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Transport of Layer 2 Frames Over MPLS

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Abstract

This document described a method for transporting the Protocol Data Units (PDUs) of layer 2 protocols such as Frame Relay, ATM AAL5, and ethernet across an MPLS network.

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[1. Specification of Requirements](#)

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](#).

[2. Introduction](#)

In an MPLS network, it is possible to carry the Protocol Data Units (PDUs) of layer 2 protocols by prepending an MPLS label stack to these PDUs. This document specifies the necessary label distribution and encapsulation procedures for accomplishing this. We restrict discussion to the case of point-to-point transport. QoS related issues are not discussed in this draft.

[3. Tunnel Labels and VC Labels](#)

Suppose it is desired to transport layer 2 PDUs from ingress LSR R1 to egress LSR R2, across an intervening MPLS network. We assume that there is an LSP from R1 to R2. That is, we assume that R1 can cause a packet to be delivered to R2 by pushing some label onto the packet and sending the result to one of its adjacencies. Call this label the "tunnel label", and the corresponding LSP the "tunnel LSP".

The tunnel LSP merely gets packets from R1 to R2, the corresponding

label doesn't tell R2 what to do with the payload, and in fact if penultimate hop popping is used, R2 may never even see the corresponding label. (If R1 itself is the penultimate hop, a tunnel label may not even get pushed on.) Thus if the payload is not an IP packet, there must be a label, which becomes visible to R2, that tells R2 how to treat the received packet. Call this label the "VC label".

So when R1 sends a layer 2 PDU to R2, it first pushes a VC label on its label stack, and then (if R1 is not adjacent to R2) pushes on a tunnel label. The tunnel label gets the MPLS packet from R1 to R2; the VC label is not visible until the MPLS packet reaches R2. R2's disposition of the packet is based on the VC label.

If the payload of the MPLS packet is, for example, an ATM AAL5 PDU, the VC label will generally correspond to a particular ATM VC at R2. That is, R2 needs to be able to infer from the VC label the outgoing interface and the VPI/VCI value for the AAL5 PDU. If the payload is a Frame Relay PDU, then R2 needs to be able to infer from the VC label the outgoing interface and the DLCI value. If the payload is an ethernet frame, then R2 needs to be able to infer from the VC label the outgoing interface, and perhaps the VLAN identifier.

Note that the VC label must always be at the bottom of the label stack, and the tunnel label, if present, must be immediately above the VC label. Of course, as the packet is transported across the MPLS network, additional labels may be pushed on (and then popped off) as needed. Even R1 itself may push on additional labels above the tunnel label. If R1 and R2 are directly adjacent LSRs, then it may not be necessary to use a tunnel label at all.

This document does not specify a method for distributing the tunnel label or any other labels that may appear above it on the stack. Any acceptable method of MPLS label distribution will do.

This document does specify a method for assigning and distributing the VC label. Static label assignment MAY be used, and implementations SHOULD provide support for this. If signalling is used, the VC label MUST be distributed from R2 to R1 using LDP in the downstream unsolicited mode; this requires that an LDP connection be created between R1 and R2.

Note that this technique allows an unbounded number of layer 2 "VCs" to be carried together in a single "tunnel". Thus it scales quite well in the network backbone.

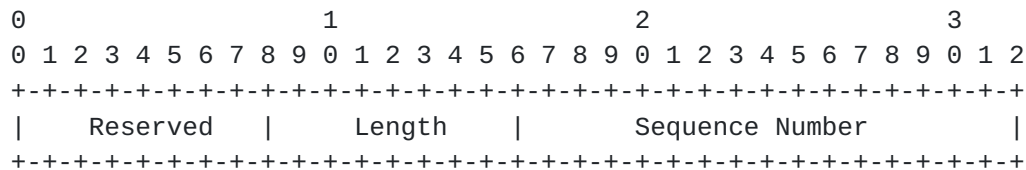
4. Optional Sequencing and/or Padding

Sometimes it is important to guarantee that sequentiality is preserved on a layer 2 virtual circuit. To accommodate this requirement, we provide an optional control word which may appear immediately after the label stack and immediately before the layer 2 PDU. This control word contains a sequence number. R1 and R2 both need to be configured with the knowledge of whether a control word will be used for a specific virtual circuit.

Sometimes it is necessary to transmit a small packet on a medium where there is a minimum transport unit larger than the actual packet size. In this case, padding is appended to the packet. When the VC label is popped, it may be desirable to remove the padding before forwarding the packet.

To facilitate this, the control word has a length field. If the packet's length (without any padding) is less than 256 bytes, the length field **MUST** be set to the packet's length (without padding). Otherwise the length field **MUST** be set to zero. The value of the length field, if non-zero, can be used to remove any padding.

The control word is defined as follows:



The first 8 bits are reserved for future use. They MUST be set to 0 when transmitting, and MUST be ignored upon receipt. The length byte is set as specified above.

The next 16 bits are the sequence number that is used to guarantee ordered packet delivery. For a given VC label, and a given pair of LSRs, R1 and R2, where R2 has distributed that VC label to R1, the sequence number is initialized to 0, and is incremented by one for each successive packet carrying that VC label which R1 transmits to R2.

The sequence number space is a 16 bit unsigned circular space. PDUs carrying the control word **MUST NOT** be delivered out of order. They may be discarded or reordered.

5. Protocol-Specific Issues

5.1. Frame Relay

A Frame Relay PDU is transported in its entirety, including the Frame Relay Header. The sequencing control word is optional.

The BCN and FCN signals are carried unchanged across the network in the frame relay header. These signals do not appear in the MPLS header, and are unseen by the MPLS network.

If the MPLS edge LSR detects a service affecting condition as defined in [2] Q.933 Annex A.5 sited in IA FRF1.1, it will withdraw the label that corresponds to the frame relay DLCI. The Egress side should generate the corresponding errors and alarms as defined in [2] on the Frame relay VC.

The ingress LSR MAY consider the DE bit of the Frame Relay header when determining the value to be placed in the EXP fields of the MPLS label stack.

5.2. ATM AAL5

Only ATM Adaptation Layer 5 (AAL5) is supported. A CPCS-PDU is transported as a single packet without segmentation. No AAL5 trailer is transported. The sequencing control word is optional.

If the edge LSR receives an AIS F5 OAM cell, or fails to receive a pre-defined number of the End-to-End loop OAM cells, or the physical interface is down, it will withdraw the LSP mapping for the VC associated with the failure. The egress LSR will generate AIS F5 OAM, or stop returning/forwarding the End-to-End loop OAM Cells to the remote destination of the VC associated with the withdrawn LSP.

The ingress LSR MAY consider the CLP bit when determining the value to be placed in the EXP fields of the MPLS label stack.

The egress LSR MAY consider the value of the EXP field of the VC label when determining the value of the ATM CLP bit.

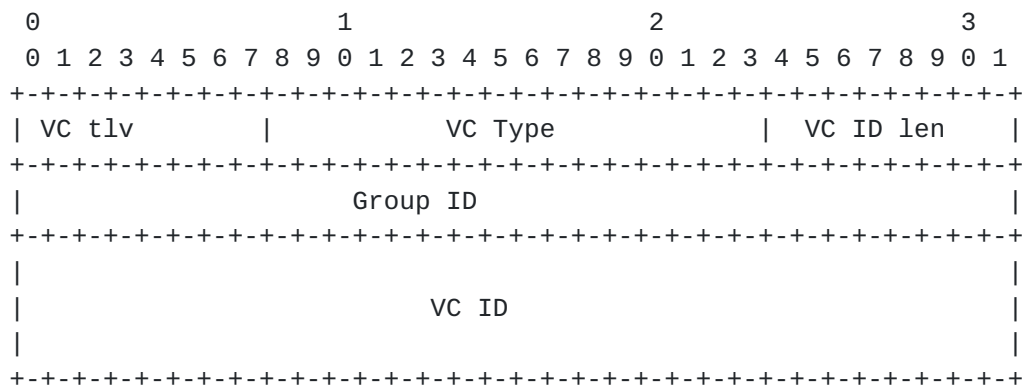
5.3. Ethernet

If the VC label corresponds just to an ethernet interface, then the ethernet frame is sent in its entirety. If the VC label corresponds to a particular VLAN, however, then the VLAN tag should be removed.

6. LDP

The VC label bindings are distributed using the LDP downstream unsolicited mode described in [1]. The LSRs will establish and LDP session using the Extended Discovery mechanism described in [1, [section 2.4-2.5](#)]

A new type of FEC TLV, a VC FEC Element is defined as follows:



- VC Type

A two octet quantity containing a value which represents the type of VC. Assigned Values are:

- 1 - Frame Relay DLCI
- 2 - ATM PVC
- 3 - Ethernet
- 4 - Ethernet VLAN
- 5 - HDLC
- 6 - PPP

- VC ID length

Length of the VC ID field in octets. If this value is 0, then it references all VCs using the specified Link ID

- Group ID

An arbitrary 32 bit value which represents a group of VCs.

- VC ID

Identifies a particular VC. The interpretation of the identifier depends on the VC type:

- * Frame Relay

- A 16-bit DLCI value.

- * ATM

- A 32-bit value representing a 16-bit VPI and a 16-bit VCI.

- * Ethernet

- A port identifier (details TBD).

- * Ethernet VLAN

- A port identifier plus a VLAN tag (details TBD).

- * HDLC

- A port identifier (details TBD).

- * PPP

- A port identifier (details TBD).

7. Security Considerations

This document does not affect the underlying security issues of MPLS.

8. References

- [1] "LDP Specification", [draft-ietf-mpls-ldp-06.txt](#), 10/5/99
- [2] ITU-T Recommendation Q.933, and Q.922 Specification for Frame Mode Basic call control, ITU Geneva 1995
- [3] "MPLS Label Stack Encoding", [draft-ietf-mpls-label-encaps-07.txt](#), 9/13/99

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