Transmission of SCHC-compressed packets over IEEE 802.15.4 networks

draft-ietf-6lo-schc-15dot4-01

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Introduction (I)

Assumptions:
- Best case, global addr.
- CoAP
  a) No header options
  b) Table 6, RFC 8824

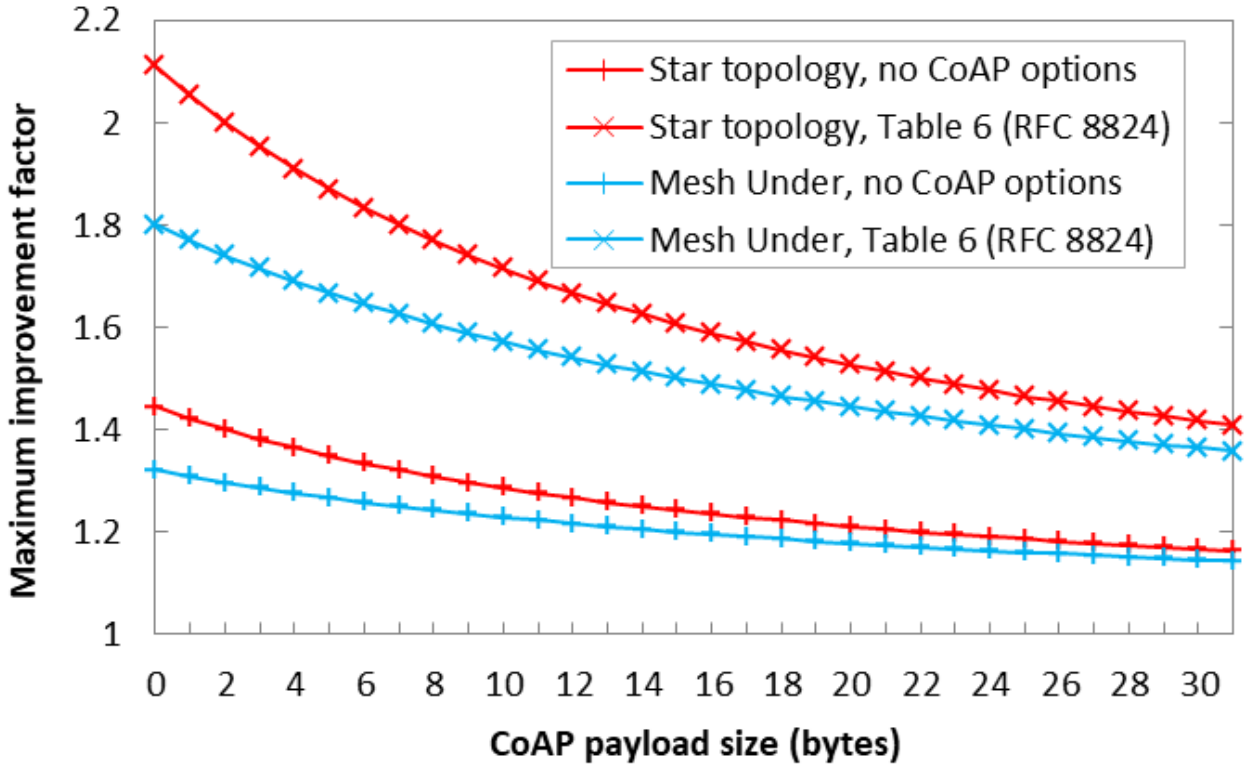
- IPv6/UDP/CoAP header size

	IPv6/UDP (bytes)	CoAP (bytes)		TOTAL (bytes)	
		a)	b)	a)	b)
No compression	48	4	16	52	64
6Lo(WPAN) - RFC 6282	7	4	16	11	23
SCHC - RFC 8724, 8824	1	1	1	2	2

  - SCHC: static context, a priori knowledge of header field values
- Theoretical battery lifetime improvement over IEEE 802.15.4 by a factor up to >2
  - Actual improvement will be lower, depending on device HW, MAC/adaptation/application layer settings, payload size, network topology, etc.

Introduction (II)

- Maximum battery lifetime improvement factor
  - Short MAC addresses, intra-PAN
  - E.g. a battery-operated sensor that periodically sends a message over IEEE 802.15.4



NOTE: actual improvement will be lower

Status

- WG adoption
  - draft-ietf-6lo-schc-15dot4-00
    - Same content as draft-gomez-6lo-schc-15dot4-05
  - In January 2023

- Version -01
  - Several significant additions
  - A new co-author

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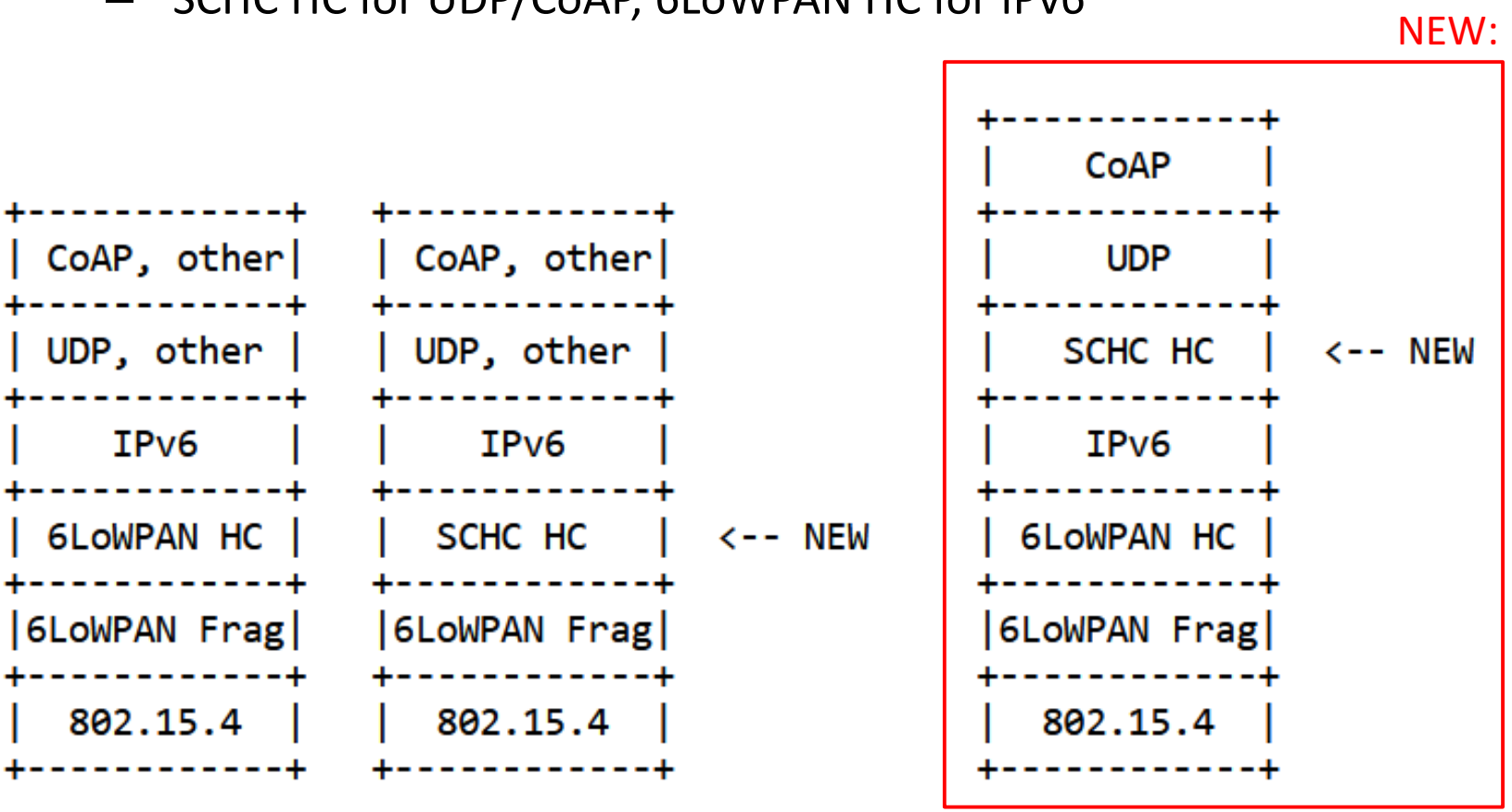
March 2023

Table of Contents

Major updates

3.1. Protocol stack

- Transition protocol stack
  - Intended to ease a transition from existing 6LoWPAN implementations to introduce support for SCHC
    - SCHC HC for UDP/CoAP, 6LoWPAN HC for IPv6



3.3. Multihop communication

- 3.3.1. Straightforward Route-Over approach
  - All nodes MUST store all the Rules in use in the network
  - Suitable for small, stable networks, and/or without memory issues

- 3.3.2. Tunneled, RPL-based Route-Over approach
  - An endpoint MUST store the Rules for the communications it is involved in (as an endpoint)
  - RPL non-storing mode, IPv6-in-IPv6 tunnels, and RFC 8138

NEW:

- 3.3.3. Pointer-based Route-Over approach
  - As in 3.3.2, intermediate nodes do not have to store the Rules
  - Does not require 3.3.2 artifacts:
    - RPL non-storing mode, IPv6-in-IPv6 tunnels, and RFC 8138

- 3.3.4. Mesh-Under approach
  - An endpoint MUST store the Rules for the communications it is involved in

3.3.2. Tunneled, RPL-based R.O. (I)

- RPL non-storing mode
- Overview:
  - Packets sent by a 6LN are tunneled Upward to the root
  - If the final destination is another 6LN, packets are tunneled Downward from the root
  - RFC 8138 to compress routing artifacts
- RFC 9008:
  - Downward traffic:
    - IPv6-in-IPv6 tunnel (except when the root is the packet source)
    - Tunnel terminates at the 6LN (if it is a RAL) or last 6LR (if 6LN is a RUL)
  - Upward traffic:
    - IPv6-in-IPv6 by the 6LR, if 6LN is a RUL (no tunnel if destin. is the root)
    - IPv6-in-IPv6 (“may”) from the 6LN, if the 6LN is a RAL

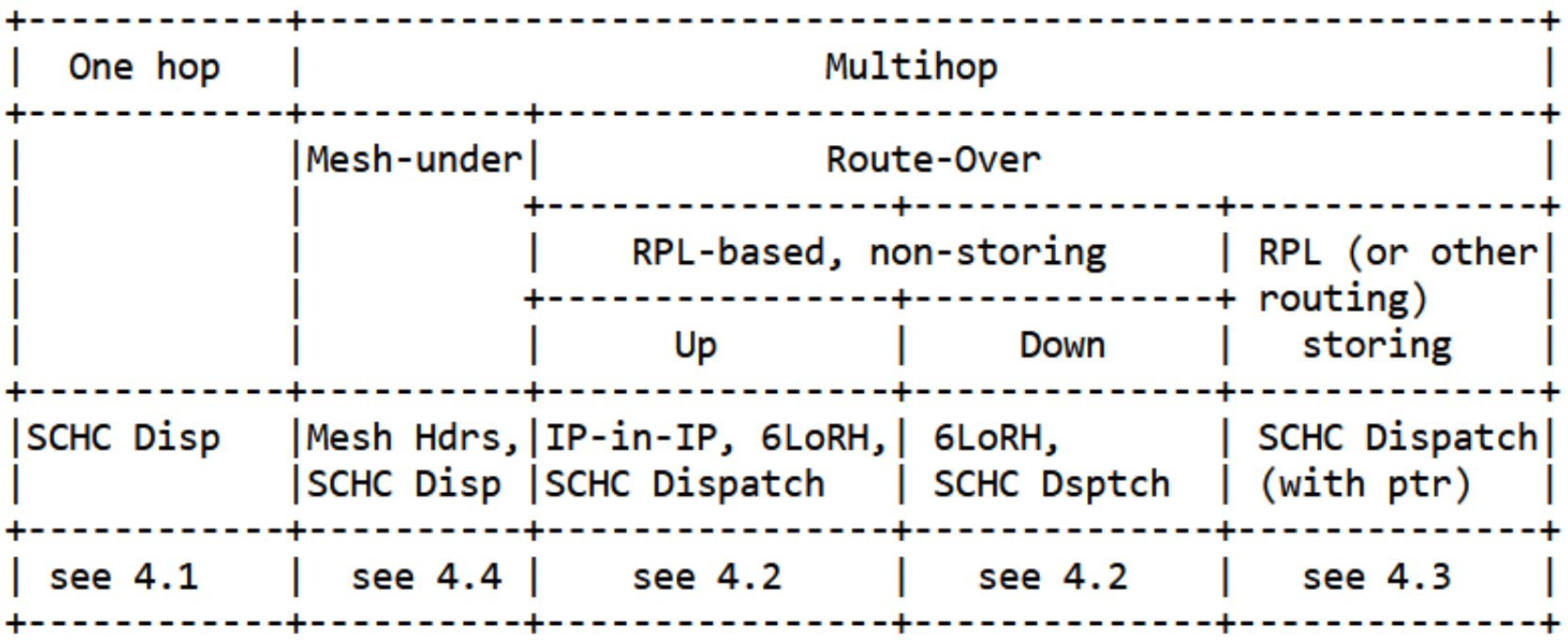
3.3.2. Tunneled, RPL-based R.O. (II)

- Upward traffic:
  - When a 6LN transmits a SCHC-compressed IPv6 packet, it MUST be tunneled by means of IPv6-in-IPv6 up to the root, regardless of the final destination
  - If the 6LN is a RUL: (NEW)
    - » IPv6-in-IPv6 encapsulation performed by the first 6LR
    - » The first 6LR SHOULD be provided with SCHC Rules for the packets sent by that 6LN
- Downward traffic:
  - If the 6LN is a RUL: (NEW)
    - » The last 6LR SHOULD be provided with SCHC Rules for the packets sent to that 6LN

3.3.3. Pointer-based Route-Over

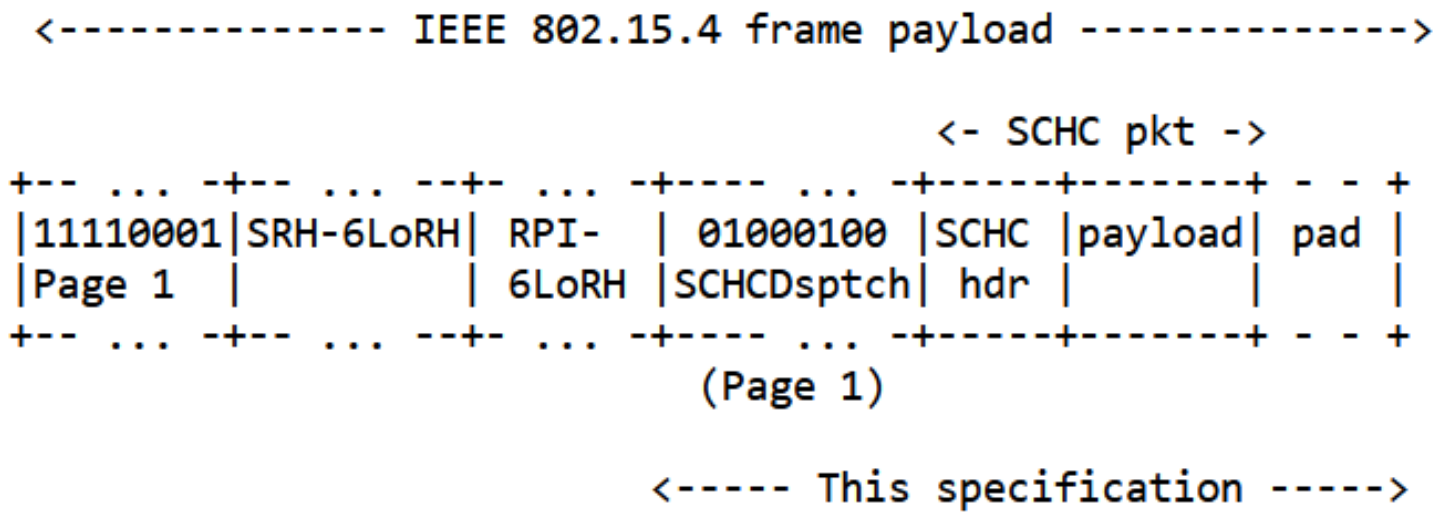
- An alternative to the tunneled, RPL-based approach for Route-Over
- Overview:
  - A SCHC Pointer is added after the SCHC Dispatch
  - The SCHC Pointer indicates the location and length of the destination address residue in the SCHC header
- Assumption:
  - The destination is within the same IEEE 802.15.4 network
    - IPv6 destination prefix is the same as the prefix used subnet-wide
- Features:
  - Compatible with RPL storing mode or other routing protocols
  - Intermediate nodes do not need to store the Rules for all communicating endpoints

3.4. Summary


One hop
Multihop
Mesh-under
Route-Over
RPL-based, non-storing
RPL (or other routing)
Up
Down
storing
SCHC Disp
Mesh Hdrs, SCHC Disp
IP-in-IP, 6LoRH, SCHC Dispatch
6LoRH, SCHC Dsptch
SCHC Dispatch (with ptr)
see 4.1
see 4.4
see 4.2
see 4.2
see 4.3

4. Frame formats (I)

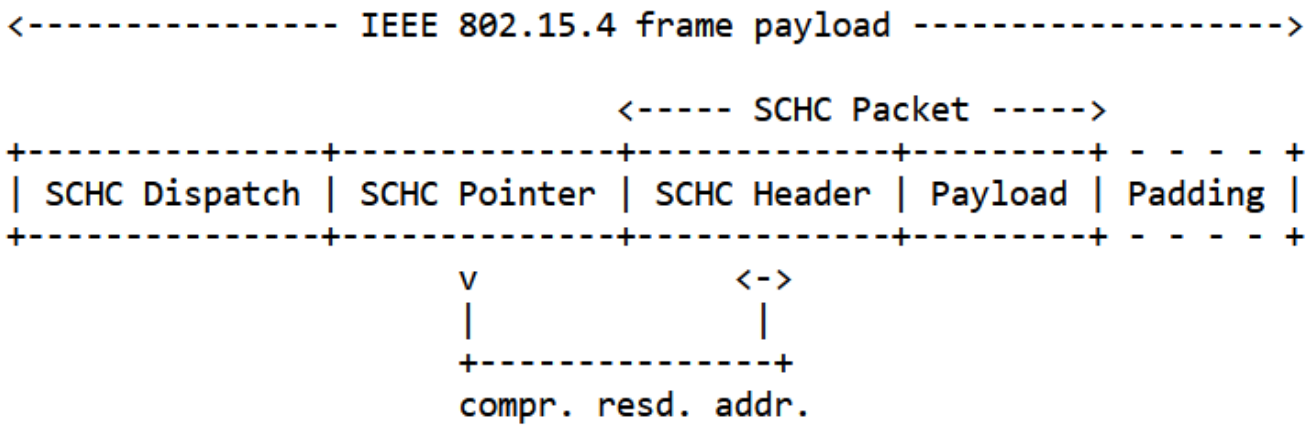
- 4.2. Tunneled, RPL-based Route-Over:
  - Downward, when the source is the RPL root



  - This case is an exception:
    - No tunnel (IPv6-in-IPv6) encapsulation is needed

4. Frame formats (II)

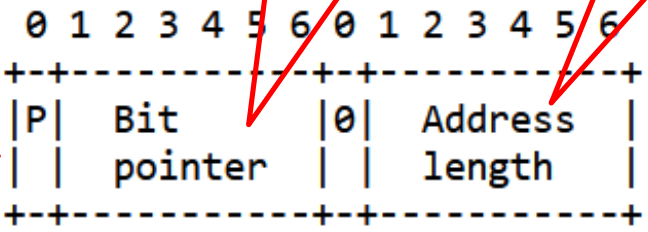
- 4.3. Pointer-based, Route-Over frame format:



- SCHC Pointer:

Starting position of IPv6 destination address residue

Length of IPv6 dest. address residue

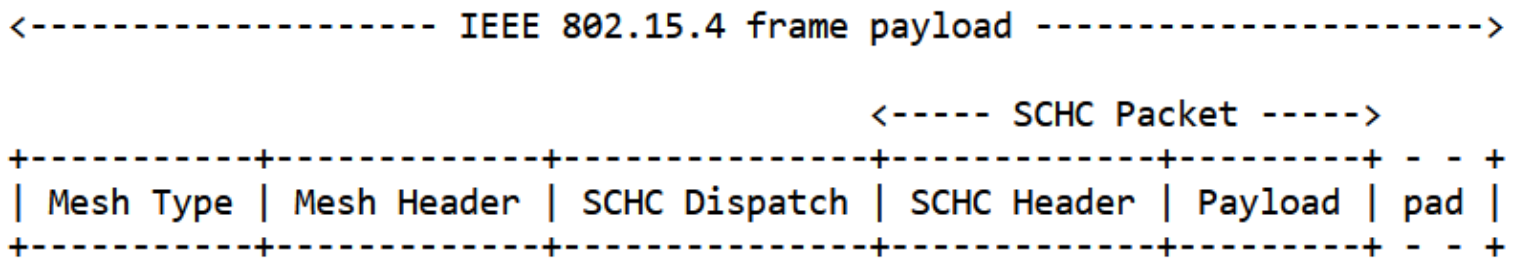


The next fields are present or not

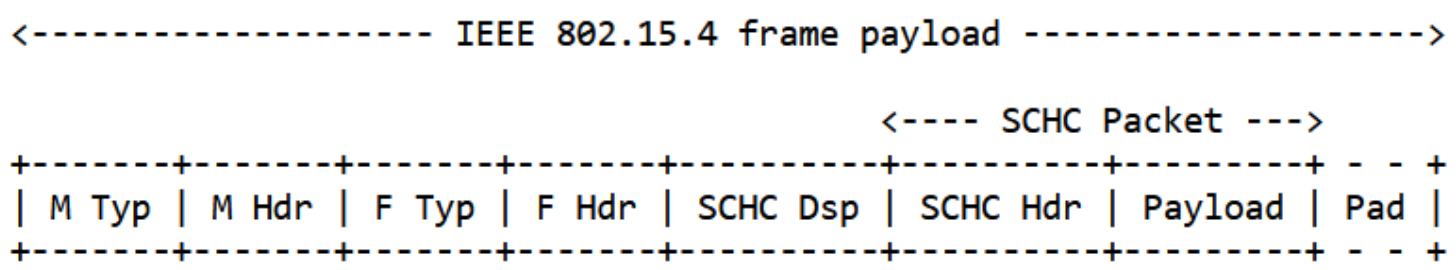
TO-DO: consider a second SCHC Dispatch for SCHC Pointer

4. Frame formats (III)

- 4.4. Mesh-Under frame formats
  - Same as in RFC 4944, but with SCHC Dispatch
  - No fragmentation:

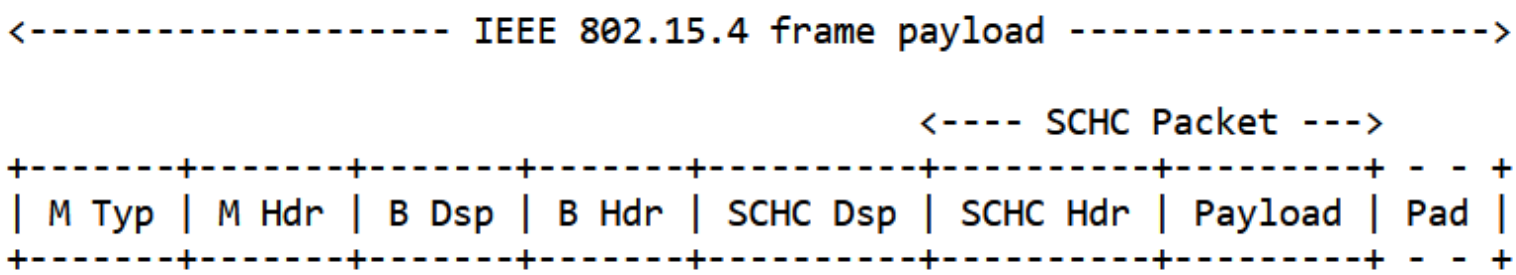


  - Fragmentation:



4. Frame formats (IV)

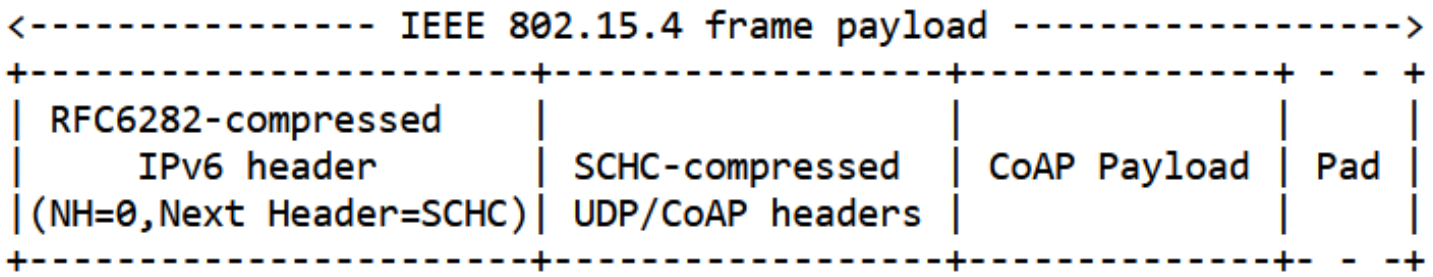
- 4.4. Mesh-Under frame formats
  - No fragmentation, broadcast:



  - As in RFC 4944, when more than one header needed, headers appear in the following order:
    - Mesh Addressing Header, Broadcast Header, Fragmentation Header

5. Enabling the transition protocol stack

- Exploiting INTAREA WG on-going work to define an Internet Protocol Number for SCHC
  - draft-ietf-intarea-schc-ip-protocol-number



  - RFC 6282 is used to compress the IPv6 header
    - NH=0
    - Next Header = SCHC (8 bits, uncompressed)

6.1.2. UDP checksum field

- RFC 8724:
  - “a SCHC compressor MAY elide the UDP checksum when another layer guarantees at least equal integrity protection for the UDP payload and the pseudo-header”
- IEEE 802.15.4 carries a 16-bit FCS computed by using ITU-T 16-bit CRC
  - Same size as the UDP checksum
  - Greater error detection capabilities than UDP checksum
  - IEEE 802.15.4 CRC checked at each hop
- The UDP checksum MUST be elided when using SCHC to compress UDP headers

7. Neighbor Discovery

- Several Neighbor Discovery optimizations developed for 6LoWPAN or 6lo
  - E.g., RFC 6775, RFC 8505

- SCHC can also be used to compress 6LoWPAN Neighbor Discovery messages
  - As of the writing, SCHC compression of ICMPv6 or ICMPv6-based protocols has not been specified
    - Currently, only the IPv6 header can be compressed
  - Future specifications may define how ICMPv6 and 6LoWPAN ND messages can be compressed by means of SCHC
  - New SCHC WG new charter:
    - Includes “ICMPv6-based protocols” over SCHC

10. Security considerations

- To compress CoAP headers with SCHC:
  - "As in RFC 8824, the use of a cryptographic integrity-protection mechanism to protect the SCHC headers is REQUIRED"
- Question: perhaps, could a "SHOULD" be considered here?
  - Motivation for using SCHC is performance
  - MUST/REQUIRED for LPWAN networks, where link-layer security is being used, but what if there is a network without link-layer security (as allowed in IEEE 802.15.4)?

Comments/Questions?

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