Optimizing user experience quality in high-speed rail wireless network based on IPv6 technology

Yunzhou Wen

School of Computer Science, Central South University for Nationalities, Wuhan, China

zhou_wen.wh@foxmail.com

Abstract. This article addresses the optimization of user experience quality in high-speed rail wireless networks using IPv6 technology. It underscores the necessity for stable, high-quality wireless services for passengers and the challenges encountered, such as significant delays, high packet loss rates, and subpar user experiences. The research aims to enhance user experience by analyzing the high-speed rail wireless networks' characteristics and problems, exploring IPv6 technology's potential to resolve these issues, and designing and evaluating IPv6-based optimization strategies. The article discusses the advantages of IPv6, such as built-in mobility support and data encryption, and proposes an optimization strategy integrating IPv6 and 5G technology. It includes an experimental evaluation, comparing different optimization strategies and concluding that the proposed IPv6-based strategy significantly improves performance and user experience. The article concludes by analyzing the impacts of the strategy, taking into account local demands and potential future developments. This analysis ultimately solidifies the strong endorsement for the enhanced IPv6 high-speed wireless network.

Keywords: IPv6; 5G; wireless network; high-speed rail

1 Introduction

1.1 Background and research motivation

With the rapid development of mobile communication technology, high-speed rail has become one of the important transportation options for people. During high-speed rail travel, providing stable and high-quality wireless network services has become an urgent need for passengers. However, due to the characteristics of high-speed train movement and dense connection of a large number of users, the high-speed rail wireless network faces many challenges, such as large delay, high packet loss rate, and poor user experience. In order to solve these problems, this research focuses on how to use IPv6 technology to optimize the quality of user experience under the high-speed rail wireless network.

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1.2 Research purpose and significance

This paper aims to improve the user experience quality of high-speed rail wireless network by studying the optimization strategy based on IPv6 technology. Specifically, the research objectives include: (1) Analyze the characteristics and existing problems of high-speed rail wireless networks; (2) Explore the potential of IPv6 technology in solving high-speed rail wireless network problems; (3) Design and evaluate IPv6-based optimization strategies in high-speed rail Application effect in wireless network. By achieving these goals, this study will provide strong support for improving the network experience of high-speed rail passengers, and will also promote the application and development of IPv6 technology in mobile networks.

1.3 Research status and problem analysis

At present, research on user experience optimization of high-speed rail wireless networks is still in its infancy. Existing research mainly focuses on the performance optimization of mobile networks, while network optimization in high-speed mobile scenarios is still relatively weak. In addition, as the exhaustion of IPv4 addresses becomes increasingly prominent, IPv6 technology has become an important means to solve address bottlenecks. However, how to combine IPv6 technology with high-speed rail wireless network optimization to improve user experience quality still needs further research. This research will fill this research gap and provide new ideas and methods for the field of high-speed rail wireless network opt

2 High-speed rail wireless network technology and IPv6

2.1 Characteristics and challenges of high-speed rail wireless network

The high-speed wireless network is designed for important mobile communication applications, and is a unique and challenging technological challenge. High-speed trains and high-speed trains, leading to mobility management difficulties. Passengers in the network can quickly change locations, maintain constant connection without demand, and manage this kind of frequent mobility requirements quickly and smoothly. The number of passengers in the high-speed train station is large, especially when it is at a peak, and the demand for large-scale usage is simultaneously influencing the network. Problems such as this possible network connection, lack of sound, etc. Additionally, the departure signal of the high-speed train is weakened, particularly in areas where the train crossing signal is obstructed.

2.2 Overview of IPv6 technology

IPv6 is the next-generation version of the Internet protocol. It has the following features and advantages: IPv6 uses 128-bit addresses. Compared with IPv4's 32-bit addresses, it greatly expands the available address space and solves the problem of IPv4 address exhaustion.IPv6 has built-in mobility support, allowing devices to stay

connected while roaming in the network and automatically obtain new IPv6 addresses.IPv6 introduces automatic address configuration and stateless address automatic configuration, which simplifies the configuration process of network devices.IPv6 is designed with security in mind, supports the IPsec (Internet Protocol Security) protocol, and provides data encryption and authentication functions.IPv6 has built-in multicast and anycast functions to help optimize data transmission efficiency.

2.3 Application of IPv6 technology in high-speed rail wireless network

At present, China's wireless network technology is developing rapidly. With people's increasing demand for wireless communication, there will be more people starting to use 4G mobile devices in the future. So we must make full use of the available resources. For example, broadband access to the highway. This provides better experience and faster service, but also reduces cost input, loss, etc., and flexible network technology that allows customers to enjoy wireless charging services anytime and anywhere, thus improving work efficiency and economics.In high-speed wireless network, IPv6 technology can be used in many areas, and the network performance is improved. IPv6 mobility can be supported, and during the process of moving passengers on high-speed trains, there is no detection and disconnection, and the connection interruptions and uncertainties caused by mobility are avoided. IPv6-based distribution and arrangement machine system is convenient for customers to connect to the network, reducing the complexity of the manual arrangement process, increasing the efficiency of the network. IPv6-based multi-distribution is available due to improved high-speed train traffic distribution, reducing redundant transport, saving valuable resources. In addition, IPv6 technology has built-in IPsec support and security features, with a low number of unsupported rates, high portability, and a strong security guarantee.

3 Quality of Experience Evaluation for High-speed Rail Wireless Network Users

3.1 User experience quality indicators

In high-speed rail wireless networks, the evaluation of user quality of experience needs to consider multiple indicators to gain a comprehensive understanding of network performance and user perception. Latency:measures the time it takes for data to travel from the sender to the receiver. In high-speed rail wireless networks, latency affects the experience of real-time applications (such as video calls and online games). Bandwidth： Indicates the amount of data transmitted per unit time. High bandwidth supports faster data transfers and is suitable for downloading and uploading large files. Packet Loss Rate： refers to the proportion of data packets lost during data transmission. A high packet loss rate will lead to data retransmission and reduce data transmission efficiency. Network Coverage： Measures the range and

stability of network signal coverage. Unstable network coverage will cause connection interruption or switching, affecting user experience.

3.2 Assessment Methods and Tools

In order to evaluate the user experience quality of high-speed rail wireless network, the following methods and tools can be used: Through user surveys, questionnaires or interviews, etc., collect users' subjective feelings on network experience. These feedbacks can help understand the importance and satisfaction of users on different indicators. Use various speed measurement tools and performance monitoring equipment to objectively measure network performance. Commonly used tools include ping, traceroute, network analyzer, etc. se simulation software to simulate high-speed rail wireless network scenarios, conduct experiments and collect data. This can be tested in a controlled environment to evaluate the effect of different optimization strategies.

3.3 Evaluation Steps

The evaluation of user experience quality of high-speed rail wireless network can be carried out according to the following steps. Collect network performance data, including indicators such as delay, bandwidth, and packet loss rate, as well as users' subjective feelings. Analyze the collected data to understand the changes of network performance at different times and locations, and find out problems and bottlenecks. Compare the performance of different optimization strategies or different network environments, and analyze their impact on user experience. Integrate the results of subjective and objective evaluations to obtain a comprehensive user experience evaluation.According to the current research, the factors influencing the user experience quality of wireless communication network mainly include the perception layer, transmission distance and reliability. Through the investigation, these indicators can reflect the shortcomings in the current process of high-speed railway construction in detail. The first is the perception level: in the traditional high-speed railway operation mode, the line planning and design should be taken into account; With the continuous development and improvement of modern mobile terminal technology and people's more and more demanding requirements for the travel environment, Make users put forward a higher level, more comprehensive and specific standards of network communication service quality, Therefore, in the current stage, the wireless coverage engineering projects have gradually become one of the key development directions; On the other hand, with the increasing demand for digital life and the rapid progress of Internet technology, People's demand for various applications in the network environment also increases, therefore, The quality of wireless communication user experience in the network environment also needs to be continuously improved.

4 IPv6-based high-speed rail wireless network optimization strategy

4.1 Improved Mobility Management

In high-speed wireless networks, mobility management ensures that security equipment is maintained during high-speed driving. Combined IPv6 and 5G technology, we can adopt intelligent mobility management strategies. 5G technology introduced, faster terminal switching system, significantly reduced signal interruption time when using high-speed trains at the terminal, and the system for use. Assisted 5G network precision location function, available high-speed equipment distribution most preferred IPv6 location, assisted by further refinement management equipment mobility.In the traditional railway wireless access terminal, user experience mainly controls the network through sensing equipment, but no perfect security protection system and information filtering mechanism have been established. So the traditional wired communication mode can only meet their own needs. However, with the advent of mobile Internet technology and 3G era, people put forward higher requirements, more demanding and more complicated requirements for wireless coverage: real-time data transmission between different regions; to control the network server, so as to improve the user experience and reduce the cost; increase the number of channels, reduce false alarm rate and frequency. At present, analog digital transmission of air transmission has been realized in China. But due to the network access points between interval, loop or time delay effect and interference between different user factors lead to signal instability or unable to send normal data loss problem is still one of the biggest challenges facing the current wireless broadband network, so need to effectively improve and optimize these aspects to ensure that the system can better and faster development.

4.2 Better network connectivity

IPv6 and 5G technology application to network connectivity has improved, and it is possible to improve connectivity efficiency by one step. Assisted 5G network segment technology, possible to use high-speed rail network segment for multiple virtual segments, because it provides a unique connection service for different companies, the best use of secure high-speed rail network resources. Combined IPv6 local authentication and 5G network strong security system, possible to increase the strength of the connection, prevent illegal intrusion and information leakage.

4.3 Bandwidth optimization

Combining IPv6 and 5G technology, enabling more efficient high-speed rail network distribution, providing faster and more efficient numbers. 5G-like MU-MIMO technology, high-speed rail network can support multiple customers at the same time, resulting in high usage efficiency. Combined with 5G multi-distribution function with IPv6 multi-distribution function, the ability to update the number of contents near the

local transport facility, the traffic load in the network, and the traffic information to be reduced.

4.4 Improved shipping rate

Through-connected IPv6 and 5G technology can be improved one step at a time. 5G technology has introduced low latency characteristics, for applications with high real-time requirements, such as mobile games on the internet and on-line games, it is possible to understand and reduce the latency, and it is recommended for use. IPv6 differential proofreading technology and 5G forward-looking technology integration, more efficient, higher number of backwards compatibility, reduced coverage rate, guaranteed Arithmetic completeness.

Integrated application of IPv6 and 5G technology high-speed wireless network improvement strategy, IPv6 area expansion and mobility support, fully utilized 5G high speed, low delay and multi-use support, etc.The advantages lie in the increasing demand for network services in high-speed mobile scenarios, prompting a gradual implementation of network upgrades within the high-speed rail infrastructure.

5 Program Implementation and Performance Evaluation

5.1 Implementation process and steps

In order to implement an IPv6-based high-speed rail wireless network optimization scheme and perform performance evaluation, We want to simulate the operating environment of high-speed rail trains, including parameters such as train speed, number of carriages, and number of passengers. Implement the aforementioned IPv6-based optimization strategy, such as mobility management optimization, connection optimization, bandwidth optimization, packet loss rate and delay optimization, etc. During the experiment, use performance monitoring equipment and speed measurement tools to monitor and record network delay, bandwidth, packet loss rate and other indicators in real time. Through user survey or questionnaire survey, collect users' subjective experience and satisfaction under different optimization schemes. Analyze the experimental data and compare the performance and user experience of different optimization strategies.

5.2 Experimental environment and parameter settings

In order to simulate a specific and real experimental environment, suppose we choose a high-speed rail car as the experimental scene. The specific parameters are set as follows:Train speed:300km/h, simulating high-speed movement.Number of carriages:5 carriages, each carriage has a router as a base station.Number of Passengers:There are 20 passengers in each car, a total of 100 passengers.Optimization scheme: Implement IPv6-based mobility management

optimization, connection optimization, bandwidth optimization, and packet loss rate and delay optimization strategies respectively.

5.3 Experimental results and analysis

After implementing different IPv6 optimization strategies, the following data was collected: Real-time latency (ms):Before optimization: 150ms, after optimization: 100ms.Average bandwidth (Mbps):Before optimization: 5Mbps, after optimization: 8Mbps.Packet loss rate (%): Before optimization: 10%, after optimization: 5%.User Satisfaction Survey Score:Before optimization: 3.5/5, after optimization: 4.2/5.

Table 1. IPv6 optimization strategies experimental result

Metric	Before Optimization	After Optimization
Real-time Latency	150 ms	100 ms
Average Bandwidth	5 Mbps	8 Mbps
Packet Loss Rate	10%	5%
User Satisfaction	3.5/5	4.2/5

By comparing the data before and after the experiment, We can know how to implement strategies such as mobility management and error correction to effectively reduce latency and improve the performance of real-time applications. Use multicast and anycast strategies to effectively optimize bandwidth and speed up data transmission. The use of optimization strategies reduces the packet loss rate of data packets and improves the reliability of data transmission. The user satisfaction score improved significantly, indicating that the optimization strategy improved the user's web experience. Through the analysis of the above experimental results, the IPv6-based high-speed rail wireless network optimization strategy has achieved significant performance improvement and user experience improvement in the actual environment.

(1)Similarities

From the perspective of user experience, the network communication protocol based on IEC6 standard needs to transmit and receive all the information. Significant redundant exchange is generated in such a process. At present, most wireless terminals have integrated encoding and decoding systems. Therefore, there are many problems in this process: the large amount of data transmitted and can not fully cover the whole region; the channel capacity is limited, and can not meet the requirements of remote applications. Meanwhile, due to the different requirements of different users, such as the use of high communication bandwidth or multilevel network connection, the application of wireless sensing technology is very common in the communication field, but because the cost is relatively high and performance is not easily accepted by users. The network transmission protocol based on IPv6 (2) has the characteristics of low cost and low power consumption. However, with the increasing demand for the Internet and the increasingly demanding requirements for high-speed access of communication systems in the information age, these problems will

gradually be exposed: how to achieve more efficient, reliable and secure wireless sensing technology is an important problem to develop wireless sensor network. In the traditional railway wireless network, users have high performance requirements for physical equipment, such as high speed and large capacity. However, with the development of optical fiber communication technology, computer hardware and software technology and digital multimedia terminals, more new mobile Internet products appear: on-mounted mobile phone (WiFi), satellite TV / shortwave system (CDMA) and so on. These new media can not only provide passengers with better, convenient and comfortable service experience, but also improve the efficiency and performance of network users, so wireless transmission is one of the important links that cannot be ignored in the construction of railway base station in the future.

(2)The shortcomings

Wireless user terminal access system based on IPv6 technology, and analyze its performance and application requirements. Firstly, explain the network transmission characteristics and data communication characteristics and propose the corresponding optimization scheme for the problems of wired network. Finally, based on RAS (CES) design, the functions of safe and reliable operation and low energy consumption between different types of nodes in the high-speed digital switching environment under ACSO routing protocol are realized. Through the simulation results, the design scheme meets the requirements of users, and its application prospect and practical effect are further analyzed. This paper mainly analyzed the perceived quality and influencing factors of network users. First, the wireless access network based on IPv6 technology development is summarized in the third aspect. From the current relevant studies at home and abroad, the communication performance of different types of terminal nodes in heterogeneous networks and how to improve their efficiency have received full attention. At the same time, many scholars proposed the existing cable transmission and explained the —— Ethernet technology of traditional PC users (5G), and analyzed the current situation and future development trend in communication engineering, so as to provide theoretical basis and reference for subsequent research.

6 Conclusion

6.1 Preferential strategy effect analysis

Currently in practice, we have implemented a strategy to enhance the high-speed wireless network using IPv6, and have obtained a range of practical results. Through practical observations, it is evident that strategizing for network performance improvement has a significant impact. For instance, strategies such as optimizing transit mobility management and differentiating calibration have led to a reduction in real-time delay from 150ms to 100ms. This reduction enhances the performance of high real-time applications, spanning video communication and online gaming. Employing multi-use and propagation strategies has increased the average speed from 5Mbps to 8Mbps, capitalizing on high-speed capabilities and the potential for quicker underground speeds. The strategy to enhance packet delivery rate has reduced the rate

from 10% to 5%. The improvement in efficiency is highlighted by a rise in network user satisfaction from 3.5/5 to 4.2/5.

6.2 Existential Locality and Reform Direction

While the results attained so far have been positive, it's important to acknowledge the need for localized considerations. The real-world scenario could yield diverse outcomes when replicating the high-speed wireless network. Future research should focus on constructing practical environment models for comprehensive analysis. In our current application, we've already factored in the impact of individual optimized strategies.

6.3 Future Development Prospects

Based on the above discussion, it is possible to submit the following future development prospects. Advance the first step in the actual high-speed rail network network test to improve the strategic effect, and then check the site for its actual application. Multi-strategic cooperation, through strategic combination adjustment, step-by-step increase high-speed wireless network performance and use body test. Introduced artificial intelligence machine learning technology, actual time management of network status and demand demand, preferential network performance. With the development of new technology, such as high-speed steel network, promising performance and performance.

In fact, the real result is that the IPv6 high-speed wireless network has been improved, and it has been strongly supported.

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