RTO considerations in LPWAN

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1. Introduction

- Flagship LPWAN technologies (e.g. LoRaWAN and Sigfox):
  - Reduced bit rate (e.g. < 1 kbit/s)
  - Reduced message rate (e.g. < 1 message/minute)
- As a result, long or very long RTTs:
  - In ideal scenarios: RTT in the order of several seconds or tens of seconds
  - Additional delays: RTTs up to several minutes or even more
- RTT (and its variance) in LPWAN, much greater than typical ones on the Internet
  - Default RTO in TCP, currently: 1 second
  - Default RTO in CoAP: between 2 and 3 seconds
- In LPWAN, RTOs:
  - When using CoAP, for CON messages
  - In SCHC fragmentation (ACK-Always, ACK-on-Error)

How do we deal with LPWAN RTTs?
2. Ideal scenario RTT. LoRaWAN

- Assumptions
  - Negligible losses, buffering delay, processing delay
  - 4-byte SCHC-compressed IPv6/UDP/CoAP downlink response

- Minimum and maximum RTT
  - 4-byte to maximum-sized L2 uplink payload
  - First receive window and second receive window

- Default CoAP RTO
  - Always below the RTT
  - Often below the RTT
2. Ideal scenario RTT. Sigfox

- **Assumptions**
  - Negligible losses, buffering delay, processing delay
  - 4-byte SCHC-compressed IPv6/UDP/CoAP downlink response

- **Minimum and maximum RTT**
  - 4-byte to maximum-sized L2 uplink payload
  - Response at the beginning or at the end of the downlink receive window

- **Default CoAP RTO**
  - Always below the RTT
3. Higher order RTTs

- Compliance with spectrum access regulations
  - E.g. duty cycle below 1% in some EU frequency bands
    - Sender may wait for $99x$ sec. after transmission of $x$ sec.
  - RTT may grow by up to 2 orders of magnitude
    - E.g. up to 282 seconds (LoRaWAN), 253 seconds (Sigfox)

- DL response buffering delay at the GW
  - Described in draft-toutain-core-time-scale-00
  - The GW misses the opportunity for DL transmission
    - Duty-cycle compliance by the GW
    - Busy sending DL messages for other devices
  - Next DL transmission opportunity only after the next UL transmission
  - RTT depends on the Dev message rate: may be minutes, hours…
4. Approaches for the RTO

- If delay is not relevant, set the (default) RTO to the highest expected RTT
- If delay is relevant, and higher order RTTs expected:
  - Dual-RTO algorithm

```plaintext
initial state

if N_THRESH_HIGH
  consecutive RTT samples > THRESH_HIGH_RTT
if N_THRESH_LOW
  consecutive RTT samples < THRESH_LOW_RTT
```

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Next…

• Next steps
  – Analysis also for “DL RTTs”
    • UL response
  – Dual-RTO algorithm
    • Further refinement, performance evaluation

• Questions
  – Interest in this work?
  – Different kinds of contributions. Keep within a single document?
    • Guidance for RTO settings (rather “Informational”)
    • Proposal of an algorithm (could be “experimental”, “standards track”…)

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