
Static Context Header Compression
[sjiek]
Where do we want to go
in RIOT?
RIOT SUMMIT 2020 - BART MOONS

MAIN GOAL

Integrate libSCHC for

- standard, IPv6-based connectivity to the smallest devices
- reliable fragmentation at MAC layer

OBJECTIVES

1. SCHC for end-to-end security
    1. CoAP + OSCORE
2. RIOT on LoRaWAN gateway/network server
3. SCHC as a generic framework
    1. HTTP, CoAP, MQTT
    2. NDN?
4. SCHC for reliable fragmentation

COMPRESSION

LIBSCHC

Currently
`GNRC_NETTYPE_SCHC`
bypasses the `gnrc_udp` and
`gnrc_ipv6` layer

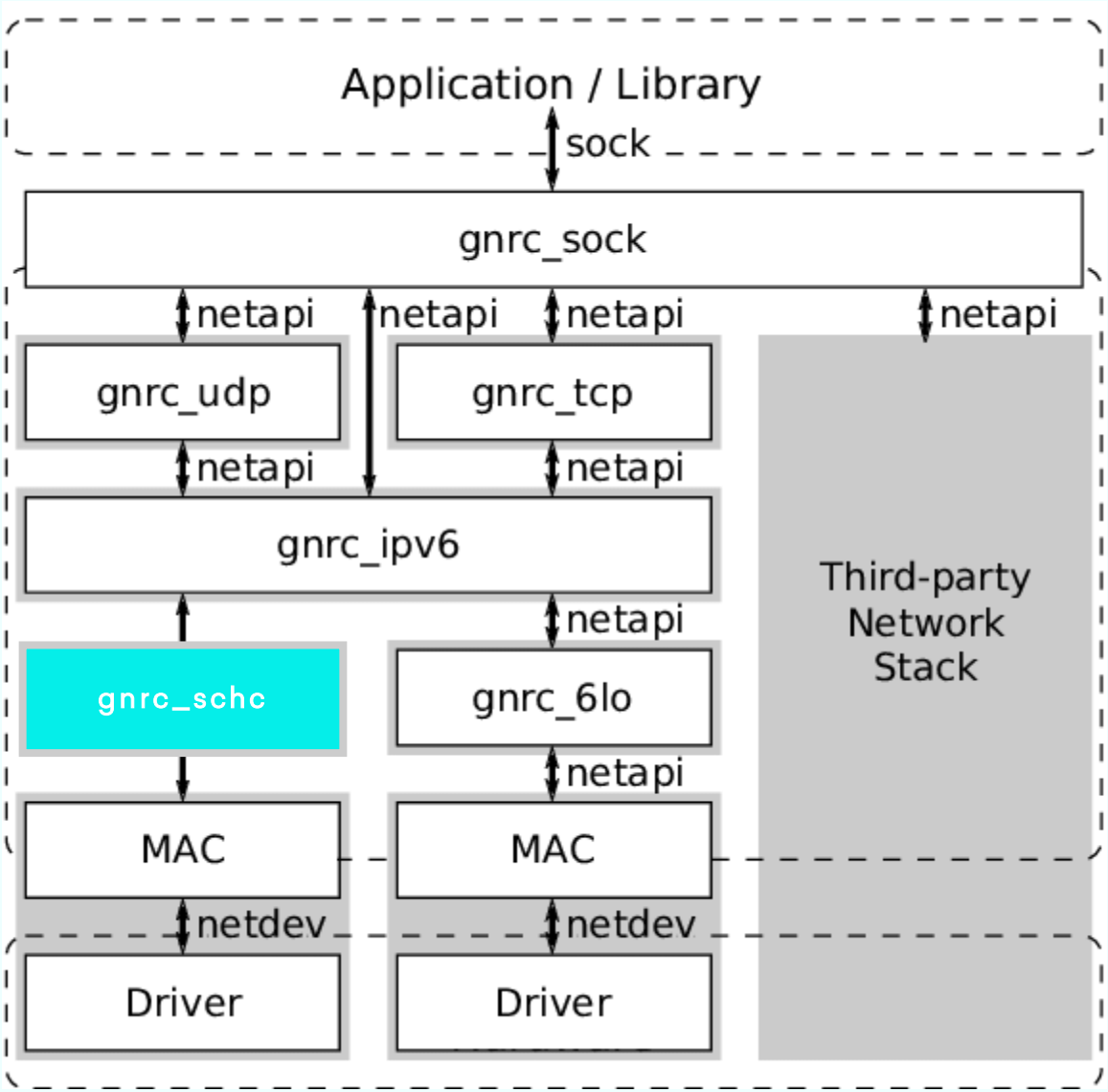
```
ip->type = GNRC_NETTYPE_IPV6;
ipv6_hdr_t *ip_hdr = (ipv6_hdr_t *)ip->data;
ip_hdr->hl = 64;
ip_hdr->nh = PROTNUM_UDP;
ip_hdr->len = byteorder_htons(payload_size +
udp->size);
ip_hdr->src = src;
udp_hdr_t *udp_hdr = (udp_hdr_t *)udp->data;
udp_hdr->length = byteorder_htons(payload_size +
udp->size);
gnrc_udp_calc_csum(udp, ip);

/* send packet */
if(!gnrc_netapi_dispatch_send(GNRC_NETTYPE_SCHC,
GNRC_NETREG_DEMUX_CTX_ALL, ip)) {
        puts("Error: unable to locate SCHC
thread");
        gnrc_pktbuf_release(ip);
        return;
}
```

LIBSCHC

What it should be

- Behave like `gnrc_6lo` adaptation layer (fragmentation + compression)
- Fragmentation w/o compression



LIBSCHC

Layers can be identified by RIOT using `GNRC_NETTYPE_x`: no configuration

Currently set at compile time inside compressor

```
#define USE_COAP            1
#define USE_UDP             1
#define USE_IPv6            1
```

LIBSCHC

Use a protocol parser per layer

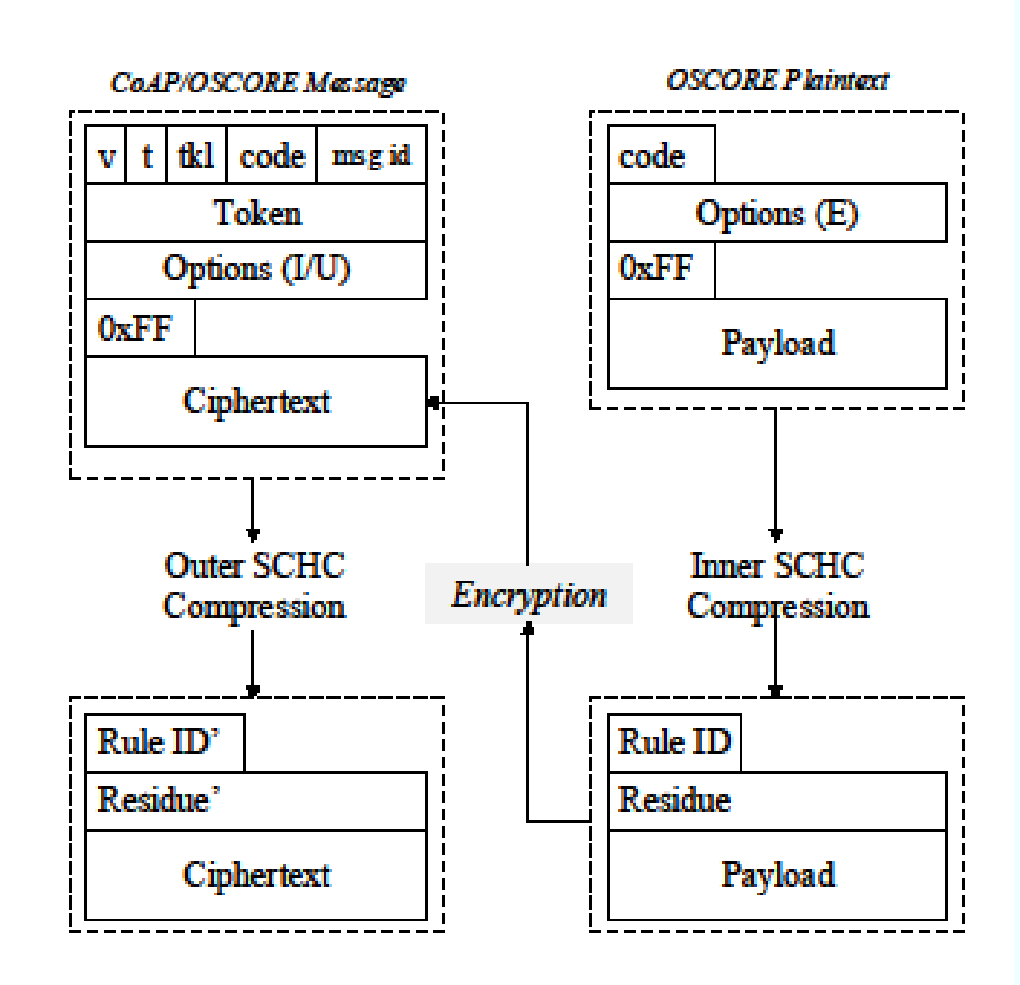
- detect protocol stack at compile time

```
struct schc_rule_t* schc_compress(uint8_t *data,
uint16_t total_length,
        schc_bitarray_t* dst, uint32_t
device_id, direction dir) {
#if USE_IPv6
        compress(dst, &src, (const struct
schc_layer_rule_t*) ipv6_rule, dir);
#endif
#if USE_UDP
        compress(dst, &src, (const struct
schc_layer_rule_t*) udp_rule, dir);
#endif
#if USE_COAP
        compress(dst, &coap_src, (const struct
schc_layer_rule_t*) coap_rule, dir);
#endif
}
```

LIBSCHC

Protocol parser per layer

- What about OSCORE? How can we offer SCHC (L2) + OSCORE (L5)?
  - Compression in 2 steps



FRAGMENTATION

LIBSCHC

Fragmentation

- libSCHC requires
  - information about the `netif` (MTU, duty cyle)
  - configuration per packet for
    - reliability mode

```
schc_conn.mtu = 8; // network driver MTU
schc_conn.dc = 5000; // 5 seconds duty cycle
schc_conn.device_id = device_id; // the device
id of the connection
schc_conn.bit_arr = &schc_bitbuff;
schc_conn.schc_rule = schc_rule;
schc_conn.RULE_SIZE = RULE_SIZE_BITS;
schc_conn.MODE = ACK_ALWAYS;
if (schc_rule == NULL) {
        DEBUG("schc: Can not retrieve
rule.\n"); return;
}

/* release original headers and payload */
gnrc_pktbuf_release(pkt);

/* start fragmentation loop */
schc_fragment(&schc_conn);
```

CURRENT IMPLEMENTATION

Memory management

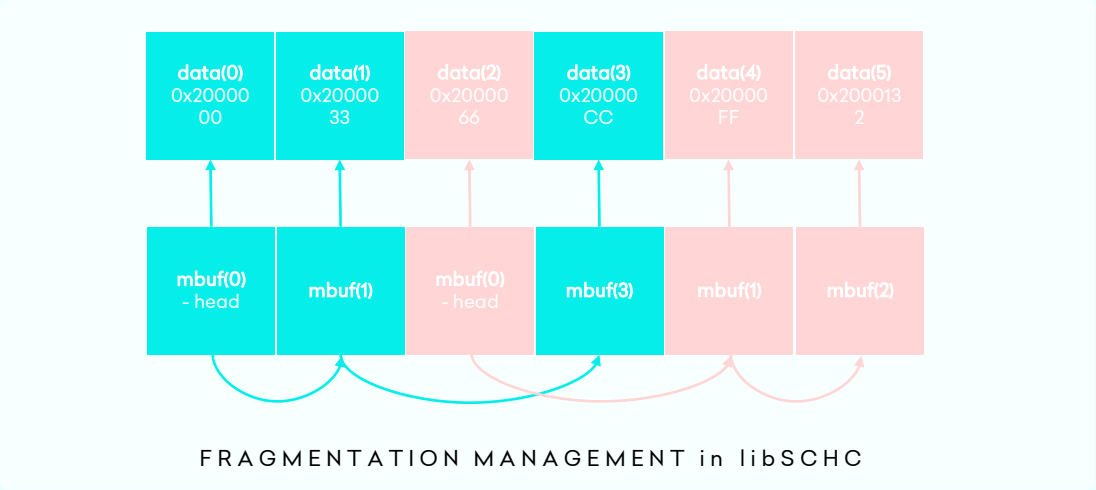
- fragmented packet uses pre-allocated chunk of memory, stored in a **mbuf** (*network memory buffer*) **chain**
- contains a pointer to headers and payload

```
typedef struct schc_mbuf_t {
        ...
        /* the length of the fragment */
        uint16_t len;
        /* pointer to the chunk of memory */
        uint8_t* data;
        /* pointer to the next mbuf */
        struct schc_mbuf_t next;
} schc_mbuf_t;
```

FRAGMENTATION MANAGEMENT

Abstraction required

- differentiate between end-devices
- possibility to
  - reorder linked list (missing fragments)
  - take a single **payload** byte from the chain
    - to calculate MIC

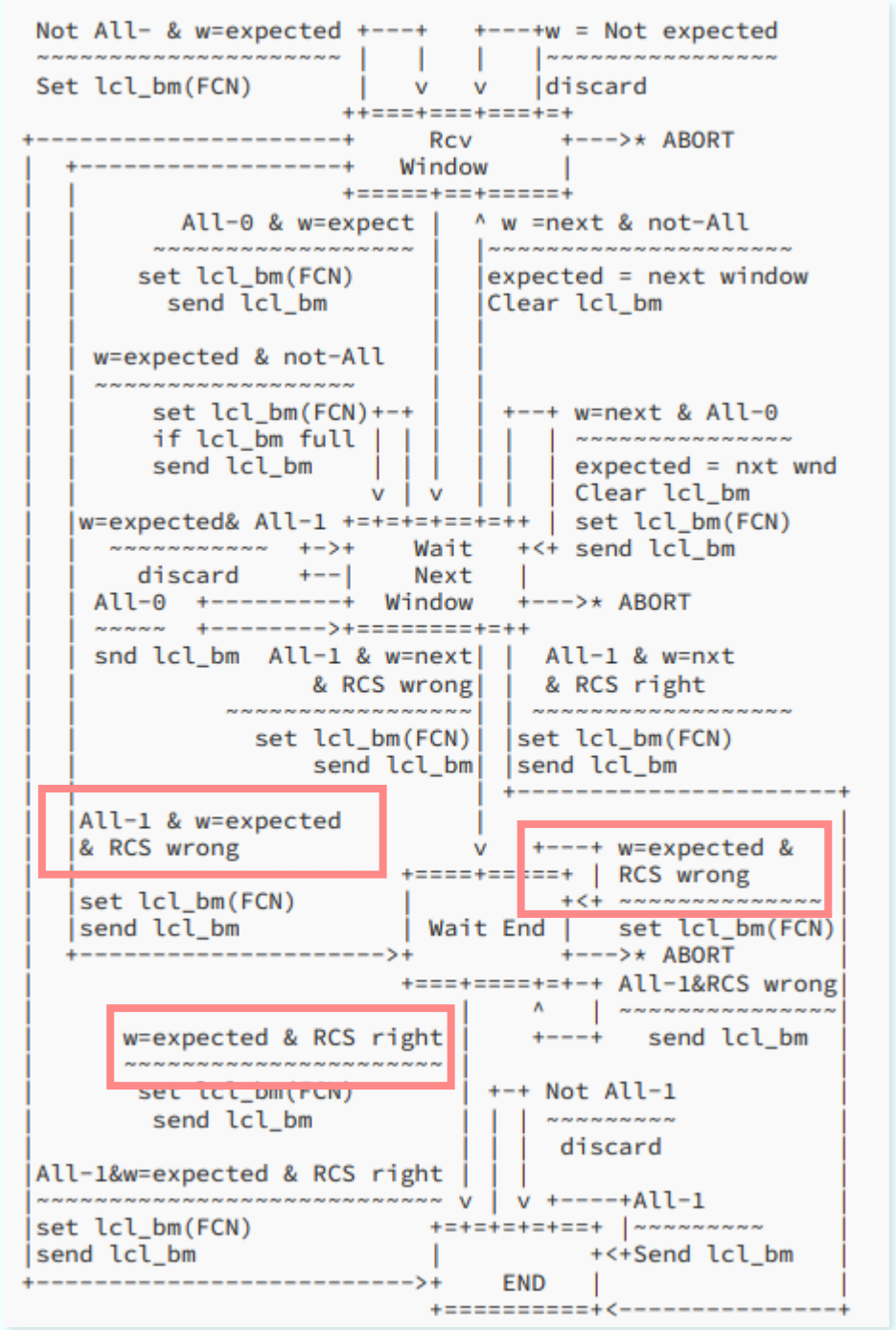


FRAGMENTATION MANAGEMENT in libSCHC

LIBSCHC

libSCHC works on a per fragment basis that relates to the original packet

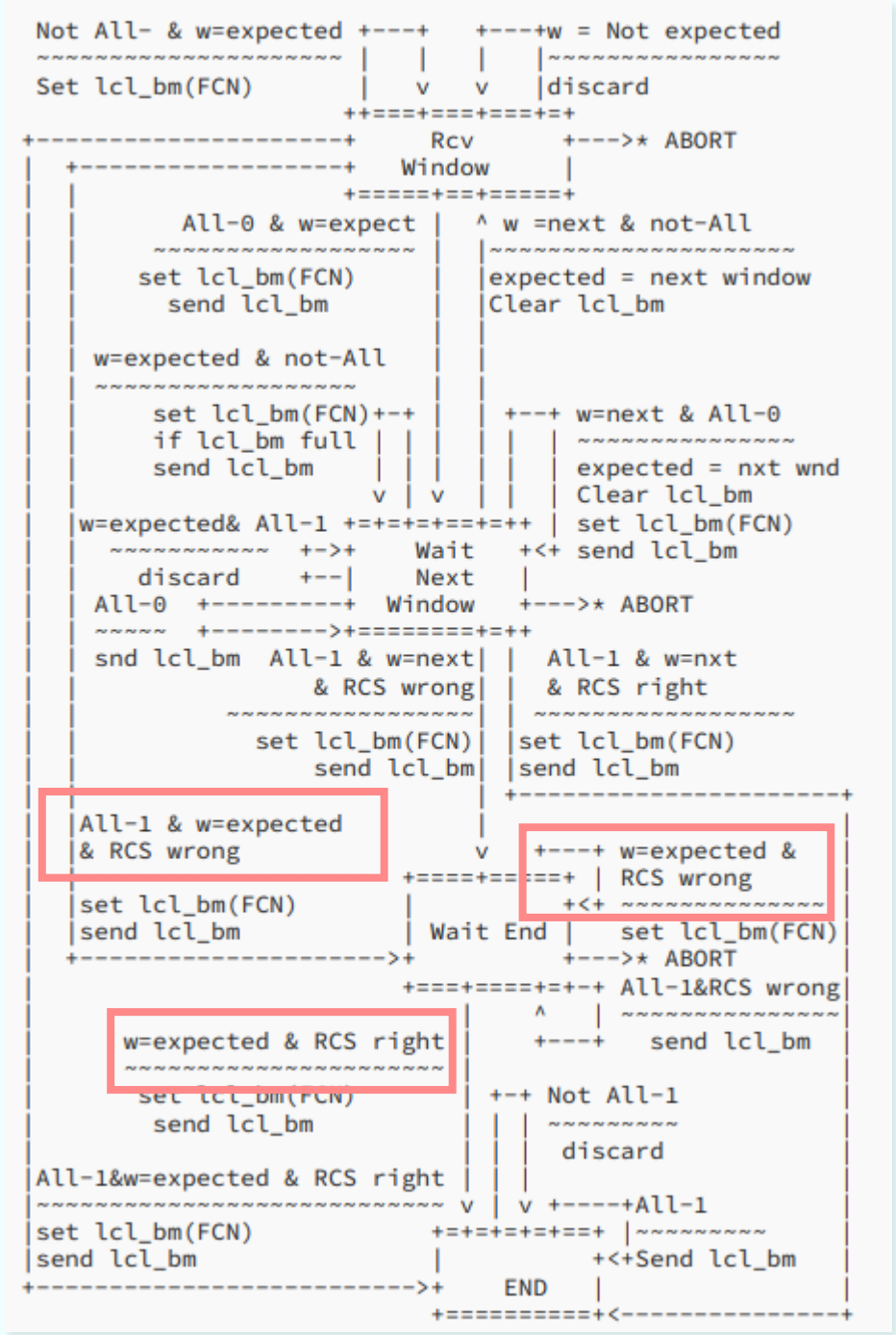
- Receiver can ask the retransmission of a specific fragment



LIBSCHC

Receiver should be able to reconstruct the original packet (removing the fragmentation headers) to calculate the RCS (MIC)

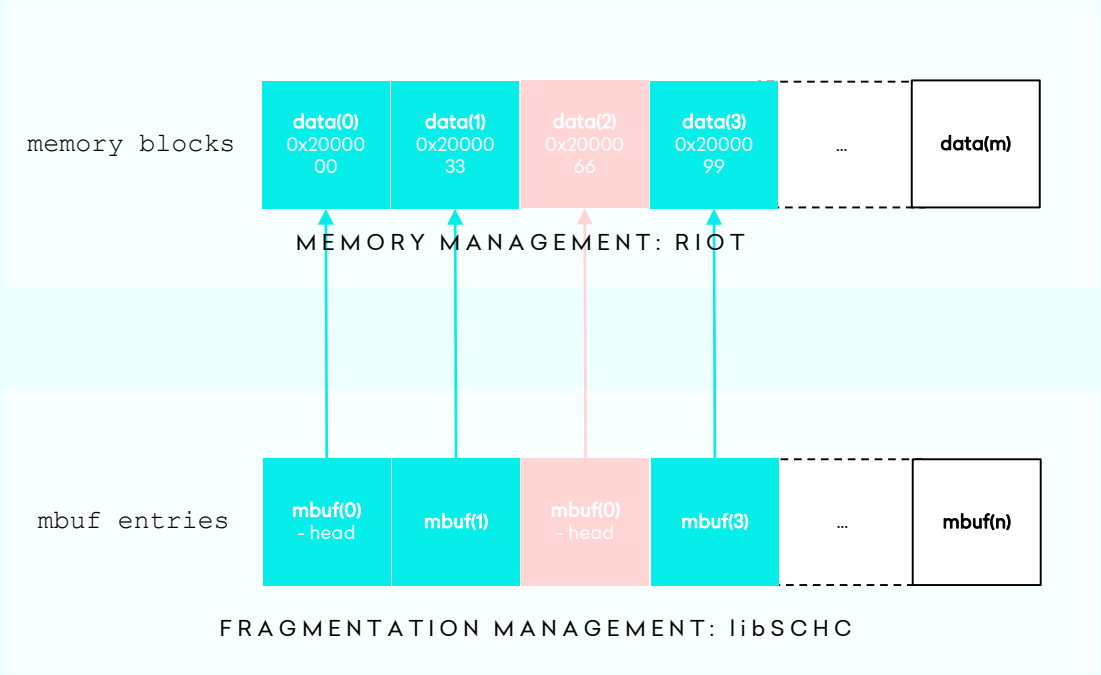
- `mbuf`



RIOT INTEGRATION

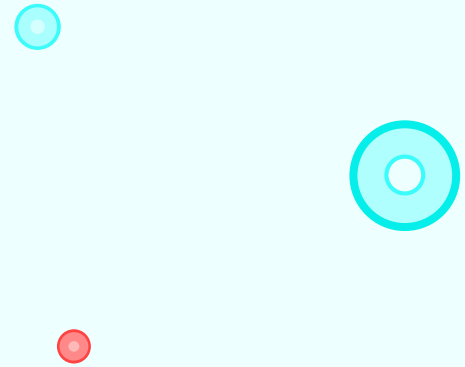
Currently poor memory management in `libSCHC`.

- Separate memory and `mbuf` logic and instead use `pktsnip`



RIOT INTEGRATION

- RIOT as a SCHC network gateway
  - `pktqueue` to queue packets for multiple devices that are restricted in downlink communication
- Configuration?



RIOT INTEGRATION

- Device configuration

```
/* combine compression and fragmentation
parameters */
const struct schc_rule_t schc_rule_1 = { 0x01,
&not_found_404, NOT_FRAGMENTED, 0, 0, 0, 0 };
const struct schc_rule_t schc_rule_3 = { 0x03,
&not_found_404, ACK_ON_ERROR, 3, 6, 1, 0 };

/* save rules in flash */
const struct schc_rule_t* node1_schc_rules[] = {
        &schc_rule_1, &schc_rule_2,
&schc_rule_3, &schc_rule_4, &schc_rule_5,
&schc_rule_6, &schc_rule_7, &schc_rule_8,
&schc_rule_9, &schc_rule_10, &schc_rule_11,
&schc_rule_12, &schc_rule_13, &schc_rule_14,
&schc_rule_15, &schc_rule_16,
&schc_rule_17 };

/* rules for a particular device */
const struct schc_device node1 = { 0x06, 17,
&node1_schc_rules };
const struct schc_device node2 = { 0x01, 17,
&node1_schc_rules };
```

RIOT INTEGRATION

- Setting up the context
  - RIOT filesystem?

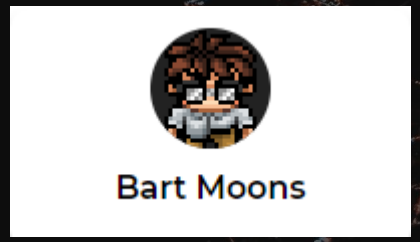
```
#if USE_UDP
const static struct schc_udp_rule_t udp_rule1 =
{ 1, 4, 4, 4, {
          { "src port", 2, 16, 1, BI,
          { 0x33, 0x16, 0x33, 0x17},
          &mo_matchmap,    MAPPINGSENT },
          { "dest port", 2,16, 1, BI,
          {0x33, 0x16, 0x33, 0x17},
          &mo_matchmap,    MAPPINGSENT },
          { "length", 0, 16, 1, BI,
          {0, 0}, &mo_ignore, COMPLENGTH },
          { "checksum", 0, 16, 1, BI,
          {0, 0},&mo_ignore, COMPCHK }
}};
#endif
```

Static Context Header Compression [sjiek] in RIOT

BART MOONS.

Ghent University – IDLab – imec

bamoons.moons@ugent.be
idlab.ugent.be



GHENT UNIVERSITY

IDLab
INTERNET & DATA LAB

imec
embracing a better life