FTTH Conference 2010

ITU-T Standardization: from G-PON to 10G XG-PON

FTTH Optical Infrastructure: Standardization Activities in SG15

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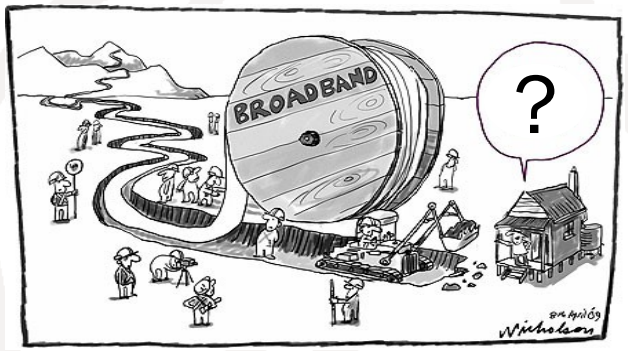
ITU International Telecommunication Union

Introduction

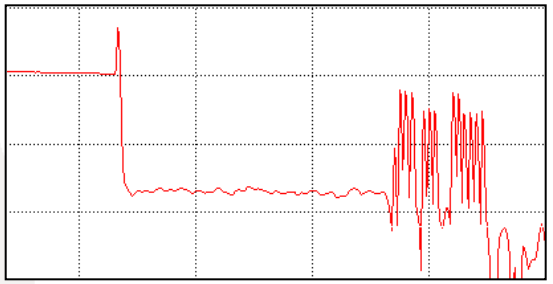
- The development of a modern optical fibre access network is considered an "essential facility" with high social impact, beneficial for the Country in terms of economic growth and availability of new services for the citizens.
- The saturation of copper cable's capabilities for ADSL systems, the lack of bandwidth for launching innovative services, along with the increase of Capex and Opex to face up network obsolescence, make attractive the deployment of FTTH technologies.
- The new FTTH network will allow the implementation of an all IP network, provide ultra broadband connectivity for mobile access, support the convergence of Telecommunications- Media- ICT.
- The success of this challenging project relies on the possibility for all the Players to build up an infrastructure with the state of the art, most reliable, cost effective and homogeneous technologies. For this purpose STANDARDS are needed.
- In this evolving scenario ITU-T has oriented its studies to produce a set of Recommendations capable to pave the way toward the construction of the FTTH networks.

The road to FTTH

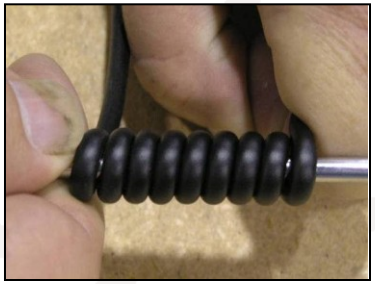


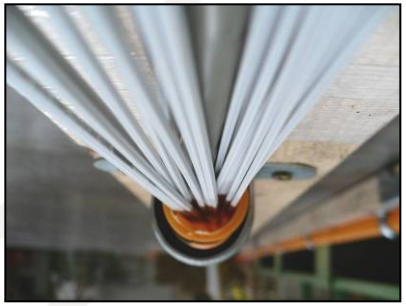
Installation techniques

Network development and maintenance



Fibres and cables and components





ITU-T SG 15
Standardization activity on FTTH

- The standardization of products and installation techniques relevant for the deployment of *FTTX* has been addressed since more than ten years by **ITU-T** under a global umbrella: products, planning, deployment and maintenance

- This encompasses the **development and updating** of **standards for the construction of the physical layer of the access network and the customer premises**

- The activity related to optical infrastructures and products was carried out until 2008 by ITU-T in the Study Groups 6 and 15 and is now under the leadership of **Study Group 15 WP2 "Optical access/transport network technologies and physical infrastructures"**

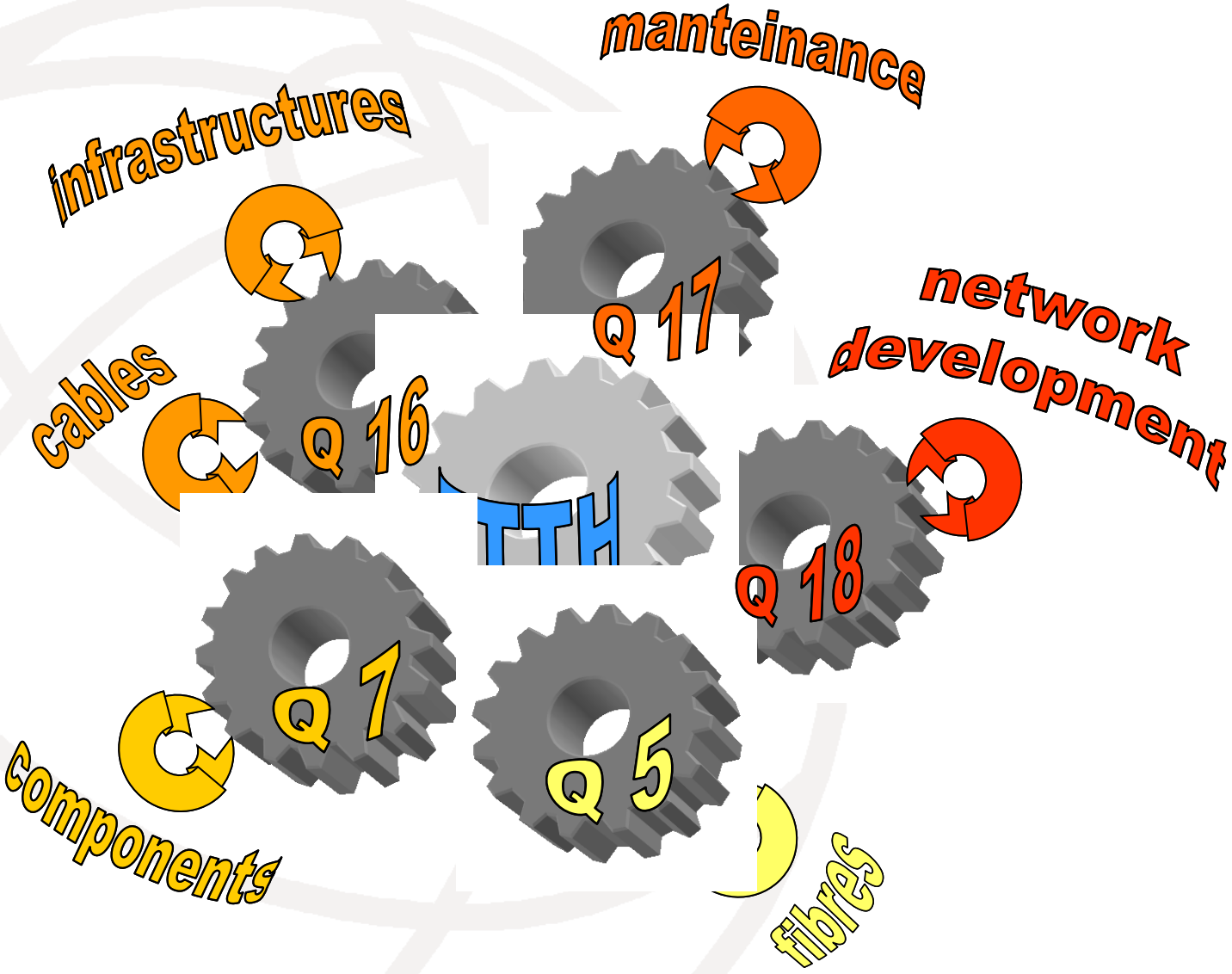
- Care is taken in the harmonization of standards with other Standardization Organizations, in particular with IEC TC86 and its WGs

Trends and challenges in the Outside Plant

- **The construction of the OSP physical layer represents the prevalent cost in the customer connection. With traditional techniques is in the range between 60% (in urban areas) and 90% (in rural areas) of the total plant cost.**
- **The trend of miniaturization of the optical cable structures as well as the availability of low bend fibres allows the reduction of the ducts dimensions and, consequently, of the dimensions of the road cutting**
- **The spread of optical fibre cables into the access network is a key issue with the developement of new infrastructures as well as the re-using the existing ones both in urban areas and in buildings.**
- **To pave the way to FTTH, Telcos are looking for technologies allowing:**
  - ***To re-use as far as possible the existing infrastructures (even if partially occupied by other cables)***
  - ***To minimize the environmental impact by means of reduced dimension diggig techniques (or no dig at all!)***
  - ***To reduce the skill of manpower***

ITU-T SG15 is working on the standardization of all the available technologies to enable FTTH development. Possible solutions include the development of new installation techniques as well as new cables and accessories construction.

Questions assigned to ITU-T SG15 WP2



Q 5 "Characteristics and test methods of optical fibres and cables"

The responsibility under this Question includes the following areas for single-mode fibres & multimode fibres

- description / parameters
- definitions of attributes
- test methods for geometrical, transmission, mechanical and reliability characteristics
- different possible fibre solutions for local access networks

and the following major Recommendations on optical fibers:

- G.650 test method series
- G.651 multimode 50/125 µm
- G.652 dispersion unshifted single-mode optical fibre
- G.653 dispersion shifted single-mode optical fibre
- G.654 cut-off shifted single-mode optical fibre
- G.655 non-zero dispersion-shifted single-mode optical fibre
- G.656 non-zero dispersion-shifted single-mode fibre for wideband optical transport
- G.657 bending loss insensitive single-mode optical fibre

Recent activities on Fibres

- Agreement on new **Recommendation on bending-insensitive fibres G.657** optimized for FTTH deployements
- **New studies on aspects related to the specific FTTH installative context** in cooperation with Q.16: reliability, compatibility, etc.
- **ITU-T Handbook "Optical Fibres, Cables and Systems for Telecommunications"**
- **Revision of the main Recommendations** on optical fibres

ITU-T G. 657 Recommendation on bend insensitive single-mode fibres

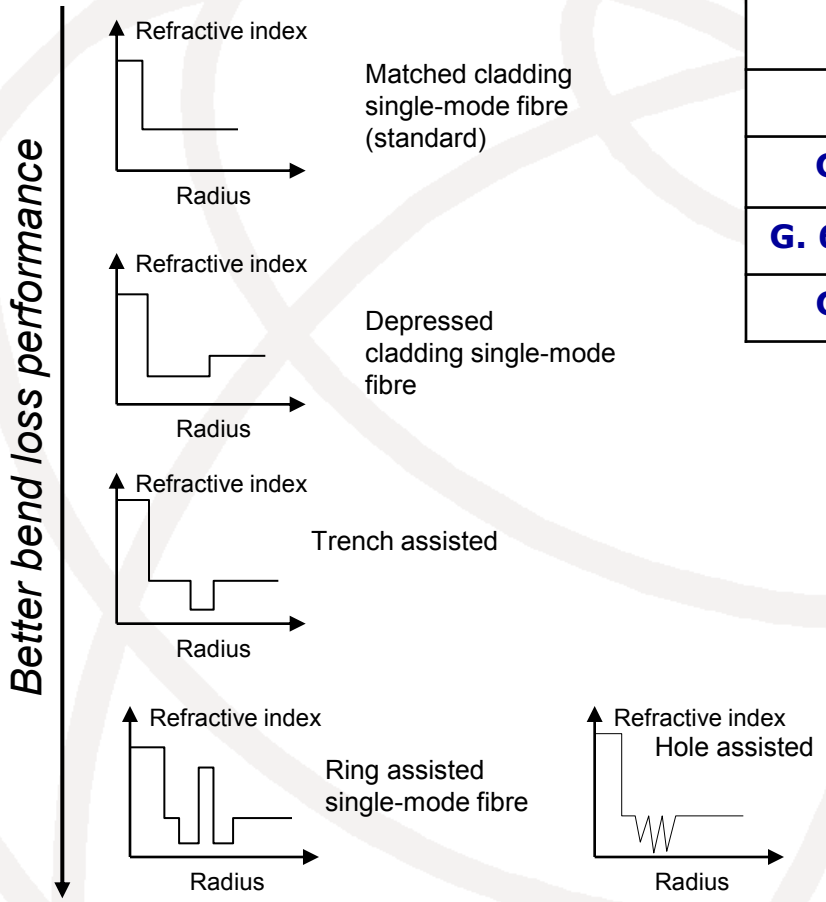
During the last SG15 meeting in Geneva (Oct 2009), agreement has been reached for the following classification:

G.657 A (G.652 compliant) **A1 fibre for 10 mm bending radius**
A2 fibre for 7.5 mm bending radius

G.657 B (not G.652 compliant*) **B2 fibre for 7.5 mm bending radius**
B3 fibre for 5 mm bending radius

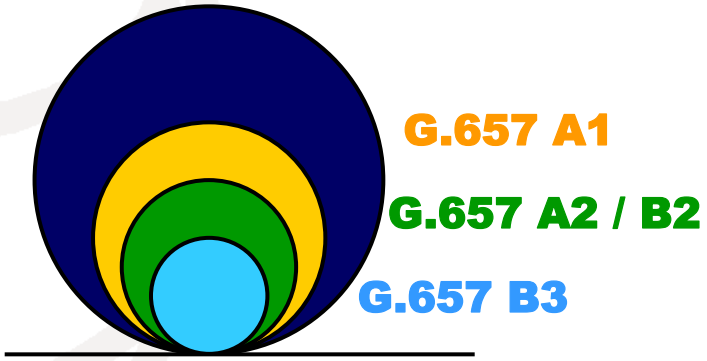
Following issues are addressed as the future study point:
- possibility of A3 fibre
- connectivity to G.652 fibre (level of compliance*)
- wavelength dependence of the transmission characteristics

G.657 fibre technologies



	Specified loss in dB for 1 turn at 1550 nm for radius:			
ITU-T	15 mm	10 mm	7.5 mm	5 mm
G. 657A1	<0.025*	<0.75	-	-
G. 657A2 / B2	<0.03	<0.1	<0.5	-
G. 657B3	-	<0.03	<0.08	<0.15

* These values are recalculated from loss data for 10 turns



G.657 fibre reliability issues

using bend insensitive G.657 fibres in FTTH installations…..

allows lower attenuations with bending, giving

- the possibility to **reduce accessories size** (e.g. storage boxes) allowing installation in crowded infrastructures
- **higher power budget margins** also in the in house tortuous paths
- the possibility to use **quick and cheap installative methods**

but some aspects should be carefully analized

- the impact on the **fibre lifetime in real installation conditions** of: high numbers of small radius bends, length of fibres involved and bending + tension stress applied together
- the effect of the **"compatibility" levels** between fibres from different manufacturers (different technologies) on the insertion loss of splice/connector
- the difficulty to **detect severe or wrong installation conditions** with instruments during installation

Q 1 "Characteristics of optical components and subsystems"

The responsibility under this Question includes **active, passive and hybrid or dynamic/adaptive optical components, devices and related network infrastructure equipment**

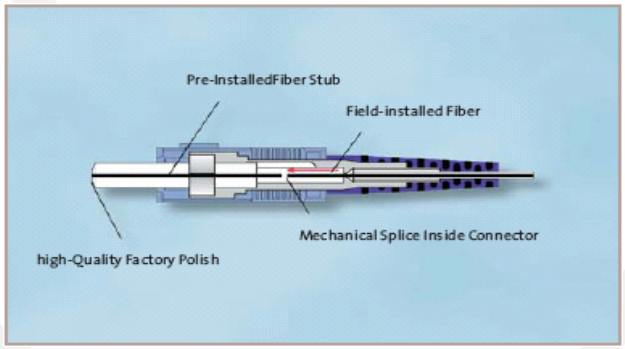
and the following **Recommendations are relevant for FTTH:**

- G.671 transmission characteristics of optical components and subsystems (PON Splitters, Connectors, Attenuators)
- L.12 optical fibre splices
- L.13 sealed closures for outdoor environment
- L.31 optical fibre attenuators
- L.36 single-mode fibre optic connectors
- L.37 optical branching components (non-wavelength selective)
- L.45, L.46 environment aspects related to the outside plant
- L.50, L.51 optical distribution frames for central office environments

Q1 What's going on

- Customer and distribution boxes and terminals (L.distr)
- Pre-terminated fibre drop cables & hardened connectors (L.drop)
- Environmental protection of optical devices and optical connectivity in outside plant conditions (L.modc)
- Outdoor optical cross connect cabinets (L.oxcon)

Optimization of space Unbundling?



Example: Need of new Recommendations on field mountable connector technologies

Q 16 "Optical physical infrastructure and cables"

Recommendations on cable construction

L.10 Optical fibre cables for duct and tunnel application (12/2002)
L.26 Optical fibre cables for aerial application (12/2002)
L.43 Optical fibre cables for buried application (12/2002)
L.58 Optical fibre cables: Special needs for access network (03/2004)
L.59 Optical fibre cables for indoor applications (01/2008)
L.60 Construction of optical/metallic hybrid cables (09/2004)
L.67 Small count optical fibre cables for indoor applications (10/2006)
L.78 Optical fibre cable construction for sewer duct applications (05/2008)
L.79 Optical fibre cable elements for microduct blowing installation application (07/2008)

Q 16 "Optical physical infrastructure and cables"

Recommendations on installation techniques

L.35 Installation of optical fibre cables in the access network (10/1998)

L.38 Use of trenchless techniques for the construction of underground infrastructures for telecommunication cable installation (09/1999)

L.39 Investigation of the soil before using trenchless techniques (05/2000)

L.48 Mini-trench installation technique (03/2003)

L.49 Micro-trench installation technique (03/2003)

L.57 Air-assisted installation of optical fibre cables (05/2003)

L.61 Optical fibre cable installation by floating technique (09/2004)

L.73 Methods for inspecting and repairing underground plastic ducts (04/2008)

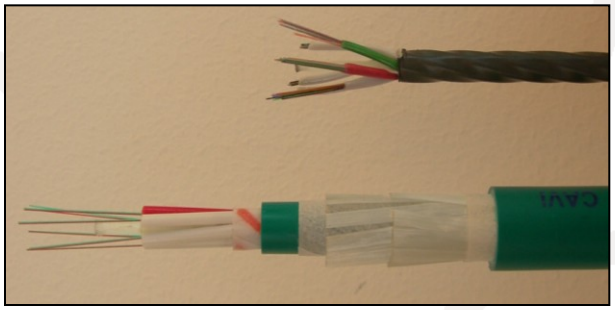
L.77 Installation of cables in sewer ducts (05/2008)

Q 16 Installation of o. f. units or mini-cables by blowing technique (L.57) 1/2

- The reduction of diameter and weight of the ***mini cables*** allow the installation in very small ducts with innovative techniques as ***air blowing***.
- The same products can be installed in overhead plants or on building facades.

Traditional cable

- *96 o.f..*
- *Diameter 15 mm*
- *Weight 200 Kg/Km*
- *Bending Radius 210 mm*
- *Winch installatiion*



Mini cable

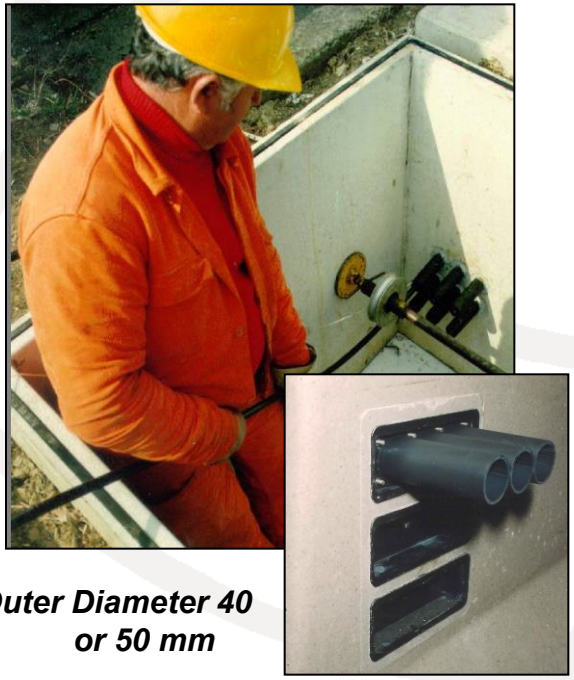
- *Up to 120 (144) o.f.*
- *Diameter 8 mm*
- *Weight 50 Kg/Km*
- *Bending Radius 160 mm*
- *Air blowing installation*

Q 16

Installation of o. f. units or mini-cables by blowing technique (L.57) 2/2

- In the same way also the dimensions of ducts can be reduced.
- In this new scenario large dimension road cuttings are unnecessary, as sections of several cm or some tens cm are sufficient.

TRADITIONAL



Outer Diameter 40 or 50 mm

MINIATURIZED

Diameter 10/14 mm (inner/outer)

Q 16 Low impact minitrench installation techniques (L.limt)

- Installation of mini ducts structures inside a small dimension trench: width less than5 cm and depth in the range 20-30 cm (compared with 10x30 cm of the conventional one)
- Possibility of installing up to 3 linear arrays of 5 mini ducts ∅ 10/14 mm directly buried

Advantages	Drawbacks
Cost effectiveness	*Difficulty to obtain the permissions by Municipalities*
Low impact on environment and traffic	*Medium /low protection grade of the plant*

Q 16 "Light"No-Dig Technique

- It is a guided drilling technique with small machines (also for use in manholes) for the laying of a ∅ **40 mm single duct, equipped with 4 miniducts and with anti rodent protection**
- **It represents an evolution of the technique described in L.38**

Advantages	Drawbacks
Ease to obtain permissions	*Need of a georadar survey*
Zero impact on environment and traffic	*Dependance on the soil type*
No need of expensive road restoration	

Q 16 Solutions for installation of ducts and cables in an occupied infrastructure (L.coi)

- Outfitting of existing ducts (telcos, street lighting,power..) with10/12 mm mini ducts
- Use of completely dielectric minicables
- Separation of the telecomunication access points with the use of reduced dimensions manholes

Advantages	Drawbacks
Cost effectiveness	*Coexistence with other services*
Immediate availability of Infrastructure	*Reduced protection of the plant*
No need of expensive road restoration	*Definition of the "rules" with the infrastructure owner*
Low impact on environment and traffic	*Definition of safety procedure for the O&M activities*

Q 16 New technologies in action

Q 16 Existing building infrastructures challenges

The most critical issues of the FTTH deployment are related to the cabling of existing buildings, especially in metropolitan areas, due to:

- ***Limited availability of TLC infrastructures***
- ***Trouble in obtaining permissions for installing "at sight" solutions***
- ***Old rules related to copper that do not allow to exploit the dielectric characteristics of optical fibres to make its installation more flexible***

ITU-T SG15 is working on the standardization of all the
new products
accessories
test methods
and installation techniques
optimized for the "existing buildings scenario"

Q 16 About installation in buildings....

Q 16 What's going on

- Optical fibre cable functions for premises indoor application (L.caind)
- Optical fibre cable constructions for drop application (L.cda)
- Optical cabling systems in buildings (L.teib)
- Optical fibre cable constructions for new application (L.cna)

- Installation of cables in gas ducts (L.cigd)
- Installation of cables in water ducts (L.ciwd)
- Solutions for installation of ducts and cables in an occupied infrastructure (L.coi)
- Installation of optical fibre units or mini-cables by blowing technique (L.fubt)
- Installation of optical fibre cable by replacement of existing copper cables (L.recc)

Q 17 "Maintenance and operation of optical fibre cable networks"

- What are the functional requirements for optical fibre identification?
- What procedures and methods can be employed for optical fibre identification without interrupting optical services?
- What kinds of reliable technologies can apply to preserve and protect outside plant facilities?

Recommendations on O&M issues

L.25 Optical fibre cable network maintenance (10/1996)
L.40 Optical fibre outside plant maintenance support, monitoring and testing system (10/2000)
L.41 Maintenance wavelength on fibres carrying signals (05/2000)
L.53 Optical fibre maintenance criteria for access networks (05/2003)
L.64 ID tag requirements for infrastructure and network elements management (02/2007)
L.66 Optical fibre cable maintenance criteria for in-service fibre testing in access networks (05/2007)

Q 17 What's going on

- Use of GPS (Global Positioning System) to create referenced network maps (L.gpsm)
- Optical fibre identification for the maintenance of optical access networks (L.ofid)
- Questionnaire on optical fibre identification technologies

Q 18 "Development of optical networks in the access area"

- What are the suitable passive optical network (PON) configurations from initial to final stage?
- What are the suitable optical access network for urban areas and rural areas?
- What are the key considerations for indoor and outdoor and aerial infrastructures?

Recommendations on network design

L.42 Extending optical fibres solutions into the access network (05/2003)

L.52 Deployment of passive Optical Networks (PON) (05/2003)

L.65 Optical fibre distribution of access networks (12/2006)

L.72 Data bases for optical access network infrastructures (01/2008)

Q 18 What's going on

- Aerial infrastructure design for optical access network (L.aid)
- Passive optical networks (PON) configuration for FTTx (L.pon)
- Technical aspects of unbundling and sharing of outside plant elements in optical networks (L.shropt)
- Optical access network design for urban and rural areas (L.uara)
- Questionnaire on "Optical cabling shared with multiple operators in buildings"

Conclusions

- In the last ten years of activity, ITU-T SG15 (and SG6) produced about 40 Recommendations related to FTTH physical layer;
- About 20 Recommendations are in preparation in this study period addressing fibres reliability items, cost effective installation techniques, cables and materials for the indoor brown-field scenario;
- The set of Recommendations produced will speed up the FTTH deployment, as they give timely answers to the most topical issues and allow the FTTH Players (Operators, Investors…) to make the correct choices for the implementation of a future-proof optical fibre access network.

Thank you

The Authors wish to acknowledge Mr. G. Bonaventura and Mr. R. Casale for the useful comments