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Access, Terminals, Transmission and Multiplexing (ATTM);
General engineering of optical fibre cabling in buildings

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Foreword

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

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 present document is effective when the optical fibre cabling in a building is shared between multiple optical access operators.

Figure 1 shows a schematic representation of what could exist in a building with multiple operators' FTTH access networks, in two distinct situations:

a) without shared cabling by using or not using a building access demarcation point (see figure 1);

b) with shared cabling between the building distribution point and the ENTI (see figure 2).

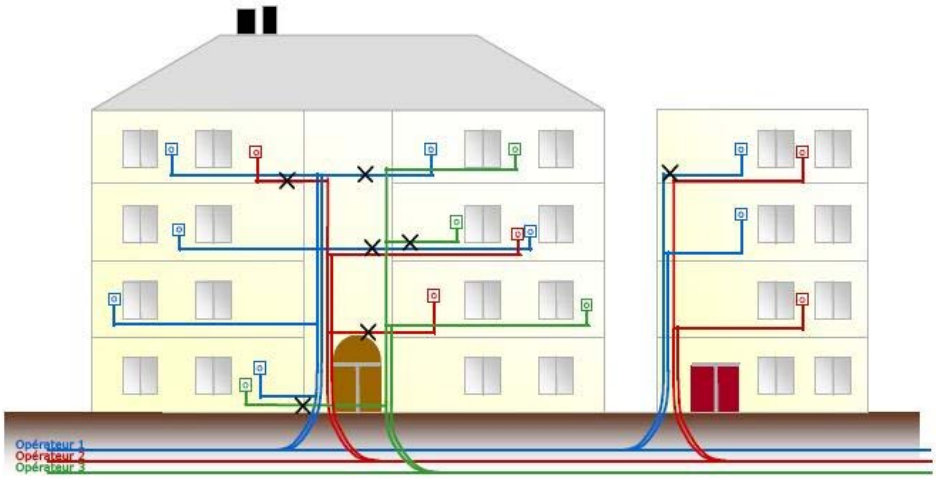

Figure 1: Individual optical fibre cabling in buildings for each operator

Many cables and boxes could be installed in common parts in this assumption which can cause permanent disturbance for inhabitants. Besides, saturation of infrastructures could be reached with a strong impact on reliability of existing and new cables and on maintenance issues.

A challenge for operators in that case could be to try to provide the condition for optical fibre cabling sharing inside the building, as shown in figure 2.

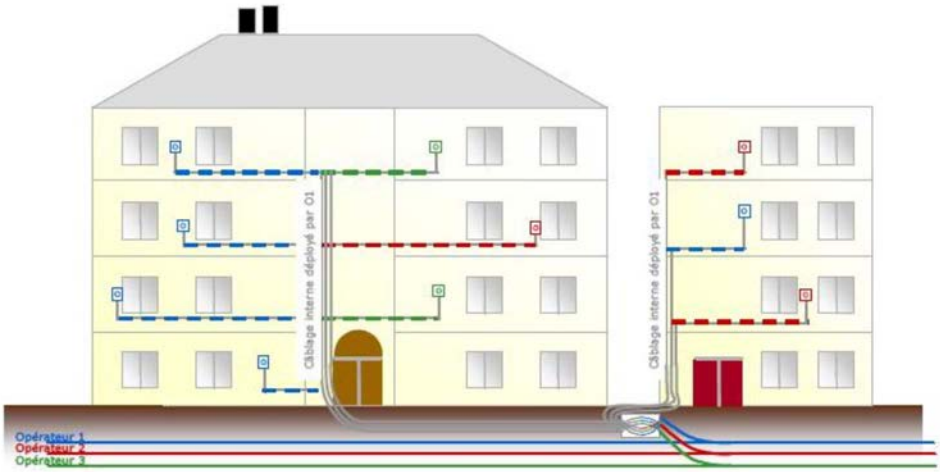

Figure 2: Shared optical fibre cabling in buildings for all operators (when multiple "optical access networks" are deployed)

1 Scope

The present document specifies the optical fibre cabling in a building when it is shared between multiple optical access operators.

The proposed optical fibre cabling allows access to each operator to optical fibres in the building for Multi-Dwelling Units (MDUs). The main goal of the concept is to be able to share the optical fibre cabling among different optical access operators.

The present document details the different architectures of a shared optical fibre cabling and each element of the cabling in the building in coherence with the definition used in the standard EN 50700 [i.14].

These elements are the Access Demarcation Point, the indoor optical fibre cabling and the optical termination at the customer premises.

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.

[1] EN 50575:2014/A1:2016: "Power, control and communication cables - Cables for general applications in construction works subject to reaction to fire requirements", produced by CENELEC.

[2] EN 61754 series: "Fibre optic connector interfaces", produced by CENELEC/IEC.

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] EN 60794-2: "Optical fibre cables - Part 2: Indoor optical fibre cables", produced by CENELEC/IEC.

[i.2] EN 60794-2-20: "Optical fibre cables - Part 2-20: Indoor cables - Family specification for multi-fibre optical distribution cables", produced by CENELEC/IEC.

[i.3] Recommendation ITU-T L.87 (2010): "Optical fibre cables for drop applications".

[i.4] ETSI TS 102 873: "Access, Terminals, Transmission and Multiplexing (ATTM); Optical External Network Testing Interface".

[i.5] EN 61755-1: "Fibre optic connector optical interfaces - Part 1: Optical interfaces for single mode non-dispersion shifted fibres - General and guidance", produced by CENELEC/IEC.

[i.6] EN 60793-2-50: "Optical fibres - Part 2-50: Product specifications - Sectional specification for class B singlemode fibres", produced by CENELEC/IEC.

[i.7] EN 61754-4: "Fibre optic connector interfaces - Part 4: Type SC connector family", produced by CENELEC/IEC.

[i.8] EN 61754-20: "Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 20: Type LC connector family", produced by CENELEC/IEC.

[i.9] ETSI TS 103 247: "Access, Terminals, Transmission and Multiplexing (ATTM); Singlemode Optical Fibre System Specifications for Home Cabling".

[i.10] 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.11] EN 50411-3-1: "Fibre organisers and closures to be used in optical fibre communication systems - Product specifications - Part 3-1: Fibre management system, splice wall box, for category C & G", produced by CENELEC.

[i.12] EN 50411-3-4: "Fibre organisers and closures to be used in optical fibre communication systems - Product specifications - Part 3-4: Fibre management system, wall box for splice to patchcord connections, for category C & A", produced by CENELEC.

[i.13] EN 61280-4-2: "Fibre-optic communication subsystem test procedures - Part 4-2: Installed cable plant - Single-mode attenuation and optical return loss measurement", produced by CENELEC.

[i.14] EN 50700: "Information technology - Premises distribution access network (PDAN) cabling to support deployment of optical broadband networks", produced by CENELEC.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

Access Demarcation Point (ADP): location from which premises distribution access network cabling is routed to subscribers

NOTE: This point allows the connection of the outdoor cable (feeder and/or drop) to the indoor (in-house or building) cable. The type of connection may be a fusion splice or other optical connection.

branching cable: individual cable which links up the access demarcation point to the optical External Network Testing Interface (ENTI)

NOTE: This cable can be composed by one or more fibres.

building operator: operator who installs and is responsible for the maintenance of the vertical and/or horizontal cabling in the building and gives an access to it to the other operators

building optical line: optical line between the distribution point at the building basement and the customer outlet

customer outlet: physical point that allows the connection of fibre(s) from a cable to the ONT

dedicated fibre: fibre dedicated for only one operator, which is available permanently for this operator

NOTE: The fibre may be part of an indoor cable or of a blowing-based microducts.

optical External Network Test Interface (ENTI): physical point at which a subscriber is provided with access to an optical communications network

outdoor branching cable: outdoor cable that comes into the building, ending at the access demarcation point

NOTE: This is actually the optical connector adapter in the customer outlet.

secondary distributor: distributor, if exists, is situated on one floor and distributes fibres or indoor cables on one or across the floor(s) to each customer/individual apartments

shared fibre: fibre shared between several operators, which is available temporarily or permanently for one operator.

vertical cabling: part of the cabling between the distribution point and the floor distributor (when it exists.) or the ENTI

3.2 Symbols

Void.

3.3 Abbreviations

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

ADP	Access Demarcation Point
APC	Angled Physical Contact
ENTI	External Network Test Interface
FTTH	Fibre To The Home
HAN	Home Area Network
LC	Lucent Connector
MDU	Multi Dwelling Unit
ONT	Optical Network Termination
PD	Primary Distributor
POF	Plastic Optical Fibre
PON	Passive Optical Network
SC	Subscriber Connector
SD	Secondary Distributor
SI	Subscriber Interface

4 Shared optical fibre cabling in buildings

4.1 Introduction

The building operator or building owner may take the initiative in cabling a building. They should expect to give the access to telecom operators to the optical building lines with a distribution point at the building basement. The number of operators should be limited by a maximum, for practical deployment reasons and based on the real needs of the market.

The "building operator" deploying the optical fibre cabling in buildings could be in charge of the installation and/or maintenance of this sharing point. Usually this is the first operator who comes in.

The shared optical fibre cabling in buildings combined with the access demarcation point should support both Point to Point and Point to Multipoint access network topologies. So, a Point to Point cabling shall be used by all telecom operators between the building basement and customer outlets or External Network Testing Interfaces (ENTIs).

4.2 Single fibre architecture (one fibre for each customer, shared among different operators)

Choice could be made to deploy only one fibre per customer in the vertical part of the building and to share it between the different operators. This choice could be made by the building operator or by the owner of the building, depending on free room in the vertical shaft or may be subject of co-operation contracts between operators.

Telecom operators could have access to shared fibres at the distribution point. Each fibre is temporarily assigned to one operator when needed to give access to its services for customers.

The single fibre dedicated to the customer could be contained in a single fibre drop cable or in a multi-fibres riser cable (see clause 6).

4.3 Multi-fibres architecture (more than one fibre for each customer, dedicated to single operators or shared among them)

A multi-fibres architecture can be chosen in which a fibre is dedicated to each operator. The deployment of four fibres per apartment is recommended. Operators could have access to dedicated fibres at the distribution point, which are permanently available for their own use.

It could be also possible to give access to shared fibres with this architecture.

5 Access Demarcation point

The Access Demarcation Point (ADP) is the interface between optical access networks of different operators and the optical fibre cabling in a building. It should be compatible with Point to Point or Point to Multipoint optical access network architectures.

Depending on building, area and networks topologies, the ADP could be used for one building when the building size is sufficient, but could also be shared between several buildings. It could be installed inside or outside buildings. Information about the localization, number of apartment connected, owner and type of ADP should be available for all operators.

It represents:

- a flexibility point where the building operator can manage the allocation of customers' fibres between telecom operators;
- a demarcation point to separate the responsibility of each operator among telcos and with building operators;
- a point for optical measurements (attenuation and return loss), if optical connections available and demountable.

The ADP should be composed of three parts (figure 3):

- a "customer's area" for the management of fibres from riser cables or indoor cables (customer module);
- "operator's area" dedicated for each operator for the management of fibres coming from their access network. This separated area could be sort of modules with connectors or splice trays for example. They should be able to accept potential splitters. When it is not possible splitters could be installed in another box;
- a "connection area" for interconnection between fibres of the cabling in buildings and access networks with use of patchcords or pigtails.

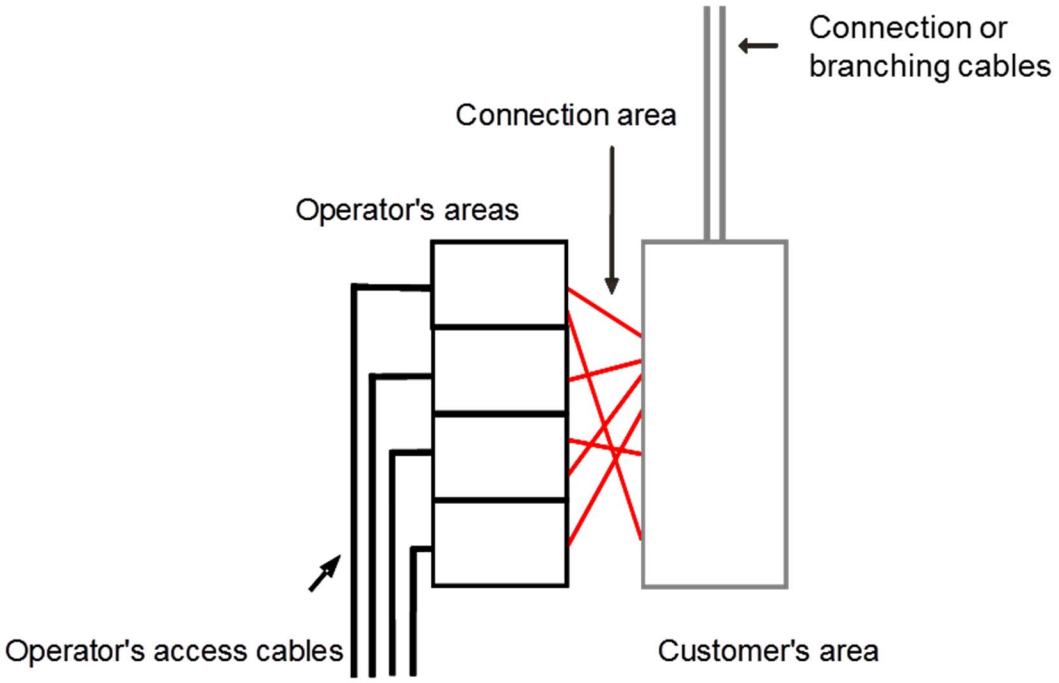

Figure 3: Illustration of a ADP

In case of a single fibre sharing architecture, the ADP should allow an "any to any" cross-connection between shared fibres of the cabling in buildings and fibres from access networks of each operator.

When a multi-fibres architecture is deployed in the building the ADP should allow, for each operator which has a dedicated fibre in the building, the connection of its own fibres in the building with fibres from its access network. The sharing point could give both access to dedicated fibres and shared fibres if the operator wants to share its fibres.

The ADP should be designed to allow:

- frequent arrangements of fibres;
- new cables installation or older cables replacement;
- add-on or replacement of optical splitters when splitters are considered inside the sharing point (for PON access networks);
- splicing operations (fusion or mechanical).

NOTE: It should be noted that the non-standardized dimensions of the mechanical splice protectors are not compatible to dimensions of the fusion splice protectors, therefore it is advisable to avoid the mechanical splices in the distribution point.

The customer's area should be dimensioned for all customers at day one. It could be useful to have the possibility to install operator's areas only when needed with a modular solution.

The ADP should consider the environmental impact (climatic, mechanical, dust, …) to allow indoor and outdoor installation.

6 Indoor cabling

6.1 Cabling solutions in buildings

Based on operators' consensus, different cabling systems could be installed in the indoor part:

- easy mid span access cables;
- microcabling solutions;
- pre-connectorized solutions, etc.

Cables used inside the building should be compliant with EN 60794-2 [i.1] series.

Cables that are installed in a permanent manner shall meet the requirements specified in EN 50575 [1]. Figure 4 shows examples of cabling solutions in a building, both applicable to the single fibre or multi-fibres architecture. The ADP is co-located with the Primary Distributor (PD) acting as an optical distribution point.

The ADP is connected to the Secondary Distributors (SDs) (if exists) with connection cables.

The cables arriving at the optical ENTIs are called branching cables.

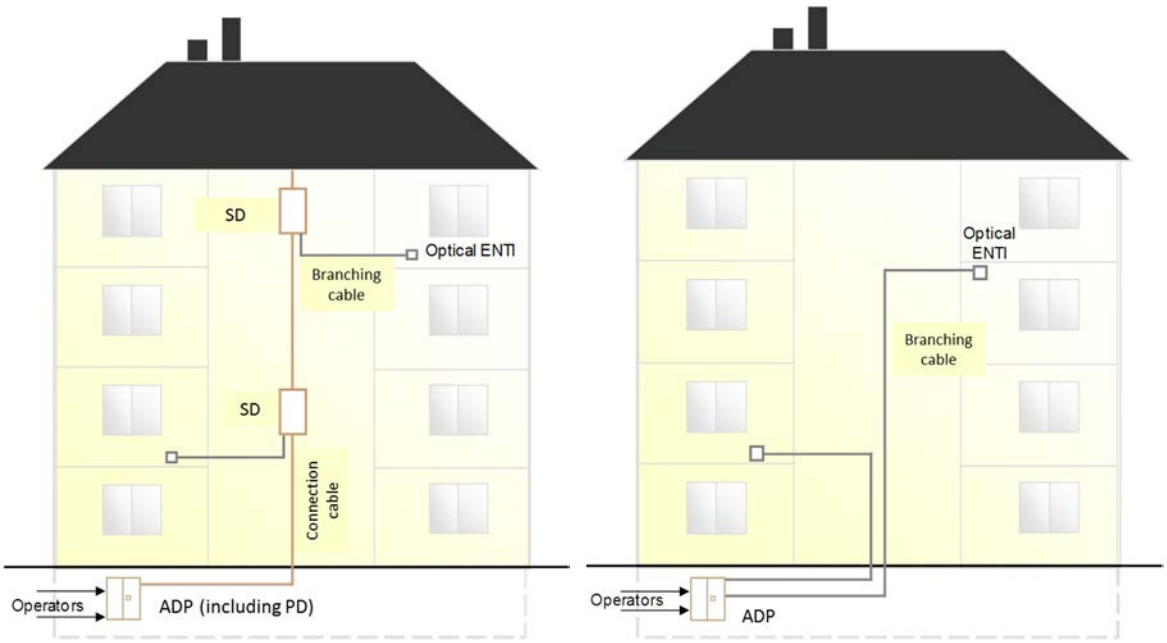

Figure 4: Example of cabling solutions in buildings

The indoor cables may contain one or more fibres for each customer depending on the chosen architecture.

Cabling for Home Area Network (HAN) is specified in ETSI TS 103 247 [i.9] for singlemode optical fibres and ETSI TS 105 175-1-1 [i.10] for Plastic Optical Fibres (POF).

6.2 Connection cable

The connection cable(s) should be dimensioned to connect all customers premises in the building.

Depending on the building configuration (number of apartments, floors, …), type of sharing architecture (single fibre or multi-fibres), a connection cable could be based on single elements of one or several fibres (4, 8 or 12 fibres for example) to serve ADP.

In order to reduce the time for installation of the cable extremity in the distribution point, it could be pre-terminated with connector plugs.

6.3 Branching cable

Branching cables should be compliant with requirements given in EN 60794-2-20 [i.2] and recommendations in Recommendation ITU-T L.87 [i.3].

Typically, one single branching cable is used for each customer. It can contain one single mode fibre (case of a single fibre sharing architecture) or several single mode fibres (multi-fibres architecture). For a multi-fibres architecture, a branching cable with four single mode fibres is recommended.

Depending on building architectures, drop cables could be laid (see figure 4):

- from the ADP to the External Network Testing Interface or the Customer Outlet;
- from the SD to the External Network Testing Interface or the Customer Outlet.

Dimensional and mechanical characteristics of the cable shall be adapted for different building configurations. The branching cable can be pulled in existing sleeves but also stuck or stapled along the walls, or installed in a conduit. Techniques of blown cables/fibres in microducts can also be used.

Installation of the branching cable could be made at day one (for example in case of new buildings), or only on demand when a customer ask for service (existing buildings).

The branching cable could be pre-terminated with connector plugs, at only one end or at both ends. This would significantly reduce the cost and skill-set required for installation of the branching cable. It could also be interesting for quality reasons. The use of pre-terminated cables with connector plugs at both ends requires a number of certain lengths of the cables and management of cable over-length. On the other hand, the use of pre-terminated cables with a connector plug at only one end provides a simple installation where the non-terminated end of the drop cable is cut to the suitable length and its fibres are spliced to the continuing fibres at the distribution point.

6.4 Secondary Distributor

6.4.1 Generalities

The link between connection cable(s) and branching cables could be located at the secondary distributor Point.

Fibres of the vertical cable are connected to fibres of branching cables by splices or/and connectors, or directly routed to the customer premises. In the first case the ADP could be made by a secondary distributor Box or a secondary distributor System. In the second case it could be made by a simple breakout box.

6.4.2 Secondary Distributor box

The secondary distributor Boxes should be designed to allow splices and/or connectors (with pre-connectorized solutions or field mountable connectors for instance). They should allow the management of fibres.

The secondary distributor Boxes are installed in the vertical part of the building at floors levels. Their location depends on distribution boxes capacity, cables modularity, number of floors and customers per floor, installation facilities (existence or not of a vertical shaft, width and depth of the vertical shaft). A distributor box can serve several floors.

For connection cables with single elements dedicated to a single customer small secondary distributor boxes dedicated for only one customer can be used. These boxes should be only installed when laying the drop cable instead of at initial time when laying the riser cable.

Wall boxes for distribution purposes are defined in EN 50411-3-1 [i.11] (for splice only) and EN 50411-3-4 [i.12] (for splice to patchcord connections).

6.4.3 Secondary Distributor Breakout box

A breakout box could be used to break out and distribute the single elements from the connection cable into small protective tubes without need of any splice. With the term "element" one fibre or a group of fibres is indicated. The protected single elements can be routed directly from the connection cable to the customer premises or to an intermediate point with splice.

6.4.4 Secondary Distributor System

A secondary distributor System could be used when there is not enough free space in the vertical shaft or it is not possible to obtain the permission to install "at sight" distribution box at floor level.

The secondary distributor system could include:

- breakout boxes + small tubes to extract and protect the single elements;
- protection accessories which allow to protect the splice between the fibres from the riser cable and the fibres from the branching cable with a miniaturized solution.

Both the breakout box and the splice(s) protection accessory could be physically separated and located in different points at floor level (as an example the breakout box is necessary located in the vertical shaft on the riser cable but the splice protection accessory could be located inside the tube to the customer flat). An example of Distribution System is shown in figure 5.

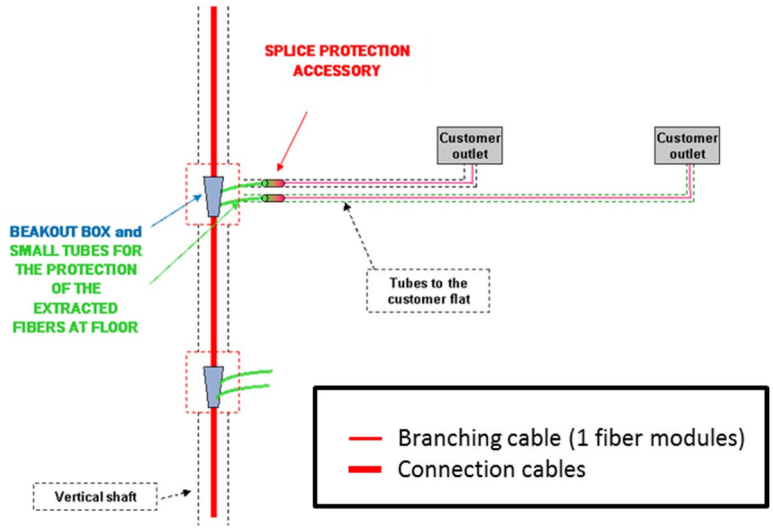

Figure 5: Example of a Distribution System

When the secondary distributor system is dedicated for only one customer, the installation of the distribution system could be made partially at initial time, installing the breakout box, but the splice protection accessory could be installed only when the customer is connected with the branching cable.

Several customers could be served by one single tube over several meters from the connection cable to an additional derivation point and then have their own tube entering the flat: an example is shown in figure 6, in which at this derivation point the connection among the protective small tubes is made by using an appropriate accessory.

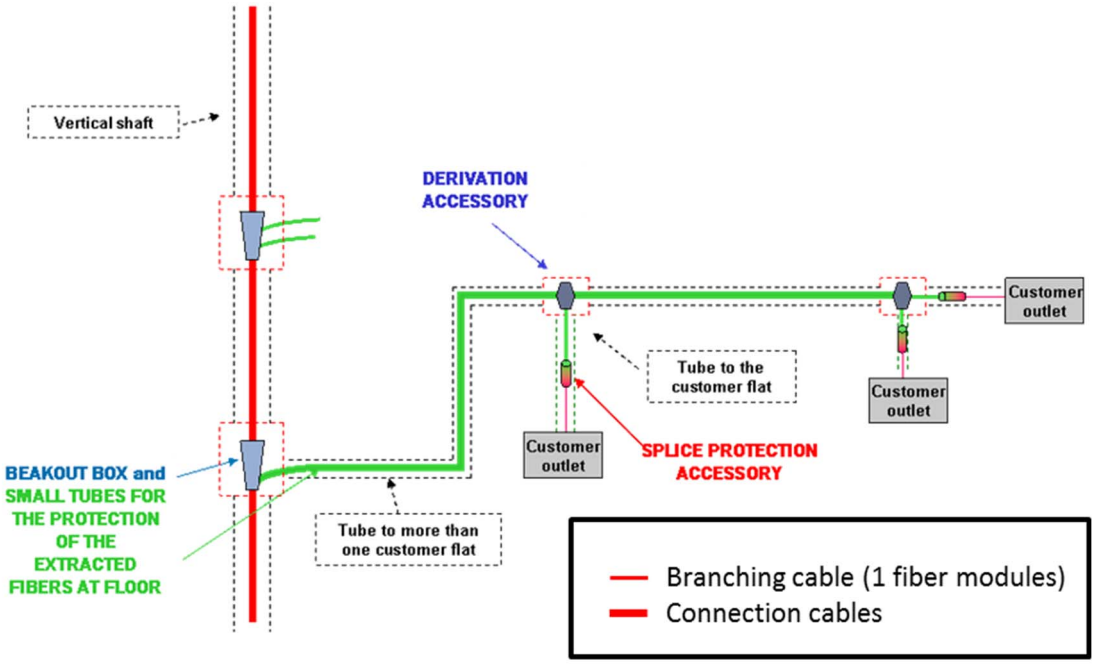

Figure 6: Example of a secondary distributor System + derivation accessory in the case of initial sharing of customer tube

7 Optical termination

7.1 Introduction

The connection of a branching cable (or a single element extracted from the connection cable or from the connection cable itself) fibre with the Optical Network Termination at the customer premises could be accomplished through the Subscriber Interface (SI) called optical External Network Testing Interface (ENTI) here.

Figure 7 illustrates typical configurations.

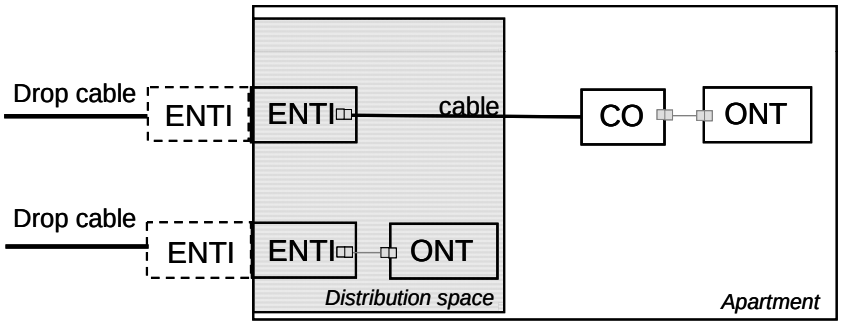

Figure 7: Illustration of typical cabling configurations at the customer premises

7.2 Optical External Network Testing Interface (optical ENTI)

The optical ENTI is defined in ETSI TS 102 873 [i.4]. It is a demarcation, measuring and testing point and allows isolation of customer's in-house cabling from the building's cabling. It would be installed at the entrance of each apartment outside or inside the apartment. When installed inside it should be in a distribution space (collocated near the home distributor).

The ENTI allows the connection of fibre(s) from a branching cable to the ONT.

The fibre(s) from the branching cable could be spliced with pigtail(s) or terminated with field mountable connectors when the cable is not already pre-terminated with optical plug(s). A patchcord (fibre optic cable terminated with connectors on both ends) is then used to connect the ONT to the ENTI.

8 Optical budget and return loss

In order to be used by any operator, independently of the transmission technology chosen, the building operator or the building owner should guarantee for the optical lines they provide:

- a maximum attenuation between the two ends of the line;
- a minimum return loss.

Considering that the attenuation of the fibre due to short fibre length is not significant, a theoretical value of the attenuation could be calculated by taking into account the numbers, type of connections (connectors, fusion splices or mechanical splices) and type of fibres connected. This calculated maximum allowable attenuation of the link can be used for testing the installed cabling. EN 61280-4-2 [i.13] provides information about test procedures for attenuation measurement in cable plant.

For the definition of the maximum required attenuation budget, a margin should be added to the theoretical value of the maximum attenuation for, but not limited to, changes of environmental conditions, contamination of connector end faces and aging.

This attenuation value of the line could vary a lot according to the cabling architecture in a building. Connection attenuation and return loss values are defined in standard EN 61755-1 [i.5] for optical connectors. For mechanical and fusion splices the values in the following table shall be used.

Table 1: Attenuation and return loss for both mechanical and fusion splices

Characteristic	Mechanical splice	Fusion splice
Max. attenuation	0,25 dB	0,15 dB
Return loss	≥ 60 dB	≥ 60 dB

9 Fibres

Single mode optical fibres described in EN 60793-2-50 [i.6], categories B1.3 and B6 should be used for cables (connection cables, branching cables), patchcords and pigtails at the different parts of the cabling in buildings depending upon users' environmental conditions and technical requirements.

Bending loss insensitive single mode optical fibres EN 60793-2-50 [i.6], category B6 should be preferred, especially for the branching part of the cabling in buildings where fibres should have more bend constraints. It could allow a faster and safer installation, and also a possible reduction of boxes sizes.

In cases of limited optical budget, care should be taken to use for the whole cabled fibres which are compatible for connection in order to minimize insertion losses for each connection. When EN 60793-2-50 [i.6], categories B1.3 and B6 fibres are used at the same time, choice of EN 60793-2-50 [i.6], category B6_a would be then preferred for bending loss insensitive fibres.

10 Connections, connectors and cords

Connectors could be used in the distribution point, the external network testing interface, the distribution box and customer premise equipment with different environmental conditions. They could be manipulated by qualified technicians in the sharing point for example but also by the customer at the outlet. They have to be reliable over a long time period, with low insertion losses.

The SC connector (SC/APC or SC/UPC) according to EN 61754-4 [i.7] is the most commonly used in optical fibre cabling in buildings by operators who deploy FTTH. LC connector according to EN 61754-20 [i.8] could also be employed to increase the density of materials. The mechanical interface of the connector hardware shall be in accordance with one of EN 61754 [2] series.

Depending on their location it could be useful to use connectors and/or adaptors with integrated end face and dust protection and with optical power blocking. For the connections between the ENTI and ONT following aspects for the terminated cords shall be considered:

- means for disconnecting the connector without destroying the ENTI box by accidental tensile load;
- means for preserving dust to interfere with connection while connector is open;
- means for sure connecting/disconnecting in the premises environment;
- cord cables to withstand severe environmental impact in the premises.

In order to be compliant with services which require high quality transmission (and therefore low reflection losses), it could be recommended to use Angled Physical Contact (APC) connectors with specified return loss of 60 dB (mated) or 55 dB (unmated).

Connectors can be mounted on fibres at the factory but also in the field. Main features of field mountable connectors in terms of types, fields of application, configurations and technical aspects should be defined in a future document.

History

Document history		
V1.1.1	September 2012	Publication
V1.2.1	April 2022	Publication