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# Control Word Option
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## Abstract

This document introduces new IPv6 options for DOH, to carry flow identifier, sequence number, and other customer service mapped information that is encapsulated by the provider network, to support flow-specific treatment, such as statistics, monitoring, QoS, redundancy elimination and reordering, etc.

## 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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This Internet-Draft will expire on 26 June 2026.

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## 1. Introduction

[RFC4385] defines Pseudowire Emulation Edge-to-Edge (PWE3) Control Word for use over an MPLS packet switched network (PSN). It explicitly indicate that the payload behind the MPLS label stack is non-IP, to avoid intermediate nodes always treating payload as IP payload, e.g., in the case of hash function in a load distribution scheme. PW MPLS Control Word (PWMCW) is used to encapsulate PW data packets. PW label is used for flow identification. PWMCW includes Sequence Number field for out of order checking and reordering functions, that is suitable for circuits sensitive to packet out of order, such as Time Division Multiplexed (TDM) circuits. [RFC8964] also defines DetNet Control Word (d-CW) in MPLS data plane. S-label is used for flow identification. d-CW includes Sequence Number field for out of order checking and reordering functions for DetNet flows. The reason for out of order is multi-path transmission, which may be intentional path planning or forced path switching during network failures.

Some provider networks are migrating from MPLS to IPv6. Customer services (including out of order sensitive services) will be uniformly encapsulated in IPv6. The customer services may not be aware of this migrating. However, the service requirement should be smoothly met. The current IPv6 standards lack a unified encapsulation method for the identification and sequence number of original customer flows. Although, an IPv6 flow can be typically identified by 5-tuple (source address, destination address, source port, destination port, and the transport protocol type), some of these fields may be unavailable due to either fragmentation or encryption, or locating them past a chain of IPv6 extension headers may be inefficient. [RFC6437] defines Flow Label, which, combined with Source Address and Destination Address fields, is a more efficient IPv6 flow classification. However, the purpose of flow classification is often to obtain specific treatment from the provider network, instead of a discriminator for the original

customer flows. Multiple customer flows may encapsulate the same Flow Label. [RFC9343] defines the AltMark option, which includes FlowMonID field to identify the monitored flow, but without enough space to define the sequence number. [RFC9566] defines MPLS based d-CW over IPv6, which is high cost and requires the IPv6 data plane to support additional MPLS forwarding logic beyond pure IPv6 forwarding.

This document defines Conctrol Word option in Destination Options Header that includes flow identity, sequence number, and other customer service mapped information to facilitate support for flow-specific treatment, such as statistics, monitoring, QoS, redundancy elimination and reordering, etc.

### 1.1. Requirements Language

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.

## 2. Control Word Option

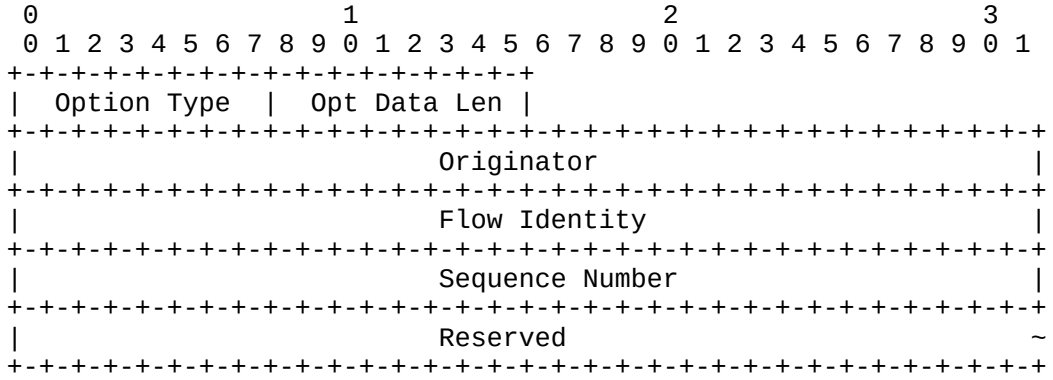


Figure 1

Option Type: 8-bit identifier of the type of option. Value TBD by IANA; the highest-order 3 bits of thie field is 001 to skip over this option and continue processing the header if the processing IPv6 node does not recognize the Option Type and to permit the Option Data to be changed en route to the packet’s final destination.

Opt Data Len: 8-bit unsigned integer. Length of the Option Data field of this option, in octets. It is variable, may set to 12, or other larger values if the Reserved field has been defined in future.

Originator: 32-bit identifier of the originator that specify control word for the customer flow. In general, the originator is the flow entrance node. Note that some intentionally defined forwarding methods may frequently remove and add IPv6 header, resulting in the Source Address field no longer containing the original source address (i.e., the address of the flow entrance node).

Flow Identity: 32-bit identifier of the customer flow, allocated by the originator. It is used to mark packets of a given flow. The value of zero is to indicate unmarked packets.

Sequence Number: 32-bit unsigned integer, represents the sequence number of a packet in a flow, increasing by 1 with each newly sent packet of the same flow. The circular unsigned 32-bit number space excludes the value zero.

Reserved: If Opt Data Len is set to 12, the Reserved field does not exist. The actual length of field Reserved is equal to Opt Data Len minus 12.

## 3. Encapsulation of CW Options On Ingress Node

The flow entrance node, when encapsulating the customer flow with an outer IPv6 header, can explicitly insert a DOH contains CW option in the outer IPv6 header according to the flow states. The DOH must be inserted before the Routing Header (RH), if RH also needs to be inserted.

The flow entrance node can use local algorithm to assign different flow identities to different customer flows. The algorithm can check the 5-tuple of the customer flow to ensure that the generated flow identity value has local uniqueness. Although flow aggregation can map multiple flows to the same traffic class, it is still recommended to assign different flow identities to these member flows.

For a given cutomer flow, the sequence number assigned to the first received packet is 1. For each new packet received, the sequence number increases by 1, until it reaches the maximum value and then cycles back to 1. For consecutive packets of a given flow, their sequence number must be continuous.

The Originator field is set to the unique ID of the flow entrance node within the network.

For MPLS and SRv6 interworking case, the border node should copy Control Word information from the receiving header to the sending header, e.g, from MPLS CW to IPv6 CW.

## 4. Operations of CW Options On Destination

When the packet reaches the node identified in the Destination Address field of the outer IPv6 header, CW option is read and used for flow-specific treatment, such as packet replication and elimination. The destination node may be each segment of Routing Header (RH) or final destination. How to config flow-specific treatment on the destinaiton node and trigger this treatment is out the scope of this document. Note that some processing may need flow states maintained on the node.

The content of CW option must not be modified en route. If the outer IPv6 header is not removed, the DOH with CW option is also not removed. Some intentionally defined forwarding methods may frequently remove and add outer IPv6 header en route, in this case the DOH with CW option should also be removed and added. If there are further outer IPv6 header encapsulated on the outer IPv6 header, e.g., an underlay traffic engineering path, the DOH with CW option is generally not necessary to copy to the further outer IPv6 header, since the flow-specific treatment is not usually configured on nodes along the underlay traffic engineering path to avoid too many flow states on intermediate nodes.

## 5. IANA Considerations

TBD

## 6. Security Considerations

TBD

## 7. Acknowledgements

TBD.

## 8. Normative References

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