

5G IN IOT ECOSYSTEMS: OPTIMIZING MASS DEVICE COMMUNICATION

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Анотація

У роботі досліджується вплив технології 5G на екосистеми Інтернету речей (IoT). Основна увага приділяється вирішенню проблеми масової міжмашинної взаємодії (mMTC) за рахунок архітектурних переваг мережі п'ятого покоління. Проаналізовано методи оптимізації передачі даних, зокрема використання мережевого нарізання (network slicing) та периферійних обчислень (edge computing) для зменшення затримки та підвищення пропускної здатності в децентралізованих системах.

Ключові слова: 5G, Інтернет речей, mMTC, периферійні обчислення, мережеве нарізання, міжмашинна взаємодія.

Abstract

This paper examines the impact of 5G technology on Internet of Things (IoT) ecosystems. The main focus is on solving the massive Machine-Type Communications (mMTC) challenge through the architectural advantages of fifth-generation networks. Methods of data transmission optimization are analysed, specifically the use of network slicing and edge computing to reduce latency and increase bandwidth in decentralized systems.

Key words: 5G, Internet of Things, mMTC, edge computing, network slicing, machine-type communication.

Introduction

The rapid expansion of the Internet of Things (IoT) has transformed how physical devices interact within digital ecosystems. From smart city infrastructure to industrial automation, the number of connected devices is growing exponentially. However, traditional 4G LTE networks were primarily designed for human-centric communication (broadband internet, video streaming) and face severe limitations when handling simultaneous requests from millions of micro-devices. This bottleneck leads to increased latency, packet loss, and inefficient energy consumption.

The deployment of 5G networks marks a paradigm shift in telecommunications, specifically addressing the needs of IoT through the introduction of massive Machine-Type Communications (mMTC). This paper analyses the core architectural approaches of 5G that optimize mass device communication and enable the next generation of scalable IoT ecosystems.

Research results

The optimization of mass device communication in 5G-enabled IoT ecosystems is achieved not merely by increasing raw bandwidth, but through structural changes in network architecture. Our analysis highlights primary mechanisms that resolve traditional bottlenecks, particularly through advanced resource allocation and traffic management.

Unlike previous generations, 5G introduces network slicing – a technology that allows the creation of multiple virtual networks on top of a single physical infrastructure. In an IoT ecosystem, a dedicated "slice" can be allocated specifically for massive Machine-Type Communications (mMTC). This slice is optimized for low-bandwidth, low-power, but high-density connections, supporting up to one million devices per square kilometre. This logical separation prevents smart sensors from competing for bandwidth with high-demand applications, such as cloud gaming or autonomous driving, thereby ensuring stable and continuous data transmission for critical infrastructure.

In addition to network slicing, 5G addresses latency and network congestion through edge computing and traffic decentralization. In traditional architectures, all IoT data is sent to a centralized cloud for processing. Conversely, 5G seamlessly integrates Multi-Access Edge Computing (MEC) by moving computational

resources closer to the data source, such as at the cellular base station. This allows IoT devices to offload processing tasks locally, which drastically reduces the volume of raw data transmitted across the core network. Consequently, response times are minimized to single-digit milliseconds, enabling devices within the system to interact almost instantaneously.

Furthermore, the implementation of 5G introduces advanced sleep-mode protocols for connected objects. This optimization significantly extends the battery life of remote sensors, which remains a critical requirement for the sustainable mass deployment and maintenance of large-scale IoT networks.

Conclusion

The integration of 5G technology fundamentally redefines the capabilities of IoT ecosystems. By shifting from a "one-size-fits-all" network model to a flexible, software-defined architecture utilizing network slicing and edge computing, 5G successfully solves the challenge of mass device communication. These optimizations reduce latency, decentralize traffic, and provide the essential infrastructure required to transition from isolated smart devices to fully integrated, real-time autonomous systems.

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