SLOVENSKI STANDARD
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Dostop prek optiļ nih vlaken do konļ nega uporabnika - Napotki za gradnjo optiļ nega omreģja FTTX

Fibre optic access to end-user - A guideline to building of FTTX fibre optic network

Lichtwellenleiterzugang zum Endkunden - Leitfaden für die Erstellung von FTTX Lichtwellenleiternetzen

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Fibre optic access to end-user - A guideline to building of FTTX fibre optic network

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This Technical Report was prepared by the Technical Committee CENELEC TC 86A, Optical fibres and optical fibre cables.

The text of the draft was submitted to vote in accordance with the Internal Regulations, Part 2, Subclause 11.4.3.3 (simple majority) and was approved by CENELEC as CLC/TR 50510 on 2007-07-06.

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Contents

Executive summary

FTTX normally refers to networks that deploy fibre directly into the customer residences, which can be either single dwelling units (houses) or multi dwelling units (blocks of flats).

Most FTTX networks are designed without any active equipment in the external network and are therefore classified as passive optical networks. The only active equipment is at the central office and the customer premises. FTTH - PON networks can be designed around different architectures.

The purpose of this Technical Report is to be a first guideline for those considering to install a high bandwidth (high bit-rate) FTTX-network. After studying the Technical Report operators, communities, energy companies, installers and other will understand the necessary steps to take to plan and install FTTX-networks with high quality and cost effectiveness, and to secure a uniform structure and a high quality level on such networks.

The main part of this Technical Report describes the FTTX-networks, but Clause 1 also contains more general information to give an understanding how these networks fit into the planning of the fibre infrastructure.

FTTX has for many years been regarded as the most future-proof technique for transmission of broadband multi-media applications. The building of FTTX-networks has previously been prevented by high costs. New investigations show, however, that the cost to install a new fibre based network (100 Mbit/s) is a little less than to install a new copper network. The FTTX-network is also the only structure, which with certainty can offer both the present and the future needs, which broadband access services require. At the same time the technique allows efficient operating maintenance and cost savings.

The networks to be presented used to be called FTTH, but with the strategy described here fibre networks can reach anywhere (X). The end-user can be separate homes, houses, office environments, optoelectrical transitions in equipment for alarms, surveillance, monitoring devices etc.

The Technical Report also describes recommendations and gives basic requirements to be fulfilled by a fibre installation in an FTTX-network to satisfy present and future requirements on capacity, transmission distance and quality. As a target, the minimum capacity is set to 1 Gbit/s (1 000 Mbit/s) up to 10 km distance; for certain access applications (e.g. flats or multi-tenants buildings) a shorter distance can be targeted, e.g. 500 m to 2 000 m. Relevant types of optical fibres (single-mode and multimode) are specified in EN 60793-2-50 and EN 60793-2-10. However, in the industry a single-mode fibre is typically called by its ITU terminology (e.g. G.652). The physical network should have an expected lifetime of 25 years.

The recommendations are written for a general audience, but in particular for people involved in private and public enterprises, people responsible for broadband decisions, planning and installations.

The Technical Report is divided into six independent clauses:

- Clause 1 is an introduction and gives a view of the IT-infrastructure and a survey of the basic structure for the fibre optical broadband.
- Clause 2 describes system solutions for FTTX including requirements on capacity and installation techniques.
- Clause 3 is a guideline on how to create a network and gives an overview of applicable network topologies.
- Clause 4 gives basic information about installation and planning before installation.
- Clause 5 treats measurements and documentation.
- Clause 6 treats quality issues.

A number of annexes are included to give deeper knowledge in certain areas. They are broad examples and can be used to give a better view on the principles for installation of FTTX-networks with cables, microduct optical fibre cables, microducts and microduct fibre unit cables (blown fibres). To some extent these annexes are company specific, which the reader should be aware of. Annex A (reference [1]) gives a comprehensive list of standards. References [2], [3] and [5] give a good overview of the present status in both ITU-T, IEC and the general CENELEC view.

Some of the requirements put forward in this Technical Report are unique for an FTTX-network and should not be used in a general sense for optical networks.

1 Network Structure and Nodes – A guideline

1.1 Introduction

This Technical Report describes the FTTX-network. As a guideline other parts of the fibre optic infrastructure are given in this clause.

First some basics: sound, pictures, voice, data carried by networks are digital data expressed in terms of bit, bytes and their multiples (kilo (k), mega (M), giga (G), tera (T)). A bit (binary digit) is the smallest digital unit and has only two values: 0 or 1. A byte includes 8 bits and defines the size of a data file. Transmission capacity of networks and terminals is not expressed by using bytes, but using bit per second (bps). When a data file is transferred in a network two supplementary bits are necessary. It means that 10 bits are required for 1 byte.

In the case of a VDSL subscriber with 10 Mbit/s, who wants to upload a pdf data file, the Web provider indicates for instance the following size: 20 Megabytes. It should then take 20 s. However, for any Mbit/s subscription the fact is that the real final data flow is about a quarter of the notified data flow, because the data flow is shared between subscribers and its quality depends on the activity of the other subscribers. It means that the 20 Megabytes data file will need 1 min 20 s to be uploaded. For instance a 15 Mbit/s ADSL system gives only 1 Mbit/s for uploading. The following table gives some further examples of transmission times for uploading a quality DVD-movie, if there is no data flow sharing.

Transmission speed	**Uploading time**
0,128 Mbit/s	5 days, 8 h
10 Mbit/s	8 h
100 Mbit/s	0,8 h
1 000 Mbit/s	50 s

We do not know the new tools that will be created by the real high bit rate networks. New applications (not invented today) will appear and applications originally dedicated to professionals will be extended to all in a similar way as it happened with the mobile phone.

It is important to define the meaning of « low, medium and high bit rate transmission ». One possible classification is presently the following:

– low bit rate transmission: up to 1 Mbit/s

– medium bit rate transmission: 1 up to 10 Mbit/s

– high bit rate transmission: 10 up to 100 Mbit/s and more.

1.2 Levels

For a level-designed view on the components in the build-up of the infrastructure, see Figure 1.

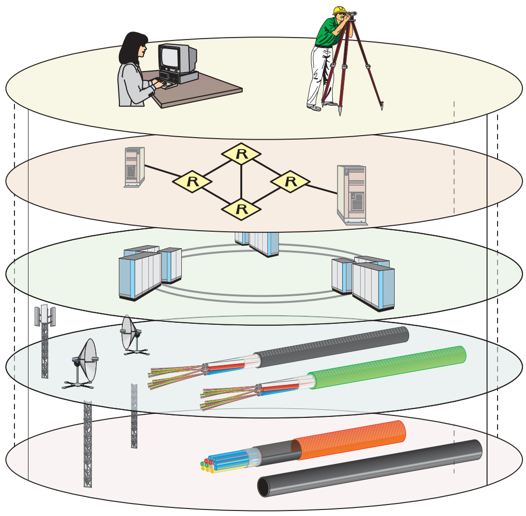

Figure 1 – Network levels

From the bottom up, Figure 1 shows:

- Physical routing: Duct for cables, for microduct optical fibre cables, and for microduct fibre unit cables (blown fibre products) and for structures for antennas
- Passive transmission and interconnecting media: optical fibre cable, connectors, antennas, boxes, closures and their physical interconnections
- Active transmission systems: Logical connections over a physical connection
- IP: The internet operator network service to the user
- Application: Equipment, program and data bases of the user

Designing the infrastructure in levels makes it possible for different ownership of individual levels. This creates possibilities for open networks and competition, but also presents risks regarding responsibilities and long-term interaction.

1.2.1 Physical routing

The lowest level in the physical network is the physical routing. It consists of ducts in standard dimensions, antenna structures, network material and microducts among others. Also existing infrastructure tubing as sewer-, gas-, and drinking water tubes may be used. It should have an expected lifetime of 25 years.

A large part of this level belongs to the FTTX and will be thoroughly described in this book. Most of the cost for a broadband network is in the planning and installation of the routing layer. It is therefore important to be accurate in planning, installation and documentation, and that the material of the parts is of high quality. Normally the network owner owns this level.

1.2.2 Passive transmission media

Level 2 contains optical fibres and cables, interconnecting devices (connectors, splices, closures, …), copper cables (not treated here) and antennas (also not treated here) for radio networks (FWA, WLAN, 2G, 3G, 4G, LMDS).

The optical fibre and cable have a mechanical lifetime that corresponds to the ducting level. However, the transmission lifetime depends on required future services on the fibres. These future requirements may demand more capacity compared to present planning prediction. If that is the case, the fibre may need to be replaced by a fibre with better transmission performance. It is therefore proposed in this guideline to use single-mode fibre in the FTTX-networks, since it has by far the largest capacity well above the 1 Gbit/s over long distances up to 40 km. In cases where the length is limited to 500 m – 2 000 m (e.g. multi-tenant buildings) also multimode fibres can be considered. By installing optical fibres and cables in ducts the costs for replacements and repair are substantially lower than without ducts. The network owner normally owns cable and fibre.

1.2.3 Transmission-, IP- and application level

Transmission-, IP- and application level will not be described in this Technical Report.

1.2.4 Ownership, operating and maintenance

When all parts in the infrastructure fulfil specified quality requirements regarding transmission and installation, different ownerships could be possible. Ownership and operation could be split by different governmental or community companies, jointly owned companies between different communities, energy companies, building enterprises. Housing co-operatives, house-owner associations, private persons and landowners may also own the local network closest to the end-users.

Considering operation and maintenance the network level owners have to specify acceptable downtimes.

1.3 Network topology – Terminology

1.3.1 Infrastructure parts

To get an overall picture about optical fibre networks it is necessary to explain some of the terminology and concepts used.

The higher the network is in a network topology, the higher traffic volume, capacity, requirements on function and availability and therefore also the strategic significance and need for protection and security in the network. All IP-traffic can be distributed, which means that this hierarchy may be flattened in a few years. The present network is a combination of a traditional telephone- and a future IP-network, which can be described as in Figures 2 to 7. This means that the information can find the best route when alternative routes are available.

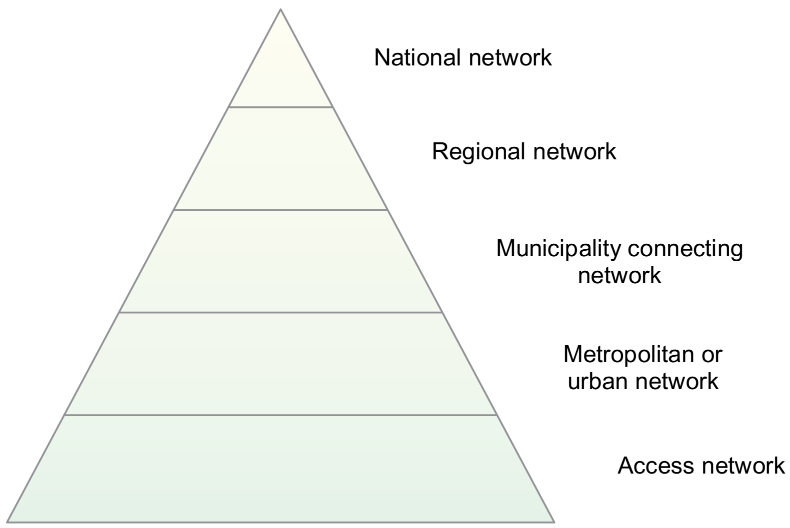

Figure 2 – The new infrastructure is based upon both old and new network hierarchy

The highest level is the national network, see Figure 2 and the lowest is the network for connecting end-users or subscribers.

1.3.2 National network

The national network connects all regions in the country and is connected to international networks. This type of network has a very high security level. A national network has normally few owners.

1.3.3 Regional network

A regional network or a community-connecting network connects networks within a region. Networks within a region often consist of municipality-connecting networks from different communities. A regional network is then connected to the national network.

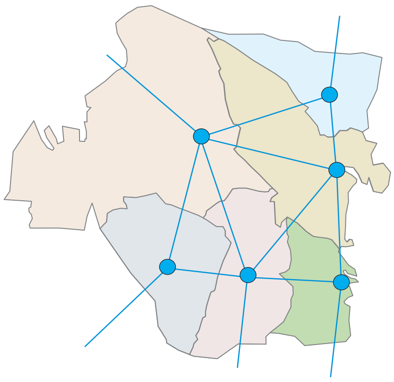

Figure 3 – A regional network, e.g. in a county

Some of the main communities can be connected to nearby regions (Figure 3).

1.3.4 Municipality connecting network

Municipality-connecting networks connect different municipalities (places) within a community. These networks are in turn connected upwards to regional networks or community-connecting networks and downwards to access networks. The connection is made through the community main node.

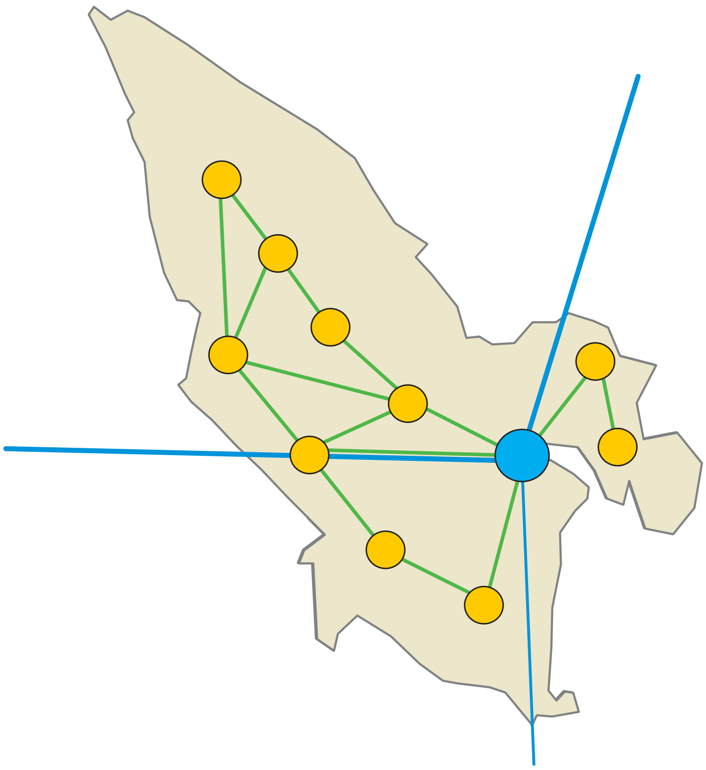

Figure 4 – The municipality-connecting network connects the larger places within a community

In each place there are one or more nodes, access nodes (possibly also distribution nodes), which connects the end-user – the subscriber (Figure 4).

1.3.5 Metropolitan or urban network

City (metropolitan) or urban networks are networks within a city or in a sparsely populated area. The function is to give a broadband infrastructure, which can satisfy a long-term need. It shall be easy to establish cost-effective solutions of access networks to reach subscribers. This can be achieved by using existing or planned networks of different kinds. These networks are directly connected to the main node or to a distribution node (redundancy), which could be a possible fibre optic cross-connect node (fccn) to another main node, if so required.

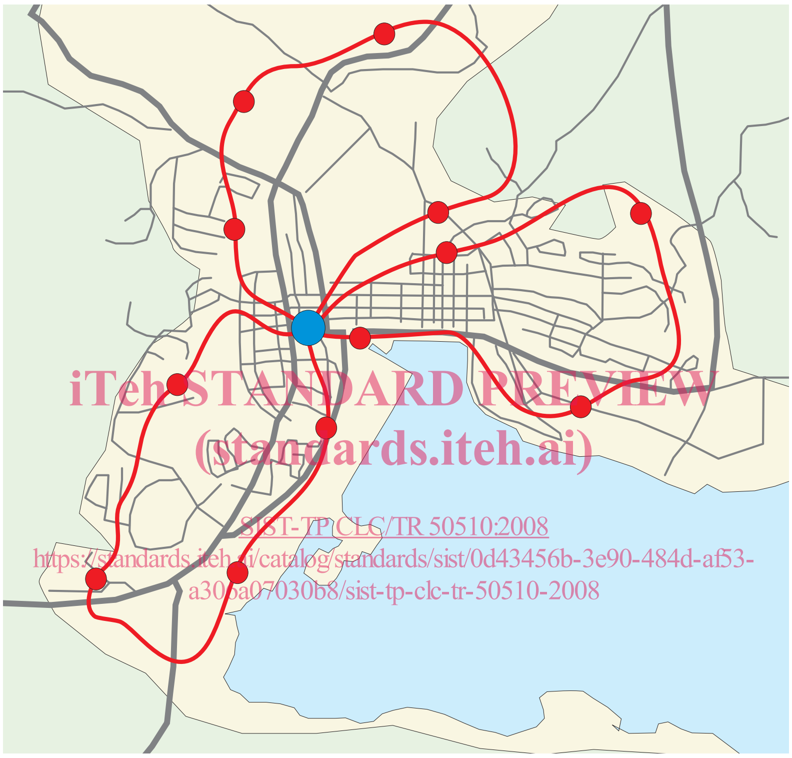

Figure 5 – The metropolitan or urban network, the red lines, connects areas in a thinly populated area

Access nodes are connected along the ring structure (Figure 5).

1.3.6 Access network

The access network connects subscribers or group of subscribers to an access node. Earlier described networks have normally been installed on public land. The opposite is normally valid for the access network. A large number of the access networks will be installed on private properties or land. Subscribers from houses, terraced houses, blocks of flats, companies, hospitals and authorities can be connected to the access network. Also masts for FWA (Fixed Wireless Access) or WLAN (Wireless LAN) and antennas for the mobile network can be connected. Furthermore equipment for security, surveillance, fire-alarms and control equipment can be connected.

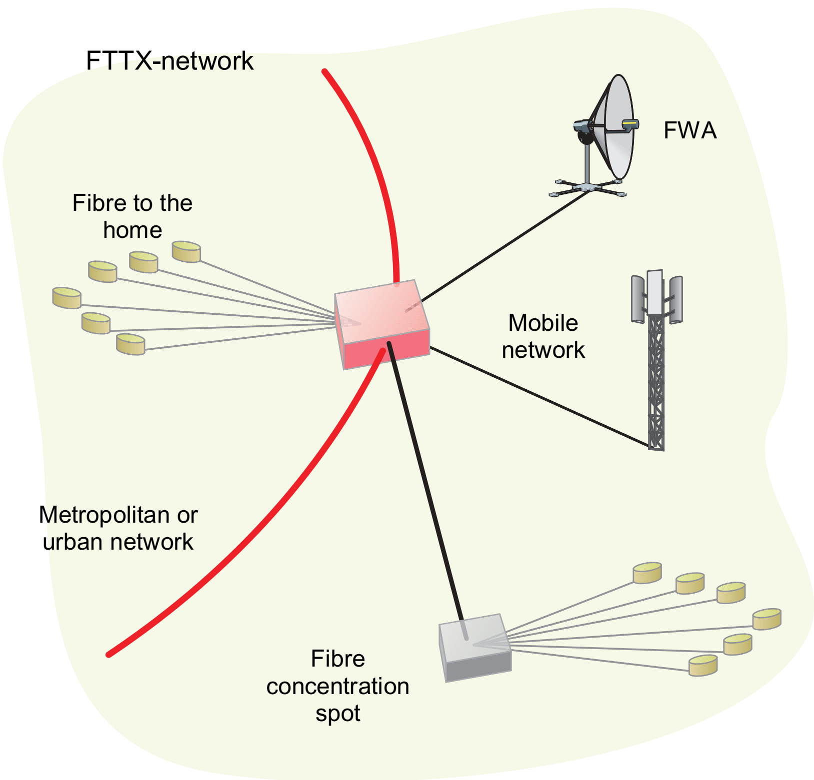

Figure 6 – The access network connects a large number of end-users

1.4 Node topology – Terminology

There are a number of junctions (also known as nodes) in a broadband network, where single traffic flows are mixed, multiplexed and de-multiplexed to create an efficient flow through the network. In the nodes data packages are given a choice of route to make the distribution. Joint traffic between different network owners or operators is also possible. The largest number of nodes will be used for the connection of the end-customers.

The nodes are spaces filled with transmission equipment, cross-connect devices, splice boxes, uninterrupted power supplies and equipment for climate control.

The design of the access node will be briefly described in the following but other types of nodes will not be discussed, except for a few comments.

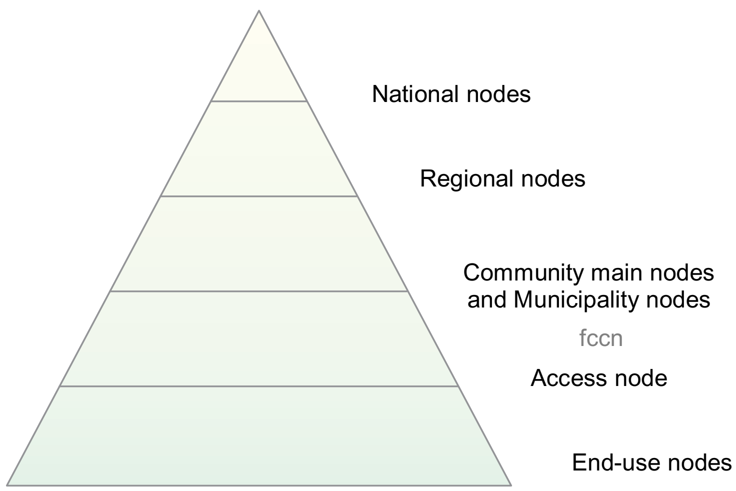

Figure 7 – Node hierarchy