Smart Nanshan in Shenzhen: 5G-Powered City

> As a developed administrative area in the first-tier city, Nanshan follows a comprehensive top-level design plan powered by cutting-edge 5G + technologies to enable city-level governance and services. By taking into account governance, public services and industry development, the plan addresses the most pressing needs of the majority. From terminals to networks, a super-large city-level cognitive network of 5G + IoT capability has been built that presents growth trends of the urban 5G industry in a panoramic, layered, and dynamic manner, and reshapes the coupling effects of 5G+ smart cities.

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Case Overview

In 2018, the Nanshan District started to build its 3D modelling database and application system for urban buildings which was completed by telecom cincluded 3D building models covering 170 km^2 in the Nanshan District. Then it started a comprehensive overhaul of the 3D data in the Smart Nanshan database in January 2020 and completed the construction of the Smart Cloud urban application service platform of Nanshan, Shenzhen in April 2021.

A super-large city-level cognitive network of 5G + IoT capability is built based on the existing system of "three networks, three platforms, and three centres" to facilitate the application of 5G technologies in different scenarios. A national level security service system that supports domestic encryption algorithms like SM1, SM2, SM3, SM4, and SM9 is provided to promote innovation in information technology and disaster recovery. The network can connect millions or even billions of IoT devices and enable flexible resource expansion. With independent iterative upgrade capabilities, this digital access network is highly integrated to serve the development of industrialization in the district.

Convergence of 5G with multiple technologies for city-level governance and services - A system that presents vital indicators of city operation is enabled by accurate, comprehensive, real-time, and quantifiable IoT data. In this way, the system provides a consolidate interface to display and monitor key operational indicators of the city for intelligent early warning. To break down barriers in urban services and governance, and to address the pain points in public services and social governance, 5G technology and 5G network are integrated with AI, big data, edge computing, and cloud computing to drive unified access between urban governance and public services. Smart application across different scenarios then facilitates smooth and efficient governance as well as convenient and considerate public services.

The city's 5G industrial operation is presented in a panoramic, layered, and dynamic manner. The City Information Modelling (CIM) platform makes city's digital-twin possible. Supported by multi-dimensional cognitive capability and real-time interconnection, the entire city is visualized and presented to city managers to assist with their urban decision-making and to optimise the experience and efficiency of urban management. The CIM platform integrates 5G industry information from various dimensions and creates digitalised city twins for comprehensive analysis. This allows the provision of standardised services for businesses and citizens, and fuels the growth of 5G industries to rocket in all aspects.
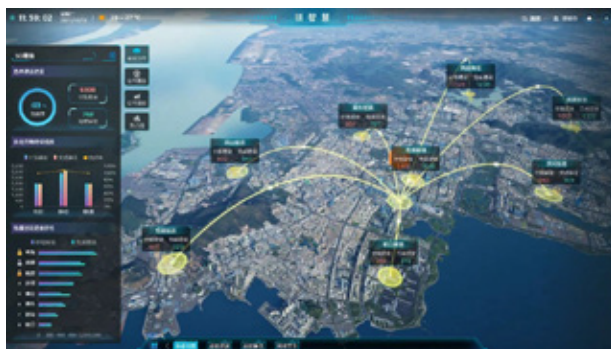
Industry Challenges

Massive connections of 5G intelligent terminals

A city consists of a vast territory, complex requirements, and ever-changing conditions (such as people flow, traffic, transactions, energy consumption, environment, weather, etc.). In the era of intelligent 5G connectivity and IoE (Internet of Everything), a wide portfolio of sensors can be deployed across the city to timely and accurately capture information that reflects the state of a city. As a result, explosive growth has been seen in the number of terminals and types of devices. However, the complexity of the networks that smart sensors connect to can pose challenges to the compatibility and interworking between services in a smart city.

Convergence of multi-source heterogeneous data

Urban data usually come from multiple origins of different structures. They tend to fall into three categories: unstructured data from images, voice and text; structured data acquired from e-government services; and spatial-temporal data represented by geographic information and IoT data (such as traffic flow, people flow, energy consumption, weather, etc.). Data is large in volume and dynamic, while smart city applications usually require a multitude of data from many different types and origins. It is, therefore, another challenge to manage this complex data and effectively support applications after it has been collected into the system.

Breaking down information silos

smart public service and management, empowered by 5G, inevitably requires information to be accessible among citizens, governments, and enterprises when needed. This involves a wide range of operations, complex methodologies, and demanding technical requirements It is difficult to complete this task by any single organization. In the traditional model of "integrator + subcontractors", all organizations involved tend to do their jobs based on their own products and technologies, resulting in information silos, which are difficult to solve.

Solutions and Benefits

Urban governance solutions are categorized based on the following three types of scenarios:

To enable urban governance and services in the three scenarios, a framework is designed as follows:

5G-powered Urban Services and Governance

Government governance

Solutions

Urban full-lifecycle digital twin applications

5G private network construction and integrated management of information infrastructure

COVID-19 prevention and control powered by "5G + Big Data + AI + IoT"

Intelligent traffic management powered by "5G + AI + Big Data"

5G drone management of illegal buildings

Public Services

Solutions

5G-enabled emergency response with multi-functional smart poles

5G robots for intelligent urban services

Cultural tourism and government services based on 5G RCS

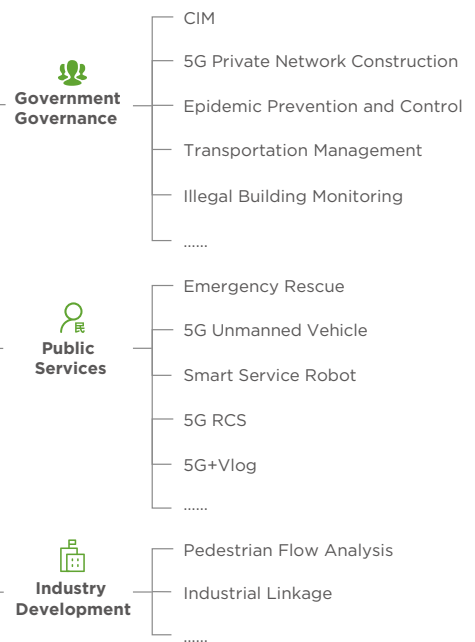### Industry Development

Solutions

5G-enabled panoramic industrial chain

Real-time passenger flow and density statistics powered by "5G + AI"

Sensor
Camera
Robot
Unmanned Vehicle
Multi-function Smart Pole
Smart phone
......

Smart Nanshan in Shenzhen

Government Governance
- CIM
- 5G Private Network Construction
- Epidemic Prevention and Control
- Transportation Management
- Illegal Building Monitoring
- ......

Public Services
- Emergency Rescue
- 5G Unmanned Vehicle
- Smart Service Robot
- 5G RCS
- 5G+Vlog
- ......

Industry Development
- Pedestrian Flow Analysis
- Industrial Linkage
- ......

5G City

Government Governance   The end-to-end services that cover the entire process and the full life cycle can empower 5G construction. By leveraging 5G as the basic communication technology, we can enable CIM, epidemic prevention and control, intelligent transportation, intelligent building construction, and other applications to assist government decision-making and improve governance efficiency.

Public Services   The fast, stable 5G network with low latency can allow a series of public services such as emergency rescue, 5G unmanned vehicles, 5G intelligent service robots, 5G RCS, and intelligent cultural tourism.

Industry Development   The rapid development of upstream, midstream, and downstream industries can be fuelled through network infrastructure construction, the introduction of terminals including sensors, cameras, intelligent robots, drones, and smartphones, and the application of artificial intelligence, big data processing, cloud computing, edge computing, 5G, and 4K/8K HD video.

01 Governance Scenarios

⌃ 5G in Digital Epidemic Prevention and Control

The Smart Nanshan in Shenzhen project enables COVID-19 epidemic prevention and control in Nanshan entirely digital. 5G network and terminals play a critical role in dynamic data aggregation, data mining and analysis, expert video conferencing, and on-site real-time linkage thanks to fast deployment, high bandwidth, and low latency. The platform can independently and intelligently collect basic information and health status of personnel returning to work online, which helps the government approve enterprises' production resumption application. Citizens' travel trajectories in the past 14 days are automatically tracked to identify any possible source of infection through big data analysis. 5G cameras and NB-IoT locators are deployed in key epidemic prevention and control areas for epidemic monitoring. AI robots can automatically make calls to investigate persons and collect information. Technologies like AI, big data, and 5G are integrated to accelerate virus detection and diagnosis, monitoring and analysis, and full traceability management.

Traffic management involves various complex scenarios. Easy-to-deploy and convenient 5G cameras, together with AI and big data, create a new mode of intelligent traffic management. 5G cameras can be deployed anywhere, both in ordinary locations and restricted areas such as protected historic sites and ancient buildings. They feature easy deployment, convenient usage, and low deployment cost. 5G's high transmission rate, massive bandwidth, and reliability allow the cameras to capture massive high-definition data, which are turned into intelligent traffic information after AI and big data analysis and processing. The information can help in traffic management plan optimization, management policy development, carbon emission reduction, and determination of traffic safety technology and management methods through accident cause analysis.

⌃ 5G in Intelligent Traffic Management

As to building construction management, the inspection of illegal buildings is a laborious and time-consuming task, and some unauthorized works may be easily ignored. 5G drones make the process easier. After setting the cruise inspection routes and collecting data during the first flight, officers can establish a digital model. Flight inspections can then be initiated at a certain interval on demand. Automatic algorithm analysis via AI can spot the differences among different periods, therefore finding any new illegal buildings. At the same time, the fast and stable 5G network allows real-time postback and playback of high-definition video to assist manual inspection. 5G drone features high efficiency and low cost and can inspect one square kilometre in 20 minutes.

02 Public Services

▲ 5G Multi-functional Smart Pole Serving Residents

Unattended early warning for drowning, fire, and trespassing is made possible by integrating 5G border patrol inspection, 5G multi-functional smart poles, 360-degree panoramic live broadcast equipment, and 5G cameras, along with regional monitoring linkage and AI. In case of drowning, fire, and tourists crossing the red line to damage monuments and landscapes, multi-level alarms will be automatically triggered for broadcast repulsion or rescue. When an accident occurs, life-saving equipment can be acquired through face recognition, and the use of equipment and rescue process can be fully recorded in the background. Compared to traditional rescue boats, intelligent rescue robots are smaller and more dexterous, thus greatly accelerating the rescue and reducing the risks faced by rescuers. Fast, safe, and efficient water rescue becomes a reality. 5G broadcast equipment and 5G video linkage enable remote alerting in key areas, as well as advertising and emergency evacuation. In addition, 5G multi-functional poles are equipped with 5G micro-base stations, WIFI6 hotspots, AED defibrillators, and weather monitoring modules.

5G intelligent service robot features voice interaction, conversation for Q&A, face recognition, semantic understanding, environment perception, and autonomous positioning & navigation. The LED screen on the robot can spread the knowledge of history, epidemic prevention, and garbage classification in all areas. When deployed in scenic spots, the robot with a guide function can interact with visitors to introduce the attractions and recommend routes. Pedestrians can throw garbage in the trash can brought by the robot to keep the city clean and tidy.

▲ 5G Intelligent Service Robot Serving Residents

▲ 5G RCS Serving Residents

"5G+" services drive intelligent empowerment for enterprise employees and community residents. In cultural tourism services, auto photo-taking booths (real-time 5G message pushing), virtual commentary, humanistic propaganda screens, and 3D guide services are provided. In government affair services, active 5G pushing allows the public to access the services anywhere anytime. As long as there is 5G network, residents can open their RCS app to get the inquiry, consultation, reservation, and queuing services offered by the government's public accounts and mini programs, instead of downloading, following, registering, and logging in. Without leaving home, residents can reach out to more than 500 government services.

5G City

Built on L4-class autonomous vehicles and stable, low-latency, and fast 5G network, "5G Smart Unmanned Vehicles" offer a smart service platform on the wheels. It can provide residents and tourists with free meals, first-aid medicine, masks, alcohol, and anti-mosquito medicine. The unmanned vehicle can run 24 hours a day. Residents can beckon the vehicle and scan the code to get the needed services. The vehicle can also be used as a mobile propaganda station for epidemic prevention and extreme weather notification. At the same time, it can act as a video collector to connect tourists, vehicles, roads, traffic data in real time, therefore providing effective data for urban governance.

5G Intelligent Unmanned Vehicle Serving Residents

The "tourist + scenery" star-style 5G + Vlog can be a cultural carrier to better expose the scenic spots by stimulating tourists to share the fun. Customized high frame rate cameras can automatically capture touring clips. With such algorithms as beauty, background defocusing, and automatic exposing and focusing, the camera can generate exclusive travel logs to record the amazing moments for each tourist. Suitable for recording different scenes, the customized camera allows animal recognition, delayed photography, night photography, and wide-angle photography. It can automatically select clips and generate a collection of the best moments for each tourist and the attraction every day. The edge all-in-one machine locally pulls video streams. Supported by customized recognition algorithms and theme templates of the scenic spot, the camera can rapidly edit multi-shot video streams, which can be received and downloaded by tourists through 5G RCS.

5G + Vlog Serving Residents

Summary and Next-steps

The smart city built by Nanshan District maximizes the coupling effect of 5G + smart city. It comes with digital services across the process, efficient and orderly urban governance, data opening, integrating and sharing, green and economic development. A construction model for smart city 4.0 or 5G + smart city, is put in place to tailor to city scale, governance needs, construction pain points, budget, industrial distribution, and other factors. All types of administrative areas in not only first-tier cities but also second- and third-tier ones can transform into 5G+ smart cities instantly.

The convergence of 5G with new-generation information technologies such as big data, AI, IoT, and cloud computing will link up the "end-edge-hub" hierarchical smart scenarios to empower smart cities. 5G + AIoT help shape an intelligent Internet of Everything and generate massive data. 5G + MEC contribute to edge intelligence, which boosts the seamless connection between urban cognition and urban intelligence. 5G + IOC make possible central intelligence that promotes data circulation, sharing, interaction, and collaboration to create more value and incubate various innovative applications. This further catalyses urban management and service reform to save countless labour, resources, and capital, improve management efficiency, and bring down costs. With 5G network, smart cities find more and more application scenarios. Smart community, smart transportation, smart culture and tourism penetrate all aspects of people's life. The adoption of network slicing and edge computing technologies for 5G network can better satisfy user needs, improve service customization, drive deeper integration of network and services, and make services more friendly. Thus, residents can be more aware of the "smart city" and more satisfied with the services. In addition, integrated, intensive construction can avoid unnecessary and repeated construction works for service informatisation, thereby reducing unnecessary and overlapping investment. In the future, smart city applications can also be built on the project's construction achievements and information infrastructure for incremental upgrade or application expansion. This can not only protect existing investment but also save expenditures on managing different networks with common needs.

The demonstration project helps verify the digital twin city system and offers a reproducible solution for 5G-powered urban service and governance.