

„Zwiększenie efektywności transmisji z wykorzystaniem węzłów pośrednich w sieciach LoRa”

Abstract (EN)

The dissertation investigates methods of improving the efficiency of LoRaWAN networks through the use of relay nodes and a comprehensive theoretical analysis of LoRa chirp spread spectrum (CSS) modulation. The central hypothesis is that properly designed and managed relay nodes can enhance network performance under variable propagation conditions, and this hypothesis is systematically examined and ultimately confirmed. The research covers path-loss variability over time and space, the impact of multipath fading and delay spread on LoRa signal detection, the degree of transmission orthogonality across different spreading factors, and the role of the spreading factor in balancing receiver sensitivity, throughput, and coverage. A detailed LoRa simulator was developed as the main research tool, accurately representing the modulation process and time-correlated propagation effects. A key innovation of the simulator is the integration of artificial neural networks to model variations in radio-path attenuation based on empirical data. The simulator enabled both the analysis of theoretical limits of LoRa modulation and the evaluation of relay-assisted retransmission strategies. The results confirm the hypothesis, showing that appropriately deployed and configured relay nodes improve the reliability of data delivery and extend the effective coverage of LoRaWAN networks while maintaining a favorable trade-off between energy consumption and cost.

Artur Frankiewicz