

# Research on the Application of 5G in Smart Campuses of Universities

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## Abstract

With the rapid development of 5G technology, 5G technology occupies an important position in the new information technology revolution. This also presents new challenges and opportunities for future education. In the future, digital education and smart learning environment in the universities in China will rely on the application of 5G in educational innovation. With the help of 5G's ultra-high data transmission rate and large-scale links, the construction of smart campuses in Chinese universities can develop educational and teaching spaces that integrate virtual and real scenarios in the future, and take advantage of online education to optimize the allocation of educational resources to promote the balanced development of education in China. Today, 5G technology is still in a development stage, and various problems will be encountered in subsequent applications. However, the future development and application of 5G technology is a trend, and the development of smart campuses in Chinese universities should continue unswervingly.

## Keywords

5G Technology; Smart Campus; Development.

## 1. The Concept of 5G and Smart Campus in China

Nowadays, 5G has been applied in business field for more than a year in China, and the construction momentum of 5G base stations is swift and violent. Last year, China built more than 600,000 5G base stations. At this stage, 5G networks have basically covered prefecture-level cities and above in China. As 5G networks are used more and more widely, my country's 5G has entered a development stage that focuses on application promotion.

Smart campus refers to an Internet of Things(IoT) based environment that integrates campus working and learning. Education informatization is an important part of educational modernization. With the advent of the informatization 2.0 era, China actively advocates the construction of digital campuses represented by domestic colleges and universities.

Smart campus is an advanced form of education informatization. Smart campus provides new ideas and broader development horizons for the construction of Chinese universities. Smart campuses can use advanced information technology and "cyberspace" technology to perform a comprehensive digital simulation of the campus environment to gain a comprehensive perception, therefore making data collection management and analysis more efficient for teachers' work and students' study.

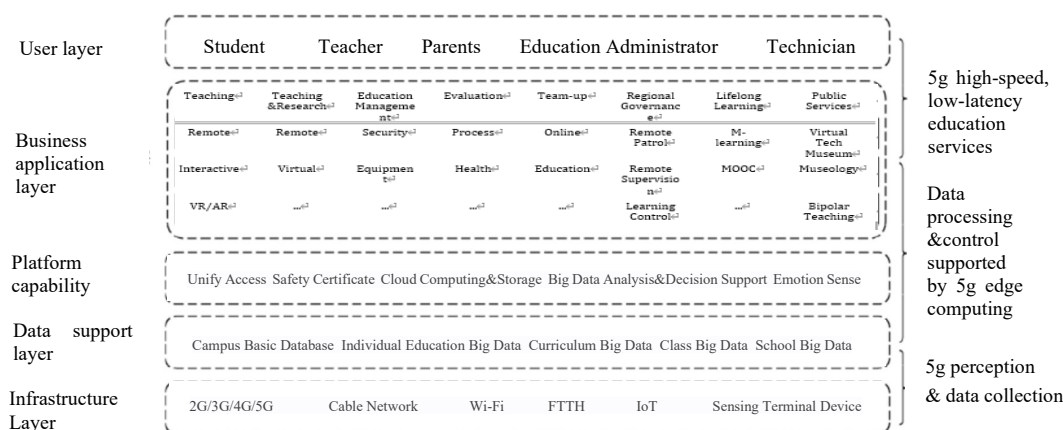


Figure 1. Intelligent Education Framework

## 2. Smart Campus Construction in the 5G Era

The construction of a smart campus must rely on the foundation of "Internet +". After years of Internet development in China, the Internet infrastructure has been fully developed, and at the same time, the development of 5G technology is also in a leading position in the world, which has laid a solid foundation for the application of smart campus.

Teaching is one of the most important scenes of education. Through the 5G layout of the smart campus, various information devices are connected to provide a powerful data stream carrier, from the realization of smart education manufacturers under 5G. The combination of virtual reality and 5G can bring immersive and personalized interactive teaching experience to teachers and students.

The smart education created by 5G and smart campus can add value to the contemporary information technology in the education industry, and it is also the only way to create a new type of education. The integration of 5G and technologies, such as artificial intelligence, virtual reality, cloud computing, big data, and ultra-high-definition video, will provide broader application scenarios for smart education.

## 3. Analyze the Application Scenarios of 5G and Smart Campuses in Chinese Universities Today

In the smart campus construction mode, virtual reality technology and cloud computing technology are used to present the text, images and animations in a trinity in smart education classrooms, which not only enhances students' interest in learning, but also helps students to learn and absorb new knowledge. Under the network covered by 5G, students can interact in the classroom and watch instructional videos by wearing AR glasses. Smart education under the combination of 5G and smart campus also provides more convenience for students to review after class. Students can review the content of the class by watching class videos on demand after class.

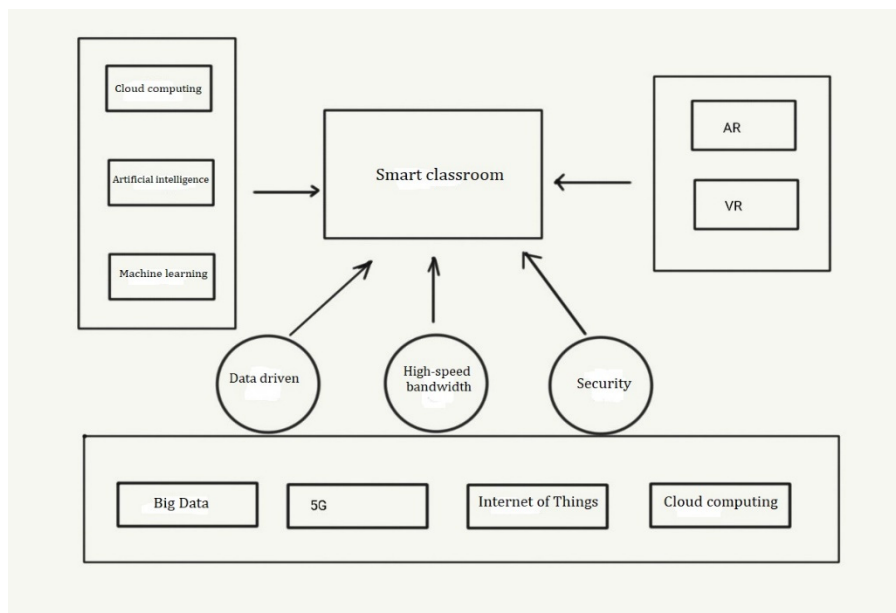
The smart campus based on 5G can break through the "last mile" link in education. For example, taking the online teaching method of webcast in major universities and countries under coronavirus pandemic, various forms of student-centered interactive teaching can solve problems such as the inability to provide timely feedback in traditional online courses, and can better motivate students. At the same time, with the development of network technology, teachers have more room to expand their teaching methods and content, which also helps to improve the quality of teaching and achieve quality educational goals. Besides, using VR remote

cameras and ultra-high-definition cameras can collect 360-degree full-HD images on the classroom, and send them back to the media processing platform through the 5G network. After processing, all teachers and students will be mapped to the same virtual classroom, achieving cloud teaching and classroom interaction.

**Table 1.** Intelligent Campus Scene Network Requirements

Business Type	Parameter	Access Bandwidth	Latency	Packet Loss
Video Terminal Access	3~4/class	Each terminal≥8Mbit/s	≤150ms	≤5%
Teaching Terminal Access	30~50/class	Each terminal≥2Mbit/s	≤200ms	≤5%
Classroom Gateway Access	1/class	≥50Mbit/s		
Internet Terminal Access		≥50Mbit/s		≤5%
Classroom Interactive Course Access Cloud		≥50Mbit/s, Depending on the school situation	≤100ms	≤0.5%
Cloud Service Access Capability		Each class≥50Mbit/s, concurrent support for more than 100 courses; Each 4 Mbit/s, concurrent support for more than 30,000		
VR/AR	30~50/class	≥80Mbit/s	≤20ms	
Immersive Experience	8K	100Mbit/s	≤20ms	
	16K~32K	100Mbit/s~1Gbit/s	≤10ms	

The development of 5G technology has provided a foundation for the realization of cyberspace technology, and a holographic classroom constructed with 5G plus a smart campus has a prerequisite for application. The holographic classroom under the digital campus can largely solve uneven distribution of educational resources. This is because the holographic classroom can allow multiple people from different places to join in, and students and teachers from different places can join the classroom at any time, with no limit on the number of attendances.



**Figure 2.** Application of Smart Campus Technology in 5G Era

Furthermore, the smart teaching in the holographic classroom can establish the real-time interaction between teachers and students, and that was impossible to realize in traditional online courses. With use of the new teaching mode, all content in the teaching environment can be interacted in real time and receive synchronous feedback, making the content of online lectures intuitive and efficient. Finally, with the high bandwidth and low latency of the 5G network, devices such as smart glasses, mobile phones, and personal computers can be connected in real time, so that the content and interaction presented in the classroom can be seamlessly connected.

The smart campus also provides a more friendly, convenient and smooth communication platform for the campus management of colleges and universities, and also brings a more intelligent and convenient teaching space for teachers and students. For example, in the 5G network environment, the smart campus combined with artificial intelligence technology can conduct scene analysis through face recognition, behavior analysis, etc., to improve the response speed of emergency events. By improving the school vehicle management platform, 5G network can also realize the recognition of license plates in key areas, conduct dynamic trajectory analysis of the vehicles in the school, and identify vehicle violations. Through the application technology of the Internet of Things (IoT), the laboratory's access control management, the equipment and experimental materials management, and the security alarm system can be related to each other, thereby improving the reliability and safety of laboratory management.

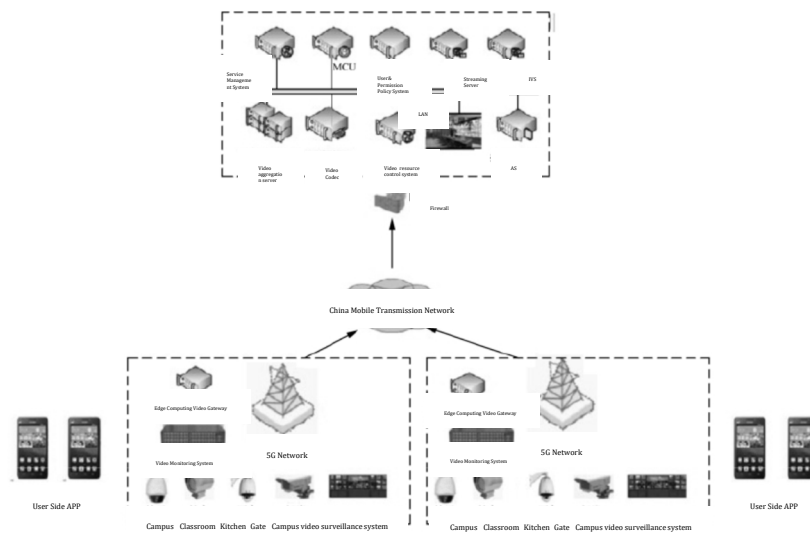


Figure 3. Monitoring System Architecture

#### 4. Analyze the Problems and Solutions in the Construction of Smart Campuses

In recent years, as universities have continuously upgraded the construction goals of smart campuses, and as relevant national policies have also emerged one after another, the construction of smart campuses in Chinese universities is also in full swing. However, the construction of smart campuses based on 5G has also exposed some problems. For example, 5G+ smart education application standards are not complete yet; the integration of application and network, and education applications still lack standards; and resources to adapt teaching content are scarce. Moreover, "smart campus" in China is still in the initial stage of development, full of new concepts and new things. Therefore, "smart campus" still has many drawbacks in some sense. However, with the development of education, "smart campus" will become an

inevitable future trend. The next step is to analyze how the combination of 5G and smart campus will break through the limitations of current education technology.

New teaching methods require brand-new teaching content, and the producers of these content are not teachers, but professionals. In addition, the production of UHD content may encounter many problems, because the production is expensive and time-consuming, and it also needs personalized customization, making the input-output ratio not attractive. With the emergence and application of new technologies, many unknowable problems will be brought about, but as technologies and applications mature, the convenience they bring must be more convenient than the difficulties encountered in the process.

First, the teaching environment under the smart campus asks for higher teaching abilities. Under the new model, the immersive education method will gradually move from science and technology museums to major universities and even ordinary schools, and eventually become a real classroom, to serve teachers and students. Under this trend, our demand for talents with modern educational technology will greatly increase. Talents in the cross-field of education and information technology are the training targets for the next stage of education, with the aim of creating a group of professional education talents who understand both education and technology. At the same time, driven by the new model, higher-level requirements have been put forward for the technical and operational personnel who is responsible for platform development. For example, the interface friendliness of the smart campus system must meet the high-level requirements of convenience, smoothness and barrier-free access, and the design and research on the safety, stability and reliability of the system also need more secure and reliable technologies to achieve. Facing the massive data brought by the 5G network and distributed management, it is also a huge test for system maintainers. How to maintain the stable operation of the system and filter and analyze data in a timely and effective manner will become a huge challenge for future technicians and operators, and this also puts forward higher requirements for the cultivation of talents in related fields.

## 5. Conclusion

Educational inequality is the biggest problem in education, and the lack of teachers, equipment and resources is a hinder in the pursuit of educational equity. But with the construction of 5G and smart campus applications, these problems are beginning to be solved. Nowadays the integration of 5G and HD video has entered a mature stage, and video lectures with ultra-high definition have been applied to the smart campus scenarios. With the development of this technology, more students can enjoy high-quality educational resources, which means that even students in ordinary schools can also enjoy the classrooms of famous teachers at Tsinghua University, which will reduce the imbalance of education.

Strengthening the exploration of 5G education applications, accelerating the research and development of educational smart technology, exploring typical scenarios of 5G education applications, and studying the transformation of learning and teaching models in the 5G era are the basis for promoting the new ecology of smart education in the 5G era.

Based on the continuous development of the 5G application in smart campuses of colleges and universities, education in the future will be more open, by breaking through the boundaries of time and space and the restrictions of educational groups, and ensure that everyone can learn at all times and everywhere.

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