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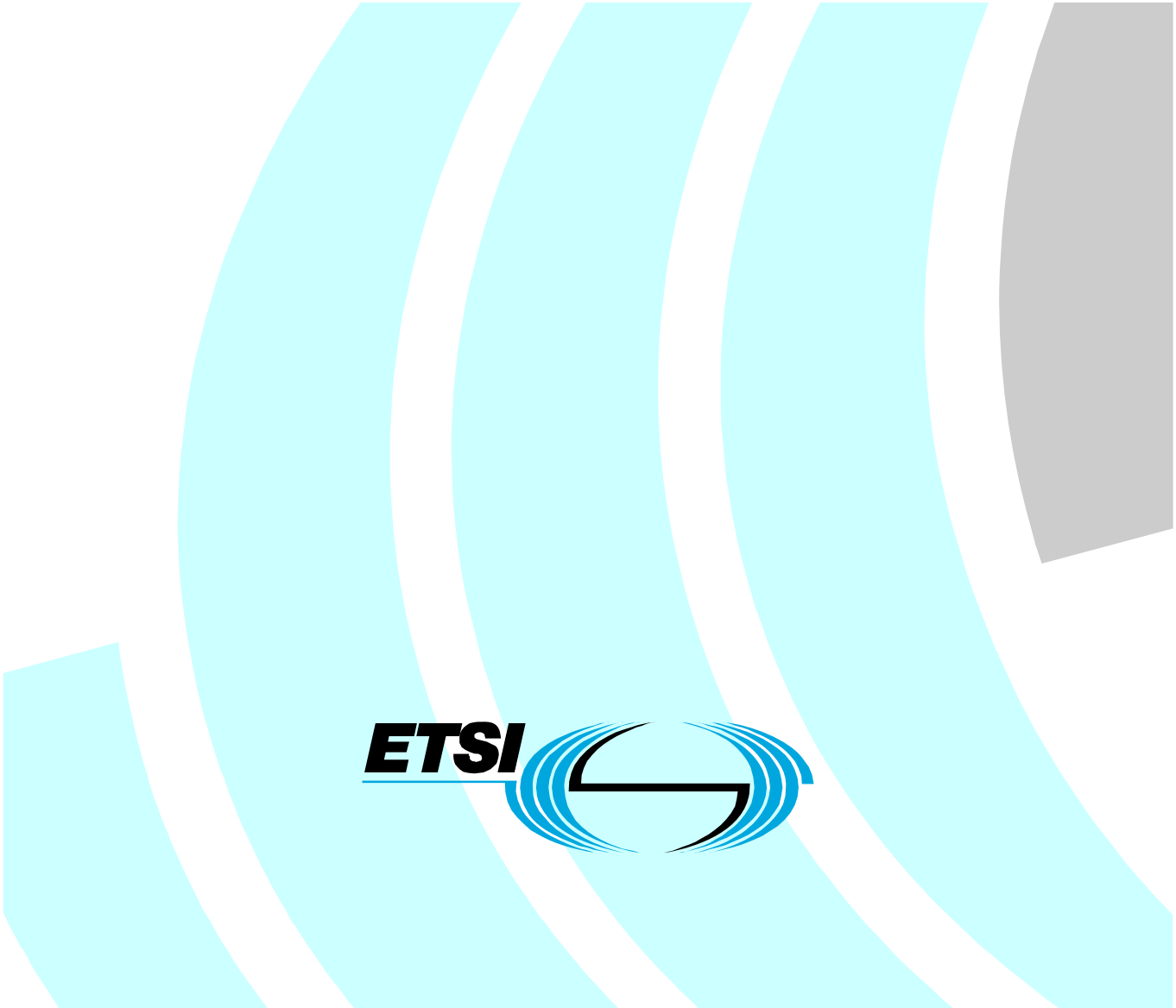
Technical Report

**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)**



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Contents

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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 5-1 of a multi-part deliverable. Full details of the entire series can be found in part 1 [i.36].

Introduction

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

- 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 delivered over different infrastructures.

As a result of this convergence, the development of new services, applications and content has resulted in an increased demand for bandwidth, reliability, quality and performance, with a consequent increase in the demand for power which has implications for cost and, in some cases, availability. It is therefore important to maximize the energy efficiency of all the network elements necessary to deliver the required services.

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 5-1 of a multi-part deliverable 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). It 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).

1 Scope

The present document details measures which may be taken to improve the energy efficiency within homes (single-tenant) by virtue of 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.

Within the present document:

- clause 4 describes the nature of customer premises networks in homes (single tenant), defines the interfaces to those networks and identifies the standardization bodies working on the design and installation of those networks;
- clause 5 describes the strategies that may be employed within homes (single tenant) to both increase the energy efficiency of installed information technology equipment and to use the facilities offered by information technology services to reduce overall energy consumption.

This will enable the proper implementation of services, applications and content on an energy efficient infrastructure, though it is not the goal of this multi-part deliverable to provide detailed standardized solutions for home broadband 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.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

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] European Commission: "DG-JRC Code of Conduct on Energy Consumption of Broadband Equipment".

[i.2] CENELEC EN 50090 series: "Home and Building Electronic Systems (HBES)".

[i.3] CENELEC EN 50173-1: "Information technology - Generic cabling systems - Part 1: General requirements".

[i.4] CENELEC EN 50173-4: "Information technology - Generic cabling - Part 4: Homes".

[i.5] CENELEC EN 50174-1: "Information technology - Cabling installation - Part 1: Installation specification and quality assurance".

[i.6] CENELEC EN 50174-2: "Information technology - Cabling installation - Part 2: Installation planning and practices inside buildings".

[i.7] CENELEC EN 50090-2-1: "Home and Building Electronic Systems (HBES) - Part 2-1: System overview - Architecture".

[i.8] CENELEC EN 50090-2-2: "Home and Building Electronic Systems (HBES) - Part 2-2: System overview - General technical requirements".

[i.9] CENELEC EN 50090-2-3: "Home and Building Electronic Systems (HBES) - Part 2-2: System overview - General functional safety requirements for products intended to be integrated in HBES".

[i.10] CENELEC EN 50090-3-1: "Home and Building Electronic Systems (HBES) - Part 3-1: Aspects of application - Introduction to the application structure".

[i.11] CENELEC EN 50090-3-2: "Home and Building Electronic Systems (HBES) - Part 3-2: Aspects of application - User process for HBES Class 1".

[i.12] CENELEC EN 50090-3-3: "Home and Building Electronic Systems (HBES) - Part 3-3: Aspects of application - HBES Interworking model and common HBES data types".

[i.13] CENELEC EN 50090-4-1: "Home and Building Electronic Systems (HBES) - Part 4-1: Media independent layers - Application layer for HBES Class 1".

[i.14] CENELEC EN 50090-4-2: "Home and Building Electronic Systems (HBES) - Part 4-2: Media independent layers - Transport layer, network layer and general parts of data link layer for HBES Class 1".

[i.15] CENELEC EN 50090-4-3: "Home and Building Electronic Systems (HBES) - Part 4-3: Media independent layers - Communication over IP".

[i.16] CENELEC EN 50090-5-1: "Home and Building Electronic Systems (HBES) - Part 5-1: Media and media dependent layers - Power line for HBES Class 1".

[i.17] CENELEC EN 50090-5-2: "Home and Building Electronic Systems (HBES) - Part 5-2: Media and media dependent layers - Network based on HBES Class 1, Twisted Pair".

[i.18] CENELEC EN 50090-5-3: "Home and Building Electronic Systems (HBES) - Part 5-3: Media and media dependent layers - Radio frequency".

[i.19] CENELEC prTS 50090-6-4: "Home and Building Electronic Systems (HBES) - Part 6-4: Interfaces - Residential gateway model for a home and building electronic system".

[i.20] CENELEC EN 50090-7-1: "Home and Building Electronic Systems (HBES) - Part 7-1: System management - Management procedures".

[i.21] CENELEC EN 50090-8: "Home and Building Electronic Systems (HBES) - Part 8: Conformity assessment of products".

[i.22] CENELEC EN 50090-9-1: "Home and Building Electronic Systems (HBES) - Part 9-1: Installation requirements - Generic cabling for HBES Class 1 Twisted Pair".

[i.23] CENELEC TR 50090-9-2: "Home and Building Electronic Systems (HBES) - Part 9-2: Installation requirements - Inspection and testing of HBES installation".

[i.24] CENELEC EN 50491-2 (in development): "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) -- Part 2: Environmental conditions".

[i.25] CENELEC EN 50491-3 (in development): "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) -- Part 3: Electrical safety requirements".

[i.26] CENELEC EN 50491-5-1 (in development): "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) -- Part 5-1: EMC requirements, conditions and test set-up".

[i.27] CENELEC EN 50491-5-2 (in development): "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) -- Part 5-2: EMC requirements for HBES/BACS used in residential, commercial and light industry environment".

[i.28] CENELEC EN 50491-5-3 (in development): "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) -- Part 5-3: EMC requirements for HBES/BACS used in industry environment".

[i.29] CENELEC EN 50491-6 (in development): "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) -- Part 6: Design, planning and installation".

[i.30] ETSI TS 102 973: "Access Terminals, Transmission and Multiplexing (ATTM); Network Termination (NT) in Next Generation Network architectures".

[i.31] IEEE 802.3af: "IEEEE Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Data Terminal Equipment (DTE) Power Via Media Dependent Interface (MDI)".

[i.32] IEEE 802.3at: "Standard for Information Technology Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment: Data Terminal Equipment (DTE) Power Via the Media Dependent Interface (MDI) Enhancements".

[i.33] IEEE 802.3az: "IEEE Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Amendment: Media Access Control Parameters, Physical Layers and Management Parameters for Energy-Efficient Ethernet".

[i.34] ISO/IEC 15018: "Information technology - Generic cabling for homes".

[i.35] Commission Regulation (EC) No 1275/2008 of 17 December 2008, implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to "ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment".

[i.36] 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.37] CENELEC EN 60603-7 series: "Connectors for electronic equipment -- Part 7: Detail specification for 8-way".

[i.38] CENELEC EN 50491-4 (in development): "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS); Part 4: Functional safety requirements".

[i.39] ETSI TR 105 174-4: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment - Energy Efficiency and Key Performance Indicators; Part 4: Access networks".

3 Definitions and abbreviations

3.1 Definitions

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

application: system, with its associated transmission method that is supported by telecommunications cabling (this corresponds to a Layer One application in the OSI 7-layer model)

Broadcast Communication Technology (BCT) application: system, with its associated transmission method using the HF band (3 MHz to 30 MHz), the VHF band (30 MHz to 300 MHz) and the UHF band (300 MHz to 3 000 MHz) dedicated to the transmission of sound radio, TV and two-way data services, as well as for in-home inter-networking

NOTE: See EN 50173-1 [i.3] modified.

BCT service: transmission of sound radio, TV and two-way data

NOTE: See EN 50173-1 [i.3] modified.

Control, Command and Communications in Building (CCCB) application: system, with its associated transmission method dedicated to providing appliance control and building control

NOTE: See EN 50173-1 [i.3] modified.

CCCB services: appliance control and building control

NOTE: See EN 50173-1 [i.3] modified.

Information Communication Technology (ICT) applications: system, with its associated transmission method for the communication of information

ICT services: creation, communication dissemination, storage and management of information

network convergence: ability of a network, by virtue of the applications it supports, to deliver multiple ICT, BCT and CCCB services

3.2 Abbreviations

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

ACP	Area Connection Point
ACS	Adjacent Channel Selectivity
BACS	Building Automation and Control Systems
BCT	Broadcast Communications Technology
BO	Broadcast Outlet
CATV	Cable Television
CCCB	Command Control and Communications in Buildings
CGIC	ETSI CLC Co-ordination Group on Installations and Cabling
CO	Control Outlet
CPE	Customer Premises Equipment
DC	Dedicated Control
DSL	Digital Subscriber Line
DTE	Data Terminal Equipment
ENTI	External Network Termination Interface
FTTH	Fibre To The Home
HBES	Home and Building Electronic Systems
HD	Home Distributor
HDMI	High Definition Media Interface

ICT	Information and Communication Technology
KPI	Key Performance Indicator
MATO	Multi-Application Telecommunications Outlet
MDI	Media-Dependent Interface
NGN	Next Generation Network
OIE	Operator Independent Equipment
OSE	Operator Specific Equipment
PDA	Personal Digital Assistant
PoE	Power over Ethernet
POF	Plastic Optical Fibre
QoE	Quality of Experience
QoS	Quality of Service
SHD	Secondary Home Distributor
SMI	Structure of Management Information
TO	Telecommunications Outlet
VoIP	Voice over Internet Protocol

4 Customer networks in homes (single-tenant)

4.1 Overview of home network infrastructures

4.1.1 General

Homes, both as single-tenant and multi-tenant premises, are unique with respect to cabling infrastructures for the following reasons:

- they represent the largest constituency for broadband services;
- there are limited or non-existent cabling infrastructures within the home for the distribution of external network telecommunications services or internally generated information technology services;
- residents are either willing to physically move within the home, or install service-specific wireless systems to access the primary telecommunications equipment;
- residents tend to situate their living space(s) according to the availability of the BCT service;
- the ongoing development of BCT services and the consequent requirements of the local cabling (HDMI etc.) restrict distribution of those services within the home since a significant percentage of installations have been changed by the user and which restrict the capability of the infrastructure to support upgraded services.

The growth of ICT applications within the home and the advent of broadband services allowing access to BCT services using ICT applications has failed to encourage large scale installation of home cabling infrastructures as a means of distribution since:

- aesthetic considerations have prominence in domestic premises;
- refurbishment of the building structures is uncommon;
- residents expect temporal flexibility in access to services.

Instead there has been a substantial investment in wireless infrastructures within the home. These systems lie outside the scope of this multi-part document.

4.1.2 Network convergence

Within the home, telecommunications services fall into three groups:

- ICT (also referred to as HBES Class 2): for example, telephone, local area network;

- BCT (also referred to as HBES Class 3): for example, broadcast television;
- CCCB (also referred to as HBES Class 1): for example, security alarms, surveillance and door access control, environmental controls.

Annex A includes details of the types of services and the group into which they fall.

Access networks providing ICT services are also supporting BCT and CCCB services using ICT applications. Access networks providing BCT services also support ICT services using embedded ICT applications.

Within customer premises, the range of networks has, in the past, reflected the diversity of the services with:

- ICT services being delivered over a variety of cabling infrastructures ranging from those suitable only for basic telephony through to those used for generic cabling (see clause 4.2.1);
- BCT services being delivered over application-specific coaxial cabling systems;
- CCCB services being delivered over a variety of cabling infrastructures ranging from application-specific solutions described in general terms in clause 4.2.2, often including those combining power with control systems, through to those used for generic cabling (see clause 4.2.1).

However, the network convergence seen in the access network may also extend into the customer premises. Within customer premises, the opportunity for network convergence is further enhanced by the development of ICT networking standards that support delivery of Power over Ethernet (PoE). These can typically provide approximately 13 W via IEEE 802.3af [i.31] and approximately 25 W via IEEE 802.3at [i.32]) when using ICT applications such as 10/100/1000BASE-T.

The emergence and further development of PoE is expected to encourage the use of cabled infrastructure installations since:

- both existing residents and developers of new homes will recognize the benefits of being able to control and provide power to a wide range of equipment (for example, surveillance systems, door access control, environmental control system) that can be managed from a central location and via a common infrastructure;
- residents will see an increase in equipment specified for connection to PoE without the need for external power supplies and with a common connection style (EN 60603-7 series [i.37], also known as the RJ-45).

By these means, ICT applications, such as 10/100/1000BASE-T, are able to support ICT, BCT and CCCB services within the home.

In order to meet the potential need for a common infrastructure to support network convergence within the home, CENELEC TC215 developed EN 50173-4 [i.4], covering the design and specification of generic cabling.

4.2 Infrastructure standardization activities

4.2.1 Generic cabling designs in accordance with EN 50173-4

NOTE: EN 50173-4 [i.4], first published in 2007, has a similar scope to that of ISO/IEC 15018 [i.34] produced by ISO/IEC JTC1 SC25. However, the two documents contain different requirements and are therefore not identical at a technical level.

4.2.1.1 Infrastructure layers

EN 50173-4 [i.4] specifies two layers of infrastructure as shown in figure 1 (*modified from EN 50173-4 [i.4]*). Both layers are fed from a Home Distributor (HD) or, if the dimensions of the home, its configuration or the complexity of the network supports their use, Secondary Home Distributors (SHD) as shown in figure 2 (*modified from EN 50173-4 [i.4]*). Figure 2 (*modified from EN 50173-4 [i.4]*) shows that generic cabling of EN 50173-4 [i.4] not only provides distribution of broadband services delivered over cabled media via the access network but also supports the reception of BCT services using antennae.

It should be noted that within multi-tenant premises the network telecommunications equipment and access network cabling shown in figure 1 and figure 2 may be replaced by other equipment and a private backbone cabling infrastructure operated by the premises owner or other party.

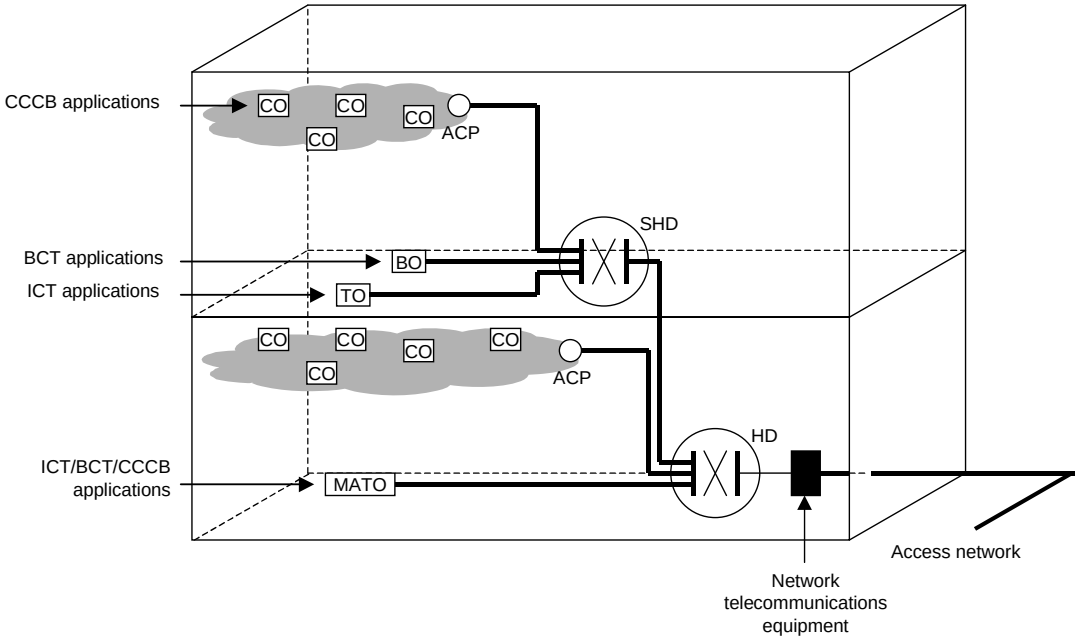

Figure 1: Dual layer infrastructure of EN 50173-4 [i.4]

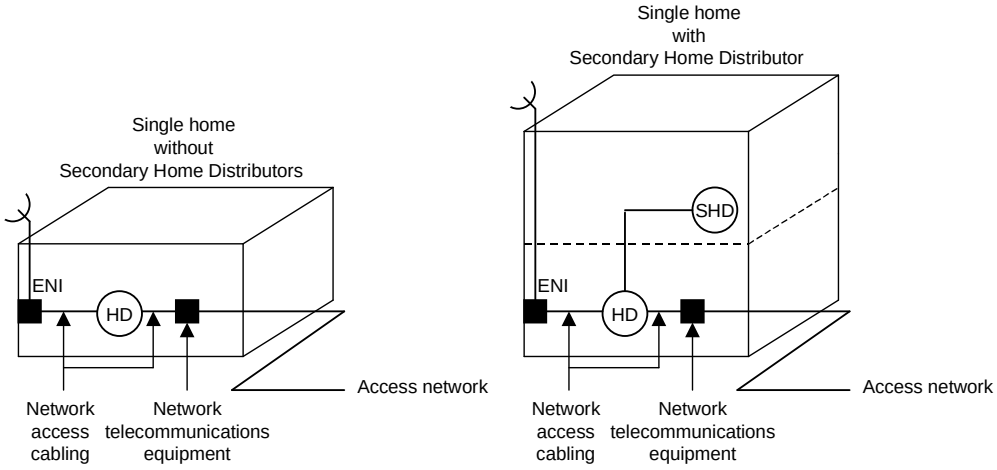

Figure 2: Examples of generic cabling within the home according to EN 50173-4 [i.4]

4.2.1.2 CCCB infrastructure

The provision of CCCB services is achieved by the connection of:

- control devices (e.g. sensors and/or actuators) at the Control Outlets (CO);
- the relevant system control equipment at the HD/SHD as shown in figure 3 (as in EN 50173-4 [i.4]).

A CO may be connected directly (i.e. point-to-point) to the HD/SHD or may be connected via an Area Connection Point (ACP) which allows a range of point-to-multipoint topologies in a given area where required by the needs of that area and as allowed by the CCCB system serving that area.

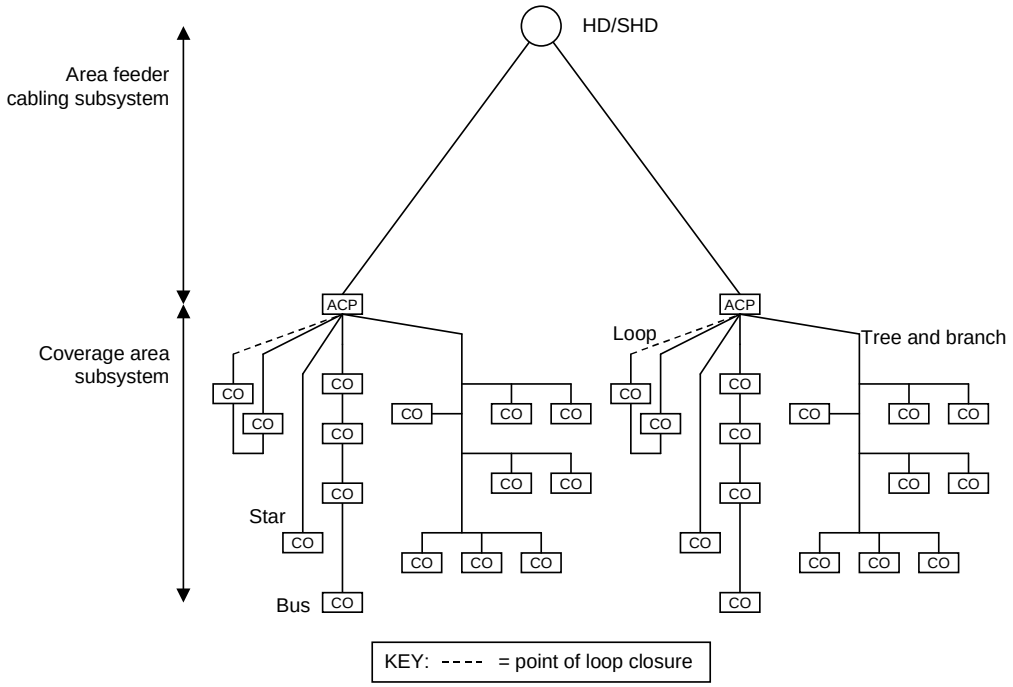

Figure 3: CCCB cabling topologies of EN 50173-4 [i.4]

The type of cabling components and the installed transmission performance is defined by EN 50173-4 [i.4]. This allows a wide range of CCCB applications to be supported but inevitably not all CCCB applications are supported over such an infrastructure. Other cabling design standards exist to support these applications (see clause 4.2.2).

NOTE: The ACP also supports the implementation of wireless sensor networks.

4.2.1.3 ICT and BCT infrastructure

The provision of ICT and BCT services is achieved by the connection of:

- terminal equipment (e.g. telephones, computers and television receivers) at the Telecommunications Outlet (TO) and Broadcast Outlet (BO) respectively - both of which adopt a point-to-point star topology to the relevant distributor;
- the relevant system equipment at the HD/SHD as shown in figure 4 (as in EN 50173-4 [i.4]).

NOTE: The Multi-Application Telecommunications Outlet (MATO) is a co-location of BO, TO and ACP/CO.

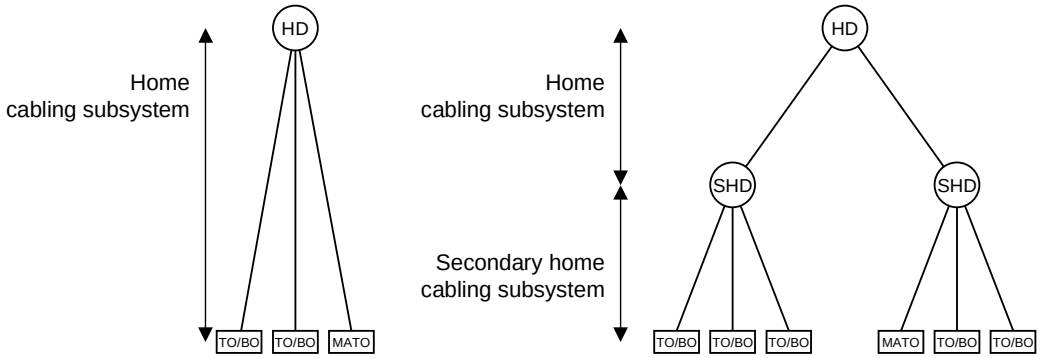

Figure 4: BCT/ICT cabling topologies of EN 50173-4 [i.4]

4.2.1.4 Cabling

The ICT and CCCB infrastructures are implemented using balanced cabling. There is a common minimum transmission performance between the HD (or SHD) and the TO and ACP (defined as Class D of EN 50173-1 [i.3]).

NOTE: EN 50173-4:2007 [i.4] does not include support for optical fibre as a cabling medium in the home. See annex B for details of proposals in this area.

Class D cabling of EN 50173-1 [i.3] is capable of supporting applications up to and including 1000BASE-T and incorporating power distribution to the TO or ACP in accordance with IEEE 802.3at [i.32].

Although the BCT infrastructure may be implemented using coaxial cabling or balanced cabling, the ultimate objective of network convergence is achieved by delivering both CCCB and BCT services using ICT applications.

4.2.2 Cabling designs in accordance with EN 50090 and EN 50491 series

The EN 50090 series of standards [i.2] specifies system solutions for the provision of Home and Building Electronic Systems (HBES). HBES support the distribution of CCCB, ICT and BCT services which are designated Class 1, Class 2 and Class 3 respectively.

Some of the HBES Class 1 systems are supported over generic cabling for CCCB described in clause 4.2.1 and shown in figure 3. Others have specific requirements for cabling design that fall outside the provision of generic cabling.

HBES Class 1 applications between the equivalent of the HD/SHD and CO of EN 50173-4 [i.4] typically adopts a bus topology (see figure 5) although tree (see figure 6), star (see figure 7) and combined topologies are also supported by certain HBES Class 1 implementations as shown in figure 8.

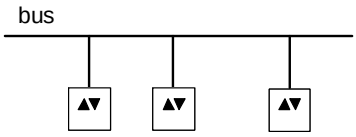

Figure 5: Bus topology for HBES cabling and device connection

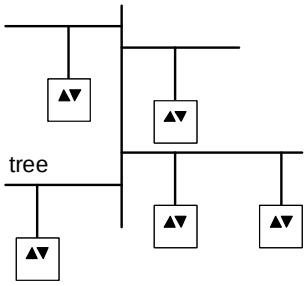

Figure 6: Tree topology for HBES cabling and device connection

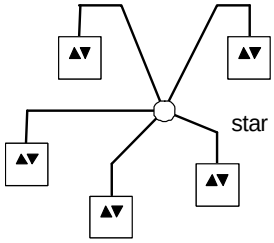

Figure 7: Star topology for HBES cabling and device connection

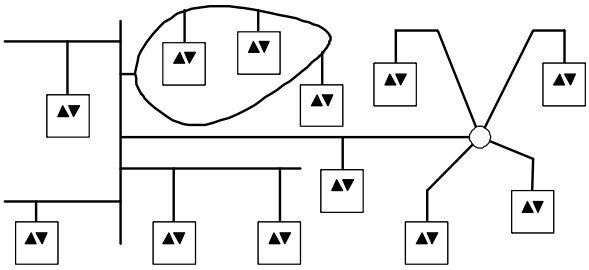

Figure 8: Combined topologies for HBES cabling and device connection

Once HBES devices are connected to the infrastructure, it is necessary for them to be configured to exercise their function via simple or complex commands (scenarios). Device configurations include set points and timing for temperature controllers, zone partitioning for temperature and alarm controllers and scenario definition in control units.

The EN 50491 series of standards is entitled "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS)" and contains requirements for HBES devices including:

- environmental performance, EN 50491-2 [i.24];
- safety, EN 50491-3[i.25];
- functional safety, EN 50491-4 [i.38];
- EMC, EN 50491-5 series [i.26], [i.27] and [i.28];
- design, planning and installation, EN 50491-6 [i.29].

The EN 50491 series is in the process of replacing the existing EN 50090 series of standards [i.2] entitled "Home and Building Electronic Systems (HBES)" covering the following areas:

- system overview, EN 50090-2 series [i.7], [i.8] and [i.9];
- aspects of application, EN 50090-3 series [i.10], [i.11] and [i.12];
- media independent layers, EN 50090-4 series [i.13], [i.14] and [i.15];
- media and media dependent layers, EN 50090-5 series [i.16], [i.17] and [i.18];
- interfaces, EN 50090-6 series [i.19];
- system management, EN 50090-7 series [i.20];
- conformity assessment of products, EN 50090-8 series [i.21];
- installation requirements, EN 50090-9 series [i.22] and [i.23].

4.2.3 Cabling installation in accordance with EN 50174 standards

EN 50174-1 [i.5] and EN 50174-2 [i.6] contain requirements and recommendations for the specification, quality assurance, planning and installation practices that apply to all information technology cabling media in all premises. Clause 10 of EN 50174-2 [i.6] specifies the additional/amended requirements and recommendations that apply within the home.

In recognition of the domestic environment described in clause 4.1, clause 10 of EN 50174-2 [i.6] focuses on the provision of spaces and pathways to house the cabling infrastructures in support of both EN 50173-4 [i.4] and EN 50491 standards.

It is planned that EN 50174-1 [i.5] and EN 50174-2 [i.6] will support the essential aspects of planning and installation and this will be reflected in external references from EN 50491-6 [i.29].

4.3 Network access infrastructure

The connection between the operator's access network and the home distributor as shown in figure 2 (or the equivalent in non-generic cabling) is provided by network access cabling and some type of network telecommunication equipment as shown in figure 9.

The network telecommunications equipment typically comprises a passive interface (ENTI) and an optional item of apparatus. The apparatus may be specific to the network operator (OSE) or may be operator independent (OIE) as described in the following examples:

- OIE: DSL modem, FTTH modem (where interoperability standard exists).

NOTE: See TS 102 973 [i.30].

- OSE: CATV modem, FTTH modem (where no interoperability standard exists);

The OSE is part of the access network whereas the OIE is part of the customer premises infrastructure.

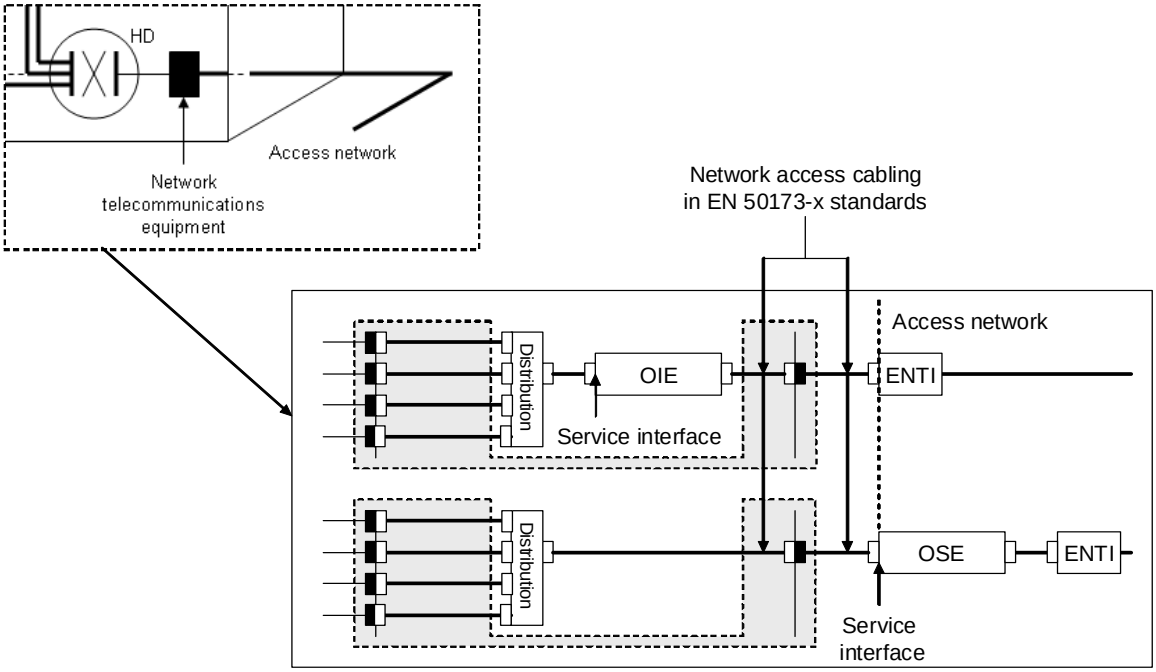

Figure 9: Network access cabling and equipment

In most cases the OIE, or some part of it, may be powered from the access network. In some cases the OSE may be powered from the customer premises.

For this reason, the energy efficiency of the access network takes into account any power required to maintain the functionality at the service interface, whether or not it is part of the access network (and is covered in TR 105 174-4 [i.39]).

The EU Code of Conduct on Energy Consumption of Broadband Equipment [i.1] provides a framework for ensuring operational energy efficiency consumption of network telecommunication equipment.

5 Energy efficiency

5.1 General

It is not possible to determine Key Performance Indicators (KPIs) for the energy efficiency of information technology networks within homes (single tenant). However, it is relevant to identify strategies for the improvement of energy efficiency of information technology infrastructures in the home (see clause 5.2) and also to introduce short term and medium term actions, based on the use of information technology networks, to reduce the overall energy consumption within homes (see clause 5.3).

5.2 Energy efficiency of information technology infrastructures

The principal strategy to be adopted involves:

- the use of devices in accordance with the Energy Efficient Ethernet project (IEEE 802.3az [i.33]);
- the use of low consumption visual interfaces;
- the use of common visual interfaces (acting as displays for ICT and BCT services, independent of the type of application used to deliver the BCT service);

- not just using standby modes for attached devices (opting to turn them off instead).

NOTE: The future provision of equipment meeting the requirements of European Commission Regulation (EC) No 1275/2008 [i.35] will assist in observing this strategy.

5.3 The use of information technology to reduce total energy consumption

5.3.1 Infrastructure

The creation of appropriate network infrastructures can assist in reducing energy consumption by minimising the energy wasted due to poor control of attached equipment.

Examples include:

- the use of PoE and PoE Plus, representing power on demand:
  - encouraging the use of equipment options with lower power consumption;
  - replacing permanently connected, "on" all the time, equipment (including DC converters in mains sockets);

NOTE: It is recognized that PoE may not be as energy efficient as a means of powering an individual device but it is considered that the benefit of PoE will lie in the control of usage that its fixed infrastructure provides.

- the implementation of wireless access technologies to allow portable access to information technology services rather than duplicating equipment.

5.3.2 Applications

CCCB services offer significant opportunities to reduce energy consumption (e.g. light and heating levels in unoccupied areas) which can be further enhanced by integration with broadband delivery to monitor and control energy usage via those CCCB systems.

The marketing of such "intelligent" home systems has, to date, concentrated on the features of such systems rather than on the benefits of using them. As energy costs rise, the opportunity exists to re-focus on potential energy savings offered by information technology solutions. The ability to monitor, in real time, the energy usage in the home, either as a total or more specifically as related to individual circuits (lighting, heating) or components (ovens, refrigerators) and to display this information using a common visual interface using an ICT application both within the home (see clause 5.2) or remotely may contribute significantly to the reduction of energy consumption within the home.

The opportunity presented by PoE suggests that optical fibre in the home may not be as advantageous as one might think despite the ultimate bandwidth limitations of the copper cabling specified in EN 50173-4 [i.4] (specified today to support 1000BASE-T, Class D).

5.3.3 Green issues

The use of high bandwidth broadband deployment to support true "home working" (enabling effective "telepresence") allows the "carbon footprint" of employees to be reduced.

A variety of studies, including those undertaken in the United Kingdom by The Carbon Trust, shows that home working provides substantial beneficial impact.

An increased focus by employers on "mobility", requiring equivalent access to corporate networks, applications and tasks independent of the location from which they are accessed, recognizes home working as offering reductions in both capital and operational expenditure in terms of office space, corporate infrastructure and energy consumption. However, true mobility requires provision of high speed broadband delivery which can replicate, effectively, the office-based environment in the remote location.

Annex A:
Services within the home

Within table A.1, the access network refers to the distribution infrastructure technology.

Table A.1: Services, applications and required infrastructure

			Access network - coaxial	Access network - balanced/OF	Set Top Box	Home Gateway	TV	PC	Home server	Residential network	Sensors
	BCT Services										
Entertainment	BCT Applications										
	Television and radio		X		X		X				
	ICT Applications										
	Television and radio			X		X	X	X			
	ICT Services										
	ICT Applications										
Entertainment	Entertainment: Multimedia		X	X	X	X		X		X	
	Entertainment: Photo/video	Photo frames					X	X	X		
	Entertainment: Photo/video (shared)	Photo frames, mobile TV terminals, videophone				X	X	X	X	X	
	Entertainment: Audio-HiFi	Audio players (dedicated MP3 player, mobile terminals, etc)		X			X	X	X		
	Entertainment: Audio-HiFi (shared)	Audio players (dedicated MP3 player, mobile terminals, etc.)		X		X	X	X	X	X	
	Entertainment: Game	Game console					X	X			
	Entertainment: Game (shared)	Game console		X		X	X	X	X		
Socio-cultural	Telelearning	Video-communication terminals, biomedical terminals		X		X		X	X		
	Teleworking, cooperative working	Phone terminals, video-communication terminals		X		X		X	X		
	Home news, Info-push and virtual community	Video telephony		X		X		X	X		
	Home banking, and on-line purchases	Video telephony		X		X		X	X		
Telecommunications	Remote access to corporate LAN			X		X		X	X		
	Integration with mobile phones, PDA, etc.	PDA, etc, mobile terminals, femtocell		X		X			X		
	Telephone services	Phone terminals (fixed and mobile)		X		X			X		
	Videocommunication	Video-communication terminals		X		X		X	X		
	E-mail	Phone terminals (fixed and mobile)		X		X		X			
Health and wellbeing	Homecare	Video-communication terminals, biomedical terminals		X		X			X		
	Remote assistance	Video-communication terminals, biomedical terminals		X		X			X		
	Remote monitoring	Video-communication terminals, biomedical terminals		X		X			X		X
	Telemedicine	Video-communication terminals, biomedical terminals		X		X		X	X		

			Access network - coaxial	Access network - balanced/OF	Set Top Box	Home Gateway	TV	PC	Home server	Residential network	Sensors
	CCCB Services										
	CCCB or ICT Applications										
	Security: Anti-intrusion										
	Security: Access control			X		X			X		X
	Safety: Ambient control (e.g. fire, gas, …)			X		X	X	X	X		X
	Programming and controlling white goods			X		X	X	X	X		X
	Motor control (e.g. rolling shutter)										
	Lighting (scenarios)										
	Heating/Air-conditioning										
	Energy management: Load control										
	Heating/Air-conditioning										
	Lighting (automatic switch off)										

Annex B:
Proposal for plastic optical fibre within the home

The following text is provided by ETSI experts and is a placeholder for future work in this area.

Alternative proposals are included in Amendment 2 of ISO/IEC 15018[i.34].

No plans exist for the inclusion of optical fibre within generic cabling within the home according to EN 50173-4 [i.4].

Plastic Optical Fibre System Specifications for 100 Mbit/s and 1 Gbit/s

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The goal of this document is to go towards specifications of Plastic Optical Fibre (POF) systems for 100 Mbit/s and 1 Gbit/s for interoperability between different suppliers. Specifications and requirements are given from operators' point of view. The system comprises the active optical elements, the cables and connectors.

A future step will be to achieve integration of POF interfaces into end equipment.

1. Context

Even if "no new wires" solutions (radio, power line communication) are today the preferred to interconnect devices inside the home, it is necessary in some cases to use a wired solution to guarantee a sufficient reach or Quality of Service (QoS). Optical fibre, and particularly PMMA Step Index Plastic Optical Fibre (SI POF), appears as an excellent solution for reliable, high-speed home networking mainly for the following key advantages:

- Material: the core of this fibre is constituted of PMMA, a very inexpensive material. It is very easy to handle and to cut, unlike silica fibre that has to be cleaved and spliced with specialist tools.
- Geometry: the core has a step index profile, particularly simple to elaborate. The core diameter is wide (1 mm), which relaxes tolerances for connecting fibre.
- POF cables are very thin (a few millimetres in diameter) compared to Cat5 cable, and easy to integrate in home fittings. As optical fibre is insensitive to electromagnetic perturbations, it can be installed in the proximity of electrical cables without interference.
- POF systems use visible light, (in contrast with silica fibre which uses infrared light), which makes implementation easier: the customer, taking a glance at the fibre extremity can see if the signal is present or not with no risk to the users eye safety. The optical transmitter is of the same type as those used in an optical computer mouse, without any danger regarding ocular safety.

These native properties have to be balanced by some drawbacks: PMMA exhibits a strong attenuation, minimum for visible light (0,15 dB/m to 0,20 dB/m at 650 nm, to be compared to 0,25 dB/km at 1 550 nm for silica single mode fibre), which limits the reach of the links to about hundred meters without bends. The large diameter, the step index profile and the low cost transmitters with slow modulation speed also limit the bandwidth of POF systems. However, POF is an excellent trade-off between easy implementation and performance that meets the requirements for home networking: it is a very low cost technology and allows a "Do It Yourself" (DIY) approach for visible cables and for in-duct cabling when authorised: indeed, the customer may easily install a POF network himself, without any specialist tools, only a cutter. Considering performance, commercial equipments today work at a bit rate of 100 Mbit/s, well adapted for Fast Ethernet applications, with a reach up to a hundred meters. In the mid term (mid 2009), using advanced signal processing techniques, prototypes working at a bit rate of one Gbit/s with the same reach will be available allowing the possibility to set up a Gigabit Ethernet based home network and other industrial or special environments such as hospitals.

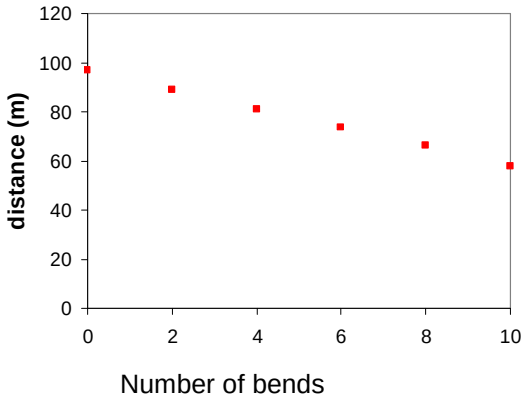
2. 100 Mbit/s System (Fast Ethernet)

2.1 Performance

Today on the market several suppliers offer PMMA POF media converter solutions at 100 Mbit/s. With such performance PMMA fibre may be used in the home to interconnect all devices usually communicating through Fast Ethernet interfaces for example the link between the home gateway and the TV.

Feature	Specification	Comment
Link distance	50 cm to 100 m	See figure below
Max Physical-Layer Data Rate	125 Mbit/s	
Bit Error Rate	$<10^{-12}$	
Service	Full Duplex	Today media converters are based on duplex service which are achieved by using duplex POF. However the availability of a duplex service over simplex POF systems needs to be investigated as ultimately they may provide practical advantages to end users.
Latency	< 5 ms in either direction	Today media converters do not implement any traffic management and are configured to simply pass the data through.
Additional Standards	IEEE 802.3	The physical layer will be compatible with 100 MbE CPE.
Temperature Range	0 to +60 ºC	This is the ambient operating temperature
Eye Safety	Class 1	For consumer applications all equipment must by design be Class 1 compliant.

The PMMA fibre presents a high attenuation coefficient, so the transmission distance is limited. For our applications we recommend the POF solution support a 100 Mbit/s bit rate over 50 m with about 10 bends. This configuration lets to simulate the worst installation case. The bandwidth distance product will be dependent on the installation configuration (with or without bending stresses) as showed on the figure below.



2.2Higher Level System Features

	Feature
1	Shall conform to QoS specifications per channel as outlined in DSL Forum Technical Report TR-126 Triple-Play Services, Quality of Experience (QoE) Requirements, Dec 2006.
2	Interoperability between multiple vendors systems to stimulate competition and ensure security features are common throughout vendors.
3	Interoperable from a mix of vendors shall be interoperable at the data rate specified.
4	Bridges shall be able to support both IPv4 & IPv6.
5	Devices should be "Plug & Play", such that the user is able to install them very easily.
6	It shall be possible to add/remove additional nodes without service interruption to existing nodes.
7	Devices shall be transparent to either ACS or via a TR069 proxy on the HG (or other equipment) thus supporting the remote management of CPE such as switches and STB's that are linked by POF.

2.3 Cable

The cable has to include 1 or 2 PMMA POF fibres. In the latter case one for the downstream and the other one for the upstream.

The PMMA fibre must be compliant with the categories A4.a1 and/or A4.a2, defined in the IEC 60793-2-40 Add ref to 2.2 international standard regarding the POF fibres.

The fibre dimension (with the external coating) must be fitted according to the transceivers available on the market today.

The cable design must allow an easy access to the fibres.

With this cable the connection must be fast and easy. Several solutions can be chosen, the use of connectors already standardized like SMI (IEC 61754-21) or SC/RJ (IEC 61754-24) or preferably systems without connectors.

For home network applications material used in the cable manufacturing must meet health requirements. Thus the cable jacket must be fire resistant according to the international IEC 60332 series and possibly halogen-free.

2.4 Installation

The PMMA POF solution is very attractive to do a point to point architecture in an already constructed house, because the installation of the cable can be performed by the user himself. Several installation configurations can be considered: the cable can be installed in existing ducts (empty or already used by a copper/electrical cable) or installed along the wall or plinths by stapling or gluing.

In the case of a visible home-cabling the constraints applied on the cable are stricter (several corners and doors). So the cable design must be adapted to support small bending radii without leading to a too high bending loss. We can take as reference 0,5 dB attenuation for a 25 mm bending radius.

3. Evolution towards 1 Gbit/s

With option of using the same optical support of 100 Mbit/s system (only changing interfaces).

3.1 Performance:

Feature	Specification	Comment
Link distance	50 cm to 100 m	It is anticipated that the link may have an adaptive data rate depending upon link length and number of bends. An indicative performance table is shown below.
Max Physical-Layer Data Rate	1,25 Gbit/s	1,25 Gbps of data shall be achievable for a link up to 50 m when the cable does not suffer from bending loss
Bit Error Rate	$<10^{-6}$	Requirement coming from: ➢ ITU-T IPTV Focus Group Proceedings 2008 ➢ DSL Forum Technical Report TR-126 Triple-Play Services, Quality of Experience (QoE) Requirements, Dec 2006
Service	Full Duplex	It is understood that the duplex service will be achieved by using duplex POF. However the availability of Duplex service over simplex POF would be of interest.
Latency	< 5 ms in either direction	Services such as Gaming & VoIP require low latency. Note that adaptive data rates will require traffic management and will increase latency.
Additional Standards	IEEE 802.3	The physical layer will be compatible with GbE CPE.
Temperature Range	0 to +60 ^{o}C	This is the ambient operating temperature range internal in the customer premise equipment (CPE). Transceiver component operating temperature range will in general be higher.
Humidity	5 % to 95 %	Non condensing.
Eye Safety	CPE must be Class 1	For consumer applications all equipment must by design be Class 1 compliant.

Indicative Link Performance

Link Length (m)	No. 90^{o} Bends of 12 mm Radius	Physical-Layer Data Rate (Gbps)
50	0	1,25
50	10	0,85
75	0	0,87
75	10	0,45
100	0	0,5
100	10	0,08

Higher Level System Features

	Feature
1	Shall conform to QoS specifications per channel as outlined in DSL Forum Technical Report TR-126 Triple-Play Services, Quality of Experience (QoE) Requirements, Dec 2006.
2	Interoperable from multiple vendors for security of supply and to ensure competitive commercial terms.
3	Interoperable from a mix of vendors shall be interoperable at the data rate specified.
4	Bridges shall be able to support both IPv4 & IPv6.
5	Devices should be 'Plug & Play', such that the user is able to install them very easily.
6	It shall be possible to add/remove additional nodes without service interruption to existing nodes.
7	Devices shall be transparent to either ACS or via a TR069 proxy on the HG (or other equipment) thus supporting the remote management of CPE such as switches and STB's that are linked by POF.

3.2 Cable: see 2.2

3.3 Installation: see 2.3

4. Energy efficiency

Ultimately POF transceivers will be integrated in the user equipments thus reducing the number of power supplies hence the overall electrical consumption.

An alternative to this would be to power up the media converter by means of USB interface or Power over Ethernet (PoE) on the RJ45 interface.

Energy efficiency targets are set out in the EU "Code of Conduct on Energy Consumption of Broad Band Equipment" version 3 18 November 2008.

Feature	Specification	Comment
Maximum power consumption	<0,4 W in full operation per port for 100 MbE POF transceiver <3,5 W in full operation 100 MbE media converter < 3,5 W in full operation per port for 1 GbE media converter	The target is to achieve as low power consumption as possible. The targets present here are the 2011 targets of the EU Code of Conduct on Energy Consumption of Broad Band Equipment.
Power Management	Required	Devices shall offer a standby mode and they shall enter this mode after a configurable period without any traffic.
Maximum power consumption in standby mode	<0,5 W	
Power Mode Transition Time	<1 s	Devices shall transition from the standby mode to active mode when traffic is detected.

5. Acknowledgement

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History

Document history		
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