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Optical fibres and cables for the access networks; Standardization & FTTH development in Europe

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Abstract *The development of ITU-T Recommendations for fibre cable used in access networks is highlighted, emphasising the new Rec. G.657 for bend insensitive single mode fibre. In addition developments of FTTH in Europe will be reported.*

Introduction

The International Telecommunication Union (ITU-T) has started activities to serve broadband services in the access network, e.g. *Access Network Transport Standards and Optical Systems for Fibre Access Networks.* In November 2006 the first recommendation on bend insensitive single mode fibres was consented, under the designation G.657.
Further work continues on application of bend loss optimized graded-multimode fibres in optical access networks for multi-tenant buildings.

New activity in ITU-T

ITU-T activities are organized in Study Groups [1]; subjects related to (cabled) optical fibres are assigned to Study Group 15 (SG15): "Optical and other transport network infrastructures". Sub-activities are organised by means of "Questions". The regular work on cabled optical fibre is taken care of in Question 5 of SG15.

Late 2003 a new sub-activity was created on fibre cable designed for access networks, organised in Question 10[1] of SG15. The motivation to start this work is the growing demand for broadband services (multimedia, high-speed internet, HDTV) in buildings and homes requiring high-capacity transmission media into the local network. Optical fibre is viewed to be an important option for any broadband media mix created for this purpose.

The first year dealt with organization of work and – avoiding duplication – gathering existing information concerning fibres and cables for access networks. In November 2004 the first technical contributions were offered [2], containing two proposals:

1). Small bending radius optimized single mode fibres (SMF). Due to the many obstacles and the restricted space available, stringent low bend radius requirements may arise, for the fibre to and in the building. In addition, access networks require increased resistance to incidental bends originating from improper fiber deployment. Although this should be prevented in general, the employment of lower skilled installation crews, the installation in various types of premises and the large scale use of patch panels in telecom offices and street cabinets will make the occurrence of incidental bends inevitable. Modern SMF preferably has to answer the requirement for an improved resistance to this maltreatment.

2). Graded-index multimode fibres, used in optimised optical access networks in multi-tenant building environments (e.g. in Europe and Asia) with a separate access switch in the basement. Due to the potentially high connection density and the short lengths of the optical distribution cable, investment cost per connection can be relatively low in this particular sub-segment of access networks.

These two proposals have been the subject of study in the following period, with G.smx as draft recommendation for bend insensitive single mode fibre and G.mmx as draft recommendation for multimode fibre.

Due to large interest in the market (operators and industry) Rec. G.smx was already consented in November 2006, more than a half year earlier as originally planned. This official recommendation for bend insensitive fibre has been published as Rec. G.657 [3].

Rec. G.657: Bend insensitive single mode fibre

Various contributions from multiple delegations lead to a split of the G.657 single mode fibre recommendation into two categories:

Category A fibres, suitable to be used in the O, E, S, C and L-band (i.e. 1260 to 1625 nm range). These fibres are a subset of G.652.D fibres (are therefore fully backwards compatible) and have the same transmission and interconnection properties. The main improvements are in reduced bending loss and tighter dimensional specifications. Both improvements reduce connectivity losses.

Category B fibres, suitable for transmission at 1310, 1550, and 1625 nm for restricted distances that are associated with in-building transport of signals. These fibres may have different splicing and connection properties than G.652 fibres, but are capable at very low values of bend radius.

Table 1 shows the main characteristics of both categories.

Table 1: Main characteristics of Rec. G.657A and G.657B

Attributes	G.657A		G.657B		
Mode field diameter 1310 nm **Nominal range** **Tolerance**	**8.6 - 9.5 µm** **± 0.4 µm**		**6.3 - 9.5 µm** **± 0.4 µm**		
Macrobending loss					
Radius (mm)	**15**	**10**	**15**	**10**	**7.5**
Number of turns	**10**	**1**	**10**	**1**	**1**
Max. at 1550 nm (dB)	**0.25**	**0.75**	**0.03**	**0.1**	**0.5**
Max. at 1625 nm (dB)	**1.0**	**1.5**	**0.1**	**0.2**	**1.0**
Main transmission attributes (/ PMD / Chrom. Dispersion)	**As per G.652.D**		**TBD**		

Lifetime of bent fibre

An important discussion in Q10/15 concerned the lifetime aspects of bent fibres. Based on common lifetime modelling of fibres stored in reduced size cassettes of fibre management systems, it was shown that the current minimum proof stress value of 0.69 GPa as recommended in G.652 suffices to maintain a guaranteed operational lifetime of 20 years [4, 5]. See also Figure 1.

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[1] The Question numbering used in the present study period is used. In 2003 this question started as Q20/15.

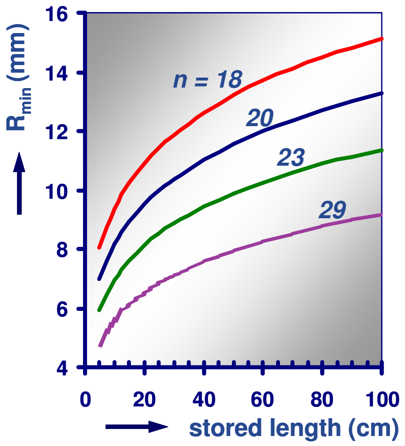

Figure 1: Minimum bend radius as function of storage length and stress corrosion parameter n, based on a failure rate of 0.001% over 20 years.

FTTH development in Europe

FTTx connections:

By June 2006, 28 countries in Europe (EU-28) counted around 820,000 FTTx subscribers (+32% vs June 2005), with 2.74 millions homes passed (+13% vs June 2005) and a growing penetration rate of 29.8% in 2006 (2005: 25.6%) [6]. This level of subscribers is far below that in Asia, in particular in Japan (April 2006: 5,642,000 FTTx subscribers), but not too far behind the USA with around 4M homes passed and 1M connected mid 2006 [7].

One reason for the lower level of FTTx connections in Europe may be the relative good copper and cable-TV networks, allowing high DSL speeds, specially in Scandinavia, France and the Benelux. For example Belgium is leading this bandwidth league with 91.5% of DSL subscribers connected to at least 2 Mb/s, followed by Iceland (45.7%), Sweden (41.9%), Norway (30.7%), Netherlands (30%) and France (28.8%).

Other factors may be a lower commitment to FTTH by most incumbent operators, compared to e.g. some Asian countries. In the USA the decision of the FCC to lift the unbundling requirements for optical fibre access networks in 2003 lead to a strong impulse of investments in FTTx networks. In Europe incumbent operators criticize the present unclear regulatory framework as not being helpful in investing new FTTx networks.

96% of the EU-28 FTTx subscribers are concentrated in 5 countries: Denmark, Netherlands, Sweden, Italy and Norway, which shows the large difference between the European countries. Municipalities and power utilities still lead the build out of FTTx networks in Europe; yet, Incumbent and alternative operators are warming up for the deployment of very high speed networks.

Positive demand indicators can be mentioned: strong growth of ownership of digital camera's (with increasing file sizes), breakthrough of large-screen HD-ready displays, new next-gen games machines and new HD-DVD formats, all pushing for increased demand of higher speeds in the access networks [8].

Technical architecture of European FTTx deployments:

In Europe still P2P Ethernet is outnumbering PON [6], also in new significant projects like in Paris (Iliad/Free) and Amsterdam. On the other hand, PON has been selected for several major projects since 2005:
- in Spain, the government of Asturias: GPON;
- EnergiMidt, a Danish power utility: BPON;
- France Telecom since June 2006: GPON.

One of the considerations for ILECs may be the more difficult unbundling practice when using GPON.

Open Network Models are often chosen by Municipalities.

Future important FTTH deployments [6,8]:

- France Telecom deployment confirmed:
  Deployment began in 2006 based on GPON. Plan to connect 10 major French cities by end 2008. 1 M homes passed and up to 200 000 subscribers by end 2008. Investment estimated to 270 M EUR in two years.
- Free (Iliad) FTTH deployment launched in France:
  Commercial launch of fibre-to-the-home (FTTH) local loop network in Paris during the first half of 2007 based on Ethernet. 4 M home passed through 2012 (15% of penetration at least expected). Plans on investing 1 Billion EUR in the project through 2012.
- The Amsterdam Municipality CityNet: Based on an Ethernet access network; deployment started in Oct. 2006. 25,000 homes connected by the end of 2007; 450.000 total by 2013.
- Dong Energy (Denmark): 900 000 homes.
- Vienna (Austria): 900 000 by 2011.
- Reykjavik (Iceland): 200 000 by 2011.

And FTTN+VDSL…

- Eircom network, in Ireland: Work started to upgrade national telecommunication network with FTTC equipment.
500,000 homes to be connected by the end of 2007. Eircom plans to invest 1 Billion EUR to complete this build out.
- Deutsche Telekom has planned to cover 2.9 millions homes in 10 major cities in Germany with FTTN and VDSL2 (end of 2006).
- KPN and Swisscom will also deployed widely VDSL platforms in 2007.

Conclusions

Preceded by its use in Japan, the bend-insensitive single mode fibre proofs its added value worldwide in the labour intensive and scarcely spaced access network environment. The ITU-T has acknowledged this and developed its new G.657 Recommendation.
In many European FttH plans, with progress hampered by the lack of a sufficiently clear regulatory framework, the use of G.657 compliant single mode fibers is expected to offer great added value for the many FttH networks still to be constructed.

References

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