Doctoral School of Information and Biomedical Technologies
Polish Academy of Sciences (TIB PAN)

SUBJECT:

Stress testing the tradeoffs between resiliency, reliability and energy efficiency in low power long range wireless networks

SUPERVISOR:

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DESCRIPTION:

The advancement of Low Power Wide Area Networks (LP WANs) enabled building efficient wireless networks providing long-range communication with minimal energy consumption. Technologies such as LoRa and Mioty have emerged as leading protocols in this domain, each offering unique benefits in terms of energy efficiency, reliability, and resiliency. This PhD thesis will aim to explore the inherent tradeoffs between these three critical factors in LP WANs, with a focus on LoRa and Mioty technologies: energy efficiency, reliability and resiliency.

The applicant will use discrete event simulation of wireless networks in tools such as OMNeT++, analytical models and laboratory trials to:

1. Evaluate the energy consumption patterns of LP WAN in various deployment scenarios. Determine the impact of different network configurations, topology and operational parameters on battery life and overall energy efficiency.
2. Investigate the reliability of data transmission in LP WAN networks under varying conditions, including interference, node density, use of relay nodes and radio signal propagation conditions. Measure packet delivery ratios, latency, and error rates to understand the reliability characteristics of each protocol.
3. Evaluate the ability of LoRa and Mioty networks to maintain functionality and performance under adverse conditions such as node failures, interferences and cyber-attacks. Identify and propose new mechanisms for each technology to ensure network resiliency.
4. Quantify and compare the tradeoffs between energy efficiency, reliability, and resiliency in LP WAN networks.
5. Evaluate and stress test the applicability of the LP WAN and other wireless communication technologies in management and monitoring of critical infrastructure.

The PhD will be based mainly on discrete event simulation models and experimental validation. The candidate will conduct extensive simulations and real-world experiments to gather data on energy consumption, reliability, and resiliency for low power wireless networks. The candidate will employ statistical analysis and machine learning techniques to model and predict the performance of these networks under various conditions. She or he will also develop optimization algorithms to

find the best balance between energy efficiency, reliability, and resiliency based on different use case scenarios.

BIBLIOGRAPHY:

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Cheikh, Imane, et al. "Multi-layered energy efficiency in LoRa-WAN networks: A tutorial." IEEE Access 10 (2022): 9198-9231.

Lv, Tiejun, et al. "Optimization of the energy-efficient relay-based massive IoT network." IEEE Internet of Things Journal 5.4 (2018): 3043-3058.

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