



**Access, Terminals, Transmission and Multiplexing (ATTM);
Broadband Deployment and Energy Management;
Part 4: Access Networks;
Sub-part 1: Fixed access networks (excluding cable)**

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

The present document is part 4, sub-part 1 of a multi-part deliverable. Full details of the entire series can be found in part 1 [i.10].

Modal verbs terminology

In the present document "shall", "shall not", "should", "should not", "may", "need not", "will", "will not", "can" and "cannot" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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Introduction

The increasing interaction between the different elements of the Information Communication Technology (ICT) sector (hardware, middleware, software, services, etc.) supports the concept of convergence in which:

- a variety of multi-service packages can be delivered over a common infrastructure;
- a variety of infrastructures is able to deliver these packages;
- a single multi-service-package may be delivered over several different infrastructures.

As a result of this convergence, the development of new services, applications and content there is an increasing demand for bandwidth, reliability, quality and performance. The consequent increase in the demand for energy which implications for cost and, in some cases, availability. It is therefore important to maximize the energy efficiency of network equipment at all levels.

New technologies and infrastructure strategies are expected to enable operators to decrease the energy consumption, for a given level of service, of their existing and future infrastructures thus decreasing their costs. This requires a common understanding among market participants that only standards can produce.

The present document is Part 4, sub-part 1 of a multi-part set which has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM) in close collaboration with CENELEC via the Co-ordination Group on Installations and Cabling (CGIC). The document set offers a contribution to the required standardization process by establishing an initial basis for work on ICT networks and transmission engineering, with active collaboration from a number of other ETSI and CENELEC Technical Bodies. When complete, the document set contains information that has been jointly evolved to present developments in installations and transmission implementation, and describing their progress towards energy efficiency in next generation networks (NGN).

The present document analyses the work on Fixed Access Networks whilst details of each of the other parts of the document set can be found in Part 1 [i.10]. Clearly the energy efficiencies of Operator Sites, Data Centres, the Core Networks and Customer Network Infrastructures are also important in maximizing the end-to-end energy efficiency of broadband communications and these issues are covered in other parts of the document set. However, Access Networks differ from the other network components in that they are likely to include a very large number of locations each consuming a relatively low amount of energy. Not only do such small installations tend to be inefficient in their power utilization but when multiplied by their number, their total energy usage becomes considerable. Thus any energy saving which can be achieved becomes significant when the number of sites is taken into account.

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1 Scope

The present document details measures which may be taken to improve the energy efficiency of access networks for broadband deployment. The present document:

- identifies the standardization bodies working on diverse aspects of the access networks infrastructures interfaces, cabling, installation, operation, etc.;
- outlines some of the principal access network topographies and their differences in respect of energy consumption;
- provides strategic analysis of energy consumption trends within access networks.

This enables the proper implementation of services, applications and content on an energy efficient infrastructure, though it is not the goal of the present document to provide detailed standardized solutions for network architecture.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

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NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] "EC Code of Conduct on Energy Consumption of Broadband Equipment" V5.
- [i.2] Recommendation ITU-T G.984.1 (03/2008): "Gigabit-capable passive optical networks (GPON): General characteristics".
- [i.3] Recommendation ITU-T G.984.2 (03/2008): "Gigabit-capable passive optical networks (GPON): Physical Media Dependent (PMD) layer specification".
- [i.4] Recommendation ITU-T G.984.3 (04/2012): "Gigabit-capable passive optical networks (GPON): Transmission convergence layer specification".
- [i.5] Recommendation ITU-T G.984.5 (10/2009): "Enhancement band for gigabit capable optical access networks".
- [i.6] Recommendation ITU-T G.984.6 (05/2012): "Gigabit-capable passive optical networks (GPON): Reach extension".

- [i.7] Recommendation ITU-T G.992.1 (03/2003): "Asymmetric digital subscriber line (ADSL) transceivers - Annex A: Specific requirements for an ADSL system operating in the frequency band above POTS".
- [i.8] Recommendation ITU-T G.992.3 (06/2008): "Asymmetric digital subscriber line transceivers 2 (ADSL2) - Annex J: All digital mode ADSL with improved spectral compatibility with ADSL over ISDN".
- [i.9] Recommendation ITU-T G.992.5 (01/2009): "Asymmetric digital subscriber line (ADSL) transceivers - Extended bandwidth ADSL2 (ADSL2plus)".
- [i.10] ETSI TS 105 174-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment and Energy Management; Part 1: Overview, common and generic aspects".
- [i.11] Recommendation ITU-T G.987.1 (04/2012): "10 Gigabit-capable passive optical networks (XG-PON): General requirements".
- [i.12] Recommendation ITU-T G.987.2 (02/2012): "10-Gigabit-capable passive optical networks (XG-PON): Physical media dependent (PMD) layer specification".
- [i.13] Recommendation ITU-T G.987.3 (06/2012): "10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification".
- [i.14] Recommendation ITU-T G.987.4 (06/2012): "10-Gigabit-capable passive optical networks (XG-PON): Reach Extension".
- [i.15] Recommendation ITU-T G.989.1 (03/2013): "40-Gigabit-capable passive optical networks (NG-PON2): General requirements".
- [i.16] Recommendation ITU-T G.985 (01/2009): "100 Mbit/s point-to-point Ethernet based optical access system".
- [i.17] Recommendation ITU-T G.986 (01/2009): "1 Gbit/s point-to-point Ethernet-based optical access system".
- [i.18] ETSI GS OEU 012: "Operational energy Efficiency for Users (OEU); Technical Global KPIs for Fixed Access Networks".
- [i.19] ETSI EN 300 132 series: "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment".
- [i.20] ETSI EN 300 132-3-1: "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V; Sub-part 1: Direct current source up to 400 V".
- [i.21] ETSI TS 105 174-2: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment and Energy Management Part 2: ICT sites".
- [i.22] IEEE 802.3-2012 - "IEEE Standard for Ethernet".
- [i.23] IEEE 802.11-2012 - "IEEE Standard for Information technology--Telecommunications and information exchange between systems Local and metropolitan area networks--Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".
- [i.24] ETSI ES 205 200-3: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures; Part 3: Global KPIs of ICT Sites".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

access circuit: telecommunications circuit connecting the operator site to the subscriber's premises

access network: part of the network that is deemed to include the last active component at the relevant operator site and the first active element at the subscriber's premises

access point: termination point on a telecommunications network allowing access by nomadic devices to obtain telecommunications services to which they have subscribed elsewhere

active element: network component that requires externally supplied electric power to enable it to perform its network function

community network: communications network, usually wireless, established by and for a local community often to compensate for lack of publicly available access to relevant facilities

customer: person or entity using a telecommunications service and who may or may not be the subscriber

Digital Access Carrier System (DACs): 0+2 pair gain system providing two separate telephone lines over one copper pair using digital technology

Digital Subscribers Line (xDSL): access circuit over which information is carried in a digital format and where the upstream and downstream transmission rates may be the symmetrical (SDSL) or asymmetrical (ADSL)

energy consumption: measure of the energy consumed by the operation of the electronic devices necessary to provide a specific communications service

enterprise network: network established by a large company or similar enterprise to serve its internal telecommunications needs with connectivity to one or more public networks

Ethernet: frame-based local area networking technology standardized as IEEE 802.3 [i.22]

fibre to the cabinet: optical fibre distribution network providing connectivity from the network operator's site to a shared distribution node close to the end-user's premises

firewall: security measure designed to prevent unauthorized electronic access to a networked computer system

flexibility point: device in the access network where access circuits can be configured to their intended destination by cross connecting metallic pairs

home network: network that supports and distributes within the home, those services to which a customer subscribes

intrusion detection system: mechanism by which any attempt by an unauthorized user or terminal to gain access to a communications network is detected

meshed network: communications network, usually wireless, in which every node has connectivity with a number of other nodes thus enabling a variety of possible communication paths between nodes

network gateway: device which will enable the interconnecting of two networks which inherently use different and incompatible protocols

packet: information block identified by a label at layer 3 of the OSI reference model

peripheral: peripheral is a device attached to a host computer whose primary functionality is dependent upon the host, and which expands the host's capabilities, but is not part of the core architecture of the system

point-to-multi-point: communications link operating between a network operator's site and a number of other locations

point-to-point: communications link operating between two, usually fixed, locations

service: provision of a defined functionality in a computer systems or telecommunications environment

sub-loop: secondary access circuit from a street cabinet or similar access node used to deliver one or more services to a customer

subscriber: person or entity responsible for paying for a telecommunications service

Subscribers Loop Carrier (SLC): equipment providing multiple telephone circuits over one or two standard subscriber's telephone lines (see also DACS)

triple play (telecommunications): provision of cable TV, telephony and broadband data as a combined service offering, possibly using a single bearer medium

Watt (W): unit of power, the rate at which work is done; in electrical terms it is the product of the supply voltage (volts) and the current passed (amps)

Watt-hour (Wh): unit of energy used or work done; the product of the rate at which work is done and the time for which it done

NOTE: The terms "Watt" and "Watt-hour" are frequently confused.

WiFi: technology defined by the IEEE 802.11 standards [i.23]

3.2 Symbols

For the purposes of the present document, the following symbols apply:

DC_G	Data Centre Gauge
DC_P	Data Centre Performance
EC_{DC}	Total of energy consumptions by a data centre over a year
EC_{FEN}	Consumption of locally generated electricity based on fossil energy
EC_{HE}	Total of energy consumptions by equipment processing data, for purposes of calculating, storing or transporting, over a year
EC_{REN}	Consumption of locally generated electricity based on renewable sources
EC_{REUSE}	Total of energy consumption from reused energy
EER	Energy Efficiency Ratio expressed as thermal kWh extracted by one electrical kWh
KPI_{DCEM}	Global KPI for data centre energy management
KPI_{EC}	Objective KPI for "Energy Consumption"
KPI_{REN}	Objective KPI for "Renewable Energy"
KPI_{REUSE}	Objective KPI for "Energy Reuse"
KPI_{TE}	Objective KPI for "Task Efficiency"
W_{REN}	Mitigation factor for KPI_{REN}
W_{REUSE}	Mitigation factor for KPI_{REUSE}

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternative Current
ADSL	Asymmetrical Digital Subscribers Line

NOTE: See Recommendation ITU-T G.992.1 [i.7].

ADSL2 Second generation ADSL with extended upstream bandwidth

NOTE: See Recommendation ITU-T G.992.3 [i.8].

ADSL2+ Second generation ADSL with extended downstream bandwidth

NOTE: See Recommendation ITU-T G.992.5 [i.9].

BEF	Building Entrance Facility
CATV	Cable Television

CGIC	Co-ordination Group on Installations and Cabling
CO	Central Office
CPE	Customer Premises Equipment
DACS	Digital Access Carrier System

NOTE: See also SLC.

DC	Data Centre
DCEM	Dataprocessing and Communication Energy Management
DPU	Distribution Point unit

NOTE: ONU for FTTP architectures.

DSL	Digital Subscriber Line
EC	European Commission
EE	Environmental Engineering
EMC	Electro Magnetic Compatibility
ENTI	External Network Test Interface
FAN	Fixed Access Node
FDM	Frequency Division Multiplex
FTTB	Fibre To The Building
FTTC	Fibre To The Curb
FTTCab	Fibre To The Cabinet
FTTdp	Fibre To The distribution point
FTTD	Fibre To The Door
FTTH	Fibre To The Home
GPON	Gigabit Passive Optical Network
HD	Home Distribution
HEF	Home Entrance Facility
HFC	Hybrid Fibre Coaxial
ICT	Information and Communications Technology
IEEE	Institution of Electrical and Electronics Engineers (USA)
ISDN	Integrated Services Digital Network
ISG	Industry Specification Group
ITU	International Telecommunications Union
ITU-T	ITU's Telecommunication standardization sector
KPI	Key Performance Indicator
KPIEC	Key Performance Indicator Energy Consumption
KPIECG	Key Performance Indicator total consumption of energy by the Group
LT	Line Termination
NGN	Next Generation Network
NTP	Network Termination Point
OIE	Operator Independent Equipment
OLT	Optical Line Terminal
ONT	Optical Network Termination for single user residential users (FTTH)
ONU	Optical Network Unit for collective or in case of secondary transmission (e.g.: DSL)
OSE	Operator Specific Equipment
PON	Passive Optical Network
POTS	Plain Old Telephone Service
PUE	Power Usage Effectiveness
RPF	Reverse Power Feeding
SDSL	Symmetric Digital Subscriber Line
SLC	Subscribers Line Carrier (system)

NOTE: See also DACS.

TDM	Time Division Multiplex
UPS	Uninterruptible Power Supply
VAC	Voltage in an Alternating Current
VDC	Voltage in a Direct Current
VDSL	Very high-speed Digital Subscriber Line
VHBB	Very High BroadBand
W	Watt