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

Digital networks – Network capabilities and functions

Management capabilities of transport networks based on the synchronous digital hierarchy (SDH)

ITU-T Recommendation G.831

(Formerly CCITT Recommendation)

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ITU-T Recommendation G.831

Management capabilities of transport networks based on the synchronous digital hierarchy (SDH)

Summary

This Recommendation describes the management requirements of the layered and partitioned SDH transmission networks defined in ITU-T G.803. These include the path management processes and the interfacing requirements for interworking across administrative domain boundaries both within a single network operator's network and between networks operated by different network operators. The technical details to implement these requirements will be found in other Recommendations.

History and source

Recommendation history	
Issue	**Notes**
03/2000	Second revision. The API definition in clause 3 is extended with a specification of the padding character for strings less than 15 characters. A new Appendix I covering a section/path trace has been added.
08/96	First revision
03/93	Initial version

ITU-T Recommendation G.831 was revised by ITU-T Study Group 13 (1997-2000) and approved under the WTSC Resolution 1 procedure on 10 March 2000.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. 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 Conference (WTSC), 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 WTSC 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.

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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, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation G.831

Management capabilities of transport networks based on the synchronous digital hierarchy (SDH)

1 Scope

It is of prime importance for the design and operation of SDH telecommunication networks in multi-vendor, multi-technology and multi-operator environments to develop commonality of processes and parameters for management standards including in-service performance management, operations and maintenance management.

1.1 Structure of Recommendation

Clause 2 identifies the management capabilities of SDH. Clause 3 gives the requirements of access point identifiers and recommends a format for the identifiers. Clause 4 contains information on SDH trail management functions.

1.2 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; all 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.

– ITU-T E.164 (1997), *The international public telecommunication numbering plan*.

– ITU-T G.707 (1996), *Network node interface for the synchronous digital hierarchy (SDH)*.

– ITU-T G.774 (1992), *Synchronous digital hierarchy (SDH) management information model for the network element view*.

– ITU-T G.784 (1999), *Synchronous digital hierarchy (SDH) management*.

– ITU-T G.803 (2000), *Architecture of transport networks based on the synchronous digital hierarchy (SDH)*.

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

– ITU-T T.50 (1992), *International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 or IA5) – Information technology – 7-bit coded character set for information interchange*.

– ISO 3166 (All Parts), *Codes for the representation of names of countries and their subdivisions*.

1.3 Abbreviations

This Recommendation uses the following abbreviations:

API Access Point Identifier

IRA International Reference Alphabet

ISDN Integrated Services Digital Network

SDH Synchronous Digital Hierarchy

TMN	Telecommunications Management Network
VC-n	Virtual Container-n
VC-n-xc	Virtual Container-n x times concatenated

2 Management capabilities

2.1 Categories of management capability

The SDH will enable a greater degree of automation in the management of transmission networks and of the fabric which supports them. Management capabilities fall broadly into three categories from the viewpoint of standards support. These are:

a) Those capabilities which must be standardized to allow automated interaction between the managed networks of different network operators.

b) Those capabilities which should be standardized to simplify operations within the domain of a single operator who must obtain equipment from different vendors.

c) Those capabilities which may be defined within a single management domain to optimize operations within that domain.

2.2 Management processes of SDH networks

This clause introduces specific management capabilities and processes for SDH transport networks:

i) The capability to set up a path between any client access points, across any domain and across any network operator boundaries. The client will generally be another network layer but may, in the case of a leased line, be an end user. The path may be:
   - a point-to-point Virtual Container-n (VC-n and VC-n-xc according to ITU-T G.707) path; or
   - a branch of a point-to-multipoint connection in the path layer network realized within, e.g. satellite subnetworks; or
   - a part of an asymmetrical connection in the path layer network.

   The path may be a full time connection or a part time connection. This capability will have to operate to financial and time-to-deliver constraints and also be intelligent enough to ensure that it does not disrupt temporary usages of subsections such as restoration connections or even testing activities. The need for a competitive supply arrangement is left for further study.

ii) The capability to set up a path will require access to:
   - remote activity monitoring features; and
   - inventory control facilities.

iii) The capability to maintain the paths to a level of performance as agreed in the contract for supply of the network service.

iv) The capability to continuously monitor and record the performance of the allocated paths:
   a) for acceptance testing; and
   b) while in service to validate compliance to commitment of the required performance level.

v) On a point-to-multipoint network, the capability to identify individual branches which are failing to meet their performance limits.

vi) Restoration actions must be activated, if a transgression of the performance limit is detected.

vii) The management system will require the capability to communicate securely with an external network operator or special domain management system to inform them that there is a problem.

viii) The capability will be provided for simple remote maintenance of the fabric of the network including the identification and location of faulty equipment within an operator domain and at operator domain boundaries.

ix) The capability will be provided to perform directly the simple remote maintenance action of individual network elements.

x) The capability to generate resource utilization information to provide input to the billing process both within a domain and between network operators. This information will also assist with the:
   - planning of routes; and
   - inventory control.

xi) The capability to support ancillary management functions as identified as being appropriate to SDH network management.

3 SDH access point identification

An essential requirement for successful management of SDH networks incorporating features such as point-to-point and point-to-multipoint paths is a unique means of identifying significant points in the network, e.g. access points. The features of Access Point Identifiers (APIs) are:

- each access point identifier must be globally unique in its layer network;
- where it may be expected that the access point may be required for path set-up across an inter-operator boundary, the access point identifier must be available to other network operators;
- the access point identifier should not change while the access point remains in existence;
- the access point identifier should be able to identify the country and network operator which is responsible for routing to and from the access point;
- the set of all access point identifiers belonging to a single administrative layer network should form a single access point identification scheme;
- the scheme of access point identifiers for each administrative layer network can be independent from the scheme in any other administrative layer network.

It is recommended that the VC-11, VC-12, VC-2, VC-2-xc, VC-3, VC-4 and VC-4-xc should each have the access point identification scheme bases on a tree-like format to aid routing control search algorithms. The access point identifier should be globally unambiguous.

The API shall begin with either the country code as defined in ITU-T E.164 (one, two or three numeric characters) or, the three alphabetic character country code as defined in ISO 3166.

The remainder of the API characters that follow the country code shall be a matter for the organization to whom the country code has been assigned, provided that uniqueness is guaranteed. These characters may be any alphanumeric characters as defined in ITU-T T.50 (International Reference Version – 7-bit coded character set for information interchange).

The alphanumeric character set consists of the characters "a" to "z", "A" to "Z", and "0" to "9".

In the case where the API uses less than fifteen characters, the API will be padded (extended) with the T.50 "NUL" character to get a fifteen byte character string.

For interworking with equipment developed prior to this version of the Recommendation that may use the T.50 space as a padding character, new equipment should be able to generate T.50 "SPACE" padding characters as an option.

A similar access and test point identification scheme is required for the section layer to support point-to-point and point-to-multipoint paths and wide area multiplexors as used in satellite subnetworks.

The byte allocations for the transmission of the access point identifier at the section layer, higher-order path layer and lower-order path layer are given in ITU-T G.707.

4 SDH trail management functions

4.1 Introduction

Within an SDH administrative layer network, the primary management functions are to set up, validate, and monitor trails and protect or restore them if necessary. These management functions may be implemented by different subnetworks (e.g. satellite subnetwork) or in network controlled by different operators. However, the following Recommendations ensure that these management functions work successfully in the inter-operator environment.

The principle described in ITU-T G.784 for integration and interworking of subnetwork management systems must be adopted by all management systems. This includes the integration of SDH systems into the generic Telecommunications Management Network (TMN).

In general, each administrative path layer network is intended to be global with the possibility of establishing a trail between any two-access points in that layer. Each administrative path layer requires a significant path set-up control system capable of working in the global, multi-operator context.

In general, each administrative section layer will not require the ability to connect any one access point to any other access point as the requirement on connectivity will be restricted by the availability of transmission media to the distant location.

4.2 Trail set-up

4.2.1 General path set-up control structure

Figure 1 illustrates the general control structure and information flows necessary for multi-operator path set-up. The control structure is characterized by processing functions and messaging between the processing functions. There are two basic types of messaging:

– messaging between levels of the control structure which pass information between a controlling process in the upper level and the controlled lower level;

– messaging within a level between the peer processing functions within a control level.

The control structure may be implemented in many ways and the structure shown in Figure 1 illustrates only essential information flows.

If the information flow crosses an external domain boundary, then a well-defined protocol must be used.

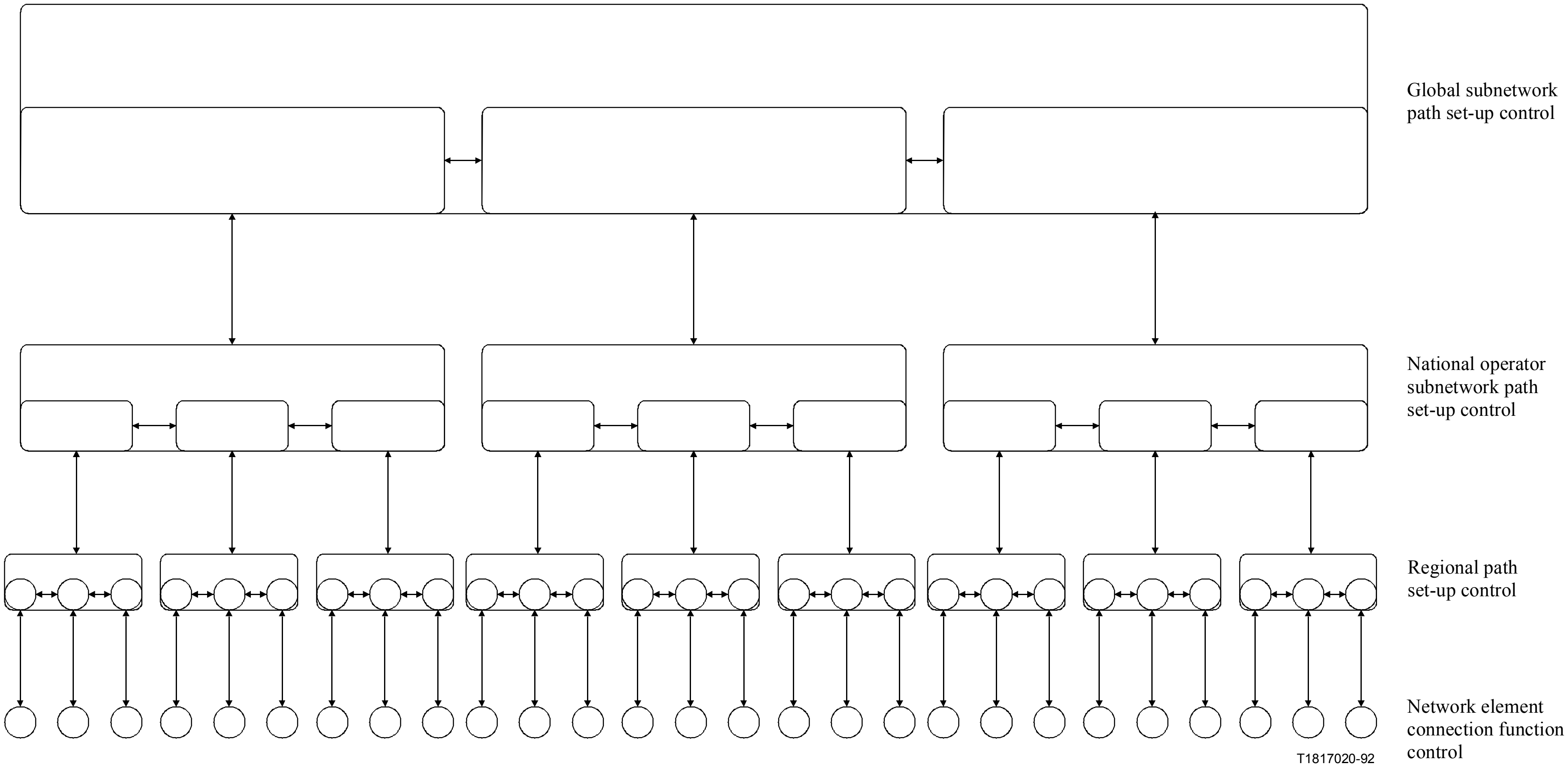

Figure 1/G.831 – Control structure for path set-up

4.2.1.1 Intra-operator path set-up

Within the network of a single operator, there is considerable freedom in the choice of system architecture for path set-up. Three basic types are described below:

a) *Centralized intra-operator path set-up* – This makes use of a single central processing facility in which all messaging is internal to the facility other than the final messages to the network elements. The messages to the network elements are described in ITU-T M.3010 and G.774. This is illustrated in Figure 2.

b) *Step-by-step routing intra-operator path set-up* – This makes use of step-by-step routing protocols common to many existing signalling systems. In this case the peer messaging may be standardized and could use the same protocol as used for the inter-operator messaging. The control messaging between the levels is internal to the processing facility. The processing facilities may be remote from the network elements in which case the messages described in ITU-T M.3010 and G.774 should be used. However, as the implementation is distributed, the processing facility could be incorporated in the network element in which case the messaging to the network element is internal. This is illustrated in Figure 2.

c) *Source routing intra-operator path set-up* – This makes use of a source routing protocol of the type described in ISO 8473. In this case the complete route across the subnetwork is decided at the first node and the message with the remote lower level control is external. The source routing cannot determine the route beyond the subnetwork and step-by-step routing must be used at this point. If the protocol used for inter-operator path set-up is capable of source routing, that protocol could be used. This messaging may be standardized and will have similar semantics to the messaging with the network elements. The messaging with the local lower level controller may be internal. If this controller resides inside a network element, the messaging with the network element will be internal. If the controller is remote from the network element, then the messaging described in ITU-T M.3010 and G.774 should be used. This is illustrated in Figure 2.

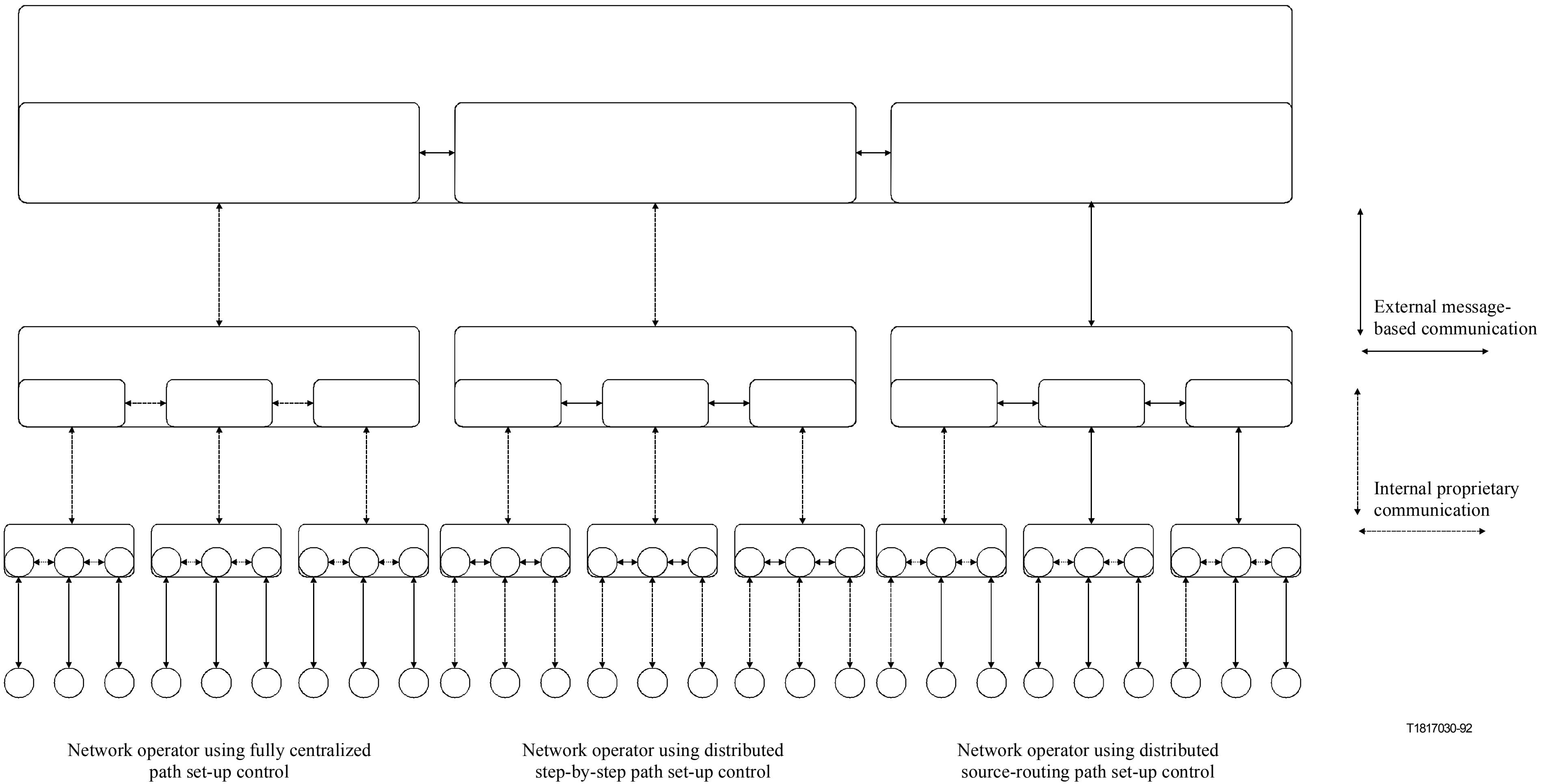

Figure 2/G.831 – Examples of specific path set-up control structures

4.2.1.2 Inter-operator path set-up

In general, each network operator will have its own management and control system which will interact on a peer basis with that of other operators. The protocol between these control systems must be standard for each administrative path layer to enable inter-operator path set-up. Two possibilities for this protocol are a step-by-step routing protocol of the type used by signalling systems or the source routing protocol of the type described in ISO 8473. Step-by-step routing is a special case of source routing.

4.2.2 Section set-up

Section set-up is likely to require human action on fibre distribution frames and/or digital distribution frames. The database required for this is not directly associated with the frame as the frame has no management interface. For this reason, there is no restriction on the location of any system controlling the section set-up.

4.3 SDH trail validation

Once the path or section has been set up, it should be validated that the correct access points have been connected. For every SDH administrative layer, the access point identifier should be sent in the in-band trail trace channel for validation by the far end. When the path or section is bidirectional, the validation should be done in both directions of transmission.

4.4 SDH trail monitoring

When the path or section has been set up and validated, it should be continuously monitored for integrity of transmission using the appropriate path overhead or section overhead and should be continuously compared to a threshold. If the performance falls below this threshold a defect is declared. In addition, the actual performance can be periodically reported to a management system. A tandem connection part of the path or section may be monitored as well as the end-to-end path or section by any one of the four methods described in ITU-T G.803.

4.5 SDH trail protection and restoration

If a defect is declared on a protected end-to-end path or section, then action may be taken to re-establish its integrity. This will involve either protection or restoration procedures. Recommended protection architectures are described in ITU-T G.803. Restoration schemes may operate by re-establishing the path by using the path set-up control system.

Care must be taken to avoid conflict between the various protection and restoration systems which may coexist within a managed network. For example, protection or restoration in a network layer may need to be delayed for a period if the server layers can provide rapid response protection or restoration. Similarly, end-to-end subnetwork connection or trail protection or restoration should not be attempted until any constituent connection protection or restoration actions have been completed.

APPENDIX I

Section/path identifier format

This appendix defines an option to the API defined in clause 3. All the network operators providing this feature may mutually agree to transmit a Section/Path Identifier in the relevant SDH overhead bytes as described in ITU-T G.707. An example of format of such an optional section/path identifier is given below.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Country code		Sending operator			Sending town/node			Receiving town/node			X°	M.1400 serial number		
F1		F2			F3			F4			F5	F6		

F1 Country code

This field contains the fixed length two alpha character country code as defined in ISO 3166 (A2).

F2 Sending operator

A three-character alphanumeric identifier for the sending operator.

F3 Sending town/node

A three-character alpha-numeric identifier for the sending town or node. Defined by the sending operator.

F4 Receiving town/node

A three-character alphanumeric identifier for the receiving town or node. Defined by the receiving operator.

F5 X°

An undefined alphanumeric character that the sending operator can use to guarantee uniqueness for any path identifier generated. When the use of this field is not necessary to guarantee uniqueness, an alphanumeric T.50 character should be used to pad this field within the path identifier.

F6 M.1400 serial number

A three-character numeric field, it numbers the path from the sending operator's node. The number is taken from the last three digits of the M.1400 designation for the path, padded to three digits with leading zeros where necessary.

The alpha and/or numeric characters used in all the above fields are as defined in ITU-T T.50 (International Reference Version – 7-bit coded character set for information interchange). Alpha characters consist of the characters "a" to "z" and "A" to "Z". Numeric characters consists of the characters "0" to "9".

Bibliography

– ITU-T M.1400 (1997), *Designations for international networks*.

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