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SERIES M: TMN AND NETWORK MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS, TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE AND LEASED CIRCUITS

International transport network

Operational procedures for the maintenance of the transport network

ITU-T Recommendation M.2130

(Formerly CCITT Recommendation)

ITU-T M-SERIES RECOMMENDATIONS

TMN AND NETWORK MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS, TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE AND LEASED CIRCUITS

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ITU-T Recommendation M.2130

Operational procedures for the maintenance of the transport network

Summary

This ITU-T Recommendation specifies the operational procedures that two international maintenance organizations have to follow in case of failure or degradation of the transport network: paths, section or synchronization. These procedures are required in order to: localize and clear the fault, permit protection/reversibility and facilitate restoration and return to the original configuration. The maintenance procedures in this ITU-T Recommendation defines reference points requiring information to be exchanged between maintenance organizations of involved Network Operators/Service Providers.

Source

ITU-T Recommendation M.2130 was revised by ITU-T Study Group 4 (1997-2000) and approved under the WTSC Resolution 1 procedure on 4 February 2000.

Keywords

Degradation, failure, fault, maintenance, path, procedure, protection, restoration, reversibility, section.

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

Introduction

This ITU-T Recommendation specifies the operational procedures to manage faults occurring without recovery mechanisms, with automatic protection (revertive and non-revertive) or manual protection. It also covers the operational procedure for restoration plan.

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Operational procedures for the maintenance of the transport network

1 Scope

This ITU-T Recommendation covers PDH and SDH international paths, sections and synchronization.

A brief description of maintenance procedures is provided. These maintenance procedures follow the approach expressed in ITU-T Recommendations M.20 [2] and M.21 [3], the PDH and SDH paths and sections maintenance procedures expressed in ITU-T Recommendations M.2100 and M.2101 [7], the SDH paths and sections recovery procedures expressed in ITU-T Recommendation M.2102 [8], PDH and SDH maintenance procedures expressed in ITU-T Recommendation M.2120 [9].

Synchronization faults usually result in degradation rather than unavailability of the supported trails. The relevant maintenance procedure is detailed in Annex A.

The following six cases are addressed:

1) no recovery mechanisms;
2) automatic protection (revertive);
3) automatic protection (non revertive);
4) manual protection;
5) restoration plans (automatic restoration revertive, automatic restoration non revertive, manual restoration);
6) extraneous events.

The relevant flow charts are provided.

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.

[1] ITU-T Recommendation G.810 (1996), *Definitions and terminology for synchronization networks.*

[2] CCITT Recommendation M.20 (1992), *Maintenance philosophy for telecommunication networks.*

[3] CCITT Recommendation M.21 (1992), *Maintenance philosophy for telecommunication services.*

[4] ITU-T Recommendation M.60 (1993), *Maintenance terminology and definitions.*

[5] ITU-T Recommendation M.1400 (1997), *Designations for international networks.*

[6] ITU-T Recommendation M.2100 (1995), *Performance limits for bringing-into-service and maintenance of international PDH paths, sections and transmission systems.*

[7] ITU-T Recommendation M.2101 (2000), *Performance limits and objectives for bringing-into-service and maintenance of international SDH paths and multiplex sections*.

[8] ITU-T Recommendation M.2102 (2000), *Maintenance thresholds and procedures for recovery mechanisms (protection and restoration) of international SDH VC trails (paths) and multiplex sections.*

[9] ITU-T Recommendation M.2120 (2000), *PDH path, section and transmission system and SDH path and multiplex section fault detection and localization procedures.*

3 Terms and definitions

This ITU-T Recommendation uses terms defined in ITU-T Recommendations M.20 [2], M.60 [4], M.2100 [6], M.2101 [7] and M.2102 [8].

4 Abbreviations

This ITU-T Recommendations uses the following abbreviations:

ACK Acknowledgement

APS Automatic Protection Switch

FS Frontier Station

GPS Global Positioning System

IB International Border

ICPCE Inter-country Path Core Element

IDTC International Digital Transmission Centre

IG International Gateway

IPCE International Path Core Element

MTIE Maximum Time Interval Error

NACK Negative Acknowledgement

OS Operations System

PCE Path Core Element

PDH Plesiochronous Digital Hierarchy

SASE Stand Alone Synchronization Equipment

SDH Synchronous Digital Hierarchy

SSU Synchronization Supply Unit

TDEV Time Deviation

5 Reference cases

In all cases below, a path or section between two points under the jurisdiction of Control Stations A and B respectively is assumed. For the purposes of the following discussions, the direction of transmission from B to A is considered. A disturbance in this transmission has taken place.

Synchronization faults usually result in degradation rather than unavailability of the supported trails. The relevant maintenance procedure is detailed in Annex A.

A general description of mandatory information to be exchanged (e.g. ITU-T Recommendation M.1400 [5] designation of the path or section, other information (e.g.: equipment facility), APS event time stamp etc.) follows.

5.1 No recovery mechanisms

The procedures to be applied are shown in Figures 1, 2, 3 and 4. The acceptable, degraded and unacceptable states and relevant thresholds are defined in ITU-T Recommendations M.2100 [6] and M.2101 [7]. In particular:

– the degradation procedures normally involve the count of relevant events and the measurement of their duration. Additionally, taking into consideration that specific maintenance degradation processes also involve commercial aspects (e.g. extra costs for the possible withdrawal of the degraded path or section from service), their establishment is completely left to agreements among all involved Network Operators/Service Providers;

– in all Figures from 1 to 4, every reference to "acceptable performance" implies the use of the BIS Performance after Repair limits as defined in ITU-T Recommendations M.2100 [6] and M.2101 [7].

5.2 Automatic protection (revertive)

5.2.1 The (revertive) protection succeeded

Control Station A acknowledges the activation of the protection and agrees with Control Station B to begin the process of fault diagnosis to understand the reason for the recovery initiation with the goal of returning to the original configuration.

In this case Control Station A shall send, at least, the following information to Control Station B:

a) ITU-T Recommendation M.1400 [5] designation of the path or section;

b) time[1] of the recovery initiation;

c) request for diagnosis.

The fault shall be repaired in a fixed time window. If this window is exceeded, an escalation procedure, if it exists, shall be activated. Thus, it is necessary to discover the reason of the failure analysing the network configuration. In particular it is necessary to find out if the fault is located in the IPCE or in the ICPCE. If the faulty element is found in the IPCE the maintenance organization involved clears it and the control station responsible communicates to the other control station:

a) the cause of the fault;

b) the date and time for returning to the original configuration.

If the faulty element is located in the ICPCE, the two control stations cooperate to locate and repair the fault.

Return to the original configuration will take place as specified in ITU-T Recommendation M.2102 [8].

If the return to the original configuration does not occur, then either the normal is non working, in which case the procedure described in this subclause should be restarted, or there is some other problem which needs investigation.

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[1] Wherever, in this ITU-T Recommendation, date and time are referred, the time is intended to be UTC (Universal Coordinated Time).

5.2.2 The (revertive) protection failed

Control Station A detects the failure in the recovery mechanism and agrees with Control Station B to begin the process of fault diagnosis with the goal to recover the transmission capacity as soon as possible, by any means possible.

In this case Control Station A shall send, at least, the following information to Control Station B:

a) ITU-T Recommendation M.1400 [5] designation of the path or section;

b) request for diagnosis.

The fault shall be repaired in a fixed time window. If this window is exceeded, an escalation procedure, if it exists, shall be activated. Thus, it is necessary to discover the reason of the failure analysing the network configuration. In particular it is necessary to find out if the fault is located in the IPCE or in the ICPCE.

If the faulty element is found in the IPCE the maintenance organization involved clears it and the control station responsible communicates to the other control station:

a) the cause of the fault;

b) the date and time for returning to the original configuration.

If the faulty element is located in the ICPCE, the two control stations cooperate to locate and repair the fault.

5.3 Automatic protection (non-revertive)

5.3.1 The (non-revertive) protection succeeded

Control Station A acknowledges the activation of the protection and agrees with Control Station B to begin the process of fault diagnosis to understand the reason for the recovery initiation with the goal of returning to the original configuration.

In this case Control Station A shall send, at least, the following information to Control Station B:

a) ITU-T Recommendation M.1400 [5] designation of the path or section;

b) time of the recovery initiation;

c) request for diagnosis.

The fault shall be repaired in a fixed time window. If this window is exceeded, an escalation procedure, if it exists, shall be activated. Thus, it is necessary to discover the reason of the failure analysing the network configuration. In particular it is necessary to find out if the fault is located in the IPCE or in the ICPCE. If the faulty element is found in the IPCE the maintenance organization involved clears it and the Control Station responsible communicates to the other Control Station:

a) the cause of the fault;

b) the date and time for returning to the original configuration.

If the faulty element is located in the ICPCE, the two control stations cooperate to locate and repair the fault.

Once the fault is repaired, the Control Station responsible for the repair communicates to the other the cause of the failure and the date and time of the fault clearing. Thereafter the two entities negotiate a BIS test according to ITU-T Recommendation M.2100 [6] or ITU-T Recommendation M.2101 [7] using the Performance after Repair limit.

After the test, the Control Stations agree the date and time of returning to the original configuration and the kind of recovery initiation (forced switch to normal or manual switch to normal) to be performed.

5.3.2 The (non-revertive) protection failed

Control Station A detects the failure in the recovery mechanism and agrees with Control Station B to begin the process of fault diagnosis with the goal to recover the transmission capacity as soon as possible, by any means possible.

In this case Control Station A shall send, at least, the following information to Control Station B:

a) ITU-T Recommendation M.1400 [5] designation of the path or section;

b) request for diagnosis.

The fault shall be repaired in a fixed time window. If this window is exceeded, an escalation procedure, if it exists, shall be activated. Thus, it is necessary to discover the reason of the failure analysing the network configuration. In particular it is necessary to find out if the fault is located in the IPCE or in the ICPCE.

If the faulty element is found in the IPCE the maintenance organization involved clears it and the control station responsible communicates to the other control station:

a) the cause of the fault;

b) the date and time for returning to the original configuration.

If the faulty element is located in the ICPCE, the two control stations cooperate to locate and repair the fault.

5.4 Manual protection

The case "Manual protection" may apply also if the automatic protection fails to operate. In this case Control Station A shall send, at least, the following information to control station B:

a) ITU-T Recommendation M.1400 [5] designation of the path or section;

b) the date and time of the failure.

Thus, both parties agree upon the time and the kind of recovery initiation to perform. Afterwards both parties verify if the service was restored and subsequently they cooperate to localize the faulty element.

The fault shall be repaired in a fixed time window. If this window is exceeded, an escalation procedure, if it exists, shall be activated. Thereafter it is necessary to discover the reason of the failure analysing the routing and all the sections involved. In particular it is necessary to find out if the fault is located at the national or international level. If the faulty element is found in the national portion or in the IPCE the maintenance organization involved clears it and the control station responsible communicates to the other control station:

a) the fault cause;

b) the date and time when the original configuration of the path or section will be available.

If the faulty element is located in the ICPCE, the two control stations cooperate to locate and repair the failure.

Once the fault is repaired, the control station responsible for the reparation communicates to the other the cause of the failure and the date and time of the new availability of the path or section. Thereafter the two control stations negotiate an acceptance test on the normal path or section whose characteristics (time, thresholds) depend on the type of the failure: degradation, interruption or card breakdown.

If the test is OK, the control stations agree on the date and time for which the original path or section has to be brought again into operation and the kind of recovery initiation (forced switch to normal or manual switch to normal) to be performed.

If the manual protection cannot be performed because the alternate path or section is not available, subclause 5.1 applies.

5.5 Restoration plans

A restoration plan is a set of prearranged actions to be carried out in case of failures involving paths or sections. Examples of restoration plans can be found in Appendix I, reference [B1]. The plan can be executed by an OS or manually. If the plan is carried out by an OS, the return to the original configuration can be performed by manual switch to normal (automatic restoration non-revertive) or, also, by automatic OS controlled switch to normal (automatic restoration revertive). In case of manual restoration, this can be performed either by manual switch to alternate or by manual patch to alternate. Consequently, the return to the original configuration can be carried out by forced switch to normal, manual switch to normal or manual patch to normal.

The restoration plan (either automatic or manual) can be performed at the path level or at the section level.

5.5.1 Automatic restoration

In this case, the restoration plan is automatically initiated by the OS. After an agreed time interval, the maintenance organization responsible for the path or the section shall check to see if the service has been restored.

If the restoration is successful, Control Station A and Control Station B cooperate in the localization of the fault, determining if the fault is in the IPCE or in the ICPCE.

In case of failure in the ICPCE, the two control stations work together to locate and repair the fault.

Once the fault is repaired, the Control Stations involved in the repair specify the cause of the failure and the date and time for returning to the original configuration. Thereafter the two Control Stations negotiate a BIS test according to ITU-T Recommendation M.2100 [6] or ITU-T Recommendation M.2101 [7] using the Performance after Repair limit.

After the test, the Control Stations agree on the date and time for returning to the original configuration and the kind of recovery initiation (automatic OS controlled switch to normal or manual switch to normal) to be performed. In case of automatic restoration non-revertive, only the manual switch to normal can be performed.

If the plan cannot be executed by one or more parties, subclause 5.1 applies and the party that cannot execute its part of the plan informs the others of the reason (e.g. lack of spare network resources due to the activation of another restoration plan).

5.5.2 Manual restoration

In this case Control Station A communicates to Control Station B:

a) ITU-T Recommendation M.1400 [5] designation of the path or section;

b) the date and time of the failure.

Then, both parties execute the part of the plan for which they are responsible and, when the plan is completed, check to see if the service has been restored.

If the restoration is successful, Control Station A and Control Station B cooperate in the localization of the fault finding out if the fault is in the IPCE or in the ICPCE.

In the case that the fault is in the IPCE for which Control Station B is responsible, Control Station B informs Control Station A about:

a) the fault cause;

b) the date and time when the original configuration of the path or section will be available.

Once the fault is repaired, the Control Stations involved in the repair specify the cause of the failure and the date and time for fault clearing. Thereafter the two control stations negotiate a BIS test according to ITU-T Recommendation M.2100 [6] or ITU-T Recommendation M.2101 [7] using the Performance after Repair limit.

After the test, the Control Stations agree on the date and time for returning to the original configuration and the kind of recovery initiation (forced switch to normal, manual switch to normal or manual patch to normal) to be performed.

In case of failure in the ICPCE, the two control stations work together to locate and repair the fault.

If the plan cannot be executed by one or more parties, subclause 5.1 applies and the party that cannot execute its part of the plan informs the others of the reason (e.g. lack of spare network resources due to the activation of another restoration plan).

5.6 Extraneous events

Events which do not last long enough to allow for restoration processing may be detected by a control station (for instance A) which cannot ascribe the event to an automatic switch between equipment under its responsibility.

In this case, Control Station A shall record all information regarding these events (date and time of the occurrence, etc.) and report these to Control Station B according to bilateral or multilateral agreements, in order to get subsequent in-depth analysis and solve these problems to avoid their serious impact onto the carried services.

This kind of event can be closed as:

- self healing (when both parties acknowledge the event but they do not know the real cause);
- problem not found if one party does not acknowledge the event.

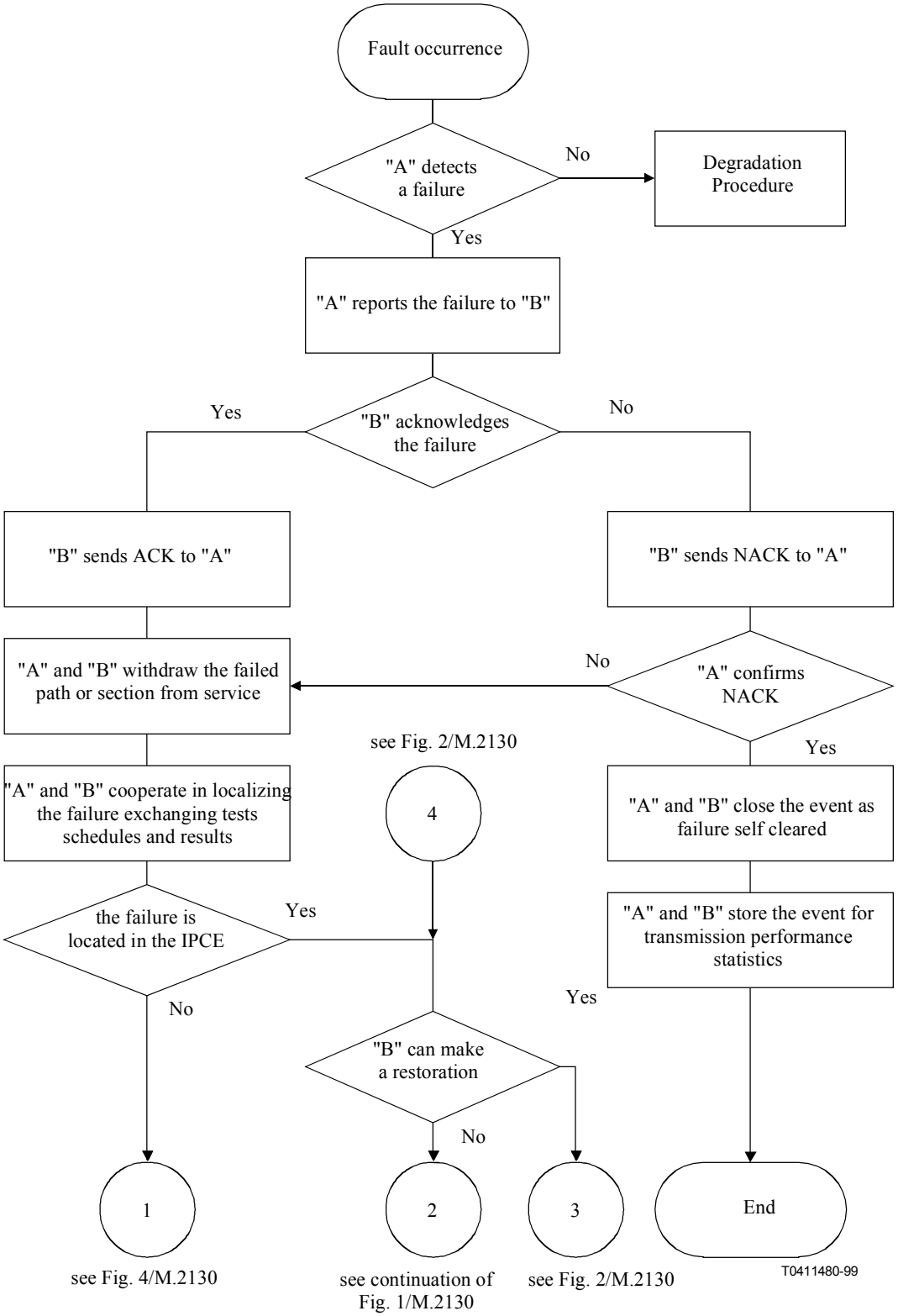

Figure 1/M.2130

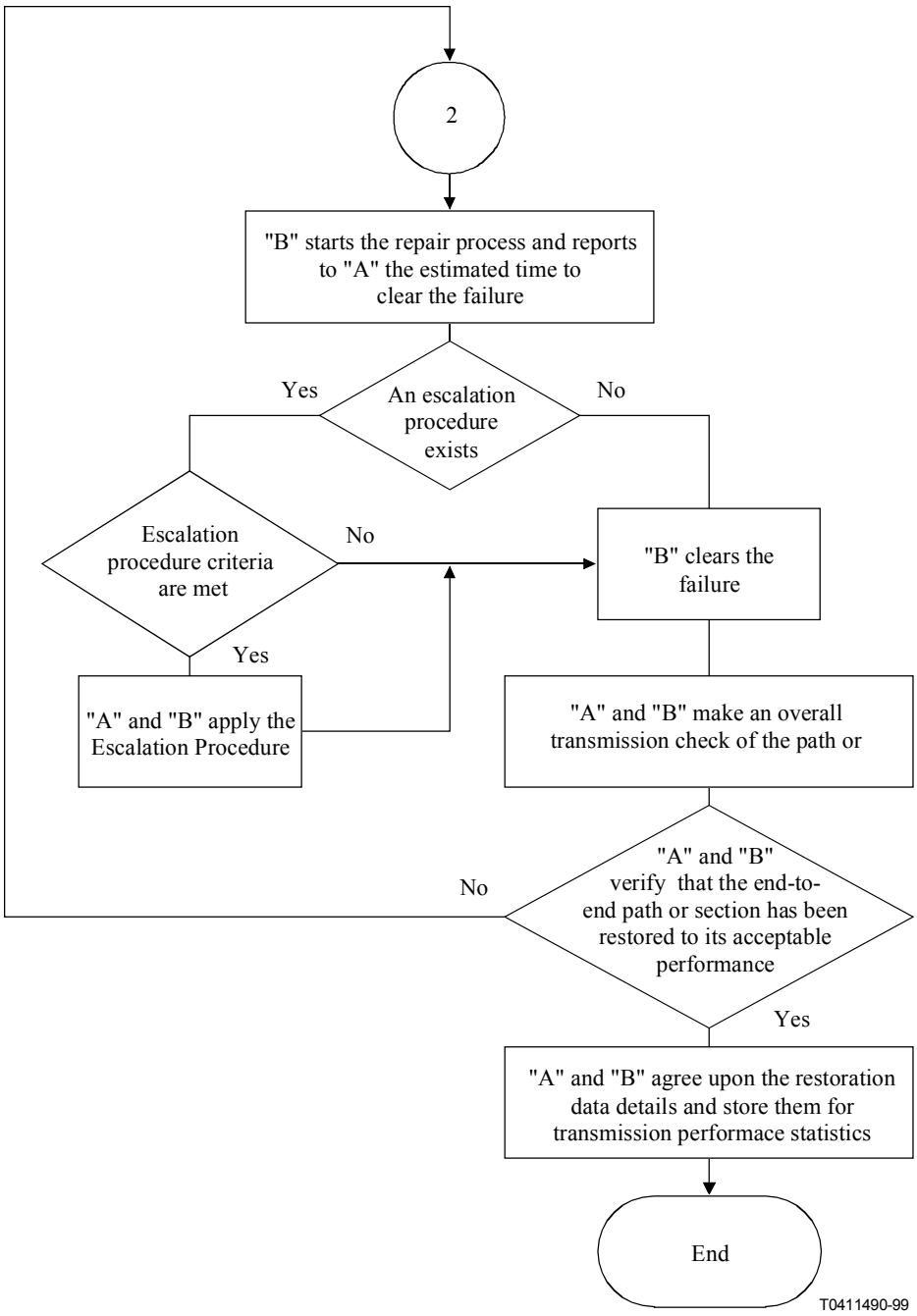

Figure 1/M.2130 ***(continued)***

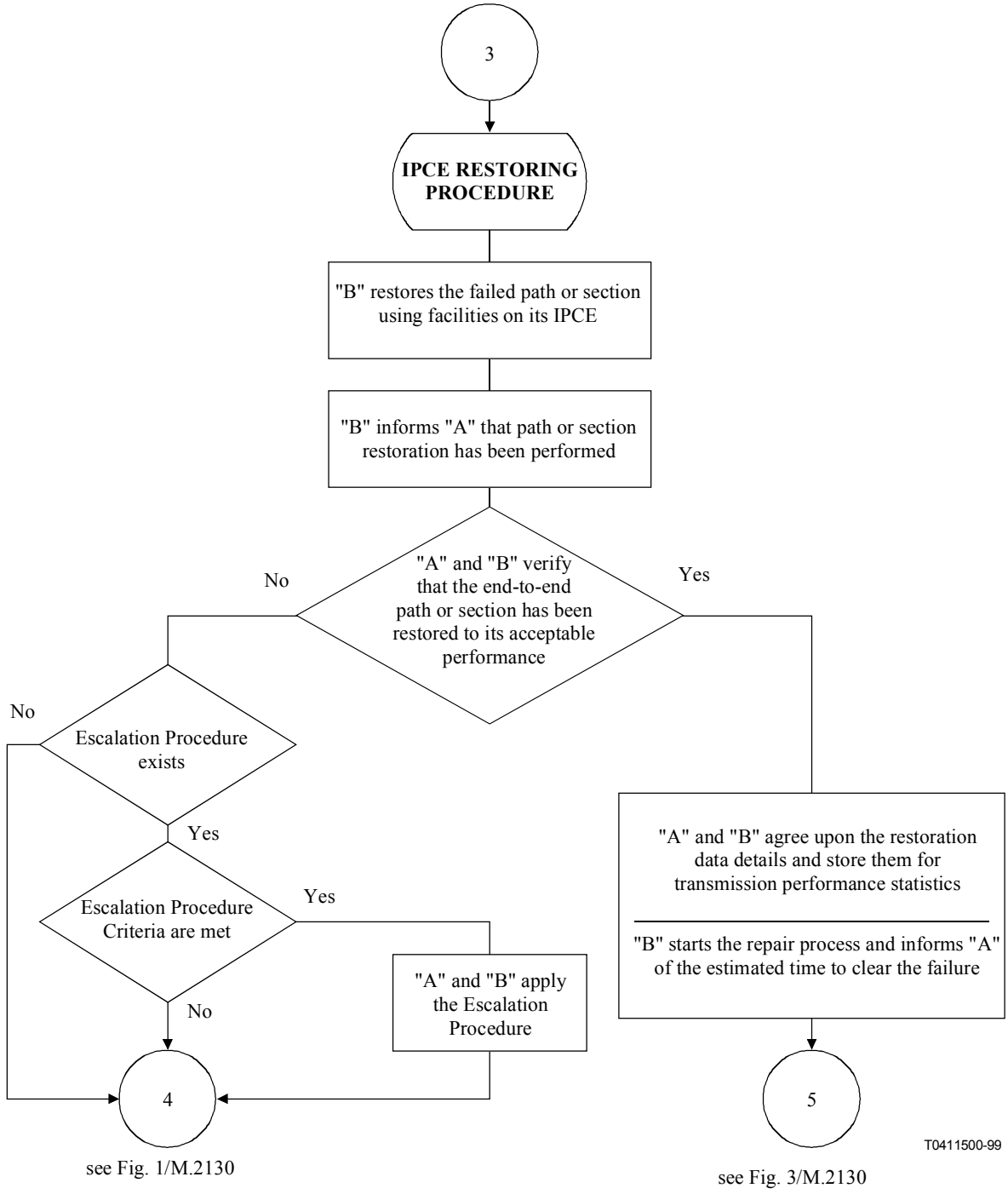

Figure 2/M.2130

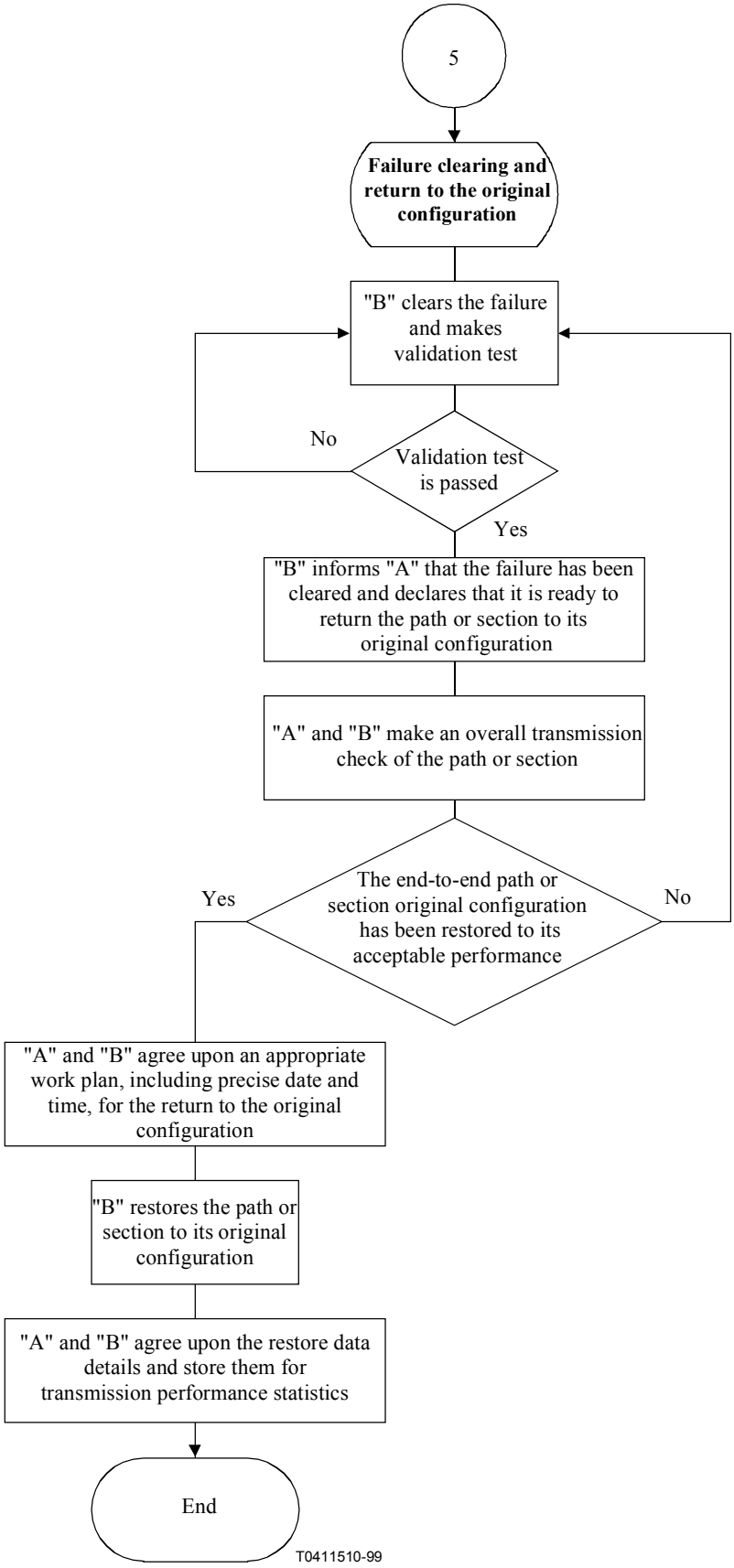

Figure 3/M.2130

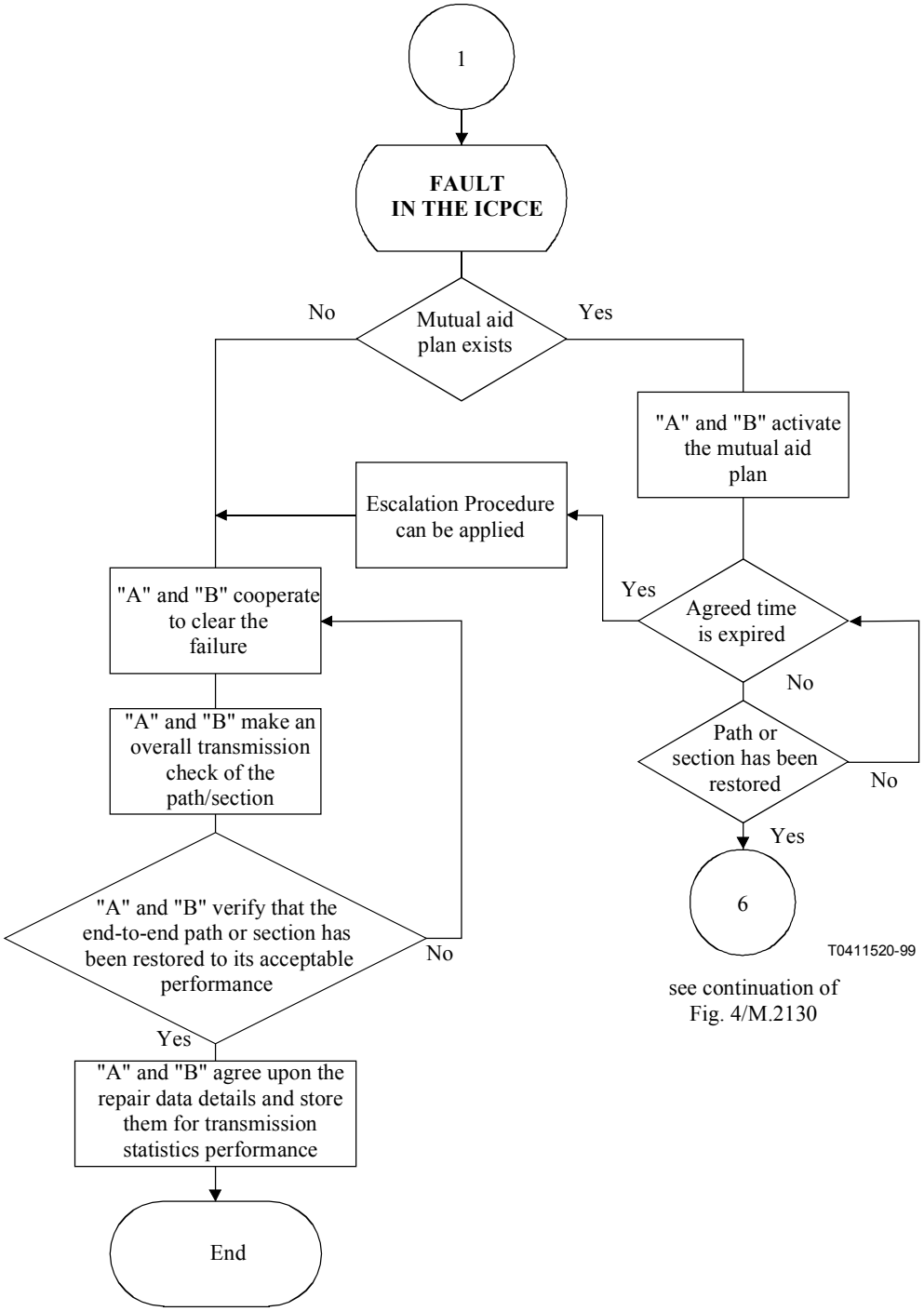

Figure 4/M.2130

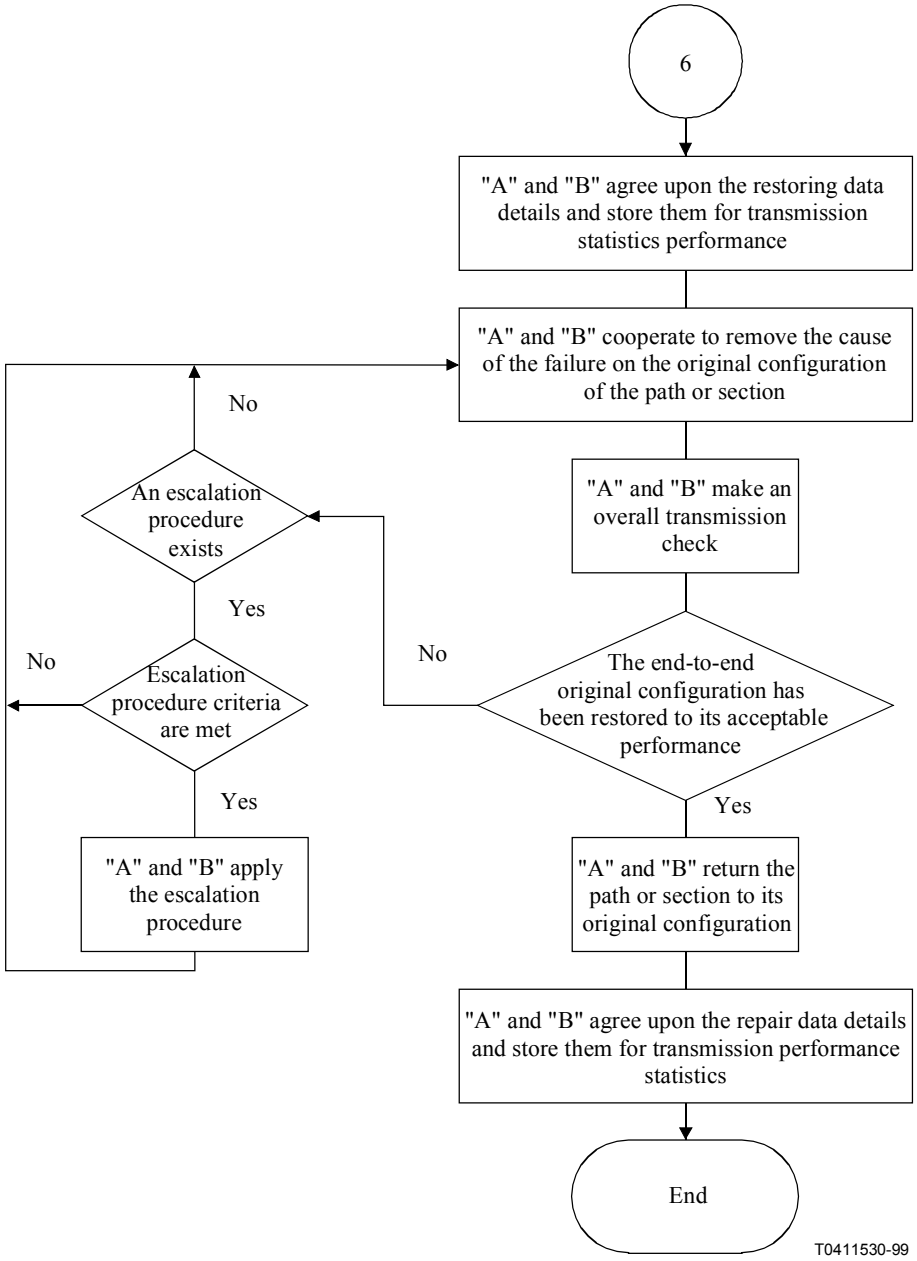

Figure 4/M.2130 ***(continued)***

ANNEX A

Synchronization faults

A synchronization fault exists whenever a fault event is detected in the active synchronization equipment[2], causing a degradation in the availability performance of a clock source and the relevant accuracy of synchronization.

If the level of synchronization degradation exceeds a limit, agreed between the Network Operators involved, the following procedure should be followed.

If a synchronization fault is individually detected by one of the Control Stations involved, it should check the synchronization equipment, all digital clock distributors, and all synchronization bearers.

Control Station A shall record all information regarding the event. In case of severe degradation that may have serious impact on the carried services, Control Station A shall also report all information regarding the event (e.g. date and start time of the fault) to Control Station B according to specific bilateral agreements.

Once the synchronization fault has been cleared, Control Station A shall inform Control Station B on the causes and resolution (e.g. date and end time). Furthermore, Control Station A shall continue monitoring synchronization performance (e.g. MTIE, TDEV) for an agreed period of time to verify that the degraded or unacceptable conditions are definitively cleared.

It is very important to manage all types of synchronization faults efficiently to avoid possible negative impact on services. The reporting of synchronization faults allows the operator to avoid some service affecting events entirely or, when services are impacted, reduce restoration time.

APPENDIX I

Bibliography

[B1] URM Universal Restoration Manual (latest Edition).

This document is distributed by co-owners on a system-by-system basis.

[2] The Synchronization equipment is normally called Stand Alone Synchronization Equipment (SASE) or Synchronization Supply Unit (SSU) (see ITU-T Recommendation G.810 [1]). It usually includes different synchronization sources for reliability purposes (e.g. synchronization bearers from high-level source, GPS source, local rubidium/quartz crystal oscillator).

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