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TACS自主创新引领新质生产力，赋能轨道交通高质量发展

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TACS（列车自主运行系统）是指以列车为核心，采用资源管理理念，基于车车通信，以信号系统与车辆深度融合为特征，实现列车运行方式由自动化向自主化转变的一种全新系统制式。

2024年4月26日，TACS示范工程——青岛地铁6号线开通，标志着采用以列车为核心、以资源交互为基础的新型列车控制系统已进入商用阶段。

TACS技术源自CBTC（基于通信的列车控制）系统，与CBTC系统相比，TACS更安全、更可靠。TACS基于其功能分配和技术特点，具有以下优势：可减少轨旁设备，简化控制逻辑，能有效降低轨旁设备故障率，从而提高系统整体的可靠性；由于移动授权计算等ATP（列车自动保护）功能由轨旁转移到了车载，将故障时的影响范围从单区域缩小至单列车，可有效提升系统整体的可用性；信号系统与车辆融合设计，一方面打破了信号系统与车辆两个专业间的壁垒，简化了车辆-信号接口设计，另一方面信号系统高安全等级的控制设计理念强化了列车的门控、制动、牵引等电路的安全性设计，从而能提升系统整体的安全性。

TACS基于车车通信，相较于CBTC架构下列车与列车之间不能直接进行信息交互，TACS具有列车间直接的信息交互渠道——这正是它的精髓所在。同时，TACS采用的资源管理理念，可使每列车根据各自不同的参数特征、实时运行状态、资源组织方式，在有限时间和区域内独占所需的资源、释放不需要的资源，互联互通时不限制列车必须采取统一的资源组织规则。也就是说，在资源共享的基础上，列车可采用固定闭塞、准移动闭塞、移动闭塞等各种不同规则来组织资源。因此，对于实现互联互通而言，TACS是一种更便捷、更友好的基础技术架构。而且，在TACS架构下，同一线路不同时期采购的列车性能不能差异太大的问题也能迎刃而解。

在TACS研发实践中产生了许多技术创新，对列车控制系统的发展带来了深远影响。以资源方式描述线路及相关基础设施，能提升折返效率；在线路上的任意点，可以实现列车在短至12 s内以最高安全等级启动反向运行；在隧道内、站台区域出现突发情况时，可为运营方提供更加灵活的运营组织方式，从而提高整体线路运营的可用性和安全性；信号系统与车辆融合设计，对于雨雪等恶劣环境条件造成的轨道粘着出现较大变化的情况，也能提供基于动态检测计算保证制动率进行动态调整的可能性，从而提升运营的安全性。

TACS从概念提出到系统研发和试验，从示范工程批复到如今的开通运营，历经8年时间，其成功是建立在长期以来轨道交通领域推进国产化和自主化的基础之上，不但凝聚了无数专家和技术人员的智慧和心血，更是我国轨道交通行业践行“跟跑—并跑—领跑”之自主创新道路的成功见证。

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Commentary

TACS Independent Innovation Leading New Quality Productive Forces, Empowering Rail Transit High-quality Development

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TACS (train autonomous circumambulation system) refers to a new system type that is centered on train and transforms train operation mode from automation to autonomy, with the adoption of resource management concept, the basis of train-to-train communication, and the feature of signaling system and vehicle deep integration.

On April 26th, 2024, the TACS demonstration project—Qingdao Metro Line 6 has been put into service, marking the commercialization era of this new train control system that centers on train and relies on resource interaction.

TACS technology originates from the CBTC (communications-based train control) system. Compared to CBTC, TACS offers enhanced safety and reliability. Based on its functional allocation and technical features, TACS has the following advantages: Reduction of wayside equipment and simplification of control logic, which effectively lowers the failure rate of wayside equipment, thereby improving the overall reliability of the system. The transfer of ATP (automatic train protection) functions such as mobile authorization computation from wayside to onboard reduces the impact range of failures from a whole area to a single train, significantly enhancing the overall availability of the system. The integrated design of signaling system and vehicle, on one hand, breaks down the barrier between the signaling system and vehicle, simplifying the vehicle-signal interface design. On the other hand, the high safety level control design concept of the signaling system strengthens the safety design of circuits related to train door control, braking, and traction, thereby enhancing system overall safety.

TACS, based on train-to-train communication, compared to CBTC architecture where direct information exchange between trains is not possible, possesses direct information exchange channel between trains, exactly where the essence of TACS lies. Meanwhile, TACS adopts a resource management concept that allows each train to exclusively occupy the necessary resources and release the unwanted ones within a limited time and area, based on its specific parameters, real-time operating status, and resource organization method. This interoperability does not require trains to follow a uniform resource organization rule. Consequently, on the foundation of resource sharing, trains can organize resources using various rules such as fixed block, moving-like block, and moving block. This makes TACS a more convenient and user-friendly foundational technology architecture for achieving interoperability. Moreover, the performance disparity issue among trains procured at different times on the same line can be effectively addressed under the TACS architecture.

Numerous technological innovations have emerged from the research and design practice of TACS, profoundly impacting the development of train control systems. Describing the line and related infrastructure in terms of resources can enhance turn-back efficiency. Trains can initiate reverse operation with the highest safety level in as short as 12 seconds at any point on the line. During sudden incidents in tunnels or platform areas, TACS provides more flexible operational organization modes for operators, thereby increasing the overall operational availability and safety of the line. The integrated design of signaling system and vehicle can also provide the possibility of dynamic adjustments based on dynamic detection and calculation to ensure braking rates under conditions where track adhesion significantly changes due to adverse weather such as rain and snow, thereby enhancing operational safety.

From concept proposal to systematic research, development, and testing, and from the approval of demonstration project to the current operational launch, TACS has undergone an eight-year journey. Its success is built on the longstanding efforts to promote localization and self-independence in the rail transit field. This achievement not only embodies the wisdom and dedication of countless experts and technicians but also stands as a testament to China's rail transit industry's pursuit of the 'follow-run, parallel-run, and lead-run' path of independent innovation.

(**Translated by ZHANG Liman**)