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Transmission and Multiplexing (TM); Requirements of passive Optical Access Networks (OANs) to provide services up to 2 Mbit/s bearer capacity

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Foreword

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

This ETS describes cost effective and flexible access networks using optical fibre technology and is designed to provide both services to meet the current demands and an infrastructure which is able to satisfy the requirements of the future.

Transposition dates	
Date of adoption of this ETS:	16 August 1996
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1 Scope

This European Telecommunication Standard (ETS) describes cost effective and flexible access networks using optical fibre technology. This ETS is designed to provide both services to meet the current demands and an infrastructure which is able to satisfy the requirements of the future.

This ETS describes the characteristics of an Optical Access Network (OAN) with the capability of transporting interactive services, based on 64 kbit/s bearer capabilities, between the User Network Interface (UNI) and the local exchange. The ETS considers an OAN capable of providing business and residential customers with a range of services (up to 2 Mbit/s) over a passive split optical network. Distributive services (e.g. cable television) are outside the scope of this ETS.

The OAN described in this standard has considered the requirement for the access network to adapt to the changing requirements of individual customers in terms of capacity, flexibility and types of services offered without the need for network operators to provide service specific overlay networks.

The considered systems within this ETS are based on Time Division Multiple Access (TDMA) and/or Subcarrier Multiple Access (SCMA) methods. One and two fibre systems are described.

This ETS considers OANs where the Optical Distribution Network (ODN) is based on point-to-multipoint tree and branch options as described in ETS 300 681 [5].

This ETS is not a complete system definition. It identifies aspects that can be defined without preventing transmission innovation.

2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative 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 ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1]   EC SYN 287 (1990): "Proposal for the council directive concerning the protection of individuals in relation to the processing of personal data".

[2]   EC SYN 288 (1990): "Proposal for the directive concerning the protection of personal data and privacy in the context of public digital telecommunication networks, in particular the integrated services digital network (ISDN) and public digital mobile networks".

[3]   EN 41 003: "Particular safety requirements for equipment to be connected to telecommunication networks".

[4]   EN 60 950: "Safety of information technology equipment, including electrical business equipment".

[5]   prETS 300 681 (1996): "Transmission and Multiplexing (TM); Optical distribution network for Optical Access Networks (OANs)".

[6]   prETS 300 736: "Transmission and Multiplexing (TM); Operation and maintenance of Optical Access Networks (OANs)".

[7]   ETR 080: "Transmission and Multiplexing (TM); Integrated Services Digital Network (ISDN) basic rate access; Digital transmission system on metallic local lines".

[8]   ETS 300 011: "Integrated Services Digital Network (ISDN); Primary rate user-network interface; Layer 1 specification and test principles".

[9]   ETS 300 012: "Integrated Services Digital Network (ISDN); Basic user-network interface; Layer 1 specification and test principles".

[10]   ETS 300 019: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".

[11]   ETS 300 233: "Integrated Services Digital Network (ISDN); Access digital section for ISDN primary rate".

[12]   ETS 300 288: "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U); Network interface presentation".

[13]   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)".

[14]   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)".

[15]   ETS 300 376-1: "Signalling Protocols and Switching (SPS); Q3 interface at the Access Network (AN) for configuration management of V5 interfaces and associated user ports; Part 1: Q3 interface specification".

[16]   ETS 300 378-1: "Signalling Protocols and Switching (SPS); Q3 interface at the Access Network (AN) for fault and performance management of V5 interfaces and associated user ports; Part 1: Q3 interface specification".

[17]   ETS 300 462-2: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 2: Synchronization network architecture".

[18]   ETS 300 462-5: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 5: Timing characteristics of slave clocks suitable for operation in Synchronous Digital Hierarchy (SDH) equipment".

[19]   ETS 300 418: "Business TeleCommunications (BTC); 2 048 kbit/s digital unstructured and structured leased lines (D2048U and D2048S); Network interface presentation".

[20]   ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".

[21]   ITU-T Recommendation G.704: "Synchronous frame structures used at 1 544, 6 312, 2 048, 8 488 and 44 736 kbit/s hierarchical levels".

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

[23]   ITU-T Recommendation G.823: "The control of jitter and wander within digital networks which are based on the 2 048 kbit/s hierarchy".

[24]   ITU-T Recommendation G.832: "Transport of SDH elements on PDH networks: Frame and multiplexing structures".

[25]   ITU-T Recommendation I.430: "Basic user-network interface - Layer 1 specification".

[26]   ITU-T Recommendation M.3010: "Principles for a telecommunications management network".

[27]   EC ITSEC: "Information Technology Security Criteria (ITSEC)".

3 Definitions and abbreviations

3.1 Definitions

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

access link: The whole of transmission means between a given network interface and a single user interface. The concept of access link is used in order to allow a functional and procedural description and a definition of the network requirements.

> NOTE 1: The user-side and the network-side of the access link are not identical and therefore the access link is not symmetrical.

Adaptation Unit (AU): An AU provides adaptation functions between the Optical Network Unit (ONU) and the user side.

diplex working: Bidirectional communication using a different wavelength for each direction of transmission over a single fibre.

duplex working: Bidirectional communication using the same wavelength for both directions of transmission over a single fibre.

Field Replaceable Unit (FRU): A FRU is the lowest level of maintenance spare and will typically be a plug-in card. The modules of an Optical Line Termination (OLT) and ONU should be FRUs.

full access: Given no other connections, any slot on one side of the concentrator may be connected to any slot on the other side of the concentrator.

multiplexing; static: A system of multiplexing where the relationship between the position of the tributaries to the multiplexed format (channels) is predetermined and fixed.

multiplexing; dynamic: A system of multiplexing where the relationship between the position of the tributaries to the multiplexed format (channels) is flexible. It also allows for tributaries to be aggregated where there are more tributaries than available channels and the possibility to vary the bandwidth to n times the capacity of the channels.

non-blocking: Any allowable connection may be made at any time, regardless of the order in which connections are established or removed. (An allowable connection assumes that the respective slots are free).

Optical Access Network (OAN): The set of access links sharing the same network-side interfaces and supported by optical access transmission systems.

> NOTE 2: The OAN may include a number of ODNs connected to the same OLT.

Optical Distribution Network (ODN): An ODN provides the optical transmission means from the OLT towards the users, and vice versa.

Optical Line Termination (OLT): An OLT provides the network-side interface of the OAN and is connected to one or more ODNs.

Optical Network Unit (ONU): An ONU provides (directly or remotely) the user-side interface of the OAN and is connected to the ODN.

optical filter: A device for the selection of optical signals at optical specific wavelengths.

optical power splitter: A device that has n inputs with k outputs, where n = 1 to k and k $\geq$ 2.

passive component: A component part of the ODN that does not require external power, i.e. fibre, splitter, filter.

point-to-multipoint: A transmission system which can have one input or output at one end with multiple inputs or outputs at the other end.

Passive Optical Network (PON): A PON is a subset of an ODN and refers to a point-to-multipoint option.

Space Division Multiplexing (SDM): Bi-directional multiplexing using different fibres for up and downstream signals.

Sub Carrier Multiplexing (SCM): Multiplexing multiple electrical frequencies onto a single fibre at a single wavelength to provide an individual frequency to each multipoint to point path.

serial number: A reference number assigned to an object, component, etc.

service channel: Each bearer service is allocated a service channel in the PON systems. e.g. a 64 kbit/s channel to support the Public Switched Telephone Network (PSTN).

Service Unit (SU): A FRU that supports service interface (Service Unit (SU)) function(s).

simplex working: Communication which uses a different fibre for each direction of transmission.

Time Compression Multiplexing (TCM): Bi-directional multiplexing using different time slots for up and downstream signals.

Time Division Multiplexing (TDM): Multiplexing information onto fixed time ranges.

Tributary Unit (TU): A TU is a FRU with one or more tributary interface functions.

Wavelength Division Multiplexing (WDM): Bi-directional multiplexing using different optical wavelength for up and downstream signals.

3.2 Abbreviations

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

AC	Alternating Current
A/D	Analogue to Digital (conversion)
AN	Access Network
ATM	Asynchronous Transfer Mode
AU	Adaptation Unit
BA	Basic Access
B-ISDN	Broadband Integrated Services Digital Network
DC	Direct Current
D/A	Digital to Analogue (conversion)
D2048S	2 048 kbit/s digital structured ONP leased line
D2048U	2 048 kbit/s digital unstructured ONP leased line
FDM	Frequency Division Multiplexing
FITL	Fibre In The Loop
FRU	Field Replaceable Unit
ISDN	Integrated Services Digital Network
ISDN-BA	ISDN-Basic Access
ITSEC	Information Technology Security Criteria
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
NNI	Network to Network Interface
NT	Network Termination
NTI	Network Termination 1
OAM	Operations Administration and Maintenance
OAN	Optical Access Network
ODN	Optical Distribution Network
OLT	Optical Line Termination
ONP	Open Network Provision
ONU	Optical Network Unit

OS	Operations System
OSI	Open Systems Interconnection
OTDR	Optical Time Domain Reflectometer
PON	Passive Optical Network
POTS	Plain Old Telephony Services
ppm	parts per million
PRA	Primary Rate Access
PRC	Primary Reference Clock
PSTN	Public Switched Telephone Network
Q_{AN}	Q interface for the Access Network
SCM	Sub Carrier Multiplexing
SCMA	Sub Carrier Multiple Access
SDH	Synchronous Digital Hierarchy
SDM	Space Division Multiplexing
SELV	Subscriber Extra Low Voltage
SNI	Service Node Interface
SPF	Signalling Processing Function
SSU	Synchronization Supply Unit
SU	Service Unit
TCM	Time Compression Multiplexing
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
TNV	Telecom Network Voltage
TU	Tributary Unit
UIpp	Unit Intervals peak to peak
UNI	User Network Interface
VC	Virtual Container
VF	Voice Frequency
WDM	Wavelength Division Multiplexing

4 Configuration of an OAN

The configuration of an OAN is considered in this clause. It provides an introduction to the detailed requirements of an OAN.

NOTE: The functional architecture issues are under study in ETSI Sub Technical Committee (STC) TM3.

4.1 Topological and functional issues

A configuration for an OAN is shown in figure 1. An OAN consists of:

a) one OLT;

b) at least one ODN;

c) at least one ONU;

d) AUs.

The ODN provides the optical transmission means from the OLT towards the users and vice versa. ONUs provide the user-side interface of the OAN and are connected to the ODN. The functions comprised by the AU include adaptation of the service interfacing between ONU and user (e.g. conversion of data communication protocols and rates) as well as transportation of the service over the last drop between the ONU and user when these interfaces do not coincide (e.g. Network Termination 1 (NT1) for Integrated Services Digital Network, Basic Access (ISDN-BA)).

The reference points User Network Interface (UNI) and Service Node Interface (SNI) as well as the Q3 interface shown in figure 1. The R and S reference points are described in ETS 300 681 [5].

NOTE: Standardization work related to such an AU is outside the scope of this ETS.