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INTRODUCTION TO OPENSCHC

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STANDARDS ECOSYSTEM

RFC 8376, 8724, 8824, 9011 – TS 10

LoRa Alliance® Launches IPv6 Over LoRaWAN®; Opens Wide Range of New Markets for LoRaWAN

Fremont, Calif. – May 17, 2022 – The LoRa Alliance®, the global association of companies backing the open LoRaWAN® standard for the internet of things (IoT) low-power wide-area networks (LPWANs), today announced that LoRaWAN now seamlessly supports Internet Protocol version 6 (IPv6) from end-to-end. By expanding the breadth of device-to-application solutions with IPv6, LoRaWAN's addressable IoT market is also broadened to include internet based standards required in smart electricity metering and new applications in smart buildings, industries, logistics, and homes.

The new IPv6 adaptation layer facilitates and accelerates development of secure and interoperable applications over LoRaWAN and builds on the alliance's commitment to ease of use. IP-based solutions, commonly found in enterprise and industrial solutions, among many others, can now be transmitted over LoRaWAN, and easily integrated with cloud infrastructures. This allows developers to quickly enable internet-based applications, while significantly reducing time-to-market and total cost of ownership.

"As digitization across market sectors continues, integrating multiple technologies to achieve end-to-end solutions is critical," said Donna Moore, CEO and Chairwoman of the LoRa Alliance. "At the same time, companies are requiring solutions that provide increased interoperability and adhere to standards. Now that LoRaWAN readily integrates with any IP application, end users have both. IPv6 is a core technology underpinning IoT, so enabling IPv6 over LoRaWAN opens a huge number of new markets and a much larger addressable application space to LoRaWAN. Developers and end users with IPv6 devices recognize the benefits of digital transformation and IoT, and already create solutions that can improve lives and the environment, as well as drive new revenue streams. By supporting IPv6, they now have a

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Verticals

Smart Buildings / Facilities Management, Smart Homes / Consumer, Smart Industry / Industrial IoT, Smart Metering / Smart Utilities, Transportation / Logistics / Supply Chain

OPENSCHC

Open source
  https://github.com/openschc

Written in Python during IETF Hackathon

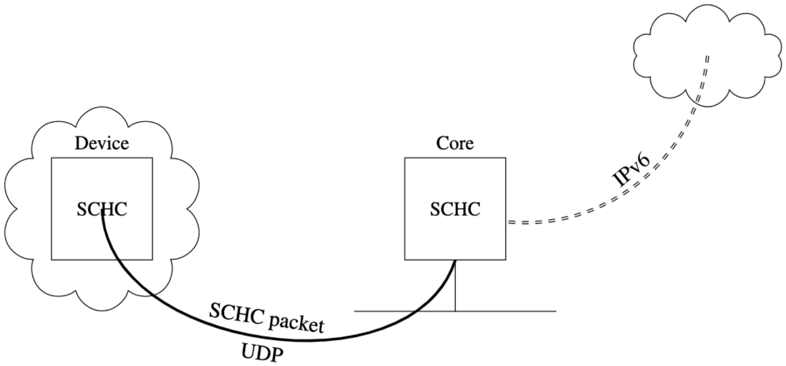
Goal:
  Understand SCHC protocol
  Test new algorithms
  Used for RFC 8724

Interface with:
  UDP tunnels
  LoRaWAN LNS

Book of SCHC / Tutorial at WFIoT2022

OPENSCHC

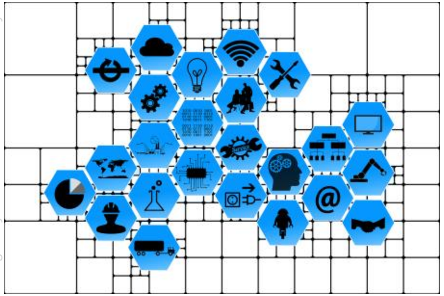
- Open source
  - **https://github.com/openschc**
- Written in Python
- Goal:
  - **Understand SCHC protocol**
  - **Test new algorithms**
  - **Standardization of RFC 8724**
- Interface with:
  - **UDP tunnels**
  - **LoRaWAN LNS**



Book of SCHC / Tutorial at WFIoT2022 / MOOC IMT (dec 2022)

INTERNET PROTOCOLS

Images by Gerd Altmann from Pixabay



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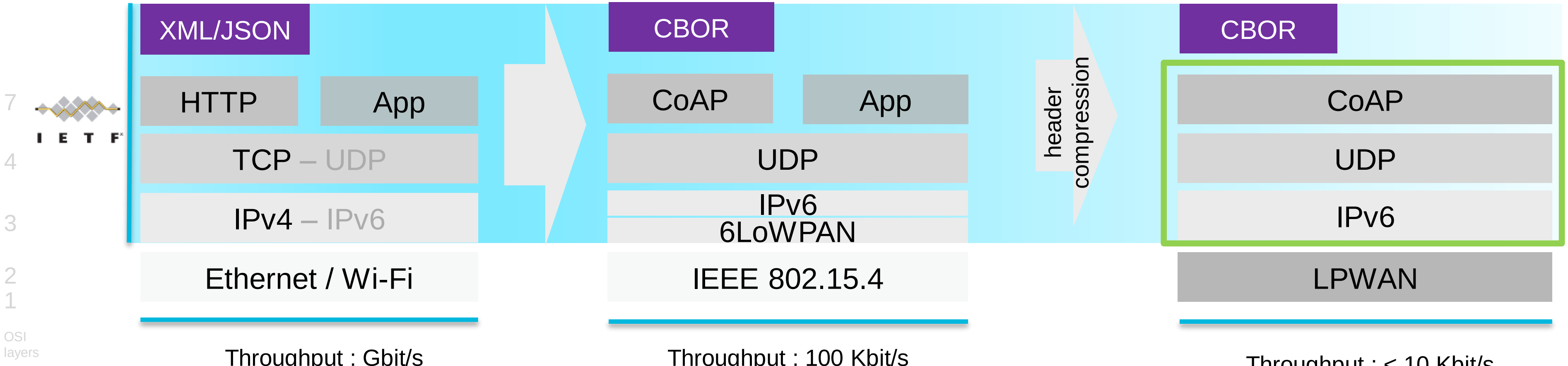


Throughput : Gbit/s
MTU : ~1000 Bytes

Throughput : 100 Kbit/s
MTU : ~100 Bytes

Throughput : < 10 Kbit/s
MTU : ~10 Bytes

DESIGN PRINCIPLES

Assumes

- rare configuration/application changes
- very constrained transmission (energy, time on air)
- constrained memory, not-so-constrained computation
- point-to-point link, no out-of-order delivery

Supports

- unidirectional/asymmetric or bidirectional links
- constant or variable MTU

Provides

- adaptable mechanism
- extreme header compression
- efficient fragmentation
- little control dialog

GLOBAL ARCHITECTURE

SCHC: “*Static Context Header Compression and fragmentation*”

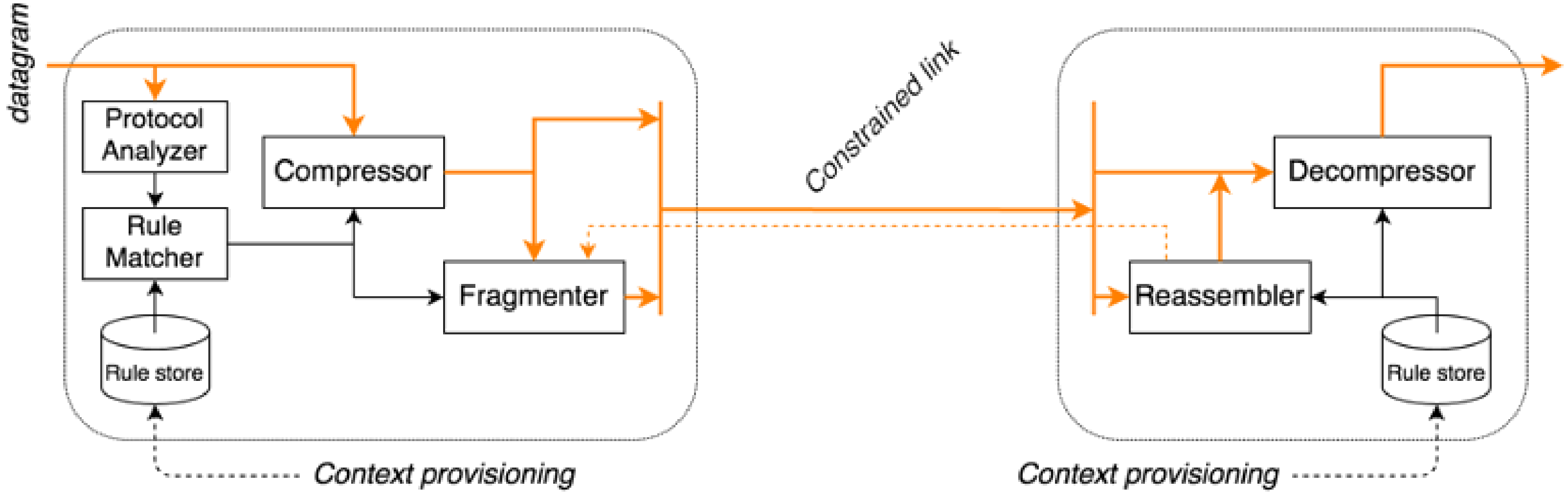
Context is static for the duration of the communication

- Contains Compression Rules, Fragmentation Rules

Compression is conducted according to Rule with a pattern matching the datagram

- results in a Rule Identifier + Compression Residue

Fragmentation is applied if needed (Fragments, ACKs, …)



RULE IDENTIFIERS

SCHC messages start with the RuleID

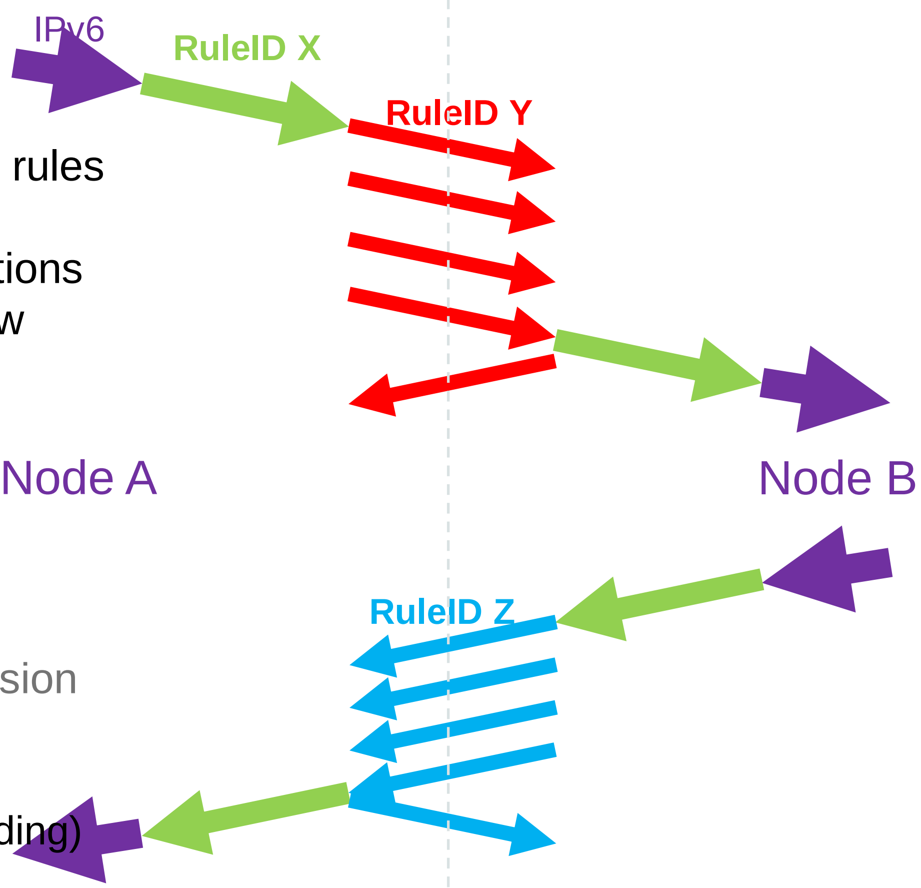
RuleID identifies Fragmentation and Compression rules

- Compression rules are used for both flow directions
- Fragmentation parameters are used for one flow direction

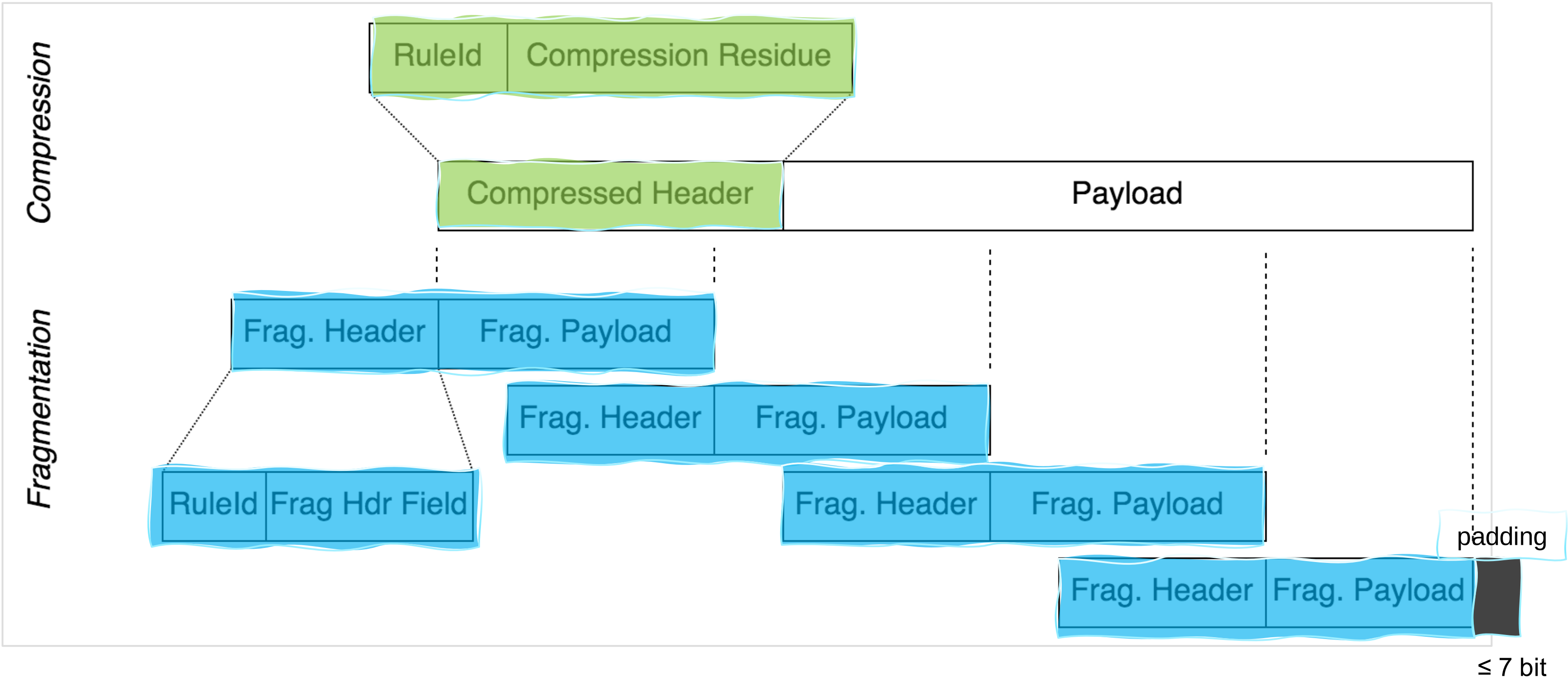
A special RuleID must be defined for No Compression

RFC 8724 does not mandate RuleID size

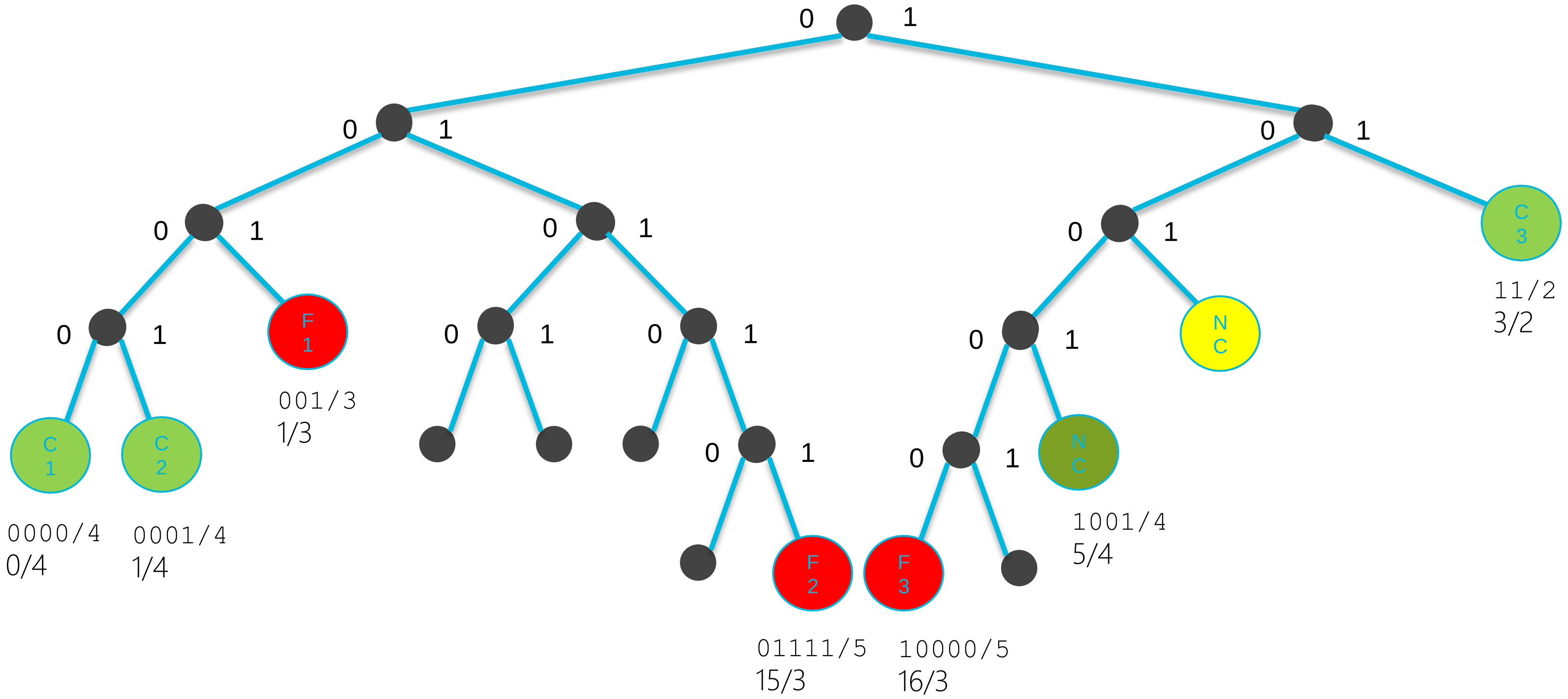
- RuleID could even be of variable size (entropic coding)



SCHC GENERIC FRAMEWORK



RULE ID BINARY TREE



OPENSCHC RULES

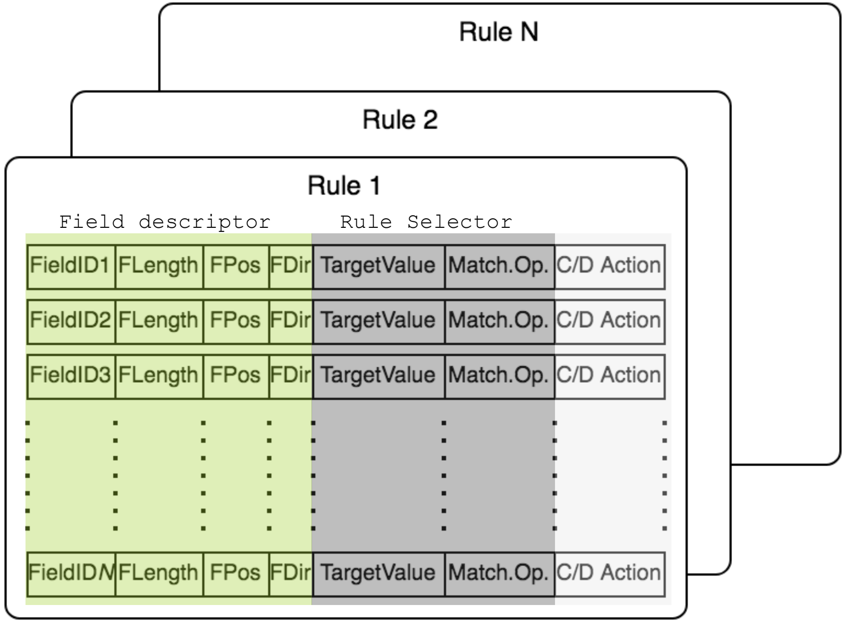
```
from gen_rulemanager import *

RM = RuleManager()

rule1100 = {
  "RuleID" : 12,
  "RuleIDLength" : 4,
  "Compression" : []
}

rule001100 = {
  "RuleID" : 12,
  "RuleIDLength" : 6,
  "Fragmentation" : {
    "FRMode" : "noAck",
    "FRDirection" : "UP"
  }
}

RM.Add(dev_info=rule1100)
RM.Add(dev_info=rule001100)

RM.Print()
```

```
****************************************
Device: None
/-------------------------\
|Rule 12/4          1100  |
|---------------+---+--+--+------------------------------+-------------+----------------\
\---------------+---+--+--+------------------------------+-------------+----------------/
/-------------------------\
|Rule 12/6        001100  |
!=========================+=============================================================\
!^ Fragmentation mode : noAck    header dtag 2 Window  0 FCN  3                     UP ^!
!^ No Tile size specified                                                              ^!
!^ RCS Algorithm: crc32                                                                ^!
\=======================================================================================/
```

HEADER COMPRESSION

Field descriptor:

- Field expected Position
- Field expected Length
  - may be Variable:
    Compression Residue Length needs to be transmitted
- Direction Indicator
  - Allows sharing customized Rule between uplink/downlink
  - E.g., IPv6 Source/Destination prefixes swapped



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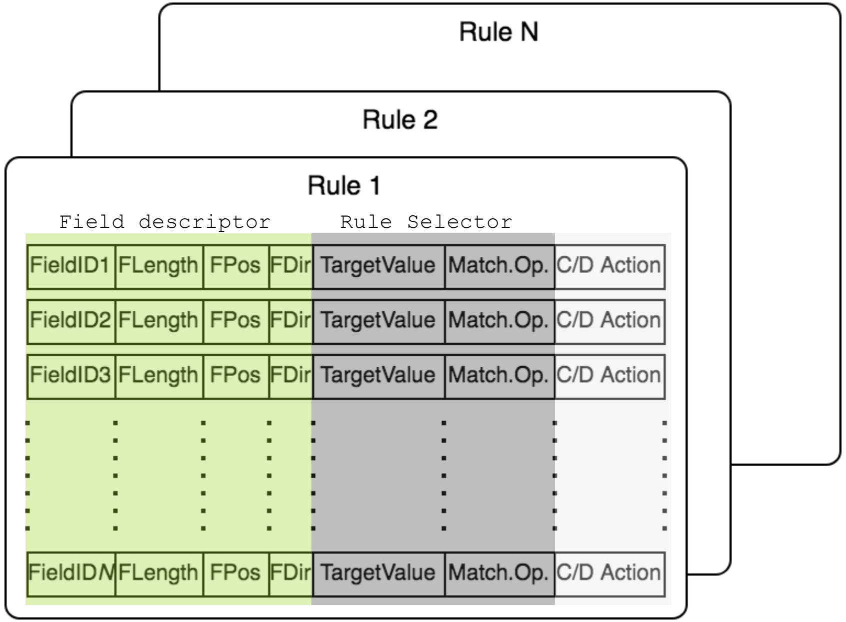
Rule Selector:

– Target Value
– Matching Operator: `Equal, Ignored, Match-mapping, MSB(x)`

If there is a 1-to-1 match between the fields in the packet and the fields in the candidate rule, then this rule is eligible for compressing that packet



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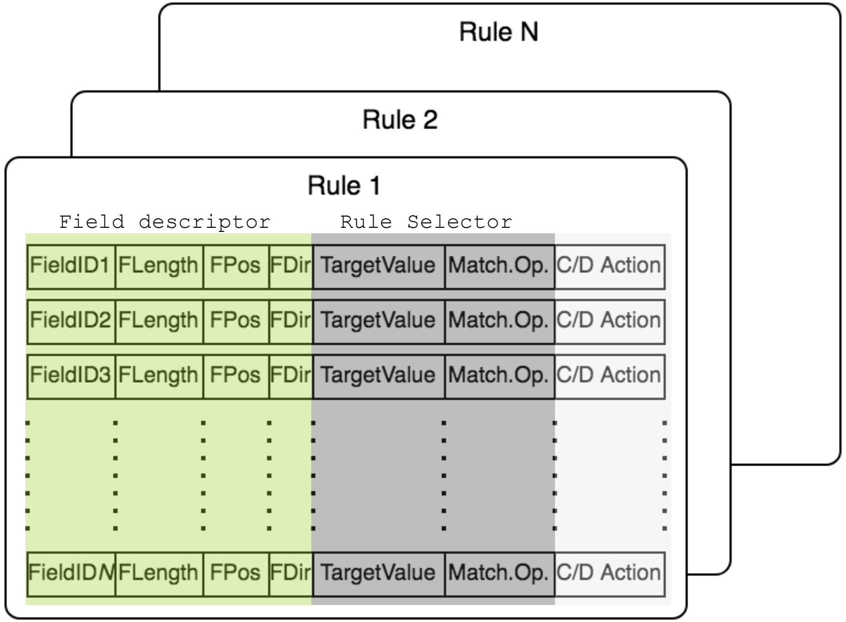
Compression:

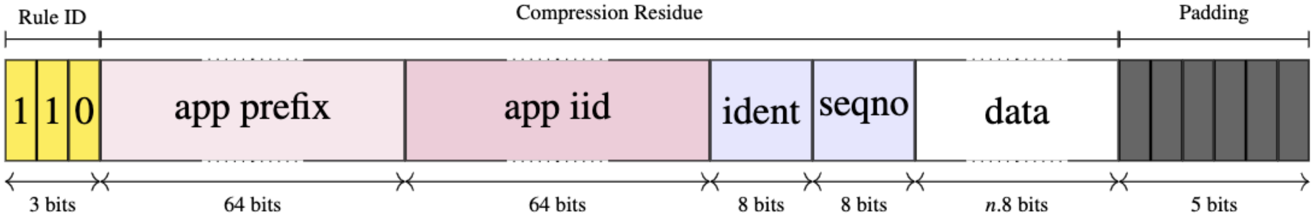
- Elided, Sent, Mapping-sent, LSB, Recomputed, DevIID,



ICMPV6 COMPRESSION


```
{
    "DeviceID" : "udp:54.37.158.10:8888",
    "SoR" : [
        {
            "RuleID": 6,
            "RuleIDLength": 3,
            "Compression": [
            {"FID": "IPV6.VER", "TV": 6, "MO": "equal", "CDA": "not-sent"},
            {"FID": "IPV6.TC",  "TV": 0, "MO": "equal", "CDA": "not-sent"},
            {"FID": "IPV6.FL",  "TV": 0, "MO": "ignore","CDA": "not-sent"},
            {"FID": "IPV6.LEN",          "MO": "ignore","CDA": "compute-length"},
            {"FID": "IPV6.NXT", "TV": 58, "MO": "equal", "CDA": "not-sent"},
            {"FID": "IPV6.HOP_LMT", "TV" : 255,"MO": "ignore","CDA": "not-sent"},
            {"FID": "IPV6.DEV_PREFIX","TV": "2001:470:1F21:1D2::/64",
                                                 "MO": "equal","CDA": "not-sent"},
            {"FID": "IPV6.DEV_IID", "TV": "::2","MO": "equal","CDA": "not-sent"},
            {"FID": "IPV6.APP_PREFIX",        "MO": "ignore","CDA": "value-sent"},
            {"FID": "IPV6.APP_IID",        "MO": "ignore","CDA": "value-sent"},
            {"FID": "ICMPV6.TYPE",  "DI": "DW", "TV": 128,"MO": "equal","CDA": "not-sent"},
            {"FID": "ICMPV6.TYPE",  "DI": "UP", "TV": 129,"MO": "equal","CDA": "not-sent"},
            {"FID": "ICMPV6.CODE",  "TV": 0,  "MO": "equal","CDA": "not-sent"},
            {"FID": "ICMPV6.CKSUM", "TV": 0, "MO": "ignore","CDA": "compute-checksum"},
            {"FID": "ICMPV6.IDENT", "TV": 0,"MO": "ignore","CDA": "value-sent"},
            {"FID": "ICMPV6.SEQNO", "TV": 0,"MO": "ignore","CDA": "value-sent"}

            ]
```

FRAGMENTATION

Rule indicates fragmentation message format and protocol parameters.

No-ACK mode

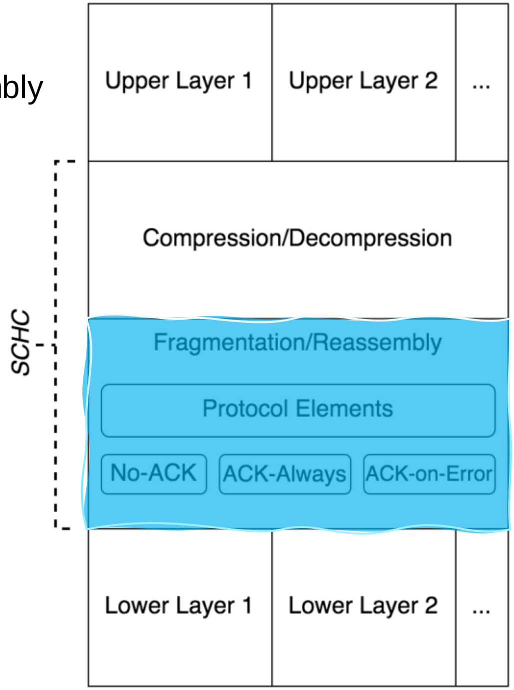
- Supports unidirectional links, variable MTU
- **Reassembly Check Sequence (RCS)** is sent with last fragment to validate reassembly

ACK-Always mode

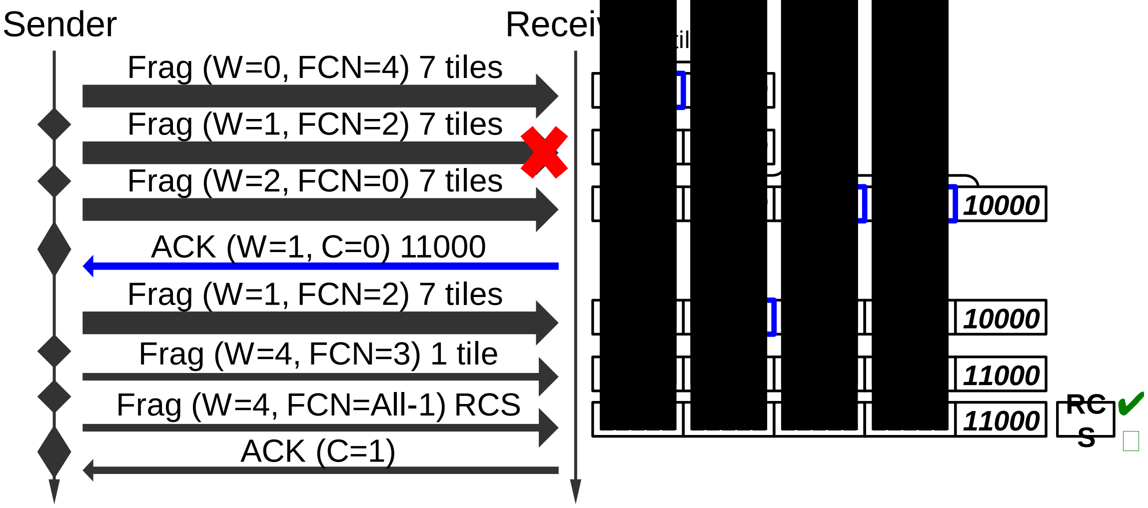
- Fragments are sent in batches (windows)
- an ACK is sent back at the end of each window, with bitmap of received fragments
- Missing fragments are re-transmitted before moving on to the next window
- RCS is used to perform final reassembly check

ACK-on-Error

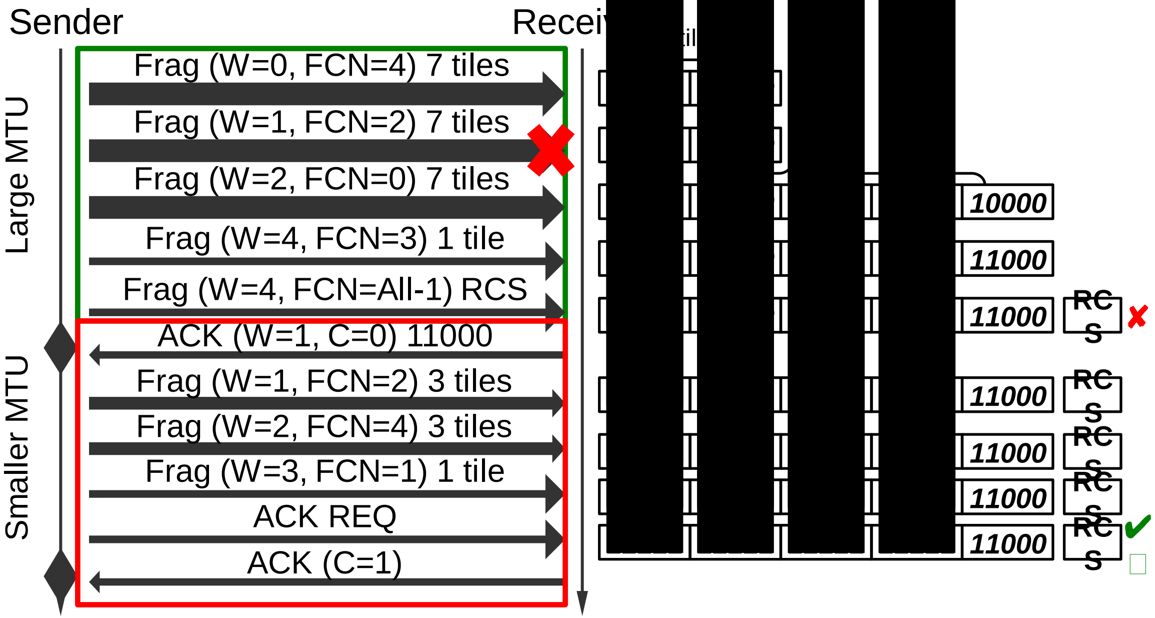
- ACKs are only sent back for windows with missing fragments or for last window
- ACK includes bitmap of received fragments, and reassembly check bit
- Missing fragments are re-transmitted, in any order
- RCS validates final reassembly
- **Supports variable MTU**, Out-of-Order delivery



SCHC ACK-ON-ERROR FRAGMENT[redacted]THM EXAMPLE 1, CONSTANT MTU



SCHC ACK-ON-ERROR FRAGMEN [redacted] RITHM
EXAMPLE 2, DECREASING MTU



ACK-ON-ERROR FRAGMENTATION WRAP-UP

- Reliable
  - Uses ACKs, retransmissions of missing tiles and RCS
- Supports variable MTU
- uses ACKs sparingly
  - Only for windows with missing tiles
- No transmission error means no ACK, except for the one final ACK
  - Valuable for uplink fragmented packet transmission in asymmetric LPWANs
  - Exact number of ACKs depends on rate and distribution of errors
- Simple sender/receiver state machines
  - Loosely coupled
- Little receiver state
  - One bit per tile
  - Bitmaps for full windows can be freed

WHAT'S NEXT

New protocols and proxy behavior:

OAM (icmpv6), Bacnet, SNMP, Matter

Advanced rule manager

How to select the best rules for compression and fragmentation

SCHC for mesh network

Integration with 6LoWPAN

Extended Yang data model

Device authentication

SCHC for other media (UHF, Satellite, …)

Internet Architecture Evolution

Internet Area Working Group
Internet-Draft
Intended status: Informational
Expires: 7 September 2022

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6 March 2022

Gap Analysis in Internet Addressing
draft-jia-intarea-internet-addressing-gap-analysis-02

Abstract

There exist many extensions to Internet addressing, as it is defined in [RFC0791] for IPv4 and [RFC8200] for IPv6, respectively. Those extensions have been developed to fill gaps in capabilities beyond the basic properties of Internet addressing. This document outlines those properties as a baseline against which the extensions are categorized in terms of methodology used to fill the gap together with examples of solutions doing so.

MORE INFO

book.openSCHC.net

Augmenting LoRaWAN Devices with Internet Protocol Support

WEBCAST 01:39:00

Did you know that LoRaWAN can now support IP (Internet Protocol)-based applications? Indeed, the support of IPv6 over LoRaWAN through the "Static Context...

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IEEE 8th World Forum on Internet of Things

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