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5G RedCap enhancement towards Improved Cellular LPWAN/5G-IoT for Smart Cities and Industrial IoT using genetic algorithm-based neural network

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Abstract: Background: The low power wide area networks (LPWANs) technologies significantly impact numerous IoT deployment use cases, especially in the smart cities' scenario. LPWAN is used to support low data rate use cases. Unfortunately, medium data rate (up to 50 Mbps and more) IoT applications are not operational by LPWAN. Hence, a 5G reduced capability (RedCap) new ra□dio (NR) device was provided to address this limitation. However, the 5G RedCap suffers a cover□age loss due to the reduction of the physical layer complexity of the 5G legacy user equipment (UE). Therefore, 5G RedCap enhancements require coverage loss compensation. Objective: This paper aims to improve the performance of 5G RedCap in terms of coverage, energy efficiency, and throughput for Smart Cities and Industrial IoT (IIoT) using a genetic algorithm□based neural network (GA-NN) model. Method: The method involves using a GA-NN model for a two-fold enhancement of the 5G Red□Cap. This enhancement includes a specialized-enhancement RedCap (se-RedCap) for low data rates and an enhanced RedCap (eRedCap) for high data rates (up to 300 Mbps) support. The GA□NN model has been implemented and assessed in MATLAB Global Optimization and 5G Toolbox. Furthermore, an introduced and modified parametric rectified linear unit (ePReLU) activation func□tion fA evaluates the final summation data parameters trained with a specific threshold for the best
performance. Results: The numerical results confirm that the specialized-enhancement RedCap (se-RedCap) and enhanced RedCap (eRedCap) outperform legacy cellular LPWANs and conventional RedCap when considering coverage, energy efficiency, and throughput.
Conclusion: This paper successfully covers two types of usage scenarios: the very low data rate typically seen in LPWAN and the high data rate of up to 300 Mbps, which is not yet compatible with the existing RedCap system. As a result, the GA-NN model creates se-RedCap and eRedCap, providing support for these two scenarios, respectively.