

Exploration on Intelligent Operation and Maintenance Construction and Application of Dalian Public Transport Group

As one of the first batch of "Transit Metropolis" demonstration cities in China, Dalian actively implements the spirit of the national, provincial and municipal instructions on "giving priority to the development of urban public transport". Based on the concept of "public transport leads urban development", the Dalian Public Transport Group strives to build a domestic leading and world's first class public transport system with Dalian characteristics, and a domestic leading "Transit Metropolis" following international standards, so as to provide citizens with convenient, thoughtful, fast, punctual, economical, comfortable, green, environmentally friendly, safe and reliable public transport services.



Founded in July 2006, Dalian Public Transport Group Co., Ltd. (the "Group") undertakes 95% of the city's public passenger transport tasks, mainly operating urban tramcar, buses, minibuses, bus rapid transit, sightseeing buses, taxis and other passenger transport, as well as bus IC cards, bus advertising, vehicle maintenance, tourist hotels and other projects. The Group also undertakes a number of major public transport construction tasks in Dalian, and is a large state-owned public transport enterprise integrating passenger transport operation and engineering construction. The Group has won many honorary titles, such as the National May Day Labor Award, the National Top Ten Advanced Enterprises of Urban Public Transport and the National Civilized Unit.

Dalian Public Transport Group owns the right to operate 173 bus lines in Dalian and Wafangdian City. Among them, there are 151 bus lines of nearly 10 types of bus lines in the city and 22 bus lines in Wafangdian. The total length of the bus lines is 2,059.8 kilometers, with 5,472 bus stops, and there are 28.47 buses per ten thousand people. The satisfaction of citizens is 97.68%, the daily operating mileage is 500,000 kilometers, and the average daily passenger flow is 2 million. There are 4,137 public transport vehicles of various types, including

tramcar, trolleybuses, pure electric buses, LNG natural gas buses, hybrid buses, hydrogen fuel vehicles, etc. Energy-saving and environmental protection vehicles account for 73.79% of all vehicles.

The informatization construction of Dalian Public Transport Group was started in 2007. After more than ten years of construction efforts, the Group has built three platforms, including dispatching command platform, customer service platform and cloud data platform, developed and applied more than 20 systems, such as intelligent dispatching, passenger service and vehicle management, and gradually realized the intellectualization, visualization and informatization of enterprise management. Based on this, the Group provides intelligent support for the precise supervision of the industry, the precise management of enterprises, the precise dispatch of vehicles and the precise service of the society, which is conducive to promoting the improvement of the level of industry supervision, enterprise management and service, and lays a solid foundation for Dalian to become a national "Transit Metropolis" demonstration city.

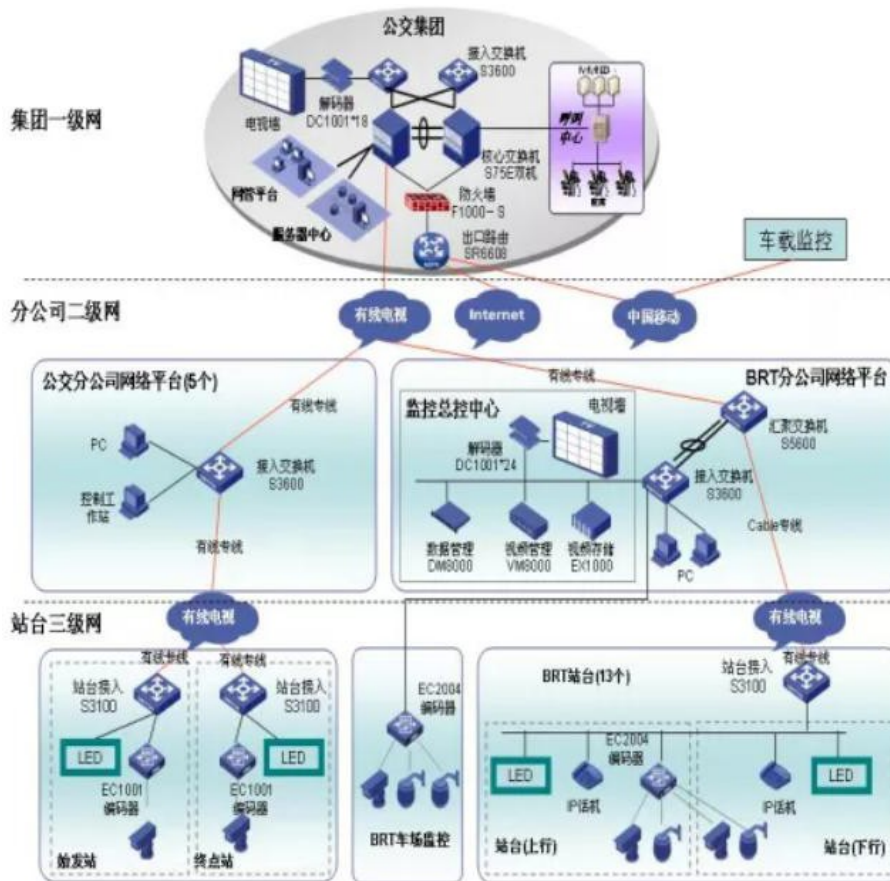
Through the establishment of two-level dispatching and command system in the group and the operation company and the establishment of regional dispatching and command centers in 10 operating companies, the Group has realized the regional intelligent center dispatching covering the whole line network, realized the real-time docking of vehicle real-time data with provincial and municipal two-level supervision and management platforms, and realized the real-time connection of vehicle real-time data with provincial and municipal supervision and management platforms. Thus, the utilization rate of drivers and vehicles, as well as the line operation effect, passenger flow, safety, vehicle location and other conditions can be grasped in real time. With the group website, 968600 customer service hotline, Dalian public transport mobile phone APP, electronic stop board, departure screen, LCD display screen and other information release channels are available to the public, providing them with real-time bus line changes, bus arrival and other information, so that citizens can plan their travel routes in advance. With its mobile payment platform, the Group provides citizens with multi-channel payment methods including contactless payment by scanning QR code with mobile phone or payment via the NFC function built in mobile phone, which provides convenience for citizens to take a bus. Dalian Public Transport Group has established an overall intelligent public transport management system.

In recent years, with the development of post-"Transit Metropolis", in the process of exploring the development direction of public transport information construction and application, we are committed to continuously improving the construction of intelligent public transport system, planning the layout from the digital transformation of enterprises, and applying new technologies such as big data, Internet of Things, Internet of Vehicles, 5G and artificial intelligence. We have planned a large data platform, an intelligent data acquisition platform, an enterprise whole process platform, an integrated operation and maintenance platform, and a public service platform based on the construction of the data platform. The construction and application of large data analysis system, enterprise whole process system, intelligent data acquisition system, integrated operation and maintenance system, energy on-line monitoring system, vehicle and spare parts and personnel life cycle management system have been

constructed initially. The Group has made it clear that the goal of its informatization construction in the "14th Five-Year" Plan period is to establish a new type of intelligent public transport system, so as to accelerate the digital transformation of enterprises and the innovation of business processes, optimize and promote the seamless connection and integration of various business systems within and outside the public transport group, and to open up information flow, data flow, business flow, capital flow and knowledge flow inside and outside the Group. With these efforts, we will accelerate the formation of a data-driven business model based on data structure and improve digital competitiveness.

From the accumulation of information construction and application in recent years, we have selected the pilot project of intelligent operation and maintenance construction and application, and shared some exploration experience.

Since the implementation of Dalian Public Transport Intelligent Project, an intelligent management system covering groups, branches, fleets, lines and vehicles has been initially built, and intelligent vehicle terminal equipment supporting Beidou and GPS dual-mode has been installed on nearly 4,000 bus operating vehicles. It is also equipped with 5-8 sets cameras, bus lane snapshot, LCD stop board, LED information screen, passenger flow detector, RFID electronic tag, CAN bus adapter, etc. Video surveillance, RFID reading head, departure screen, electronic stop board and so forth are installed at the bus platform, parking lots and junction stations. There are intelligent scheduling room, central machine room, video monitoring, RFID reading heads and AP points in the fleet construction; there are 10 regional intelligent dispatching centers, 1 group dispatching command center and customer service center, cloud data center, etc.



Intelligent construction architecture

With the deepening of intelligent construction and application, along with a large number of intelligent public transport management systems supported by different types and functions, the reliability requirements and guarantee role of operation and maintenance work are highlighted, and the proportion of operation and maintenance costs in information construction is gradually expanding, which means "construction accounts for 30% while operation and maintenance accounts for 70%". All kinds of equipment have the characteristics of complex professional technology, high technology content and high safety requirements, as well as the industry characteristics of real-time requirements for public transport. Many links such as equipment operation status data acquisition, equipment patrol inspection, maintenance test, spare parts, material reserve and so on must be followed up in an efficient and order way, and no link can go wrong. At the beginning of the application of intelligent construction, the paper ledger and human-driven working mode are widely used. With the continuous development of intelligent public transport construction, the previous collection of equipment operation status data and the operation and maintenance mode of information assets could not meet the needs of intelligent public transport, so improvement and reform are extremely urgent. How to realize the digital transformation of intelligent operation and maintenance and operation management, and how to use digitalization to empower enterprises, is an important issue we are facing. To this end, we have carried out the construction of integrated public transport operation and maintenance system, with the aim of exploring the digital transformation of public transport intelligent construction and operation and maintenance work

through the construction of intelligent operation and maintenance system.

We use the technologies of Internet of Things, cloud computing and big data, take "rapid response, real-time acquisition" as the purpose, realize the acquisition of equipment operation status data as the core goal, and integrate the operation status data of on-board equipment, data center equipment and station equipment into an integrated public transit operation and maintenance data acquisition and monitoring management system.

With the help of the integrated operation and maintenance system of public transport, Dalian Public Transport Group has realized the automation and convenience of fault reporting, visualization of work order tracking, standardization of service files and data, digitalization of maintenance evaluation, reduction of equipment failure rate and maintenance stay time, improvement of maintenance efficiency, reduction of maintenance cost, digitalization of data acquisition and visualization of data analysis as well as process improvement, so as to improve the reliability of equipment operation and effectively guarantee the normal operation of intelligent public transport system.



In the future, by focusing on the 5G era and the construction of intelligent public transport, based on the research and development of public transport network planning system, dynamic scheduling system and operation optimization system under the analysis of big data, Dalian Public Transport Group will establish a new technology, new format, comprehensive three-dimensional, cross-border interconnected public transport information system, urban public transport data resource bank as well as integrated cloud video storage system covering the whole process of public transport management, integrated multi-level intelligent public transport dispatching system and intelligent integrated public service platform system, so as to further improve the level of public transport informatization, and speed up the construction of intelligent public transport system that can cover the whole process of enterprises, be perceived by the public and be supervised by the whole process of the industry, providing

convenience for citizens to travel and making due contributions to the construction of smart cities.