

## 建设标准化的城市轨道交通云和大数据平台

李中浩

(中国城市轨道交通协会专家和学术委员会副主任,原铁道部信息技术中心主任)



鉴于全国各地城市轨道交通(以下简称“城轨”)建设起步不一且所处阶段不同,特别是对“城轨+信息化”的认识程度深浅有别以及信息化标准因地制宜,致使各城市的城轨信息化进程参差不齐,应用程度和水平高低不一。与此同时,随着云计算、大数据、物联网、人工智能及5G等新兴信息技术的飞速发展,城轨信息化、智能装备、智慧城轨的建设步伐也随之加快。为此,中国城市轨道交通协会以“交通强国,城轨担当”的使命感,研究编制了《中国城市轨道交通智慧城轨发展纲要》(以下简称《纲要》),以促进我国城轨行业信息化的健康发展。《纲要》指导和鼓励各城市按照“因地制宜、开拓创新、大胆探索、勇于实践”的原则,有序推进城轨信息化和智慧城轨建设。

那么,城轨信息化和智慧城轨是什么关系呢?从本质上讲,智慧城轨是利用新兴信息技术集成城轨各系统和集成各类服务的结晶,是城轨领域信息化建设进入新阶段的集中体现;信息化建设是智慧城轨建设的核心和基础。可见,城轨信息化和智慧城轨是相互融合的统一体,智慧城轨的顶层设计也是城轨信息化建设的顶层设计。

最近国家号召企业实现数字化转型。那么,数字化转型与智慧城轨又是什么关系呢?数字化转型有双重内涵:一是数字化,二是转型。数字在自动化和管理过程中产生,然后在大数据平台进行共享、融合、应用;数字化不仅要求数据的准确性、及时性和完整性,而且要求数据的可用性和可靠性,因为这是一切智慧应用的基础。转型则意味着,在数字化及大数据应用的条件下调整生产关系,实现组织架构转型,演变成为数字化企业。城轨行业数字化转型的本质是业务驱动,而不是数字驱动。在城轨领域,无论是业主,或是设计院、集成商、施工单位、产品供应商等各类企业,都可以用数字化转型来表述其数字化、信息化、智能化、智慧化过程,且带有普遍性。而《纲要》是对城轨行业数字化转型的精细化表述。智慧城轨和数字化转型,可以说是从不同维度表述了同一个概念。

在《纲要》中用121个字给出了智慧城轨的定义:“应用云计算、大数据、物联网、人工智能、5G、卫星通信、区块链等新兴信息技术,全面感知、深度互联和智能融合乘客、设施、设备、环境等实体信息,经自主进化,创新服务、运营、建设管理模式,构建安全、便捷、高效、绿色、经济的新一代中国式智慧型城市轨道交通。”其中,前半段是讲数字化,后半段是讲转型,所以也可以说,智慧城轨是数字化转型在城轨行业的具体应用。

在智慧城轨建设中,采纳城轨云架构,已成为智慧城轨信息化建设的共识。过去上“云”,标志了先进;今天不上“云”,意味着落后。城轨信息化建设的主要问题不是上不上“云”,而是上什么样的“云”。

在编制《纲要》的同时,还进行了中国城轨信息化规范体系的研究。城轨信息化规范体系由“1-3-5-2”4个层级组成,即1个总体规范、3个上位规范、5个关键技术规范及2个实用技术规范。其中“1-3-5”已经发布,“2”正在紧锣密鼓地编制并争取在2021年底发布。城轨信息化建设须遵循以下原则:一是必须将城轨企业的所有业务上“云”,实现数据共享,所有业务可以分别隶属安全生产、企业管理、对外服务3个域;二是信息化的基础——城轨云与大数据平台建设要与智慧城轨的应用适度分开,即新线建设时城轨云大数据平台的建设应一步到位,而智慧城轨应用(数字化转型)可成熟一个推进一个,与生产关系调整相配合,以产生实效为本。可以说智慧城轨的建设将永远在路上。在新一轮的城轨新线建设中,应该把基础打好,采用符合城轨信息化系列标准的标准化城轨云与大数据平台。

城轨的信息化具有如下特征:一是具有实时控制特性,因为它涉及行车安全,且安全性要求很高;二是具有大数据共享、综合应用需求,需采用大数据等新一代信息技术来提升交通运输的安全、便捷、绿色、高效和经济性;三是需要通过互联网和移动互联网连接乘客、员工,以及应用于乘客服务、维修、应急响应、网络化运营等场合;四是标准化的城轨云具有以私有云为基础的混合云属性以及信息化(IT)+自动化(OT)的双重特征。

城轨云及大数据平台的标准化将对智慧城轨建设的健康发展起到关键作用。标准化能够集约资源,形成强有力的产业链;能够移植应用、维护经验、取长补短、以点带面,尽快形成智慧化态势;能够顺应信息化技术发展的大趋势,形成标准及系列产品,降低造价;能够形成网络安全纵深动态防护体系,促进城轨系统信息化队伍的建设与健康发展。

新一轮的城轨新线建设中,上标准化的城轨云和大数据平台已经形成趋势。智慧城轨建设必然助推新建城轨线网2025年达到世界先进水平、2035年达到世界领先水平。

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通过实车测试,采用嵌套式减振扣件的组合减振方案的隧道壁处减振效果可达 16.9 dB(Z 振级)。

关于轮轨力及安全性指标的实车测试目前尚未进行,与仿真计算结果的符合程度尚有待验证。但本工程从试运行到通车至今,已实际运营超过 2 年,采用组合减振地段的行车平稳,未见轮轨异常磨损以及居民因环境振动而投诉。这基本可以说明,采用组合减振方案的效果良好。

20 世纪 90 年代,国内某地铁曾发生过减振扣件和弹性短轨枕两种减振措施组合使用而导致振动增加的情况,因此行业内一般认为 2 种不同形式的减振措施不宜组合在一起使用。但本工程的组合减振方案,采用的是两种不同原理和不同等级减振措施的组合,其中减振扣件主要靠扣件弹性进行减振,其固有频率一般在 31.5~40.0 Hz,主要降低高频振动;橡胶减振垫主要是靠弹性进行隔振,其固有频率一般在 14 Hz 左右,主要降低低频振动。本工程组合减振方案中 2 种措施的固有频率相差较多,相互之间可起到补偿作用,不易引起振动叠加。类似措施在香港地铁马鞍山线上已有良好的应用。本工程作为国内近些年实施的首例组合减振项目,对减振组合进行了初步的尝试,可为后续处理类似问题提供思路。

此外,本文重点对竖向动力学指标做了一些仿真计算和测试,但对横向位移、横向刚度匹配和适

应性等未进行深入探讨,后续将陆续开展这方面的对比研究。

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## Commentary

# Establish Standardized Urban Rail Transit Cloud and Big Data Platform

LI Zhonghao

(Deputy Director of China Association of Metros Expert and Academic Committee, Director of Former Ministry of Railways Information Technology Center)

In view of the differences in launching time and current stage of urban rail transit construction in cities nationwide, especially of the differences in the cognition level of "urban rail transit+informatization" and standards of informatization across regions, the informatization progress and implementation level is not universally organized across the cities. Meanwhile, with the rapid development of new information technologies such as cloud computing, big data, Internet of Things, artificial intelligence and 5G, the construction of urban rail transit informatization, intelligent equipment, smart urban rail accelerates. For this circumstance, with the responsibility of "Transportation Power Lies in Urban Rail", China Association of Metros has devised China Urban Rail Transit Smart Urban Rail Development Outline (referred to as "Outline" in the following context) for the healthy development of urban rail industry informatization in China. Outline directs and encourages every city to advance the informatization and smart urban rail systematically, following the principle of "Localization, Innovation, Exploration, Experimentation".

In this sense, what is the relationship between urban rail informatization and smart urban rail? Essentially, smart urban rail is the formation from using new information technology to integrate all systems and services in urban rail, the epitomized demonstration of how informatization construction in urban rail field is entering a new stage. Informatization construction is the core and foun-

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ation of smart urban rail construction. Conceivably, urban rail informatization and smart urban rail is a coalescent entity so much so that they share the top-level design.

In recent years, our nation has called for enterprises to enact digitalization transformation. In this regard, what is the relationship between digitalization transformation and smart urban rail? The two keywords in "digitalization transformation" has denoted the two levels of insight. Digits come into existence in the process of automation and management, and are shared, integrated and utilized on big data platform. Digitalization asks for not only accuracy, punctuality and integrity of digits, but also the applicability and reliability of data, for that is the foundation of all smart application. Transformation means to adjust relations of production under the condition of digitalization and big data application, so that organization structure transformation is realized, and the company evolves into digitalized entity. Digitalization transformation of urban rail industry is essentially business-driven, rather than numbers-driven. In this field, all types of companies, including owners, design institutes, integrators, builders, product suppliers, can use "digitalization transformation" to describe its process of digitalization, informatization, intelligentization in a communal sense. The Outline is a meticulously elaborated interpretation of urban rail industry digitalization transformation. Smart urban rail and digitalization transformation are describing the same concept from their respective dimensions.

In the Outline, 121 characters are used to define smart urban rail: "By applying new information technologies such as cloud computing, big data, Internet of Things, artificial intelligence, 5G, satellite communication, block chain, and by comprehensively perceiving, profoundly connecting, intelligently integrating physical information such as passenger, facility, equipment and environment, the independent evolution process gives rise to innovative modes of service, operation, construction and management, and new generation China smart urban rail transit that is safe, convenient, highly-efficient, green, economic is constructed." In this paragraph, the first half focuses on digitalization, while the latter half on transformation, meaning that smart urban rail is the individualized implementation of digitalization transformation in urban rail industry.

In the construction of smart urban rail, adopting urban rail cloud structure has been universally acknowledged for the informatization practice. Going on "cloud" represents advancement in the past, while not going on "cloud" nowadays marks falling behind. The major issue in urban rail informatization construction is not about whether to go on "cloud" or not, but about what "cloud" to go on.

When editing the Outline, study on China urban rail transit informatization standard system is carried out concurrently. The system consists of four levels "1-3-5-2", referring to 1 overall regulation, 3 upper-level regulations, 5 key-technology regulations, 2 implementation technology regulations. Among all, the "1-3-5" have been published, and the "2" is undergoing intensive devisal to be published by the end of 2021. The informatization construction of urban rail must respect the following principles: Firstly, all business of urban rail companies must go on "cloud" for data sharing, and all business can be categorized into three fields, safety and production, company management and foreign services. Secondly, the construction of urban rail cloud and big data platform, the foundation of informatization, should be appropriately separated from smart urban rail implementation, meaning that the construction of urban rail cloud and big data platform should be completed simultaneously with the new lines, while the implementation of smart urban rail (digitalization transformation) can be promoted step by step, accommodating the adjustment of relations of production, rooted in producing substantial results. In a certain sense, the construction of smart urban rail will always be on the journey. In the new round of constructing urban rail new lines, the foundation should be laid solidly, and standardized urban cloud and big data platform in accordance with urban rail informatization series standard should be adopted.

The informatization of urban rail demonstrates following characteristics: Firstly, real-time control, since it is involved with operation safety, which requires thoroughly high level. Secondly, demand of big data sharing and comprehensive application, new generation information technologies such as big data need to be adopted for advancing safe, convenient, green, highly-efficient and economic transportation. Thirdly, internet and mobile internet are needed to connect passengers, staff, and to be applied in scenarios such as passenger service, maintenance, emergency response, network operation. Fourthly, standardized urban rail cloud has properties of hybrid cloud based on private cloud, and dual characteristics of IT+OT.

The standardization of urban rail cloud and big data platform makes crucial contribution to the healthy development of smart urban rail construction. Standardization can intensify resources and form substantial industrial chain, as well as port application and counterbalance shortcomings, upgrade experiences and apply them to broader areas, bringing about the intelligentization trend. Standardization complies with the prevailing information technology development, lowering costs by establishing product standard and series. Standardization can uphold network safety in-depth dynamic defense system, nurturing construction and healthy growth of urban rail system informatization team.

In the new round of constructing urban rail new lines, interacting on standardized urban rail cloud and big data platform has become the practice. Smart urban rail construction will surely boost newly-built urban rail network to achieve world-advanced level by 2025, and world-leading level by 2035.

(Translated by ZHANG Liman)