February 2020

STRUCTURED FLOW LABEL

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ABSTRACT

This proposal provides a technique to restructure a Flow Label into 4-bits of per-flow flags and 16-bits of entropy within controlled domains. In various implementations, the flags may be used for performance information, Operations, Administration, and Maintenance (OAM), or the like. This proposal may allow providing a premium service on top of Internet Protocol version 6 (IPv6).

DETAILED DESCRIPTION

In an IPv6 network, the "Flow Label" field of an IPv6 header is used to label packets of a flow. However, there is a lack of per-flow flags in the IPv6 header. Such flags are only available in the form of an 8-bit "Traffic Class" field in which the entire 8-bits are allocated to a 6-bit Differentiated Services Code Point (DSCP) indication and a 2-bit Explicit Congestion Notification (ECN) indication. Network operators typically build their own tools for performance monitoring or other purposes. Due to the lack of IPv6 per-flow flags, network operators typically build hacks to be able to provide per-flow flags in the IPv6 header of packets.

The IPv6 Flow Label is currently defined as a 20-bit field in the IPv6 header that is used by a source node to label sequences of packets that are to be treated in a network as a single flow. At IPv6 transit nodes, the 20-bit Flow Label can be used as an entropy for load balancing purposes. However, there is no defined requirement that a 20-bit Flow label is needed for the entropy. Thus, the currently existing 20-bits are unneeded.

Even the hash function suggested in Internet Engineering Task Force (IETF) Request For Comments (RFC) 6437 (https://tools.ietf.org/html/rfc6437#appendix-A),

which defines the IPv6 Flow Label specifications, calculates the flow label hash as 16-bits and then applies a mask of '0xfffff' to fill the remaining 4-bits. In addition, the Linux® kernel (where packets are sourced) computes a flow label as 16-bits (or a multiple of 16-bits) and then applies a mask to zero out the un-needed bits (https://elixir.bootlin.com/linux/v5.4-rc7/source/include/net/ipv6.h#L860).

This proposal provides a technique to restructure the Flow Label field into 4-bits of per-flow flags and 16-bits of entropy within controlled domains. The flags may be used for performance information, OAM, or the like. Figure 1, below, illustrates example details associated with a restructured Flow Label field, as provided by this proposal.

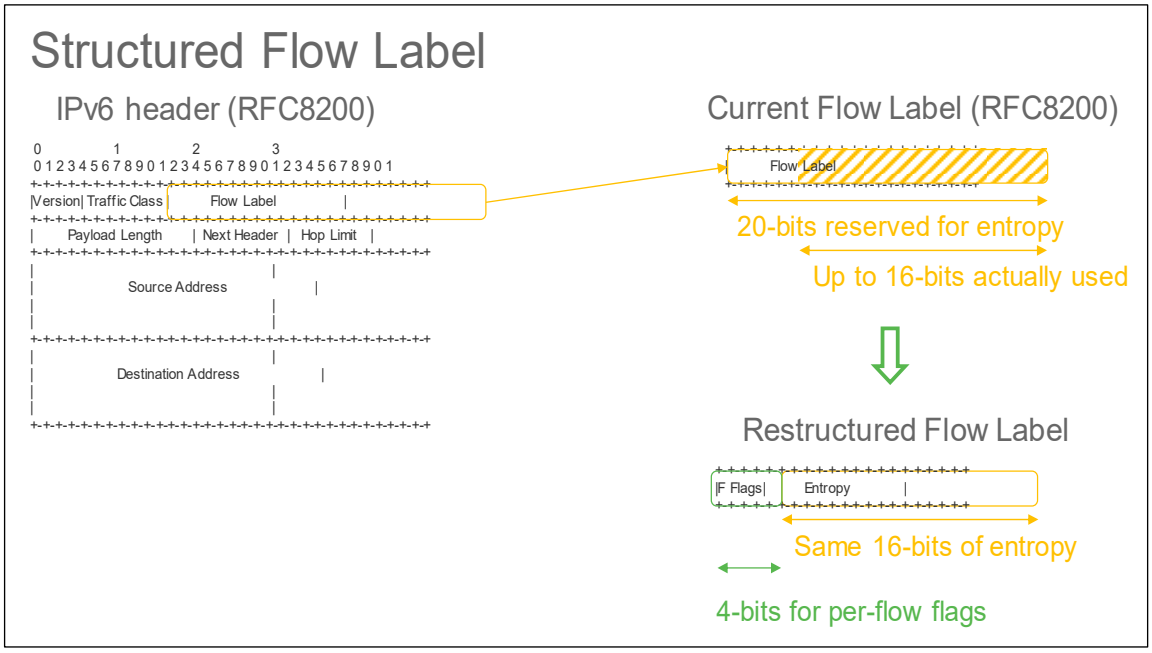

Figure 1

Consider a workflow example involving provider edge (PE) node and provider (P) transit nodes, which may utilize the restructured Flow Label of this proposal. Upon reception of customer traffic, the PE nodes can encapsulate packets in an outer IPv6 header in which a flow label is only encoded in the last 16-bits of the Flow Label (FL) field, FL[4:19], and FL[0:3] is leveraged using the 4-bit per-flow flags.

The P nodes may provide IPv6 transit (forwarding) through load-balancing (LB) operations and inspection of flags in the restructured Flow Label. Load-balancing may include generating an LB-vector using only the last 16-bits of the Flow Label field. Every

IPv6 forwarding node must perform flag inspection to check the per-flow flags. If a flag is active, then a related action for the flag can be performed.

Various additional considerations of the restructured Flow Label field proposed herein may include potential backward compatibility considerations, hardware implementation considerations, and/or entropy requirements. For backward compatibility considerations, if a non-upgraded node is deployed in a given network, then the non-upgraded node can utilize the entire 20-bits of the Flow Label field, including both the flag bits and the entropy bits, for equal-cost multi-path (ECMP) load balancing. Recall that the flags are per-flow, thus, there is no effect on customer traffic regardless of the flags.

For hardware implementation considerations, this proposal may be implemented using a new micro-code profile on a device and can be applied by an operator to all routers in a single domain, thereby enabling the new functionality. The flags may be defined on a per micro-code profile basis. For entropy requirement considerations, the currently existing 20-bits are unneeded, as noted previously.

In summary, this proposal provides a technique to restructure a Flow Label into 4-bits of per-flow flags and 16-bits of entropy within controlled domains. This proposal may allow providing a premium service on top of IPv6.