

Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment - Energy Efficiency and Key Performance Indicators; Part 4: Access networks

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Foreword

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

The present document is part 4 of a multi-part deliverable. Full details of the entire series can be found in part 1 [i.22].

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 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 documents will contain 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 Access Networks whilst details of each of the other parts of the document set can be found in Part 1. 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 will be 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. At the same time, it is likely that the energy consumption of the customer-owned equipment connected to the access network is likely to have an energy demand far in excess of that of the network equipment. This is completely outside the scope of any possible standardization initiative and can only be influenced by manufacturers minimizing the power requirements of their products, perhaps under a Code of Conduct.

In order to monitor the implementation and operation of energy efficient broadband deployment, the documents will also discuss Key Performance Indicators (KPI) for energy efficiency and focus on the possible consequences of standardization of installations, cabling techniques and equipment. In particular, the study will investigate possibilities and suggest solutions for development of processes for optimization in installation techniques and energy consumption.

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1 Scope

The present document details measures which may be taken to improve the energy efficiency the access networks for broadband deployment. Clauses 2 and 3 contain references, definitions and abbreviations which relate to this part; similar information will be included in the corresponding clauses of the other parts, thus ensuring that each document can be used on a "stand-alone" basis.

Clause 4 of the present document:

- identifies the standardization bodies working on interfaces to, cabling within, installation of, and other aspects of the communication infrastructures of, access networks;
- 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;
- develops the concept of Key Performance Indicators (KPI), introduced in Part 1 of this multi-part set of documents, to enable consistent monitoring of energy efficiency;
- outlines further work needed to ensure the improvement of energy efficiency in communication networks.

This will enable 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

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
 - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
 - for 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.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

- [i.1] ETSI TR 102 530: "Environmental Engineering (EE); The reduction of energy consumption in telecommunications equipment and related infrastructure".
- [i.2] ETSI TS 102 533: "Environmental Engineering (EE); Measurement Methods and limits for Energy Consumption in Broadband Telecommunication Networks Equipment".
- [i.3] "EC Code of Conduct on Energy Consumption of Broadband Equipment".
- [i.4] IEEE Standard 802.11: "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.5] IEEE Standard 802.15.1: "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 15.1: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Wireless Personal Area Networks (WPAN)".
- [i.6] IEEE Standard 802.15.4: "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low Rate Wireless Personal Area Networks (WPANs)".
- [i.7] IEEE Standard 802.16: "IEEE Standard for Local and metropolitan area networks - Part 16: Air Interface for Broadband Wireless Access Systems".
- [i.8] ITU-T Recommendation G.983.1 (05/2005): "Broadband optical access systems based on Passive Optical Networks (PON)".
- [i.9] ITU-T Recommendation G.983.2 (01/2007): "ONT management and control interface specification for B-PON".
- [i.10] ITU-T Recommendation G.983.3 (07/2005): "A broadband optical access system with increased service capability by wavelength allocation".
- [i.11] ITU-T Recommendation G.983.4 (01/2005): "A broadband optical access system with increased service capability using dynamic bandwidth assignment".
- [i.12] ITU-T Recommendation G.983.5 (01/2002): "A broadband optical access system with enhanced survivability".
- [i.13] ITU-T Recommendation G.984.1 (03/2008): "Gigabit-capable passive optical networks (GPON): General characteristics".
- [i.14] ITU-T Recommendation G.984.2 (03/2008): "Gigabit-capable passive optical networks (GPON): Physical Media Dependent (PMD) layer specification".
- [i.15] ITU-T Recommendation G.984.3 (01/2002): "Gigabit-capable passive optical networks (GPON): Transmission convergence layer specification".
- [i.16] ITU-T Recommendation G.984.4 (01/2002): "Gigabit-capable passive optical networks (GPON): ONT management and control interface specification".
- [i.17] ITU-T Recommendation G.984.5 (01/2002): "Enhancement band for gigabit capable optical access networks".
- [i.18] ITU-T Recommendation G.984.6 (01/2002): "Gigabit-capable passive optical networks (GPON): Reach extension".

- [i.19] ITU-T Recommendation 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.20] ITU-T Recommendation 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.21] ITU-T Recommendation G.992.5 (01/2009): "Asymmetric digital subscriber line (ADSL) transceivers - Extended bandwidth ADSL2 (ADSL2plus)".
- [i.22] ETSI TS 105 174-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment - Energy Efficiency and Key Performance Indicators; Part 1: Overview, common and generic aspects".
- [i.23] ETSI TR 105 174-5-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment - Energy Efficiency and Key Performance Indicators; Part 5: Customer network infrastructures; Sub-part 1: Homes (single-tenant)".

3 Definitions 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

Bluetooth: short range wireless network defined by IEEE Standard 802.15 and usually considered to be part of a Personal Area Network (PAN)

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 radio: any wireless link system in which the information carried is encoded in any one of a variety of digital formats

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

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

games console: electronic device on which one or more games may be played and which is often capable of being connected to a communications network

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

hotspot: location that offers publicly accessible internet access over a wireless connection

Industrial, Scientific and Medical (ISM) band: band of radio frequencies allocated for use for industrial, scientific and medical purposes

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

mobile phone: terminal device capable of voice (and often data) communications which operates using one or more types of publicly available wireless communications systems

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.

3.2 Abbreviations

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

3G	3rd Generation (mobile networks)
3GPP	3G (mobile) Partnership Project
4G	4th Generation (mobile networks)

ADSL	Asymmetrical Digital Subscribers Line
NOTE:	See ITU-T Recommendation G.992.1 [i.19].
ADSL2	Second generation ADSL with extended upstream bandwidth
NOTE:	See ITU-T Recommendation G.992.3 [i.20].
ADSL2+	Second generation ADSL with extended downstream bandwidth
NOTE:	See ITU-T Recommendation G.992.5 [i.21].
BBF	Broadband Forum
BEF	Building Entrance Facility
BSC	Base Station Control site
BSS	(Mobile) Base Station
CATV	Cable Television
CMTS	Cable modem termination system
CoC	Code of Conduct
CPE	Customer Premises Equipment
DACS	Digital Access Carrier System - see also SLC
DECT	Digital Enhanced Cordless Telecommunications
DHCP	Dynamic Host Configuration Protocol
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EC	European Commission
EE	Environmental Engineering
EEF	(broadband service) Energy Efficiency Factor
ENTI	External Network Test Interface
FDM	Frequency Division Multiplex
FSO	Free Space Optics
FTTB	Fibre To The Building
FTTC	Fibre to the Cabinet
FTTH	Fibre To The Home
GPON	Gigabit Passive Optical Network
GPRS	General Packet Radio Service
GSM	General System for Mobile communication/Global Mobile System
HEF	Home Entrance Facility
HFC	Hybrid Fibre Coaxial
HGI	Home Gateway Initiative
IEEE	Institution of Electrical and Electronics Engineers (USA)
ISDN	Integrated Services Digital Network
ISM	Industrial, Scientific and Medical (frequency band)
ISP	Internet Service Provider
ITU	International Telecommunications Union
KPI	Key Performance Indicator
LAN	Local Area Network
LBL	Lawrence Berkley Laboratories
NGN	Next Generation Network
NPC	Normalized Power Consumption (per line)
NTP	Network Termination Point
OIE	Operator Independent Equipment
OLT	Optical Line Terminal
ONT	Optical Network Termination
ONU	Optical Network Unit
OSE	Operator Specific Equipment
PAN	Personal Area Network
PC	Personal Computer
PLC	Power Line Carrier
PON	Passive Optical Network
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
QAM	Quadrature Amplitude Modulation