Assessment and Suggestions on the Digital Transformation Path of Guangzhou's Smart Transportation

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https://doi.org/10.70695/AA1202502A08

Abstract

This paper first defines smart transportation and digital intelligence concepts. Next, it deeply analyzes the development experience and path evaluation of benchmark cities in China's smart transportation digital transformation in recent years. Finally, it selects the most suitable digital transformation path for Guangzhou's smart transportation, considering the current problems in its construction, to boost the high -quality development of Guangzhou's smart transportation.

Keywords Smart Transportation; Smart Transportation System; Transformation and Upgrading; Path Evaluation; Development Strategies

1 The Connotation and Development Trend of Smart Transportation

1.1 The Meaning and Types of Smart Transportation

Smart transportation refers to the collection of traffic information through new-generation information technologies such as cloud computing, the Internet, big data, blockchain, artificial intelligence, the Internet of Things, and vehicle-to-everything (V2X) networks. After real-time analysis and processing of this information, it forms a transportation governance and service system that is wide-ranging, accurate, real-time, and secure. Smart transportation is generally divided into three types of application scenarios: urban road traffic, urban rail transit, and highways.

The goal of urban road traffic in smart cities is to improve urban road traffic conditions. This ensures orderly and coordinated operation of the four key factors: people, vehicles, roads, and environment. In this way, the efficiency of urban transportation can be maximized. The goal of urban rail transit in smart cities is to achieve comprehensive perception of information on passengers, facilities, equipment, and the environment. This enables precise and flexible transportation organization and management, as well as coordinated and efficient dispatching and command. It also allows for intelligent fault diagnosis and maintenance. As a result, cities can be provided with a safer, more convenient, intelligent, and comfortable three-dimensional transportation system. This promotes high-quality urban transportation development and supports the building of green and low-carbon cities.

The goal of smart highways is to enhance traffic efficiency while ensuring safety. New technologies can transform human judgment into machine judgment. This eliminates the limitations of human eyes and brains' extreme reaction times, thus resolving the conflict between safety and high speed. Additionally, by improving management mechanisms, conducting data analysis, and optimizing highways, the management quality can be upgraded. This provides a higher-level service for vehicles using the highways.

1.2 Development Trend of Smart Transportation

Networked Transportation Infrastructure and Ubiquitous Perception Driving the Internet of Everything

As a key part of new infrastructure, smart transportation infrastructure has become one of the important application scenarios for implementing digital twin cities. Through various Internet of Things

(IoT) devices such as communication networks, traffic lights, traffic signs and markings, video surveillance facilities, and in-vehicle terminals, ubiquitous traffic perception can be achieved. Data collection methods and content are constantly being enriched. Consequently, the traffic system is shifting from being "unmeasurable and uncontrollable" to "measurable and controllable".

Full-Element and Scenario-Based Data Enablement of Transportation

The widespread and interconnected perception systems have greatly enhanced the timeliness, accuracy, and comprehensiveness of transportation data. Based on real-time data from various sources, such as holographic road data, vehicle travel data, dynamic high-precision map data, traffic light data, mobile communication data, parking data, weather data, Internet data, and even urban big data, a dynamic data system is formed. This system integrates multi-source, massive, and interconnected elements. The integration and enrichment of transportation and urban data provide fuel for data intelligence. In the digital twin city scenario, it can achieve:Visibility of city-wide traffic operations. Identifiability of common and occasional problems. Manageability of routine business processes. Controllability of traffic congestion and abnormal situations. Resolvability of complex and difficult-to-treat problems. Servability for both managers and the general public.

Transition from Centralized Management to Diversified Collaboration

The systematic planning and construction of smart transportation, along with the coordinated development of smart city infrastructure, will break the traditional siloed management and stovepipe construction patterns of intelligent transportation. This avoids issues like data fragmentation and duplicate construction. By creating a unified digital transportation brain foundation, data integration, sharing, and governance can be achieved. To meet business needs such as traffic governance, safe cities, and smart municipal management, various business-oriented mid-platforms are formed based on the business logic of management services. Through modular assembly-like combinations, these platforms can quickly respond to new application requirements and effectively improve the efficiency of multi-department collaborative governance.

Emergence of Connected Transportation Systems and Evolution from Centralized to Collective Intelligence

With the development of intelligent connected Vehicle-road cooperation management and control technologies, there is a shift from passive coordinated control of discrete traffic entities to large-scale collective intelligence-based collaborative control. Meanwhile, the transition is also happening from V2X (vehicle-to-everything)-supported real-time information interaction to trusted interactions among mixed traffic entities. The existing centralized intelligent perception and coordinated control are gradually evolving into collective intelligence-based decision-making and coordinated control under the vehicle-road collaboration environment. An integrated intelligent connected transportation system involving people, vehicles, roads, clouds, and maps is gradually taking shape. Collective intelligence-based decision-making and coordinated control, based on all-time-and-space traffic information perception, integration, and interaction, are expected to become a reality. Compared with the traffic brain concept, vehicle-road collaboration emphasizes bidirectional perception. It serves a broader range of objects, provides smarter, more convenient, and efficient social governance capabilities for government departments, and accelerates the development of new industries such as autonomous driving for economic growth, with huge industrial chain potential.

2 Status of Intelligent Transportation Development in China

2.1 Development Status of Advanced Cities in Intelligent Transportation

In recent years, General Secretary Xi Jinping has repeatedly made important instructions and instructions for the vigorous development of intelligent transportation, and the report of the 19th CPC National Congress formally put forward the construction of a major strategic plan for a strong transportation country.2019,The Outline for the Construction of a Strong Transportation State points out: "Transportation is the key to the emergence of a country, the foundation of a strong country, and the strategic goal of a strong transportation country will be basically achieved in 2035, basically resolving the situation of urban congestion. Vigorously develop intelligent transportation, promote the deep integration of new technologies and the transportation industry [4],By 2050, a world-class, people's satisfaction, strong protection of the transportation power. 2020, the Ministry of Transportation issued a guide to promote the construction of new infrastructure in the field of transportation: "digitalization, networking, intelligence as the main line, technological innovation as the traction, comprehensively In

2021, the state issued the Outline of the National Comprehensive Three-dimensional Transportation Network Plan, which draws a blueprint for the development of China's intelligent transportation, emphasizing the need to promote the digitization of transportation infrastructure, network connectivity, all-around layout of the traffic perception system, and the simultaneous planning and construction of the transportation infrastructure to create an integrated intelligent travel platform, laying a general foundation for the development of China's intelligent transportation. In July, three ministries and commissions issued the management specification for road testing and demonstration application of intelligent networked vehicles, putting forward specific requirements and measures to promote road digitization, intelligence, network connectivity, etc., and continue to deepen the layout of the construction of intelligent transportation. 2022, the State Council issued the "Overall Layout Plan for the Construction of Digital China", "14th Five-Year Plan", "Development of Modern Comprehensive Transportation System", and "The Development of Modern Comprehensive Transportation System". "Modern Comprehensive Transportation System Development Plan" and other documents, put forward to accelerate the depth of the promotion and application of intelligent technology, promote the intelligent upgrading of infrastructure, promote the deep integration of new technologies such as the Internet, big data, artificial intelligence, blockchain and the transportation industry, promote the application of advanced technology and equipment, and build a ubiquitous and interconnected, flexible and cooperative, globally competitive intelligent transportation system [5]. 2023, the Ministry of Transportation issued a five-year action plan to accelerate the construction of a strong transportation country and accelerate the opinions on the construction of smart ports, waterways and highways to comprehensively promote the digital transformation of the transportation industry, accelerate the development of intelligent transportation construction, and enhance the foundation of the construction and operation of intelligent transportation to improve the level of management and service. 2024, Premier Li Qiang pointed out in the government's work report that: consolidate and expand the intelligent network connected new energy vehicles and other Industry leading edge, and actively promote digital industrialization, industrial digitization, to promote the deep integration of digital technology and the real economy, comprehensively accelerate the process of intelligent transportation digital intelligence [6]. Under the strong impetus of the Party Central Committee and the state, Shanghai, Hangzhou, Shenzhen, Beijing, etc. in the smart transportation digital intelligence upgrading and transformation, towards the goal of a strong transportation country, to achieve high-quality development, and achieve remarkable results.

Shanghai: "IDPS system" to help the new mode of intelligent traffic management

The total number of motor vehicles in Shanghai is more than 6 million, and the city of Shanghai, with the overall structure of IDPS and the requirement that "city management should be as fine as embroidery", has put forward a response to build an intelligent road traffic management system, and constructed an intelligent transportation "IDPS system". "Layer I (Infrastructure), real-time perception, insight micro. Through the "1+1 > 2" combination of old access to the city's more than 100,000 units of equipment networking upgrades and complementary points of the new equipment <10,000 units, more than 6,500 networked signaling machines, sensory equipment 24 hours a day, uninterrupted collection of more than 400 million vehicle dynamic data, the formation of a real-time sensory, artificial + automatic collection of the "neuron". "D layer (Data), massive convergence, accurate cognition. By building a city-wide computable road network in the system, road attributes and traffic facilities are digitally modeled in accordance with the rules of the road. At the same time, the system defines the area closed by sensing equipment as virtual parking lot, and divides the city into 12,000 branch road-level, 1,810 arterial road-level and 16 district-level virtual parking lots, which supports the accurate cognition of the elements of urban traffic management. p-layer (Platform), deduces the law and synchronizes the mirror image. Through the research and development of more than 300 sets of calculation models, the trajectory of vehicle travel and parking characteristics are portrayed. For the city's daily average of 4.4 million vehicles, a total of about 13 million trips, in accordance with the concept of digital twins, in order to achieve synchronized mirroring in the computational space composed of computable road networks and virtual parking lots, in the virtual world parallel mapping of the physical reality of the vehicle. At present, it has basically calculated the number of vehicles traveling in the city, the distribution area, the composition of the car registration, and deduced the macro-micro, dynamic and static change rules. s layer (System &Service), each take what they need, widely empowered. In terms of service, the public was provided with information on staggered travel guidance during holidays, effectively shortening the length of congestion; in terms of management, a number of road safety hazards were found and rectified, contributing to a significant drop in fatal traffic accidents; in terms of law enforcement, a number of illegally operating dump trucks, cloned cabs, and hazardous chemical vehicles evading GPS supervision

were pushed and jointly investigated, promoting the formation of a synergy of supervision of the key vehicle industry In terms of law enforcement, we have pushed and jointly investigated a number of illegally operating dump trucks, cloned taxis, and hazardous chemical vehicles evading GPS supervision, promoting the formation of synergy in the supervision of key vehicle industries. The completion and application of Shanghai's "IDPS" system has formed a new model of refined and intelligent road traffic management in Shanghai, and has become the world's first intelligent transportation system applied in a mega-city.

Hangzhou: "City Traffic Brain", promoting traffic management into a new era

Since 2016, Hangzhou City has relied on the "City Brain" as the basis for the construction of "Hangzhou Traffic Brain" as a breakthrough in the field of transportation, and has started the exploration of using big data to improve urban transportation, carrying out a modernized traffic governance system in terms of digital transformation of transportation facilities, digital enhancement of industry governance, and digital construction of credit management. In terms of digital transformation of traffic facilities, digital enhancement of industry governance, and digital construction of credit management, a modernized traffic governance system will be carried out. Firstly, it promotes the integration and application of transportation resources, and fully exploits the spatial and temporal resources of roads. As of February 2024, Hangzhou has built more than 2,000 SCATS adaptive traffic control system intersections, basically realizing extensive coverage of adaptive control of urban road traffic flow. Secondly, it promotes the integration and management of different road networks. Hangzhou continues to promote video surveillance and other IOT sensing equipment in the road network seamless integration, the establishment of high expressway and ground road network linkage strategy, in the comprehensive use of on-ramp signal intelligent control, on-ramp intelligence board induction, up and down ramps hard management facilities and other methods at the same time, and actively promote the construction and application of regional guidance release system. Third, promote the application of data resource sharing. Promote the traffic police, transportation, planning, construction, urban management and other government departments to share relevant data, encourage map navigation, public transport, instant messaging, financial payments and other Internet platforms and software to provide the public with road dynamics, bus arrivals, customized buses, subway feeder, taxi cab, parking guidelines, etc., and gradually build a personalized, customized and convenient intelligent travel service system. Fourth, intelligent management to build a solid transportation bottom line. Through the "two passengers and two cargoes" intelligent management upgraded again, build Hangzhou "two passengers and two cargoes" comprehensive management platform, the whole chain management of hazardous chemical vehicles, concrete vehicle driver qualification online training guide and other functions have been put into application, Hangzhou "Two passengers and two cargoes" in the field of ‘full-time tracking, the whole process of strict control' of the intelligent dynamic supervision system has been basically established. Build "intelligent identification +" to combat illegal operation, continue to strengthen Hangzhou transportation law enforcement data base and comparison model, the use of "intelligent identification +" means to continue to combat all types of illegal operation. Constructing a closed-loop network of non-existing "super", from 2020, Hangzhou newly built 25 points of 80 off-site law enforcement lanes, and citywide promotion of "super" off-site law enforcement "Tonglu mode", the implementation of real-time monitoring of the source, transportation remote monitoring, over the threshold value of the automatic alarm and distribution of disposal, and strive to enhance the investigation and handling of cases.

Shenzhen: the combination of policing and data empowers the fine-grained management of transportation

Shenzhen has a population of 22 million and a motor vehicle fleet of 3,547,500 vehicles. Shenzhen makes full use of cutting-edge core technologies to plan the overall architecture of traffic management at the technological level, and continuously improves the level of intelligent traffic management. First, it is spread from intelligent iteration. From 2019 to date, the establishment of 1+N business intelligence synthesis model. 1 is the command center operation platform, N is the intelligence, command, supervision, publicity and other business development, the ability to sink to the grassroots. At present, Shenzhen in the city to build a "invisible but ubiquitous" perception network, to realize the dynamic trajectory of the vehicle intelligent research and judgment and real-time vehicle deployment and control early warning of efficient command. Second, from the wisdom of empowerment into. Shenzhen to "wisdom +" as an entry point, and actively promote police change, build a new system of intelligent traffic management work, to create by the business sector led by the application of scientific and technological innovation, science and technology departments to provide a platform to support the new police mechanism, the division of labor, the full mobilization and play the role of the functions of various departments, so that the traffic control work to play a better and greater role.

Beijing Municipality: Constructing "Intelligent Command" and Exploring New Applications of Vehicle-Road Collaboration

By the end of 2023, the total number of motor vehicles in Beijing reached 6.032 million. Beijing builds a new generation of intelligent traffic management system. The use of a variety of means of communication networking constitutes a modern command and scheduling system, accurate and rapid positioning of vehicles. Through the video surveillance on the road, microwave detectors and buried in the ground coil detector collection record analysis of traffic flow, speed and other information, analysis and processing to achieve optimal signal regulation [7]. First, vehicle-circuit coordination. Beijing Yizhuang National Intelligent Vehicle and Intelligent Transportation (Beijing-Hebei) Demonstration Zone, through the customized development of low-latency, high-reliability roadside equipment, compatible to meet the object perception, violation of the rules to capture a number of functional requirements, to integrate and universal principles to create a future digital transportation base. The second is to carry out automatic driving demonstration applications. Beijing relies on L4-level autonomous driving technology innovation to create high-level autonomous driving rental, autonomous parking and other scenarios, exploring "holographic perception, intelligent decision-making, efficient operation, stable and controllable" high-level automated driving vehicle-road cooperation applications. Third, the construction of five systems of intelligent transportation. That is, intelligent road, smart car, real-time cloud, reliable network and accurate map, to open up the key links of technology and management of network-connected cloud-controlled automatic driving, and to form a city-level engineering test platform [8].

2.2 Status of Intelligent Transportation Development in Guangzhou

As of February 2024, Guangzhou has a total road mileage of 14,561 kilometers, including about 5,700 kilometers of municipal roads, 8,800 kilometers of highways, and 1,056 kilometers of expressways, with a motor vehicle population of about 3,081,800 vehicles. Guangzhou is one of the six cities selected as a pilot city for the collaborative development of smart city infrastructure and intelligent networked vehicles (the "Double Smart Pilot").

Digital and Intelligent Operation of Intelligent Transportation

Guangzhou Municipal Bureau of Transportation has built "one center, three platforms" as the city's intelligent transportation system, with more than 80 transportation industry management, enterprise application and public service systems, covering nearly 160,000 municipal vehicles and 180,000 vehicles outside Guangzhou, realizing a comprehensive coverage of all fields of the city's transportation industry and new business models. It has won the World C40 Cities "Green Technology" Award and the first prize of China's "Internet + Transportation" Innovation and Entrepreneurship Competition. First, it has built a data sharing and analysis model platform for the transportation industry, accessing more than 90 transportation industry information systems in 17 industries, with a total data volume of more than 200 billion articles and a daily increase of 250GB, which is widely used in monitoring and analysis of passenger flow in key areas, transportation security, traffic management, and high speed road maintenance. Secondly, it is the first one in China to build the "Intelligent Transportation" system, which has supported the evacuation of more than 50 million passengers in Guangzhou for five consecutive years, and has been hailed by the media as the "Strongest Brain" of the Spring Festival, and has won the "Excellent Innovation Case" of China's "Xueliang Project" and the "Best Innovation Case" of China's "Xueliang Project". It won the first prize in China's "Excellent Innovation Case of Snow Light Project" and China's "Internet + Transportation" Innovation and Entrepreneurship Competition. Third, it is the first in the country to build the "Traffic Wise Eye" platform, building and sharing high-definition video of more than 80,000 roads, carrying out the integration of artificial intelligence and traffic big data and innovative applications, supporting traffic law enforcement and industry management departments to coordinate and link up, and grasping the spatial and temporal patterns of illegal vehicles for hire, to assist in precision crackdowns. We have innovated the first 5G rapid transit intelligent dispatching demonstration line in China and the "Sightseeing 2" demonstration line in Guangzhou, which has been awarded the "New Energy Bus High Quality Line" in China for two times. Fourthly, the first comprehensive traffic information service application "Guangzhou Traffic-Xingxuntong" was innovatively launched to provide one-stop and intensive services, with a total of more than 10 million registered users. Fifthly, it has built a management platform for the net car and shared bicycle industries, accessing about 280,000 net cars and 450,000 shared bicycles, and promoting the standardized operation and management services of the new industry. It has promoted the road testing of self-driving vehicles, and released 67 open test road sections and road ratings with a total mileage of 135 kilometers.

Construction of Intelligent Traffic Management

Municipal Public Security Bureau Traffic Police Intelligent Traffic Management System has gone through two generations of construction, the system structure has been gradually improved, and the information system has covered the core business of command and control, signal control, illegal processing, accident processing, vehicle and driving management services, team management, etc. First, the construction of "Traffic Management Big Data Resource Pool". Firstly, the system has built a "big data resource pool for traffic management", which comprehensively gathers data resources such as six-in-one, bayonet, traffic operation, command and dispatch, and Gao De, etc. The current data volume reaches 36.1 billion pieces of data (with a weekly increment of about 207 million pieces of data), which basically covers data of internal and external equipment (such as bayonet, parking lot, mobile terminal equipment and vehicles), driver information, accident type and violation type, and data of accident type and violation type, as well as data of traffic management. The data statistics of accident category and violation category, and the establishment of big data resource base for traffic management. It improves the traffic management data governance capacity in the accident category, law enforcement category, vehicle combat tracking, daily modeling statistics and other businesses. Secondly, in the management of urban traffic congestion, with the goal of smooth and orderly traffic, we have developed the "Eagle Eye" system, safety supervision and auxiliary decision-making platform (DG platform), popularized a new generation of mobile police system, and created an efficient mode of automatic detection of traffic events and drones, so that the effectiveness of comprehensive traffic management is increasingly prominent. 2020, the city's central city The weekday evening peak speed of the entire road network is 23.2km/h, an increase of 5.5% year-on-year, and the city's road congestion index is 1.36, a year-on-year decrease of 2.2%. Traffic congestion police 90,000 cases, down 5.8% year-on-year, parking police 133,000 cases, down 2.4% year-on-year. Third, in terms of illegal processing. Through technological innovation and fusion of motion image restoration and multi-target positioning and other high-end technologies, millisecond comparison of the "blacklist database", to achieve rapid and accurate investigation and seizure of key suspected illegal vehicles, highly affirmed by the Ministry of Public Security and promoted nationwide. 2020 to investigate and deal with the "two passengers, one dangerous and one heavy cargo" violations of 577,000 cases, down 2.4%. "In 2020, it will investigate and deal with 577,000 violations of the law and 125,000 violations of the law by dump trucks. Highway 11 categories of key year-on-year increase of 90%, 8 categories of national and provincial highways year-on-year increase of 390%, 4 categories of rural roads year-on-year increase of 590%, 5 categories of hazardous chemical vehicles key violations year-on-year increase of 538%, the traffic order continues to purify. Fourth, in terms of convenient services, through the construction of Guangzhou Traffic Police e convenient service system and promote the application of Guangdong Province, traffic control 12123 APP, etc., by the end of 2020, 85% of the vehicle management business online self-service has been realized, and 100% of the comprehensive business can be booked online.

Digitalization of "Sui Zhi Management" Traffic Command

"Spike Smart Management" traffic operation theme from the traffic infrastructure, urban comprehensive transportation, urban public transportation, traffic governance and other four thematic sections, the full convergence and integration and analysis of the traffic industry in the field of government data, social data, Internet big data and other resources, to build up the city's external and internal traffic overall operating situation "One map" to grasp the city's traffic trends in real time. Focusing on the difficulties and pain points of urban traffic management and services, the company has focused on the construction of a number of application scenarios, such as monitoring of passenger evacuation at Guangzhou South Railway Station, scientific and technological law enforcement at Guangzhou South Railway Station, monitoring of "two passengers and one hazardous area", regulation of Internet rental bicycles, and monitoring of metro passenger traffic, etc., and has applied data research and judgment, AI intelligent identification, video surveillance and other technical means to realize The company uses data research and judgment, AI intelligent recognition, video surveillance and other technical means to realize intelligent operation monitoring and scientific management services of urban transportation, and help the transformation of digital intelligence in transportation management.

Development of Digitalization in the Transportation Industry

As the first consumer market and the first manufacturing base of the automotive industry, Guangzhou has favorable basic conditions for intelligent transportation, with a number of enterprises with core technologies. In terms of traffic brain, vehicle-circuit coordination, and IOT (Internet of Things) perception, it has leading enterprises such as Jadu Technology, Fangwei Technology, Huawei, Baidu Apollo, and Gaoxin. In terms of intelligent vehicles, Guangzhou is one of the first cities in China to carry out road testing of self-driving cars, and has leading domestic self-driving head enterprises such as

Baidu Apollo, Wenyuan Zhixing, and Pony Zhixing. In terms of complete vehicles, it has Guangzhou Automobile Group, Dongfeng Nissan, Xiaopeng Automobile, BAIC Guangzhou and other enterprises, with a number of intelligent networked vehicles with core competitiveness. In terms of intelligent transportation system construction, Jadu Technology and its subsidiary Guangdong Fangwei Technology have constructed the Shanghai Urban Road Traffic Management Information System (IDPS), which, as one of the ten systems of the Shanghai Municipal Party Committee and Municipal Government's "One Network Unified Management", has played an important role in creating a new mode of refinement and intelligence for Shanghai's road traffic management. The system, as one of the ten systems of the Shanghai Municipal Party Committee and the Shanghai Municipal Government in the work of "one network unified management", plays an important role in creating a new model of refinement and intelligence for Shanghai road traffic management. Baidu Apollo reached an agreement with the Municipal Public Transportation Group to build an autonomous driving bus demonstration project, and invested more than 77 million yuan in the first phase to put 10 electric buses into demonstration operation on BRT bus routes. GAC new energy joint Huawei independent development of the world's first 5G + V2X intelligent communication system, integrated with Huawei's latest generation of Baron 5000 5G chip to create the first mass-produced intelligent car has been listed in December 2020. 2020-2023 Municipal Science and Technology Bureau of the key areas of research and development program deployment of intelligent networked vehicles, new energy, new materials and other special projects, to carry out Digital cockpit, autonomous parking, fuel cells, vehicle road coordination and other areas of key core technology research. In terms of application results, the city's Telematics Pilot Zone, relying on the Intelligent Networked Vehicle Competition race track renovation, the construction of Nansha Bridge (Humen II Bridge), the Pearl Bay Starting Area, the first phase of the construction of Lingshan Island Tip Intelligent Driving Demonstration Segment, the 5G-V2X demonstration application for BRT buses and other key Telematics projects, has been constructed and renovated 18 key intersections in Huangpu, Nansha, Tianhe and other areas, and 20 sets of roadside units and 74 5G base stations that can be applied to Vehicle Networking, covering 23.6 kilometers of roads and 2.7 square kilometers of area, and realizing 56 LTE-V2X scenarios for testing and demonstration application, with the scenarios covering a variety of types, such as 5G-V2X Vehicle-Road Collaboration, Autonomous Driving Vehicle-Road Collaboration, and Green Wave Passing for BRT Buses, and so on.

2.3 Comparative Analysis of the Transformation Path of Digital Intelligence between Guangzhou and Advanced Intelligent Transportation Cities

To sum up, the "city brain", "intelligent transportation" and "traffic brain" proposed by the domestic advanced cities of intelligent transportation have different kernels, but without exception, at this stage, they are all The city traffic brain is considered as an upgraded iteration of the traditional intelligent transportation system, to strengthen the comprehensive perception of people, vehicles, roads, the environment and other elements of traffic, convergence and integration of government and enterprises, industry, different sources of traffic data, to achieve real-time computation of the massive spatial and temporal tracks of traffic individuals, and ultimately to build a digital twin of road traffic, through the fusion of data and a new generation of information technology and innovation, providing supply and demand matching services for the government, industry regulators, enterprises, the public and so on. Through the integration and innovation of data and new generation information technology, it can provide governmental industry regulators, enterprises, and the public with an intelligent and efficient transportation system with the appropriate matching of supply and demand, the optimal system, and the best travel experience. The common point of the above cities in the technical path is that through AI, big data, cloud computing and other technologies, whether it is perception, cognition or action processing level are gradually developed towards intelligence. The three-layer logical architecture of "perception+brain+application" is the most common intelligent transportation management technology path. Compared with the domestic intelligent transportation advanced cities, the overall development level of intelligent transportation in Guangzhou is at the forefront of the national cities, but there are problems of fragmentation, fragmentation, overlapping functions, multiple management, duplication of construction, etc., and a lack of overall synergies in the construction, operation and governance of intelligent transportation, and there is still a gap between the level of development of intelligent transportation in Shanghai, Hangzhou and other cities.

3 Problems in the Development of Guangzhou Intelligent Transportation Digital Intelligence

3.1 There is a Gap in the Level of Application of Key Technologies of Intelligent Transportation

The current level of intelligent transportation technology in Guangzhou is relatively backward with the domestic intelligent transportation advanced cities, Guangzhou intelligent transportation on people, cars and roads state perception is mainly dependent on video, geomagnetic, radar and other traditional collection equipment, the collection of data to the road cross-section of the flow is mainly. In the traffic big data analysis and judgment, the historical past information to fit the current state of trend prediction, often only analyze the trend, distinguish between normal, general and episodic problems, focusing on the macro, the characteristics of vehicular traffic and lack of accurate research and judgment of the operating law. The past traffic management is a sloppy management mode, relying on artificial, traffic management department to fight alone, traffic management is more passive. The domestic intelligent transportation advanced cities in the technical path is more advanced and innovative, give full play to big data, the Internet, AI, cloud computing and other advanced technologies to achieve accurate perception of individual vehicles and lane-level traffic data, calculate the regional operation of vehicles and the regional carrying capacity, accurate research and judgment, the development of traffic control strategies, timely response to emergencies, and then through the client impact on the travel behavior of individual users.

3.2 The Overall Intelligent Transportation System Is Not Built

Guangzhou transportation business to departmental block management, not to realize the whole element perception and integrated operation. Transportation-related departments and the number of subordinate units, the lack of integrated business operation mechanism to form a synergy, resulting in the lack of unified planning, such as the front-end construction, the internal system "barbaric growth", poor system compatibility and other issues. Reflected in the construction of the system, will inevitably "headache, treat the foot", resulting in most of the current traffic information technology system to support only a relatively independent business, the data show a fragmented distribution of information utilization rate is low and the degree of integration of the poor, because of the failure to realize the full elements of the perception of the command and scheduling brought about by the poor. Intelligent transportation pilot business dispersed in the city traffic, public security, political numbers, industry and information technology departments, the lack of overall synergy and coordination, it is difficult to form a perfect integrated intelligent transportation system.

3.3 Insufficient Investment in Construction Funds

Guangzhou in the construction of intelligent transportation capital investment lags behind Shanghai, Shenzhen, Hangzhou and other cities, becoming a new technological conditions under the development of intelligent transportation constraints. Guangzhou financial annual investment in intelligent transportation system construction investment scale of about 200 million yuan, and Shanghai, Shenzhen, Hangzhou and other cities to invest on the scale of 1 billion yuan gap is obvious.

3.4 Information Infrastructure Lagging Behind

Traffic control and other operations required for the construction of the density of the field perception equipment, and Beijing, Shenzhen, Shanghai and other cities compared to a large gap. Signal control in the five downtown districts adopts SCATS system, about 20% of signaling points are single-point control, aging equipment, and the city's signal control networking system needs to be strengthened.

3.5 Failure to Establish a Perfect Industrial Ecology

Although Guangzhou's intelligent transportation industry has a good foundation, and the related algorithm research and development, roadside unit, IOT sensing and vehicle manufacturing enterprises have their own characteristics, but ecologically, the upstream and downstream industry technical

standards have not yet been unified, the market demand has not been effectively placed in front of the overall design of urban roads for the information infrastructure, especially sensing and information exchange facilities are not unified planning, the lack of demonstration scenarios with a greater impact, and sustainable construction mode and operation mode are still being explored. The sustainable construction mode and operation mode are still being explored.

4 Guangzhou Intelligent Transportation Digital Intelligent Transformation and Upgrading Development Recommendations

Guangzhou should comply with the development trend of network connection of intelligent transportation, increase financial investment, take the opportunity of "double wisdom pilot" work to further improve the whole area perception of transportation infrastructure, build accurate decision-making, real-time response of the traffic brain and application platform, and gradually realize the data-driven intelligent traffic management mode and service mode. Through the construction of intelligent traffic management innovation highland, we can effectively improve the road traffic order in Guangzhou, make up for the short board of road traffic management, enhance the ability and level of road traffic accident prevention and congestion relief, reduce carbon emissions, help "carbon neutral, carbon peak" goal to achieve, and create a "good governance, intelligent governance, benefit enterprises, benefit the people" overall digital To create an international first-class smart city with "digital twin and self-driven evolution", which is "good governance and wise governance, benefiting enterprises and people", with convenient and efficient overall digital government and urban services, fine and intelligent urban governance, leading development of the digital economy, and ubiquitous perception of urban components.

4.1 Take the New Technology and New Application of Urban Transportation Brain as the Traction, and Actively Build a First-class Smart City

Drawing on the experience of Shanghai IDPS system in realizing real-time road traffic data of mega-city with full-area, full-volume and full-time computation, based on the needs of comprehensive transportation development in Guangzhou, we will build a city traffic brain as a basic platform for transportation and a large base for urban traffic management. First, realize the holographic perception of individual travel. Based on the principle of "should be extracted as much as possible" and the goal of "holographic sensing", we will carry out the construction of an intensive, standardized and highly reusable sensing system to promote the full-area, full-volume, full-measurement of road traffic elements, such as "people, vehicles, roads" and so on. To promote the collection of full-area, full-volume and full-time information of road traffic elements, to create a solid "traffic data base", to dynamically reflect the city's traffic macro, meso and micro levels of traffic status, and to realize a more scientific, reasonable and objective assessment and management of the existing urban road traffic. Secondly, it realizes the transformation of data from fragmentation to high value. Standardize data access, data processing, data organization, data service and data governance of sensing equipment, promote its multi-dimensional integration with business data, realize the transformation of data from fragmentation to high value, and provide sufficient, accurate and vivid data management and service for the current traffic business and future business scenarios. Thirdly, it realizes the provision of universally beneficial "smart traffic" applications. In accordance with the principle of "service + management", the construction of common applications will be unified, and specialized applications will be constructed by business authorities to support the construction and operation of the "Spike Intelligent Management" urban operation and management hub, and to support the special thematic applications of various industries, including intelligent networked vehicles, so as to further improve Social security, urban management, comprehensive governance and people's services capacity and management level, and constantly improve the people's sense of access, happiness and security.

4.2 Taking Overall Synergistic Leadership as the Traction, Actively Promote the Sustainable Development and Continuous Leadership in the Field of Intelligent Transportation in Our City

Accelerate the transformation of innovative technologies and applications into specifications, strengthen the implementation and supervision of industry specifications, and promote the in-depth integration of innovative achievements and industries. In terms of intelligent transportation, networking of vehicles, V2X vehicle-circuit coordination, automatic driving and urban management, develop regional, industry-level and national-level specifications, at the same time, deepen domestic and foreign exchanges and cooperation, focusing on international and domestic standards and specifications synergistic, and give full play to the role of standards to support the leading role of the city's industrial development, and to lead the way for high-quality development. Break the barriers of compartmentalization and departmental coordination, and strive to build the city into a policy and standards innovation curator for autonomous driving, vehicle-circuit coordination, urban management, and traffic management.

4.3 Taking the Construction of Intelligent Network Facilities as a Traction, Exploring New Paths for the Collaborative Development of Intelligent Network Cars

Combined with the latest technological development, on the basis of the existing mature pilot areas, deploy roadside sensing equipment such as LIDAR, edge computing platforms and roadside communication units to realize comprehensive sensing and automatic collection of infrastructure data, promote the intelligent upgrading and transformation of traffic signage and marking such as road traffic signals and traffic electronic signs, improve the level of cellular vehicle networking (C-V2X) network coverage, and gradually build Low-latency, large bandwidth, high computing power vehicle-circuit coordination environment, and synchronously promote the integration and interoperability of multi-source information such as municipal equipment, roads, traffic and vehicles. Explore the construction of intelligent travel platform "car city network", the city road facilities, municipal facilities, communication facilities, sensing facilities, vehicles and other further digitalization, and access to the "car city network" platform for management, to achieve a comprehensive perception and car city interconnection [10].

4.4 Intelligent Transportation Construction as a Traction, Building the City's New Engine of Digital Economic Growth

As an important part of the new infrastructure, smart transportation construction belongs to the basic, pioneering, strategic and service industries of the national economy, which has an extremely strong role in promoting economic growth, especially digital economic growth, and also accelerates the economic ties between regions. Seizing the development opportunity of Guangdong, Hong Kong and Macao Greater Bay Area, with reference to the model of the Greater Bay Area Railway Transportation Industry Investment Group, promote the local enterprises in Guangzhou that master the core technology to jointly form the Greater Bay Area Intelligent City Industry Investment Enterprises, and explore the long-term operation mechanism of the Guangzhou Urban Transportation Brain. At the same time, around the goal of creating a national leading intelligent transportation industry highland, focusing on strengthening the industrialization of forward-looking technology research, bold, take the lead, widely used products and achievements of Guangzhou enterprises, open application scenarios, promote the high-end and intelligent development of the industry, to create a number of nationally significant influence of intelligent transportation demonstration zones and industrial bases, to build the city's digital economic development of a new engine of growth.

Acknowledgement

This work was supported without any funding.

Conflicts of Interest

The authors declare no conflicts of interest.

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廣州智慧交通數智化轉型升級路徑評估及建議

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摘要：文章首先界定智慧交通及數智化概念,其次深入分析近年來國內智慧交通數智化轉型升級標桿城市的發展經驗與路徑比較評估,最後結合當前廣州智慧交通數智化轉型升級建設存在問題,選擇最適合廣州智慧交通數智化轉型升級路徑,助力廣州智慧交通高質量發展。

關鍵詞：智慧交通；智慧交通系統；轉型升級；路徑評估；發展對策

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