International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.979

(11/2016)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Optical fibre submarine cable systems

Characteristics of monitoring systems for optical submarine cable systems

Recommendation ITU-T G.979

International Telecommunication Union

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
General	G.900–G.909
Parameters for optical fibre cable systems	G.910–G.919
Digital sections at hierarchical bit rates based on a bit rate of 2048 kbit/s	G.920–G.929
Digital line transmission systems on cable at non-hierarchical bit rates	G.930–G.939
Digital line systems provided by FDM transmission bearers	G.940–G.949
Digital line systems	G.950–G.959
Digital section and digital transmission systems for customer access to ISDN	G.960–G.969
Optical fibre submarine cable systems	**G.970–G.979**
Optical line systems for local and access networks	G.980–G.989
Metallic access networks	G.990–G.999
MULTIMEDIA QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G.7000–G.7999
PACKET OVER TRANSPORT ASPECTS	G.8000–G.8999
ACCESS NETWORKS	G.9000–G.9999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T G.979

Characteristics of monitoring systems for optical submarine cable systems

Summary

Recommendation ITU-T G.979 is concerned with the characteristics of monitoring systems for optical fibre submarine cable systems. It covers the aspects relating to functional architecture, the characteristics of monitoring equipment and the parameters for monitoring.

This second edition of the Recommendation includes some modifications to apply monitoring systems to repeaterless systems as well as repeatered systems.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.979	2012-10-29	15	11.1002/1000/11793
1.1	ITU-T G.979 (2012) Cor. 1	2014-05-14	15	11.1002/1000/12183
2.0	ITU-T G.979	2016-11-13	15	11.1002/1000/13118

Keywords

Monitoring systems, optical fibre submarine cable systems.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T G.979

Characteristics of monitoring systems for optical submarine cable systems

1 Scope

This Recommendation is concerned with the characteristics of monitoring systems for optical fibre submarine cable systems. It covers the aspects relating to functional architecture, the characteristics of monitoring equipment and the parameters for monitoring.

The purpose of this Recommendation is to help users (e.g., submarine network operators) in their operation and maintenance, diagnostics and deployment of optical fibre submarine cable systems.

Detailed information is given for:

1) monitoring system architecture
2) reference points
3) parameters for monitoring.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provision 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.972] Recommendation ITU-T G.972 (2011), *Definition of terms relevant to optical fibre submarine cable systems.*

[ITU-T G.976] Recommendation ITU-T G.976 (2014), *Tests methods applicable to optical fibre submarine cable systems.*

[ITU-T G.977] Recommendation ITU-T G.977 (2015), *Characteristics of optically amplified optical fibre submarine cable systems.*

[IEC 61746-1] IEC 61746-1 (2009), *Calibration of optical time-domain reflectometers (OTDR) – Part 1: OTDR for single mode fibres.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 maintenance controller [ITU-T G.972]: A computer with an interface to the supervision and remote maintenance equipment, which is commonly used during the supervision and remote maintenance activity.

3.1.2 optical fibre submarine cable system [ITU-T G.972]: A set of equipment designed to permit the interconnection of two or more terminal stations.

The optical fibre submarine cable system is usually composed of terminal equipment (terminal transmission equipment, power feeding equipment, maintenance controller, etc.), and submersible equipment (cable, repeater(s), branching unit(s), etc.).

3.1.3 supervisory system [ITU-T G.972]: The whole of equipment and sub-assemblies commonly providing one or more of the following functions:

– monitoring the performance of the submarine equipment and sub-assemblies;

– monitoring the performance of the system terminal equipment;

– monitoring the end-to-end performance of the digital line sections;

– enabling fault location inside the submarine plant, to within one repeater section, where possible;

– controlling redundancy switching, if provided inside the submarine portion;

– providing interfaces to other management facilities.

3.1.4 terminal station [ITU-T G.972]: The telecommunication station usually located in the vicinity of the landing point and housing the optical fibre submarine cable system terminal equipment and that of associated terrestrial systems.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 active monitoring equipment (AME): One of the two categories of monitoring equipment (ME) with the other being passive monitoring equipment (PME). AME monitors the status of submerged equipment by communicating with the monitored equipment to obtain a performance status.

3.2.2 monitoring equipment (ME): Equipment used to monitor the status of the submerged plant of a submarine cable system, which is classified into one of two categories according to the monitoring mechanism: passive monitoring equipment (PME) with no communication between the submerged plant and the monitoring equipment, or active monitoring equipment (AME) which has communication between the submerged plant and the monitoring equipment.

3.2.3 passive monitoring equipment (PME): One of the two categories of ME with the other being AME. PME does not communicate with the submerged plant, but monitors the status of the submerged plant by detecting optical/electrical paths, e.g., monitoring equipment based on OTDR/COTDR. To obtain a performance status, return paths within the submerged plant (described in clause 7.5 of [ITU-T G.977]) are necessary.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AME Active Monitoring Equipment

BU Branching Unit

COTDR Coherent Optical Time Domain Reflectometry

CTE Cable Terminating Equipment

MC Maintenance Controller

ME Monitoring Equipment

OTDR Optical Time Domain Reflectometry

PFE Power Feeding Equipment

PME Passive Monitoring Equipment

TTE Terminal Transmission Equipment

ROPA Remote Optically Pumped Amplifier

5 Conventions

None.

6 General architecture

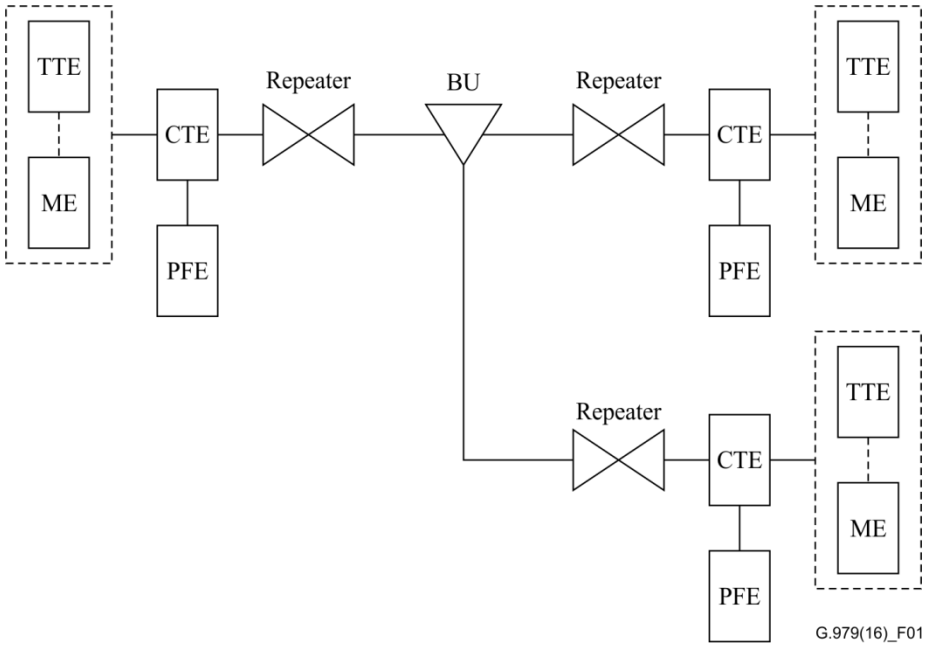


Figure 1 – General architecture of repeatered system

Figure 1 shows the general architecture of a repeatered optical fibre submarine cable system with monitoring equipment (ME). Monitoring equipment should be deployed in each terminal station to provide routine monitoring for maintenance. The monitoring of system status could be obtained by periodically collecting performance data from a submerged plant. Also, for maintenance convenience, it should support or provide interfaces to assist fault location.

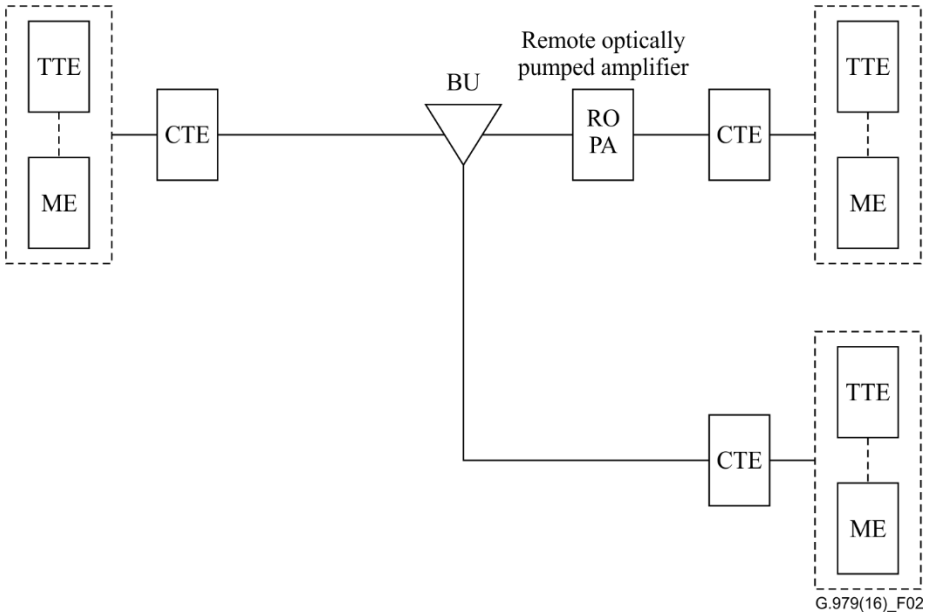
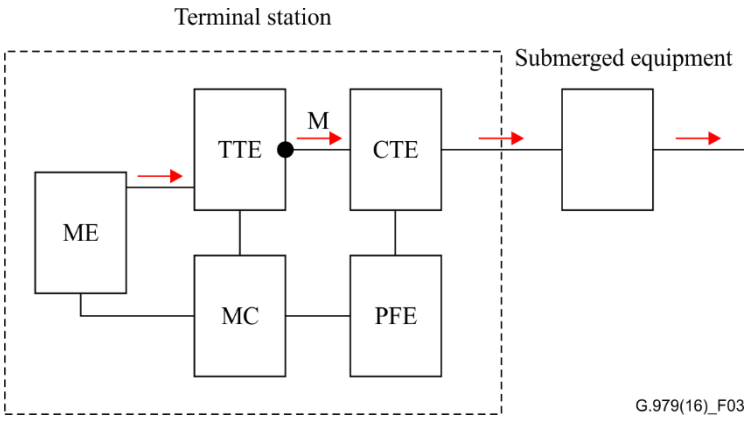


Figure 2 – General architecture of repeaterless system

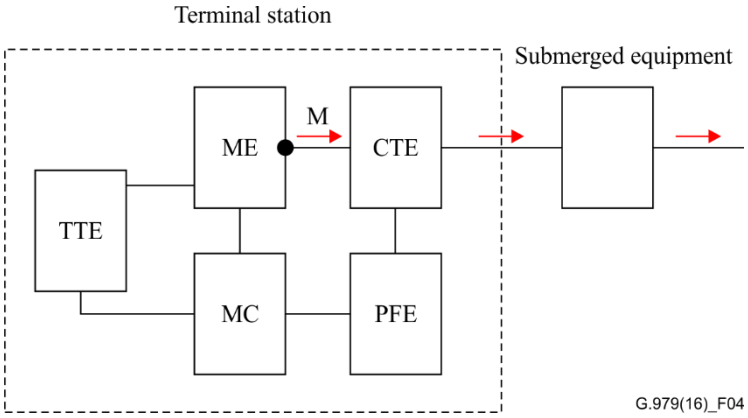
Figure 2 shows the general architecture of a repeaterless optical fibre submarine cable system with monitoring equipment. Two different ways, shown in Figure 3 and Figure 4, may be chosen to configure an ME's connection in a submarine cable system:

- In Figure 3, a terminal transmission equipment (TTE) is connected between an ME and cable terminating equipment (CTE) and monitoring signals and service signals are coupled within the TTE and sent to the submarine cable system.
- In Figure 4, an ME is connected between a TTE and CTE and service signals and monitoring signals are coupled within the ME and sent to the submarine cable system.



NOTE 1 – M denotes monitoring output interface to cables.
NOTE 2 – → denotes the monitoring signal flow in the sending direction; the receiving signal is obtained from the other fibre.
NOTE 3 – This figure defines only one terminal station in the system, the others are the same as this one.
NOTE 4 – PFE used in repeatered systems only.

Figure 3 – Monitoring output from TTE



NOTE 1 – M denotes monitoring output interface to cables.
NOTE 2 – → denotes the monitoring signal flow in the sending direction; the receiving signal is obtained from the other fibre.
NOTE 3 – This figure defines only one terminal station in the system, the others are the same as this one.
NOTE 4 – PFE used in repeatered systems only.

Figure 4 – Monitoring output from ME

As part of a supervisory system, MEs are commonly connected to MCs through management interfaces.

6.1 Reference points

With reference to Figure 3 and Figure 4, reference points should comply with the parameters specified for monitoring.

At point M, a monitoring output interface needs to comply with the following parameters:

- probe light output power, wavelength and pulse width (for passive monitoring)
- modulation parameters (for active monitoring).

7 Characteristics of monitoring equipment

7.1 Passive monitoring

In passive monitoring, performance is obtained by detecting optical or electrical signals. Probe signals are sent to a submerged plant, and the returned signals will be analysed to reflect the system's performance status. For example, the backscattered light of the OTDR/COTDR described in [IEC 61746-1] is detected and processed, usually as curves of signal intensity versus distance to analyse and diagnose system status. One PME monitors one direction performance of the submarine cable system. To get bidirectional performance, a PME should be deployed in each terminal station.

It is recommended that status changes in the probed optical paths, such as fibre breaks, variations of repeater gain and fibre attenuation or reflections, are monitored in passive monitoring.

As passive monitoring obtains the system status indirectly, comparison with baselines is used in status monitoring. Status monitoring should use the same parameters as the baselines to ensure the validity of the comparison and find changes in the performance caused by damage or faults that alter system status.

Baselines should be collected after the system has been properly deployed and should be updated after each repair or reconfiguration of the system.

7.1.1 Fault location

Fault location is often performed manually in the out-of-service state. It could be performed by a PME based on the OTDR/COTDR mechanism, or by commercial OTDR/COTDR equipment.

Highly accurate resolution in fault location is always useful for maintenance. Convenient functions are recommended, for example, automatic fault location and fast fault location with less accuracy but a shorter time.

The submerged equipment should have return paths as described in clause 7.5 of [ITU-T G.977] to support OTDR/COTDR for fault location.

7.2 Active monitoring

In active monitoring, the ME requests and collects directly the performance status of the submerged equipment. Related performance parameters are input power, output power, pump current, etc.

7.3 Monitoring impact

Monitoring signals may impact on the transmission performance of the monitored submarine systems.

8 Recommended parameters for monitoring

Parameters for monitoring are highly implementation-dependent and may vary among different systems. The following is a minimum set of parameters for a user's maintenance convenience.

8.1 Parameters for passive monitoring

- repeater's gain
- fibre attenuation
- fibre break location.

8.2 Parameters for active monitoring

- repeater input optical power
- repeater output optical power
- pump working current
- pump output power.

Appendix I

Examples of parameters of monitoring systems for optical submarine cable systems

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

This appendix contains examples of a PME and an AME to demonstrate the applicable parameters. Since these parameters are highly system-related, they are not specifications or requirements for MEs. It shows the cases of obtainable parameters from current technologies.

Table I.1 gives information on the parameters of a PME.

Table I.1 – Example parameters of a PME

Parameter	Accuracy	Note
Variation of repeater gain	±1.0 dB	
Fibre break location	±1.0 km	
a) These parameters are applied in an OTDR/COTDR based PME. b) Values include contributions from measurement uncertainty and the threshold of variation should reflect the submerged equipment's failures, e.g., pump faults.		

Table I.2 gives information on the parameters of an AME.

Table I.2 – Example parameters of an AME

Parameter	Accuracy	Note
Repeater input optical power	±0.5 dB	
Repeater output optical power	±0.5 dB	
Pump working current	±0.1 A	
Pump output power	±0.5 dB	

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	**Transmission systems and media, digital systems and networks**
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2017