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OUTSIDE PLANT

Optical fibre distribution of access networks

ITU-T Recommendation L.65



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Optical fibre distribution of access networks

Summary

This Recommendation deals with four stages of optical fibre distribution based on the increasing number of customers, namely the initial stage, the growth stage, the mature stage and the final stage, to enable design, construction and maintenance of optical fibre access networks immediately, effectively and economically.

Source

ITU-T Recommendation L.65 was approved on 22 December 2006 by ITU-T Study Group 6 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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Introduction

Progress on communication technologies has led to the active development of many kinds of broadband services such as data and video communication using access networks. It is important to realize high-speed broadband networks to provide such services economically. In order to provide these services in a timely way, we must construct optical access networks immediately, effectively and economically for "fibre-to-anything" (FTTx). The development of optical fibre access networks for FTTx can largely be divided into four stages based on the increasing number of customers, namely the initial stage, the growth stage, the mature stage and the final stage. To achieve the above goals, the network design must take construction, maintenance and operation into account.

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Optical fibre distribution of access networks

1 Scope

This Recommendation deals mainly with important considerations concerning optical fibre distribution of each stage in terms of designing, constructing, maintaining and operating optical fibre access networks immediately, effectively and economically for FTTx.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T G.982] ITU-T Recommendation G.982 (1996), *Optical access networks to support services up to the ISDN primary rate or equivalent bit rates.*
- [ITU-T G.983.1] ITU-T Recommendation G.983.1 (2005), *Broadband optical access systems based on Passive Optical Networks (PON).*
- [ITU-T G.983.2] ITU-T Recommendation G.983.2 (2005), *ONT management and control interface specification for B-PON.*
- [ITU-T G.983.3] ITU-T Recommendation G.983.3 (2001), *A broadband optical access system with increased service capability by wavelength allocation.*
- [ITU-T G.983.4] ITU-T Recommendation G.983.4 (2001), *A broadband optical access system with increased service capability using dynamic bandwidth assignment.*
- [ITU-T G.983.5] ITU-T Recommendation G.983.5 (2002), *A broadband optical access system with enhanced survivability.*
- [ITU-T G.984.1] ITU-T Recommendation G.984.1 (2003), *Gigabit-capable Passive Optical Networks (G-PON): General characteristics.*
- [ITU-T L.40] ITU-T Recommendation L.40 (2000), *Optical fibre outside plant maintenance support, monitoring and testing system.*
- [ITU-T L.42] ITU-T Recommendation L.42 (2003), *Extending optical fibre solutions into the access network.*
- [ITU-T L.53] ITU-T Recommendation L.53 (2003), *Optical fibre maintenance criteria for access networks.*
- [ITU-T L.58] ITU-T Recommendation L.58 (2004), *Optical fibre cables: Special needs for access network.*

3 Definitions

For the purpose of this Recommendation, the definitions given in [ITU-T G.982], [ITU-T G.983.1], [ITU-T G.983.2], [ITU-T G.983.3], [ITU-T G.983.4], [ITU-T G.983.5], [ITU-T G.984.1] and [ITU-T L.42] apply.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

FTTB	Fibre to the Building
FTTC	Fibre to the Curb
FTTH	Fibre to the Home
FTTx	"Fibre to the x", where "x" indicates the final location on the user side of any one of a variety of optical fibre architectures, e.g., FTTH, FTTB, FTTC.
ODF	Optical Distribution Frame
OLT	Optical Line Terminal
ONU	Optical Network Unit
PON	Passive Optical Network

5 Conventions

None.

6 Optical fibre distribution

An optical access network comprises four areas, namely a central office area, a feeder area, a distribution area and a user area from a central office to residential premises as shown in Figure 1. The feeder area extends from optical distribution frames (ODFs) in the central office to a distribution point. In the distribution area, a distribution cable is connected with a feeder cable at the distribution point and led to an access point. In the user area, a drop cable is connected with a distribution cable at the access point and led to an optical network unit (ONU) in an individual home, apartment or business building, etc. It is most important that the optical fibres are distributed in such a way that efficient design, construction, maintenance and operation for FTTx is achieved.

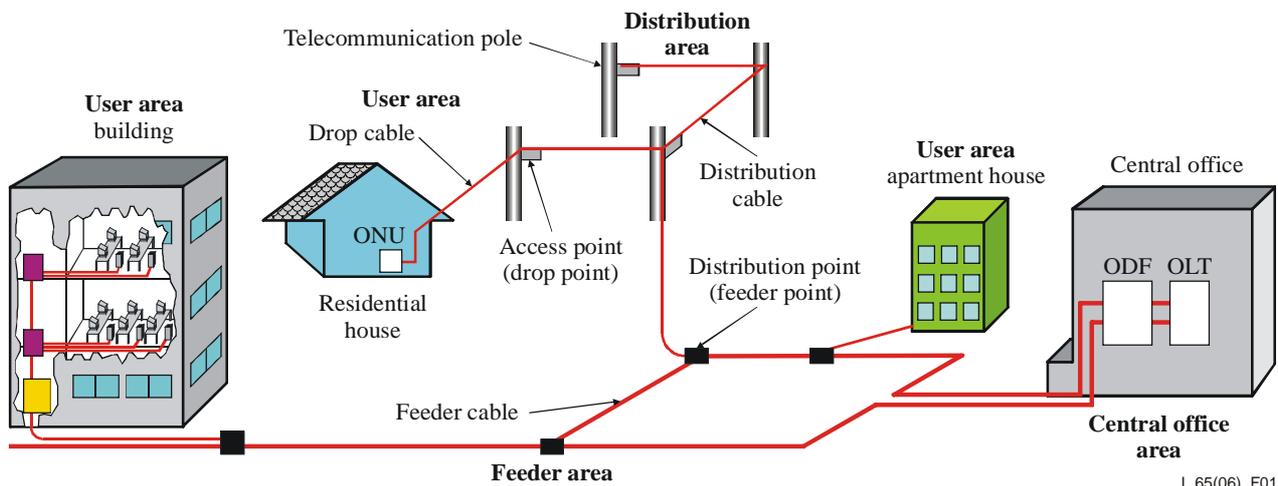


Figure 1 – Configuration of an optical access network

Therefore, in order to determine the network architecture, design, construction, maintenance and operation approach for the optical access network, and to select optical components for FTTx, telecommunication companies should mainly consider the following:

- Scalability (number of terminated fibres, number of fibre jointing points (joint closures), total fibre length of network, etc.).
- Survivability (security, supervisory system, etc.).
- Functionality (bit rate, transmission distance, etc.).
- Construction and maintenance costs (cost, quality and reliability of components to position in the network, etc.).
- Network upgradeability (increased transmission capacity, transmission length, number of customers (including future demand) and potential evolution or migration of architecture).
- Operability and suitability over designed network lifetime.

Telecommunication companies should develop appropriate designs based on the optical access network requirements for each country. In addition, the development of optical fibre access networks can largely be divided into four stages based on the increasing number of subscribers as shown in Figure 2, namely the initial stage, the growth stage, the mature stage and the final stage. Telecommunication companies should focus particularly on the following items in each stage.

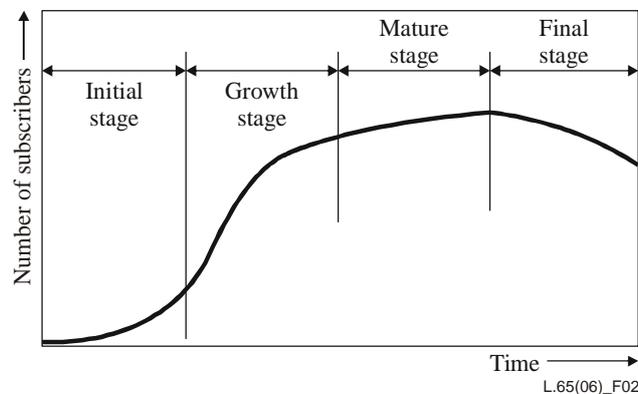


Figure 2 – Progressive increase in number of FTTx subscribers

6.1 Initial stage

6.1.1 Effective and economical optical fibre distribution for demand dispersed over a wide area

In the initial stage, the demand for optical fibre will be dispersed over a wide area. Therefore, telecommunication companies should respond by designing effective and economical approaches to optical fibre distribution. For example, it is important to determine the distribution point and access point allocation, which is closely related to construction cost and construction workability. Moreover, to flexibly respond to demand, ease of branching and dropping after the initial cable installation should be considered as described in [ITU-T L.58] when selecting the optical fibre cables.

6.1.2 Optical fibre distribution taking account of future demand

In addition to the above, it is important that the optical fibre distribution scheme should take account of the potential demand during the growth and mature stages. For example, the number of fibres in the cables and the number of branches for the branching devices in a passive optical network (PON) are important optical fibre distribution parameters as regards future demand. Technologies that support deferred cost for subsequent up-scaling of fibre capacity could be considered.

6.2 Growth stage

6.2.1 Optical fibre distribution for quick response to demand

In the growth stage, the demand for optical fibre will occur randomly over a wide area. It is therefore very important for the optical fibre distribution scheme to be able to quickly respond to this demand. In particular, it is necessary to design the optical access network with a view to achieving easy optical fibre distribution over the last mile between an access point and individual homes, apartments, business building, etc., because the distribution over the last mile is large scale and the demand is random. However, in the growth stage, the demand for optical fibre will be widely dispersed in rural areas. Therefore, an effective and economical optical fibre distribution scheme that responds to this demand will be needed for rural areas.

6.2.2 Optical fibre distribution for easy maintenance and operation

In addition to the above, at this stage there will be a rapid expansion of the optical access network infrastructure, including optical fibre and optical fibre cable. Therefore, it is important to be able to easily maintain and operate the optical access network infrastructure. For example, there will be a need to use the optical fibre network maintenance support, monitoring and testing system described in [ITU-T L.40] and [ITU-T L.53]. In addition, an optical access network infrastructure database will need to be constructed and used to operate and administer the huge expansion of the infrastructure, taking into account other future Recommendations on databases for optical access network infrastructure and system architecture for data transmission, database access and interoperability.

Moreover, it is anticipated that overlay of fibre networks into areas of legacy metallic networks will eventually occur, presenting challenges for both aerial and underground deployment. In addition, it will be important to use existing facilities such as cable ducts for the effective and economical installation of optical fibre cables. For example, several optical fibre cables could be installed in a cable duct. This is because the optical access network infrastructure will increase and the available facilities may become scarce. Consideration could be given to active cable duct management solutions to ensure their future economical usability.

6.3 Mature stage

6.3.1 Optical fibre distribution for easy maintenance and operation

In the mature stage, the demand for new optical fibre will be slow and a huge optical access network infrastructure will be in place. Therefore, it is of utmost importance that the optical fibre distribution scheme be easy to maintain and operate. This will require an optical fibre network maintenance support, monitoring and testing system, and a corresponding database.

In addition, customers who require very high reliability should be provided with two or more fibres using a ring network in each stage, as described in [ITU-T L.42].

Telecommunication companies should select appropriate architectures and optical components (e.g., optical fibre cable and passive optical components), and design and construct optical access networks taking account of the above factors in each stage.

6.4 Final stage

In the final stage, demographic considerations may determine that the demand for optical fibre may decline and the plant and land re-used for a different purpose or purposes e.g., industrial, commercial, retail or residential, or a mix of these uses. Such events may be common in urban areas. It is likely that there will be a threshold at which systems and networks will become uneconomic to operate and need to be decommissioned.

Appendix I

Japanese experience

(This appendix does not form an integral part of this Recommendation)

I.1 Introduction

Fibre to the home (FTTH) in Japan has grown rapidly in recent years. The number of FTTH subscribers exceeded 6.3 million by end of June 2006. It seems that FTTH has moved from the initial stage to the growth stage. Some design techniques have been developed in order to construct the access network effectively for the growth stage. This appendix describes the optical fibre network design method in Japan for the coming growth stage.

I.2 Design of optimum margin for demand fluctuation for feeder area

The total number of fibres for a feeder area depends on the number of fibres required for each distribution area. In this case, the number of fibres for each distribution area must be more than the expected user demand in order to be able to cope with demand fluctuations. However, it is less cost-effective if additional fibres are distributed for every distribution area. On the other hand, cost-effectiveness is also reduced by the additional construction time and cost required if the fibres in a feeder cable are distributed and connected to the fibres in a distribution cable to meet every new user demand. Thus, optimizing the margin for demand fluctuation is important for feeder areas.

A design method that overcomes the above problem is shown in Figure I.1. In the feeder area, the fibres are divided into two groups. In the first group, the number of fibres corresponds to the expected user demand for each distribution area. In the second group, some fibres are used in common for the whole distribution area. This design is cost-effective and highly reliable with a minimum number of fibres that use the common fibre when there is demand fluctuation.

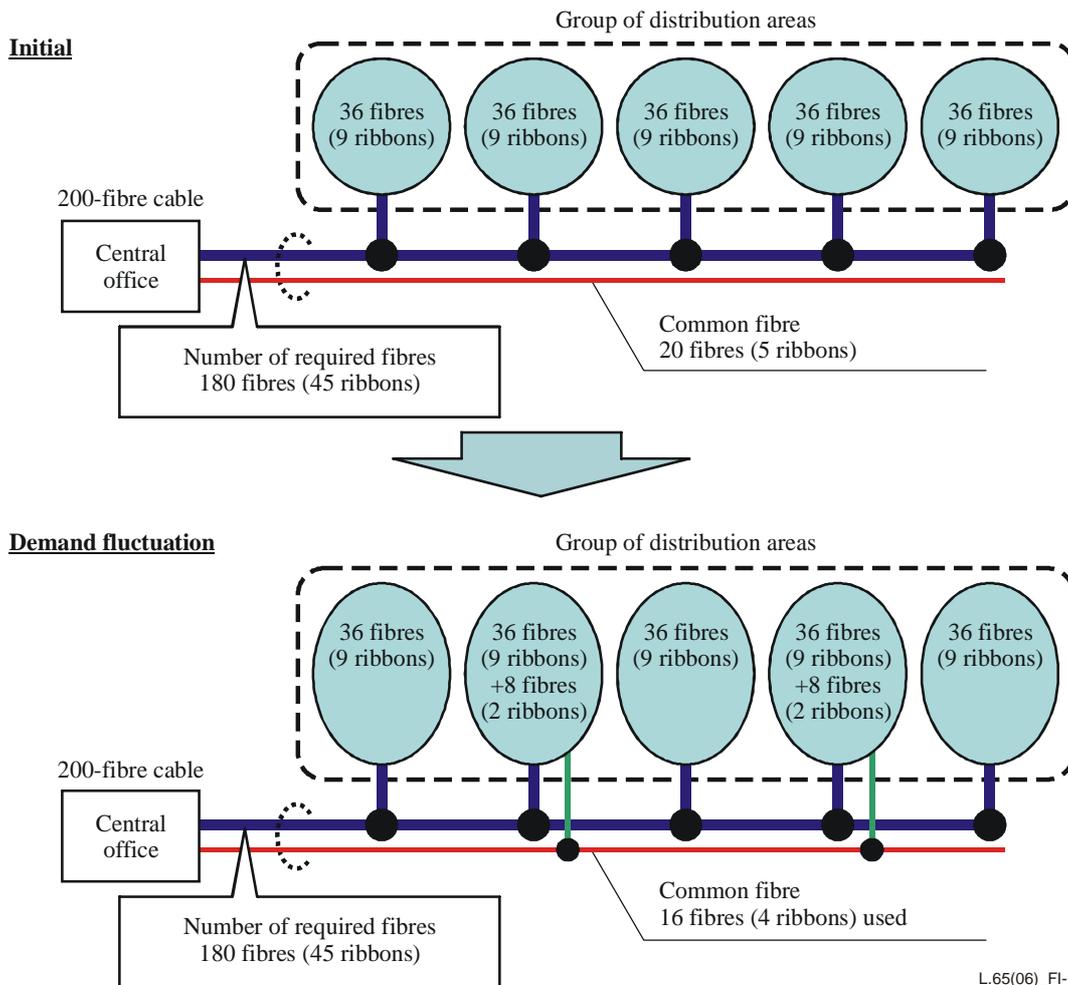


Figure I.1 – Configuration of fibre distribution method for demand fluctuation (with 200-fibre cable (4-fibre ribbons × 50 ribbons))

For example, 10 to 20% of the total distributed fibre is provided to meet demand fluctuations, although the number of fibres (or fibre ribbons) that are required depends on factors such as the size of each distribution area.

I.3 Balanced use of distributed fibre to each drop area in aerial distribution areas

An aerial distribution area is divided into several drop areas based on user demand of the growth stage. Since the user demand is large in the growth stage, it is effective to distribute the optical fibre ribbons to every drop area. However, it is not effective to distribute the optical fibre ribbons to every drop area in the initial stage, when user demand is not great. Thus, in order to prevent excessive distribution of optical fibres, each optical fibre ribbon is distributed to a limited number of drop points serving each specific drop area. An example distribution area is shown in Figure I.2. Distribution cables branch to some drop areas and fibre ribbons must be distributed to each drop point. In this case, the fibre ribbons are distributed to drop areas D, E and F through drop areas A, B and C. Therefore, if the user demand rises and additional fibres are needed, any of the fibres in the fibre ribbon that passes through these areas can be used. The effective use of fibres is achieved by first selecting fibre in a distributed fibre ribbon with a low use rate. This can prevent the need for reconstruction due to a shortage of fibres.

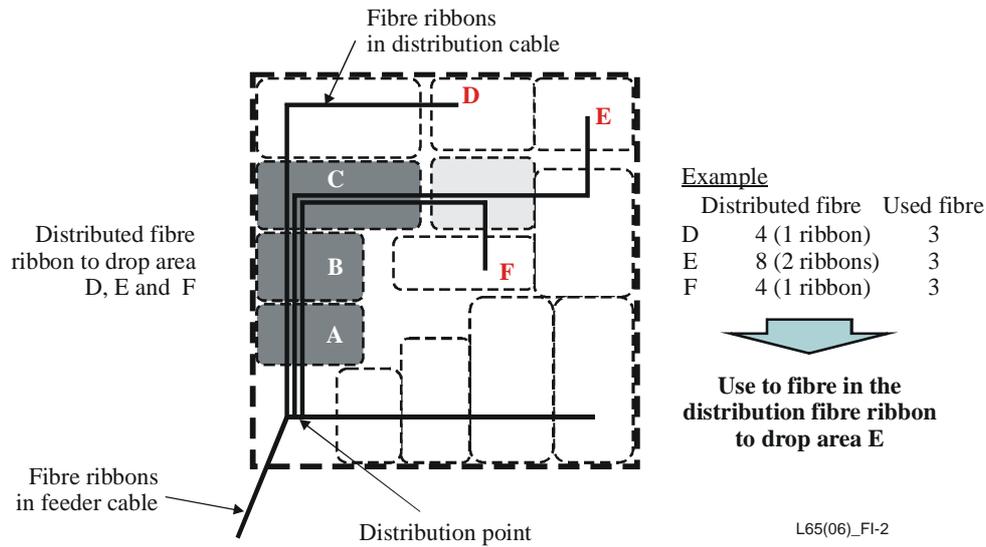


Figure I.2 – Configuration of balanced use in aerial distribution area

If the above technique is used, it is very important to establish an operation database and a management system. In addition, a fibre ribbon separation technique at mid-span without cutting fibre ribbon is required.

I.4 Reference

[ITU-T L.42] ITU-T Recommendation L.42 (2003), *Extending optical fibre solutions into the access network, Appendix I.*

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