Telecom Operator's Research and Application of Digital Platform Architecture for Cloud-Network Operations

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Abstract. The digital transformation trend in telecom operators' cloud and network operations is the starting point of this paper. It then discusses the difficulties in cloud and network operations and suggests a way to create a digital cloud-network operations platform that is focused on enhancing efficiency in actual production and operational scenarios. It delves deeper into the real-world application of the technology in production settings. The study intends to enhance operators' digital transformation, increase operational efficiency, and improve user experience by offering theoretical insights and useful advice for creating effective, integrated cloud-network operations platforms.

Keywords: digital operations, knowledge graph, decision-making reasoning, cloud-network intelligence.

1 Introduction

The telecoms sector is entering a new era of cloud-network convergence due to the deep integration of new-generation information technologies, including cloud computing, big data, and artificial intelligence, with communication networks as a result of the sweeping wave of digital transformation. Meeting increasing user demands and competitive market pressures is made more difficult by the difficulties that traditional operator cloud and network operation models confront, such as the inability to foresee network problems, identify the underlying causes of network issues, and achieve autonomous cloud-network operations. In order to accomplish digital transformation and improve their core competitiveness, operators now need to develop an agile, effective, and intelligent digital cloud-network operations platform.

2 Digital Transformation Status of Operators

2.1 Digital Transformation Status of the Telecommunications Industry

The digital economy in China has advanced to a new level of excellence. It is anticipated that the value of China's core digital economy industries and digitally transformed

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sectors will surpass 50% of the country's GDP by 2025. The digital economy is speeding up the shift of traditional sectors toward digitalization and intelligence, propelled by technologies like 5G and artificial intelligence. In the age of the digital economy, utilizing digital tools to increase operational efficiency, accomplish digital transformation, and develop new, high-quality productive forces has become a crucial obstacle for state-owned businesses. Many operators view digital transformation as a strategic cornerstone for future success, and it has become an inevitable trend in the telecommunications sector [1]. The transformation of telecom enterprises primarily focuses on key areas such as the intelligent transformation of production processes, and innovation in operation and maintenance (O&M) service models [2].

2.2 Challenges in Enhancing Cloud-Network Operational Efficiency

As the construction of new information infrastructure advances, the scale of operators' backbone networks continues to expand, network resources are growing rapidly, and requirements for network reliability are constantly increasing, leading to a steady rise in the workload of cloud and network operations. Current cloud-network operations largely rely on manual processes, and existing maintenance methods, models, and personnel are struggling to meet user demands on networks [3]. The traditional approach to improving cloud-network operational efficiency faces the following key challenges: unpredictable network failures, manual network changes easily trigger failures, difficulty in identifying root causes of network issues, and challenges in achieving autonomous cloud-network operations.

3 Cloud-Network Operations Digital Platform Architecture

3.1 Functional Design

To address the challenges in enhancing cloud-network operational efficiency, this paper proposes the development of an intelligent cloud-network operations digital platform tailored for telecom operators—a core system designed for frontline operation and maintenance (O&M) production. The platform focuses on end-to-end intelligent O&M management, integrating capabilities such as fault localization, intelligent analysis, automated operations, and big data-driven insights. It establishes an integrated system covering cloud-network fault resolution, cross-domain collaboration, risk prediction, and decision support, aiming to improve O&M efficiency, reduce manual intervention, and ensure network stability. As illustrated in Figure 1, the designed platform leverages an AI-powered digital intelligence engine to enable smart cloud-network operations and empower end-to-end O&M scenarios.

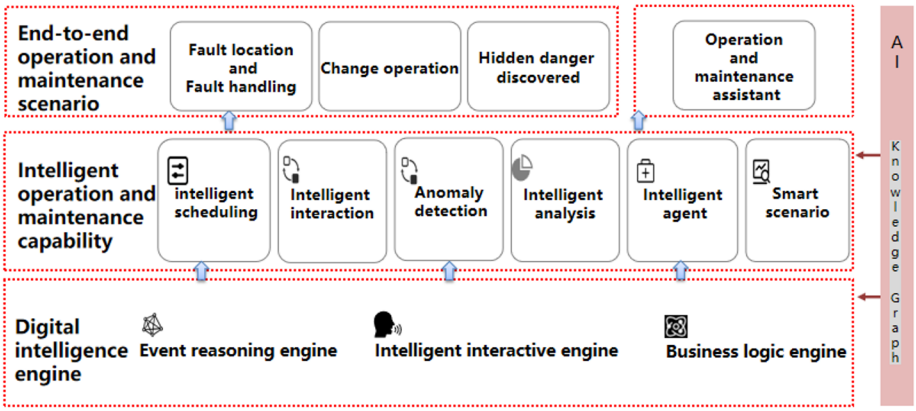

Fig. 1. Cloud-Network Operations Digital Platform Architecture

3.2 Technical Architecture Design

The digital cloud-network operation platform for telecom operators aims to achieve intelligent, automated, and efficient cloud-network operations through a multi-tiered technical architecture. The upper-level planning focuses on providing an intelligent interactive experience, efficient business process management, and robust data analysis capabilities, while leveraging AI and big data technologies for intelligent forecasting, anomaly detection, and decision support. By adopting a layered architecture, the interaction layer, application layer, service layer, technical component layer, and infrastructure layer are organically integrated to form a complete closed loop from the user interface to the underlying resources, ensuring efficient system operation and flexible scalability.

At the interaction layer, the platform constructs user-friendly front-end interfaces using technologies such as Vue, HTML5, and JavaScript. The application layer serves as the core business processing layer of the platform, integrating various intelligent and automated functions. The service layer provides foundational business logic processing and AI capability support for the platform. The PaaS and IaaS layers provide underlying technical support and data processing capabilities for the platform.

4 Application Practices of Cloud-Network Operation Digital Platforms

As operators deepen their digital transformation, the complexity and agility demands of cloud-network operations have exposed the shortcomings of traditional operation and maintenance (O&M) models—specifically, "delayed response, fragmented knowledge, and coarse-grained decision-making." The massive volume of device alerts makes it difficult to identify root causes of cross-domain faults based on O&M personnel experience alone; decentralized work order systems and isolated data silos result in wasted historical fault resolution experience; and rule-script-driven automation tools

often reveal rigidity and blind spots when facing dynamic and evolving cloud-network operational requirements. These challenges have driven practical innovations in cloud-network operation digital platforms: end-to-end fault management must break down barriers between tools and processes, enabling agile cross-domain responses through low-code orchestration; knowledge graph construction aims to transform fragmented O&M data into structured, inferable, and reusable knowledge networks, ending repetitive and reactive operations; and decision reasoning capabilities must go beyond the limitations of traditional threshold-based alerts, leveraging data-driven intelligent models to proactively predict risks, generate strategies, and reshape the initiative and precision of O&M.

End-to-End Fault Management Based on Low-Code Scenario Orchestration. In the construction of cloud-network operation digital platforms, low-code scenario orchestration serves as a key technical enabler, simplifying the design and execution of complex O&M processes to achieve agile response and efficient collaboration [4]. At its core, this approach transforms traditional code-dependent process development into a lightweight, visualization-centric design paradigm. The platform's built-in visual workflow designer allows O&M personnel to rapidly build cross-domain, multi-system automated scenarios by dragging and dropping logic nodes, configuring trigger conditions, and linking API interfaces. The value of low-code scenario orchestration lies not only in enhanced operational efficiency, but more importantly in the continuous accumulation of process data as enterprise knowledge assets, providing a data foundation for future intelligent evolution, marking a paradigm shift in cloud-network operations from "manual experience-driven" to "standardized capability reuse."

Construction of Cloud-Network Operation Knowledge Graph. In the complex environment of cloud-network operations, the efficient integration of massive alert data, heterogeneous device metrics, and fragmented O&M experience is key to addressing the challenges of ambiguous root causes and delayed fault resolution. The cloud-network operation knowledge graph [5], built on multi-source heterogeneous data, establishes a three-dimensional knowledge network spanning devices, services, and operational experience through knowledge extraction, semantic association, and dynamic reasoning, providing foundational support for intelligent operations. The design of the knowledge graph is driven by business needs and data characteristics, defining its ontology based on cloud-network fault cases and historical work orders. It leverages NLP and graph computing for knowledge extraction and integration from multi-source data, and enables precise, scenario-based O&M knowledge retrieval through semantic reasoning.

Construction of Cloud-Network Operation Decision Reasoning Capability. The core of cloud-network operation decision reasoning capability lies in transforming static knowledge into dynamic decision-making through the deep integration of data and knowledge, driving operations and maintenance to evolve from "experience-dependent" to "cognition-driven." Supported by knowledge graph and multimodal AI technologies, the platform has built an intelligent decision-making system covering root cause inference of faults, optimization recommendations for solutions, and risk prediction, achieving autonomous evolution of the "perceive-analyze-act" closed-loop. The

value of cloud-network operation decision reasoning capability lies not only in improved efficiency, but more importantly in building an intelligent O&M ecosystem characterized by "predictable risks, traceable root causes, and explainable decisions" through deep integration of knowledge and real-world scenarios, providing a technological cornerstone for operators to achieve network autonomy and business continuity.

5 Future Outlook

The intelligence and autonomy of cloud-network operation digital platforms will become a primary focus of operators' digital transformation due to the rapid advancements in artificial intelligence and the deep evolution of cloud-network integration. The operations and maintenance (O&M) system will go from "assisted decision-making" to "fully autonomous closed-loop" operations as a result of future developments in this area, which will focus on three areas: cognitive augmentation, scenario generalization, and ecosystem collaboration.

Technically speaking, paradigms for knowledge building and reasoning will change as a result of generative AI (AIGC) based on huge models [6]. The creation of knowledge graphs nowadays still mostly depends on manually created ontologies and rules. Nonetheless, automatic induction and dynamic evolution of defect information may be made possible by the cooperative training of general large models with domain-specific small models.

Scenario generalization is key to extending platform value. While current intelligent applications are primarily focused on core scenarios like fault handling and resource scheduling, future platforms must extend across the entire lifecycle—including network planning, energy efficiency optimization, and customer experience management.

Industrial win-win outcomes and practical execution depend on ecosystem collaboration. In order to enable smooth integration with third-party toolchains and vertical industry applications, cloud-network operation digital platforms must overcome the constraints of "point-level intelligence" by building open technology stacks and standardized interfaces. By working together with academic institutions and open-source communities, operators can create a shared ecosystem of "computing power, data, and algorithms," train more generalized intelligent agents, and use federated learning to aggregate cross-domain knowledge while protecting data privacy. This will help shape a new industrial paradigm where "platform as a service" and "intelligence as a capability" become a reality.

6 Conclusion

Operators' O&M systems underwent a paradigm shift with the development and deployment of the cloud-network operations digital platform, going from being "experience-driven" to "dual-driven by data and knowledge." In order to show how intelligent technologies significantly improve operational efficiency, cost optimization, and service quality, this paper methodically elaborates on the main technologies and useful results of the cloud-network digital operations platform. Knowledge graphs dismantle

semantic walls across multi-source data, low-code scenario orchestration facilitates cross-domain collaboration, and decision-reasoning engines enable operations to move from reactive to proactive forecasts. By forming a closed-loop chain of "perception–analysis–decision–execution," these three skills provide a technical foundation and reusable technique to tackle the intricate operational issues of the cloud-network convergence age.

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