MPLS Extension Headers: Enabling Extensible In-Network Services in MPLS Networks

draft-song-mpls-extension-header
draft-song-mpls-eh-indicator
draft-andersson-mpls-eh-architecture
draft-andersson-mpls-eh-label-stack-operations

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Version History

• MPLS Extension Header (EH) draft -00 published in July 2018, evolves to -06 today
• MPLS EH Indicator (EHI) draft -00 published in February 2019, evolves to -04 today
• Two MPLS EH Architecture and Operation drafts -00 published in February 2019, evolves to -02 today
Motivation

• In-Network Services over user packets
  • In-situ OAM
  • Network Slicing
  • Service Function Chaining (SFC)
  • Bier
  • Segment Routing/Network Programming
  • Network security, network telemetry ...

• Requirements
  • User packet to encapsulate extra instruction header or metadata
  • Add, process, and remove instruction header or metadata in a network
  • Possibly stack multiple coexisting services on one packet
  • Should support fast data-plane processing

• Supporting In-Network Services in MPLS
Solution – MPLS Extension Headers

• Stop designing piecemeal and incompatible solutions which compete the same resource (e.g., SPL, the location after the label stack)

• Instead, a generic framework once for all: Extension Headers (EH) between MPLS label stack and payload with an in-stack indicator

• Learn the lessons from IPv6 EH!
  • Only end hosts are allowed to add/remove EHs → in network operations
  • Only one HBH header allowed, forcing a hierarchical structure to support multiple HBH options → allow multiple chained HBH headers
  • Need to scan through all the EHs to access the original L4 headers → allow skipping EHs in one step
  • Drop packets with unknown EHs → ignore unknown EHs
  • Not necessarily for fast path → optimized for data plane fast path processing
Requirements

- Flexibility
- Extensibility
- Performance
- Backward compatibility
The In-stack EH indicator (EHI) options

- **MPLS Open DT has decided to not go to the GAL/GACH path**
- **SPL is our preferred method**
- **Proposal has been made to encode the EHI with other information**
EHI SPL

- Redefine unused CoS/TTL field in the EHI SPL
- "H" flag indicates the existence of HBH EH(s)
  - Existence of EHI itself indicates the existence of EHs
  - Help non-EHP-edge-nodes to avoid unnecessary EH checking
- "EH offset" provides the offset of the HEH from the current location
  - Only useful if EHI is not at BoS
  - Could use fewer bits and save some bits for other purpose
MPLS Extension Header (EH)

• Multiple Extension Header(s) can be chained together
  • Each EH indicates the length of itself and the type of the next EH
  • EH type could adopt the standard Internet protocol numbers
  • For better extensibility, an EH could have subtypes, specified in a subfield

• Special Next Header types
  • “NONE”: no next EH and payload, for special packets (e.g., probe)
  • “UNKNOWN”: only in last EH, indicate the payload type is unknown
  • “MPLS”: another MPLS label stack follows

• EHs are located after BoS
  • If GAL/GACH is present, located after GACH

• All EHs can be jumped in one step
  • A Header of EH summarize the EH stack

• Support E2E and HBH types
  • E2E EHs are located below HBH EHs
MPLS EH Format Details

- Up to 15 EHs in a packet allowed
- Maximum lengths of EHs is 1K Bytes
- Allow HEH + 0 EH
Performance Optimization using FEC labels

• The need to find EHI below ToS could be a performance concern
• When establishing an LSP, two FEC labels are advertised, and one of it means “No EH in the packet”
• EH-incapable nodes do the regular forwarding
• EH-capable nodes
  • If regular label is received, need to examine if there are EHs in the packet
    • If yes, use regular label to forward the packet
    • If not, use “No EH” FEC label to forward the packet
  • If “No EH” label is received
    • If the node doesn’t add EH to the packet, no need to examine EH, continue to use “No EH” label to forward the packet
    • Otherwise, use regular label to forward the packet
Hardware Implementation Considerations

• Design for simplicity and performance
  • A simple post-stack EH header chain with a simple in-stack indicator can minimize the parser FSM size (storage) and depth (latency)
  • HBH EHs listed before E2E EHs to maximize the usability given limited header buffer size
  • Prefer to put the EH indicator at the BoS for simplicity and backward compatibility
    • Could use FEC labels to avoid unnecessary label stack scanning
Summary

- EH is a generic solution for MPLS in-network services
  - Built on common industry practices
  - Keep performance, flexibility, and extensibility in mind
- EH is especially compelling for MPLS
  - MPLS label stack overhead is much smaller than IPv6
  - MPLS is protocol independent, can encapsulate various protocols
  - No too much history burden. More freedom for innovations