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

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Internet protocol aspects – Transport

Terms and definitions for optical transport networks (OTN)

Recommendation ITU-T G.870/Y.1352

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

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Recommendation ITU-T G.870/Y.1352

Terms and definitions for optical transport networks (OTN)

Summary

Recommendation ITU-T G.870/Y.1352 provides terms, definitions and abbreviations used in optical transport network (OTN) Recommendations. It contains a list of the definitions and abbreviations introduced in Recommendations associated with optical transport networks, and can be considered a companion Recommendation to Recommendations ITU-T G.780/Y.1351 and ITU-T G.8081/Y.1353. This Recommendation does not include terms specific to the physical layer or synchronization. The goal of this Recommendation is to be a single normative source for terms in this subject area.

History

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Keywords

Acronyms, optical transport network, OTN, terminology, terms.

FOREWORD

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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.

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Terms and definitions for optical transport networks (OTN)

1 Scope

This Recommendation contains a complete listing of the terms, definitions and abbreviations introduced in the Recommendations associated with optical transport networks. OTN terms specific to synchronization or physical layer characteristics are not a part of this Recommendation.

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.709] Recommendation ITU-T G.709/Y.1331 (2009), *Interfaces for the Optical Transport Network (OTN).*

[ITU-T G.780] Recommendation ITU-T G.780/Y.1351 (2008), *Terms and definitions for synchronous digital hierarchy (SDH) networks*.

[ITU-T G.805] Recommendation ITU-T G.805 (2000), *Generic functional architecture of transport networks*.

[ITU-T G.806] Recommendation ITU-T G.806 (2009), *Characteristics of transport equipment – Description methodology and generic functionality*.

[ITU-T G.808.1] Recommendation ITU-T G.808.1 (2006), *Generic protection switching – Linear trail and subnetwork protection*.

[ITU-T G.872] Recommendation ITU-T G.872 (2001), *Architecture of optical transport networks*.

[ITU-T G.873.1] Recommendation ITU-T G.873.1 (2006), *Optical Transport Network (OTN): Linear protection*.

[ITU-T G.7710] Recommendation ITU-T G.7710/Y.1701 (2007), *Common equipment management function requirements*.

[ITU-T G.7712] Recommendation ITU-T G.7712/Y.1703 (2008), *Architecture and specification of data communication network*.

[ITU-T G.8081] Recommendation ITU-T G.8081/Y.1353 (2008), *Terms and definitions for Automatically Switched Optical Networks (ASON).*

[ITU-T G.8201] Recommendation ITU-T G.8201 (2003), *Error performance parameters and objectives for multi-operator international paths within the Optical Transport Network (OTN).*

[ITU-T M.3010] Recommendation ITU-T M.3010 (2000), *Principles for a telecommunications management network*.

[ITU-T M.3013] Recommendation ITU-T M.3013 (2000), *Considerations for a telecommunications management network*.

[ITU-T X.700] Recommendation ITU-T X.700 (1992), *Management framework for Open Systems Interconnection (OSI) for CCITT applications*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 adaptation: [ITU-T G.805].

3.1.2 adaptation function: [ITU-T G.806].

3.1.3 adapted information: [ITU-T G.805].

3.1.4 administrative domain: [ITU-T G.805].

3.1.5 atomic function: [ITU-T G.806].

3.1.6 automatic protection switching (APS): [ITU-T G.780].

3.1.7 block: [ITU-T G.780].

3.1.8 characteristic information (CI): [ITU-T G.805].

3.1.9 connection: [ITU-T G.805].

3.1.10 connection function (C): [ITU-T G.806].

3.1.11 connection point (CP): [ITU-T G.806].

3.1.12 connection supervision: [ITU-T G.805].

3.1.13 data communications channel (DCC): [ITU-T G.780].

3.1.14 defect: [ITU-T G.806].

3.1.15 errored block (EB): [ITU-T G.780].

3.1.16 embedded control channel (ECC): [ITU-T G.7712].

3.1.17 failure: [ITU-T G.806].

3.1.18 fault: [ITU-T G.806].

3.1.19 function: [ITU-T G.806].

3.1.20 layer: [ITU-T G.780].

3.1.21 link connection: [ITU-T G.805].

3.1.22 managed object: [ITU-T X.700].

3.1.23 management application function (MAF): [ITU-T G.780].

3.1.24 management information (MI): [ITU-T G.806].

3.1.25 member: [ITU-T G.806].

3.1.26 message communication function: [ITU-T M.3013].

3.1.27 multiplex section (MS): [ITU-T G.780].

3.1.28 multiplex section overhead (MSOH): [ITU-T G.780].

3.1.29 network: [ITU-T G.805].

3.1.30 network connection (NC): [ITU-T G.805].

3.1.31 network element: [ITU-T M.3010].

3.1.32 network element function (NEF): [ITU-T M.3010].

3.1.33 network node interface (NNI): [ITU-T G.780].

3.1.34 operations systems function (OSF): [ITU-T M.3010].

3.1.35 path: [ITU-T G.806].

3.1.36 path overhead (POH): [ITU-T G.780].

3.1.37 process: [ITU-T G.806].

3.1.38 reference point: [ITU-T G.780].

3.1.39 section: [ITU-T G.806].

3.1.40 signal degrade (SD): [ITU-T G.806].

3.1.41 signal fail (SF): [ITU-T G.806].

3.1.42 subnetwork: [ITU-T G.805].

3.1.43 subnetwork connection (SNC): [ITU-T G.805].

3.1.44 synchronous transport module (STM): [ITU-T G.780].

3.1.45 telecommunications management network: [ITU-T M.3010].

3.1.46 trail: [ITU-T G.805].

3.1.47 trail termination function (TT): [ITU-T G.806].

3.1.48 unequipped VC: [ITU-T G.780].

3.1.49 unprotected: [ITU-T G.780].

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 1+1 (protection) architecture: A 1+1 protection architecture has one normal traffic signal, one working transport entity, one protection transport entity and a permanent bridge.

At the source end, the normal traffic signal is permanently bridged to both the working and the protection transport entities. At the sink end, the normal traffic signal is selected from the better of the two transport entities.

Due to the permanent bridging, the 1+1 (protection) architecture does not allow an unprotected extra traffic signal to be provided.

3.2.2 1:n (protection) architecture (n ≥ 1): A 1:n protection architecture has n normal traffic signals, n working transport entities and one protection transport entity. It may have one extra traffic signal.

At the source end, a normal traffic signal is either permanently connected to its working transport entity and may be connected to the protection transport entity (in the case of a broadcast bridge), or is connected to either its working or the protection transport entity (in the case of a selector bridge). At the sink end, the normal traffic signal is selected from either the working or the protection transport entity.

An unprotected extra traffic signal can be transported via the protection transport entity, whenever the protection transport entity is not used to carry a normal traffic signal.

3.2.3 $(1{:}1)^n$ protection architecture: n parallel 1:1 protection architectures, which have their n protection transport entities share (and compete for) the protection bandwidth. It has n normal traffic signals, n working transport entities and n protection transport entities. It may have an extra traffic signal, in which case an additional protection transport entity will be present.

NOTE – This architecture is applicable in cell/packet layer networks (e.g., ATM, MPLS).

3.2.4 access function (AC): An access function provides access (add, drop and continue) at CPs to communication channels transported in the overhead.

3.2.5 active transport entity: The transport entity from which the protection selector selects the normal traffic signal.

3.2.6 adaptation management: The set of processes for managing client layer network adaptation to/from the server layer network.

3.2.7 APS-byte pass-through: The action of transmitting the same APS-bytes that are being received. Protection channels are not passed through. APS-byte pass-through is bidirectional.

3.2.8 APS channel: Automatic protection switch (APS) channel is used to carry information between the two ends of a linear protection group to coordinate the head-end bridge with the tail-end selector for 1:n protection, and to coordinate the selectors in both directions in the case of bidirectional protection.

3.2.9 APS protocol: 1-phase: A means to align the two ends of the protected domain via the exchange of a single message (Z → A).

For $(1:1)^n$ architectures, the bridge/selector at Z are operated before it is known if Z's condition has priority over the condition at A. When A confirms the priority of the condition at Z, it operates the bridge and selector. For unidirectional switching, the priority is determined by Z only and the selector at Z and bridge at A are operated. For 1+1 architectures, the bridges are permanent and only the selectors are to be operated.

3.2.10 APS protocol: 2-phase: A means to align the two ends of the protected domain via the exchange of two messages (Z → A, A → Z).

For $(1:1)^n$ architectures, Z signals the switch condition to A and operates the bridge. When A confirms the priority of the condition at Z, it operates the bridge and selector. On receipt of confirmation, Z operates its selector. For unidirectional switching, the priority is determined by Z only and the selector at Z and bridge at A are operated. For 1+1 architectures, the bridges are permanent and only the selectors are to be operated.

3.2.11 APS protocol: 3-phase: A means to align the two ends of the protected domain via the exchange of three messages (Z → A, A → Z, Z → A).

For 1:n, m:n architectures, Z does not perform any switch action until A confirms the priority of the condition at Z. When A confirms the priority, it operates the bridge. On receipt of confirmation, Z operates its selector and bridge and indicates the bridge action to A. A finally operates the selector. For 1+1 architectures, the bridges are permanent and only the selectors are to be operated.

3.2.12 bridge: The function that connects the normal and extra traffic signals to the working and protection transport entities.

3.2.12.1 permanent bridge: For a 1+1 architecture, the bridge connects the normal traffic signal to both the working and protection entities.

3.2.12.2 broadcast bridge: For 1:n, m:n, $(1:1)^n$ architectures, the bridge permanently connects the normal traffic signal to the working transport entity. In the event of protection switching, the normal traffic signal is additionally connected to the protection transport entity. The extra traffic signal is either not connected or connected to the protection transport entity.

3.2.12.3 selector bridge: For 1:n, m:n, $(1:1)^n$ architectures, the bridge connects the normal traffic signal to either the working or the protection transport entity. The extra traffic signal is either not connected or connected to the protection transport entity.

NOTE 1 – In SDH, the broadcast bridge is preferred as cross connect fabrics use connection tables which are typically organized by output. In a bridge where there are two outputs and one input, the table would be populated with "OUTx1:INy" "OUTx2:INy". Using a broadcast bridge does not require the modification of the working matrix connection, only the addition of a protection matrix connection.

NOTE 2 – In ATM, the selector bridge is preferred as connection tables are typically organized by input. A broadcast bridge would require, e.g., "INx:OUTy1" "INx:OUTy2", which is more complicated than a selector bridge, which only has "INx:OUTy1" changing to "INx:OUTy2". This also applies to other packet switching technologies.

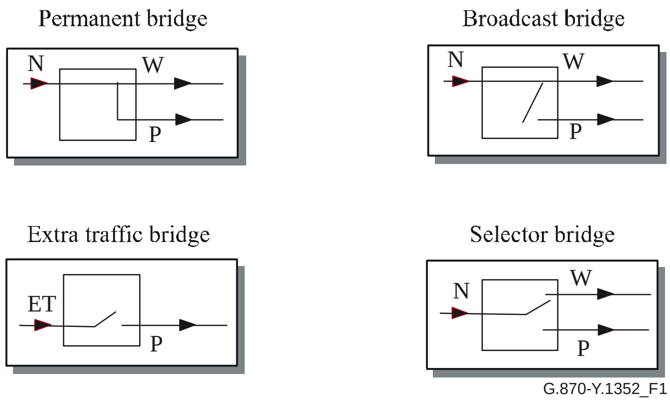

Figure 1 – Protection bridges

3.2.13 CBRx: Is a CBR signal with the approximate bit rate x.

3.2.14 CBR2G5: A constant bit rate signal of 2 488 320 kbit/s ± 20 ppm. An example of such signal is an STM-16 signal.

3.2.15 CBR10G: A constant bit rate signal of 9 953 280 kbit/s ± 20 ppm. An example of such signal is an STM-64 signal.

3.2.16 CBR40G: A constant bit rate signal of 39 813 120 kbit/s ± 20 ppm. An example of such signal is an STM-256 signal.

3.2.17 clear (CLR): Clears the active near-end lockout of protection, forced switch, manual switch, WTR state, or exercise command.

3.2.18 clear lockout of normal traffic signal #i: Clears the lockout of normal traffic signal #i command.

NOTE – In bidirectional 1:n switching, remote bridge requests for normal traffic signal #i will still be honoured to prevent APS protocol failures. As a result, a normal traffic signal must be locked out at both ends to prevent it from being selected from the protection entity as a result of a command or fault condition at either end. Multiples of these commands may coexist for different normal traffic signals.

3.2.19 connection monitoring end-point (CMEP): Connection monitoring end-points represent end-points of trails and correspond as such with the trail termination functions. Connection monitoring overhead (CMOH) is inserted and extracted at the CMEPs.

For the OCh the CMEPs are categorized in three classes:

– OCh optical section CMEP (OS_CMEP), which represents the end-points of the OTUk trail. The SM overhead field (see [ITU-T G.709]) contains the related CMOH.

– OCh tandem connection CMEP (TC_CMEP), which represents the end-points of ODUkT trails. The TCM1..6 overhead fields (see [ITU-T G.709]) contain the related CMOH.

– OCh path CMEP (P_CMEP), which represents the end-points of the ODUkP trail. The PM overhead field (see [ITU-T G.709]) contains the related CMOH.

3.2.20 connectivity supervision: The set of processes for monitoring the integrity of the routing of the connection between source and sink trail terminations.

3.2.21 continuity supervision: The set of processes for monitoring the integrity of the continuity of a trail.

3.2.22 crossing APS-bytes: When a node sees ring bridge requests of equal priority on both 'sides' (This includes a switching node receiving a ring bridge request from the other end).

3.2.23 detection time: The time between the occurrence of the fault or degradation and its detection as a defect condition and consequential activation of SF or SD condition.

3.2.24 do not revert normal traffic signal #i (DNR #i): In non-revertive operation, this is used to maintain a normal traffic signal to be selected from the protection transport entity.

3.2.25 end-to-end overhead/OAM (e): Overhead/OAM associated with the layer network's trail. Examples: OTN ODUk PM overhead, ATM VPC e-t-e OAM.

3.2.26 entity: In [ITU-T G.873.1], this is generally used to describe a transport entity connected between the head and tail-end of the protection group. In linear protection, there is one protection entity and one or more working entities. The protection entity is always numbered "0". In 1+1 protection, the working entity is numbered "1". In 1:n ODUk protection, the working entities may be assigned numbers from 1-254.

3.2.27 escalation: A network survivability action caused by the impossibility of the survivability function in lower layers.

3.2.28 exercise signal #i (EX): Issues an exercise request for that signal (null signal, normal traffic signal, extra traffic signal) and checks responses on APS messages, unless the protection transport entity is in use. The switch is not actually completed, i.e., the selector is released by an exercise request. The exercise functionality is optional.

3.2.29 extra traffic signal: Traffic signal that is carried over the protection transport entity and/or bandwidth when that transport entity/bandwidth is not being used for the protection of a normal traffic signal; i.e., when the protection transport entity is on standby. Whenever the protection transport entity/bandwidth is required to protect or restore the normal traffic on the working transport entity, the extra traffic is pre-empted. Extra traffic is not protected.

3.2.30 forced switch for extra traffic signal (FS #ExtraTrafficSignalNumber): A switch action initiated by an operator command. It switches the extra traffic signal to the protection transport entity, unless an equal or higher priority switch command is in effect. A normal traffic signal present on the protection transport entity is transferred to and selected from its working transport entity.

For the case where an APS signal is in use, an SF on the protection transport entity (over which the APS signal is routed) has priority over the forced switch.

3.2.31 forced switch for normal traffic signal #i (FS #i): A switch action initiated by an operator command. It switches the normal traffic signal #i to the protection transport entity, unless an equal or higher priority switch command is in effect.

For the case where an APS signal is in use, an SF on the protection transport entity (over which the APS signal is routed) has priority over the forced switch.

3.2.32 forced switch for null signal (FS #0): A switch action initiated by an operator command. For 1:n architectures, it switches the null signal to the protection transport entity, unless an equal or higher priority switch command is in effect. A normal traffic signal present on the protection transport entity is transferred to and selected from its working transport entity. For 1+1 architectures, it selects the normal traffic signal from the working transport entity.

For the case where an APS signal is in use, an SF on the protection transport entity (over which the APS signal is routed) has priority over the forced switch.

3.2.33 freeze: A temporarily configured action initiated by an operator command. It prevents any switch action to be taken and as such freezes the current state. Until the freeze is cleared, additional near-end external commands are rejected. Fault condition changes and received APS messages are ignored. When the freeze command is cleared (**clear freeze**), the state of the protection group is recomputed based on the fault conditions and received APS message.

3.2.34 full pass-through: The action of transmitting the same APS-bytes, and protection channels that are being received. Full pass-through may be either unidirectional or bidirectional as specified in the text. When a node enters unidirectional full pass-through, it shall continue sourcing the previously sourced APS-bytes in the opposite direction, with the exception that status information APS Byte 1 bits 6-8 shall reflect the appropriate status code.

3.2.35 group: Two or more transport entities, which are treated as a single entity for protection switching. Typically, those transport entities are routed over the same links within the protected domain.

3.2.36 GMP normal mode: The GMP normal mode is a mode of the GMP process that limits the change of Cn value in a narrow range which is decided by the ODUflex(GFP) bit rate, ODTUk.ts bit rate and their tolerances. Cn value changes outside this range will be treated as errors and would cause alarm.

3.2.37 GMP special mode: The GMP special mode is a mode of the GMP process that permits the value of Cn to change continuously but gradually and does not produce errors during ODUflex(GFP) bandwidth increase or decrease. The change of Cn value is controlled during resizing to prevent buffer overflow/underflow.

3.2.38 head-end: The head-end of the linear protection group is the end where the bridge process is located. In the case where traffic is protected in both directions of transmission, the head-end process is present at both ends of the protection group.

3.2.39 hitless activation/deactivation of a connection monitor: Applies to TC-CMEPs. It means that a CM between two TC-CMEPs can be established/released without impacting on payload data, or any unrelated OH information. Therefore, unrelated management functions are also not impacted. More specifically, previously established CMs will not reflect transient error conditions or statistics as a direct result of the activation/deactivation of the new/old CM.

3.2.40 hitless protection switch: Protection switch, which does not cause characteristic or adapted information loss, duplication, disorder, or bit errors upon protection switching action.

3.2.41 hold-off time: The time between the declaration of an SF or SD condition and the initialization of the protection switching algorithm.

3.2.42 hypothetical reference optical path: A hypothetical reference optical path (HROP) is defined as the whole means of digital transmission of an ODUk digital signal (which is a digital signal of a specified rate given in [ITU-T G.709]), including the path overhead, between equipment at which the signal originates and terminates. An end-to-end hypothetical reference path spans a distance of 27 500 km.

3.2.43 impairment: Fault or performance degradation, which may lead to SF or SD trigger.

3.2.44 intermediate node: A node on either the working transport entity physical route or the protection transport entity physical route in-between the source and sink nodes of the corresponding protected domain.

3.2.45 intra-domain interface (IaDI): A physical interface within an administrative domain.

3.2.46 inter-domain interface (IrDI): A physical interface that represents the boundary between two administrative domains.

3.2.47 link capacity adjustment scheme (LCAS): LCAS in the virtual concatenation source and sink adaptation functions provides a control mechanism to hitlessly increase or decrease the capacity of a link to meet the bandwidth needs of the application. It also provides a means of removing member links that have experienced failure. The LCAS assumes that in cases of capacity initiation, increases or decreases, the construction or destruction of the end-to-end path is the responsibility of the network and element management systems.

3.2.48 local craft terminal: Used for maintenance purposes at the NE.

3.2.49 lockout of normal traffic signal #i: A temporary configuration action initiated by an operator command. It ensures that the normal traffic signal #i is temporarily not allowed to be routed via its protection transport entity. Commands for normal traffic signal #i will be rejected. SF or SD will be ignored for normal traffic signal #i.

3.2.50 lockout of protection transport entity #i (LO #i): A temporary configuration action initiated by an operator command. It ensures that the protection transport entity #i is temporarily not available to transport a traffic signal (either normal or extra traffic).

3.2.51 maintenance indication: The set of processes for indicating defects in a connection which is part of a trail in downstream and upstream directions.

3.2.52 management communications: The set of processes providing communications for management purposes.

3.2.53 manual switch for extra traffic signal (MS #ExtraTrafficSignalNumber): A switch action initiated by an operator command. It switches the extra traffic signal to the protection transport entity, unless a fault condition exists on other transport entities or an equal or higher priority switch command is in effect. A normal traffic signal present on the protection transport entity is transferred to and selected from its working transport entity.

3.2.54 manual switch for normal traffic signal #i (MS #i): A switch action initiated by an operator command. It switches normal traffic signal #i to the protection transport entity, unless a fault condition exists on other transport entities (including the protection transport entity) or an equal or higher priority switch command is in effect.

3.2.55 manual switch for null signal (MS #0): A switch action initiated by an operator command. For 1:n architectures, it switches the null signal to the protection transport entity, unless a fault condition exists on other transport entities or an equal or higher priority switch command is in effect. A normal traffic signal present on the protection transport entity is transferred to and selected from its working transport entity. For 1+1 architectures, it selects the normal traffic signal from the working transport entity.

3.2.56 m:n (protection) architecture: An m:n protection architecture has n normal traffic signals, n working transport entities and m protection transport entities. It may have up to m extra traffic signals.

At the source end, a normal traffic signal is either permanently connected to its working transport entity and may be connected to one of the protection transport entities (in the case of a broadcast bridge), or is connected to either its working or one of the protection transport entities (in the case of a selector bridge). At the sink end, the normal traffic signal is selected from either its working or one of the protection transport entities.

Up to m unprotected extra traffic signals can be transported via the m protection transport entities whenever the protection transport entities are not used to carry a normal traffic signal.

3.2.57 network survivability: The set of capabilities that allow a network to restore affected traffic in the event of an impairment. The degree of survivability is determined by the network's capability to survive single impairments, multiple impairments, and equipment impairments.

3.2.58 no request (NR): All normal traffic signals are selected from their corresponding working transport entities. The protection transport entity carries either the null signal, extra traffic, or a bridge of the single normal traffic signal in a 1+1 protection group.

3.2.59 non-associated overhead (naOH): Supervisory information transported in an OOS.

3.2.60 non-revertive (protection) operation: A protection switching operation, where the transport and selection of the normal traffic signal does not return to the working transport entity if the switch requests are terminated.

3.2.61 normal traffic signal: Traffic signal that is protected by two alternative transport entities, called working and protection transport entities.

3.2.62 null signal: The null signal can be any kind of signal that conforms to the signal structure (characteristic or adapted information) of the reference point in the specific layer. By default, it is the signal inserted by a connection function on an output, which is not connected to one of its inputs.

The null signal is ignored (not selected) at the sink end of the protection.

The null signal is indicated in the APS protocol if the protection transport entity is not used to carry the normal or extra traffic signal.

Examples of null signals are: unequipped VC-n (SDH), ODUk-OCI (OTN), no signal (ATM, MPLS), a test signal, one of the normal traffic signals, an AIS/FDI signal.

3.2.63 optical carrier group of order n (OCG-n[r]): n optical channel carriers occupying fixed, defined positions in an OTM payload are termed an optical carrier group (OCG[r]). Two OCG structures are defined: **OCG with full functionality (OCG-n)** and **OCG with reduced functionality (OCG-nr)**.

3.2.63.1 OCG with full functionality (OCG-n): The OCG-n consists of up to n OCC payload (OCCp) and OCC overhead (OCCo).

3.2.63.2 OCG with reduced functionality (OCG-nr): The OCG-nr consists of up to n OCC payload (OCCp). Non-associated overhead is not supported.

3.2.64 optical channel (OCh[r]): The OCh is the information structure used to support the OCh trail. Two OCh structures are defined: **optical channel with full functionality (OCh)** and **optical channel with reduced functionality (OChr)**.

3.2.64.1 optical channel with full functionality (OCh): The OCh is an information structure consisting of the information payload (OCh_PLD) with a certain bandwidth and non-associated overhead (OCh_OH) for management of the optical channel.

3.2.64.2 optical channel with reduced functionality (OChr): The OChr is an information structure consisting of the information payload (OCh_PLD) with a certain bandwidth. Non-associated overhead is not supported.

3.2.65 optical channel carrier (OCC[r]): The optical channel carrier represents a tributary slot within the OTM-n. Two OCC structures are defined: **OCC with full functionality (OCC)** and **OCC with reduced functionality (OCCr)**.

3.2.65.1 OCC with full functionality (OCC): The OCC consists of the OCC payload (OCCp) and OCC overhead (OCCo). The OCCp carries the OCh_CI_PLD and is assigned to a wavelength/frequency slot of the WDM group. The OCCo carries the OCh_CI_OH and is transported within the OOS information structure.

3.2.65.2 OCC with reduced functionality (OCCr): The OCC consists of the OCC payload (OCCp). The OCCp carries the OCh_CI_PLD and is assigned to a wavelength/frequency slot of the WDM group. Non-associated overhead is not supported.

NOTE – Further characterization of the OCC may be required to differentiate one OCC tributary slot (e.g., one able to carry an OTU1) from another OCC tributary slot (e.g., one able to carry an OTU3). This is for further study.

3.2.66 optical channel data unit (ODUk): The ODUk is an information structure consisting of the information payload (OPUk) and ODUk-related overhead. ODUk capacities for k = 0, k = 1, k = 2, k = 2e, k = 3, k = 4 are defined.

3.2.67 optical channel data unit-k path (ODUk path) (ODUkP):

1) (as used in [ITU-T G.709]): The optical channel data unit-k path (ODUkP) is the information structure used to support the end-to-end ODUk trail.

2) (as used in [ITU-T G.8201]): An ODUk path is a trail carrying an OPUk payload and associated OPUk and ODUk overhead through the layered optical transport network between the ODUk path terminating equipment. An ODUk path may be bidirectional or unidirectional and may comprise both customer owned portions and network operator owned portions.

3.2.68 optical channel data unit-k, tandem connection sublayer (ODUk TCM) (ODUkT): The optical channel data unit-k TCM (ODUkT) is the information structure used to support the TCM trails. Up to 6 TCM sublayers are supported.

3.2.69 optical channel payload unit (OPUk): The OPUk is the information structure used to adapt client information for transport over an optical channel. It comprises client information together with any overhead needed to perform rate adaptation between the client signal rate and the OPUk payload rate, and other OPUk overheads supporting the client signal transport. This overhead is adaptation-specific. OPUk capacities for k = 0, k = 1, k = 2, k = 2e, k = 3, k = 4 are defined.

3.2.69.1 OPUk multiframe: A number of consecutive frames accordant with the number of tributary slots for each OPUk. That means 8 frames for OPU2, 32 frames for OPU3, and 80 frames for OPU4.

3.2.70 optical channel transport unit (OTUk[V]): The OTUk is the information structure used for transport of an ODUk over one or more optical channel connections. It consists of the optical channel data unit and OTUk-related overhead (FEC and overhead for management of an optical channel connection). It is characterized by its frame structure, bit rate, and bandwidth. OTUk capacities for k = 1, k = 2, k = 3, k = 4 are defined.

Two versions of the OTUk are defined: **completely standardized OTUk (OTUk)** and **functionally standardized OTUk (OTUkV)**.

3.2.70.1 completely standardized OTUk (OTUk): The completely standardized OTUk is used on OTM IrDIs and may be used on OTM IaDIs.

3.2.70.2 functionally standardized OTUk (OTUkV): The partly standardized OTUk is used on OTM IaDIs.

3.2.71 optical multiplex unit (OMU-n, n ≥ 1): The OMU-n is the information structure used to support optical multiplex section (OMS) layer connections in the OTN. The characteristic information of the optical multiplex section layer (OMS_CI) consists of information payload (OMS_CI_PLD) and optical multiplex section overhead information fields (OMS_CI_OH). The OMS_CI_PLD consists of the OCG-n payload. The OMS_CI_OH consists of the OCG-n overhead and OMS specific overhead and is transported within the OOS information structure. The order of the OMU is defined by the order of the OCG that it supports.

3.2.72 OTN network element (O.NE): That part of a network element that contains entities from one or more OTN layer networks. An O.NE may therefore be a standalone physical entity or a subset of a network element. It supports at least network element functions and may also support an operations system function and/or a mediation function. It contains managed objects, a message communications function and a management application function. The functions of an O.NE may be contained within an NE that also supports other layer networks. These layer network entities are considered to be managed separately from OTN entities. As such, they are not part of the O.MSN or O.MN.

3.2.73 optical overhead signal (OOS): See **OTM overhead signal (OOS)**.

3.2.74 optical physical section: See **optical physical section of order n (OPSn)**.

3.2.75 optical physical section of order n (OPSn): A layer network that provides functionality for transmission of a multi-wavelength optical signal on optical media of various types (e.g., ITU-T G.652, ITU-T G.653 and ITU-T G.655 fibre). Note that a "multi-wavelength" signal includes the case of just one optical channel.

It combines the transport functionality of the OMS and OTS layer networks without their supervisory information. OPSn capacities for n = 0 and n = 16 are defined.

3.2.76 optical supervisory channel (OSC): The optical supervisory channel is an optical carrier that transfers overhead information between optical transmission section transport entities. The optical supervisory channel supports more than one type of overhead information and some of this overhead information may be used by one or more transport network layers.

3.2.77 optical transport hierarchy (OTH): The OTH is a hierarchical set of digital transport structures, standardized for the transport of suitably adapted payloads over optical transmission networks.

3.2.78 optical transport module (OTM-n[r].m): The OTM is the information structure that is transported across an ONNI. The indexes n and m define the number of supported wavelengths and bit rates at the interface as defined below. Two OTM structures are defined: **OTM with full functionality (OTM-n.m)**, and **OTM with reduced functionality (OTM-0.m, OTM-nr.m)**.

3.2.78.1 OTM with full functionality (OTM-n.m): The OTM-n.m consists of up to n multiplexed optical channels and an OTM overhead signal to support the non-associated overhead.

It is the information structure used to support optical transmission section (OTS) layer connections in the OTN. The characteristic information of the optical transmission section layer (OTS_CI) consists of information payload (OTS_CI_PLD) and optical transmission section overhead information fields (OTS_CI_OH). The optical transmission section overhead (OTS_OH) information fields are contained within the OTM overhead signal (OOS) information structure. The order of an OTM-n is defined by the order of the OMU-n that it supports.

3.2.78.2 OTM with reduced functionality (OTM-0.m, OTM-nr.m): The OTM-0.m consists of a single optical channel without a specific colour assigned. The OTM-nr.m consists of up to n multiplexed optical channels. A non-associated overhead is not supported.

The OTM-nr.m/OTM-0.m is the information structure used to support optical physical section (OPS) layer connections in the OTN. The characteristic information of the optical physical section layer (OPS_CI) consists of information payload (OPS_CI_PLD). A non-associated overhead is not supported. The order of an OTM-nr is defined by the order of the OCG-nr that it supports.

3.2.79 optical transport network: An optical transport network (OTN) is composed of a set of optical network elements connected by optical fibre links, able to provide functionality of transport, multiplexing, routing, management, supervision and survivability of optical channels carrying client signals, according to the requirements given in [ITU-T G.872].

3.2.80 optical transport network node interface (ONNI): The interface at an optical transport network node which is used to interconnect with another optical transport network node.

3.2.81 optical transport unit-k (OTUk): See **optical channel transport unit (OTUk[V])**.

3.2.82 OTH multiplexing: A procedure by which optical channels are multiplexed.

3.2.83 OTM overhead signal (OOS): The OOS is the information structure used for the transport of an OTM non-associated overhead over the optical supervisory channel. The non-associated overhead consists of the optical transmission section overhead, optical multiplex section overhead and optical channel non-associated overhead. It is characterized by its frame structure, bit rate and bandwidth.

3.2.84 OTN compliant interface: An interface for the optical transport network based on the architecture defined in [ITU-T G.872].

3.2.85 OTN management network (O.MN): An OTN management network is a subset of a TMN that is responsible for managing those parts of a network element that contain OTN layer network entities. An O.MN may be subdivided into a set of OTN management subnetworks.

3.2.86 OTN management subnetwork (O.MSN): An OTN management subnetwork consists of a set of separate OTN ECCs and associated intra-site data communication links which have been interconnected to form a data communications network (DCN) within any given OTN transport topology.

3.2.87 OTN non-compliant interface: An interface that does not comply with the interface Recommendations that will be defined for the optical transport network based on the architecture defined in [ITU-T G.872].

3.2.88 outgoing signal fail (OSF): A signal fail indication output at the AP of a tandem connection termination function.

3.2.89 overhead access (OHA): The OHA function provides access to transmission overhead functions.

3.2.90 overhead information: Six types of overhead information are defined:

3.2.90.1 client-specific overhead information: Associated with a particular client/server relationship and is therefore processed by a particular adaptation function.

3.2.90.2 auxiliary channel overhead information: Information that may be transferred by an optical network layer but which does not by necessity have to be associated with a particular connection. An example of such an auxiliary channel is a data communications channel for the purposes of transferring management data between management entities.

NOTE – These management entities are not trail termination and adaptation functions.

3.2.90.3 reserved overhead information: This overhead is currently undefined. See [ITU-T G.872].

3.2.90.4 trail termination overhead information: The information generated by the trail termination source and extracted by the trail termination sink to monitor the trail. This overhead information is specific to a layer network and is independent of any client/server relationship between network layers.

3.2.90.5 unassigned overhead information: This overhead may be of types 1, 2, 3 or 4 as defined above.

3.2.90.6 network operator-specific overhead information: May be used by an operator to support its unique optical networking needs and/or for service differentiation. The information content is not standardized.

3.2.91 protected domain: The protected domain defines one or more transport entities (trails, subnetwork connections), for which a survivability mechanism is provided in the event of impairment affecting that or those transport entities. It begins from the selector/bridge of one endpoint to the selector/bridge of the other endpoint.

3.2.92 protection: The use of pre-assigned capacity between nodes. The simplest architecture has one dedicated protection entity for each working entity (1+1). The most complex architecture has m protection entities shared amongst n working entities (m:n).

3.2.93 protection class: trail protection: Transport entity protection for the case where the transport entity is a trail. The trail is protected by adding bridges and selectors at both ends of the trail, and an additional trail between these bridges and selectors.

The determination of a fault condition on a trail within the protected domain is performed by means of trail monitoring.

3.2.94 protection class: network connection protection: Special case of subnetwork connection protection.

3.2.95 protection class: individual: Protection is performed for a single transport entity.

3.2.96 protection class: group: Protection is performed for a set of transport entities.

3.2.97 protection communication channel: A control channel for exchanging configuration information between head-end and tail-end about a protection group.

3.2.98 protection control: The information and set of processes for providing control of protection switching for a trail or subnetwork connection.

3.2.99 protection group: The collection of head-end and tail-end functions, 1 to n normal traffic signals, optionally an extra traffic signal, 1 to n working transport entities, and a single protection entity that are used to provide extra reliability for the transport of normal traffic signals.

3.2.100 protection ratio: The quotient of the actually protected bandwidth divided by the traffic bandwidth, which is intended to be protected.

3.2.101 protection transport entity: The transport entity allocated to transport the normal traffic signal during a switch event. The protection transport entity may be used to carry extra traffic in the absence of a switch event. When there is a switch event, normal traffic on the affected working transport entity is bridged onto the protection transport entity, pre-empting the extra traffic (if present).

3.2.102 resize multiframe (RMF): A number of consecutive frames accordant with the lowest common multiple (LCM) of 256 and the number of tributary slots for each OPUk. That means 256 frames for ODU2/3 and 1280 frames for ODU4.

3.2.103 restoration: The use of any capacity available between nodes for protection. In general, the algorithms used for restoration will involve re-routing. When restoration is used, a percentage of the transport network capacity will be reserved for the re-routing of normal traffic.

3.2.104 revertive (protection) operation: A protection switching operation, where the transport and selection of the normal traffic signal (service) always returns to (or remains on) the working transport entity if the switch requests are terminated; i.e., when the working transport entity has recovered from the defect or the external request is cleared.

3.2.105 selector: The function that extracts the normal traffic signal either from the working or the protection transport entity. The extra traffic signal is either extracted from the protection transport entity, or is not extracted; in the latter case, an AIS signal will be output.

3.2.105.1 merging selector: For 1:1 and $(1:1)^n$ architectures, a selector which connects permanently the normal traffic signal output with both the working and protection transport entity inputs.

3.2.105.2 selective selector: A selector, which connects the normal traffic signal output with either the working or protection transport entity inputs.

NOTE 1 – This alternative works only in combination with a selector bridge. To prevent that AIS/FDI or misconnected/mis-merged traffic on the standby transport entity is merged with the normal traffic signal selected from the active transport entity, the merging selector includes switches in both working and protection inputs. The active transport entity will have its switch closed, while the standby transport entity will have its switch opened. Consequently, a merging selector is like a distributed selective selector.

NOTE 2 – In ATM, connections can be assigned but cells do not necessarily flow over them. A selector bridge sends cells over either the working or the protection path and therefore there will only be one copy arriving at the selector. Hence, the connection table can have two permanent matrix connections "INx1:OUTy" and "INx2:OUTy". This also applies to other packet switching technologies.

3.2.106 severely errored second (SES): A one-second period which contains ≥15% errored blocks or at least one defect (see Notes 1, 2 and 3).

NOTE 1 – The defects and related performance criteria are listed in [ITU-T G.8201].

NOTE 2 – To simplify measurement processes, the defect is used in the definition of SES instead of defining SES directly in terms of severe errors affecting the path. While this approach simplifies the measurement of SES, it should be noted that there may exist error patterns of severe intensity that would not trigger a defect as defined in [ITU-T G.8201]. Thus, these would not be considered as an SES under this definition. If in the future such severe user-affecting events are found, this definition will have to be studied again.

NOTE 3 – The percentage of errored blocks may be different for technologies other than OTN.

3.2.107 signal: The signals are actual payloads carried across the protection group. This includes normal traffic signal(s), optionally an extra traffic signal, and the null signal.

3.2.108 signal degrade group (SDG): A signal indicating the associated group data has degraded.

3.2.109 signal fail group (SFG): A signal indicating the associated group has failed.

3.2.110 signal quality supervision: The set of processes for monitoring the performance of a connection that is supporting a trail.

3.2.111 sink node: The node at the egress of a protected domain, where a normal traffic signal may be selected from either the working transport entity or the protection transport entity.

3.2.112 source node: The node at the ingress to a protected domain, where a normal traffic signal may be bridged to the protection transport entity.

3.2.113 SRP-1: Shared ring protection supporting 1 ODU per Lambda: This shared protection architecture is based on ODUk connectivity not further sub-structured in respect to the protection switching. The ODUk may be member of a wavelength group for link group protection.

3.2.114 SRP-p: Shared ring protection supporting p ODU per Lambda: This shared protection architecture is based on ODUj entities multiplexed into a HO ODUk. The ODUj may be member of a group for link group protection.

3.2.115 standby transport entity: The transport entity from which the protection selector does not select the normal traffic signal.

3.2.116 steering: A protection method in which a source node redirects a traffic to the ring section into the direction retaining connectivity to a destination node.

3.2.117 sublayer overhead/OAM (s): Overhead/OAM associated with a sublayer's trail (tandem connection, segment). Examples: SDH VC-n TC overhead, ATM VCC segment OAM.

3.2.118 subnetwork connection protection: Transport entity protection for the case where the transport entity is a subnetwork connection. The serial compound link connection within the subnetwork connection is protected by adding bridges and selectors in the connection functions at the edges of the protected domain and an additional serial compound link connection between these connection functions.

The determination of a fault condition on a serial compound link connection within the protected domain can be performed as follows:

– sublayer monitored (/S): Each serial compound link connection is extended with tandem connection monitoring or segment termination/adaptation functions to derive the fault condition status independent of the traffic signal present.
– non-intrusive monitored (/N): Each serial compound link connection is extended with a non-intrusive monitoring termination sink function to derive the fault condition status from the traffic signal that is present.
– inherent monitored (/I): The fault condition status of each link connection is derived from the status of the underlying server layer trail.

  NOTE – This inherent monitoring is also applicable for SDH VC-n serial compound link connections.
– test monitored (/T): Each serial compound link connection's fault condition status is derived from an additional monitored serial compound link connection transported via the same serial compound link.

3.2.119 subnetwork connection supervision: The set of processes providing connectivity supervision and/or continuity supervision and/or signal quality supervision for a subnetwork connection that is supporting a trail.

3.2.120 subnetwork interworking: A network topology where two subnetworks (e.g., rings) are interconnected at two points and operate such that failure at either of these two points will not cause loss of any traffic, except possibly that dropped or inserted at the point of failure.

3.2.121 switch:

1) (*For the selector*) The action of selecting normal traffic from the (current) standby transport entity rather than the (current) active transport entity.
2) (*For the bridge – in the case of permanent connection to working*) The action of connecting or disconnecting the normal traffic to the protection transport entity.
3) (*For the case of non-permanent connection to working*) The action of connecting the normal traffic signal to the (current) standby transport entity.

3.2.122 switch event: A switch event exists if either a fault condition on a working transport entity or an external command exists, and the protection algorithm has concluded that this fault condition or external command is the highest priority event.

3.2.123 switching time: Time between the initialization of the protection switching algorithm and the moment the traffic is selected from the standby transport entity.

NOTE – This definition for "switching time" is different in context to the definition found in [b-ITU-T G.671].

3.2.124 tail-end: The tail-end of the linear protection group is the end where the selector process is located. In the case where traffic is protected in both directions of transmission, the tail-end process is present at both ends of the protection group.

3.2.125 TCM control function (TCMC): A TCM control function is responsible for the activation/deactivation of a TCM trail.

3.2.126 TCM control information (TCMCI): The TCMCI is the information that passes over a TCMCP for activation/deactivation of a TCM trail.

3.2.127 TCM control point (TCMCP): A reference point where the output of an atomic function is bound to the input of the TCM control function, or where the output of the TCM control function is bound to the input of an atomic function.

3.2.128 traffic signal: Characteristic or adapted information.

3.2.129 transport entity: An architectural component, which transfers information between its inputs and outputs within a layer network. Examples are: trail, network connection, subnetwork connection, link connection.

3.2.130 transport entity protection: A method that allows transporting a traffic signal via more than one pre-assigned transport entity. The transport of a normal traffic signal via a working transport entity is replaced by the transport of this normal traffic signal via a protection transport entity if the working transport entity fails (SF condition), or if its performance falls below a required level (SD condition).

3.2.131 user-network interface (UNI): A bidirectional signalling interface between service requester and service provider control plane entities.

3.2.132 wait-to-restore normal traffic signal #i (WtR): In revertive operation, after the clearing of an SF or SD on working transport entity #i, maintains normal traffic signal #i as selected from the protection transport entity until a wait-to-restore timer expires. If the timer expires prior to any other event or command, the state will be changed to NR. This is used to prevent frequent operation of the selector in the case of intermittent failures. The wait-to-restore state will only be entered if there is no SF or SD condition for the protection transport entity.

3.2.133 wait-to-restore time: A period of time that must elapse before a transport entity that has recovered from an SF or SD condition can be used again to transport the normal traffic signal and/or to select the normal traffic signal from.

3.2.134 working transport entity: The transport entity over which the normal traffic signal is transported.

3.2.135 wrapping: The transmission of the traffic into the opposing direction in the ring, in order to route around a fault in a given ring segment.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Access function
AIS	Alarm Indication Signal
APS	Automatic Protection Switch(ing)
ATM	Asynchronous Transfer Mode
CBR	Constant Bit Rate (signal)
CM	Connection Monitor(ing)
DNR	Do Not Revert
ECC	Embedded Control Channel
FDI	Forward Defect Indication (indicator)
FEC	Forward Error Correction
FS	Forced Switch
IaDI	Intra-Domain Interface
IrDI	Inter-Domain Interface
LCAS	Link Capacity Adjustment Scheme
LO	Lockout for protection
MPLS	Multi-Protocol Label Switching

MS	Manual Switch
NE	Network Element
NR	No Request
O.MN	OTN Management Network
O.MSN	OTN Management Subnetwork
O.NE	OTN Network Element
OAM	Operations, Administration and Maintenance
OCC	Optical Channel Carrier
OCG	Optical Channel Group
OCh	Optical Channel
OChr	Optical Channel with reduced functionality
ODUk	Optical Data Unit of level k
ODUkP	Optical Data Unit of level k, Path
ODUkT	Optical Data Unit of level k, Tandem connection sublayer
OH	Overhead
OMS	Optical Multiplex Section
OOS	Optical transport multiplex Overhead Signal
OPS	Optical Physical Section
OPSn	Optical Physical Section of level n
OPUk	Optical channel Payload Unit of level k
OS	Optical Section
OSC	Optical Supervisory Channel
OSF	Outgoing Signal Fail
OTM	Optical Transport Module
OTN	Optical Transport Network
OTS	Optical Transmission Section
OTU	Optical channel Transport Unit
OTUk	Optical channel Transport Unit of level k
OTUkV	Optical channel Transport Unit of level k, functionally standardized
PLD	Payload
PM	optical transport network Path Monitoring byte
ppm	parts per million
SD	Signal Degrade
SDG	Signal Degrade Group
SDH	Synchronous Digital Hierarchy
SES	Severely Errored Second
SF	Signal Fail

SFG	Signal Fail Group
STM-N	Synchronous Transport Module, level N
TC	Tandem Connection
TCM	Tandem Connection Monitoring
TCMC	Tandem Connection Monitoring Control function
TCMCI	Tandem Connection Monitoring Control Information
TCMCP	Tandem Connection Monitoring Control Point
TMN	Telecommunication(s) Management Network
Tx	Transmit
UNI	User (to) Network Interface
VC-n	Virtual Container, level n
VP	Virtual Path (ATM)
WDM	Wavelength Division Multiplexing
WTR	Wait to Restore

5 Conventions

The following conventions are used in this Recommendation. These conventions may not be applicable to all OTN Recommendations.

5.1 **A**: End-point designation used when describing a protected domain; A is the source end of protected signals for which switch request signalling is initiated from the other, Z, end.

5.2 **head-end**: In some OTN Recommendations, the term "head-end" appears without a hyphen. The term is shown in this Recommendation with a hyphen to align with the historical use of the term from SDH.

5.3 **k**: The index "k" is used to represent a supported bit rate and the different versions of OPUk, ODUk and OTUk. Example for k are "1" for an approximate bit rate of 2.5 Gbit/s, "2" for an approximate bit rate of 10 Gbit/s, and "3" for an approximate bit rate of 40 Gbit/s.

5.4 **m**: The index "m" is used to represent the bit rate or set of bit rates supported on the interface. This is one or more digits "k", where each "k" represents a particular bit rate. For example, valid values for m are (1, 2, 3, 12, 123, 23).

5.5 **n**: The index "n" is used to represent the order of the OTM, OTS, OMS, OPS, OCG, OMU. n represents the maximum number of wavelengths that can be supported at the lowest bit rate supported on the wavelength. It is possible that a reduced number of higher bit rate wavelengths are supported. n = 0 represents the case of a single channel without a specific colour assigned to the channel.

5.6 **r**: The index "r", if present, is used to indicate a reduced functionality OTM, OCG, OCC and OCh (non-associated overhead is not supported). Note that for n = 0 the index r is not required as it implies always reduced functionality.

5.7 **tail-end**: In some OTN Recommendations, the term "tail-end" appears without a hyphen. The term is shown in this Recommendation with a hyphen to align with the historical use of the term from SDH.

5.8 **x**: gives the approximate bit rate for a CBR signal. It is used in the form "unit value, unit, [fractional unit value]". The currently defined unit value is "G" for Gbit/s. Examples for x are "40G" for 40 Gbit/s and "2G5" for 2.5 Gbit/s.

5.9 **Z**: End-point designation used when describing a protected domain; Z is the end at which switch request signalling is initiated.

Appendix I

List of source Recommendations

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

The abbreviations and terms were taken from the ITU-T Recommendations listed below. Where the definitions were not a part of an explicit definitions clause of the source Recommendation, the source Recommendation is referenced in a note following the definition. Following this Recommendation's approval, corrigenda or revisions to the original sources of these terms will be proposed to replace the definitions in those Recommendations by reference to this Recommendation (except where the definition is part of the source Recommendation text and not in a definitions clause). The end result should be a single normative definition for each term in this subject area, contained in this Recommendation.

Recommendation	Latest version
ITU-T G.709/Y.1331	12/2009 with Amd.1
ITU-T G.783	03/2006
ITU-T G.798	10/2010
ITU-T G.798.1	04/2011
ITU-T G.808.1	02/2010
ITU-T G.871/Y.1301	10/2000
ITU-T G.872	11/2001
ITU-T G.873.2	04/2012
ITU-T G.874	07/2010
ITU-T G.874.1	01/2002
ITU-T G.959.1	02/2012
ITU-T G.7042/Y.1305	03/2006
ITU-T G.7044/Y.1347	10/2011
ITU-T G.7710/Y.1701	02/2012
ITU-T G.7714.1/Y.1705.1	09/2010

Bibliography

[b-ITU-T G.652] Recommendation ITU-T G.652 (2005), *Characteristics of a single-mode optical fibre and cable*.

[b-ITU-T G.653] Recommendation ITU-T G.653 (2006), *Characteristics of a dispersion-shifted single-mode optical fibre and cable*.

[b-ITU-T G.655] Recommendation ITU-T G.655 (2006), *Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable*.

[b-ITU-T G.671] Recommendation ITU-T G.671 (2005), *Transmission characteristics of optical components and subsystems*.

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

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