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

		Maximum			
DR	Ulpld	TtxUL	TtxDL	RTTmin	RTTmax
0	51	2.79	0.99	4.52	5.81
1	51	1.56	0.58	2.99	4.15
2	51	0.70	0.29	1.92	3.00
3	115	0.68	0.14	1.73	2.82
4	242	0.70	0.07	1.66	2.78
5	242	0.40	0.04	1.37	2.44
6	242	0.20	0.02	1.19	2.22
7	242	0.04	0.003	1.00	2.05

ULpld: uplink frame payload, in bytes
TtxUL: uplink frame transmission time, in seconds
TtxDL: downlink frame transmission time, in seconds
RTTmin: minimum RTT, in seconds
RTTmax: maximum RTT, in seconds

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

				Maximum	
UL BR	Ulpld	TtxUL	TtxDL	RTTmin	RTTmax
100	12	2.08	0.39	21.8	47.1
600	12	0.35	0.39	20.6	45.4

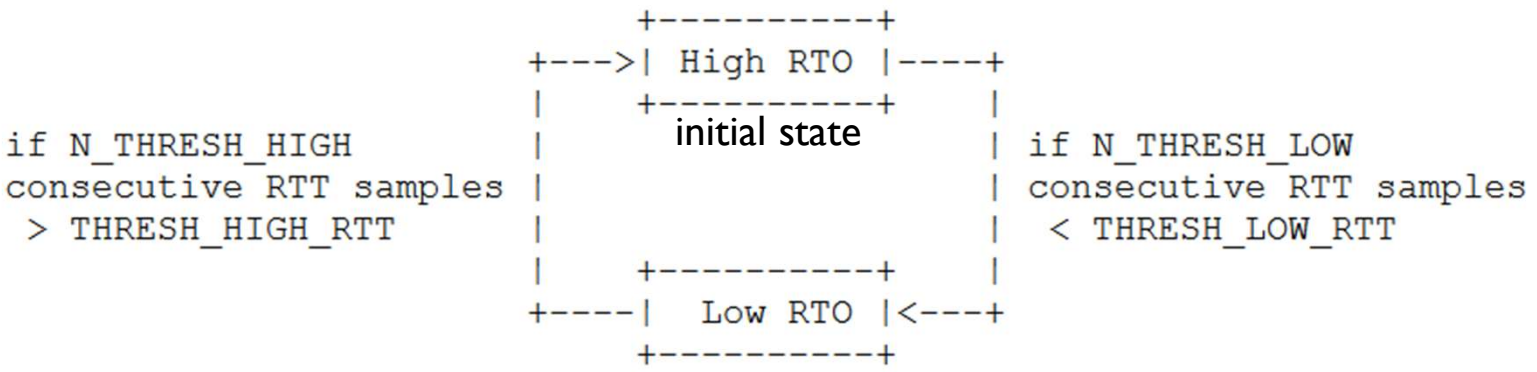
UL BR: uplink bit rate, in bit/s
ULpld: uplink frame payload, in bytes
TtxUL: uplink frame transmission time, in seconds
TtxDL: downlink frame transmission time, in seconds
RTTmin: minimum RTT, in seconds
RTTmax: maximum RTT, in seconds

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



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"…)