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# Guangzhou Metro 5G + Smart Metro

"5G technology facilitates the digital development of the traditional urban rail transit industry by driving the transformation from the traditional multi-layer, complex and fixed network to the flat, lightweight and updateable architecture. First, the high reliability of 5G network enables trains to better perceive the operating environment and their own operating status, thereby improving the transportation capacity of metro lines. Second, the massive connections of 5G network facilitate the establishment of a visual resource scheduling system for each line of the urban rail transit network. The system is designed to monitor the status of passengers and trains in real time, and improve the efficiency of operation and management. Finally, the large bandwidth of 5G network brings about new customer service platforms, allowing timely and accurate access to services in abundant transportation scenarios in the entire metro travel chain through multiple online and offline channels, and improving the travel experience."

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**Partners** 广州地铁 Guangzhou Metro · 中国移动 China Mobile · ZTE中兴

## Case Overview

Metro transportation boasts such remarkable advantages as large capacity, high efficiency, energy saving and environmental protection. It is the backbone of the public transportation system in mega cities and a critical part of the urban comprehensive transportation system, supporting and leading the urban development. Guangzhou Metro is the urban rail transit system of Guangzhou, the third largest city in mainland China, and provides transportation services for 44% of the passengers using public transportation in the city. As of September 2021, the total operating mileage of Guangzhou Metro had reached 590 kilometers, ranking the third in mainland China, and Guangzhou Metro had transported up to 11,569,400 passengers per day.

Guangzhou Metro, China Mobile and ZTE Corporation partnered to optimise the performance of the new 5G private network for Guangzhou Metro, building a safe, accurate, collaborative and green metro service system featuring ubiquitous interconnection and holographic perception. Based on the advanced 5G network technology, a number of 5G + smart applications were deployed to cater to the actual needs of metro stations, which led to significantly improved efficiency of station operation, more convenient metro operation and management, and greater passenger satisfaction.

Guangzhou Metro has been a testament to the capability of 5G private network in integrating and supporting multiple metro services.

## Industry Challenges

There were many pain points in the Smart Subway Construction and Operation:

### Complex systems

There were more than ten systems, including vehicle, power supply, communication, information, water supply and drainage, heating, ventilation and air conditioning, and each system had many subsystems. There were also complicated equipment models and system standards, and a large number of different types of terminals and equipment nodes. In addition, the systems, such as the electromechanical system and communication system, were managed and operated separately, resulting in various operation problems such as low intelligence, intensive labour and slow response. Therefore, it was imperative to improve the operation and management level.

### Inflexible network

The terminals and servers of subsystems in the stations were connected through a wired network, resulting in various problems such as troublesome and costly integrated wiring, inflexible operation and maintenance, and slow emergency response.

### Poor on-board data backhaul

There was a large amount of data from online monitoring of on-board equipment to be sent back, Due to the insufficient transmission bandwidth, transmission reliability and anti-interference ability of the existing vehicle-to-ground wireless technology, the practical application mainly relies on inefficient manual copying, and efficient real-time automatic return transmission is urgently needed.

## Solutions and Benefits

The project combines the actual business needs of the subway, based on the customized and optimized 5G network and multi-cloud platform architecture capabilities, and introduces a series of integrated and innovative applications in typical subway scenarios to effectively improve the efficiency of subway stations and internal management.

### Technology

**1**

#### Enhanced and optimised 5G private network performance

Carrier aggregation (CA) was adopted to enable a multiLine video backhaul; detection and compensation algorithm for Doppler frequency offset and super-cell technology guaranteed a high-performance network at a high driving spreed of 160 km/h; and differentiated tunnel coverage solutions were adopted to boost the uplink rate to 750 Mbps.

**2**

#### Multi-level industry cloud-based network solution

Hierarchical and fine-grained management was adopted to meet the customers' differentiated business needs with precisely matched cloud-based network solution; safe and effective end-to-end isolation was achieved by "keeping data inside stations"; and the solution was flexibly deployed together with base stations as a plug-and-play solution without prior site survey.

**3**

#### Innovative 5G indoor positioning

Based on the independently-developed UTDOA(Uplink Time Difference of Arrival) algorithm, 5G indoor positioning could keep the deviation within 2 meters.

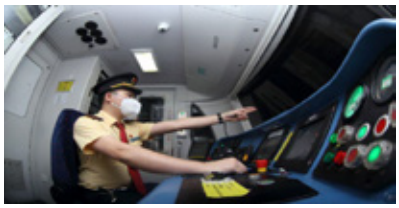
### Application

#### 01 China's first 5G metro train

For the currently fastest D-type metro train, a dedicated 5G receiving antenna and TAU(Train Access Unit) were designed and new trains are equipped with 5G upon leaving the factory to enable full-band 5G reception in shock-proof, fire-proof and wind-resistant environments for rail transit, bring high gains to the customer, and better support the platform for train data monitoring.

## 02 5G vehicle-ground wireless solution

A vehicle-ground wireless solution was created for driving safety control monitoring, operation management and passenger services, leading to enhanced protection, improved operation and maintenance efficiency and better service experience. The advantages of this solution are as follows:



Switch from passive protection to active protection

Switch from offline video surveillance to intelligent online video surveillancev

Switch from train operation-centric services to passenger-centric services

## 03 Comprehensive upgrading of physical tunnels to "tunnel digital perception"

The 5G transformation of physical metro tunnels enabled real-time perception of tunnel status from the train cab and monitoring centre, which enhanced driving safety and management and control of the metro line network, accelerated fully automatic unmanned driving, and enabled tunnel digital perception applications such as identification of track water logging, identification of foreign body falling, monitoring of civil air defense door intrusion, identification of roadbed cracks, identification of track deviation, and environmental monitoring.

Identification of track water logging

Identification of foreign body falling

Monitoring of civil air defense door intrusion

anomaly monitoring of tunnel wall box

evacuation platform personnel

Environmental monitoring

## 04 Innovative smart metro applications

Based on the 5G SA environment, various operation management and passenger travel services are provided in metro stations together with partners:

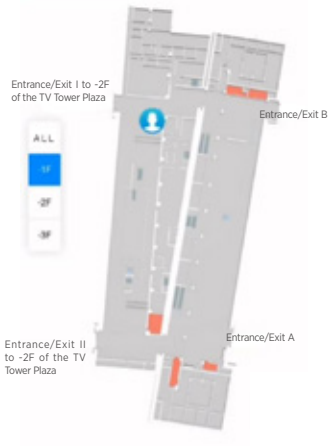
By utilising the benefits of 5G network, such as high bandwidth, low latency and no additional wiring, turnstiles in metro stations are transformed to realise face recognition, which significantly improves the passing efficiency.

Based on 5G network and 5G CPE, mobile electronic guidance screens, intelligent customer service machines, turnstiles using face recognition, intelligent security control and harmful gas sensors are deployed.

The data generated by the X-ray security check in the security check subsystem are transmitted back to the back office for monitoring through the 5G network in real time, allowing the schedulers in the back office to coordinate the X-ray security check data at all entrances and exits of the entire metro station and quickly locate any dangerous items and persons; In case of any trouble when entering the station, passengers may talk to the administrators in the back-office monitoring centre through the 5G wireless network, instead of waiting for assistance at the side door, which significantly reduces the workload of metro staff.

HD video surveillance cameras in the station are connected through the 5G network, and back-office AI video analysis capability is utilised in various scenarios such as passenger flow analysis, abnormal behavior analysis, and people evacuation.

The high-precision indoor positioning application based on 5G Qcell+MEC integration uses open APIs to connect with third-party applications. Based on the independently-developed UTDOA algorithm, 5G indoor positioning keeps the deviation within 2 meters, providing passengers with accurate indoor navigation, push notifications, in-station navigation and other positioning services.




## 05 Intelligent metro operation and maintenance

A massive amount of data on train operation is collected through 5G, and AI intelligent analysis is integrated to switch from passive to active operation and maintenance, leading to reduced costs and increased efficiency. The real-time backhaul and collection of a massive amount of data on train status enables the switch from passive to active operation and maintenance, timely intervention, and early warning. In addition, previous fixed repair is changed to on-demand repair, which reduces the maintenance cost.

### Economic benefits

At present, the online data on people, trains, operating environment, equipment and scheduling in this Guangzhou Metro project is being shared with unprecedented breadth, depth and speed, which not only improves the driving safety and transportation efficiency, but also reduces the metro operation costs. The Guangzhou Metro 5G + smart metro model may be gradually rolled out to other parts of the country. With 5G's deep integration with and wide implementation in the metro industry, the 5G industry will see substantial growth in economic benefits.

### Social benefits

The research of 5G in the metro industry facilitates the integration with the applications in the metro industry in terms of various wireless network coverage, collaborative management of cloud-edge-terminal resources, etc. By improving the convenience of urban transportation and promote the digital development of traditional industries, a new high-end and intelligent industrial ecosystem will be created to lead the high-quality development of urban rail transit.

## Summary and Next-Steps

In the future, new types of common network technology including private network for dedicated purposes, edge computing, network slicing and ubiquitous integration will be applied in the Guangzhou Metro project, so as to improve the flexibility, scalability and resilience of the typical industry systems during their construction and application. Focusing on the national key R&D plan "Broadband Communication and New Types of Network" launched by the Ministry of Science and Technology of China, we will continue to make full use of our innovative achievements starting from demonstration projects and establish a complete energy-saving system for 5G equipment in metro scenarios to meet the national requirements for energy saving and emission reduction and achieve technological breakthroughs.