Introduction to SCHC (RFC8724)

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Agenda

- LPWANs characteristics
- Header Compression at IETF
- SCHC compression
- SCHC fragmentation
- Applying SCHC

LPWANs characteristics

- See RFC8376
- Very low datarates
  - Down to 100 bits per second
- Small payloads
  - Down to a dozen of bytes
- High transmission cost
  - Battery lifetime, time-on-air
- Star topology, asymmetric links

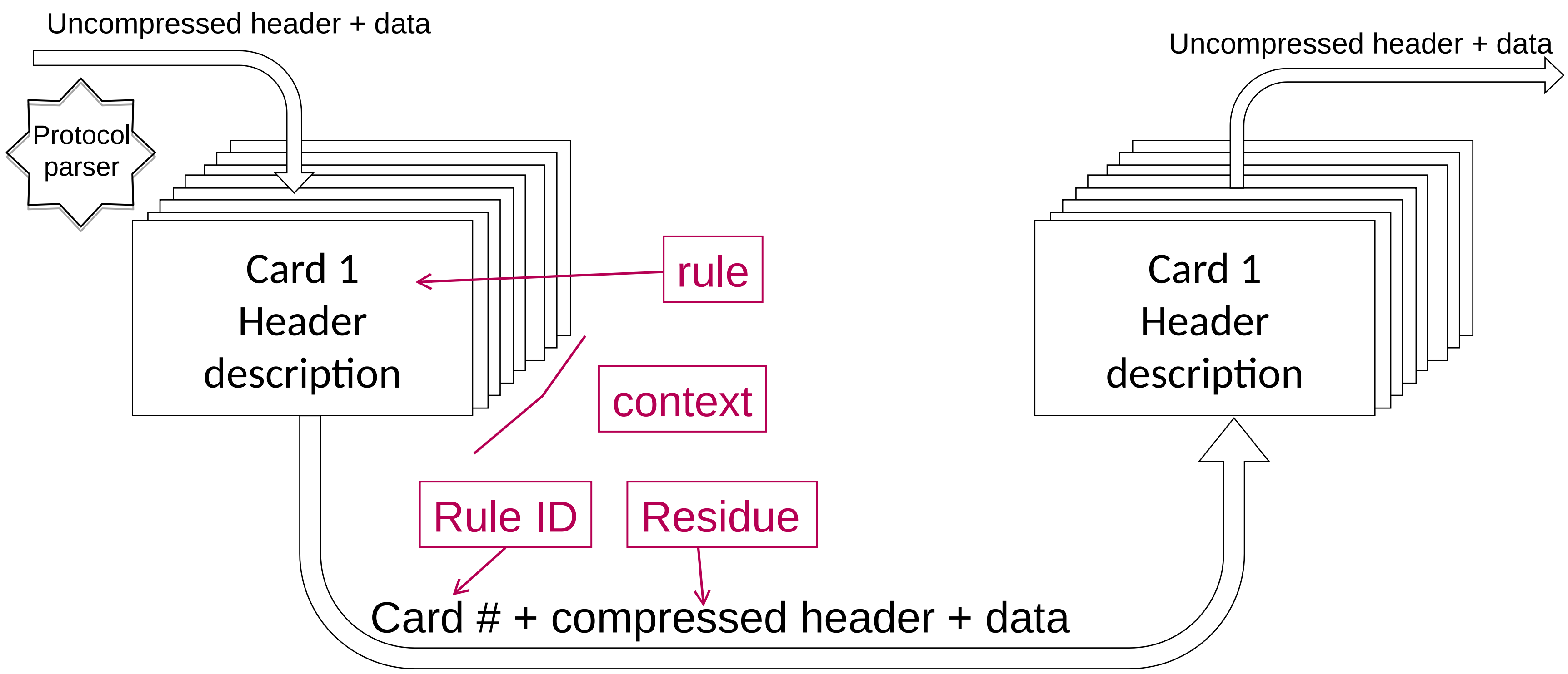
	LPWAN technologies		
	LoRaWAN	**Sigfox**	**NB-IoT**
Frequency band(s) (MHz)	868 (EU), 915 (US), 783 (China)	868 (EU), 915 (US), 923 (Japan)	Various: 416 (min), 2200 (max)
Type of band	Unlicensed	Unlicensed	Licensed
Modulation	CSS	DBPSK (uplink), GFSK (downlink)	π/2-BPSK or π/4-QPSK (upl.), QPSK (downlink)
Receiver sensitivity (dBm)	-137 (typical)	-142 (typical)	-141 (typical)
PHY layer data rate (kbit/s)	0.25 ÷ 5.47 (EU), 50 (optional)	0.1/0.6	250 (uplink), 226.7 (downlink)
Message rate constraints	Duty cycle < 1% (EU, China)	140/4 messages per day (uplink/downlink)	No
Capacity per device (order of magnitude, in bit/s)	10^{0} (DR0, EU), 10^{2} (DR5, EU)	10^{-1} (uplink) 10^{-3} (down.)	10^{4}
MAC mechanism	Aloha-based (optional ACKs + retries)	Aloha-based (3 transmissions)	Slotted Aloha (random access) + scheduling
Maximum frame payload size (bytes)	11 (DR0, USA) ÷ 242 (worldwide)	12 (uplink), 8 (downlink)	1600
Fragmentation and reassembly	No	No	Yes
Network topology	Star	Star	Star
Standards Developm. Organization	LoRa Alliance ™	Sigfox (company)	3GPP

Gomez, Carles & Minaburo, Ana & Toutain, Laurent & Barthel, Dominique & Zuniga, Juan-Carlos. (2019). IPv6 over LPWANs: connecting Low Power Wide Area Networks to the Internet (of Things). IEEE Wireless Communications.

Header Compression at IETF

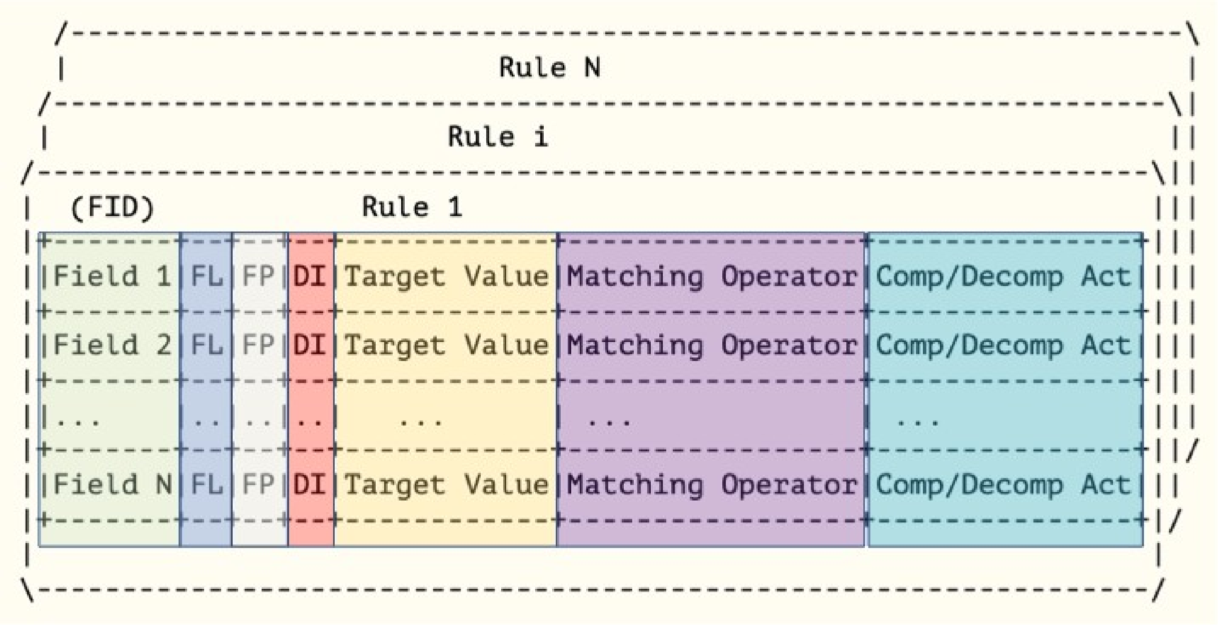
- Van Jacobson (RFC1144, Feb 1990)
  - Custom TCP/IPv4 intraflow header compression for slow links
- ROHC (2001-2013)
  - rule-based, dynamic context with feedback
- 6LoWPAN (RFC6282, Sept 2011)
  - Stateless IPv6 header compression for constrained mesh networks
- SCHC (RFC8724, Apr 2020)
  - Stateless, rule-based, static context compression for extremely constrained links
  - Also specifies fragmentation (3 different modes)

SCHC compression basic principles



SCHC compression

- Match packet header against list of fields in candidate Rule
  - Matching operator
- If match, implement Compression Action



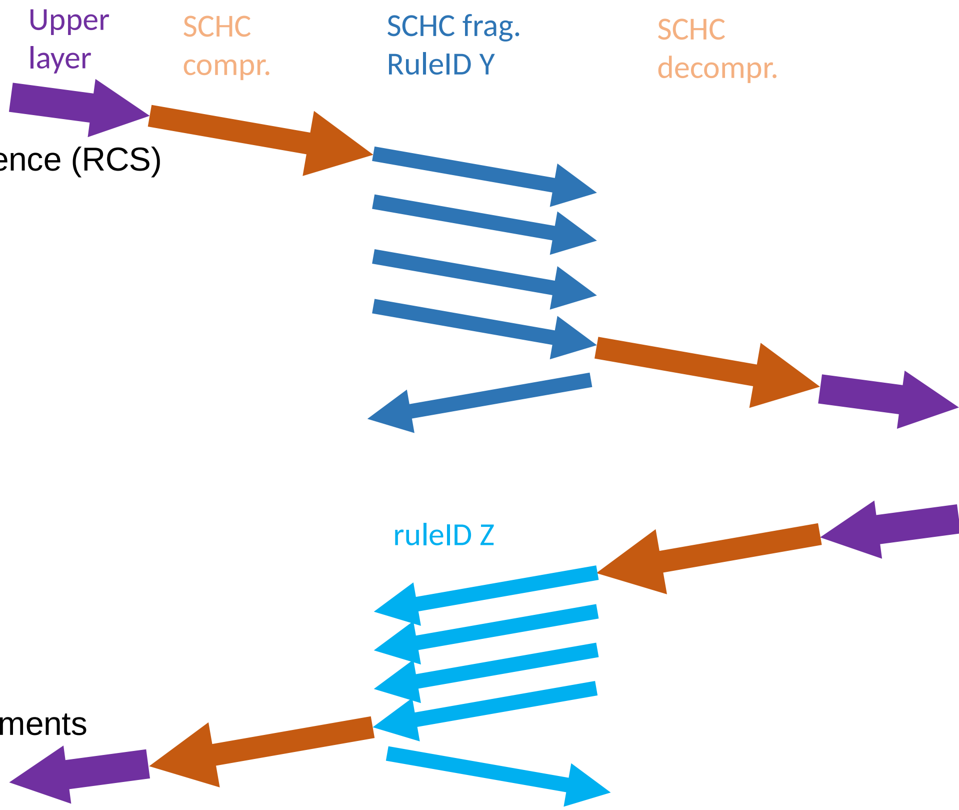
- On Decompressor side, retrieve Rule by ID and rebuild header based on Decompression Action and residue

UDP/IPv6 compression example

FID	FL	FP	DI	TV	MO	CDA	Sent [bits]
IPv6 Version	4	1	Bi	6	ignore	not-sent	
IPv6 Diffserv	8	1	Bi	0	equal	not-sent	
IPv6 Flow Label	20	1	Bi	0	equal	not-sent	
IPv6 Length	16	1	Bi		ignore	compute-*	
IPv6 Next Header	8	1	Bi	17	equal	not-sent	
IPv6 Hop Limit	8	1	Bi	255	ignore	not-sent	
IPv6 DevPrefix	64	1	Bi	[alpha/64, fe80::/64]	match-mapping	mapping-sent	1
IPv6 DevIID	64	1	Bi		ignore	DevIID	
IPv6 AppPrefix	64	1	Bi	[beta/64, alpha/64, fe80::64]	match-mapping	mapping-sent	2
IPv6 AppIID	64	1	Bi	::1000	equal	not-sent	
UDP DevPort	16	1	Bi	8720	MSB(12)	LSB	4
UDP AppPort	16	1	Bi	8720	MSB(12)	LSB	4
UDP Length	16	1	Bi		ignore	compute-*	
UDP checksum	16	1	Bi		ignore	compute-*	

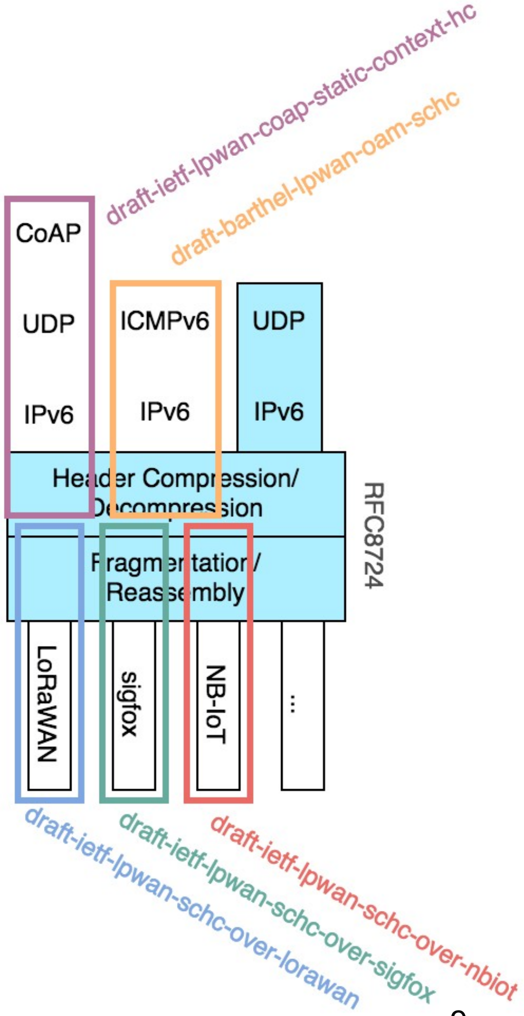
SCHC fragmentation

- No-ACK
  - Last fragment contains a Reassembly Check Sequence (RCS)
  - Receiver checks RCS to detect fragment losses
- ACK-Always
  - Fragments are grouped into windows
  - Each window is ACK'ed with bitmap of fragments
  - Missing fragments are retransmitted
  - Final window ACK also includes RCS status
- ACK-on-Error
  - Packets are divided into tiles and windows
  - Last window is ACK'ed
  - Extra ACKs sent only for windows with missing fragments
  - Supports MTU change during retransmission



Applying SCHC

- SCHC (RFC8724) is a generic mechanism
  - first applied between IP and link layer,
  - can also be used elsewhere in the stack
- Upcoming RFCs will
  - pick options and parameters
    - to fit underlying layers characteristics
  - specify SCHC rules, extensions, architecture
    - to support more upper-layers
    - e.g., OSCORE/CoAP two-layer compression



Thank you!