SUCCESS STORY

DeSSnet
Dependable, secure and time-aware sensor networks

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Project

Type of project: Key Enabling Technologies for Network Dependability, 06/2017-05/2021, strateg./ multi-firm

IMPROVING THE ROBUSTNESS OF WIRELESS INDUSTRIAL SENSOR NETWORKS

WIRELESS TECHNOLOGIES ARE KEY FOR INDUSTRY DIGITALIZATION, BUT REQUIRE IMPROVEMENTS TO BE DEPENDABLE IN HARSH INDUSTRIAL ENVIRONMENTS

The digitalization of industry requires state-of-the-art communication technologies that support industrial sensing, condition monitoring, and the automation and optimization of production processes. Wireless industrial networks offer reduced operation costs and higher flexibility than traditional wire solutions. But the challenges of wireless propagation in industrial environments make many technologies unsuitable for this use. LoRa (i.e., Long Range) technology has triggered significant interest in research and industry because of its small cost and great configuration flexibility. It promises to be a cost-effective solution for many industrial applications. However, advanced techniques to increase its communication robustness are needed to meet the industrial requirements in terms of dependability.

There are several approaches to improve robustness. One is to send redundant data to allow the receiver to recover some transmission errors. Another is to use spatial diversity to overcome link failures. By deploying additional nodes (i.e., relays) that listen to transmissions and retransmit data from different locations, the probability of packet reception increases. We have developed both approaches in a combined scheme that adds the cooperative relaying functionality to LoRa networks. Our solution can be implemented in commercial transceivers since it does not require hardware modifications. It also complies with the technology standard as technology specific limitations, like the duty-cycle constraint, are accounted for in our design. These two features are of main importance for its practical adoption.

Federal Ministry
Republic of Austria
Climate Action, Environment, Energy, Mobility, Innovation and Technology

Federal Ministry
Republic of Austria
Digital and Economic Affairs

Version 01/2020

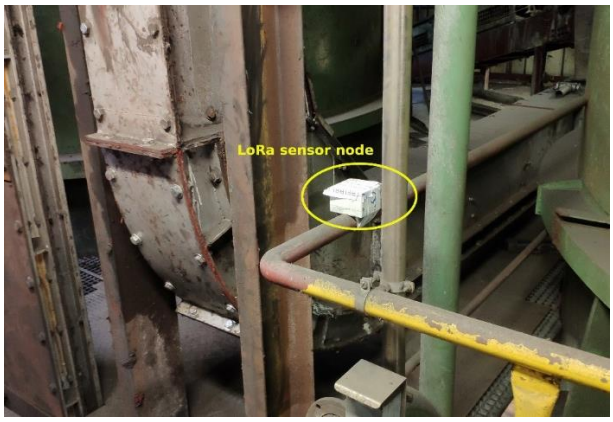
We performed extensive simulations to evaluate the measurements loss-rate as well as the sensor energy expenditure per delivered measurement. Our results show that relaying is highly beneficial with a single relay halving the measurement loss-rate. When more relays are deployed, up to two orders of magnitude gains can be achieved. We presented these results at the IEEE Global Communications Conference in December 2019.

Based on these promising relying results, our next step was to replace our initial repetition redundancy with more powerful network coding designs. We designed two application-layer coding schemes specially tailored for LoRa that we presented at the IEEE International Conference for Communications in May 2020.

Impact and effects

We developed a proof-of-concept implementation to experimentally test our designs. This is compliant with the LoRa Alliance Protocol specification and extends it with our relaying functionality and data redundancy. A long-term measurement campaign, lasting over seven months, was performed with this testbed in a production hall from a chemical plant in Althofen, Carinthia. Our initial goal was to test the basic LoRa in real-world settings and to collect data to characterize the wireless channel behavior. The experimental results showed that an industrial sensor network can be built upon LoRa when measures are taken to overcome the high packet losses that LoRa suffers from, because of the harsh propagation environment.

Our next step is to deploy and test our modified LoRa implementation, to experimentally corroborate our simulation results, and to assess the gains that can be obtained in practice with respect to the basic LoRa scenario. Furthermore, we will deploy our modified LoRa solution to support different industrial use cases like the wear monitoring of a chain conveyor for example, which supports predictive maintenance.



LoRa sensor node in an industrial environment (©Lakeside Labs GmbH)

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This success story was provided by the consortium leader and by the mentioned project partners for the purpose of being published on the FFG website. DeSSnet is a COMET Project within the COMET – Competence Centers for Excellent Technologies Programme and funded by BMK, BMDW, SFG and KWF. The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet