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**Access, Terminals, Transmission and Multiplexing (ATTM);**
**Broadband Deployment and Lifecycle Resource Management;**
**Part 5: Customer network infrastructures;**
**Sub-part 1: Homes (single-tenant)**

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# Contents

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

# 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 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 be 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 sub-part 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 of terms 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

## 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 referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://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.

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

Not applicable.

## 2.2 Informative 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 referenced document (including any amendments) applies.

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] 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: "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: "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: "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: "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: "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: "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 and Energy Management; 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".

[i.40] ETSI TS 105 175-1 (V2.0.0): "Access, Terminals, Transmission and Multiplexing (ATTM); Plastic Optical Fibre System Specifications for 100 Mbit/s and 1 Gbit/s".

[i.41] ETSI TS 105 175-1-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Plastic Optical Fibres; Part 1: Plastic Optical Fibre System Specifications for 100 Mbit/s and 1 Gbit/s; Sub-part 1: Application requirements for physical layer specifications for high-speed operations over Plastic Optical Fibres".

[i.42] ETSI TS 105 175-1-2: "Access, Terminals, Transmission and Multiplexing (ATTM); Plastic Optical Fibres; Part 1: Plastic Optical Fibre System Specifications for 100 Mbit/s and 1 Gbit/s; Sub-part 2: 1 Gbit/s and 100 Mbit/s physical layer for Plastic Optical Fibres".

[i.43] CENELEC EN 50173 series: "Information technology - Generic cabling systems".

# 3 Definition of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the following terms 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 CENELEC EN 50173-1 [i.3] modified.

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

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

**CCCB services:** appliance control and building control

NOTE: See CENELEC 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 Symbols

Void.

## 3.3 Abbreviations

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

| | |
|---|---|
| ACP | Area Connection Point |
| BACS | Building Automation and Control Systems |
| BCT | Broadcast Communications Technology |
| BO | Broadcast Outlet |
| CAT | CATegory |
| CATV | CAble Television |
| CCCB | Command Control and Communications in Buildings |
| CGIC | ETSI CLC Co-ordination Group on Installations and Cabling |
| CO | Control Outlet |
| DC | Dedicated Control |

| | |
|---|---|
| DSL | Digital Subscriber Line |
| DTE | Data Terminal Equipment |
| EC | European Commission |
| EEE | Energy Efficient Ethernet |
| EMC | Electro-Magnetic Compatibility |
| ENTI | External Network Termination Interface |
| EU | European Union |
| FTTH | Fibre To The Home |
| HBES | Home and Building Electronic Systems |
| HD | Home Distributor |
| HDMI | High Definition Media Interface |
| HD/SHD | Home Distributor / Secondary Home distributor |
| ICT | Information and Communication Technology |
| IEC | International Electrotechnical Commission |
| LAN | Local Area Network |
| LPI | Low Power Idle |
| MATO | Multi-Application Telecommunications Outlet |
| MDI | Media-Dependent Interface |
| NGN | Next Generation Network |
| OF | Optical Fiber |
| OIE | Operator Independent Equipment |
| OSE | Operator Specific Equipment |
| PC | Personal Computer |
| PDA | Personal Digital Assistant |
| PoE | Power over Ethernet |
| POF | Plastic Optical Fibre |
| RJ | Registered Jack |
| SHD | Secondary Home Distributor |
| SI | Step Index |
| SI-POF | Step Index Plastic Optical Fibre |
| TO | Telecommunications Outlet |
| TR | Technical Report |
| TV | TeleVision |

# 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;
- Other services technology, known as CCCB (also referred to as HBES Class 1): for example, security alarms, surveillance and door access control, environmental controls, IoT.

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 (CENELEC 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 CENELEC 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 CENELEC EN 50173-4

#### 4.2.1.1 Infrastructure layers

CENELEC EN 50173-4 [i.4] specifies two layers of infrastructure as shown in figure 1. 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. Figure 2 shows that generic cabling of CENELEC 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.

NOTE: CENELEC 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.

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.

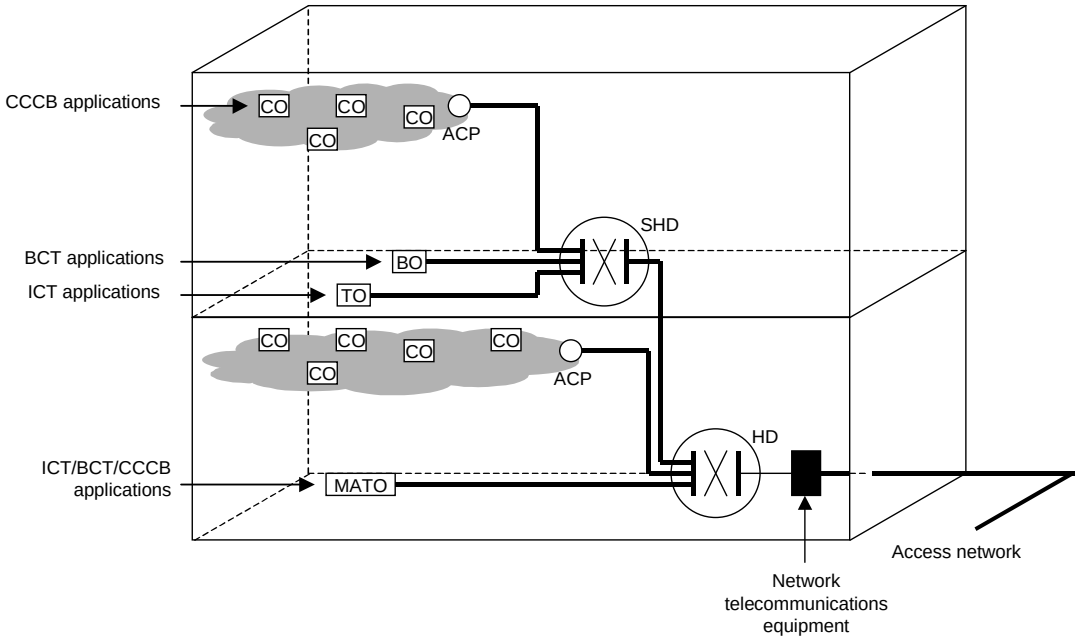




**Figure 1: Dual layer infrastructure of CENELEC EN 50173-4 [i.4]**

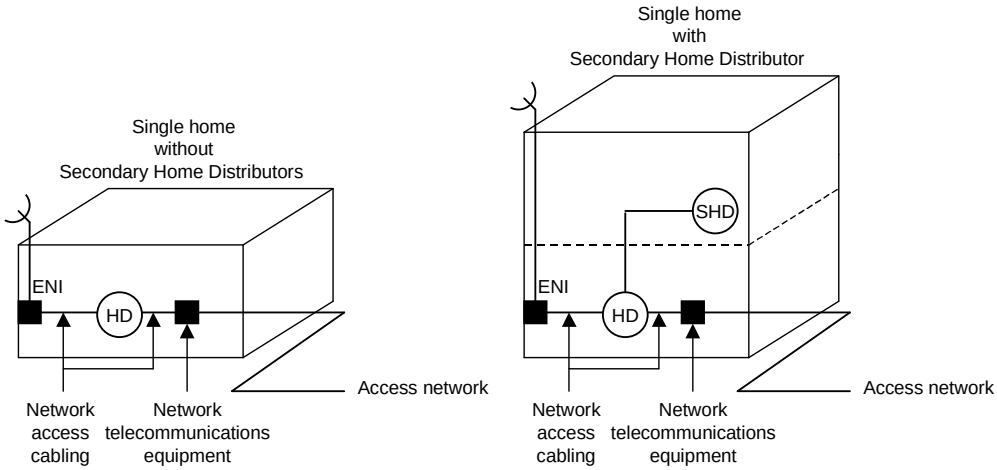




**Figure 2: Examples of generic cabling within the home according to CENELEC EN 50173-4 [i.4]**

### 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 CENELEC 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.

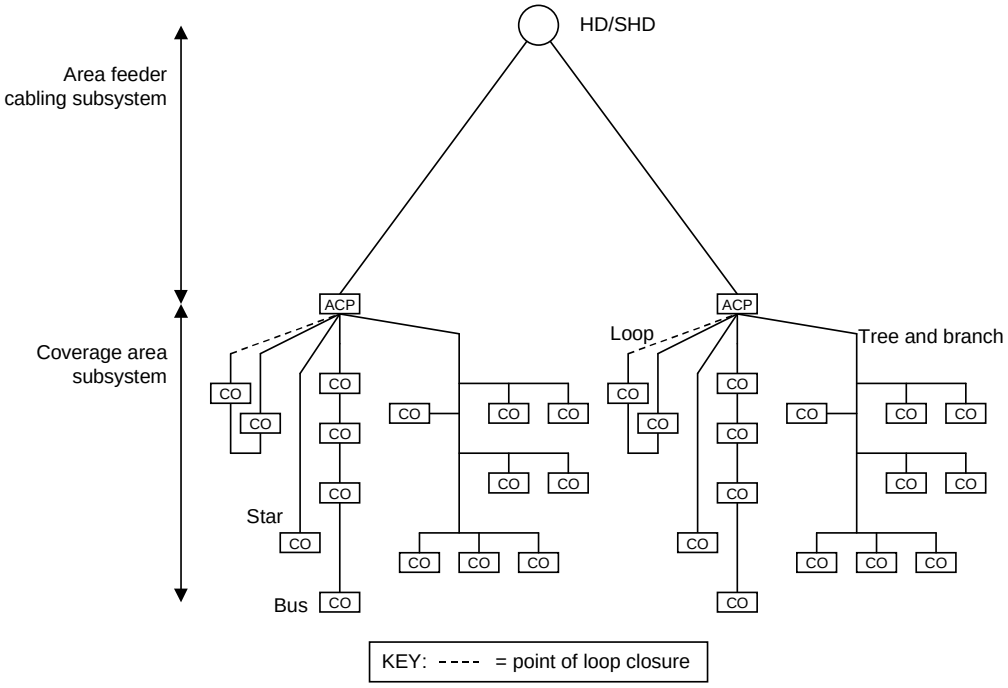




**Figure 3: CCCB cabling topologies of CENELEC EN 50173-4 [i.4]**

The type of cabling components and the installed transmission performance is defined by CENELEC 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 CENELEC EN 50173-4 [i.4]).

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

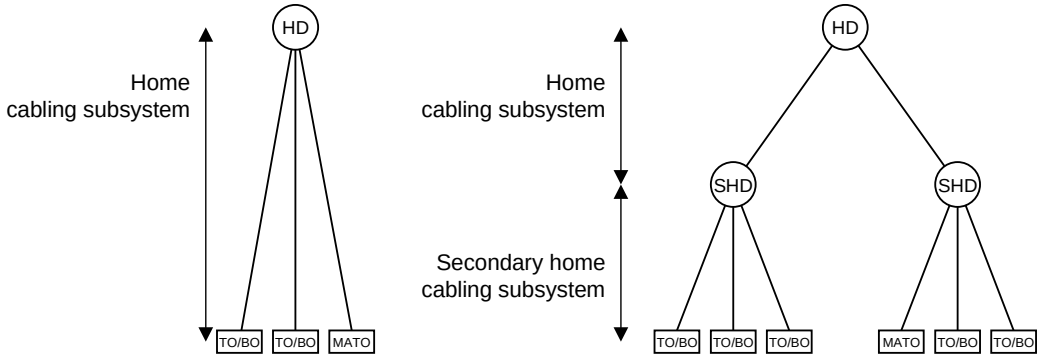




**Figure 4: BCT/ICT cabling topologies of CENELEC EN 50173-4 [i.4]**

#### 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 CENELEC EN 50173-1 [i.3]).

Class D cabling of CENELEC 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 installation in accordance with CENELEC EN 50174 standards

CENELEC EN 50174-1 [i.5] and CENELEC 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 CENELEC 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 CENELEC EN 50174-2 [i.6] focuses on the provision of spaces and pathways to house the cabling infrastructures in support of both CENELEC EN 50173-4 [i.4] and CENELEC EN 50491 standards [i.24] to [i.29].

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

## 4.3 Network access infrastructure

### 4.3.0 Energy Efficiency in network access cabling and equipment

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 5.

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 ETSI 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.

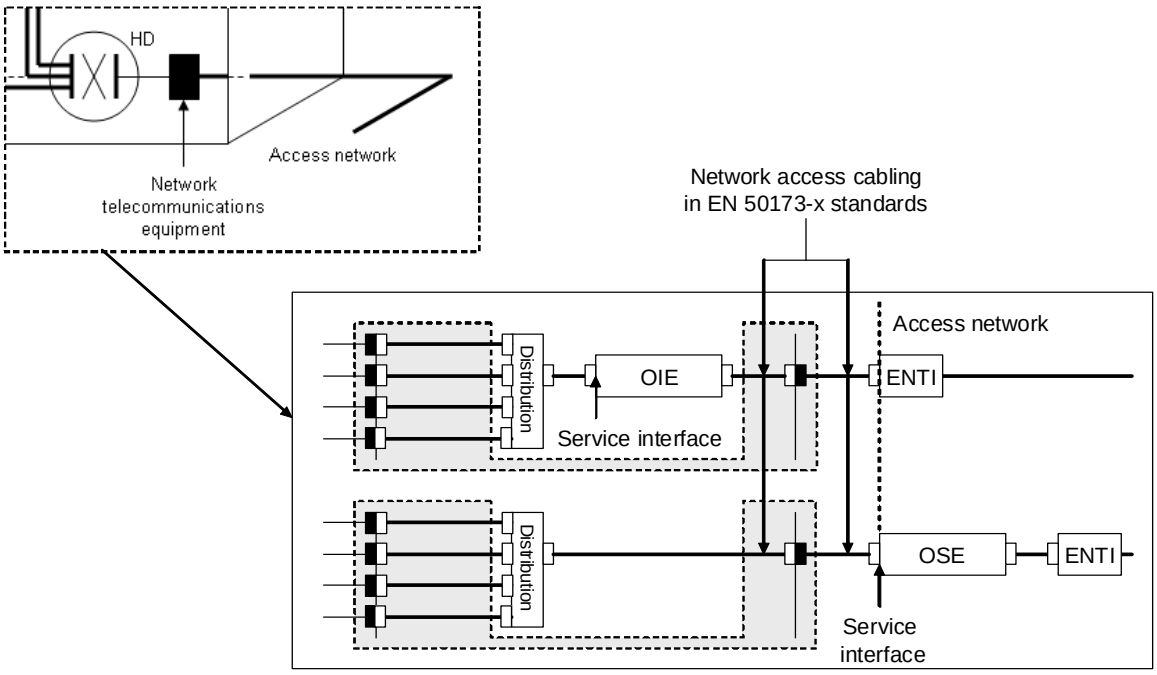


**Figure 5: Network access cabling and equipment**

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 ETSI 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.

### 4.3.1 Cabling designs in accordance with CENELEC EN 50090 and CENELEC EN 50491 series

The CENELEC 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 CENELEC EN 50173-4 [i.4] typically adopts a bus topology (see figure 6) although tree (see figure 7), star (see figure 8) and combined topologies are also supported by certain HBES Class 1 implementations as shown in figure 9.

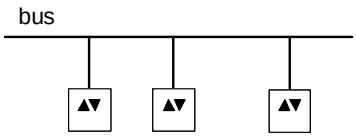


**Figure 6: Bus topology for HBES cabling and device connection**

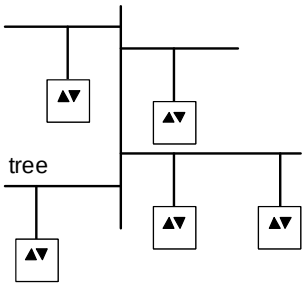


**Figure 7: Tree topology for HBES cabling and device connection**

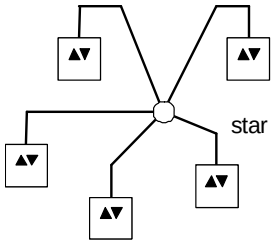


**Figure 8: Star topology for HBES cabling and device connection**

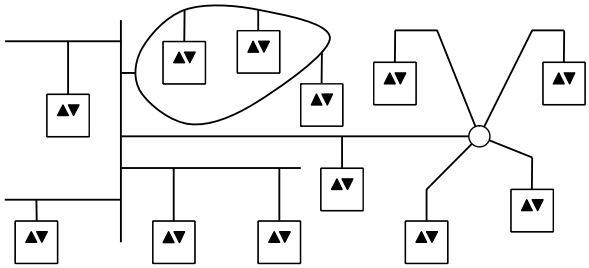

**Figure 9: Combined topologies for HBES cabling and device connection**

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

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

- system overview, CENELEC EN 50090-2 series [i.7], [i.8] and [i.9];
- aspects of application, CENELEC EN 50090-3 series [i.10], [i.11] and [i.12];

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

# 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 minimizing 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 CENELEC 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.

## 5.4 The POF cabling case: ETSI TS 105 175-1-1

### 5.4.0 Generalities

According to ETSI TS 105 175-1-1 [i.41] one of the possible solutions for home networking cabling is the use of POF. This clause describes, how the use of that TS is an optimum strategy for energy reduction.

### 5.4.1 ETSI TS 105 175-1-1

ETSI TS 105-175-1-1 [i.41] describes a home network architecture based in a gigabit back-bone of SI-POF using the ETSI TS 105 175-1-2 [i.42] physical layer.

ETSI TS 105-175-1-1 [i.41] and ETSI TS 105 175-1-2 [i.42] fulfil the requirements of the ETSI TS 105 175-1 [i.40].

The Plastic Optical Fibre might be installed between wall-plugs, connecting the home devices to the network either by RJ-45 wall plug connectors or Wi-Fi repeaters in every wall-plug.

### 5.4.2 Typical power consumption values

Table 1 shows power consumption of the POF application compared with 802.3 1000BASE-T and 802.3 1000BASE-SX solutions.

**Table 1: Typical power consumption values per link**

| Name | EEE | PoE/PoE+ | Power Consumption | | | | |
|---|---|---|---|---|---|---|---|
| | | | 100 % Traffic | 50 % Traffic | 10 % Traffic | No Traffic | Idle mode |
| ETSI TS 105 175-1-1 [i.41] | Yes | No | 650 mW | 375 mW | 150 mW | 100 mW | < 1 mW |
| 802.3 1000BASE-T | Yes | Yes | 1000 mW | 800 mW | 300 mW | 100 mW | < 1 mW |
| 802.3 1000BASE-SX | No | No | 600 mW | 600 mW | 600 mW | 600 mW | - |

This values coming from market product datasheet are best market values at the time of writing. 50 % and 10 % traffic values are estimated values.

### 5.4.3 Low Power Idle mode

The use of Energy Efficient Ethernet (EEE) technics can reduce significantly the power consumption in the home network. In the case of the POF system, the energy efficient operation is called Low Power Idle (LPI).

Figure 10 shows a comparison between 1000 Base-T (EEE-1G) and POF LPI (EE-POF):

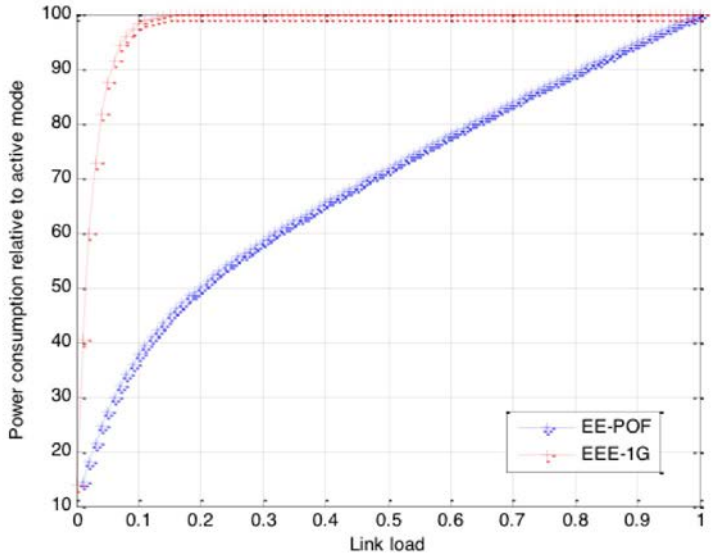


**Figure 10: Comparison between 1000BASE-T (EEE-1G) and POF LPI (EE-POF)**

### 5.4.4 Idle mode - Wake up functionality

Each component in the POF network is an active component acting as bridges between the POF back-bone and the home devices connected via CAT x cables or Wi-Fi.

It is important to have and idle & wake-up functionality in the active components to reduce power consumption when connected devices are powered off, or no Wi-Fi connections are done. In this case, the optimum solution is the disable of the giga-bit back-bone connection switching off completely the optical transceivers.

Local or remote wake-up functionality might be implemented in the case of traffic, reconnection of devices, or powering on of devices. Implementation of the idle-mode and wake-up functionality is not standardized, but is strongly recommended by the present document.

# Annex A (informative): 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:<br>Anti-intrusion | | | | | | | | | | |
| | Security:<br>Access control | | | X | | X | | | X | | X |
| | Safety:<br>Ambient control (e.g. fire, gas, etc.) | | | 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:<br>Load control | | | | | | | | | | |
| | Heating/Air-conditioning | | | | | | | | | | |
| | Lighting (automatic switch off) | | | | | | | | | | |

# History

| Document history | | |
|---|---|---|
| V1.1.1 | October 2009 | Publication as ETSI TR 105 174-5-1 |
| V1.3.1 | July 2018 | Publication as ETSI EN 305 174-5-1 |
| V1.4.1 | January 2020 | Publication |
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