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DIGITAL SECTIONS AND DIGITAL LINE SYSTEMS

DEFINITION OF TERMS RELEVANT TO OPTICAL FIBRE SUBMARINE CABLE SYSTEMS

ITU-T Recommendation G.972

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The 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 Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation G.972 was prepared by the ITU-T Study Group XV (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

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

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INTRODUCTION

The purpose of this Recommendation is to provide definitions of terms relevant to optical fibre submarine cable systems.

A small number of terms defined in this Recommendation are associated with definitions in the Recommendations G.106, G.601 and G.701. Reference to these definitions are given in parenthesis as an aid to ensure consistency between the different Recommendations in the event of future amendments.

Figure 1 shows the basic concept of optical fibre submarine cable systems and boundaries. Optical submarine repeaters or optical submarine branching units could be included, depending on each system requirement.

In Figure 1, A denotes the system interfaces at the terminal station (where the system can be interfaced to terrestrial digital links or to other submarine cable systems), and B denotes beach joints or landing points. Letters in brackets in the definitions given in this Recommendation refer to Figure 1.

Recommendation G.972

DEFINITION OF TERMS RELEVANT TO OPTICAL FIBRE SUBMARINE CABLE SYSTEMS

(Helsinki, 1993)

1 Terms relevant to elements of system configuration

For the purposes of this Recommendation, the following definitions apply.

1001 optical fibre submarine cable system: 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.].

1002 optical fibre submarine cable link: A link which interconnects two terminal stations using a single optical fibre submarine cable system or an integrated system using system portions supplied by different suppliers.

1003 optical fibre submarine cable network: A network which interconnects three or more terminal stations using a single optical fibre submarine cable system or an integrated system made of system portions supplied by different suppliers.

1004 land portion: The portion between the system interface in the terminal station (A), and the landing point (B) or beach joint when it exists. It includes the optical fibre land cable, land joints, and the system terminal equipment.

1005 submarine portion: The portion of the system laid on the sea bed, between the beach joints or landing points (B), which includes the optical fibre submarine cable and the submarine equipment [e.g. optical submarine repeater(s), optical submarine branching unit(s), and optical submarine cable jointing box(es)].

1006 beach joint: The cable joint made between the optical fibre submarine cable and the optical fibre land cable.

1007 terminal station: 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.

1008 terminal station equipment (TSE): The TSE comprises the STE and the ancillary equipment used for the operation of the optical fibre submarine cable system.

1009 system terminal equipment (STE): The STE comprises all equipments specific to a given optical fibre submarine cable system.

1010 terminal transmission equipment (TTE): The equipment terminating the optical submarine transmission line at the optical interface, and connected to the system interface.

1011 supervisory system: The whole of equipment and subassemblies commonly providing one or more of the following functions:

- monitoring the performance of the submarine equipment and subassemblies;
- 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.

1012 maintenance controller: A computer with an interface to the supervision and remote maintenance equipment, which is commonly used during the supervision and remote maintenance activity.

1013 power feeding equipment (PFE): The equipment providing, through a power conductor in the optical fibre submarine cable, a stabilised constant electrical current for powering optical submarine repeaters and/or optical submarine branching units.

1014 cable terminating equipment (CTE): The equipment providing the interface between the optical fibre from the TTE and the optical fibre from the cable, and the interface between the power feeding line from the PFE and the power feeding conductor from the optical fibre cable.

NOTE – The CTE is usually part of the PFE.

1015 power feed earth: The earth provided to establish the return path of the repeater power feeding current circuit.

1016 power feed earth electrode cable: The cable installed between the power feed earth and the PFE.

1017 optical fibre station cable: The optical fibre cable installed inside the cable station.

1018 optical fibre land cable: The optical fibre cable installed between the CTE and the beach joint.

1019 optical fibre submarine cable: The submarine cable using optical fibres as transmission line.

1020 optical submarine repeater (related to Recommendation G.601, definition 1001, *Blue Book*): An equipment essentially including one or more regenerators or amplifiers, and associated devices, in the submarine portion.

1021 bipolar repeater: An optical submarine repeater which can be powered by a power feeding current flowing in either direction.

1022 branching unit (BU): An equipment connecting more than two optical fibre submarine cable sections.

NOTE – Applications for the optical submarine branching unit may include the following additional functions:

– optical signal path switching;

– signal regeneration or amplification;

– power path switching.

1023 undersea branching multiplexer (UBM): A branching unit that separates lower level digital signals from incoming optical line signals and recombines them differently in outgoing optical line signals.

1024 integration specification: A set of specification established to permit the interconnection of two or more optical fibre submarine cable systems designed by different suppliers.

1025 integration line optical interface: The optical interface between fractions of the submarine portion provided by different suppliers.

1026 shallow water: Water depths down to a given limit, corresponding to the depths of fishing activity, or more generally of marine activity, creating a risk of cable fault.

NOTE – The limit of shallow water is of the order of 1000 metres.

1027 deep water: Water depths exceeding the limit of shallow water.

1028 elementary cable section: The whole length of optical fibre cable between two pieces of equipment (repeaters, branching units or terminal transmission equipment).

2 Terms relevant to system aspects

2001 system design life: The period of time over which the optical fibre submarine cable system is designed to operate in conformance with its performance specification.

2002 optical power budget: The allocation of the available optical power in an optical section.

2003 digital line section (DLS) (related to Recommendation G.701, definition 3007 and 3012, *Blue Book*): The whole of the means of transmission of a digital signal at a specified bit rate between the corresponding input and output system interfaces at the digital distribution frame or equivalent. A digital line section forms a part of a digital link and includes terminal equipment, repeaters and branching units. The definition normally applies to the combination of "go" and "return" directions of transmission.

NOTE – This definition differs from the definition of Recommendation G.701 as the latter excludes multiplexers. In an optical fibre submarine cable system, a digital line section is meant to include optical submarine branching multiplexers, if any, and also terminal multiplexing equipment included in the terminal transmission equipment (TTE) which may include multiplexing.

2004 optical section: The whole of the optical path as physical transmission medium between the optical source output (point O) of one equipment and the optical detector input (point I) of the following equipment.

2005 optical source output: The point where the launched power is measured (point O).

2006 optical detector input: The point where the received optical power is measured (point I).

2007 supervisory section: The fraction of the submarine portion extending from one specified point in a repeater to a similar point in the adjacent repeater which can be identified using the supervisory system for fault location.

2008 system interface (related to Recommendation G.701, definition 1008, *Blue Book*): The point (A) on the specified equipment, such as the digital distribution frame, at which each digital line section terminates. The interfaces are usually designated as Ii, pertaining to the incoming tributaries, and Io, pertaining to the outgoing tributaries.

2009 optical interface (related to Recommendation G.701, definition 1008, *Blue Book*): A common boundary between two associated parts of an optical section.

2010 transmit terminal optical interface: The optical interface at the output port (point S) of a transmit terminal equipment.

2011 receive terminal optical interface: The optical interface at the input port (point R) of a receive terminal equipment.

2012 repeater (or BU) optical output interface: The optical interface at the output port (point S) of a repeater (or BU).

NOTE – The output port is usually at the splice between the repeater fibre and the cable fibre.

2013 repeater (or BU) optical input interface: The optical interface at the input port (point R) of a repeater (or BU).

NOTE – The input port is usually at the splice between the repeater fibre and the cable fibre.

2014 optical line signal: The optical signal transmitted on one optical fibre in the submarine portion.

2015 line frame (related to Recommendation G.701, definition 4007, *Blue Book*): A cyclic set of consecutive time slots in the optical line signal, in which the relative position of each time slot can be identified.

NOTE – The line frame results from the multiplexing and coding operations performed by the TTE, taking into account the inclusion of the service and supervisory channels.

2016 system interface bit rate (related to Recommendation G.701, definition 2013, *Blue Book*): The number of bits (binary digits) per unit time in the digital signal at the system interface.

NOTE – Several interface bit rates may coexist for one single optical fibre submarine cable system.

2017 line error ratio: The error ratio as could be observed using appropriate means at a given location in the submarine portion.

2018 apparent line error ratio: The value of the line error ratio obtained using the supervisory equipment of the submarine optical fibre cable system.

2019 electroding: The use of undersea equipment for the detection of a low frequency modulation of the power feeding current for cable location purposes.

2020 power feeding current: The stabilized electric current provided by the PFE through the cable power conductor with return through the power feed earth.

2021 line bit rate (related to Recommendation G.701, definition 2014, *Blue Book*): The number of signal elements of the optical line signal per unit time.

NOTE – The line bit rate results from the multiplexing and coding operations performed by the TTE, taking into account the inclusion of the service and supervisory channels.

2022 line code (related to Recommendation G.701, definition 9002, *Blue Book*): A code chosen to suit the characteristics of the submarine portion, that defines the equivalence between sets of digits presented for transmission and the corresponding sequence of signal elements transmitted over that channels.

NOTE – The line code and violations of the line code can be used for system monitoring and supervisory.

2023 system performance penalty: A parameter included in the optical power budget to take into account phenomena such as chromatic dispersion, partition noise, etc.

2024 cable section margin: A parameter included in the optical power budget, to take into account the variation of the fibre attenuation due to ageing during the system design life.

2025 equipment margin: A parameter included in the optical power budget to take into account the variation of the optical power at both ends of a cable section due to equipment component ageing during the system design life.

2026 repair allowance (provision): A parameter included in the optical power budget to take into account the possible increase of attenuation of the cable fibre due to cable repair during the system design life.

2027 unassigned margin: A parameter included in the power budget as a provision for unforeseen phenomena.

2028 guaranteed margin: The minimum margin in the power budget.

2029 overload margin: The minimum difference between the received power and the input power above which the bit error ratio would exceed a specified level.

2030 expected ship repair number: The mean number of repairs by cable ship (statistical expectation) due to system failures during the system design life.

NOTE – This excludes faults due to external aggression.

2031 reliability budget: A reliability model indicating the reliability of each of the components of the submarine portion to be met so as to keep the expected ship repair number below a given limit.

2032 availability (see Recommendation G.106, definition 7105, *Blue Book*, and Recommendation G.602, *Blue Book*): The ability of the system to be in a state to perform adequately at a given instant of time within a given time interval. The availability of an optical fibre submarine cable system is quantified by the ratio of the time during which the system is operating to a specified total time.

NOTE – System interruptions due to faults requiring ship repair are excluded for availability calculation.

2033 end-to-end performance monitoring: The evaluation of the end-to-end transmission quality performance of each digital line section in the submarine optical fibre cable transmission system.

2034 supervisory of an optical fibre submarine cable system (see Supplement No. 6 to E-Series Recommen-dations of Fascicle II.3, definition 6022, *Blue Book*): The function provided by the supervisory system of the optical fibre submarine cable system so as to permit fault localization, repeater performance monitoring and remote controlled redundancy switching.

3 Terms relevant to terminal equipment

3001 service channel: A communication channel established between associated terminal stations through the optical fibre submarine cable system for the purpose of operating and maintaining the system.

3002 order wire channel: A voice service channel.

3003 PFE earth protection equipment: A protective device that automatically routes the power feeding current to the station earth under abnormal PFE earth conditions.

3004 PFE personnel protection equipment: Protective equipment installed to prevent personnel from gaining access to dangerous potentials.

3005 PFE mutual protection: The ability of a power feeding unit installed at one end of a link to provide in an emergency situation the whole of the power necessary for a given link, when in normal operating condition that total power is shared between the power feeding equipment installed at both ends of the link.

3006 PFE nominal current: The nominal value of the power feeding current.

3007 maximum PFE current: The value of the power feeding current above which the PFE switches off in order to protect the system.

3008 maximum PFE voltage: The value of the voltage at the PFE output above which the PFE switches off in order to protect the system.

3009 PFE current stability: The limitation of the variation of the PFE current in time.

4 Terms relevant to optical submarine repeaters and branching units

4001 repeater (or BU) housing: The mechanical piecepart of a repeater (or branching unit).

4002 repeater (or BU) optoelectronic unit: The optoelectronic piecepart of a repeater (or branching unit).

4003 repeater (or BU) supervisory circuit: Electronic circuits installed in a repeater (or branching unit) to perform, in association with the supervisory equipment installed in the terminal station, system supervision and fault localisation.

4004 repeater (or BU) power supply and protection circuit: The electronic circuits installed in a repeater (or BU) to power in association with the PFE the repeater (or BU) optoelectronic unit with a regulated voltage, and to provide protection against electrical discharges due to cable discharge or lightning.

4005 branching unit sea electrode: An electrode provided at a BU to establish the return path of the power feeding current through the sea.

5 Terms relevant to optical fibre submarine cable

5001 light weight cable: Cable suitable for laying, recovery and operation, where no special protection is required.

5002 light weight protected cable: Lightweight cable with an additional protective layer.

NOTE – This cable is suitable for laying, recovery and operation in areas where cable erosion or fishbite risk is significant.

5003 single armoured cable: Lightweight cable with a single layer of protective steel wires.

NOTE – This cable is suitable for laying, burial, recovery and operation and is suitably protected for specific area in shallow water.

5004 double armoured cable: Lightweight cable with a double layer of armour wires.

NOTE – This cable is suitable for laying, burial, recovery and operation and is suitably protected for specific area in shallow water.

5005 rock armoured cable: Lightweight cable with a double layer of armour wires, the second layer being wound with a small pitch.

NOTE – This cable is suitable for laying, recovery and operation and is suitably protected for specific area in shallow water.

5006 land cable: Cable with suitable protection for installation in duct or direct burying in ground.

5007 cable breaking load: The tensile load which when applied longitudinally to the cable with fixed ends results in a cable break.

5008 fibre-breaking cable load: The load which when applied longitudinally to the cable with fixed ends results in an instantaneous fibre break.

5009 maximum permanent cable load: The maximum permanent cable load that does not significantly reduce the system performance, lifetime and reliability.

NOTE – Also referred to elsewhere as the nominal permanent tensile strength. Nominal in this context is understood to mean the nominal maximum value of tension.

5010 operational cable load: The maximum load that can be applied to the cable during the time necessary for a repair operation, without significantly reducing the system performance, lifetime and reliability.

NOTE – Also referred to elsewhere as the nominal operating tensile strength. Nominal in this context is understood to mean the nominal maximum value of tension.

5011 transitory cable load: The maximum short-term load that can be applied to the cable during a recovery operation, without significantly reducing the system performance, lifetime and reliability.

NOTE – Also referred to elsewhere as the nominal transient tensile strength. Nominal in this context is understood to mean the nominal maximum value of tension.

5012 longitudinal water propagation: The cable length being penetrated by water as a function of water depth or pressure and of duration of submission for an open ended cable.

5013 cable jointing box: A mechanical assembly used to join two optical fibre submarine cables.

5014 cable coupler; cable termination: A mechanical assembly used to join an optical fibre submarine cable to a repeater or a branching unit.

5015 cable transition: A transition between different types of cables, which can be achieved using either a transition cable or a transition joint.

5016 cable gyration: The rotation of one end of a cable length relative to the other end.

5017 cable elongation with fixed end: The cable elongation under a load, when both ends are prevented from rotating.

5018 cable elongation with free gyration: The cable elongation under a load, when one end is free to rotate.

5019 cable modulus: The length of cable, measured in kilometre, the weight of which in water is equal to the cable breaking load.

5020 cable operational modulus: The length of cable, measured in kilometre, the weight of which in water is equal to the operational cable load.

5021 cable full safe modulus: The length of cable, measured in kilometre, the weight of which in water is equal to the maximum permanent cable load.

5022 cable transitory modulus: The length of cable, measured in kilometre, the weight of which in water is equal to the transitory cable load.

5023 cabled fibre attenuation: The optical attenuation of the cabled fibre, including any fibre overlength and fibre splices present, as measured in decibels per length of cable.

5024 cabled fibre strain: The strain within an optical fibre in a cable after manufacture.

6 Terms relevant to manufacturing and installation

6001 qualification: The activity, part of the development process, intended to demonstrate that a technology, a component or an assembly is able to comply with its performance and reliability specification.

6002 sea trial: A test made at sea during the development process, as part of the qualification of the submarine portion.

6003 certification: The activity, part of the manufacturing process, intended to eliminate all components or subassemblies which present a risk of not complying with their performance and reliability specification.

6004 batch qualification: The activity, part of the manufacturing process, intended to eliminate batches of components suspect to present a generalized failure mechanism.

6005 route survey: The activity performed prior to cable laying so as to select the cable route and cable protection (fishbite protection, armour, burying).

6006 link assembly: The activity of jointing the cable sections, the repeaters and the branching units, together with monitoring the performance of each cable section.

6007 ship loading: The operation of installing the submarine portion or fractions of it on board the cable ship prior to laying.

6008 cable laying: The operation of laying on the sea bottom the submarine portion or fractions of it.

6009 laying limit condition: Weather and sea condition beyond which laying should not be undertaken or should be interrupted.

6010 slack control: Operation consisting in controlling that a predetermined cable overlength (slack) is layed.

6011 shore end: The end of the submarine cable, to be laid from the cableship toward the beach so as to be connected to the land cable.

6012 initial splice: The splice made on board the cableship between parts of the submarine portion at the beginning of a lay.

6013 final splice: The splice made on board the cableship between parts of the submarine portion at the end of a lay.

6014 cable burial: The operation consisting in burying the cable in the sea bed so as to provide better cable protection.

NOTE – The burial operation may be carried out either during installation or as a post-lay activity.

6015 laying angle: The angle between the cable being laid (which is theoretically along a straight line) and the sea surface.

7 Terms relevant to the maintenance of the submarine portion

7001 cable recovery: The operation of recovering a cable from the sea bottom.

7002 deep sea repair: The operation of repairing a submarine cable system installed in deep sea.

7003 shallow water repair: The operation of repairing a submarine cable system installed in shallow water.

7004 mini system: A length of cable, pre-equipped with repeaters, to be used for replacing one or more optical cable sections and the associated repeaters during a sea repair.

7005 spare repeater (or *BU*): An additional repeater (or BU) stored in a marine depot or on board a cableship to be used during a repair operation.

7006 spare cable: An additional cable length, stored in a marine depot or on board a cableship to be used during a repair operation.

7007 spare storage condition: The environment condition for storing the spare repeaters and cable.

7008 repair safety procedure: Procedures to be applied on board the cableship and in the terminal station, so as to ensure the safety of the personnel during a repair.

7009 submersible robot: A remote-controlled submersible vehicle which can be used for locating, observing, post-lay burying, or recovering a cable installed in shallow water.

8 List of abbreviations and acronyms

For the purposes of this Recommendation, the following abbreviations apply:

BU	Branching unit
CTE	Cable terminating equipment
DLS	Digital line section
PFE	Power feeding equipment
STE	System terminal equipment
TSE	Terminal station equipment
TTE	Terminal transmission equipment
UBM	Undersea branching multiplexer