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Journées LPWAN 2021 (8-9 juillet, Clermont-Ferrand)

IP header compression for LPWANs

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Future
networks

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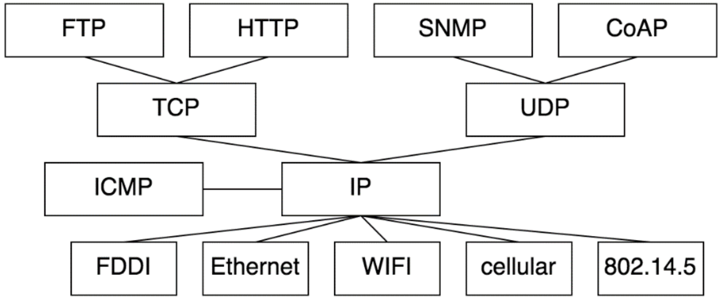
Motivation

Why IP over LPWANs?



Internet Protocols (IP) have taken over the world of networking

Some Low-Power Wide Area Networks (LPWANs) have remained non-IP so far

- **IP deemed too heavyweight, not needed**
- **Sigfox: 12 bytes uplink, 8 bytes downlink; LoRaWAN: US 11 bytes, EU 52 bytes min payload**

Cost of custom LPWAN protocols, security models, APIs

- **Technology-specific training and tools**
- **Protocol translation gateways**

Long track record of IP Header compression, fragmentation

- **Van Jacobson TCP/IP header compression, RFC1144 (1990)**
- **RoHC (Robust Header Compression) (2000-2010), see RFC 5795 for overview**
  - Used in VoLTE: RTP/UDP/IP, AMR12.2 vocoder 28.8kbps → ~15 kbps
- **6LoWPAN (2005 - 2014), 6lo (2014 -), dedicated to IEEE 802.15.4, frames usually ~100 bytes**

Why not just use 6LoWPAN for LPWANs?

RFC 4944 Header Compression

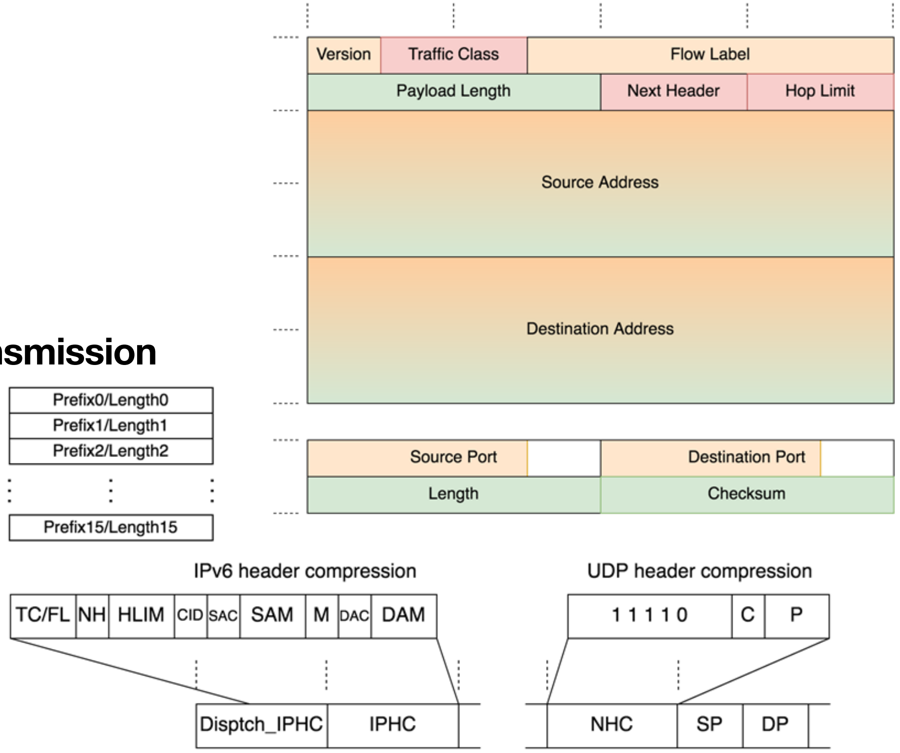
- Only compresses link-local prefixes
- Only compresses IIDs derived out of L2 address
- Best case is 7 bytes for UDP/IPv6 headers

RFC 4944 Fragmentation

- 5 bytes Fragmentation Header
- Fragment Payload in 8 bytes increments
- No individual Fragment acknowledgement and retransmission

RFC 6282 Header Compression

- 4-6 bytes for UDP/IPv6 headers (routable addresses)
- Still byte-aligned, custom-tailored per protocol



→ Can do better with new standard

SCHC

SCHC fundamental 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

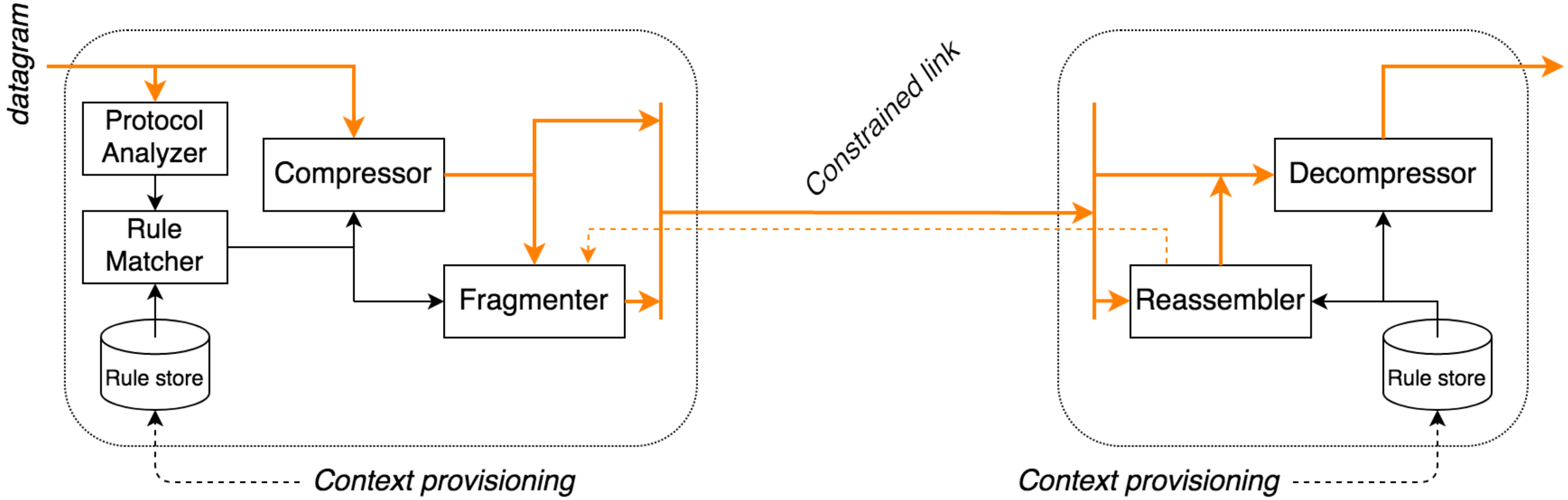
Provides

- flexible mechanism, not dedicated to any upper/lower layer
- extreme header compression
- efficient fragmentation
- little control dialog

SCHC generic 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**
- **Fragmentation is applied if needed**



SCHC generic framework

RuleIDs

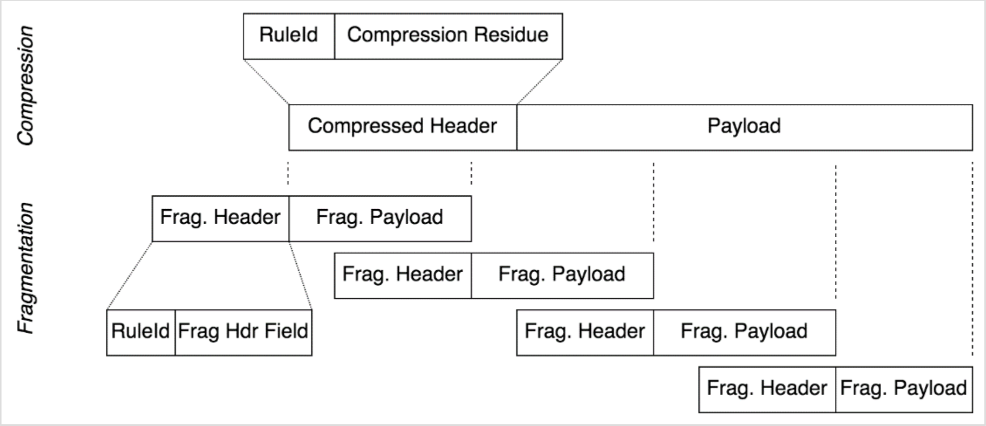
- **No set RuleID size per RFC 8724**
- **RuleID can be of variable size (entropic encoding)**
- **Compression and Fragmentation Rules share the same name space**
- **Compression RuleIDs apply to a single data direction**
  – Same RuleID can be re-used for a different Rule in the reverse direction
- **Fragmentation RulesIDs apply to both directions, if link is bidirectional**
  – Match ACKs with data

RuleID assignement example

0	Compression Rule 1
1 0	Compression Rule 2
1 1 0 0	Compression Rule 3
1 1 0 1	Fragmentation Rule 1
1 1 1 0	Fragmentation Rule 2
1 1 1 1 x x	...

Encapsulation

- **Compressed Packet is fragmented, if needed**



SCHC compression (1/3)
Matching Operators, Compression/Decompression Actions

For each expected Field

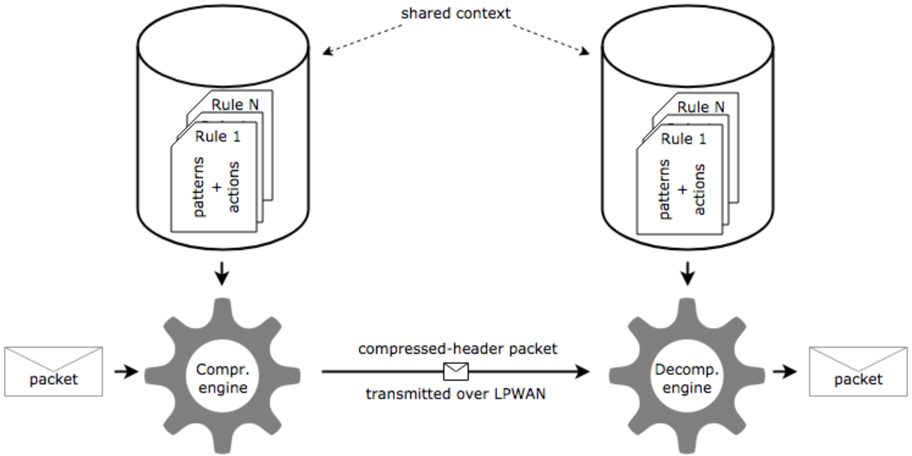
Target Value (scalar or list)

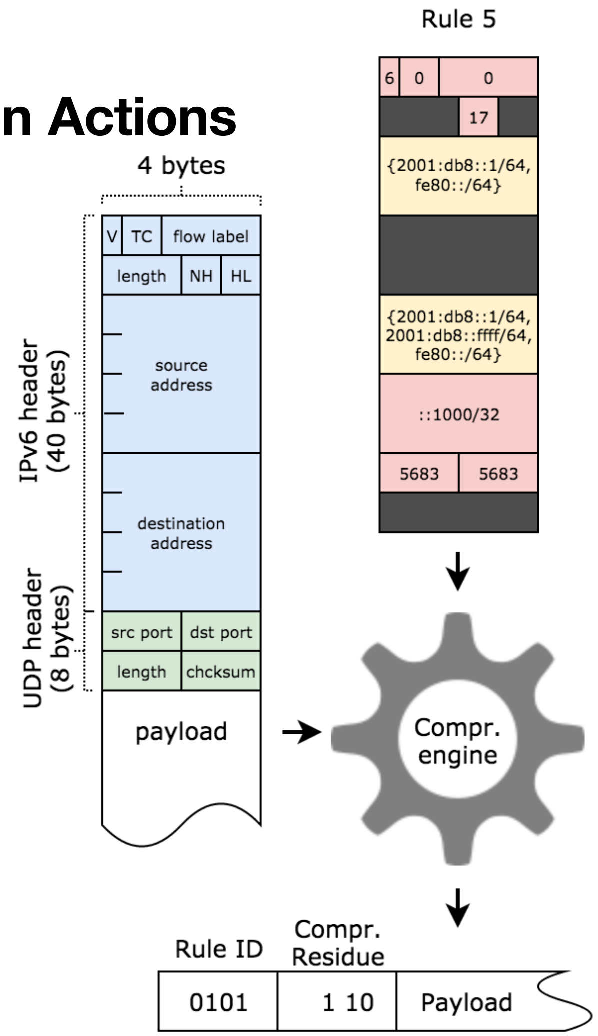
Matching Operator

- **Equal, Ignored, Match-mapping, MSB(x)**

C/D Action

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



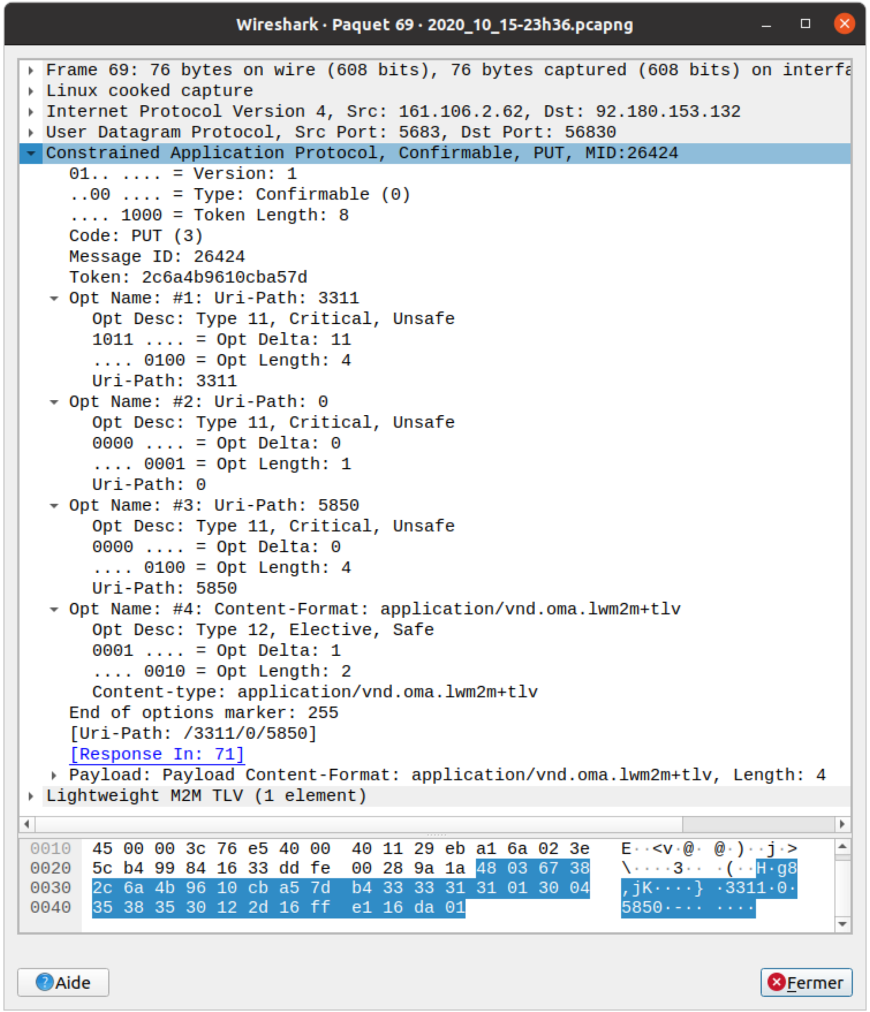


SCHC compression (2/3)
More complex protocols

Not just bit-pattern matching on incoming packet

Protocol analyzer needed

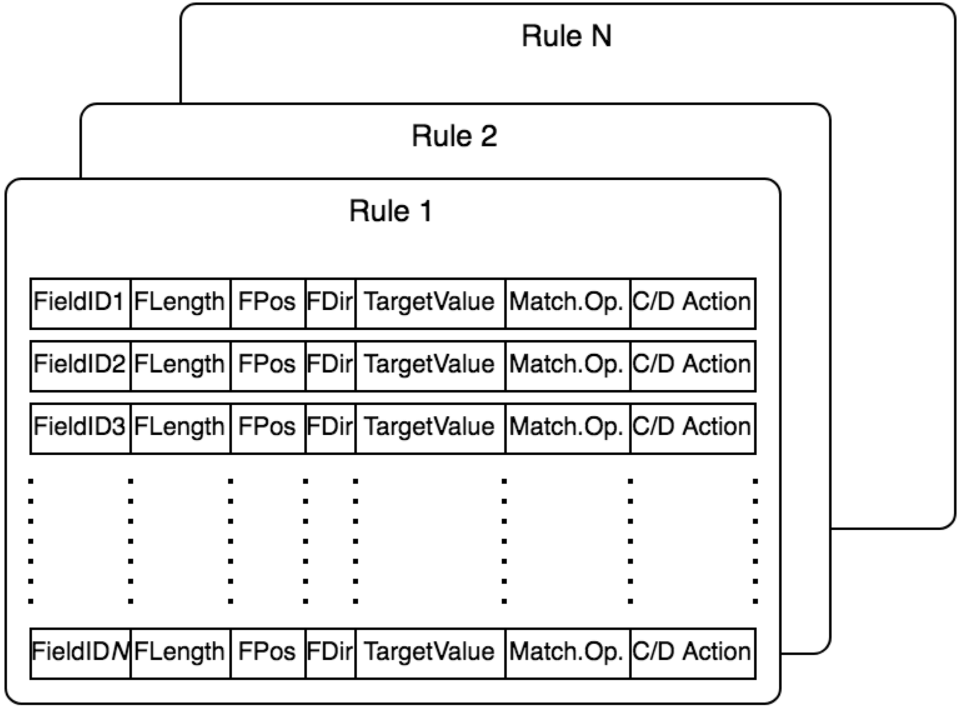
- Itemizes and labels each Header Field
- Some Fields may be of variable length
  - CoAP uri-path, uri-query, …
- Some Fields may occur multiple times
  - CoAP uri-path, uri-query, …



SCHC compression (3/3)
More complex headers

Rule includes

- **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



Formal Rules description in progress

Using SCHC

LwM2M/OSCORE/CoAP/UDP/IPv6 compression

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Smart Tracking application using LwM2M

- mangOH Red Wakaama client, Leshan server
- DTLS, OSCORE and SCHC proxies developed by Acklio
- double SCHC compression (before/after encryption)

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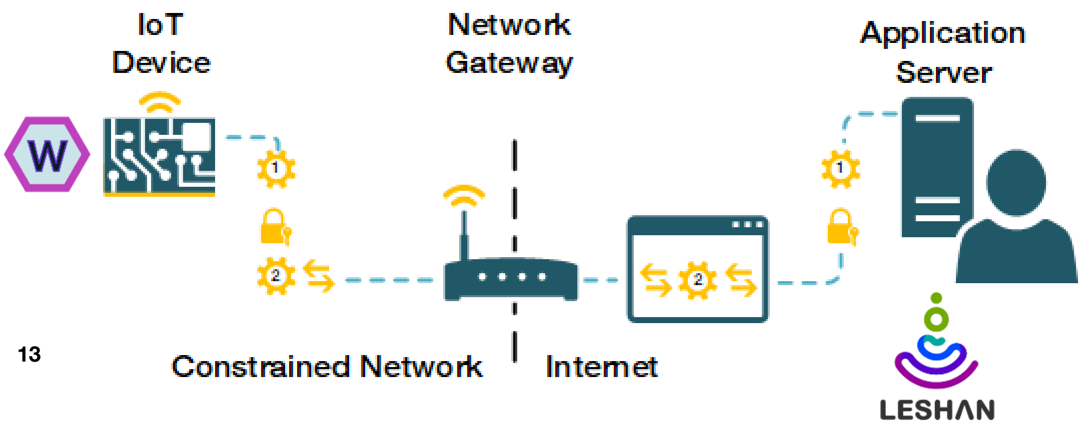
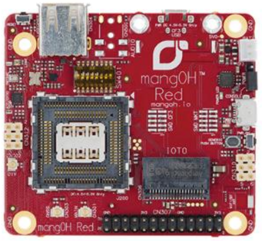
Unifying LPWA Networks



mangOH® Red – Orange™ LTE-M Starter Kit



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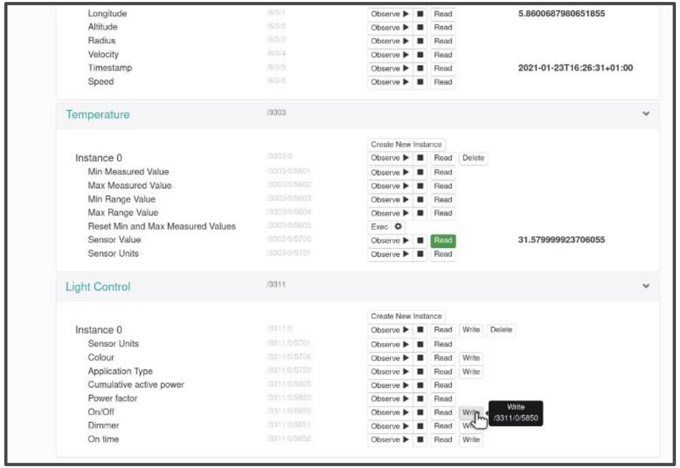
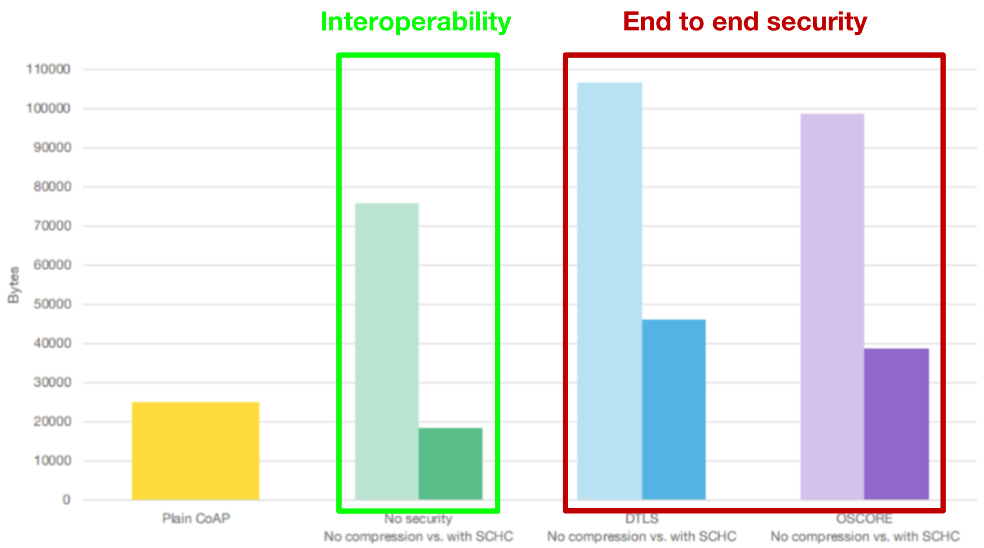
Build low-power LTE-M IoT applications that can run for up to 10 years on a battery with the newest and smallest mangOH platform and Orange LTE-M network in Europe, and send your IoT sensor data to Orange Live Objects cloud.



LwM2M/OSCORE/CoAP/UDP/IPv6 compression demo

Smart Tracking application using LwM2M

- demo shown at the Orange 2021 "Salon de la Recherche"
- paper submitted to Globecom2021 IoTSN



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Unifying LPWA Networks

DLMS over LoRaWAN
Stitching standards together rather than defining a new one

DLMS/COSEM

- an application protocol and data model
- widely used in electric/gas smart metering
- 400-500 bytes payloads typical

Wanted to allow LoRaWAN to carry DLMS

- Write new adaptation spec?

Already had DLMS/UDP/IP profile

- UDP/IPv6/LoRaWAN stack is the straightforward solution

To know more

- Official announcement (Oct 6th 2020)
- DLMS over LoRaWAN introduction

What’s next

Conclusions and Perspectives

Achieved

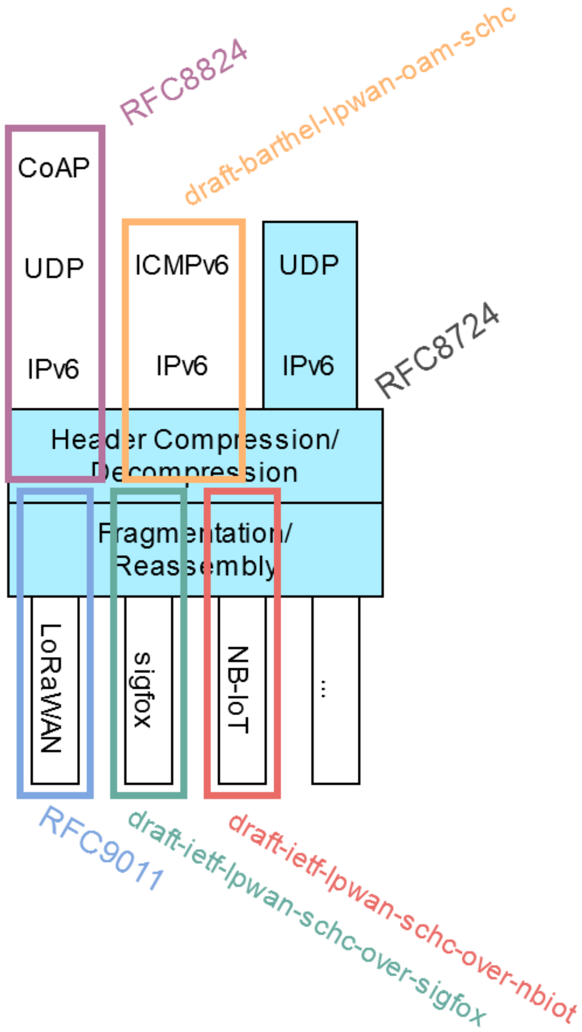
- base technology established, standardized
- adoption started

LoRa Alliance®

Next steps

SCHC'N

- Open source implementation https://github.com/openschc
- More profiles for upper layers
- More profiles for underlying layers
- Context formal definition
- Context provisioning protocol
- Automated rule generation
- Performance evaluation



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Open Source project http://openschc.net