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Scheduling Transmissions in Time-Slotted LoRa Wide Area Networks

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LoRa is a low-power and long range radio communication technology designed for low-power Internet of Things devices. The devices of a LoRa wide area network (LoRaWAN) are often deployed in remote areas where the end-to-end connectivity provided through one or more gateways may be limited. When the gateway is not available at all times, the sensing data need to be buffered locally and transmitted as soon as a gateway becomes available. To avoid bursts of collisions in a classical random channel access method like Aloha, we propose to introduce a time-slotted transmission scheduling mechanism.

LoRaWAN mainly uses frequency bands for which network usage is limited to meet the requirements of mass deployment of several thousand connected objects. For example, in the European Union, a device cannot use frequency channels for more than 1% of the time in its duty cycle. This leads to a scheduling problem with waiting times. The quality of communications between connected devices and gateways in LoRaWAN depends on a set of parameters, one of the main ones having a direct impact on overall throughput is the spreading factor (SF). The TS-LoRa protocol proposes an allocation of spreading factors for the communications of end-devices, over different periods, to respect these constraints. Here, we focus on a scheduling problem within this framework.

In this work, we formalize the LoRaWAN data scheduling optimisation problem with waiting times using linear programming. We derive an optimal algorithm for the special case of equivalent SF. We then investigate approximation algorithms for specific and general cases. We finally discuss about the general problem's complexity.