          Updates to MPLS Transport Profile (MPLS-TP) Linear Protection in
                  Automatic Protection Switching (APS) Mode

Abstract

   This document contains updates to MPLS Transport Profile (MPLS-TP)
   linear protection in Automatic Protection Switching (APS) mode
   defined in RFC 7271. The updates provide rules related to the
   initialization of the Protection State Coordination (PSC) Control
   Logic (in which the state machine resides) when operating in APS mode
   and clarify the operation related to state transition table lookup.

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Table of Contents

1. Introduction

   MPLS Transport Profile (MPLS-TP) linear protection in Automatic
   Protection Switching (APS) mode is defined in RFC 7271 [RFC7271]. It
   defines a set of alternate and additional mechanisms to perform some
   of the functions of linear protection described in RFC 6378
   [RFC6378]. The actions performed at initialization of the Protection
   State Coordination (PSC) Control Logic are not described in either
   [RFC7271] or [RFC6378]. Although it is a common perception that the
   state machine starts at the Normal state, this is not explicitly
   specified in any of the documents and various questions have been
   raised by implementers and in discussions on the MPLS working group
   mailing list concerning the detailed actions that the PSC Control
   Logic should take.

   The state machine described in [RFC7271] operates under the
   assumption that both end nodes of a linear protection domain start in
   the Normal state. In the case that one node reboots while the other
   node is still in operation, various scenarios may arise resulting in
   problematic situations. This document resolves all the problematic
   cases and minimizes traffic disruptions related to initialization,
   including both cold and warm reboots that require re-initialization
   of the PSC Control Logic.

   This document contains updates to the MPLS-TP linear protection in
   APS mode defined in [RFC7271]. The updates provide rules related to
   initialization of the PSC Control Logic (in which the state machine
   resides) when operating in APS mode. The updates also include
   modifications to the state transition table defined in Section 11.2
   of [RFC7271]. The changes in the state transition table have been
   examined to make sure that no new problems are introduced.

   This document does not introduce backward compatibility issues with
   implementations of [RFC7271]. In case a node implementing this
   document restarts, the new state changes will not cause problems at
   the remote node implementing [RFC7271], and the two ends will
   converge to the same local and remote states. In case a node
   implementing [RFC7271] restarts, the two ends behave as they do
   today.

   This document also provides some clarifications on the operation
   related to state transition table lookup.

   The reader of this document is assumed to be familiar with [RFC7271].

2. Conventions Used in This Document

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
   "OPTIONAL" in this document are to be interpreted as described in
   BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all
   capitals, as shown here.

3. Abbreviations

   This document uses the following abbreviations:

   APS   Automatic Protection Switching
   DNR   Do-not-Revert
   E::R   Exercise state due to remote EXER message
   EXER   Exercise
   MS-P   Manual Switch to Protection path
   MS-W   Manual Switch to Working path
   MPLS-TP MPLS Transport Profile
   NR   No Request
   PF:DW:R Protecting Failure state due to remote SD-W message
   PF:W:L Protecting Failure state due to local SF-W
   PF:W:R Protecting Failure state due to remote SF-W message
   PSC   Protection State Coordination
   RR   Reverse Request
   SA:MP:R Switching Administrative state due to remote MS-P message
   SA:MW:R Switching Administrative state due to remote MS-W message
   SD   Signal Degrade
   SD-W   Signal Degrade on Working path
   SF   Signal Fail
   SF-P   Signal Fail on Protection path
   SF-W   Signal Fail on Working path
   UA:P:L Unavailable state due to local SF-P
   WTR   Wait-to-Restore

4. Updates

   This section specifies the actions that will be performed at the
   initialization of the PSC Control Logic and the modifications of the
   state transition table defined in Section 11.2 of [RFC7271]. Some
   clarifications on the operation related to state transition table
   lookup are also provided.

4.1. Initialization Behavior

   This section defines initialization behavior that is not described in
   [RFC7271].

   When the PSC Control Logic is initialized, the following actions MUST
   be performed:

   o Stop the WTR timer if it is running.

   o Clear any operator command in the Local Request Logic.

   o If an SF-W or SF-P exists as the highest local request, the node
      being initialized starts at the PF:W:L or UA:P:L state,
      respectively.

   o If the node being initialized has no local request:

      * If the node being initialized does not remember the active path
         or if the node being initialized remembers the working path as
         the active path, the node starts at the Normal state.

      * Else (the node being initialized remembers the protection path
         as the active path), the node starts at the WTR state sending
         NR(0,1) or at the DNR state sending DNR(0,1) depending on the
         configuration that allows or prevents automatic reversion to
         the Normal state.

   o In case any local SD exists, the local SD MUST be considered as an
      input to the Local Request Logic only after the local node has
      received the first protocol message from the remote node and
      completed the processing (i.e., updated the PSC Control Logic and
      decided which action, if any, is to be sent to the PSC Message
      Generator).

   o If the local node receives an EXER message as the first protocol
      message after initialization and the remote EXER becomes the top-
      priority global request, the local node MUST set the position of
      the bridge and selector according to the Path value in the EXER
      message and transit to the E::R state.

   In the case of no local request, remembering the active path
   minimizes traffic switchovers when the remote node is still in
   operation. This approach does not cause a problem even if the
   remembered active path is no longer valid due to any local input that
   occurred at the remote node while the initializing node was out of
   operation.

Note that in some restart scenarios (e.g., cold rebooting), no valid
SF/SD indications may be present at the input of the Local Request
Logic. In this case, the PSC Control Logic restarts as if no local
requests are present. If a valid SF/SD indication is detected later,
the PSC Control Logic is notified and state change is triggered.

4.2. State Transition Modification

In addition to the initialization behavior described in Section 4.1,
four cells of the remote state transition table need to be changed to
make two end nodes converge after initialization. State transition
by remote message as defined in Section 11.2 of [RFC7271] is modified
as follows (only modified cells are shown):

```
        | MS-W    | MS-P    | WTR | EXER | RR | DNR  | NR
--------+---------+---------+-----+------+----+------+----
N       |         |         | (13)|      |    | DNR  |
PF:W:R  |         |         |     |      |    | DNR  |
PF:DW:R |         |         |     |      |    | DNR  |
```

The changes in two rows of remote protecting failure states lead to
the replacement of note (10) with DNR; therefore, note (10) is no
longer needed. The resultant three rows read:

```
        | MS-W    | MS-P    | WTR | EXER | RR | DNR  | NR
--------+---------+---------+-----+------+----+------+----
N       | SA:MW:R | SA:MP:R | (13)| E::R | i  | DNR  | i
PF:W:R  | SA:MW:R | SA:MP:R | (9) | E::R | i  | DNR  | (11)
PF:DW:R | SA:MW:R | SA:MP:R | (9) | E::R | i  | DNR  | (11)
```

In the tables above, the letters 'i' and 'N' stand for "ignore" and
"Normal state", respectively. Other abbreviations can be found in
Section 3.

4.3. Operation Related to State Transition Table Lookup

In addition to the rules related to the state transition table lookup
listed in Section 11 of [RFC7271], the following rule is also applied
to the operation related to the state transition table lookup:

o When the local SF-P is cleared and the priorities of the local and
   remote requests are re-evaluated, the last received remote message
   may no longer be valid due to the previous failure of the
   protection path. Therefore, the last received message MUST be
   treated as if it were NR and only the local request shall be
   evaluated.

The last paragraph in Section 11 of [RFC7271] is modified as follows:

Old text:

In the state transition tables below, the letter 'i' stands for
"ignore" and is an indication to remain in the current state and
continue transmitting the current PSC message.

New text:

In the state transition tables below, the letter 'i' is the
"ignore" flag; if it is set, it means that the top-priority
global request is ignored.

If re-evaluation is triggered, the ignore flag is checked. If it
is set, the state machine will transit to the supposed state, which
can be Normal or DNR as indicated in the footnotes to the state
transition table in Section 11.1 of [RFC7271]. If the ignore flag
is not set, the state machine will transit to the state indicated
in the cell of the state transition table.

If re-evaluation is not triggered, the ignore flag is checked. If
it is set, the state machine will remain in the current state, and
the current PSC message continues to be transmitted. If the ignore
flag is not set, the state machine will transit to the state
indicated in the cell of the state transition table.

5. Security Considerations

   No specific security issue is raised in addition to those ones
   already documented in [RFC7271]. Note that tightening the
   description of the initializing behavior may help to protect networks
   from restart attacks.

6. IANA Considerations

   This document does not require any IANA actions.

7. References

7.1. Normative References

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7.2. Informative References

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