

Latency Comparison of 500kWh Energy Solutions for Railway Communication Base Stations



AI Overview

Energy solutions for railway base stations, including 500 kWh storage or energy harvesting, can maintain ultra-low latency if properly integrated with 5G or URLLC systems, but latency depends on power stability, deployment architecture, and energy management.

Impact of Energy Solutions on Latency

- 1. Energy Harvesting (EH) from Railway Electrification:** Harvesting electromagnetic flux from electrified railway masts can provide a sustainable, self-powered solution for small cell base stations without relying on external power cables or batteries (). This approach can support continuous operation during train passage, but latency may fluctuate if harvested energy is intermittent. Proper energy buffering or hybrid storage (e.g., 500 kWh battery) ensures stable power delivery, maintaining millisecond-level latency required for URLLC ().
- 2. Battery Storage Solutions (500 kWh):** Large-capacity batteries can provide consistent power to base stations, supporting high-speed 5G communication with ultra-low latency. A 500 kWh system can sustain multiple small cells along a railway corridor, reducing the risk of power interruptions that could increase latency. Integration with smart power management and sleep modes for repeaters can further optimize energy efficiency while preserving low-latency performance ().
- 3. Solar or Photovoltaic-Powered Repeaters:** Low-power repeaters powered by PV cells can reduce energy consumption by 50–79% while maintaining data capacity (). When combined with 500 kWh storage, these repeaters can operate autonomously, ensuring stable latency. However, latency may be affected during periods of low solar input unless supplemented by stored energy.

Deployment Considerations

Distributed...

Article Content

Railway communications needs great network design

Today, railway communications are a challenge. Here's how MBB connectivity, powered by 4G and 5G network design will drive faster, safer and greener travel.

Comparison of Power Consumption Models for 5G Cellular Network Base ...

This paper conducts a literature survey of relevant power consumption models for 5G cellular network base stations and provides a comparison of the models. It highlights commonly made assumptions

Off-Network Communications For Future Railway Mobile Communication ...

Off-network communication refers to a direct communication mode between transmitter and receiver without passing the network, e.g., direct train-to-train (T2T) communication and direct train-to-ground

Artificial intelligence in rail transit wireless communication systems ...

The aim of this paper is to explore these issues in depth and propose corresponding solutions. Firstly, we integrate AI with rail transit wireless communication to build relevant

A Comprehensive Review of Energy Efficiency in 5G

The rapid evolution of wireless communication toward Fifth Generation (5G) networks has enabled unprecedented performance

Energy-saving Solutions for Base Stations in High-Speed Railway ...

In view of the problem, this paper proposes a carrier activation technology based on high-speed train arrival identification for high-speed railway dedicated network scenarios.

5G and energy internet planning for power and communication

Our study introduces a communications and power coordination planning (CPCP) model that encompasses both distributed energy resources and base stations to improve communication

Energy-efficiency schemes for base stations in 5G heterogeneous ...

In today's 5G era, the energy efficiency (EE) of cellular base stations is crucial for sustainable communication. Recognizing this, Mobile Network Operators are actively prioritizing EE for both

Analysis of the rural network deployment to achieve end-to-end latency ...

GSM for Railways (GSM-R) was born as a result of these efforts and it is a 2G-based, standardized ground-to-train communication system that enables interoperability across different

From GSM-R to FRMCS: The Evolution of Rail

The foundation of 5G-R will be built on several 5G-based technologies, such as network architecture, massive MIMO, millimetre-wave, multiple access, ultra

Energy-saving Solutions for Base Stations in High

The approach supports sustainable development goals for 5G, promoting energy efficiency and emission reductions in telecommunications

Energy Efficiency Optimization of Ultra-Reliable Low-Latency ...

Section III introduces the train-ground communication model with MRs for URLLC, and formulates the optimization problem for maximizing the system's energy efficiency.

Energy efficient power allocation for ultra-reliable and low-latency ...

Unlike traditional energy efficiency optimization that only considers energy consumption, in this paper we also take into account the impact of transmission power on data transmission rates,

Energy Efficiency Optimization of Ultra-Reliable Low-Latency ...

Abstract—With the rapid development of new communication technology, notably ultra reliable low latency communication (URLLC) in the 5th generation cellular network, and the wide deployment of

Energy-saving Solutions for Base Stations in High-Speed Railway ...

This paper analyzes the problem of insufficient energy-saving means during network idle periods in the current 5G base station deployments for high-speed railway dedicated networks,

Optimization Control Strategy for Base Stations Based on Communication ...

On the basis of ensuring smooth user communication and normal operation of base stations, it realizes orderly regulation of energy storage for large-scale base stations, participates in auxiliary peak

Study and Measurement of Latency in the 5G Mobile Communication

The importance of latency as a 5G communication key performance indicator (KPI) has drawn considerable attention from academics and industry, with the goal of developing improved

Seven Challenges for Communication in Modern

In this paper, after reviewing the main 5G communication aspects for modern railways, we describe seven main challenges faced by train connectivity,

Towards Integrated Energy-Communication-Transportation Hub: A Base ...

An effective method is needed to maximize base station battery utilization and reduce operating costs. In this trend towards next-generation smart and integrated energy-communication-transportation (ECT)

Towards Integrated Energy-Communication-Transportation Hub: A

Introducing renewable energy generation (such as wind and solar power) and energy storage solutions (batteries) in base station construction is a promising approach to reduce electricity

Intelligent Communication and Networking Systems for Future Rail ...

However, with increasing demands for the level of train automation, onboard multimedia tasks, remote train maintenance, and intelligent sensing, rail communications are evolving towards

Improving energy resilience in cellular base stations and critical ...

This survey anticipates a fully integrated energy-communication ecosystem that emphasizes multi-layered protections intended to guarantee the uninterrupted operation of cellular

5G Based on MNOs for Critical Railway Signalling

This paper describes the prototype and tests carried out to demonstrate the feasibility of implementing 4G/5G systems based on mobile

Energy Efficiency Optimization of Ultra-Reliable Low-Latency ...

Specifically, we establish the train-ground URLLC model for the HSR communication system with mobile relays (MRs), based on which we formulate the optimization problem with the QoS requirements of

Energy Efficiency Optimization of Ultra-Reliable Low-Latency ...

This paper proves that a global optimal solution can be found in a convex subset of the original feasible region for ultra-reliable and low-latency communications (URLLC), where the blocklength of channel

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