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**Dual-Homing Protection for MPLS and MPLS-TP Pseudowires  
draft-ietf-pals-mpls-tp-dual-homing-protection-04**

Abstract

This document describes a framework and several scenarios for Pseudowire (PW) dual-homing local protection. A Dual-Node Interconnection (DNI) PW is provisioned between the dual-homing Provider Edge (PE) nodes for carrying traffic when failure occurs in the Attachment Circuit (AC) or PW side. In order for the dual-homing PE nodes to determine the forwarding state of AC, PW and the DNI PW, necessary state exchange and coordination are needed between the dual-homing PEs. The PW dual-homing local protection mechanism is complementary to the existing PW protection mechanisms.

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**[1.](#) Introduction**

[RFC6372] and [[RFC6378](#)] describe the framework and mechanism of MPLS-TP Linear protection, which can provide protection for the MPLS LSP or pseudowire (PW) between the edge nodes. Such mechanism does not protect the failure of the Attachment Circuit (AC) or the Provider Edge (PE) node. [[RFC6718](#)] and [[RFC6870](#)] describe the framework and mechanism for PW redundancy to provide protection for AC or PE node failure. The PW redundancy mechanism is based on the signaling of Label Distribution Protocol (LDP), which is applicable to PWs with a dynamic control plane. [[I-D.ietf-pals-endpoint-fast-protection](#)] describes a fast local repair mechanism for PW egress endpoint failures, which is based on PW redundancy, upstream label assignment and context specific label switching. Such mechanism is applicable to PWs with a dynamic control plane.

In some scenarios such as mobile backhauling, the MPLS PWs are provisioned with dual-homing topology, in which at least the CE node in one side is dual-homed to two PEs. If some fault occurs in the primary AC, operators usually prefer to have the switchover only in the dual-homing PE side and keep the working pseudowires unchanged if possible. This is to avoid massive PW switchover in the mobile backhaul network due to the AC failure in the mobile core site, which may in turn lead to congestion due to the migration of traffic from the paths preferred by the network planners. Similarly, as multiple PWs share the physical AC in the mobile core site, it is preferable to keep using the working AC when one working PW fails in PSN network, which could avoid unnecessary AC switchover for other PWs. To meet the above requirements, a fast dual-homing PW protection mechanism is needed to protect against the failures of an AC, the PE node and the PSN network.

This document describes the framework and several typical scenarios of pseudowire (PW) dual-homing local protection. A Dual-Node Interconnection (DNI) PW is provisioned between the dual-homing PE nodes for carrying traffic when a failure occurs in the AC or PW side. In order for the dual-homing PE nodes to determine the forwarding state of AC, PW and DNI PW, necessary state exchange and coordination between the dual-homing PEs is needed. The mechanism defined in this document is complementary to the existing protection mechanisms [[RFC6378](#)][[RFC6718](#)]. The necessary protocol extensions is described in a companion document [[I-D.ietf-pals-mpls-tp-dual-homing-coordination](#)].

The proposed mechanism has been implemented and deployed in several mobile backhaul networks which use static MPLS-TP PWs for the backhauling of mobile traffic.

## **2. Reference Models of Dual-homing Local Protection**

This section shows the reference architecture of the dual-homing PW local protection and the usage of the architecture in different scenarios.

### **2.1. PE Architecture**

Figure 1 shows the PE architecture for dual-homing local protection. This is based on the architecture in Figure 4a of [[RFC3985](#)]. In addition to the AC and the service PW between the local and remote PEs, a DNI PW is provisioned to connect the forwarders of the dual-homing PEs. It can be used to forward traffic between the dual-homing PEs when some failure occurs in the AC or service PW side. As [[RFC3985](#)] specifies: "any required switching functionality is the responsibility of a forwarder function", in this case, the forwarder

is responsible for switching the payloads between three entities: the AC, the service PW and the DNI PW. The specific behavior of the forwarder is determined according to the forwarding state machine defined in this document.

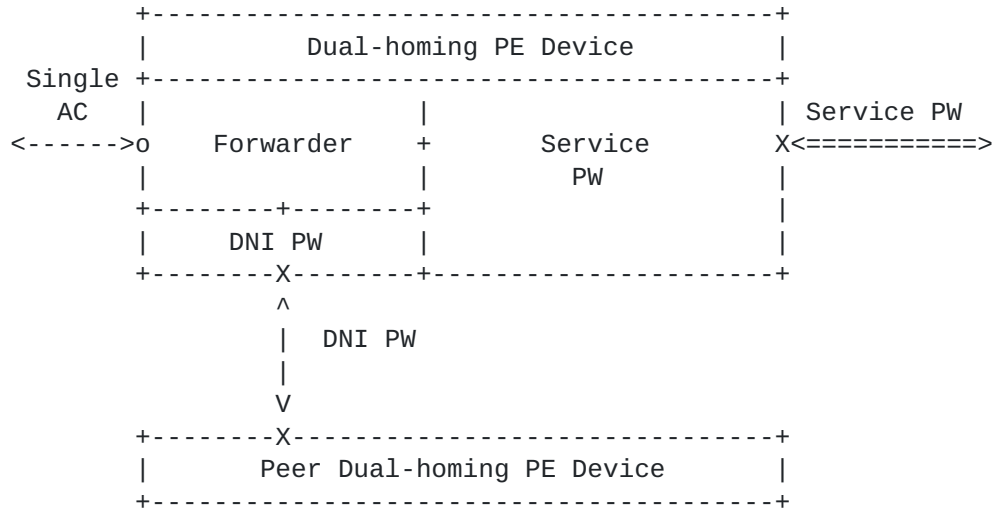


Figure 1: PE Architecture for Dual-homing Protection

**2.2. Dual-Homing Local Protection Reference Scenarios**

**2.2.1. One-Side Dual-Homing Protection**

Figure 2 illustrates the network scenario of dual-homing PW local protection where only one of the CEs is dual-homed to two PE nodes. CE1 is dual-homed to PE1 and PE2, while CE2 is single-homed to PE3. A DNI-PW is established between the dual-homing PEs, which is used to bridge traffic when a failure occurs in the PSN network or in the AC side. A control mechanism enables the PEs and CE to determine which AC should be used to carry traffic between CE1 and the PSN network. These mechanisms/protocols are beyond the scope of this document. The working and protection PWs can be determined either by configuration or by existing signaling mechanisms.

This scenario can protect the node failure of PE1 or PE2, or the failure of one of the ACs between CE1 and the dual-homing PEs. In addition, dual-homing PW protection can protect the failure occurred in the PSN network which impacts the working PW, thus it can be an alternative solution of PSN tunnel protection mechanisms. This topology can be used in mobile backhauling application scenarios. For example, CE2 might be a cell site equipment such as a NodeB, whilst CE1 is the shared Radio Network Controller (RNC).

the NodeB serves as CE2 while the Radio Network Controller (RNC) serves as CE1. PE3 works as an access side MPLS device while PE1 and PE2 works as core side MPLS devices.

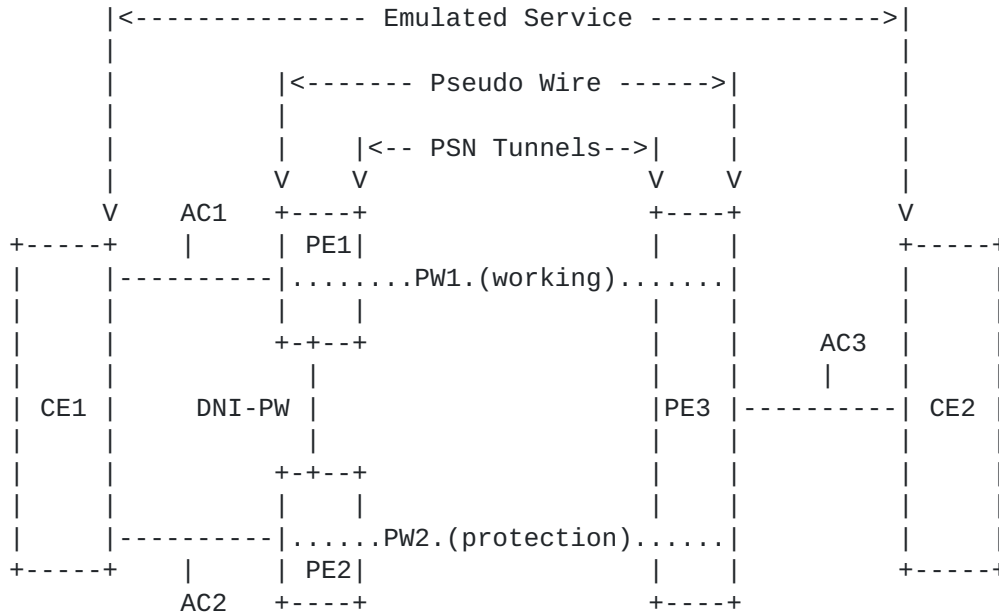


Figure 2. One-side dual-homing PW protection

Consider in normal state AC1 from CE1 to PE1 is initially active and AC2 from CE1 to PE2 is initially standby, PW1 is the working PW and PW2 is the protection PW.

When a failure occurs in AC1, then the state of AC2 changes to active based on some AC redundancy mechanism. In order to keep the switchover local and continue using PW1 for traffic forwarding which is preferred according to traffic planning, the forwarder on PE2 needs to connect AC2 to the DNI PW, and the forwarder on PE1 needs to connect the DNI PW to PW1. In this way the failure in AC1 will not impact the forwarding of the service PWs across the network. After the switchover, traffic will go through the bidirectional path: CE1-(AC2)-PE2-(DNI-PW)-PE1-(PW1)-PE3-(AC3)-CE2.

When a failure in the PSN network affects the working PW (PW1), according to PW protection mechanisms [RFC6378], traffic is switched onto the protection PW (PW2), while the state of AC1 remains active. Then the forwarder on PE1 needs to connect AC1 to the DNI PW, and the forwarder on PE2 needs to connect the DNI PW to PW2. In this way the failure in the PSN network will not impact the state of the ACs. After the switchover, traffic will go through the bidirectional path: CE1-(AC1)-PE1-(DNI-PW)-PE2-(PW2)-PE3-(AC3)-CE2.

When a failure occurs in the working PE (PE1), it is equivalent to the failures of the working AC, the working PW and the DNI PW. The state of AC2 changes to active based on the AC redundancy mechanism. And according to the PW protection mechanism, traffic is switched on to the protection PW "PW2". In this case the forwarder on PE2 needs to connect AC2 to PW2. After the switchover, traffic will go through the bidirectional path: CE1-(AC2)-PE2-(PW2)-PE3-(AC3)-CE2.

### **2.2.2. Two-side Dual-Homing Protection**

Figure 3 illustrates the network scenario of dual-homing PW protection where the CEs in both sides are dual-homed. CE1 is dual-homed to PE1 and PE2, and CE2 is dual-homed to PE3 and PE4. A dual-homing control mechanism enables the PEs and CEs to determine which AC should be used to carry traffic between CE and the PSN network. DNI-PWs are provisioned between the dual-homing PEs on both sides. One service PW is established between PE1 and PE3, another service PW is established between PE2 and PE4. The role of working and protection PW can be determined either by configuration or via existing signaling mechanisms.

This scenario can protect the node failure on one of the dual-homing PEs, or the failure on one of the ACs between the CEs and their dual-homing PEs. Meanwhile, dual-homing PW protection can protect the failure occurred in the PSN network which impacts one of the PWs, thus it can be an alternative solution of PSN tunnel protection mechanisms. This scenario is mainly used for services of important business customers. In this case, CE1 and CE2 can be regarded as service access points.

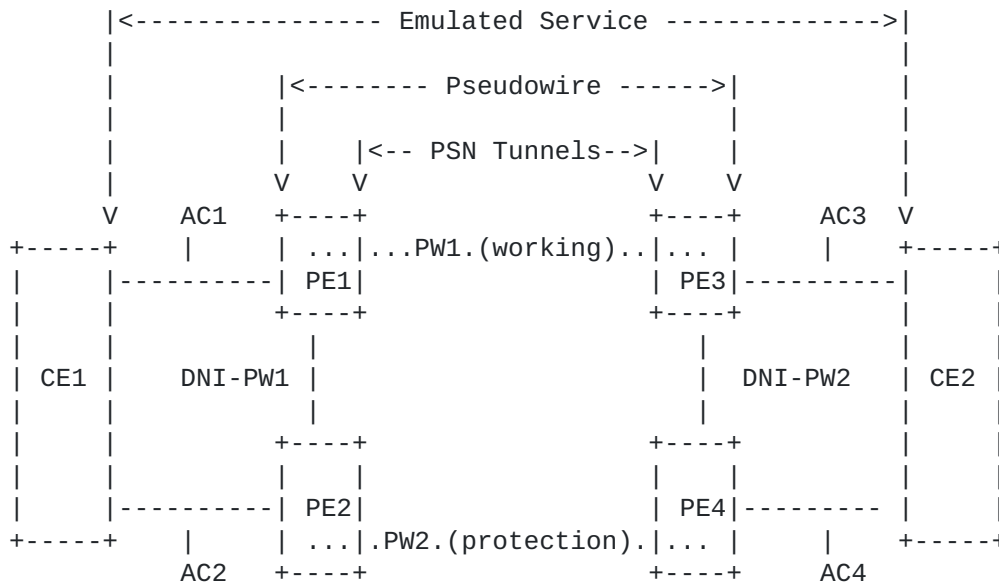


Figure 3. Two-side dual-homing PW protection

Consider in normal state, AC1 between CE1 and PE1 is initially active and AC2 between CE1 and PE2 is initially standby, AC3 between CE2 and PE3 is initially active and AC4 from CE2 to PE4 is initially standby, PW1 is the working PW and PW2 is the protection PW.

When a failure occurs in AC1, the state of AC2 changes to active based on the AC redundancy mechanism. In order to keep the switchover local and continue using PW1 for traffic forwarding, the forwarder on PE2 needs to connect AC2 to the DNI-PW1, and the forwarder on PE1 needs to connect DNI-PW1 with PW1. In this way failures in the AC side will not impact the forwarding of the service PWs across the network. After the switchover, traffic will go through the bidirectional path: CE1-(AC2)-PE2-(DNI-PW1)-PE1-(PW1)-PE3-(AC3)-CE2.

When a failure occurs in the working PW (PW1), according to the PW protection mechanism [RFC6378], traffic needs to be switched onto the protection PW "PW2". In order to keep the state of AC1 and AC3 unchanged, the forwarder on PE1 needs to connect AC1 to DNI-PW1, and the forwarder on PE2 needs to connect DNI-PW1 to PW2. On the other side, the forwarder of PE3 needs to connect AC3 to DNI-PW2, and the forwarder on PE4 needs to connect PW2 to DNI-PW2. In this way, the state of the ACs will not be impacted by the failure in the PSN network. After the switchover, traffic will go through the bidirectional path: CE1-(AC1)-PE1-(DNI-PW1)-PE2-(PW2)-PE4-(DNI-PW2)-PE3-(AC3)-CE2.

When a failure occurs in the working PE (PE1), it is equivalent to the failures of the working AC, the working PW and the DNI PW. The state of AC2 changes to active based on the AC redundancy mechanism. And according to the PW protection mechanism, traffic is switched on to the protection PW "PW2". In this case the forwarder on PE2 needs to connect AC2 to PW2, and the forwarder on PE4 needs to connect PW2 to DNI-PW2. After the switchover, traffic will go through the bidirectional path: CE1-(AC2)-PE2-(PW2)-PE4-(DNI-PW2)-PE3-(AC3)-CE2.

**3. Generic Dual-homing PW Protection Mechanism**

As shown in the above scenarios, with the described dual-homing PW protection, failures in the AC side will not impact the forwarding behavior of the PWs in the PSN network, and vice-versa. This is achieved by properly setting the forwarding state between the following entities:

- o AC
- o Service PW
- o DNI PW

The forwarding behavior of the dual-homing PE nodes are determined by the forwarding state machine as shown in table 1:

Service PW	AC	DNI PW	Forwarding Behavior
Active	Active	Up	Service PW <-> AC
Active	Standby	Up	Service PW <-> DNI PW
Standby	Active	Up	DNI PW <-> AC
Standby	Standby	Up	Drop all packets
Active	Active	Down	Service PW <-> AC
Active	Standby	Down	Drop all packets
Standby	Active	Down	Drop all packets
Standby	Standby	Down	Drop all packets

Table 1. Dual-homing PE Forwarding State Machine



In order for the dual-homing PEs to coordinate the traffic forwarding during the failures, synchronization of the status information of the involved entities and coordination of switchover between the dual-homing PEs are needed. For PWs with a dynamic control plane, such information synchronization and coordination can be achieved with a dynamic protocol, such as [[RFC7275](#)], possibly with some extensions. For PWs which are manually configured without a control plane, a new mechanism is needed to exchange the status information and coordinate switchover between the dual-homing PEs, e.g. over an embedded PW control channel. This is described in a companion document [[I-D.ietf-pals-mpls-tp-dual-homing-coordination](#)].

#### **4. IANA Considerations**

This document does not require any IANA action.

#### **5. Security Considerations**

The mechanism defined in this document do not affect the security model as defined in [[RFC3985](#)].

With the proposed protection mechanism, the disruption of a dual-homed AC, a component which is outside the core network, would have a reduced impact on the traffic flows in the core network, which could also avoid unnecessary congestion in the core network.

The security consideration of the DNI PW is exactly the same as for Service PWs in the data plane. The co-ordination/control mechanism will have its security analysis in the document that defines the mechanism.

#### **6. References**

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