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Updates to MPLS Transport Profile Linear Protection
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Abstract

This document contains a number of updates to the Protection State Coordination (PSC) logic defined in RFC6378, "MPLS Transport Profile (MPLS-TP) Linear Protection". These updates provide some rules and recommendations around the use of TLVs in PSC, address some issues raised in an ITU-T liaison statement, and clarify PSC's behavior in a case not well explained in RFC6378.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

This document contains a number of updates to PSC [RFC6378]. One provides some rules and recommendations around the use of TLVs in PSC. Three of them address issues #2, #7 and #8 as identified in the ITU's liaison statement "Recommendation ITU-T G.8131/Y.1382 revision - Linear protection switching for MPLS-TP networks" [LIAISON]. Another clears up a behavior which was not well explained in RFC6378. These updates are not changes to the protocol's packet format or to PSC's design, but are corrections and clarifications to specific aspects of the protocol's procedures. This document does not introduce backward compatibility issues with implementations of RFC 6378.

It should be noted that [I-D.ietf-mpls-tp-psc-itu] contains protocol mechanisms for an alternate mode of operating MPLS-TP PSC. Those modes are built on the message structures and procedures of [RFC6378] and so, while this document does not update [I-D.ietf-mpls-tp-psc-itu], it has an impact on that work through its update to [RFC6378].

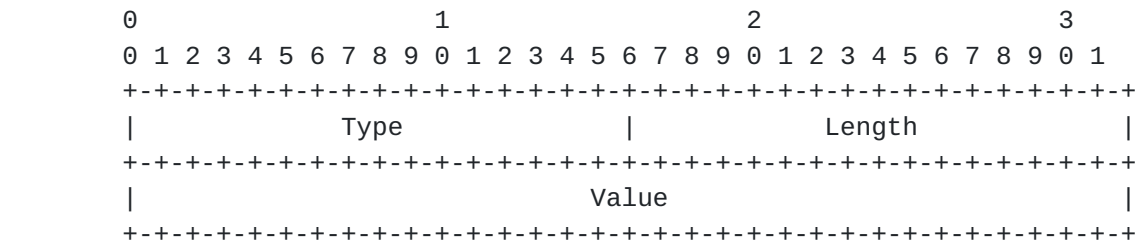
This document assumes familiarity with RFC6378 and its terms, conventions and acronyms. Any term used in this document but not defined herein can be found in RFC6378. In particular, this document shares the acronyms defined in RFC6378 section 2.1.

2. Message Formatting and Error Handling

This section covers message formatting, as well as some recommended error checking.

2.1. PSC TLV Format

[RFC6378] provides the capability to carry TLVs in the PSC messages. All fields are encoded in network byte order. Each TLV contains three fields, as follows:



Type field (T):

A two octet field that encodes a type value. The type values are recorded in the IANA registry "MPLS PSC TLV Registry".

Length field (L) :

A two octet field that encodes the length in octets of the Value field.

The value of this field MUST be a multiple of 4.

Value field (V) :

The payload of the TLV. The length of this field (which is the value of the Length field) MUST be a multiple of 4 octets, and so this field may contain explicit padding. The length of each single TLV is

the sum of the lengths of its three fields: the length of the value field + 4. The overall TLV Length field in the PSC message contains the total length of all TLVs in octets.

2.2. Error handling

It is recommended to implement error and bounds checking to ensure that received messages, if improperly formatted, are handled in such a way to minimize the impact of this formatting on the behavior of the network and its devices. This section covers two such areas - malformed messages and well-formed but unexpected TLVs.

Neither of these sections is intended to limit the error or bounds checking a device performs. The recommendations herein should be taken as a starting point.

2.2.1. Malformed messages

A implementation SHOULD:

- Ensure any fields prior to TLV Length are consistent with RFC 6378, particularly Section 4.2.
- Ensure the overall length of the message matches the value in the TLV Length + 12.
- Check that the sum of the lengths of all TLVs matches the value in the TLV Length.

If an implementation receives a message which fails any malformed message checks, it MUST drop the message and SHOULD alert the operator to the malformed message. The method(s) used to alert the operator are outside the scope of this document, but may include things like syslog or console messages.

2.2.2. Well-formed but unknown or unexpected TLV

If a message is deemed to be properly formed, an implementation SHOULD check all TLVs to ensure that it knows what to do with them. A well-formed but unknown or unexpected TLV value MUST be ignored, and the rest of the message processed as if the ignored TLV did not exist. An implementation detecting a malformed TLV SHOULD alert the operator as described in Section 2.2.1.

3. Incorrect local status after failure

Issue #2 in the liaison identifies a case where a strict reading of RFC6378 leaves a node reporting an inaccurate status:

A node can end up sending incorrect status - NR(0,1) - despite the failure of the protection LSP (P-LSP). This is clearly not correct, as a node should not be sending NR if it has a local failure. To address this issue, the fourth bullet in section 4.3.3.3 of RFC6378 is replaced with the following three bullets:

- If the current state is due to a local or remote Manual Switch, a local Signal Fail indication on the protection path SHALL cause the LER to enter local Unavailable state and begin transmission of an SF(0,0) message.

- If the LER is in local Protecting Administrative state due to a local Forced Switch, a local Signal Fail indication on the protection path SHALL be ignored.

- If the LER is in remote Protecting Administrative state due to a remote Forced Switch, a local Signal Fail indication on the protection path SHALL cause the LER to remain in remote Protecting administrative state and transmit an SF(0,1) message.

4. Handling a capabilities mismatch

PSC has no explicit facility to negotiate any properties of the protection domain. It does, however, have the ability to signal two properties of that domain, via the Protection Type (PT) and Revertive (R) bits. RFC6378 specifies that if these bits do not match an operator "SHALL [be notified]" (PT, section 4.2.3) or "SHOULD be notified" (R, section 4.2.4). However, there is no text which specifies the behavior of the end nodes of a protection domain in case of a mismatch. This section provides that text, as requested by issue #7 in the liaison.

4.1. Protection Type mismatch

The behavior of the protection domain depends on the exact Protection Type (PT) mismatch. Section 4.2.3 of RFC6378 specifies three protection types - bidirectional switching using a permanent bridge, bidirectional switching using a selector bridge, and unidirectional switching using a permanent bridge. They are abbreviated here as BP, BS and UP.

There are three possible mismatches: {BP, UP}, {BP, BS}, and {UP, BS}. The priority is:

UP > BS > BP

In other words:

- If the PT mismatch is {BP, UP}, the node transmitting BP MUST switch to UP mode if it is supported.

- If the PT mismatch is {BP, BS}, the node transmitting BP MUST switch to BS mode if it is supported.

- If the PT mismatch is {UP, BS}, the node transmitting BS MUST switch to UP mode if it is supported.

If a node does not support a mode to which it is required to switch then that node MUST behave as in Section 4.3.

4.2. R mismatch

The R bit indicates whether the protection domain is in Revertive or Non-Revertive behavior. If the R bits do not match, the node indicating Non-Revertive MUST switch to Revertive if it is supported. If it is not supported a node must behave as in Section 4.3

4.3. Unsupported modes

An implementation may not support all three PT modes and/or both R modes, and thus a pair of nodes may be unable to converge on a common mode. This creates a permanent mismatch, resolvable only by operator intervention. An implementation SHOULD alert the operator to an irreconcilable mismatch.

It is desirable to allow the protection domain to function in a non-failure mode even if there is a mismatch, as the mismatches of PT or R have to do with how nodes recover from a failure. An implementation SHOULD allow traffic to be sent on the Working LSP as long as there is no failure (e.g. NR state) regardless of any PT or R mismatch.

If there is a trigger which would cause the protection LSP to be used, such as SF or MS, a node MUST NOT use the protection LSP to carry traffic.

5. Reversion deadlock due to a race condition

Issue #8 in the liaison identifies a deadlock case where each node can end up sending NR(0,1) when it should instead be in the process of recovering from the failure (i.e. entering into WTR or DNR, as appropriate for the protection domain). The root of the issue is

that a pair of nodes can simultaneously enter WTR state, receive an out of date SF-W indication and transition into a remotely triggered WTR, and remain in remotely triggered WTR waiting for the other end to trigger a change in status.

In the case identified in issue #8, each node can end up sending NR(0,1), which is an indication that the transmitting node has no local failure, but is instead reacting to the remote SF-W. If a node which receives NR(0,1) is in fact not indicating a local error, the correct behavior for the receiving node is to take the received NR(0,1) as an indication that there is no error in the protection domain, and recovery procedures (WTR or DNR) should begin.

This is addressed by adding the following text as the penultimate bullet in section 4.3.3.4 of RFC6378:

- If a node is in Protecting Failure state due to a remote SF-W and receives NR(0,1), this SHALL cause the node to begin recovery procedures. If the LER is configured for revertive behavior, it enters into Wait-to-Restore state, starts the WTR timer, and begins transmitting WTR(0,1). If the LER is configured for non-revertive behavior, it enters into Do-Not-Revert state and begins transmitting a DNR(0,1) message.

Additionally, the final bullet in section 4.3.3.3 is changed from

- A remote NR(0,0) message SHALL be ignored if in local Protecting administrative state.

to

- A remote No Request message SHALL be ignored if in local Protecting administrative state.

This indicates that a remote NR triggers the same behavior regardless of the value of FPath and Path. This change does not directly address issue #8, but fixes a similar issue - if a node receives NR while in Remote administrative state, the value of FPath and Path have no bearing on the node's reaction to this NR.

6. Clarifying PSC's behavior in the face of multiple inputs

RFC6378 describes the PSC state machine. Figure 1 in section 3 shows two inputs into the PSC Control logic - Local Request logic and Remote PSC Request. When there is only one input into the PSC Control logic - a local request or a remote request but not both - the PSC Control logic decides what that input signifies and then

takes one or more actions, as necessary. This is what the PSC State Machine in section 4.3 describes.

RFC6378 does not sufficiently describe the behavior in the face of multiple inputs into the PSC Control Logic (one Local Request and one Remote Request). This section clarifies the expected behavior.

There are two cases to think about when considering dual inputs into the PSC Control logic. The first is when the same request is presented from both local and remote sources. One example of this case is a Forced Switch (FS) configured on both ends of an LSP. This will result in the PSC Control logic receiving both a local FS and remove FS. For convenience, this scenario is written as [L(FS), R(FS)] - that is, Local(Forced Switch) and Remote(Forced Switch).

The second case, which is handled in exactly the same way as the first, is when the two inputs into the PSC Control logic describe different events. There are a number of variations on this case. One example is when there is a Lockout of Protection from the Local request logic and a Signal Fail on the Working path from the Remote PSC Request. This is shortened to [L(LO), R(SF-W)].

In both cases the question is not how the PSC Control logic decides which of these is the one it acts upon. Section 4.3.2 of RFC6378 lists the priority order, and prioritizes the local input over the remote input in case both inputs are of the same priority. So in the first example it is the local SF that drives the PSC Control logic, and in the second example it is the local Lockout which drives the PSC Control logic.

The point that this section clears up is around what happens when the highest priority input goes away. Consider the first case. Initially, the PSC Control logic has [L(FS), R(FS)] and L(FS) is driving PSC's behavior. When L(FS) is removed but R(FS) remains, what does PSC do? A strict reading of the FSM would suggest that PSC transition from PA:F:L into N, and at some future time (perhaps after the remote request refreshes) PSC would transition from N to PA:F:R. This is an unreasonable behavior, as there is no sensible justification for a node behaving as if things were normal (i.e., N state) when it is clear that they are not.

The second case is similar. If a node starts with [L(LO), R(SF-W)] and the local lockout is removed, a strict reading of the state machine would suggest that the node transition from UA:LO:L to N, and then at some future time presumably notice the R(SF-W) and transition from N to PF:W:R. As with the first case, this is clearly not a useful behavior.

In both cases the request that was driving PSC's behavior was removed. What should happen is that the PSC Control logic should, upon removal of an input, immediately reevaluate all other inputs to decide on the next course of action. This requires an implementation to store the most recent local and remote inputs regardless of their eventual use as triggers for the PSC Control Logic.

There is also a third case. Consider a node with [L(FS), R(LO)]. At some point in time the remote node replaces its Lockout request with a Signal Fail on Working, so that the inputs into the PSC Control logic on the receiving node go to [L(FS), R(SF-W)]. Similar to the first two cases, the node should immediately reevaluate both its local and remote inputs to determine the highest priority among them, and act on that input accordingly. That is in fact what happens, as defined in Section 4.3.3:

"When a LER is in a remote state, i.e., state transition in reaction to a PSC message received from the far-end LER, and receives a new PSC message from the far-end LER that indicates a contradictory state, e.g., in remote Unavailable state receiving a remote FS(1,1) message, then the PSC Control logic SHALL reevaluate all inputs (both the local input and the remote message) as if the LER is in the Normal state."

This section extends that paragraph to handle the first two cases. The essence of the quoted paragraph is that when faced with multiple inputs, PSC must reevaluate any changes as if it was in Normal state. So the quoted paragraph is replaced with the following text:

"The PSC Control logic may simultaneously have Local and Remote requests, and the highest priority of these requests ultimately drives the behavior of the PSC Control logic. When this highest priority request is removed or is replaced with another input, then the PSC Control logic SHALL immediately reevaluate all inputs (both the local input and the remote message), transitioning into a new state only upon reevaluation of all inputs".

7. Security Considerations

These changes and clarifications raise no new security concerns. RFC 6941 [RFC6941] provides the baseline security discussion for MPLS-TP, and PSC (both RFC 6378 and this document) fall under that umbrella. Additionally, Section 2.2 clarifies how to react to malformed or unexpected messages.

8. IANA Considerations

IANA is requested to mark the value 0 in the "MPLS PSC TLV Registry" as "Reserved, not to be allocated" and to update the references to show [RFC6378] and [RFC-ietf-mpls-psc-updates-04]. Note that this action provides documentation of an action already taken by IANA but not recorded in RFC 6378.

9. Acknowledgements

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10. References

10.1. Normative References

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10.2. Informative References

[I-D.ietf-mpls-tp-psc-itu] Ryoo, J., Gray, E., Helvoort, H., D'Alessandro, A., Cheung, T., and E. Osborne, "MPLS Transport Profile (MPLS-TP) Linear Protection to Match the Operational Expectations of SDH, OTN and Ethernet Transport Network Operators", draft-ietf-mpls-tp-psc-itu-04 (work in progress), March 2014.

[LIAISON] ITU-T SG15, "Liaison Statement: Recommendation ITU-T G .8131/Y.1382 revision - Linear protection switching for MPLS-TP networks", <https://datatracker.ietf.org/liaison/1205/>.

[RFC6941] Fang, L., Niven-Jenkins, B., Mansfield, S., and R. Graveman, "MPLS Transport Profile (MPLS-TP) Security Framework", RFC 6941, April 2013.

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