to Recommendation M.3010. The part of the NEF representing the functions being managed, such as UPF, CF, TF and SPF, to the TMN are part of the TMN. They are supported by the Message Communication Function (MCF)

which provides the Q3 protocol stack. In the AN the MCF, Q3 Agent and MIB are located in the AN System Management Function (AN-SMF). The AN-SMF acts as an Agent to the TMN and as a Manager to the AN functions such as UPF, CF, etc.

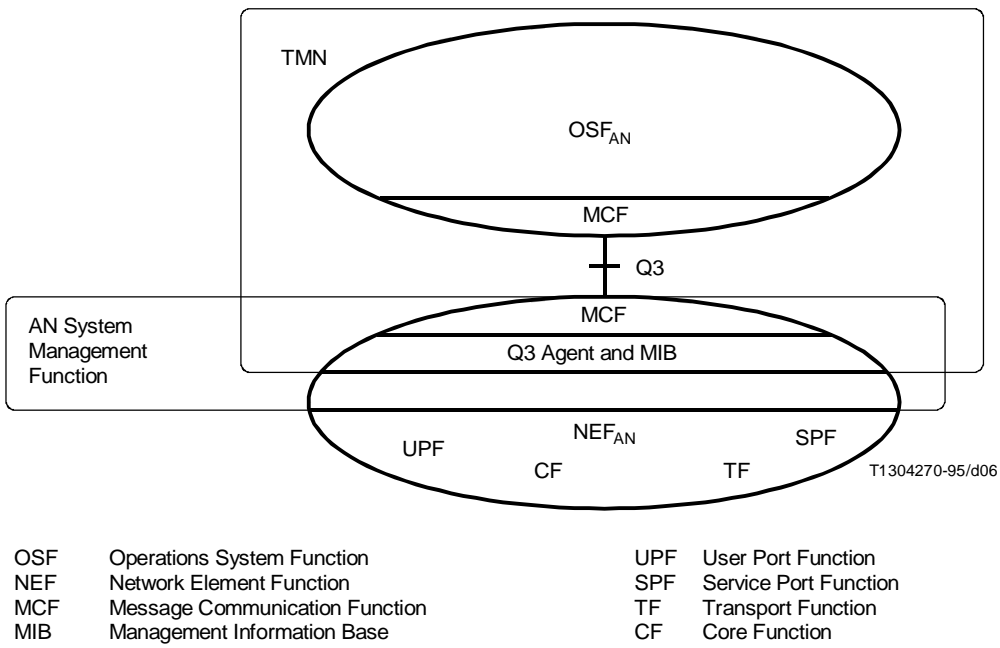
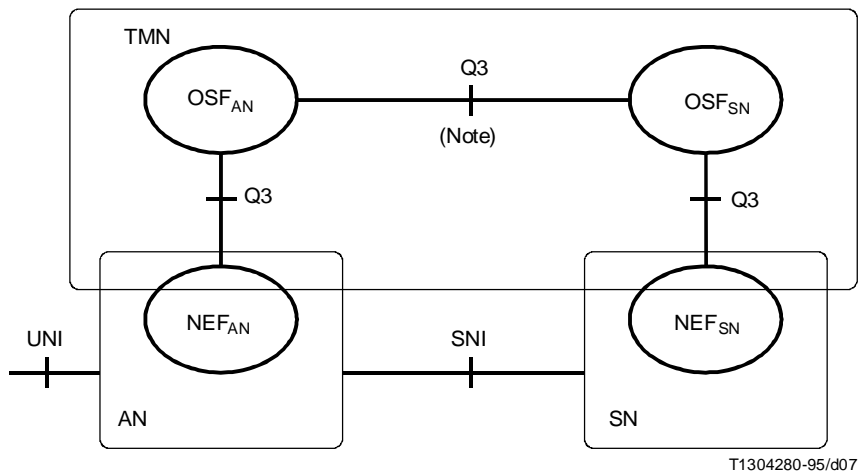


FIGURE 6/G.902

Network Element Function block of the Access Network

The functional architecture in Figure 7 shows only reference points, indicated in the Recommendation M.3010 way by small letters. The Operations System Function OSF_{AN} performs the management of the AN functionality, whereas the OSF_{SN} manages the relevant SN functions. For the coordinated management of an AN connected to an SN a cooperation of both OSFs is required. It can be done via a Q3 or an x reference point. The x reference point is required when OSF_{AN} and OSF_{SN} belong to different operators. In this case they are part of two separate TMNs, one for the AN and one for the SN.



NOTE – In case of different operators this Q3 reference point becomes an x reference point.

FIGURE 7/G.902

Functional management architecture

OSF_{AN} and OSF_{SN} may be structured according to the logical layered architecture described in Recommendation M.3010. It defines four management layers: Element Management, Network Management, Service Management and Business Management Layer. This structure is only functional. A specific implementation may combine any of these layered OSFs into physical OSs.

Figure 8 shows two examples of physical implementations of the management architecture. A Q3 interface is implemented at the AN and at the SN. OSF_{AN} and OSF_{SN} are realized in one physical OS as shown in case a) or in more than one as shown in case b). In case of more than one OS they may belong to different TMNs. According to the Logical Layered Architecture, cooperation between TMNs takes place between the Service Management Layer and/or the Network Management Layer. The definition of the required X interface(s) may be up to the mutual agreement of the partners involved.

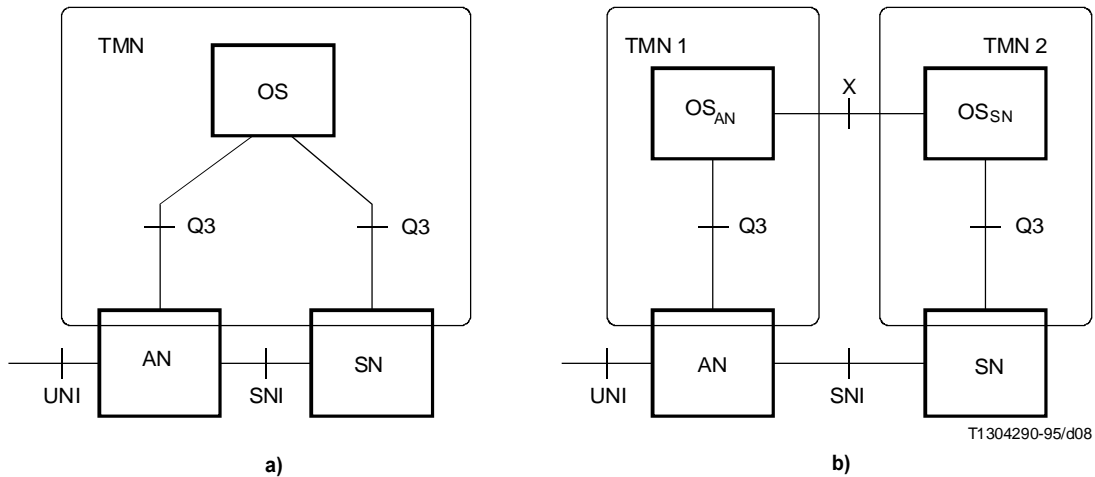


FIGURE 8/G.902

Examples of physical implementations of the management architecture

7.2 Requirements for operation and maintenance of access networks

The OSF_{AN} controls and monitors all the AN functions. This includes the hardware implementation of the user port function. Maintenance of the access line is also under control of the OSF_{AN}. The required test capabilities and the procedures may depend on the access type and its implementation, e.g. separate NT1, copper drop. See also A.4.2.

For the proper provision of services the SN needs to know only the operation status of the access. This includes the status of the user port functions and any other AN internal function relevant for that particular access. The SN needs to distinguish only between operational and non-operational condition of the user access in order to handle the service provisions correctly. It is not required to know the location of failures outside the responsibility of the SN (i.e. the ET function). In addition the SN is required to perform activation and deactivation for the ISDN basic access because of the call control relation of this function.

Annex A describes how the transition from direct access types towards accesses implemented through access networks is considered with regard to operation, testing and maintenance of the access.

7.3 Description of the AN Management Functions

In the following the management requirements of the different functional groups of the AN are described. Control primitives directed to the AN are pre-processed by the AN-SMF before being passed on to the other AN functional groups. Monitor primitives received by the AN system management are pre-processed by the AN-SMF before being transmitted via Q3 and/or SNI or being directed to other AN functions.

In addition to the control and monitoring of the AN functions the AN-SMF provides functionality for Configuration Management (equipment, software), Fault Management, Performance Management and Security Management.

The equipment management keeps track of mapping between implementation and logical representation of the AN. This includes the administration of field replaceable units. For these units the actions in the following management functional areas may apply: Configuration Management (create, read, modify, delete), Fault Management (e.g. failure detection, localization, indication, testing) and Performance Management.

Software Management includes downloading, administration of versions, software failure detection, and recovery mechanisms.

Time critical management functions (e.g. blocking of User Ports due to access network internal failures) that require real-time coordination with Service Node are performed by the AN-SMF and the SN-SMF communicating over the SNI. Further examples are allocation of access bearer capabilities on a per call basis, protection switching of bearer channels for control information or user signalling, blocking of User Ports for testing purposes.

Non-time critical functions (e.g. interface and User Port provisioning) that require a coordinated view on both sides of the SNI are performed via the Q3 interfaces (to the AN-SMF and SN-SMF).

Refer to Annex A concerning further information on access network performance and maintenance.

7.3.1 Management of the User Port Function

7.3.1.1 User Port Control

The **Activation/Deactivation** function (if required and provisioned for that particular user port) is to bring the UNI and the user terminal into active condition or inactive condition. This function can also be used for power down mode control at the user port. If this function is operated from the UNI or the SN this is for service provision purposes while the operation of the function from the OSF_{AN} may be for maintenance purposes if the port is in the non-operational condition as seen by the SN-SMF.

The **Blocking/Unblocking** function is to take the user port into operational or non-operational condition (e.g. due to a detected failure or interruption of services provision capability). After restoration of the user port functions the port should be unblocked in cooperation with the SN. It can be invoked from the SN-SMF or the OSF_{AN} .

The **Configuration** function is for conditioning of the particular user port according to the UNI specification and the allocation of optional functions and provisions for a requested access bearer capability (e.g. for Recommendation I.430 UNI, enabling of power feeding and enabling of activation/deactivation). It can only be invoked from the OSF_{AN} .

The **Testing** function is for failure localization within the user port and the UNI, but this may include the user equipment in part as well, if possible and appropriate to the particular user port. It can only be invoked from the OSF_{AN} . The user port must be in the non-operational condition before a test can be applied.

7.3.1.2 User Port Monitoring

The **Failure Detection/indication** function is to identify whether the user port functions are available or not and to indicate the “unavailable” condition. This may then cause blocking of the user port to stop service provision from the SN-SMF through a non-operational port, further this may then trigger user port testing for failure localization and restoration. Failure information is reported to the OSF_{AN} . Blocking information is reported to the SN-SMF.

The **Performance Monitoring** function provides performance information about the UNI, e.g. bit errors. Performance status information is reported to the OSF_{AN} and to the SN-SMF for operation purposes relevant to that particular user port.

7.3.1.3 User Port related Status Events

The **Blocking/Unblocking Event** reports changes of the operational status due to failures or commands. It may be sent to the OSF_{AN} and the SN-SMF.

7.3.2 Management of the Core Function

Core Management functions are those necessary for control and monitoring of bearer allocation, adaptation and protocol handling. These management functions are applied to the Core Function via the AN System Management Function and controlled by the OSF_{AN} in provisioned operation. For time-critical operation (i.e. on per call basis), the management of the Core Function is initiated through the SNI but coordinated by the AN-SMF.

7.3.2.1 Core Function control

Configuration of the Core Function is necessary to control the bearer allocation, bearer adaptation, protocol bearer allocation and protocol mapping function. Non-time critical configuration is controlled from the OSF_{AN} , whereas time critical control is performed via the SNI.

7.3.2.2 Core Function monitoring

The **Failure Detection/indication** function is to identify whether the core function is available or not and to indicate the “unavailable” condition. This may then trigger core testing for failure localization and restoration. Failure information is reported to the OSF_{AN} in case of non-time-critical and to SN-SMF in case of time-critical failure indications.

The **Performance Monitoring** function provides performance information detected by the Core Function, e.g. protocol errors. Performance status information is reported to the OSF_{AN} .

7.3.3 Management of Service Port Function

7.3.3.1 Service Port Control

Blocking/Unblocking turns the Service Port into non-operational or operational condition, or to reflect failures. It can be invoked from the OSF_{AN} and the SN-SMF.

The Service Port **Configuration** function is for the conditioning of the particular service port according to the SNI specification including capacity and number of channels for each purpose, e.g. bearer channels. It can only be invoked from the OSF_{AN} .

7.3.3.2 Service Port Monitoring

The **Failure Detection/indication** function is to identify whether the Service Port is available or not and to indicate the “unavailable” condition. This may then trigger Service Port testing for failure localization and restoration. Failure information is reported to the OSF_{AN} .

The **Performance Monitoring** function provides performance information detected by the Service Port, e.g. bit errors. Performance status information is reported to the OSF_{AN} .

7.3.3.3 Service Port related Status Events

The **Blocking/Unblocking Event** reports changes of the operational status due to failures or commands. It may be sent to the OSF_{AN} and the SN-SMF.

7.3.4 Management of the Transport Functions

These functions are independent of service related management functions such as User Port Function, Core Function and Service Port Function in order to provide transparent transport capabilities between User Ports and Service Ports within an access network.

7.3.4.1 Transport Function Control

Configuration of the Transport function is for the conditioning of the transmission media layer, the transmission path layer and the circuit layer. It can only be invoked from the OSF_{AN} .

The **Protection Switching** function controls protection switching to maintain the transport capability at the different transport layers. It is controlled by the OSF_{AN}. Autonomous protection switching may occur due to failure detection of performance monitoring.

7.3.4.2 Transport Function monitoring

Failure Detection/indication identifies whether the connections in the different transport layers are operational or not. Failure indications may initiate blocking of affected user ports and/or service ports via the AN-SMF. Failure information is reported to the OSF_{AN}.

The **Performance Monitoring** function provides performance information detected by the Transmission Function, e.g. bit errors. Performance status information is reported to the OSF_{AN}.

7.3.4.3 Transport Function related Status Events

The **Protection Switch Event** reports changes of the occurrence of a protection switch due to failures or performance degradation. It is sent to the OSF_{AN}.

7.3.5 Management of the AN System Management Function

7.3.5.1 AN System Management Function control

The **Configuration** function allows the control of the AN System Management functions such as performance evaluation, event reporting, event logging, security and usage information collection.

The **Auditing** function allows the retrieval of all relevant configuration and status information of the AN functions and AN System Management Function.

7.3.5.2 AN System Management Function monitoring

Failure Detection/indication identifies whether parts of the AN System Management Function are available or not. Failure information is reported to the OSF_{AN}.

7.4 Management Information flows

Table 2 gives the relations between AN-SMF and the access network functions to identify the management information flows identified so far. For a particular type of SNI, some of these flows may not be needed but there may be a need for other relations depending on the required functionality of that SNI. Management functions controlled by the Service Node through an embedded control protocol are not handled by the AN-SMF and therefore do not require the specification of an additional management information flow.

There are two ways to exchange coordination information between SN-SMF and AN-SMF required depending on the impact on the user service:

- non-time-critical information exchange; and
- time-critical information exchange.

Non-time-critical information shall be exchanged via the operations systems, which are connected, for example, by the X interface as described in Figure 8. This concerns coordinated provisioning in AN and SN of the SNI, the user port functions, the core function and the relevant transport functions.

Time-critical information exchange shall be done via the SNI using appropriate protocol functions to be defined. This concerns status information which has direct impact on the service provision capability and real time operation control information such as activation/deactivation of the ISDN basic rate UNI, which may have indirect impact on the service handling. Nevertheless the relevant operations system needs to be informed as well for logging or to trigger consequent actions if required for this condition.

Table 2 only shows direct relations between the different functional groups. Intra functional communication resulting from an external command or an internal event is not shown.

TABLE 2/G.902

Management information flows

Management functions	Management Information Flow						
	UPF	CF	TF	SPF	AN-SMF	OSF _{AN}	SN-SMF
Management of the User Port Function							
User Port Control							
– Activation/Deactivation	X				X	X	X
– Blocking/Unblocking	X				X	X	X
– Configuration	X				X	X	
– Testing	X				X	X	
User Port Monitoring							
– Failure Detection/Indication	X				X	X	
– Performance Monitoring	X				X	X	X
User Port related Status Events							
– Blocking/Unblocking Event	X				X	X	X
Management of the Core Function							
Core Function Control							
– Time-critical Core Function Configuration		X			X		X
– Non-time-critical Core Function Configuration		X			X	X	
Core Function Monitoring							
– Time-critical Failure indication		X			X		X
– Failure Detection/indication		X			X	X	
– Performance Monitoring		X			X	X	
Management of the Service Port Function							
Service Port Control							
– Blocking/Unblocking				X	X	X	X
– Configuration				X	X	X	
Service Port Monitoring							
– Failure Detection/indication				X	X	X	
– Performance Monitoring				X	X	X	
Service Port related Status Events							
– Blocking/Unblocking Event				X	X	X	X
Management of the Transport Function							
Transport Function Control							
– Configuration			X		X	X	
– Protection Switching			X		X	X	
Transport Function Monitoring							
– Failure Detection/indication			X		X	X	
– Performance Monitoring			X		X	X	
– Protection Switching Event			X		X	X	
Management of the AN-SMF							
AN System Management Control							
– Configuration					X	X	
– Auditing					X	X	
AN System Management Monitoring							
– Failure Detection/indication					X	X	
X Functional relation exists							

8 Service Node interfaces and service node requirements

8.1 Types of service nodes

While an AN needs to support a large variety of access types to provide a common infrastructure for this local network area, the situation may be different for the SN.

There may be SNs which may support either:

- one dedicated access type only; or
- more than one access type but all types supporting the same access bearer capability set; or
- more than one access type supporting different access bearer capability sets.

According to the capabilities required for a specific type of SN, a suitable SNI needs to be specified based on the selected access types and access bearer capability and service requirements.

This clause gives some examples of SNs.

8.1.1 Service specific Service Nodes

For those service nodes which support one specific service, Figure 9 shows an example configuration.

Examples of service specific Service Nodes are:

- a) Individual local exchange for:
 - PSTN services.
 - Narrowband ISDN services.
 - Broadband ISDN services.
 - Packet data services.
- b) Individual leased line service node for:
 - Circuit mode based leased line services.
 - ATM based leased line services.
 - Packet mode based leased line services.
- c) Service node for digital video and audio on-demand services in specific configurations.
- d) Service node for video and audio broadcast services in specific configurations:
 - For digital information.
 - For analogue information.

8.1.2 Modular Service Nodes

A Service Node may support more than one type of service. These are called Modular Service Nodes. Figure 10 shows the schematic of this approach.

Possible service node combinations are listed below as examples:

- a) Local exchange for narrowband ISDN and broadband ISDN on-demand services with an ATM based SNI;
- b) ATM node supporting on-demand broadband ISDN services and ATM leased line services with an ATM based SNI.

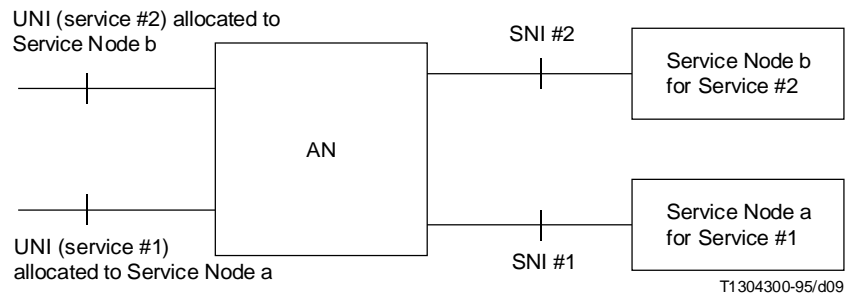


FIGURE 9/G.902
Example configuration for service specific Service Nodes

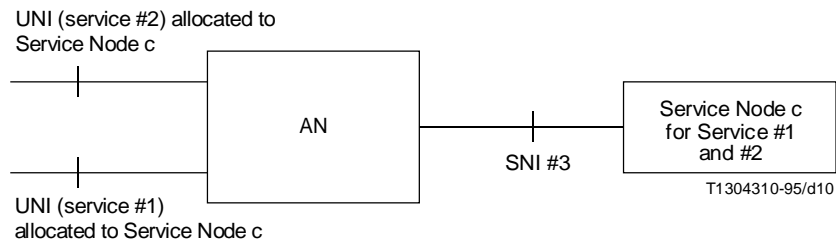


FIGURE 10/G.902
Example configuration for modular Service Nodes

8.2 Service Node Interfaces

According to clause 3, a Service Node Interface is an interface between AN and SN. This Recommendation extends the understanding of Network Node Interface according to Q-Series Recommendations which are concerning the Network Node Interface for customer access. This allows the access of further SNs like leased line service nodes, audio and video service nodes, etc. and the support of the wide spectrum of access types given in Appendix I.

Table 3 gives the access types given in Appendix I and existing SNIs for on-demand service nodes and their coverage as far as standardized for the time being.

Due to the limited functionality of the existing SNIs additional SNIs, especially of the modular type and B-ISDN access types, may be required.

TABLE 3/G.902

Standardized SNIs and their coverage of access types

Reference point class	Access individual			Access integrating	
Service Node reference point Access Type	V1 Rec. I.414 (Note 1)	V3 Rec. I.414 (Note 2)	VB1 Rec. I.414 (Note 5)	V5.1 Rec. G.964 (Note 3)	V5.2 Rec. G.965 (Note 4)
PSTN and narrowband ISDN UNI					
PSTN				X	X
ISDN BA	X			X	X
ISDN PRA, 1544 kbit/s		X			
ISDN PRA, 2048 kbit/s		X			X
Broadband ISDN UNI					
B-ISDN, SDH based, 155 Mbit/s			X		
B-ISDN, cell based, 155 Mbit/s			X		
B-ISDN, SDH based, 622 Mbit/s			X		
B-ISDN, cell based, 622 Mbit/s			X		
B-ISDN, low bit rate, 1544 kbit/s			(Note 7)		
B-ISDN, low bit rate, 2048 kbit/s			(Note 7)		
Data services					
User adaptation is integral part of AN					
User adaptation outside AN	X (Note 6)	X (Note 6)		X (Note 6)	X (Note 6)
<p>NOTES</p> <p>1 V1 is only a reference point, no interface specification exists; V1 allows access for a single UNI only.</p> <p>2 V3 allows access for a single UNI only.</p> <p>3 V5.1 allows access for multiple UNIs.</p> <p>4 V5.2 allows access for multiple UNIs and concentration.</p> <p>5 VB1 allows access for a single UNI only.</p> <p>6 If transported through a bearer channel of a semi-permanent leased line.</p> <p>7 A suitable V-reference point needs to be identified.</p>					

Annex A**Access Network architecture aspects concerning access types and access functions**

(This annex forms an integral part of this Recommendation)

A.1 The access architecture and the relevant Recommendations

According to Recommendation I.414 the (customer) access consists of the customer equipment, the access digital section and the ET function in the local exchange. This includes:

- the layer 1 functions for the provision of the access bearer capability according to the access bearer structure;
- the layers 2 and 3 of the signalling protocol (the access control plane); and
- the access management (access management plane).

Recommendation I.414 then defines the term access connection element for the combination of the access digital section and the ET function.

Recommendation Q.512 defines the Z and the V reference points (i.e. V1 to V5) for access types supporting the narrowband switched services. The equivalent access configurations to these V reference points are defined in Recommendation I.414 and the relevant access digital section specifications, i.e. Recommendations G.960, G.962 and G.963 concerning the reference points V1 to V3 and Recommendations G.964 and G.965 concerning the V5 reference point.

Recommendation Q.2512 defines the V reference points (i.e. VB) for access types supporting broadband as well as narrowband switched services. The equivalent access configurations to this V reference point are defined in Recommendation I.414.

Figure A.1 shows the access architecture as described above.

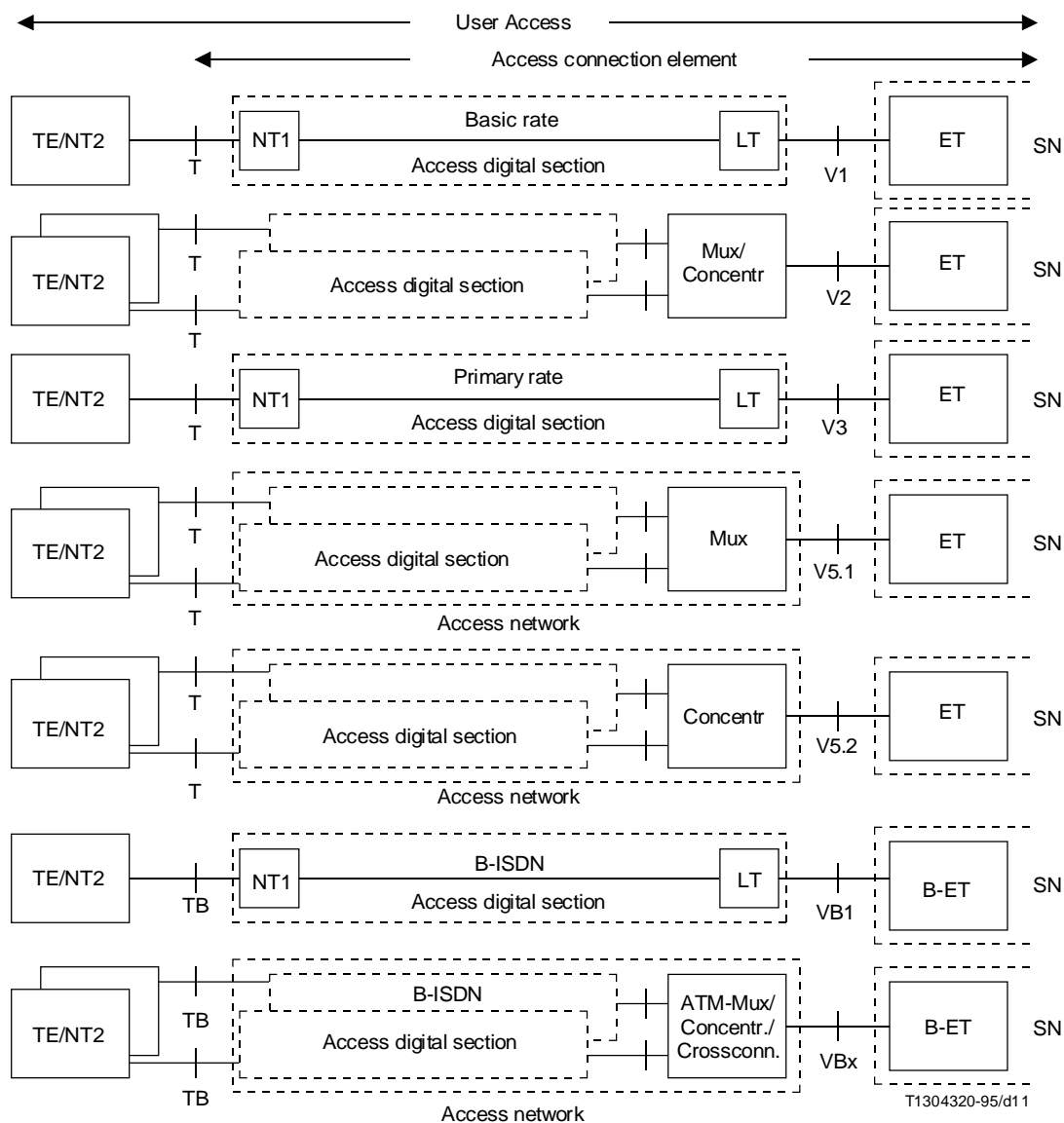


FIGURE A.1/G.902

Access architecture according to Recommendations I.414 and Q.512

A.2 Access connection element implementation cases

Five access connection element implementation cases can be distinguished from the descriptions in Recommendations I.414, Q.512, Q.2512, G.964 and G.965:

- a) the passive access connection element implementation case;
- b) the direct access connection element implementation case;
- c) the remotely connected direct access connection element implementation case;
- d) the remote access connection element implementation case; and
- e) the remotely connected remote access connection element implementation case.

Figure A.2 shows the principles of the different access connection element implementation cases, which are explained below.

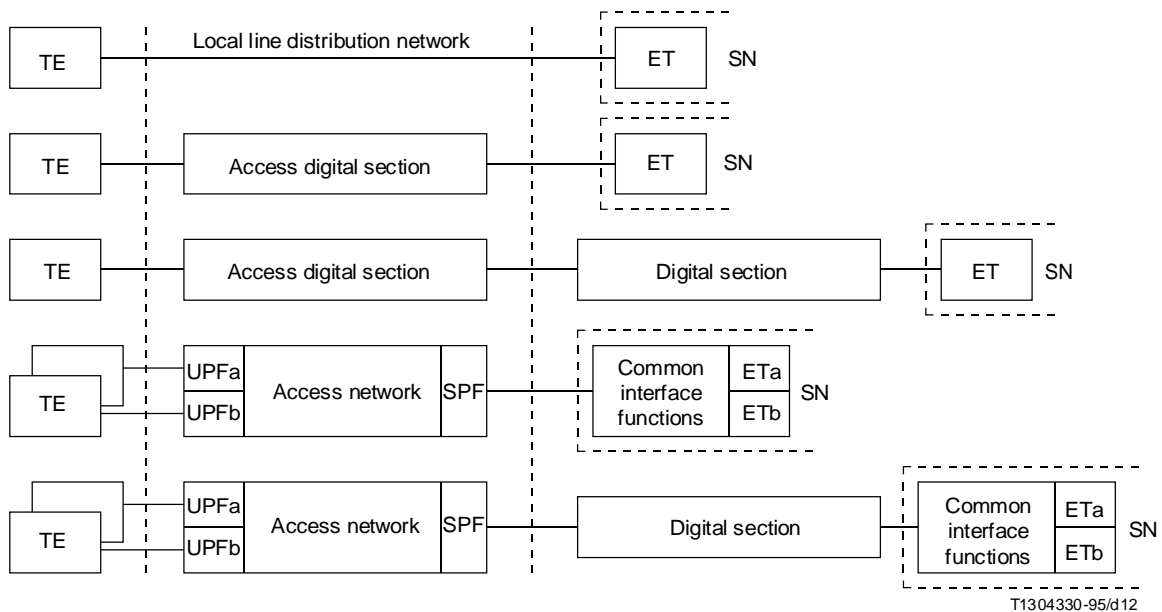


FIGURE A.2/G.902

Access connection element implementation cases

In the **passive access connection element** implementation case, there is typically only the transmission medium provided in the access connection element between the User Network Interface and the ET function in the SN (which may be a local exchange). One example is the analogue PSTN access using a copper pair from the customer premises to the SN.

The **direct access connection element** implementation case connects the User Network Interface to the ET function in the SN through its individual access digital section which is using a transmission system. There is functionally an individual V reference point for any individual customer between the ET function and the access digital section. Examples are the basic access digital section with its associated V1 reference point, the primary rate access digital section with its associated V3 reference point and the broadband access digital section with its associated VB reference point.

The **remotely connected direct access** connection element implementation case connects the User Network Interface to the ET function in the SN through its individual access digital section using a transmission system. But for the provision of the remote access a further digital section is incorporated between the V reference point at the network side of the access digital section and the V reference point at the SN. This additional digital section shall not change the structure and the content of the information at the V reference point at the network side of the access digital section, i.e. it is considered transparent to the information structure and content at the V reference point. In this case there exists the relevant V reference point at the network side of the access digital section and an associated V reference point at the SN.

The **remote access connection element** implementation case uses the concatenation approach of V reference points. This approach allocates the V reference points to either:

- the Access Individual Class of reference points; or
- the Access Integrating Class of reference points.

The Access Individual Class of reference points applies to the case in which the V reference point at the SN is customer individual. The V1 and V3 reference points belong to this class.

The Access Integrating Class of reference points applies to the case in which the V reference point at the SN has a signal structure which is a multiplex of several accesses of the same or of different access types. The V2 and V5 reference points belong to this class. In this case, functionally both, the customer individual access V reference point and the access integrating reference point are present in the access connection element.

The **remotely connected remote access connection element** implementation case uses the remote access connection element but an additional digital section is connecting the V reference point at the Access Network with the one at the SN.

In case of a remote access and providing an interface to the SN in accordance with a V reference point belonging to the Access Integrating Class, the access configuration between the User-Network interface and that particular V-interface is part of the Access Connection Element as defined above, i.e. the Access Network functions are part of the Access Connection Element of a particular access.

A.3 The ET function in the different access connection element implementation cases

The ET function in the access connection element is responsible for the service provision (the service access point) and, in conjunction with this, the ET is responsible for the operation control of the access. In the different access connection element implementation cases, the ET may be implemented in different ways and may have additional functions. This is described in this subclause on the basis of the implementation cases defined in A.2. In general the ET function may be split into:

- ET layer 1 function for coordination between ET layer 2 and the management;
- ET layer 2 function, which is the data link layer for the signalling protocol; and
- ET layer 3 function, which is the signalling protocol;

if appropriate for the type of access. For the ISDN basic access and the primary rate access the ET layer 1 function is defined in Recommendations G.960 and G.962, respectively.

The ET function is entirely implemented in the SN in case of:

- the passive access connection element implementation case;
- the direct access connection element implementation case; and
- the remotely connected direct access connection element implementation case.

In these implementation cases it is often the ET in the SN which monitors the availability and the error performance of the access and can as well initiate tests for failure localization. Figure A.3 shows the functional model of this case.

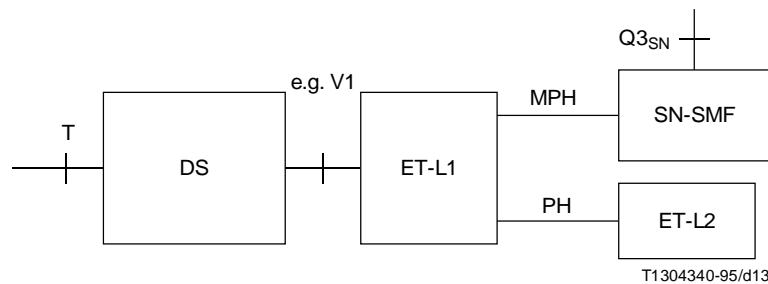


FIGURE A.3/G.902

The ET implementation for passive and direct access type

The ET function may be split between the access network and the SN in case of:

- the remote access connection element implementation case; and
- the remotely connected remote access connection element implementation case.

The main reason for this split is that the access network needs to demultiplex the various bearers for individual handling. Further the access network takes the responsibility for the availability and the error performance monitoring of the access as well as the failure detection and localization, i.e. the ET layer 1 coordination function must therefore be implemented in the access network. Additionally the statistical multiplexing of the signalling protocol requires that the data link layer is partly implemented in the access network, i.e. the identification of a valid frame before further treatment of messages. Figure A.4 shows this case. However there may be particular configurations, especially for the PSTN access type, which may allow the implementation of further ET functions in the access network because this access has only one bearer channel and a simple signalling protocol.

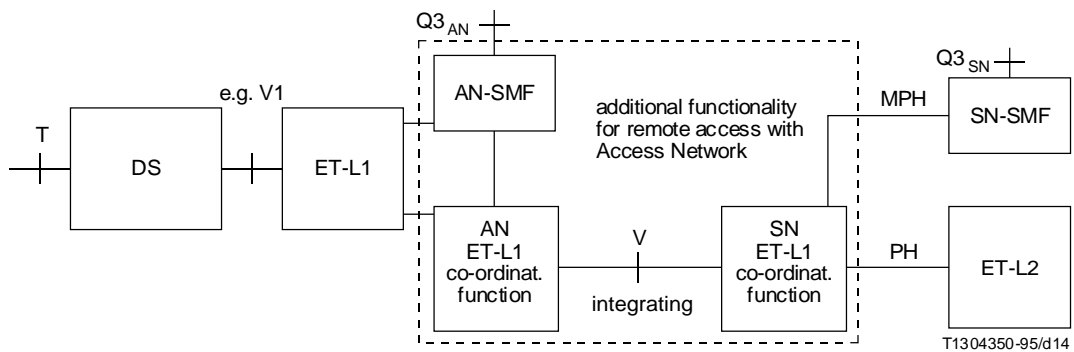


FIGURE A.4/G.902

The ET implementation for the remote access type

Irrespective of the implementation cases there will be always the user individual ET function remaining in the SN as shown in Figure A.5.

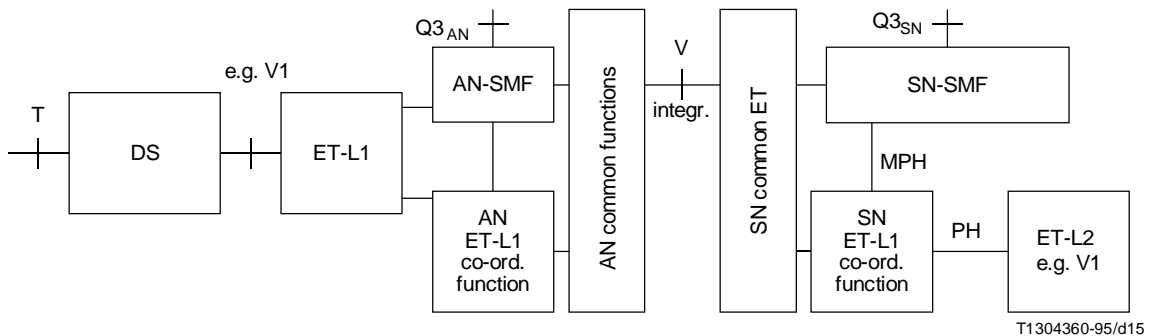


FIGURE A.5/G.902

The common ET and the individual ET

A.4 Access network performance and maintenance

A.4.1 Access network error performance

The access network system management needs to monitor the error performance of the transport function and shall maintain a performance level for all the paths so that there is no restriction in the use of paths for service provision under control of the service node. If the access network cannot maintain the required error performance level for a path, this path should not be used for new connections and thus must be blocked by the system management in the connection handling resource management.

This requirement is needed because the service node does not know which path is used for a particular connection in the connection establishment under control of the service node.

A.4.2 User port maintenance and performance in case of access networks with and without copper drop

Access networks may be implemented with or without a copper drop. In the first case the user port function is provided at the user premises, while in the second case the user port function is provided remotely from the user premises requiring some copper between the user port function and the user premises. In case of an ISDN access this requires then as well a separate NT1 providing the UNI and to terminate the transmission system from the access network.

User port maintenance is the responsibility of the access network irrespective whether there is a copper drop or not. However in case of a copper drop additional test functions may be required for the failure localization on the copper drop.

In case of an ISDN access with a separate NT1 and a copper drop the performance of the transmission system on the copper drop is not part of the access network error performance monitoring function, which is only monitoring the access network transport function performance. If error performance related service provision is required, the service node needs to know the error performance of the customer access. This requires that the error performance information, evaluated for the transmission system on the copper drop, needs to be reported to the SN for the relevant treatment of service requests.

A.5 Multi-hosting and multi-homing

According to the definition given in clause 3 multi-hosting is the change of a static association of a user port from one SNI to another SNI. Before re-provisioning the (logical) user port is statically associated through provisioning with one service node which covers all the information and the signalling bearer channels and capabilities. For the support of the user port operation and maintenance, the relevant coordination information is exchanged between the AN and the SN concerned.

During this condition the other SN is neither involved in any operation of the port nor in any call handling process because the relevant user port is not known from the operation point of view by that SN.

In case of multi-homing the user port needs to be provisioned to both SNs which may be involved in call handling related to the same user even at the same point in time. For this, both SNs need information about the operation and management status permanently and need as well access to the signalling information of that user port. Both may even need to share the information bearers available at the user port. This requires a common resource management for both SNs for the call control function in order to allocate the information bearer resources available at the user port.

This requirement makes it difficult to implement multi-homing for the currently defined circuit mode based UNIs, which have one common channel signalling path even in the passive bus configuration of the ISDN basic access. Secondly the common resource management is not possible for the two SNs especially taking into account that both may belong to competing service providers and that call processing performance requirements may not permit the involvement a further instance in call handling. These are the main reasons for the exclusion of multi-homing from the scope of this Recommendation.

It should be noted that future UNI specifications using the “shared UNI concept” may allow multi-homing of a UNI supporting more than one logical access. Each logical user port function assigned to this access, which covers the signalling and the allocated information bearer capability, may be allocated to any SNI by provisioning and may through this provide service provider selection through one UNI. The service provider selection is then a matter of the user terminal and does not concern the AN and the SNI. This can easily be provided in case of ATM but may as well be provided in new UNI circuit mode based specifications covering more than one logical access through one UNI.

A.6 Accesses for on-demand service and leased line

The AN shall be capable to support different types of accesses for on-demand services and permanent leased line services.

The requirements and provisions for on-demand services access types are discussed in A.1. They contain, besides, the information bearers as well as the signalling bearers for the call control protocol defined for the access.

The access for permanent leased line does not require a signalling bearer in the UNI for the connection control between user terminal and SN because the connection is permanently set-up between the user terminals without user signalling. This does not inhibit the possibility for the user to use part of the bearer capability for a signalling protocol to control service handling facilities in the user terminals concerned. This is however outside the scope of a permanent leased line access and user port function.

Nevertheless both types of accesses require port management function and for some particular UNIs as well as operation functions which provide information about the UNI and access status for management and maintenance.

Because of the implementation of part of ET layer 1 of the ISDN circuit mode access types (i.e. ISDN basic and primary rate access) in the AN, there is the possibility to use one or more circuit mode bearers of the on-demand access type as a leased line bearer. This is described already in Recommendations G.964 and G.965 as the “Permanent line (capability)”. The reason for this new term is that the user port function is still operated by the SN through the coordination function in the AN and thus this permanent line is not fully identical with the permanent leased line. The information bearers allocated to the permanent line in the AN shall not be accessible by the SN and must therefore be excluded from the information bearer capability provisioned in the SN available for on-demand services. The remote endpoint of the permanent line may be a suitable permanent leased line access and UNI or another circuit mode ISDN access and UNI.

Appendix I

Support of access types in Access Networks

(This appendix does not form an integral part of this Recommendation)

This appendix gives information about access types. The access network has to provide to access services at the service nodes. It covers well known services like PSTN as well as upcoming services like video-on-demand. The information is provided in Tables I.1 to I.4.

Wherever access types and user-network-interfaces are well defined and standardized the information is provided in the table together with references to the appropriate standards. On the other hand for a variety of services interface requirements are not standardized at all at the time being. This is reflected in this appendix as well, in order to give advise to ITU or other standardization bodies to focus on these open issues.

Semi-permanent leased lines, i.e. leased lines routed through an on-demand service node, are not discussed separately since from the AN perspective there is no difference to PSTN or ISDN access types. They can be interpreted either as a very long call set-up via user signalling or can be set up by other means (e.g. TMN via Q3 or by IN mechanisms). The procedure is not standardized at this point in time.

For each access type the following information is given:

I.1 Status

This column shows the degree of stability within the standardization process for the access type in ITU or other bodies. Status rating does not imply a specific time frame for realization but reflects the status of knowledge at the time being and the degree of standardization in other organizations regarding service and interfaces. Therefore ratings are to be changed according to standardization progress and contributions to this question.

The meaning of the status rating is as follows:

- I Standardized.
- II Nearly finished standard.
- III At the beginning of Standardization process.
- IV Not treated in any standards body.

I.2 UNI

This column is making reference to UNIs standardized for the individual access type or indicates the necessity to start additional standardization work. UNI is understood to be located at the reference point given in the respective reference.

In the case of ATM (B-ISDN) each UNI is capable of handling several VPs. It is desirable that the total reserved bandwidth for VPs and VCs may exceed the physical UNI bandwidth, which requires that a policing function is performed in the AN.

I.3 Access digital section

This column is making reference to the Recommendation of the corresponding access digital section as far as available. For PSTN and ISDN access types, the access digital section ranges from TE to ET as shown in Annex A.

I.4 Information type

For each access type the different types of information this access type can handle are given. Not all information types are mandatory. Their treatment within the AN may differ from each other.

I.5 Transfer mode

For each information type the transfer mode is given.

I.6 Direction

This column is providing information about the direction and symmetry of the information flow. Upstream information is flowing from the UNI to the SNI, downstream information is flowing from SNI to UNI.

For a part of the access types only symmetrical information flows can be provisioned via TMN or signalling. In the case of ATM, the upstream and downstream cell rate within a given VP and VC can be negotiated between TE and SN independently from each other.

I.7 Required channel rate or cell rate

For each information type the bit rate or range of bit rates that are accessible and usable at the UNI is given.

TABLE I.1/G.902

Information on PSTN and ISDN narrowband accesses

Access information		Interface information		Bearer information			
Access type	Status	UNI	Access digital section	Information type	Transfer mode	Direction	Required channel rate or cell rate
a) PSTN and ISDN narrowband							
PSTN	I	Not defined	Not defined	circuit	CM	b; s	64 kbit/s, octet structure (Note 1)
				signalling	PM (Note 2)	b; s	
				maintenance	PM	b; s	
ISDN basic access	I	Rec. I.430	Rec. G.960	circuit	CM	b; s	1-2 × 64 kbit/s, octet structure
				signalling	PM	b; s	The maximum bit rate for signalling, p- and f-data will be less than 16 kbit/s
				p-data (Note 4)	PM	b; s	
				f-data (Note 4)	PM	b; s	
				control (Note 3)	PM	b; s	
				maintenance	PM	b; s	
ISDN primary rate access, 1544 kbit/s	I	Rec. I.431	Rec. G.963	circuit	CM	b; s	Up to 23 × 64 kbit/s, octet structure
				signalling	PM	b; s	The maximum bit rate for signalling, p- and f-data will be less than 64 kbit/s
				p-data (Note 4)	PM	b; s	
				f-data (Note 4)	PM	b; s	
				maintenance	PM	b; s	
ISDN primary rate access, 2048 kbit/s	I	Rec. I.431	Rec. G.962	circuit	CM	b; s	Up to 30 × 64 kbit/s, octet structure
				signalling	PM	b; s	The maximum bit rate for signalling, p- and f-data will be less than 64 kbit/s
				p-data (Note 4)	PM	b; s	
				f-data (Note 4)	PM	b; s	
				maintenance	PM	b; s	

CM Circuit Mode; PM Packet Mode; FM Frame Mode; b bidirectional; s symmetrical

NOTES

- 1 With A/D conversion according to Recommendation G.711 performed by the User-Port function.
- 2 Conversion of line state signalling shall be performed by the User-Port function.
- 3 This control function covers the activation/deactivation procedures.
- 4 These types of data may be handled by the service node, e.g. a local exchange, or may be routed to a data network switching node.

TABLE I.2/G.902

Information on ISDN broadband accesses

Access information		Interface information		Bearer information			
Access type	Status	UNI	Access digital section	Information type	Transfer mode	Direction	Required channel rate or cell rate
b) ISDN broadband (Note 1)							
B-ISDN, SDH-based, 155 Mbit/s	I	Rec. I.432	(Note 2)	bearer	ATM, VP, VC	b; s	Subscription option; the cell rate cannot exceed 149,76 Mbit/s
				signalling		b; s	
				maintenance		b; s	
B-ISDN, cell based, 155 Mbit/s	I	Rec. I.432	(Note 2)	bearer	ATM, VC, VP	b; s	Subscription option; the cell rate cannot exceed (Note 3) Mbit/s
				signalling		b; s	
				maintenance		b; s	
B-ISDN, SDH-based, 622 Mbit/s	I	Rec. I.432	(Note 2)	bearer	ATM, VC, VP	b; s	Subscription option; the cell rate cannot exceed 599,04 Mbit/s
				signalling		b; s	
				maintenance		b; s	
B-ISDN, cell based, 622 Mbit/s	I	Rec. I.432	(Note 2)	bearer	ATM, VC, VP	b; s	Subscription option; the cell rate cannot exceed (Note 3) Mbit/s
				signalling		b; s	
				maintenance		b; s	
B-ISDN, low bit rate, 1544 kbit/s	III	Rec. I.432	Rec. G.963	bearer	ATM, VC, VP	b; s	Subscription option; the cell rate cannot exceed 1536 kbit/s
				signalling		b; s	
				maintenance		b; s	
B-ISDN, low bit rate, 2048 kbit/s	III	Rec. I.432	Rec. G.962	bearer	ATM, VC, VP	b; s	Subscription option; the cell rate cannot exceed 1920 kbit/s
				signalling		b; s	
				maintenance		b; s	
ATM Asynchronous Transfer Mode; VP Virtual Path; VC Virtual Connection; b bidirectional; s symmetrical							
NOTES							
1 Gross bit rate at the User-Network interface at reference point T.							
2 Recommendation to be drafted on access digital section for B-ISDN.							
3 Rate to be determined.							

TABLE I.3/G.902

Information on leased line accesses

Access information		Interface information		Bearer information			
Access type	Status	UNI	Access digital section	Information type	Transfer mode	Direction	Required channel rate or cell rate
c) Permanent leased line							
Analogue leased lines; the analogue signals need to be converted into digital signals using one of the information bearers provided by the AN							
64 kbit/s (B-channel) bearer capability	I	Clause 1/G.703	Not defined	bearer	CM	b; s	64 kbit/s, octet structure
				maintenance ^{a)}			
Multiple 64 kbit/s or 384 kbit/s (H0-channel) bearer capability	I	Clause 2/G.703; or Clause 6/G.703	Not defined	bearer	CM	b; s	n × 64 kbit/s, octet structure and integrity
				maintenance ^{a)}			
1544 kbit/s based (e.g. H11-channel) bearer capability	I	Clause 2/G.703	Not defined	bearer	CM	b; s	1536 kbit/s or 1544 kbit/s, octet structure
				maintenance ^{a)}			
H12-channel bearer capability	I	Clause 6/G.703; Rec. I.431	Not defined	bearer	CM	b; s	1920 kbit/s, octet structure
				maintenance ^{a)}			
1984 kbit/s bearer capability	I	Clause 6/G.703; Rec. I.431	Not defined	bearer	CM	b; s	1984 kbit/s, octet structure
				maintenance ^{a)}			
2048 kbit/s bearer capability	I	Clause 6/G.703; Rec. I.431	Not defined	bearer	CM	b; s	2048 kbit/s
				maintenance ^{a)}			
34 Mbit/s	I	Clause 8/G.703	Not defined	bearer	CM	b; s	Structured and/or unstructured
				maintenance ^{a)}			
139 Mbit/s	I	Clause 9/G.703	Not defined	bearer	CM	b; s	Structured and/or unstructured
				maintenance ^{a)}			
SDH, virtual container 12	I	^{a)}	SDH section may be used	bearer	CM	b; s	Subscription option
				maintenance			
SDH, virtual container 3	I	^{a)}	SDH section may be used	bearer	CM	b; s	
				maintenance			
SDH, virtual container 4	I	^{a)}	SDH section may be used	bearer	CM	b; s	
				maintenance			
ATM virtual path	See b)	Rec. I.432 or ^{a)}	^{a)}	bearer	ATM, VP	u; d; b; s; a	
				maintenance ^{a)}			
CM Circuit Mode; ATM Asynchronous Transfer Mode; VP Virtual Path; u upstream only; d downstream only; b bidirectional; s symmetrical; a asymmetrical							
^{a)} The reference to the relevant information or the need for such a function is to be identified.							

TABLE I.4/G.902

Information on other dedicated accesses

Access information		Interface information		Bearer information			
Access type	Status	UNI	Access digital section	Information type	Transfer mode	Direction	Required channel rate or cell rate
d) Data service networks Accesses of different data networks (e.g. Rec. X.25) shall be covered. However two different adaptation approaches need to be distinguished							
d1) User port adaptation is an integral part of the Access Network; Access Network provides the relevant data network UNIs	I	X. ^{a)} V. ^{a)}	Not defined	circuit, or packet, or frame	CM PM PM	b; s b; s b; s	Various bit rate requirements
d2) User port adaptation is separate from Access Network; Access Network provides the suitable bearer interfaces for the support of the relevant data network UNI	I	Defined permanent leased line interfaces and bit rates shall be used for the transport of the aggregate bit stream					
e) Broadcast access Distribution of digital audio and digital video signals. The integration of analogue audio and video signals will be done in the Transmission Media Layer							
Digital encoded audio and video	II-III	^{a)}	Not defined	bearer	CM or PM or ATM ^{a)}	d	
				maintenance ^{a)}			
f) Interactive Video	IV	There are no interface specifications and/or access capability requirements available. Therefore this access type is for further study					
CM Circuit Mode; PM Packet Mode; FM Frame Mode; ATM Asynchronous Transfer Mode; d downstream; b bidirectional; s symmetrical ^{a)} The reference to the relevant information or the need for such a function is to be identified.							

Appendice II

Examples of functional models of lower network layers of access network

(This appendix does not form an integral part of this Recommendation)

This appendix gives examples of the lower network layers of access networks.

Figure II.1 shows the boundary of layers/sublayers currently considered as being relevant for the functional definition of access networks. The example is based on the functional requirements of the 64 kbit/s circuit mode oriented service node interface (V5.1 interface) defined in Recommendation G.964 and a passive optical network.

The multiplexing of the user individual D-channels is performed on a higher layer and not shown in this figure. The structure of D and D* is not identical.

Figures II.2, II.3 and II.4 show examples of functional models of possible access network configurations. The transport of signalling and control information is not shown in these figures.

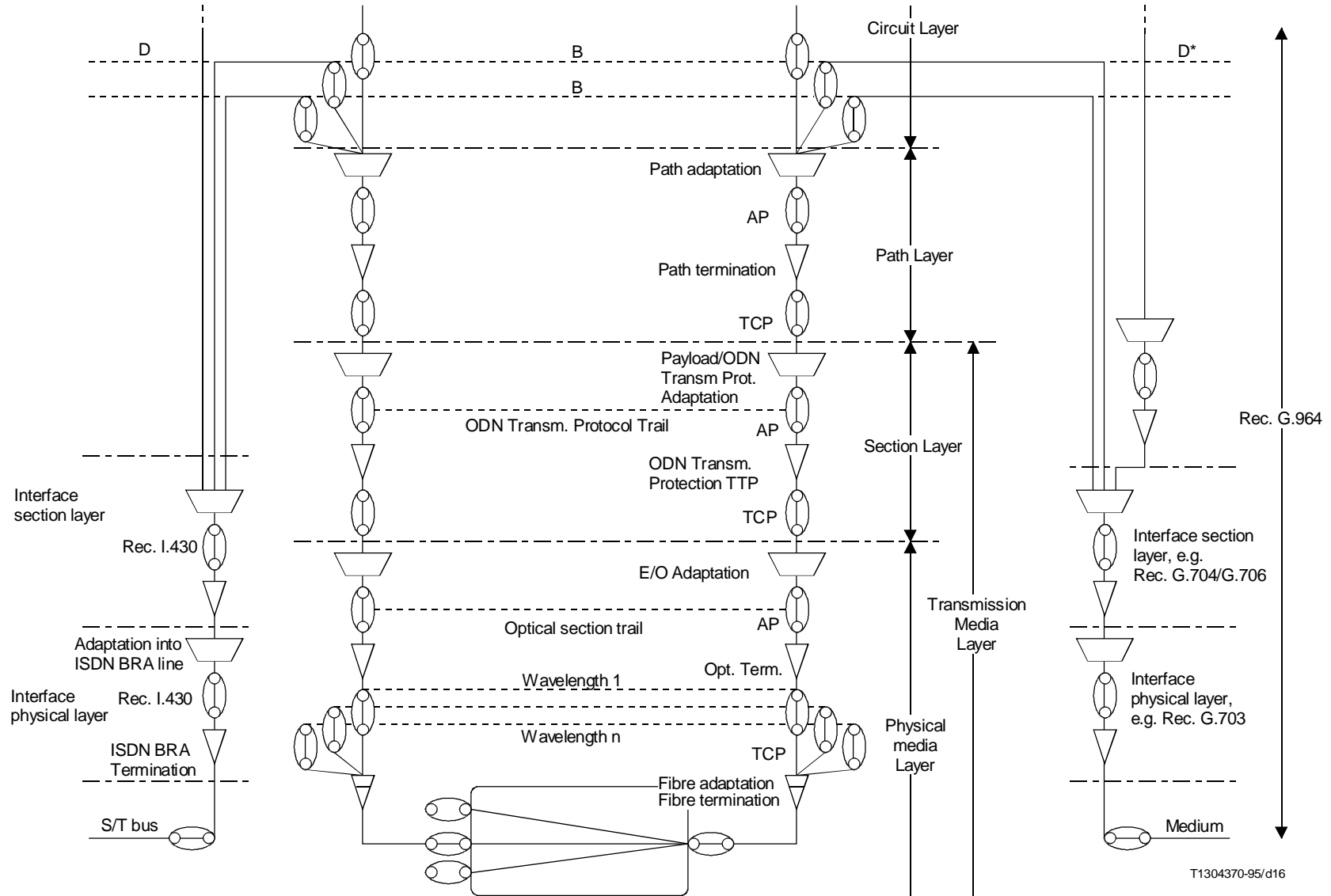


FIGURE II.1/G.902

An example of a functional model of an Optical Access Network based on Recommendation G.964

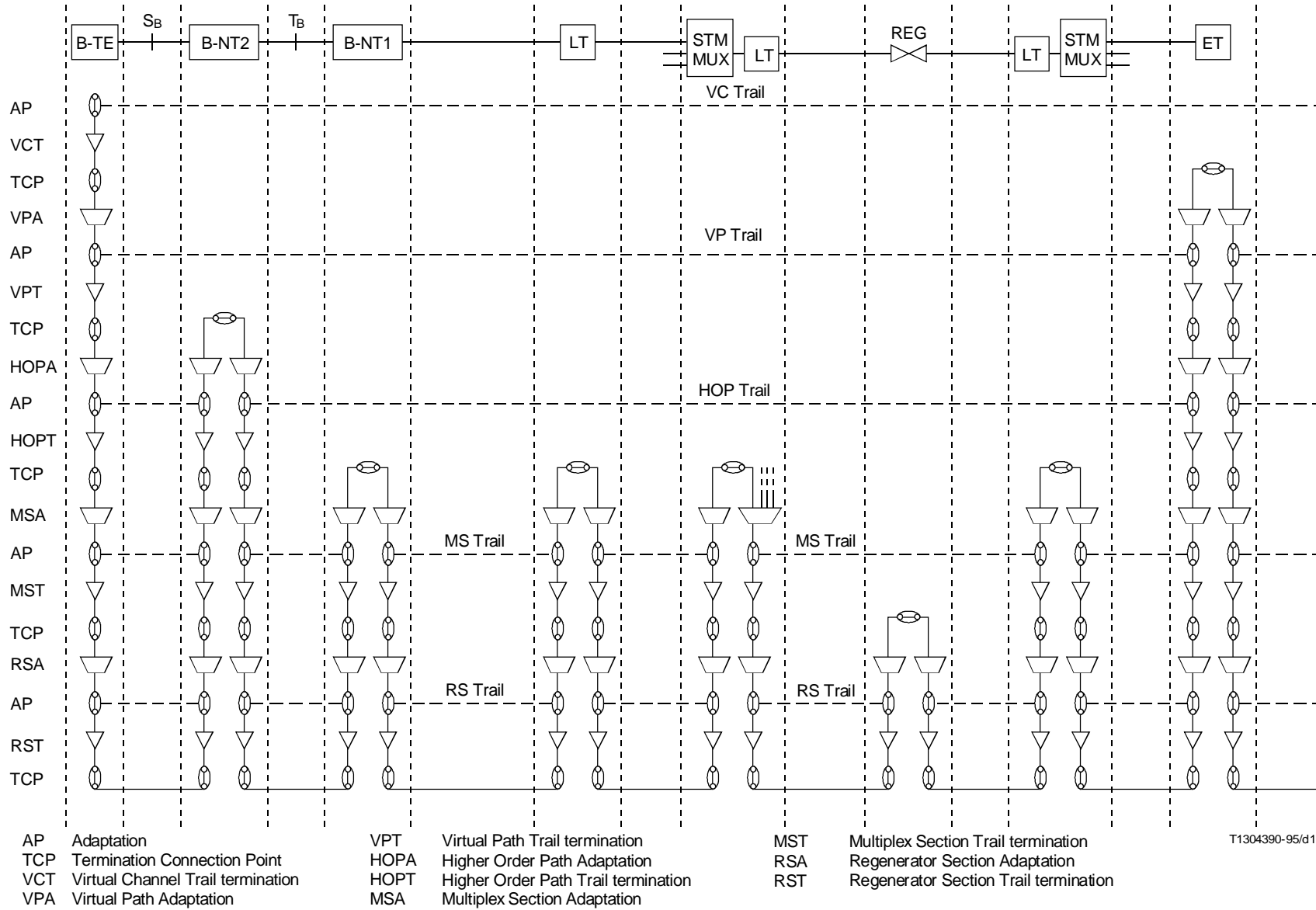
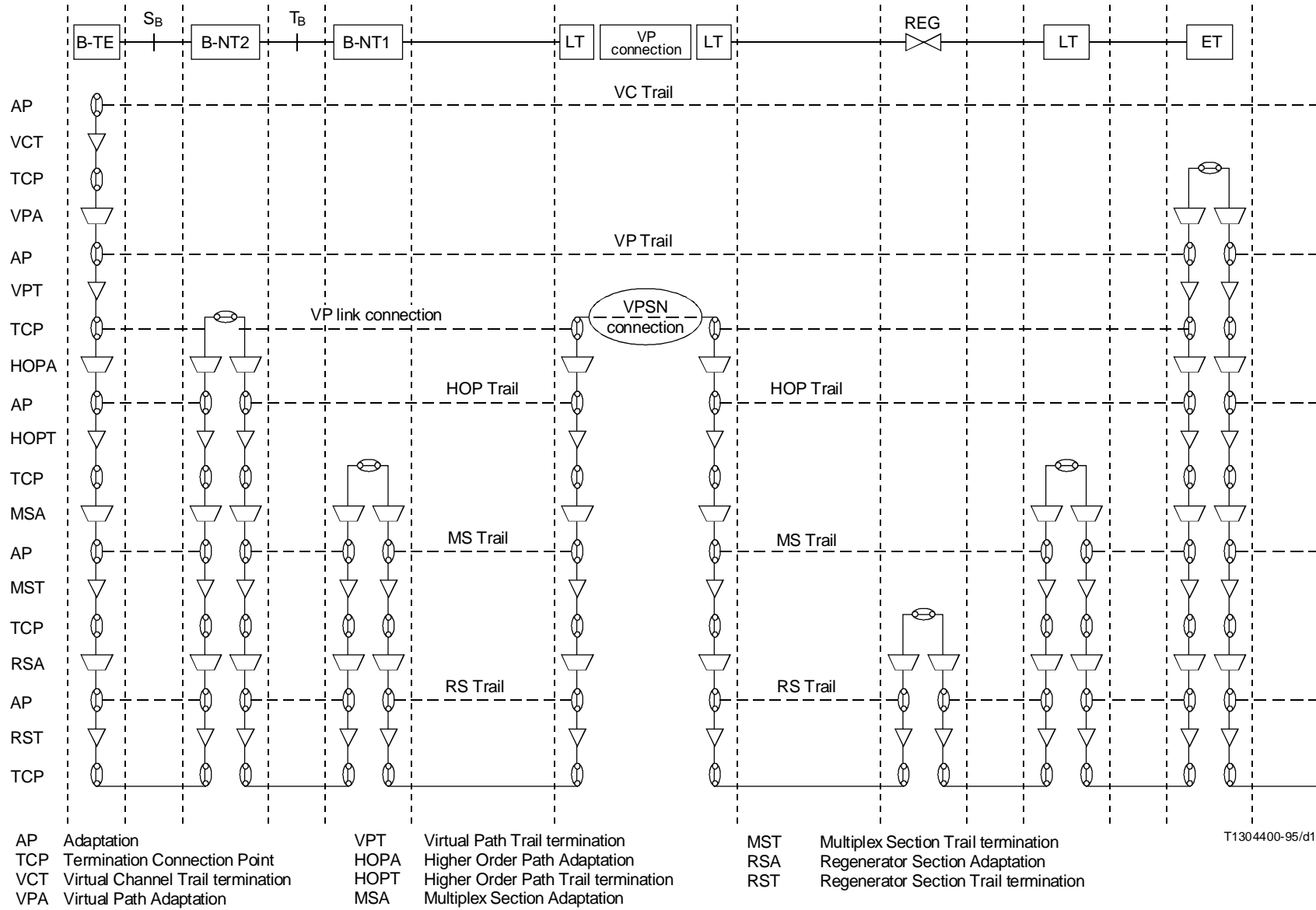


FIGURE II.3/G.902

An example of the functional model for a remote access with STM multiplexing



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FIGURE II.4/G.902

An example of the functional model for a remote access with ATM cross connect

Appendice III

Examples of different Access Network configurations

(This appendix does not form an integral part of this Recommendation)

This appendix gives examples of configurations that integrates PSTN accesses or N-ISDN accesses with B-ISDN accesses into one Access Network using different network layers.

III.1 Multiplexing on transmission media layer

Transmission media independent multiplexing of accesses can be applied within the physical layer (e.g. optical fibre, metallic pair, coax cable, radio) or the section layer (SDH and PDH paths) to integrate accesses using circuit mode and those using ATM. This does not effect the functional access network and the SNIs or UNIs sharing the same transmission media. The principle is shown in Figure III.1.

III.2 Multiplexing on path layer

III.2.1 Remote access connection

Figure III.2 shows the integration of accesses using circuit mode and those using ATM applying multiplexing on the path layer which is using ATM. This requires the conversion of the circuit mode information into ATM by use of a circuit emulation function before multiplexing with the ATM information. The information is demultiplexed before accessing the individual SPFs and the SNs.

III.2.2 Remotely connected access

Figure III.3 shows the integration of accesses using circuit mode and those using ATM applying multiplexing on the path layer which is using ATM. However the aggregate information stream is not demultiplexed in the access network and is conveyed through one SNI to the SN. The demultiplexing of the information stream is performed in the ATM service node using a circuit emulation function to transfer the ATM into circuit mode again before entering the circuit mode SN.

III.3 Full integration

Figure III.4 shows the same Access Network as given in Figure III.3, however, the ATM service node is demultiplexing the aggregate information stream internally and handles both types of information transfer modes internally.

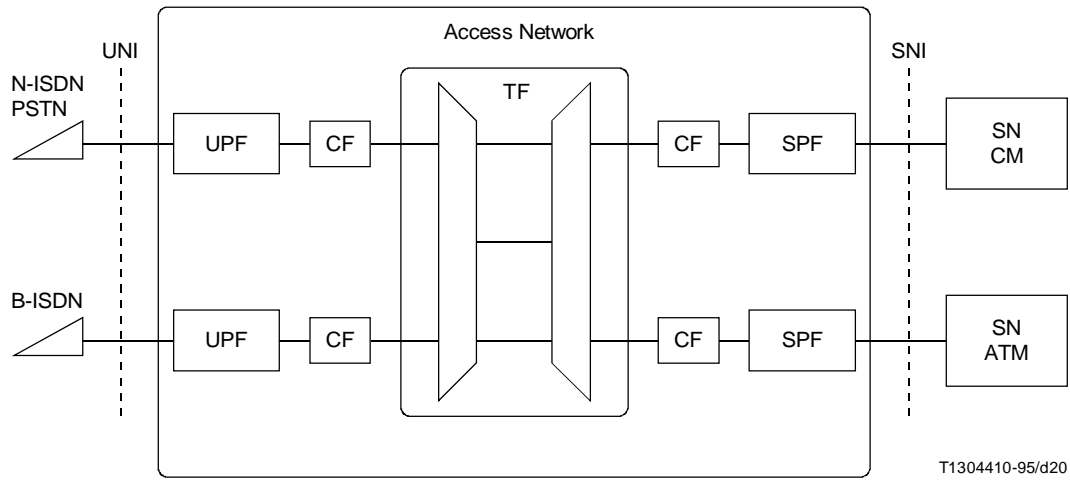


FIGURE III.1/G.902
Multiplexing on transmission physical media layer

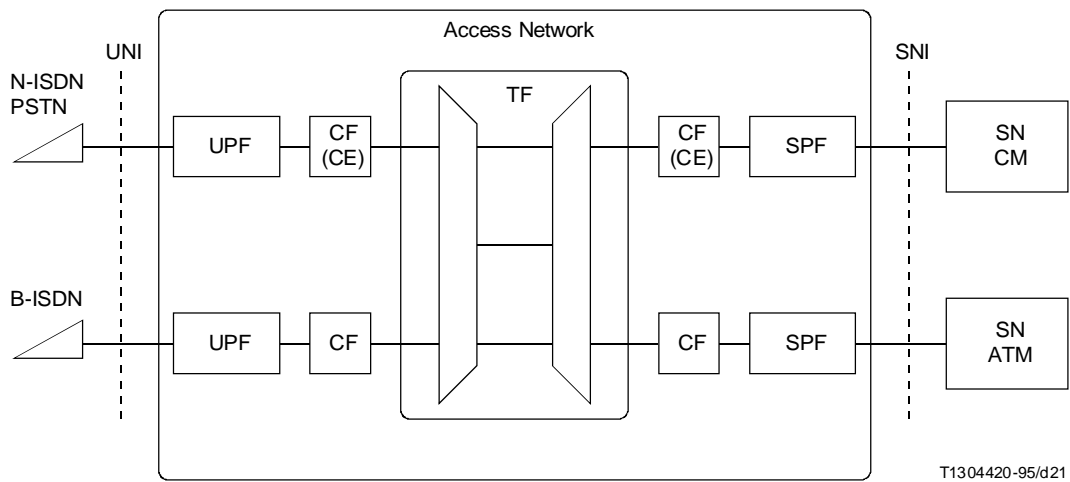


FIGURE III.2/G.902
Remote access connection

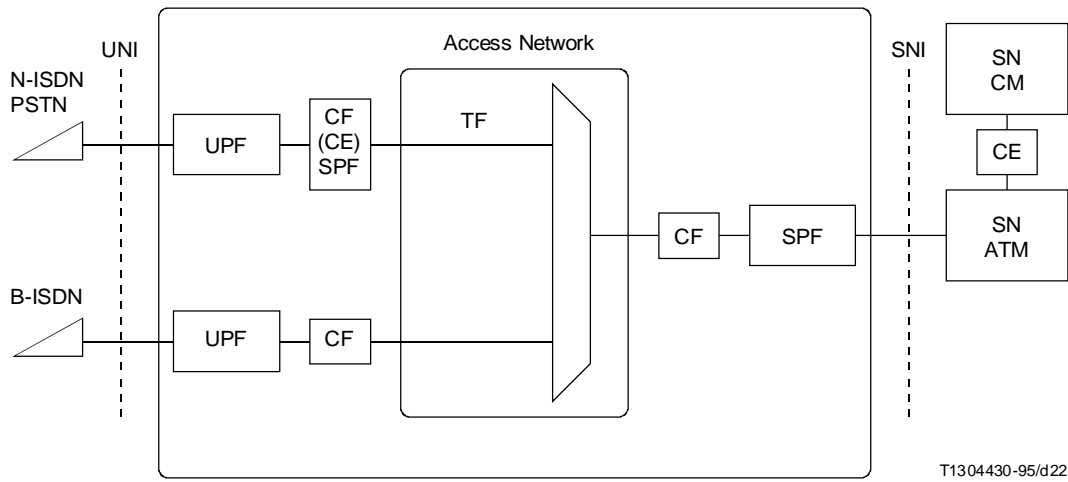


FIGURE III.3/G.902
Remotely connected access

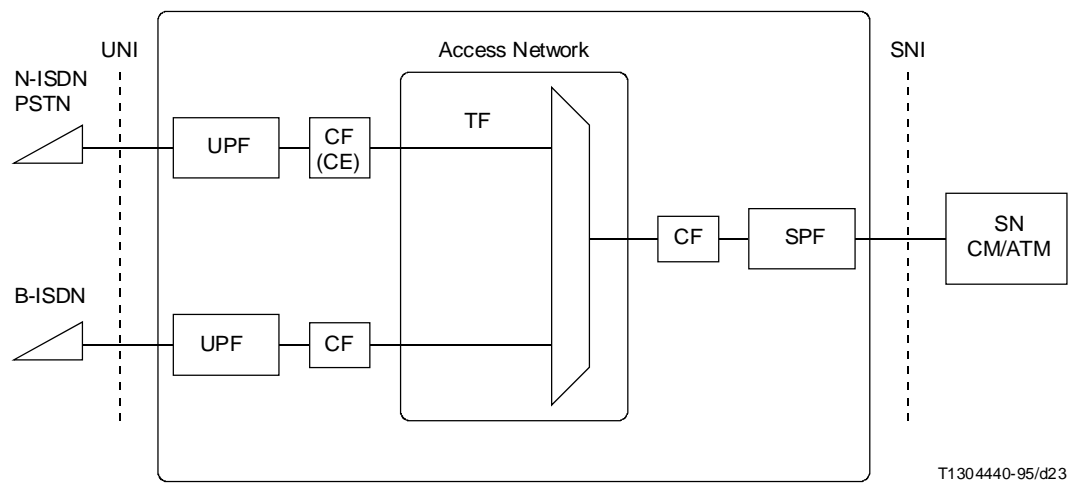


FIGURE III.4/G.902
Full integration

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