

Retraction

Retracted: Whole Scenario of 5G Communication Access in the Digital Transformation of Medium and Large Enterprises

Mobile Information Systems

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] Y. Yang, Z. Yan, and Y. Xiao, "Whole Scenario of 5G Communication Access in the Digital Transformation of Medium and Large Enterprises," *Mobile Information Systems*, vol. 2021, Article ID 7322090, 10 pages, 2021.

Research Article

Whole Scenario of 5G Communication Access in the Digital Transformation of Medium and Large Enterprises

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With the evolution and upgrading of the fifth-generation mobile communication technology, the mobile network will support a larger mobile user group and more diverse business scenarios, greatly enhance the Internet service experience, and fully support IoT-aware applications. As the forefront of the Internet of Everything, the wireless access network plays an important role in the evolution of the network. The continuous innovation of a new generation of information technology, especially the application of technologies such as big data, cloud computing, artificial intelligence, and the Internet of Things, has triggered an upsurge in the digital transformation of enterprises. Digital transformation has had a profound impact on the production and operation activities of enterprises and has also changed the organization and management of enterprise innovation activities. From the perspective of the innovation ecosystem, the digital transformation of a single enterprise leads to changes in innovation activities, which will converge and emerge new characteristics at the system level. The purpose of this article is to study the full scenarios of 5G communication access in the digital transformation of medium and large enterprises. This article starts with the development trend of wireless access networks, analyzes network slicing technologies in detail, and points out that wireless access networks are moving towards 5G. Important challenges are faced in the development of the times. Based on the adaptive random access model proposed in this paper, a feedback adaptive optimization method is proposed. This method estimates the real access load through feedback and calculates the access threshold through the access load. Then, broadcast the threshold value to each user equipment through downlink broadcast. The results show that the normalized throughput rate of random access methods using AC-RACH and FC-RACH is higher than that of RA-RACH. Especially, when the arrival rate of user requests is getting higher and higher, the throughput rate of RA-RACH access will continue to decrease with the collision until it approaches zero. By comparing the key data of normalized throughput rate and access success rate, it is concluded that the feedback adaptive method has a significant performance improvement under heavy load conditions compared with the previous method.

1. Introduction

The rapid development of digital technologies with the Internet, big data, cloud computing, artificial intelligence, and the Internet of Things as the core has provided new technical routes and development ideas for the development of the innovation ecosystem, attracting close attention from governments and enterprises. Nowadays, data is driving changes in various industries [1, 2]. On the one hand, the digital transformation of the industry is inevitable. As a new economic form, the digital economy is gradually promoting the digital transformation of the industry and the whole

society through digital technology or digitization [3, 4]. On the other hand, it is mainstream for companies to join the innovation ecosystem. The emergent development of new information technology has led to increasingly fierce competition among enterprises and the increasing complexity of technological innovation in various industries. It is difficult to rely on independent innovation to contract for all technological innovations of products. Innovation has gradually changed from an independent and isolated management model to an independent management model: information technology platform-centered collaboration and open innovation ecosystem management model [5, 6].

Compared with European and American powers, our country's previous generations of mobile communication technology have been catching up, but it is gradually becoming a global leader in the research and development of 5G standards. In recent years, under the leadership of the Chinese government, major communication companies and university scientific research institutions have worked together to actively deploy 5G communication technology frontier fields and strive to take the lead in the formulation of fifth-generation communication technology standards [7]. At the beginning of 2013, the Ministry of Industry and Information Technology, the Development and Reform Commission, and the Ministry of Science and Technology took the lead in establishing the "MT-2020 (5G) Promotion Group," which is responsible for solving the promotion of 5G research and development and communicating and coordinating with countries such as Europe, America, Japan, and South Korea to establish a good exchange and cooperation mechanism and promote the completion of global standardization and industrialization as soon as possible. The "MT-2020 (5G) Promotion Group" launched a 5G trial product in 2018, a 5G trial network in 2019, and plans to promote the official application of the 5G network in 2020. As the core members of the 5G work promotion group, China's three major operators actively promote the implementation of 5G construction projects; in 2016, the United States proposed to develop 5G technology. At that time, the US government also provided corresponding funding to telecom companies to carry out 5G projects in four cities [8]. In October 2016, South Korea's largest mobile communications operator SK Telecom announced that they have established a 5G mobile network research center in South Korea-5G Playground and built a test network in 2017, becoming the world's first 5G operator [9]. In addition, Korea Telecom (KT) completed the precommercial use of 5G networks in multiple Winter Olympics venues in 2016 and completed its fifth-generation communications technology debut at the 2018 Pyeongchang Winter Olympics, becoming the first in the world, countries that realize the official commercialization of 5G networks; in line with the goals of the Korean Winter Olympics, Japan also plans to commercialize 5G mobile communication services before the 2020 Tokyo Olympics [10].

This article uses research methods to use the TOE framework for the connotation of corporate digital transformation and corporate digital transformation capabilities, summarizes the influencing factors of manufacturing companies' digital transformation capabilities from the technical, organizational, and environmental levels, and analyzes the impact of corporate digitalization on manufacturing companies. It also proposes a feedback adaptive optimization method and finally verifies its performance through simulation experiments.

2. Whole Scenario of 5G Communication Access in the Digital Transformation of Medium and Large Enterprises

2.1. Capability Elements of Digital Transformation of Medium and Large Enterprises. The key to the digital transformation of medium and large enterprises is to have the ability to

adapt to changes in the environment. The first requirement is to have the ability to capture external information; in addition, medium and large enterprises must also have the ability to conduct reasonable operations based on their own resources. The ability of dynamic configuration in order to maintain a competitive advantage and the ability to change the internal organization level are precisely the key to constructing the dynamic core capabilities of medium and large enterprises. Therefore, when medium and large enterprises enter a new stage of transformation and upgrading, they must cultivate the ability to adapt to it [11].

2.1.1. Technical Capabilities for Digital Transformation of Medium and Large Enterprises. The ability of medium and large enterprises to apply digital transformation technology has a significant impact on the effect of digital transformation. Digital infrastructure capabilities have universal characteristics. Although they cannot directly help companies bring special competitive advantages, such capabilities also include the application and management capabilities of related facilities, which indirectly affect the competitiveness of companies in digital transformation. The technology development and upgrade capabilities of digital transformation refer to companies that make full use of current emerging technologies, develop new technologies, or update and upgrade old hardware and software, and help companies quickly use new technologies to enhance their competitiveness. Improving the ability of enterprises to obtain, generate, and share information can help enterprises deploy, use, process, develop, and utilize information resources in a more effective manner, improve enterprise R&D efficiency, and enhance enterprise R&D advantages.

2.1.2. Digital Management Capabilities for Digital Transformation of Medium and Large Enterprises. Enterprise digital management is the inheritance and innovation of traditional organization management. Enterprise digital management absorbs the essence of traditional management, and with the application and development of big data, artificial intelligence, and other technologies, it has made innovations and breakthroughs in management ideas, management tools, and management methods. Enterprise digital management capabilities are based on modern management theories, system theory, information theory, and cybernetics used as management methods, and new digital-related technologies are used as means to realize the ability of enterprises to efficiently operate in planning, organization, leadership, and control. Digital management capabilities directly affect the application capabilities and implementation effects of enterprises' digital-related technologies and equipment. An enterprise's strong digital management capabilities can effectively connect the internal and external resources of the enterprise, open up the enterprise data chain, and quickly respond to and meet customer needs. Enterprise digital management capabilities can fully demonstrate the effect of enterprise management information integration, reflect the leap of management level in quality, and provide a strong digital foundation for the

integration of enterprise internal business information flow. The digital management of an enterprise organization involves the company's R&D, production, marketing, human resources, finance, and other functional departments. The digital management capability of an enterprise organization is to realize the all-round digitization of the enterprise's production and operation management, including the digitization of business data and the digitization of business processes, manufacturing automation, digitalization of management decision-making, and digitalization of supply chain.

2.1.3. Organizational Change Capabilities of Digital Transformation of Medium and Large Enterprises. As the main participants in the digital transformation of enterprises, business managers and employees have a direct or indirect impact on the effect of digital transformation of medium and large enterprises with their ability to apply digital technology and their mastery of digital-related knowledge. Optimizing the organizational structure and improving the efficiency of production and operation are among the key points for improving the digital transformation capabilities of medium and large enterprises. The ability of organizational transformation is the endogenous force to adapt to new challenges and opportunities and determines the direction of the differentiated development of traditional enterprises. The ability of a company's digital transformation first depends on the ability of entrepreneurs.

2.2. Role of Digital Transformation in the Development of Medium and Large Enterprises. The impact of digital transformation on enterprises is mainly reflected in the following aspects.

First, the digital transformation of medium and large enterprises helps enterprises achieve cost reduction and efficiency enhancement. Realizing the digitization and visualization of enterprise production control can help medium and large enterprises replace human management with digital management, reduce management personnel in measurement and statistics, achieve precise management, and effectively reduce management costs; visualization of production statistics also effectively helps companies eliminate the drawbacks of personnel statistics, to promote enterprises to establish a new distribution model based on production big data measurement. The digitization of physical enterprises will help enterprises break through the limitations of time and space, reduce costs in procurement, marketing, and logistics, and meet the individual needs of customers at a zero price [12].

The second is that the digital transformation of medium and large enterprises helps enterprises realize the traceability management of product quality. The products produced by Chinese enterprises generally have problems such as poor product quality and low lifespan. The high-quality development of our country's industry requires the improvement of product quality to be the top priority. After the comprehensive digital transformation of the enterprise is completed, product quality can be tested in the production

process to realize the cornerstone discovery and treatment of problems in the production process and can also be traced back to the entire life cycle of product quality, thereby effectively ensuring product quality and enhancing product market competition force.

The third is that the digital transformation of medium and large enterprises helps enterprises improve their innovation capabilities. Theorists generally agree that the digital production of enterprises is the basis of flexible manufacturing, collaborative manufacturing, scale customization, green manufacturing, and other manufacturing modes, helping medium and large enterprises adapt to and satisfy customers' individual customization and scale customization and effectively enhance their innovation capabilities. The effective synergy of technological innovation and institutional innovation for enterprises has become an effective way for medium and large enterprises to enhance their competitiveness in the process of digital transformation and upgrading, and it is believed that technological learning can drive the evolution and upgrade of medium and large enterprises. The investment of enterprises in information technology is the lasting driving force of digital transformation, and the digital transformation of medium and large enterprises will also enhance their technological innovation capabilities [13].

Fourth, the digital transformation of medium and large enterprises helps enterprises optimize their organizational structure and promote management innovation. The digital transformation of medium and large enterprises can optimize the organizational structure and improve operating efficiency and effectiveness. The development of digital technology has increased the requirements for employees' technical capabilities and professionalism, but it can break the original organizational balance, and the corporate organization has changed from a "pyramid" to a "flat," reducing information dissemination, processing, and internal transaction costs of the organization wait. The digitization of enterprises can encourage enterprises to streamline and soften their organizational structure, promote the smoothness of information transmission within the enterprise, and give full play to the creativity of employees. The development and application of digital technology can promote the transformation of the management technology of medium and large enterprises and make the operation mechanism and management method of the enterprise more coordinated, efficient, and timely, assisting management decision-making and improving the company's response speed to the market [14].

2.3. Network Slicing Technology. In the 5G era, mobile communication technology will become a catalyst for the digital development of society, and many vertical industries will complete the digital transformation, such as Industry 4.0, Manufacturing in China 2025, and other industrial layouts. Therefore, a variety of new services derived from vertical industries such as VR/AR and intelligent driving will rise rapidly. Therefore, the differentiation of business needs is an important feature of the 5G era [15, 16]. In order to

realize customized network bearing for various services, network slicing emerged as a key 5G technology. Network slicing will serve various industries in the form of a logical private network, and various types of services will share the basic physical network, thereby reducing network construction costs and comprehensively improving network operation efficiency [17].

In essence, network slicing is to customize a virtual bearer network for a service, which can meet the requirements of various technical indicators of the service. The industry-consensus slice generation steps are shown in Figure 1, including, firstly, generating corresponding virtual networks according to user needs, that is, converting digital user indicators into corresponding network topology and resource requirements; secondly, mapping the generated virtual network to physical network, and then changing and adjusting the slice resource configuration and network connection according to user needs.

The current research on network slicing technology is mainly aimed at a single technical dimension such as wireless or optical, and the future 5G wireless access network will be a converged network oriented to wireless, optical, and computing collaboration. Therefore, how to construct end-to-end network slicing is an important focus of future research. In addition, in essence, the formation of slices is based on virtual networks. Therefore, most RAN slicing work is keen on discussing the problem of “slice virtual network mapping,” while the research on “virtual network design” is still relatively blank. Therefore, how to design sliced virtual networks according to business needs is an important research trend in the future and is the vitality of the slice concept [18].

2.4. Wireless Access Technology

2.4.1. Massive MIMO Technology. Multiple-input multiple-output (MIMO) technology makes full use of space resources by configuring multiple antennas at the transceiver end to provide multiplexing gain, on the one hand, to increase spectrum efficiency, and, on the other hand, diversity gain to improve system reliability. With the continuous increase of communication rates, MIMO technology has become the mainstream technology in the 5G field. In 4G systems, base stations generally configure fewer antennas, so the performance potential of MIMO technology has not been fully tapped. In response to the above problems, the concept of massive MIMO (mMIMO) was proposed. In the mMIMO system, each base station installs hundreds of antennas to make full use of space resources and can serve multiple users with the same time-frequency resources. In addition, the mMIMO system can significantly improve the flexibility of network coverage and provide coverage in different scenarios through horizontal and vertical coverage characteristics [19].

2.4.2. Millimeter Wave Communication Technology. Millimeter wave will become an important technology option for 5G mobile communication through its advantages of ultra-large spectrum bandwidth. Millimeter wave (mm

Wave) communication is the use of millimeter waves as the carrier of information transmission (30 GHz~300 GHz), which has the advantages of large capacity, narrow beam, good directivity, and less interference. In the 5G network deployment plan, low-frequency bands are the primary choice for wide coverage and high mobility communication applications. However, due to limited low-frequency spectrum resources, mm Wave will serve as a supplementary technology for low-frequency 5G communications, which can increase system capacity in hotspot areas.

2.4.3. Ultra-Dense Networking. In order to meet the 5G ultra-large data traffic and ultra-high user rate requirements, in addition to broadening the wireless spectrum and expanding the antenna scale, ultra-dense networking (UDN) will be another effective solution. The difference between UDN and traditional cellular networks is mainly reflected in the density and type of access points (AP). On the one hand, the UDN network contains thousands of APs per square kilometer, while the traditional cellular network contains 3 to 5 base stations at most. A single AP in a UDN network only connects to one or a small number of active users, while a single base station in a traditional cellular network can accommodate hundreds or even thousands of active users at the same time. On the other hand, there are multiple types of AP sites in the UDN network, such as microcells, relay stations, and AAUs, and even the user itself can act as an AP, while the macro base station is the only type of wireless site in the traditional cellular network. In addition, heterogeneous topology, irregular coverage, broadband, lower mobility, and ultra-high data rate are all characteristics that distinguish UDN from traditional cellular networks [20].

2.5. Based on 5G Packet Slicing Technology and Lo Ra WAN Technology Networking Tunnel Status Wireless Full Perception. This plan adopts the core network-backhaul network-base station-terminal model for construction, including core network construction, base station construction, backhaul network utilization of the existing local transmission network, and expansion of related boards.

2.5.1. Core Network. The core network is deployed in the computer room of Wuhan Power Supply Company. In order to realize the physical isolation of the divisional services, it needs to be deployed according to the divisions in the later period. This time, a core network is deployed. Through the E2E slicing technology, different resources are divided and used to carry I/II and III/IV area business. 5G core network control plane network elements include Access and Mobility Management Function (AMF) responsible for terminal mobility and access management; Session Management Function (SMF) responsible for dialogue management function; Unified Data Management (UDM) responsible for 3GPP AKA authentication credentials Generation, user identification processing, contract management, etc.; Authentication Server Function (AUSF) responsible for 3GPP access and non-3GPP access authentication; Policy Control

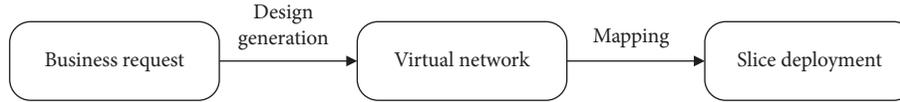


FIGURE 1: Schematic diagram of the network slice generation process.

Function (PCF) responsible for unified policy control; Network Slice Selection Function (NSSF) choosing to serve users the network slicing column [21, 22].

2.5.2. Base Station. This time, a set of 5G BBU (model V9200) was installed in the main control room of the Heping Substation, and an AAU (model A9611A) was installed on the roof of the Heping Substation Building to cover the surrounding area of the main transformer equipment of the Heping Substation. On the roof of the building, a leather cable is routed to the main control room. The BBU and AAU are connected by optical fiber. The transmission equipment in the main control room of the BBU and the substation is interconnected through GE optical ports to communicate with the core network. In order to realize the sharing of 5G base stations in the substation with operators, it is necessary to lay optical cables from the substation to the nearby tower. The base stations are registered under different core networks through different clock control boards, as shown in Figure 2.

2.5.3. Backhaul Network. Since OLT equipment is installed in the substation, and there are optical cables from the substation to the cable tunnel and the main station, the optical splitter and ONU equipment are deployed in the tunnel this time. The base station is connected to the ONU equipment through the Ethernet port.

2.5.4. Terminal. This application scenario is mainly for business backhaul in substations, tunnel monitoring, and remote operation of patrol robots, video backhaul, etc. The main deployed terminals are 5G wireless CPE equipment, cameras, etc., which are connected to terminal services through Ethernet ports. Pass back to the core network through the base station.

Through the 5G slice management module, the core network is sliced according to different regional services and divided into different PLMN numbers. The terminal identifies different core network slices through the PLMN number and finally transmits them to different service master station systems.

As, currently, only operators have 5G frequency points, operators are also facing many practical problems in the construction of 5G communication systems.

- (1) The installation density of base stations is greatly increased, and the installation location of base stations cannot be satisfied
- (2) The annual cost of base station power supply will greatly increase the system construction investment

- (3) The construction of optical cables in urban areas is strictly controlled, and it is difficult to build optical cables in a considerable part of urban areas, resulting in no signal coverage in many areas
- (4) The external environment is harsh, and the equipment often needs to endure the environment such as wind, sun, rain, and high temperature, and outdoor installation has high requirements for the protection level of the equipment
- (5) The equipment needs to be regularly inspected by personnel, which consumes a lot of manpower

By cooperating with electric power to build shared base stations, electric power can provide operators with the following conditions:

- (1) Electricity can provide power supply for base stations and terminals, and the electricity bills generated can be resolved through power line losses.
- (2) Electricity can provide distribution network optical cable channels for operators to use and solve the problem that operators cannot add new optical cables in urban areas.
- (3) Electricity provides self-owned properties such as ring network cabinets, switching stations, and substation installations for base station and terminal installation. While providing the installation environment, it can relatively reduce the terminal protection level requirements and save costs.
- (4) Since the power ring network cabinets, opening and closing stations, and other self-owned properties will also arrange special personnel for regular inspections, faulty equipment can be replaced in time without affecting terminal access.

2.6. Access Optimization Algorithm. During the operation of the system, the actual load G_{Rn} and its estimator \hat{G}_{Rn} are deviated due to the nonreality of the estimate, which leads to the degradation of system performance. In order to be able to correct this part of the deviation, a feedback-based adaptive random access method is proposed, which uses closed-loop feedback to control the output of the system. For the convenience of use, use $G(k)$ instead of G_{Rn} , and use $\hat{G}(k)$ instead of \hat{G}_{Rn} .

In order to be able to solve $G(k)$, we can consider the actual system throughput output value $S_m(k)$ and the expected system output value $S_p(k)$ to solve the difference. Assumptions:

$$G(k) = f(\hat{G}(k), S_m(k), S_p(k)). \quad (1)$$

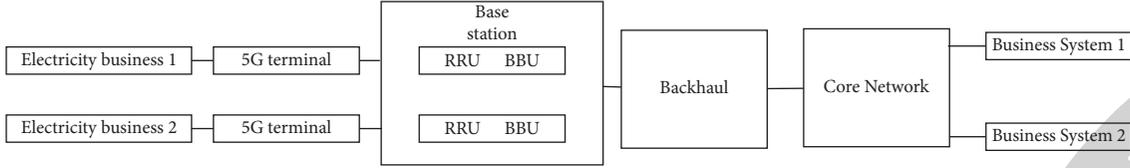


FIGURE 2: Base station.

Among them, $\widehat{G}(k)$ is the actual load estimation value, and the reference model refers to the ideal model that the system can obtain the optimal output after inputting the load estimation value. $S_m(k)$ is the ideal output value.

$G_p(k)$ is the adjusted input value, and $S_p(k)$ is the actual output value of the system. In order to maximize the throughput of the system, you need to

$$e(k) = S_m(k) - S_p(k) = 0. \quad (2)$$

In order to achieve the maximum output value of the controlled object, the relationship between $\widehat{G}(k)$ and $S_m(k)$ and $S_p(k)$ must be required. Make the output error function achieve $e(k) = 0$.

3. Simulation Experiment

3.1. The Purpose of the Experiment. This paper analyzes the existing problems of random access in massive connection scenarios and then proposes a feedback adaptive random access strategy based on the adaptive random access model, which can make the network throughput rate. It will not drop linearly with the increase in the number of users. When the user load is greater than the optimal load, the number of connected users is automatically adjusted to always maintain the network throughput rate near the maximum value. The average delay only increases linearly with the increase in the number of users, which is nonpolynomial compared to the original delay. There is a huge improvement in growth.

3.2. Simulation Scenarios and Parameter Settings. This paper uses the random access process of LTE to quantitatively analyze the throughput rate of LTE and gives a simulation diagram of the throughput rate. Then, the adaptive random access model is introduced, and on this basis, a feedback adaptive model is proposed. In order to be able to better verify the performance relationship between the various models, we are now ready to establish a single base station multiuser random access model.

3.3. Parameter Setting. In order to be able to better verify the performance relationship between the various models, we are now ready to establish a single base station multi-user randomly access model. The key simulation parameters of the system are shown in Table 1:

Different uplink and downlink ratios in TD-LTE technology will have a greater impact on the number of access users. The currently adopted configuration 2 is more commonly used, so the random access cycle time is set to 5 ms. The total number of Preambles is 64, which

TABLE 1: Random access simulation parameter settings.

Parameter	Value
Competition-based leader sequence	32
Access bandwidth	20 MHz
Access time slot length	1 ms
Access slot cycle	5 ms
Simulation time length	10000 ms
Number of simulated UEs	4000

need to be allocated to noncontention access and contention random access. When a user fails in random access, the current LTE uses uniform back-off, and the new model uses random access. The fluctuation range of the user access arrival rate refers to the range of the difference between the estimated user access arrival rate and the actual user access arrival rate. Use probabilistic avoidance. The number of access times of each UE is not unlimited, and it will stop when the number of failures reaches a certain number of times. In order to ensure the accuracy and stability of the calculation results, it is not possible to determine the final result with only one simulation result, but to calculate the total average value within a period of time. The user access arrival rate refers to how many users initiate random access within a unit time. The fluctuation range of the user access arrival rate refers to the range of the difference between the estimated user access arrival rate and the actual user access arrival rate.

3.4. Performance Evaluation Index. In the evaluation of randomly access performance, only the two most important parameters are used. One is the normalized throughput rate of the channel, and the other is the user access success rate.

3.4.1. The Normalized Throughput Rate of the Channel. The normalized throughput rate of the channel represents the ratio of the transmission bandwidth occupied by the user's successful transmission to the total bandwidth in a unit time. The transmission bandwidth is composed of the bandwidth occupied by the Preamble code and the data bandwidth.

3.4.2. Success Rate of User Random Access. After the random access fails, the user will initiate access again until the maximum number of retransmissions is reached. If the user has not successfully accessed the system, it is considered that the access has failed.

4. Simulation Results and Data Analysis

Before analyzing the results, first, determine an abbreviated name for each access model to facilitate subsequent comparisons. Use Reserved ALOHA RACH (RA-RACH) to represent the LTE random access method, Adaptive Control RACH (AC-RACH) to represent the adaptive access method, and Feedback-adaptive Control RACH (FC-RACH) to represent the feedback adaptive access method. The following will analyze the normalized throughput rate and the success rate of user access.

The existing LTE random access process is divided into two categories: one is the contention type random access, and the other is the noncontention type random access. The competitive random access method is based on the time slot reservation ALOHA protocol. The time slot reservation protocol divides the random access process into two steps. The first step is resource reservation, and the second step is data transmission.

The Adaptive Control RACH is to issue an access threshold probability through the broadcast channel when the number of access users is in the access overload interval. Only when the user is within this threshold probability will the random access process be initiated. If you are not in it, you will abandon the access process this time. The ACB idea was first proposed in 2001, and then it was revised and expanded by scholars.

It means that, during the operation of the system, due to the nontrueness of the estimation, the actual load and its estimated amount are deviated, resulting in a decrease in system performance. In order to be able to correct this part of the deviation, a feedback-based adaptive random access method is proposed, which uses closed-loop feedback to control the output of the system.

4.1. Normalized Throughput Rate. The normalized throughput rate is an important indicator to measure random access, which directly shows the quality of the randomly access process. The high normalized throughput rate indicates that the system has a strong access capability and can drive more devices with limited time-frequency resources. When RA-RACH users increase to a certain number, serious collisions will occur, resulting in poor access capabilities. The AC-RACH and FC-RACH methods do not have this problem. The specific simulation diagrams are shown in Table 2 and Figure 3:

It can be seen from Figure 3 that the normalized throughput rate of the randomly access methods using AC-RACH and FC-RACH is higher than that of RA-RACH. Especially, when the arrival rate of user requests is getting higher and higher, the throughput rate of RA-RACH access will continue to decrease with the collision until it approaches zero. AC-RACH and FC-RACH keep the normalized throughput rate near the maximum value by suppressing the real-time demand of some users, so as to realize the optimization of the system. Compared with AC-RACH, FC-RACH has more feedback to adjust the input and compensates the estimated value of the connected load

TABLE 2: Normalized throughput rate under different access methods.

User random access arrival rate	RA-RACH	AC-RACH	FC-RACH
0	0	0	0
2	0.58	0.59	0.59
4	0.76	0.74	0.76
6	0.14	0.72	0.75
8	0.05	0.68	0.76
10	0.02	0.71	0.77
12	0.01	0.7	0.78
14	0.009	0.68	0.75
16	0.005	0.71	0.76
18	0.003	0.72	0.76
20	0	0.69	0.75

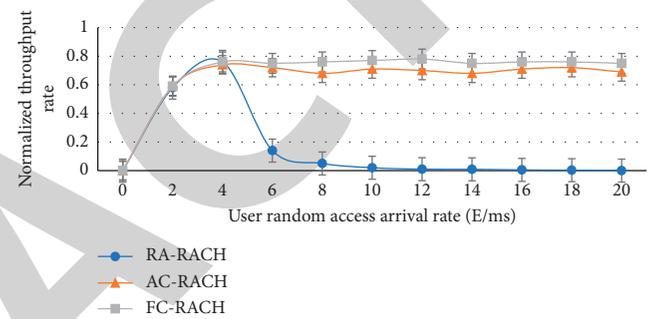


FIGURE 3: Normalized throughput rate under different access methods.

to a position closer to the real load. At this time, the control threshold selected by the system is more accurate, which improves the throughput rate.

4.2. User Access Success Rate. The randomly access success rate of users is also an indicator that needs to be considered. When the UE device is in the process of uploading data, if there is always an access failure, it will greatly affect the user experience. The access success rate is mainly affected by collisions. The specific simulation diagram is shown in Table 3:

It can be seen from Figure 4 that the success rate of RA-RACH user access decreases as the number of users increases. When the number of users is low, and the load is lighter, RA-RACH, AC-RACH, and FC-RACH have a higher access success rate. However, as the load increases, RA-RACH will quickly drop to zero. The success rate of AC-RACH and FC-RACH can basically be maintained within a fixed range. It is precise because AC-RACH and FC-RACH can control the user's access, where they can maintain a high success rate. It can be seen that when the access success rate of AC-RACH and FC-RACH is around 3, the access success rate no longer changes suddenly. This is because the optimal threshold load value is around 3. When this value is exceeded, AC-RACH and FC-RACH will immediately adjust the number of access users through the threshold probability. The access method using AC-RACH and FC-RACH is significantly better than RA-RACH in the

TABLE 3: User access success rate under different access methods.

User random access arrival rate	RA-RACH	AC-RACH	FC-RACH
0	1	1	1
2	0.98	0.98	0.98
4	0.72	0.68	0.68
6	0.08	0.65	0.66
8	0.01	0.72	0.65
10	0	0.7	0.67
12	0	0.62	0.66
14	0	0.68	0.65
16	0	0.59	0.67
18	0	0.67	0.66
20	0	0.62	0.65

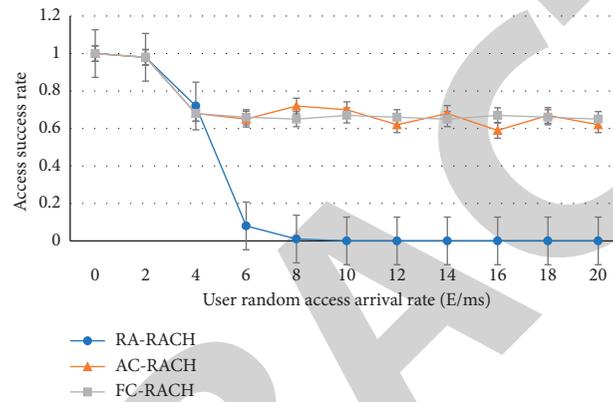


FIGURE 4: User access success rate under different access methods.

TABLE 4: Access delay in different access modes.

User random access arrival rate (Ems)	RA-RACH	AC-RACH	FC-RACH
0	0	0	0
0.5	0.352	0.263	0.153
1	2.136	2.047	3.156
1.5	4.251	4.597	4.588
2	7.351	7.195	7.452
2.5	10.073	9.725	9.621
3	20.153	13.265	12.094
3.5	12.456	19.263	14.252
4	41.526	18.867	17.654
4.5	64.253	23.653	20.956
5	81.463	22.463	21.355

case of heavy load. The access success rate of FC-RACH is similar to that of AC-RACH. This is because when the estimated access load of AC-RACH is greater than the actual access load, the number of controlled user accesses is less than the optimal access load. At this time, the success rate of user access will increase, and vice versa.

4.3. Average User Access Delay. In the delay calculation process, only the delay impact caused by the back-off of the contention conflict is calculated. Compared with other types

of delay, this part is the most important. The specific time delay comparison chart is shown in Table 4.

As shown in Figure 5, it can be seen that AC-RACH and FC-RACH have obvious advantages over RA-RACH. When the user's random access arrival rate increases, the delay exhibits a nonpolynomial exponential increase. However, the delay increase of the AC-RACH and FC-RACH method is similar to a linear increase. FC-RACH can better control the access threshold and can handle more users in the same time, and the access delay will be less than AC-RACH. When the number of user accesses increases to a certain extent,

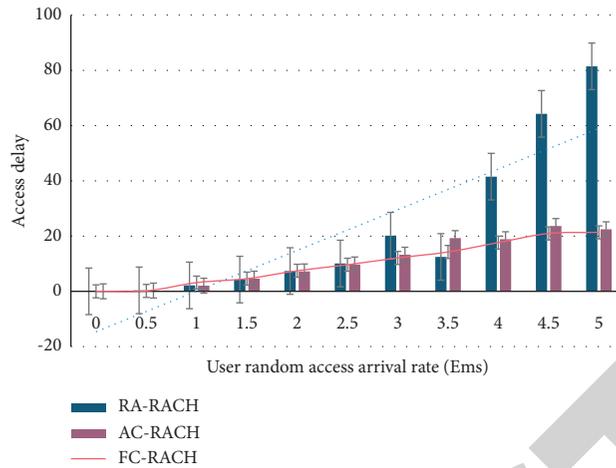


FIGURE 5: Access delay in different access modes.

AC-RACH and PC-RACH will have obvious advantages, while RA-RACH will hardly be able to be accessed and used normally.

5. Conclusions

In the future, the types of mobile services will become more and more diverse, and communication will not only be limited to people. All kinds of new mobile devices will surpass existing devices in terms of quantity and function. In order to meet the ever-increasing user bandwidth demand in the 5G era, adapt to the development trend of new services, and comprehensively improve network performance, 5G communication is gradually evolving into a converged network, which is manifested in the fusion of users' wireless access and optical transmission of data. The digital transformation capability of enterprises is also a dynamic capability for medium and large enterprises to adapt to the current ever-changing market and use digital concepts, technologies, and methods to enhance market competitiveness. It is necessary for 5G communications to access the full-scene application.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

There are no potential conflicts of interest in our paper.

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