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Resource Management and IP Interoperability for LPWANs

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Fair Adaptive Data Rate Allocation and Power Control in LoRaWAN (WoWMoM 2018)

Khaled Abdelfadeel, Victor Cionca, and Dirk Pesch

Sources of unfairness in LoRaWAN systems

- Each spreading factor has a different airtime for the same packet
- Spreading factors are not perfectly orthogonal
- Near-far Problem

Our Proposal (FADR) to achieve fairness in LoRaWAN

- FADR – data rate allocation
  - drive the SF and BW fair distribution

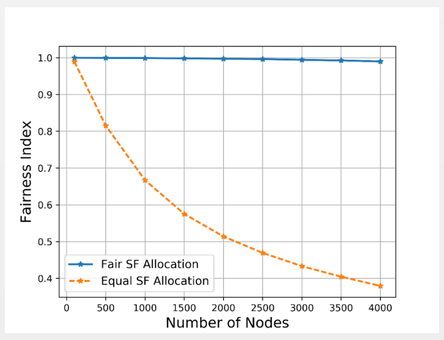
$$P_{coll,s} = 1 - e^{-[\frac{2^{s+1}}{s}\frac{l}{B} p_s c_t]} \quad \text{[prob. of collision]}$$

$$p_s = \frac{s}{2^s} / \sum_{i \in S} \frac{i}{2^i} \qquad \forall s \in S \quad (1)$$

$$p_{s,b} = (p_s \,.\, b) / \sum_{i \in B} i \quad \forall s \in S \;\&\; \forall b \in B \quad (2)$$

p_7	0.45
p_8	0.25
p_9	0.14
p_{10}	0.08
p_{11}	0.04
p_{12}	0.02

$p_{s,125}$	0.143 p_s
$p_{s,250}$	0.286 p_s
$p_{s,500}$	0.571 p_s



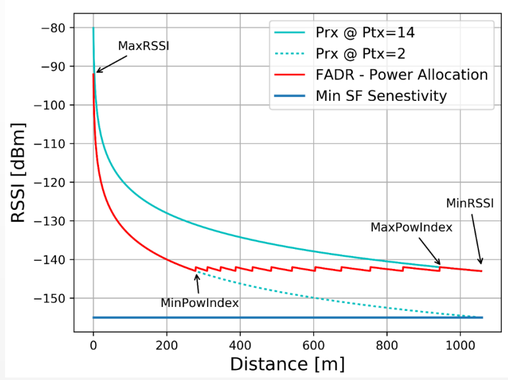
- Equations 1 &2 maintain a fair probability of collisions

- FADR – transmission power control
  - mitigate the capture effect

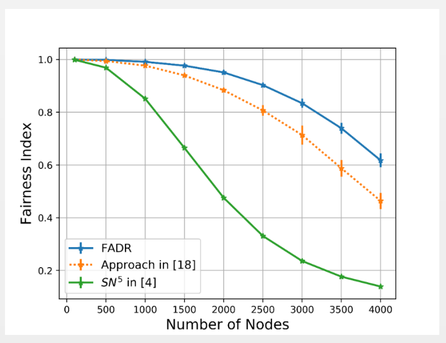
Input: **N**, **RSSI**s, and **CIR** matrix

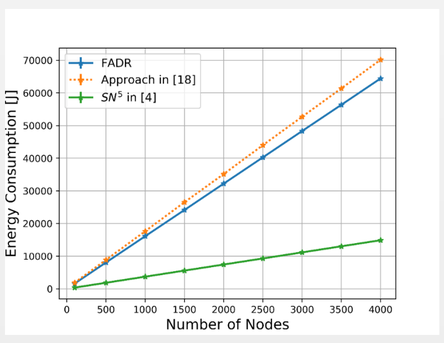
Output: $\forall n \in \boldsymbol{N}, \boldsymbol{P}[n] \in \mathbf{Pow}$

1. Collect and sort **RSSI**s
2. Assign Min power until $minpowindex$ point
3. Assign Max power until $maxpowindex$ point
4. Assign the remaining power levels between $minpowindex$ and $maxpowindex$ points without violating the above conditions



Performance Evaluation





- FADR surpasses the other approaches in terms of fairness

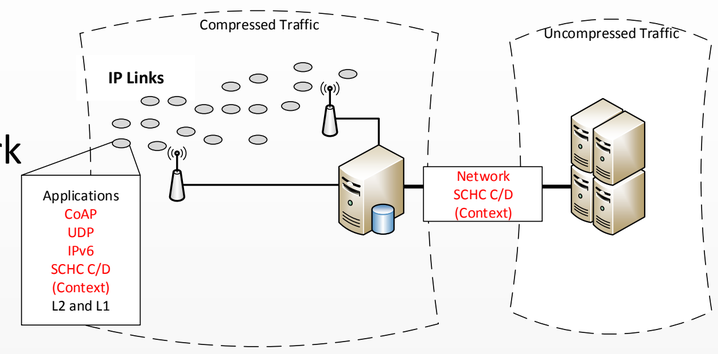
[18] B. Reynders and et al. ''Power and spreading factor control in low power wide area networks,'' in ICC'17 SAC-7 *IoT, 2017.* [4] M. Bor and et al. ''Do lora low-powr wide are network scale,'' in MSWiM*, 2016.*

Dynamic Context for Static Context Header Compression (DCOSS 2018)

Khaled Abdelfadeel, Victor Cionca, and Dirk Pesch

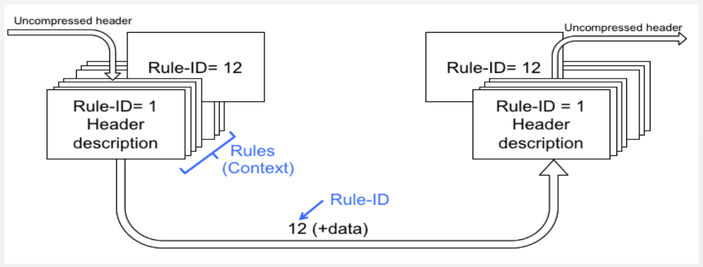
SCHC Architecture

- Enable IP traffic
- SCHC is optimized for LPWANs
- Devices and network backend are sharing the same context



SCHC Context

- Static context (does not change over time)
- No synchronization required
- A rule describes how header(s) are compressed/de-compressed
- Send only Rule ID

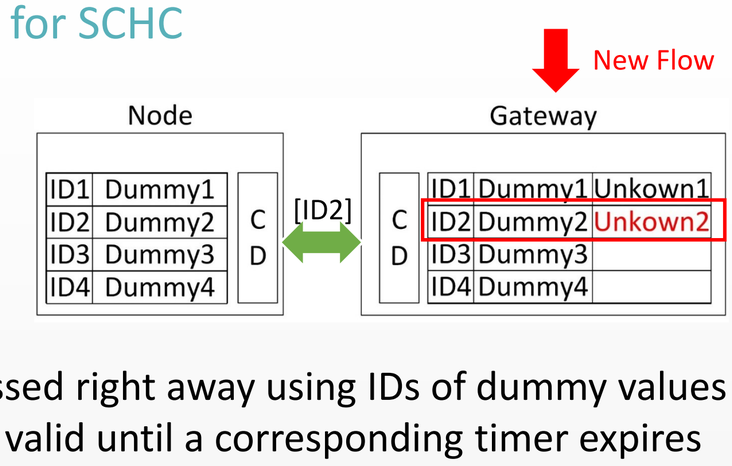


Data flows are not always known in advance, which limits the effectiveness of SCHC

- E.g., source IP addresses

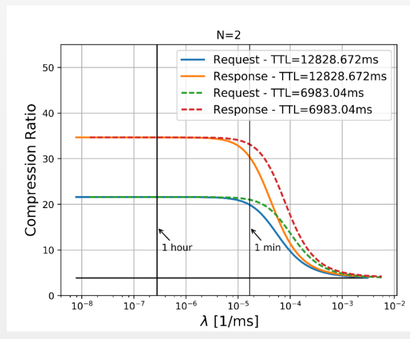
Dynamic Context for SCHC

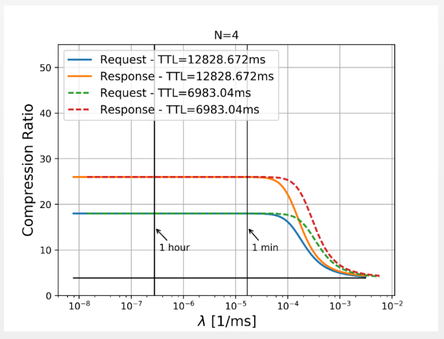
- Dummy values are shared and never changed
- Actual value is assigned to a *free* dummy value



- Packets compressed right away using IDs of dummy values
- Each mapping is valid until a corresponding timer expires

Performance Evaluation





- ***TTL*** must be longer than round-trip of response(s)
- ***N*** is the number of entities for a dummy table
- **CR** = $\mathrm{FL}/((1 - P(\rho, N))\lceil log_2 N \rceil + P(\rho, N) FL)$
- $P(\rho, N) = \rho P(\rho, N-1)/(N + \rho P(\rho, N-1)), \rho = \lambda * TTL$