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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

Internet protocol aspects – Operation, administration and maintenance

Requirements for OAM functionality for MPLS networks

ITU-T Recommendation Y.1710

(Formerly CCITT Recommendation)

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ITU-T Recommendation Y.1710

Requirements for OAM functionality for MPLS networks

Summary

This Recommendation provides the motivations and requirements for user-plane OAM (Operation Administration and Maintenance) functionality in Multi-Protocol Label Switched (MPLS) networks.

NOTE – This Recommendation does not cover the administration aspects of OAM.

Source

ITU-T Recommendation Y.1710 was prepared by ITU-T Study Group 13 (2001-2004) and approved under the WTSA Resolution 1 procedure on 13 July 2001.

Keywords

Defect, failure, LSP, MPLS, OAM, QoS, security, SLA.

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.

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

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

NOTE

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

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ITU-T Recommendation Y.1710

Requirements for OAM functionality for MPLS networks

1 Scope

This Recommendation provides the motivations and requirements for user-plane OAM (Operation Administration and Maintenance) [1] functionality in Multi-Protocol Label Switched (MPLS) networks.

NOTE – This Recommendation does not cover the administration aspects of OAM.

2 Normative 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.

[1] ITU-T I.610 (1999), *B-ISDN operation and maintenance principles and functions*.

[2] ITU-T M.20 (1992), *Maintenance philosophy for telecommunication networks*.

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

[4] IETF RFC 3032 (2001), *MPLS label stack encoding*.

[5] IETF RFC 3031 (2001), *Multi-Protocol Label Switching Architecture*.

3 Definitions

This Recommendation introduces some functional architecture terminology that is required to discuss the network components associated with OAM.

3.1 defect: Interruption of the capability of a transport entity (e.g. network connection) to transfer user or OAM information [2].

3.2 failure: Termination of the capability of a transport entity to transfer user or OAM information. A failure can be caused by a persisting defect [2].

3.3 trail termination point: A source or sink point of a trail at layer N, at which the trail overhead is added or removed respectively. A trail termination point must have a unique means of identification within the layer network [3].

4 Introduction

The motivations for this Recommendation arose from the need expressed by network operators for OAM functionality to ensure reliability and performance of MPLS LSPs (Label Switched Paths). User-plane OAM tools are required to verify that LSPs maintain correct connectivity, and are thus able to deliver customer data to target destinations according to both, availability and QoS (Quality of Service) guarantees, given in SLAs (Service Level Agreements).

The requirements presented in this Recommendation include (but are not limited to):

- tools to efficiently detect, identify, and localize defects in the MPLS layer;

- mechanisms for defect notification and defect handling (e.g. suppress alarm storms in nested LSP scenarios);
- criteria for defining availability (entry/exit) and the relationship to performance measurements;
- trigger for corrective actions (e.g. protection switching) when failures occur.

5 Motivations for MPLS OAM functions

It is recognized that OAM functionality is important in public networks for ease of network operation, for verifying network performance, and to reduce operational costs. OAM functionality is especially important for networks that are required to deliver (and hence be measurable against) Quality of Service (QoS) and availability objectives. The major motivations for MPLS OAM are discussed below.

a) Detect MPLS user-plane defects. MPLS introduces a unique functional layer network capability, and hence there will be failure modes that are only relevant to MPLS layer networks. Therefore lower-layer (server-layer) or higher-layer (client-layer) OAM cannot be a substitute for MPLS layer OAM functionality. The MPLS nesting capability (realized through label stack encoding [4]) allows the creation of multiple layer networks in their own right, within the framework of MPLS technology. MPLS user-plane defects are those that are encountered during transport of customer data. Although some MPLS control-plane OAM functions may be available, Network Operators cannot rely exclusively on the control-plane to detect all transport defects. Some reasons for these are:
   - The User-plane and the Control-plane may not necessarily have the same path. Therefore control-plane survival may not indicate the health of an LSP.
   - It is possible for an MPLS network not to have a control-plane signalling (when LSPs are set up statically).

b) Verify whether availability and Quality of Service guarantees given in SLAs (Service Level Agreements) are in fact being met by the LSP.

c) Clearly relate LSP availability to QoS performance noting that QoS performance must be measured during the available time. This information may also be used for accounting and billing purposes to ensure that customers are not inappropriately charged for degraded service or service outages.

d) Reduce operating costs, by allowing efficient detection and handling of defects. Lack of efficient automatic defect detection and handling forces operators to increase their engineering and support workforce, hence increase overall operating costs.

e) Permit rapid diagnosis and localization of defects.

f) Reduce the duration of defects and thus improve the availability.

g) Demonstrate a clear commitment to providing customer traffic security/confidentiality by ensuring that any defects that result in misdirected customer traffic (some of which are currently undetectable) are detectable/diagnosable, and lead to appropriate actions (e.g. squelching of traffic, where relevant).

h) Help decrease the number of defects that are not apparent until the customer reports a problem.

i) Allow taking necessary actions against defects in lower-layers (server-layer) that may not have taken corrective actions.

6 Requirements for MPLS OAM functions

The following items are required for MPLS OAM functions to support an MPLS network.

a) Both on-demand and continuous connectivity verification of LSPs to confirm that defects do not exist on the target LSPs.

b) If a defect occurs, it is necessary to immediately detect, diagnose, localize, notify and take corrective actions. These actions will minimize service interruptions, operational repair times and operational resource. In some cases, service interruptions can be minimized by providing the network with sufficient information to take corrective actions to bypass the defect; for example, through protection switching, re-routing, etc. It is therefore necessary that defects be detected and notified automatically.

c) A defect event in a given layer should not cause multiple alarm events to be raised simultaneously, or cause unnecessary corrective actions to be taken in the client-layers.

d) OAM functions should be stable in large-scale networks.

e) Necessary operator actions such as setting-up and activating MPLS OAM functions should be minimized, particularly, in large-scale networks where the number of LSPs may be large.

f) The use of MPLS OAM functions must be optional to the operator. Network operators may choose which functions to use and which LSPs they apply to.

g) MPLS OAM functions must be backward compatible. Label Switched Routers (LSR) that do not support such functions must silently discard the OAM packets without disturbing the user traffic or causing unnecessary actions [5].

h) Capability to measure availability and QoS performance of an LSP.

i) The OAM functionality of an MPLS layer should not be dependent on any specific server or client-layer technology. This is critical to ensure that layer networks can evolve (or new/old layer networks be added/removed) without impacting other layer networks.

j) The user-plane OAM functionality of an MPLS layer should not replace MPLS control-plane OAM; likewise, the control-plane OAM should not be a replacement for user-plane OAM.

k) All major defect conditions must be identified with in-service measurable entry and exit criteria, and all consequent actions must be clearly specified. At least the following MPLS user-plane defects must be detected:

- loss of LSP connectivity (due to a server layer failure or a failure within the MPLS layer);
- swapped LSP trails;
- LSP mismerging (including loops);
- unintended replication (e.g. unintended multicasting).

l) Specify how unavailable/available state transitions relate to the stopping/starting of the aggregation of available state QoS metrics.

m) Connectivity status assessment must not be dependent on user traffic behaviour.

n) The OAM tools provided should ensure (as far as reasonably practicable) that customers should not have to act as failure detectors for the operator.

o) The OAM function should perform reliably even under degraded link conditions (e.g. bit errors). This requires bit error correction or detection mechanisms for OAM packets.

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