China Academy of Engineering's Major Consulting and Research Project Strategic Research on Intelligent High-speed Rail (2035)

With a view to China's major strategic demand for the development of intelligent high-speed rail (hereinafter referred to as IHSR), the project team has established an IHSR system architecture, developed key technologies and a technology platform, built a standard system and an evaluation system, drawn a development blueprint, and proposed related policy advice for China's intelligent high-speed rail; the research outcomes are comprehensive, forward-looking, and strategically significant and the proposed three-stage development goals respectively in 2020, 2025 and 2035 will play a guiding role in the development of China's intelligent high-speed rail.

To maintain China's leading position in the field of high-speed rail, in January 2018, CAE, in view of current development trend of intelligence, decided to conduct a major consulting and research project Strategic Research on Intelligent High-speed Rail (2035). Academician He Huawu, Vice President of CAE, Academician Tian Hongqi, and Wang Tongjun, Deputy General Manager of China State Railway Group Co., Ltd., serve as the

Provided by Project Group of Strategic Research on Intelligent High-Speed Rail (2035)

project leaders. The project is led by China Academy of Railway Science Corporation Limited, jointly undertaken by Beijing Jiaotong University, Central South University, China Railway Engineering Consulting Group Co., Ltd., and conducted by the advisory group of 16 CAE academicians. After more than two years of joint research, significant achievements have been made in comprehensive design, key technologies, development strategies as well as innovative demonstration and applications of IHSR.

(1) Intelligentization has become a global development trend of railways. IHSR will emerge as a focus and difficulty in the new round of world competition in high-speed rail development.

Digitalization and intelligentization are emerging as an important development trend. The new generation of information technology has witnessed rapid development and wide application in various industries such as transportation, finance, energy, medical care, and education. Countries with advanced railways such as Germany, France, Switzerland and Japan have successively formulated their strategic plans for the development of intelligent railways.

The overall trend, demonstrated in the strategies of the countries with advanced railways, is to achieve the extensive application of information technology in various fields such as railway infrastructure, transportation equipment, dispatching and commanding, transportation services, maintenance, and the key development directions shown are mainly focused on automatic train operation, intelligent construction based on BIM, intelligent dispatching and command, and intelligent integrated transportation services.

(2) The project Strategic Research on Intelligent High-speed Rail (2035) first proposed the definition and implications of IHSR, built a complete systematic framework for China's intelligent high-speed rail, and carried out innovative application of IHSR in Beijing-Zhangjiakou high-speed railway. Moreover, its related achievements have taken the lead in the world.

IHSR involves the extensive application of cloud computing, big data, Internet of things, mobile Internet, artificial intelligence, BeiDou Navigation Satellite System, BIM and other new technologies, as well as the comprehensive and efficient utilization of resources. It aims to realize the overall perception, ubiquitous interconnection, fusion processing, active learning, and scientific decision-making of high-speed rail's mobile equipment, fixed infrastructure, and internal and external information, and create a new generation of high-speed railway system with integrated full life cycle management. The system architecture of IHSR comprises a technical system framework, a data system framework, and a standard system framework (see Figure 1). Following that, the technical system framework includes an AI service platform, three major technology sectors, ten major business areas, 17 key directions and numerous innovative applications (see Figure 2).

Under the guidance of the IHSR system architecture, on the basis of full testing and verification conducted in the early stage, the innovative applications in the fields of intelligent construction, equipment and operation have been implemented by relying on the Beijing-Zhangjiakou high-speed railway system, and the rationality and extensibility of the system architecture have been initially verified, which can be continuously optimized and perfected in the future in line with the progress of technology and changes of demands.
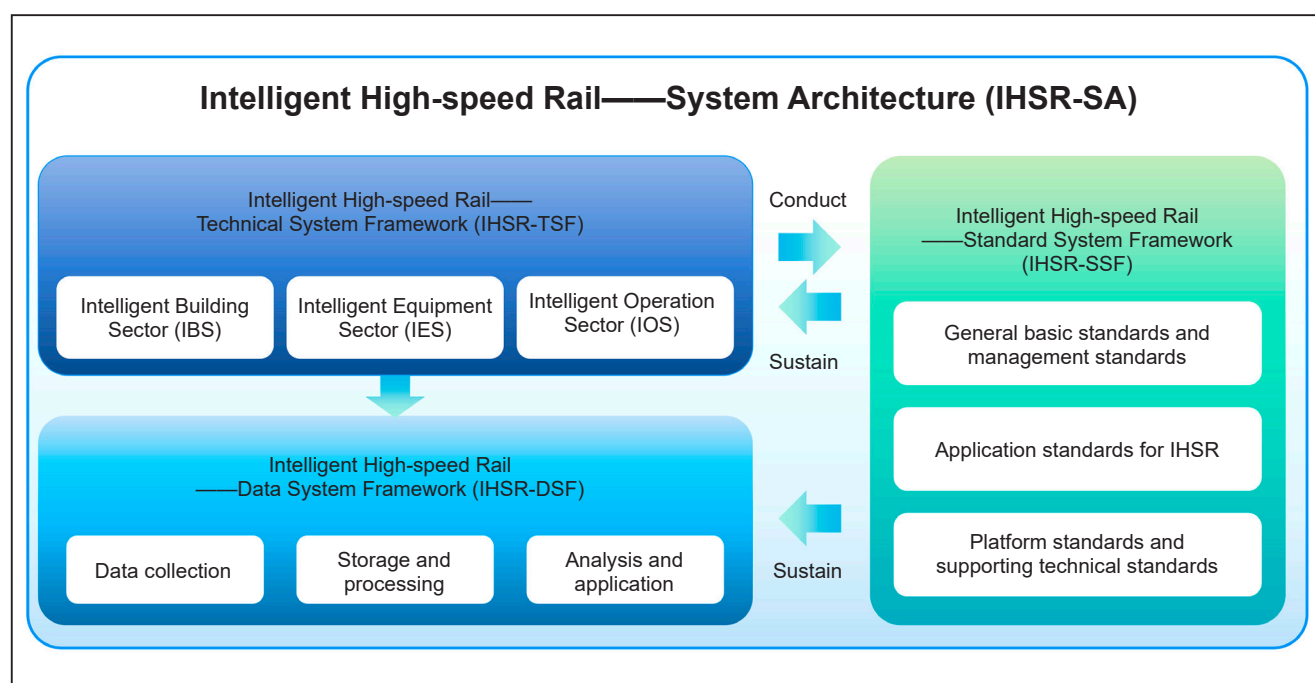

Figure 1 Intelligent High-speed Rail——System Architecture (IHSR-SA)

Figure 2 Intelligent High–speed Rail——Technical System Framework

(3) The project has put forward the three-stage development goals for China's IHSR for 2035, and formulated a reasonable and feasible implementation approach and a technological development path.

Centering on the overall goals of "IHSR being more safe and reliable, more cost-effective, more comfortable and convenient, more efficient, and more energy-saving and environment-friendly", the construction can be divided into the near-term (2018-2020), medium-term (2021-2025) and long-term (2026-2035) phases (see Figure 3), correspondingly defined as the IHSR V1.0, V2.0, V3.0.

IHSR V1.0, under the guidance of IHSR system architecture and relying on major projects such as Beijing-Zhangjiakou high-speed railway, aims to carry out intelligent and innovative applications in key areas including intelligent construction, equipment and operation, and to initially realize intelligent construction based on BIM+GIS, automatic driving of EMUs, intelligent station, cloud computing, big data and application of BeiDou satellite navigation technology.
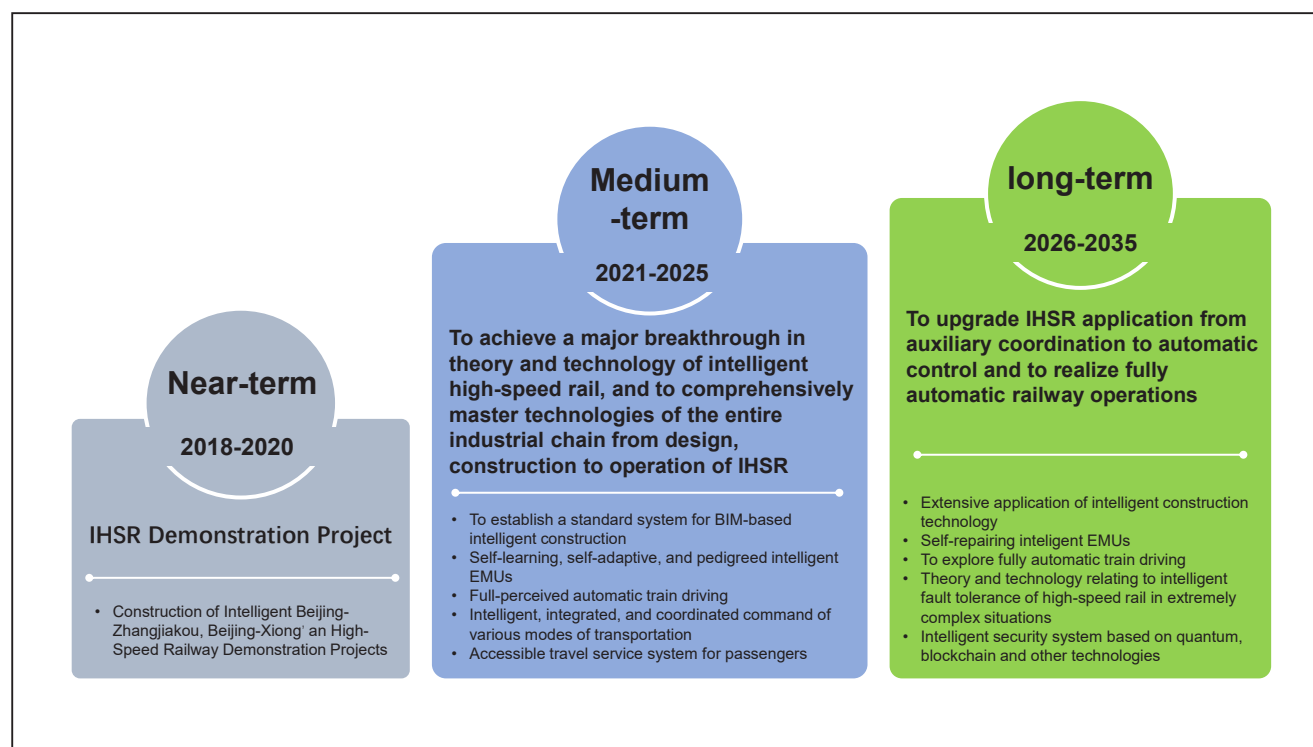

Figure 3 Three-stage development goals for IHSR

IHSR V2.0 aims to achieve further progress based on V1.0, that is, to achieve a major breakthrough in IHSR theory and technology, to form a technology system that covers the whole industry chain ranging from design, construction to operation of IHSR. According to IHSR V2.0, it is expected to establish a standard system for BIM-based intelligent construction, to build intelligent EMUs that are self-learning, self-adaptive, and pedigreed, to develop full-perceived automatic driving technology, and to deliver an accessible travel service system for passengers, which provides integrated and coordinated command of various modes of transportation.

IHSR V3.0 aims to achieve automatic control on the basis of V2.0, namely, to realize fully automatic control of railway operation. It is expected to achieve extensive application of intelligent construction technology, to develop self-repairing intelligent EMUs, to explore fully automatic driving, to make breakthroughs in theories and technologies relating to intelligent fault tolerance of high-speed railway in extremely complex situations, and to establish an intelligent security system based on new technologies such as quantum and blockchain.

With intelligent high-speed rail becoming an important development trend, China has taken the lead in research on the comprehensive design, key technologies and innovative applications of IHSR and has achieved initial results. As the IHSR construction remains a long-term process, railway workers and all sectors of society should work together to build the ecosystem of IHSR and promote the high-quality and healthy development of IHSR. China should aim at the frontier development area of IHSR, and continue to make technological breakthroughs in the fields of intelligent construction, equipment, and operation under the guidance of the overall development strategy of IHSR, thus providing important support for the implementation of national strategies such as "Building a Country with Strong Transportation Network" and "Going Global" strategy.

(Translated by Qian Jun)